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Surface Drilling



Fourth edition 2008

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The possibility to use operating pressure of up to 30 bar and Secoroc down-the-hole hammers will give you a real boost to your operation when drilling holes up to 203 mm (8") diameter. The rigs are available in short and long mast versions equipped with maximum 54 m (177 ft) of drill pipes.

Committed to your superior productivity

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President, Surface Drilling Equipment,
Atlas Copco

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Front cover:
*ROC D7 working in
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Atlas Copco, Turkey, 2008*

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Center or refer to www.surfacedrilling.com*

Foreword

Bring value into your business

Atlas Copco is dedicated to adding new productive, technology-leading products to the market. We strive to be number one in providing the lowest total cost-of-ownership for our customers. How do we do this? Read the book you have in your hands to find out.

I personally have some favourite stories in this edition. It is the stories about the SmartRig, our engagement in the working environment and the ROC Care service agreement. Why?

Well, first, the SmartRig concept has taken the world by storm since the launch in 2001. The SmartRig drastically reduces not only the cost for the operation itself, but also gives a wide range of new possibilities with increased hole quality and documentation.

Secondly, another important part of our business is to take care of the environment. We constantly strive for reducing the fuel consumption and pollution without bending the productivity. Our silenced version of the SmartRig improves the working environment since it substantially reduces the noise of the drilling operation. We have also developed the operators' environment. Last year we launched a new generation of cabins which make day-to-day business even more comfortable for our customers.

Thirdly, the life-time cost of a product in operation is closely entwined with the service of the product. We take this seriously in Atlas Copco, and continuously develop new, practical service products to support your business. One of them is the ROC Care service agreement, which many customers see as the perfect choice, combining full surveillance and systematic service performed on the rig with a low running cost.

I am proud to present the fourth edition of the Atlas Copco Surface Drilling reference book. This book was first published 6 years ago, and quickly became an important information source for people interested in surface rock extraction. We believe that the success comes from the combination of technical articles of our products with best-practice examples from all around the world. This makes it easy for you to see how our products can bring value into your business, no matter if you work in the mining or the construction sector. If this book also can stimulate interchange with the universities, then we are happy to share our knowledge with the coming generations in the business.

Now you know my favourite stories. So which are yours? Please share your thoughts with me and feel free to contact me if you have comments on this book or our equipment.

Yours sincerely



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From wagon drill to SmartRig

World leader

Atlas Copco joined the rock drill development race in 1905, and ever since has been acknowledged as the world leader in rock drilling technology. In the new millennium, this has led to sales of more than 1,500 units of the D-series drill rig, over 250 of which were radio remote control. Indeed, there are currently some 50 models of drill rig available to the quarry and construction markets.

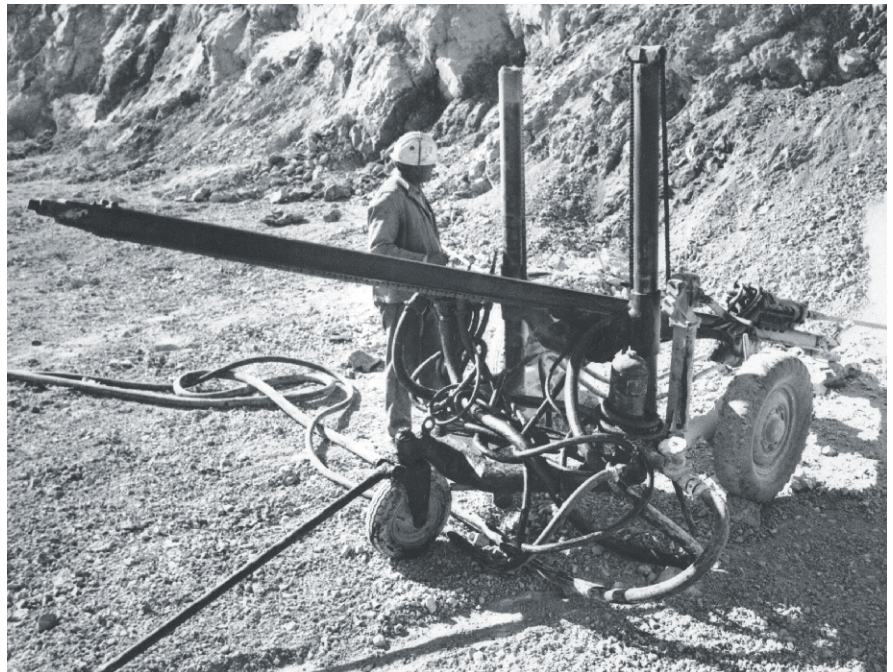
Early years

The first air-powered rock drill made by AB Atlas was a heavy, tripod mounted machine designated No 16. It was equipped with innovations such as rifle bar rotation, but was heavy and difficult to handle. Eleven were manufactured in 1905-1906, when the No 16 was superseded by light, hand-rotated rock drills such as the Cyclop and Rex, which were developed and produced over the years until well into the 1930s.

The first machine in the RH-series, the RH-70, was introduced in 1930 for drilling in hard rock. This was followed by the smaller RH-65, with double tubes for water flushing and a new rotation chuck for a 108 mm drill shank. This resulted in better guidance of the drill steel and three times longer life for the shank.

In the late 1930s, Atlas developed the pneumatic pusher leg for use with the light rock drills, at the same time experimenting with cemented carbide tipped integral drill steel.

The two were combined with the RH rock drill in 1945, when they were used on the completion of the Namforsen



In 1948 the first rubber tyred drillwagon was introduced. The BVB 23 from year 1950, see photo above, had a capacity of 80 drillmetres per shift, drilling 51 mm holes.

power plant in Sweden. The advent of the more powerful RH-656 in 1948 resulted in the Swedish Method of Rock Drilling which became the world standard underground for the next 30 years.

For surface drilling, drill wagons on rubber wheels were introduced in 1948, and the first crawler mounted rig BVB 61 appeared in 1963. The ROC 600 equipped with the powerful BBE56 rock drill followed two years later, with a capacity of 150 m/shift drilling 76 mm holes.

The introduction of button bits in the late 1960s, and their subsequent development, paralleled the improving efficiency of the rock drills, with better hole flushing and longer life.

Rapid development

Atlas Copco introduced its first hydraulic rock drill, the COP 1038, in the company's centenary year 1973, heralding the modern era of rock drilling technology. This machine offered improved penetration rates, longer drill steel life, and lower power consumption. It was produced for 10 years, during which time it was subject to continuous development. It survives today as the much-improved COP 1238. Meanwhile, the COP 4050, the company's most powerful rock drill, was launched in 1986. The best-selling COP 1838 was introduced in 1992, with an improved damping system that allowed a 50% increase in output without destroying

The first rock drill No 16 was introduced in 1905, and the first powerful version of RH came in 1948. The hydraulic era started in 1973 with the introduction of COP 1038, followed by COP 1838 in 1992 and COP 2550 in 2001.





The ROC L8 DTH crawler drill was developed for pre-splitting and large scale production work.

the drill steel. Further development resulted in the introduction of the more powerful COP 2560 and 2560 EX, the latter which incorporates a drill steel extractor unit.

Beginning from year 2000 up to this date all current rock drills have been modified to meet the demands of surface drilling applications. Bearing surface increased, large robust drivers and gearing have been implemented and the new family of rock drills named with a similar logic to their ancestors. COP 1838HE is replaced with COP 1840, COP 1238 is replaced by COP 1240 and

COP 1838LE is replaced by COP 1640. The advent of Rig Control System (RCS) in 1998 brought about a new generation of underground drill rigs with logging capabilities, better serviceability, drilling performance and positioning accuracy.

Going from Programmable Logic Controllers (PLC) to PC-based RCS has provided a more flexible and easily maintained common platform for all Atlas Copco machines, and removes some of the mystique that still persists around automation. The service department that was set up to facilitate the

The main advantages of DTH drilling are: excellent hole straightness without guiding equipment, and deep hole drilling capacity.



move from pneumatic to hydraulic rock drills still provides backup for customers to this day, supporting Atlas Copco's ongoing product development programme.

DTH drilling

Atlas Copco was early in the field with its first DTH hammer developed in 1936, which was used with good results in Swedish limestone quarries until the 1950s.

In 1969, Atlas Copco re-entered the DTH market with COP 4 and COP 6, designed for a maximum air pressure of 18 bar and with a view to dramatic increases of capacity. The high pressure design challenged the compressor manufacturers, including Atlas Copco, to introduce compressors which corresponded to the specific hammer air pressure and required air volumes.

From 1992, the COP 34-84 series of hammers was introduced, and immediately became the benchmark for productivity within DTH drilling. Over the years, the increase in the average drilling pressure to 30 bar has improved hammer performance, and productivity has increased proportionally to air pressure.

The introduction of the Atlas Copco ROC L8 and L6 series of high-performance, high-pressure DTH rigs in the late-1990s gave another boost to the market. When equipped with a COP hammer they were still the most productive 25 bar DTH drilling combination available up to 2006, when a new ROC L-range fitted with both 25 and 30 bar compressors was introduced. The COP 64 Gold, introduced by Atlas Copco Secoroc in 2001, offers sustainable efficiency, maintaining an average of 96% of original performance throughout its working life.

In 2006, a 20 m deep blasthole that took 3.5 hours to drill in 1965 using a 6.5 bar rig now takes just 15 minutes using a ROC L8 with COP 64 Gold hammer. This performance is achieved with virtually no maintenance required for the hammer over its lifetime.

The Secoroc range of DTH hammers now includes the COP 34, COP 44, and variants of COP 54, COP 64, and COP 84L for hole dimensions of 90-254 mm



Prototype of the Pit Viper PV271.

with working pressures of 6-30 bar. The DHD Classic range of low-price hammers starts at 90 mm diameter holes, and runs up to 302 mm diameter. These have been in continuous use in the quarry, construction and mining industries for more than 30 years.

Big holes

Atlas Copco now offers a complete range of big hole rotary drill rigs for open pit mining and major quarrying applications. Much of the world's mining output begins through drilling of holes with rotary drills. These were air or electric powered for many years until 1968, when Ingersoll Rand introduced the first fully hydraulic unit, the T4.

Rotary drills utilize two methods of drilling. The majority of units operate as pure rotary drills driving tricone bits in hard ground, or sometimes claw or drag bits in softer rock. The remainder use DTH drilling in which high pressure compressed air passes down the drill string to drive the hammer.

The primary difference between rotary drilling and other methods is the absence of percussion. Tricone bits rely on crushing and spalling the rock by transferring down force to the bit while rotating. This drives the carbide tips of

the tricone bit into the rock as the three cones rotate around their respective axes. Rotation is provided by a hydraulic or electric motor through a gearbox, known as the rotary head, that moves up and down the tower using a feed system. Feed systems can be cable, chain, or rack and pinion, driven by hydraulic cylinders, hydraulic motors, or electric motors. Pulldown is the force generated by the feed system, and this combines with the weight of the rotary head, drill rods and cables to provide the weight on the bit.

Rotary blasthole rigs are much heavier than DTH and top hammer rigs. The Pit Viper 351 rotary rig weighs seven times the weight of the largest ROC L8 DTH rig, yet drills a hole that is generally only twice the diameter.

The distribution of weight on a rotary rig results in an overall weight that is twice the bit load rating. Weight is necessary to provide a stable platform for the drilling operation, so, if 18,000 kg is required at the bit, a machine of 36,000 kg will be needed. However, the size of the components translates into a longer life, which will be around 30,000 hours of operation for even the smallest rotary blasthole rig.

A key element of rotary drilling is the flushing of the cuttings from the hole. In most rotary blasthole rigs the cuttings are lifted by compressed air through the annulus between drill string and hole sides. A large volume of air is required to achieve this, particularly in softer formations where the rate of drilling may be rapid. The annular space must be large enough for the cuttings to pass, otherwise heavy wear will take place between the drill string and the hole walls, which can be expensive in terms of wear and dust. Around 25 m/sec of uphole air velocity is normally required, but this varies greatly with the density of the material being drilled. Iron ore will require more bailing air than coal, for instance.

Rotary rigs are commonly applied to hole diameters above 152 mm, and the deeper the hole, the more applicable the method. DTH drilling is limited by diameter, while top hammer drilling is limited by depth. Above 250 mm diameter, rotary drilling predominates, with the larger tricone bits equipped with larger

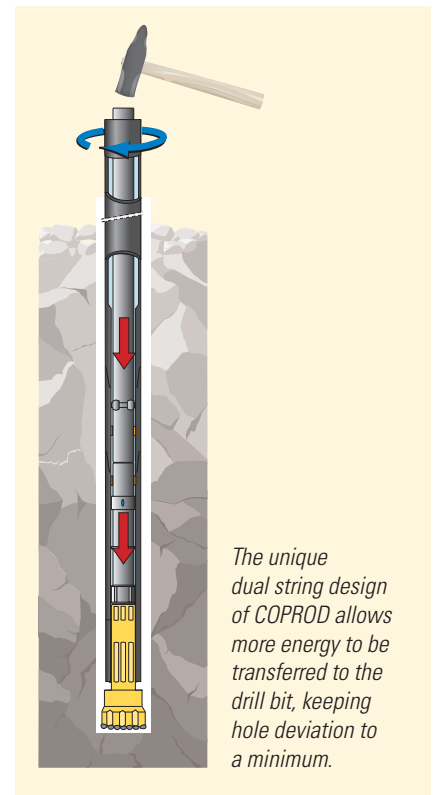
bearings able to handle higher loads for improved drilling rates. Another advantage for rotary rigs is the length of drill rods that can be carried onboard. Longer rods mean fewer connections, and, on many rigs, single pass drilling is possible using a high tower.

Second generation COPROD

The COPROD system, introduced in 1992, was hailed as a huge leap forward in blasthole drilling. Its concept is simple, but ingenious, combining the power of the top hammer with the rigidity of the DTH drill string.

COPROD rods are stacked on top of each other inside the drill tubes. They move longitudinally within each tube, transmitting the rock drill energy to the bit, while the tubes provide the rotation. Lugs on the rods prevent them from sliding out during handling and, if the bit enters a cavity during drilling operations, rotation is maintained while percussion is interrupted until the bit meets resistance again.

A new hydraulic rock drill, the COP 4050CR, was developed for the COPROD system, equipped with an anvil to transmit percussion, and a tube chuck for rotation. The COP 4050CR was



The unique dual string design of COPROD allows more energy to be transferred to the drill bit, keeping hole deviation to a minimum.



ROC D7RRC with radio remote control offers a safe and effective alternative for difficult and dangerous ground conditions.

endowed with an impact power of 40 kW and a frequency of 2,600 blows/minute. A reflexion damper provides contact between the rods, drill bit and rock, to ensure maximum efficiency and equipment life. The COPROD system offered higher speed than DTH drilling at substantially reduced fuel consumption.

A decade of experience with the original COPROD system has led to the development of a second generation launched in 2005 offering greater reliability and considerably longer life.

Accurate hole alignment has resulted in increased bit diameters being introduced by most COPROD users, resulting in greater hole spacing and more efficient blasting. Rapid bit changing is a characteristic of the COPROD system which ensures that valuable drilling time is not lost.

Advanced computerization

Atlas Copco's century of rock drill development has given rise to a range of surface drill rigs. In 2002, the SmartRig ROC D7C with computerized rig control system (RCS) was announced. This is designed to work in the 64-115 mm hole range, and can automatically adjust its impact power and feed according to the ground conditions. The result is a much smoother drilling process, maximum penetration, improved anti-jamming, and best possible drill steel life. RCS also allows a 30% decrease in the number of hydraulic components, improved efficiency of the hydraulic system, reduced risk of hydraulic fluid leakage, fewer hydraulic hoses and more than a 50% reduction in electric cable connections,

easier troubleshooting, built-in self-diagnostics, and a modular and upgradeable system. Because there are no hydraulics in the cabin, the operator has better visibility, more space, and is working in a much quieter environment.

An Atlas Copco SmartRig ROC D7C rig worked at Skanska's Fransefoss Bruk granite quarry north of Oslo. Equipped with the COP 1838HE rock drill, it worked for 10 h/day, 4 days/week over three years, and accumulated over 1,500 percussion hours.

The operator was able to measure holes and grind drill bits while the rig was drilling in an automatic mode.

In 2003, the ROC D7RRC radio remote controlled rig was launched, following extensive trials in Norway. Radio control allows it to work in difficult positions with the operator a safe distance away, but with an excellent view of both drilling and tramming.

A typical application was in Austria, where contractor Voest Alpine, Erzberg Montantechnik used their ROC D7RRC on dam construction 1,400 m above sea level. The rig set a record of 600 m of drilling in 12 hours. The flexibility of the ROC D7RRC makes it an ideal choice for such ground engineering applications.

The ROC L7CR is used extensively in hard rock mining and large quarry applications drilling holes up to 180 mm diameter. The rigs are commonly in operation for 2 or 3 shifts/day, equipped with the COP 4050 heavy rock drill with double dampening system. Rotation Pressure Controlled Feed (RPCF), anti-jamming, and Dampening Pressure Controlled Impact (DPCI) help increase nett penetration rates and rock drill and bit life, while helping the operator to control the rig in difficult geological conditions by automatically reducing impact.

The SmartRig ROC F9C is a technically advanced rig equipped with the COP 2560 rock drill, which combines the power and terrain ability of the ROC F9 with the intelligence of the computerized Rig Control System (RCS).

The first SmartRig ROC F9C was delivered to Norcem, a leading Norwegian cement producer, for use at its Bjorntvedt limestone quarry. Here it is engaged on drilling 11 m high benches

using Secoroc T51 rods with 89 mm bits. The rig will drill 45,000 m/year on a one-shift basis, where its drilling accuracy will ensure safe blasting and optimize rockbreaking costs. The quarry expects to improve its long-term planning and utilization of resources as a result.

Accurate positioning of this rig is ensured using GPS technology.

SmartRig

SmartRig is a concept that facilitates all kinds of automation in drill rigs. The hardware is designed to operate in every possible weather condition, and the software can be upgraded at site. SmartRigs have built-in logging and monitoring functions, together with support for diagnostics and faultfinding.

Computer generated electrical signals control the hydraulic valves, so the control gauges and instruments are replaced by a display unit. This releases space in the cab, increasing visibility, and improving operator ergonomics.

The RCS control system, including the anti-jamming function, will result in higher penetration rates and service life of drill string components.

Using the laser plane as a reference height, all holes are drilled to the same depth, for improved fragmentation of blasted rock and smoother benches. Hence, the costs for secondary breaking, crushing, loading and haulage are considerably reduced.

Automatic feed alignment reduces set-up time and cancels out operator error by setting the feed to pre-defined angles at the touch of a button.

The automatic rod adding system, AutoRAS, enables the operator to drill automatically to a given depth, allowing him to leave the cab to carry out other duties such as maintenance checks or grinding bits. Using Measure While Drilling, MWD, a number of parameters, such as hole depth, penetration rate, and damper, feed, percussion and rotation pressures are logged at requested intervals while drilling, and this provides input to analysis of the rock properties.

ROC Manager, a stand-alone PC-based tool, makes drill plans, measures hole deviation, and logs, presents and reports drilling data graphically. In



The HNS system on the SmartRig ROC F9C helps with positioning and performance monitoring.



The SmartRig ROC D9C can be fitted with a unique silencing kit which reduces drilling noise to about 10 dB(A) below that of comparable rigs.

ROC Manager, the MWD data can be illustrated in slices through the bench, with the rock properties identified by contrasting colours.

Hole Navigation System (HNS) using GPS has been chosen for the highest possible drill rig navigation accuracy, within 10 cm in most situations. With HNS there is no need to mark out holes manually, and the accuracy is such that all holes will be parallel. Using information on his cab display, the operator can navigate the rig to the coverage position for a given hole, and the computer will give him the information to place and align the feed exactly over the collar position. The drillplan can be provided by ROC Manager, and transferred to the rig via a PC card. The time saved by not having to aim visually to

set angles, and by being able to drill more than one hole from a single set-up, results in better rig utilization. A Norwegian contractor has retro-fitted a Hole Navigation System to a ROC D7C rig. The system uses the Anmask mapping software, available in Norway, which supplies geological data to the rig computer, making drillplans unnecessary.

The cab display screen shows exactly where each hole has to be drilled, and the software takes account of variations in the surface height of the rig. Every time the operator positions the rig for the next hole, Anmask tells him how deep to drill and at what angle.

Major benefits provided by the drilling accuracy of GPS are maximum blasting efficiency, better fragmentation,

less secondary breaking, and a flat floor after blasting. The system also allows the operator to optimize positioning, so that the maximum number of holes can be drilled from one setup.

Silenced SmartRig

The recently introduced Silenced SmartRig is for use especially in urban areas where noise levels are restricted. Substantial efforts have been put into redesigning components and soundproofing enclosures, resulting in a 10dB(A) external noise reduction. Inside the cab, this is further reduced, to just 75dB(A).

The most visible difference between the Silenced SmartRig and other SmartRigs is its patented feed enclosure. The frame and panels of the enclosure are formed from lightweight aluminium. There are four access doors, which are hydraulically operated from the cab. A rubber sliding skirt at its base encloses the hole, and this can be hydraulically raised for collaring. The whole enclosure is designed for demounting when not needed.

The SmartRig system, because it delivers the right amount of power for each phase of the drilling operation from its diesel engine, can reduce fuel consumption by up to 30%. Add this to the productivity increase from automatic rod adding and auto feed alignment, and the Silenced SmartRig is a sound investment!

In 2006, the first Silenced SmartRig, a ROC D7C, was delivered to a contractor who works in a variety of different quarries in southern Finland, some of which are very close to urban areas. The owner, who already has three ROC D7 rigs, reports that the silencing kit is so good that he can have a conversation just 15 m from the operating rig! Nevertheless, he has achieved 570 m in a 13 h shift, drilling 76 mm holes to depths of 18 m. Refuelling intervals are now much longer, and there is a notable improvement in terrain ability.

The 60 year journey from wagon drill to SmartRig is an exciting story of which everybody at Atlas Copco is justifiably proud.

Kurt Strömbäck

Principles of rock drilling

Drilling for excavation by blasting

This reference edition deals with surface rock drilling used for the purpose of excavating rock in quarries and construction projects by means of blasting. Other types of drilling, such as for oil and water, mineral exploration and exploitation, and grouting, are excluded. The reader is given a brief explanation of prevailing drilling methods, together with an introduction to blasting techniques and the interrelation of drilling and blasting. Also discussed are the main parameters involved when planning and executing blasthole drilling at quarries and civil engineering projects.

The range of Atlas Copco products, with references to the Atlas Copco websites, are presented and discussed by comparing their suitability and expected productivity related to a selection of applications. Case studies from worksites around the world should prove interesting and beneficial, especially when planning and selecting methods and equipment for blasthole drilling applications.

Blastholes have certain unique and important characteristics. These are: hole diameter, depth, direction, and straightness. Drilling produces a circular hole in the rock, the strength of which must be overcome by the drilling tool. Depending upon rock properties, there are several ways to accomplish this, as shown in the following article.

Rotary drilling

Rotary drilling can be subdivided into rotary cutting and rotary crushing.

Rotary cutting creates the hole by shear forces, breaking the rock's tensile strength. The drill bit is furnished with cutter inserts of hard metal alloys, and the energy for breaking rock is provided by rotation torque in the drill rod. This technique is limited to rock with low

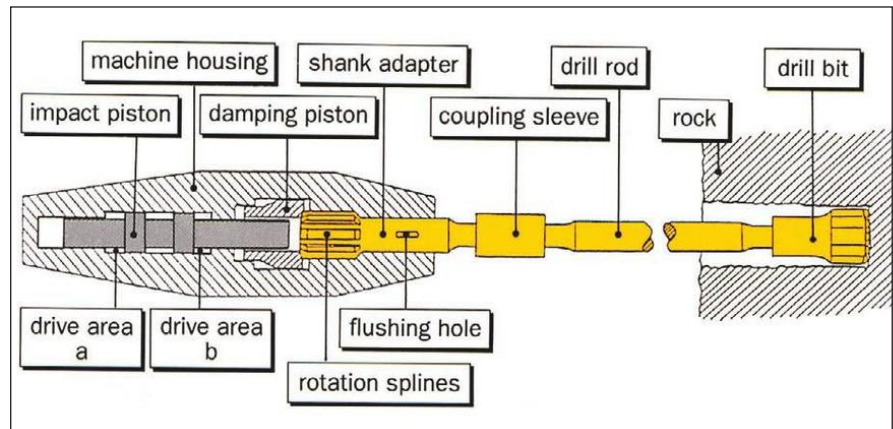


Figure 1: Principle of topammer drilling.

tensile strength, such as salt, silt, and soft limestone not containing abrasive quartz minerals.

Rotary crushing breaks the rock by high point load, accomplished by a toothed drill bit, which is pushed downwards with high force. The bit, being of tricone roller type fitted with tungsten carbide buttons, is simultaneously rotated, and drill cuttings are removed from the hole bottom by blowing compressed air through the bit.

Drill rigs used for rotary drilling are large and heavy. The downwards thrust is achieved by utilizing the weight of the drill rig itself, and the rotation, via a hydraulic or electric motor, applied at the end of the drill pipe. Common hole diameters range from 8 to 17.5 in (200-440 mm) and, because adding the heavy drill pipes is cumbersome, most blasthole drill rigs use long masts and pipes to accommodate single-pass drilling of maximum 20 m (65 ft). Electric power is usually chosen for the large rigs, whereas smaller rigs are often powered by diesel engines.

Rotation rates vary from 50 to 120 rev/min, and the weight applied to the bit varies from 0.5 t/in of bit diameter in soft rock, to as much as 4 t/in of bit diameter in hard rock.

Recent technical advances include: improved operator cab comfort; automatic control and adjustment of optimum feed force and rotation speed to

prevailing geology and bit type and diameter; and incorporation of the latest technology in electric and hydraulic drive systems.

Rotary drilling, which is still the dominant method in large open pits, has limitations in that the rigs are not suited to drilling holes off the vertical line. As blasting theories and practice have proved, it is generally beneficial to design, drill and blast the bench slopes at an angle of approximately 18 degrees off vertical.

Many rotary rig masts have pinning capabilities permitting drilling at angles as much as 30 degrees out of the vertical. However, the inclined hole drilling capabilities in rotary drilling are limited by the heavy feed force required, since part of this force is directed backwards. This causes rig stability problems, reduced penetration, and shorter life of drilling consumables. Consequently, most blast hole drilling using rotary drill rigs is for vertical holes.

Percussive drilling

Percussive drilling breaks the rock by hammering impacts transferred from the rock drill to the drill bit at the hole bottom. The energy required to break the rock is generated by a pneumatic or hydraulic rock drill. A pressure is built up, which, when released, drives the piston forwards. Figure 1 illustrates

the principle of tophammer percussive drilling. The piston strikes on the shank adapter, and the kinetic energy of the piston is converted into a stress wave travelling through the drill string to the hole bottom. In order to obtain the best drilling economy, the entire system, rock drill to drill steel to rock, must harmonize.

Stress wave

Theoretically, the stress wave has a rectangular shape, the length of which is twice that of the piston, while the height depends on the speed of the piston at the moment of impact, and on the relationship between the cross-sectional area of the piston and that of the drill steel.

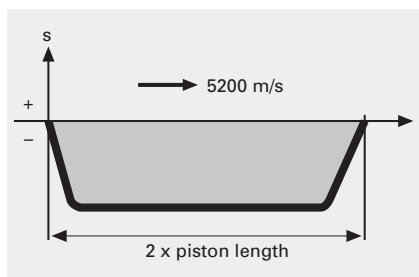


Figure 2: Stress wave energy.

The total energy that the wave contains is indicated diagrammatically in Figure 2. To calculate the output power obtained from a rock drill, the wave energy is multiplied by the impact frequency of the piston, and is usually stated in kW. Rock drill designers seek to find the best combinations of various parameters, such as the piston geometry, the impact rate and the frequency. Two rock drills having the same nominal

Figure 3: Shock wave generated by hydraulic rock drill.

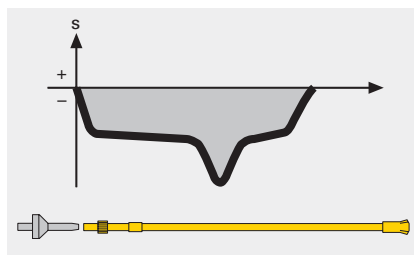
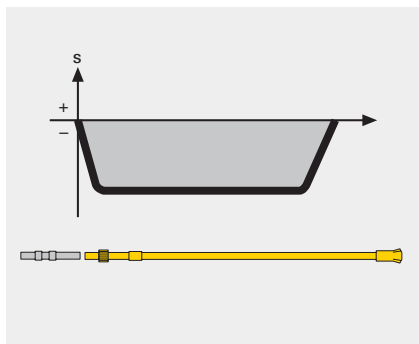


Figure 4: Shock wave generated by pneumatic rock drill.

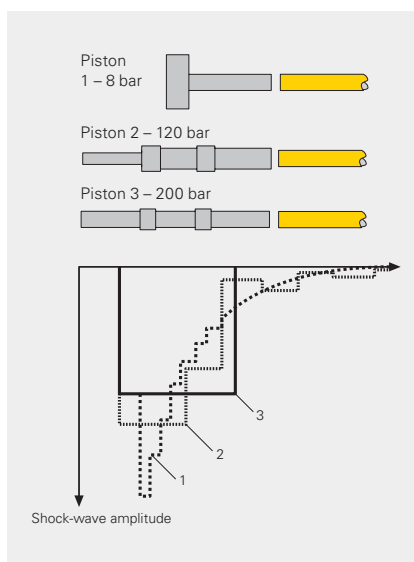
power rating might therefore have quite different properties.

The shock waves that are generated by hydraulic (Figure 3) and pneumatic (Figure 4) rock drills are significantly different in shape. Drill rods used with hydraulic rock drills will normally show substantially longer service life, compared with pneumatic rock drills, because of the higher stress level obtained with the pneumatic driven piston.

The reason is the larger cross-section needed when operating at substantially lower pressure, which is 6-8 bars, compared to the 150-250 bars used with hydraulic systems. The slimmer the piston shape, the lower the stress level.

Figure 5 compares the stress level generated by three different pistons having the same weight, but with different shapes and working different pressures. The lowest stress, or shock wave amplitude, is obtained with the long slender piston working at high pressure.

Figure 5: Stress level generated by different pistons of same weight.



Efficiency and losses

The shock wave loses some 6-10% of its energy for every additional coupling, as it travels along the drillstring. This loss is partly due to the difference in cross-sectional area between the rod and the sleeve, and partly due to imperfect contact between the rod faces. The poorer the contact, the greater the energy loss.

When the shock wave reaches the bit, it is forced against the rock, thereby crushing it. The efficiency at the bit never reaches 100%, because some of the energy is reflected as a tensile pulse. The poorer the contact between the bit and the rock, the poorer the efficiency (Figure 6).

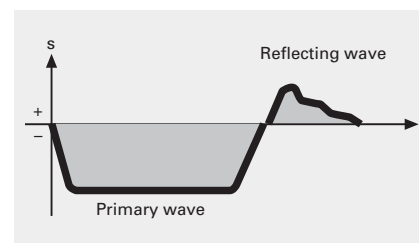


Figure 6: Poor contact between bit and rock results in poor efficiency.

To optimize drilling economy, the drilling parameters for percussion pressure, feed force, and rotation must harmonize.

Percussion pressure

The higher the percussion pressure, the higher will be the speed of the piston, and consequently, the energy. Where the bit is in good contact with hard and competent rock, the shock wave energy can be utilized to its maximum. Conversely, when the bit has poor contact, the energy cannot leave the drill string, and reverses up the drill string as a tensile wave.

It is only when drilling in sufficiently hard rock that the maximum energy per blow can be utilized. In soft rock, to reduce the reflected energy, the percussion pressure, and thus the energy, will have to be lowered (Figure 7).

For any given percussion pressure, the amplitude, and hence the stress in the drill steel, will be higher with reduced cross-section of the drill rods. To get the

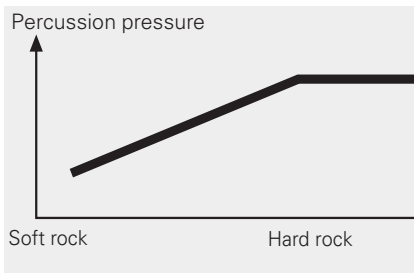


Figure 7: To reduce reflected energy, percussion pressure is lowered.

longest possible service life from shank adapters and rods, it is important to ensure that the working pressure is matched to the drill string at all times.

Feed force

The purpose of the feed is to maintain the drill bit in close contact against the rock. However, the bit must still be able to rotate. The feed force must always be matched to the percussion pressure. Figure 8 illustrates this relationship.

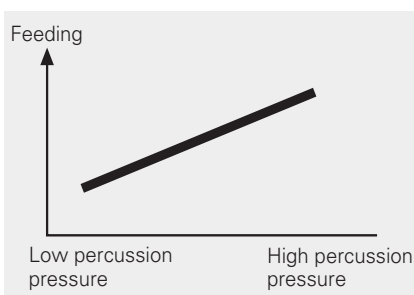
Rotation

The purpose of rotation is to turn the drill bit to a suitable new position for the next blow. Using button bits, the periphery is turned about 10 mm between blows. Consequently, the rotation rate is increased using higher impact frequency and reduced bit diameter. Using insert bits, the recommended rotation rate is 25% higher.

Setting parameters

In practice, the driller sets the percussion pressure that the rock can cope with, and then sets the rev/min with regard to the percussive frequency and the bit diameter.

Figure 8: Feed force must be matched to percussion pressure.



Drilling method	Hydraulic Tophammer	DTH	COPROD
hole diameter, mm	76-140	90-203	105-180
penetration rate	2	2	3
hole straightness	1	3	3
hole depth	1	3	1
production capacity (tons rock/shift)	2	3	3
fuel consumption/drill metre	2	1	2
service life of drill string	1	2	3
investment in drill string	2	2	1
suitability for good drilling conditions	3	3	3
suitability for difficult drilling conditions	1	3	3
simplicity for operator	2	3	1
adjustability of flushing capacity	1	2	3

Figure 9: Comparison for 20 m bench drilling in a limestone quarry. Ratings: fair = 1, good = 2, very good = 3.

When drilling starts, the feed is adjusted to get even and smooth rotation. In case this is not achieved, which will show up in low shank adapter life, the percussion pressure can be progressively reduced, until even and smooth rotation is reached.

The temperature of the adapter sleeve can be checked to ensure that the drilling parameters are correctly set. Immediately after drilling, the temperature should be 60-70 degrees for dry drilling, and approximately 40 degrees for wet drilling.

Drilling problems, mainly related to loose couplings, may arise whatever parameters are used. In order to tighten the couplings during drilling, the friction of the bit against the hole bottom has to be increased. This can be done by increasing the feed, increasing the rotation rate, or changing the bit.

Flushing

Drill cuttings are removed from the hole bottom to the surface by air blowing or water flushing. As the power output from rock drills increases, accompanied by increased penetration rate, efficient flushing becomes gradually more important. The flushing medium is normally air for surface drilling, and water for underground drilling. The required flushing speed will depend on:

specific gravity— material having a density of 2 t/cu m requires at least 10 m/sec, whereas iron ore, for example, having a density of 4 t/cu m, requires an air speed of 25-30 m/sec;

particle size – the larger the particles, the higher flushing speed required;

particle shape – spherical particles require more speed than flaky, leaf shaped particles.

Productivity and methodology

During the past century there has been a rapid and impressive increase in efficiency and productivity related to top-hammer drilling. Starting from hitting a steel manually by a sledge hammer 100 years ago, today's hydraulically powered rock drills utilize the latest state-of-the-art technology.

Every drilling method has its pros and cons, making an objective comparison quite cumbersome. In view of this, the table in Figure 9 can serve as a guideline when comparing the various percussion drilling alternatives which Atlas Copco can offer. The choice of best drilling method to apply depends on hole size and type of application.

Hans Fernberg

Jahan Compressor



Principles of rock blasting

Combination of factors

Blasting by design results from a large number of factors, all of which need to be brought under control in order to achieve the right result. These include the choice of drill rig and tools, the layout of the holes, the explosive, and the skill of the operators. Geology is the governing factor, and experience is a major ingredient. Atlas Copco produces drill rigs and systems to suit all rock types, and has the experience to recommend the correct approach to all ground conditions in order to achieve the optimum result. The following outline of the principles involved in rock blasting is a logical start point in the quest for the perfect round.

Blasting

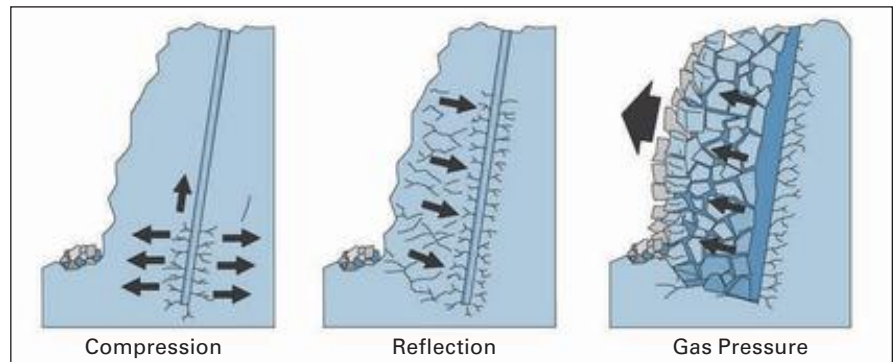
To understand the principles of rock blasting, it is necessary to start with the rock fragmentation process that follows the detonation of the explosives in a drill hole.

The explosion is a very rapid combustion, in which the energy contained in the explosives is released in the form of heat and gas pressure. The transformation acts on the rock in three consecutive stages (figures 1-3).

Compression: a pressure wave propagates through the rock at a velocity of 2,500-6,000 m/sec, depending on rock type and type of explosives. This pressure wave creates microfractures which promote rock fracturing.

Reflection: during the next stage, the pressure wave bounces back from the free surface, which is normally the bench wall or natural fissures in the rock. The compression wave is now transformed into tension and shear waves, increasing the fracturing process.

Gas Pressure: large volumes of gas are released, entering and expanding the cracks under high pressure. Where the distance between the blast hole and



Figures 1-3: Rock breaking sequence in a normal blast.

the free face has been correctly calculated, the rock mass will yield and be thrown forward.

Benching

Bench blasting is normally carried out by blasting a large number of parallel holes in each round. Considering the blasting mechanics, with a compression-reflection-gas pressure stage in consecutive order for each charge, it is of vital importance to have a proper delay between each row, and even between individual holes in each row. A proper delay will reduce rock throw, improve fragmentation, and limit ground vibrations. The blast should be planned so that the rock from the first row of holes has moved about one third of the burden, when the next row is blasted (figures 4 and 5).

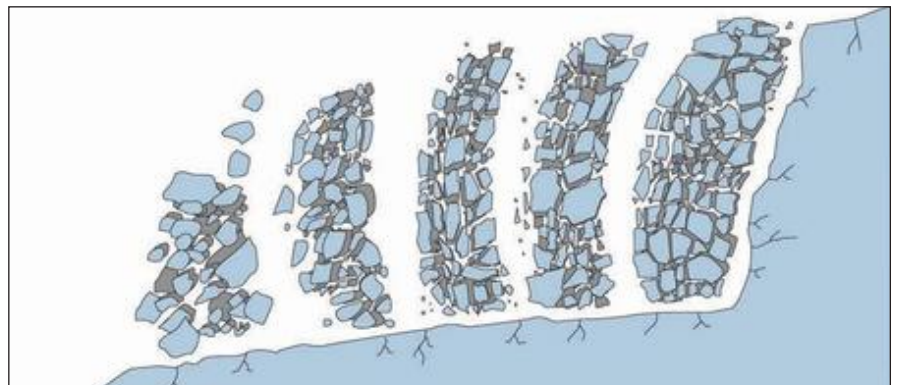
The horizontal distance between the hole and the free face is the burden, and

the parallel distance between holes in a row is the spacing. The ratio between spacing and burden will have great impact on the blasting result, and 1.25 can be considered as an average ratio. The optimum burden depends upon a number of parameters, such as rock type, required fragmentation, type of explosives, hole deviation, and hole inclination. Nevertheless, as large drill holes can accommodate more explosives, there is a distinct relationship between burden and hole diameter (figure 6).

As the bottom part of the blast is the constricted and critical part for successful blasting, it is used as a basis for deciding all other parameters. The bottom charge, normally 1.5 x burden, from where the initiation should start, requires well-packed explosives of higher blasting power than is needed in the column charge (figure 7).

Stemming of the top part of the hole is used to ensure that the energy of the

Figure 4: Delay detonation of a typical bench blast.



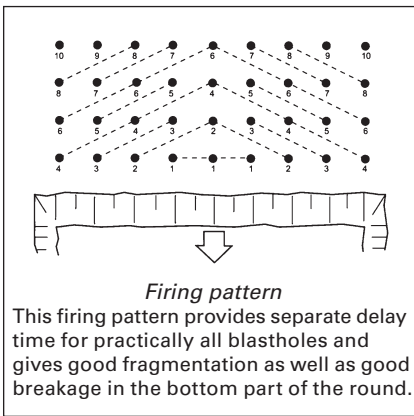


Figure 5: Firing sequence in delay blasting.

explosives is properly utilized. It will also reduce and control the fly rock ejected from the blast. This tends to travel long distances, and is the main cause of on-site fatalities and damage to equipment. Dry sand or gravel having a particle size of 4 to 9 mm constitutes the ideal stemming material.

Inclined holes give less back break, safer benches and less boulders, when compared to vertical holes.

Types of explosives

The geology frequently has more effect on the fragmentation than does the explosive used in the blast. The properties that influence the result of the blast are compressive strength, tensile strength, density, propagation velocity, hardness and structure. In general, rock has a tensile strength which is 8 to 10 times lower than the compressive strength. The tensile strength has to be exceeded during the blast, otherwise the rock will

base	type	detonation velocity m/s	features
nitro-glycerine	dynamite gelatin	5,500-4,500	highly adaptable cartridge excellent in smaller holes
ammonium-nitrate	ANFO	2,500	low cost, high safety, easy to pour or blow no water resistance, contains 5-6% fuel oil
water	slurry	4,000-3,000 watergel 5,000 emulsion range depends on storage time	basically ANFO made water resistant gel stable oil/water emulsion – heavy ANFO packaged or pumpable

Table 1: Features of common types of explosives.

not break. High rock density requires more explosives to achieve the displacement.

The propagation velocity varies with different kinds of rock, and is reduced by cracks and fault zones. Hard, homogeneous rocks, with high propagation velocity, are best fragmented by an explosive having high velocity of detonation (VOD).

An extensive range of different types and grades of explosives is available to suit various blasting applications. A breakdown is presented in table 1.

In dry conditions, ANFO has become the most used blasting agent, due to its availability and economy.

The blast hole diameter, together with the type of explosive used, will determine burden and hole depth. Practical hole diameters for bench drilling range from 30 to 400 mm. Generally, the cost of large diameter drilling and blasting

is cheaper per cubic metre than using small holes. However, rock fragmentation is better controlled by higher specific drilling.

The explosives are initiated with detonators which can be electric, electronic or non-electric. Electric systems have the advantage that the complete circuit can easily be checked with an ohmmeter to ensure that all connections and detonators are correct before blasting.

Despite higher unit price, the usage of electronic detonators is growing. As the detonation intervals are extremely accurate without any time deviation, fragmentation of blasting material can be improved. To eliminate the risk for spontaneous ignition from lightning, non-electric systems, including detonating cord, are used.

Hans Fernberg

Figure 6: Burden as a function of drill hole diameter.

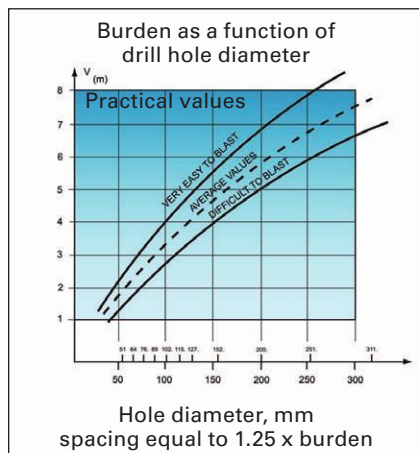
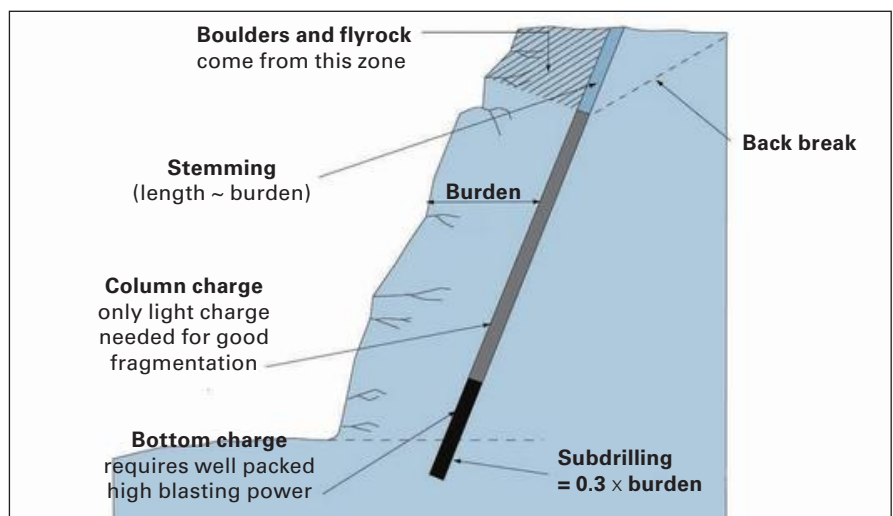


Figure 7: Charging for optimum fragmentation.



Drilling straight holes

Precision drilling

For the best overall blasting result, the drill hole needs to follow its designed path along its entire length.

Straight holes are important, so deviation should be avoided as far as possible, with each hole collared in the exact spot, and drilled in the correct direction and to the proper depth.

Precision in collaring and hole alignment can be achieved with proper surveying and mark-ups of the drill pattern grid, coupled with a drill angle indicator mounted on the feed, and a hole depth instrument. It is also essential to have a good view of the collaring procedure from the operator's cabin.

Hole deviation leads to substandard blasting results and higher overall costs. Better setup and selection of drilling method and equipment will help minimize deviation, improving the whole rock breaking operation.

Consequences of deviation

Tophammer drilling is the normal choice for civil engineering applications. However, more choices are available for quarries, where 51-165 mm-diameter holes are commonly drilled from benches up to 30 m-deep. Figure 1 illustrates various causes of hole deviation.

The main consequences of hole deviation are: uncontrolled fragmentation of blasted material; possible misfires due to intersecting holes firing at undesirable intervals; excessive burden and spacing between adjacent blastholes; secondary breaking, leading to higher costs for loading, haulage and crushing; and uneven bench floors, resulting in higher equipment maintenance costs.

Deviation can result from faulty setup, alignment and collaring, all of which can be remedied.

First, to secure a correct hole inclination before drilling, it is crucial that the rock drill and drill string be lined up parallel with the feed beam. Sliding components on the feed beam, such as

the rock drill cradle, intermediate drill support, and drill steel guide bushings, must be frequently checked, and any free play adjusted to a minimum. Worn drill rod guide bushings should be exchanged on a regular basis.

Second, double drill steel support ensures a stiff drill string alignment close to the collaring surface. Atlas Copco equips its modern ROC range of crawler drills with double drill steel support for improved visibility and rod guidance. The ROC D-series are furnished with an intermediate drill steel support on the feed.

With the lower support raised, the rock surface can be checked before the collaring sequence, and a check of drill string after initial penetration of the rock can easily be performed.

Third, instruments for inclined hole and hole-length measurements can also be combined with a laser sensor in conjunction with a laser plane, enabling drill holes to be drilled exactly to designed depth. This ensures an even bench floor, independent of rock irregularities where the holes are being drilled.

Fourth, restricted percussion, feed and flushing during collaring can ensure that the most critical part of the hole does not get off-line.

Finally, hole straightness is also a function of the stiffness of the drill string, especially when using tophammer drilling.

In-hole deviation

The magnitude of in-hole deviation is exponential to the hole depth, and it is often claimed that the deviation is proportional to the depth to the power of two.

Geological conditions are a major cause of in-hole deviation during drilling. Figure 2 illustrates the influence of bedding and foliation. The drillhole tends to deviate to a direction perpendicular to the jointing, and the more structured, foliated and faulted the rock, the greater will be the deviation. Conversely, drilling through homogeneous rock, such as isotropic granite with spa-

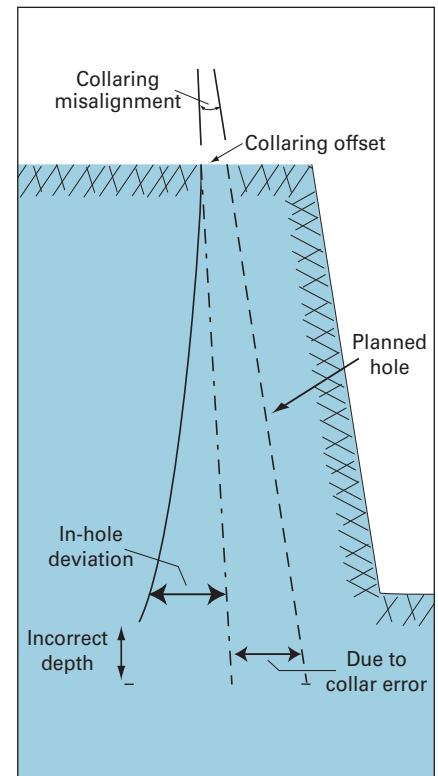


Figure 1: Various causes of hole deviation.

se jointing, does not produce in-hole deviation.

Experience shows that the approach angle of the drill bit towards the bedding is crucial. There seems to be a tendency for the bit to follow parallel to the bedding where the angle of approach is smaller than 15 degrees. Figure 2 also shows how the drill string is affected by the direction of the rock bedding, resulting in substantial hole deviation.

There are various ways and means to reduce this problem.

A stiff drill string, and small clearance between the hole and the drill string components, gives straighter holes. For tophammer drilling, Atlas Copco provides TAC tubes to be added behind the bit. The usage of TAC tubes will improve the flushing and reduce the risk of getting stuck.

A combination of reduced feed force and bit load with increased rotation speed gives less deviation.

DTH drilling, COPROD drilling, and rotary drilling all give less deviation than

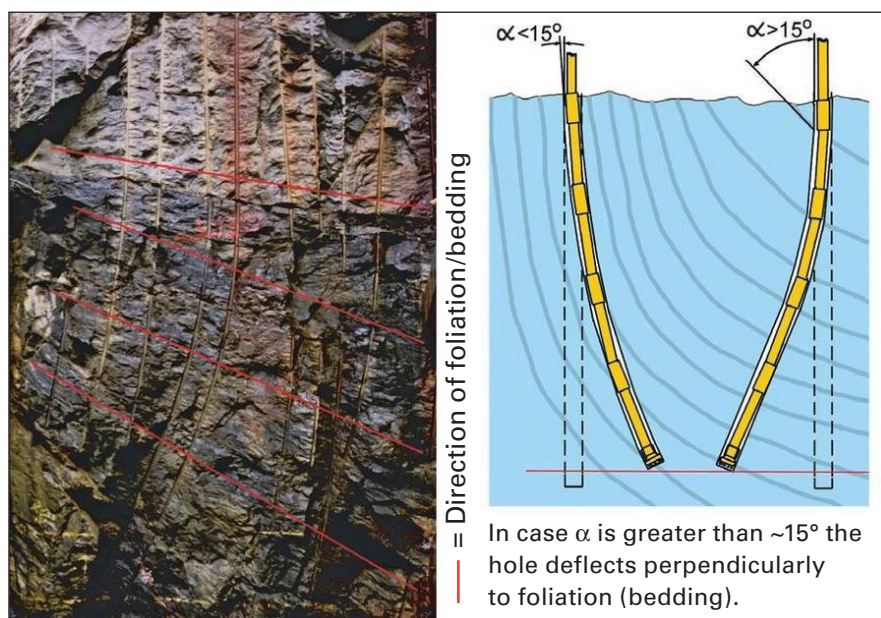


Figure 2: How deviation results from rock bedding at different angles.

tophammer drilling. Less hole depth, and consequently low benches, gives better control of deviation. As in-hole deviation is a three-dimensional problem, the burden as well as the toe spacing of adjacent holes can become excessively off-line.

Bits and rods

Although the influence of geology can never be completely eliminated, certain measures can be taken to ensure acceptable blasting results. One such measure is to employ a stiff bottom pack behind and including the drill bit, where the play between hole diameter and the following part of the drill string is as

small as practicable. Drill bit and rod selection play a key role. Crossbits, for example, generally result in straighter holes compared to button bits. However, they have lower penetration coupled with more frequent grinding intervals, leading to higher costs.

Ballistic button bits that are reground on a regular basis will, in most cases, result in straighter holes than spherical button bits. Dull, worn out buttons result in lower penetration and increased hole deviation. A concave bit front also results in straighter holes than a flat front, which, when subjected to abrasive rock and several regrinds, gradually gets more convex. A drop centre type of bit is therefore commonly used.

Figure 4: Straight holes result in improved rock fragmentation and lower overall cost.

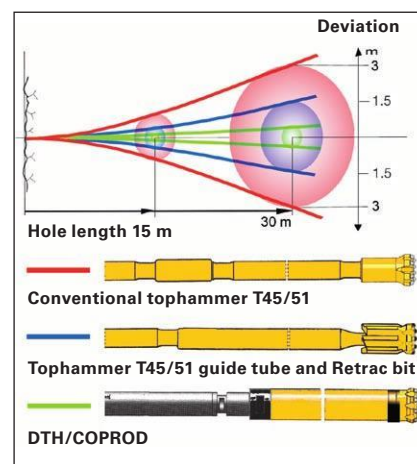
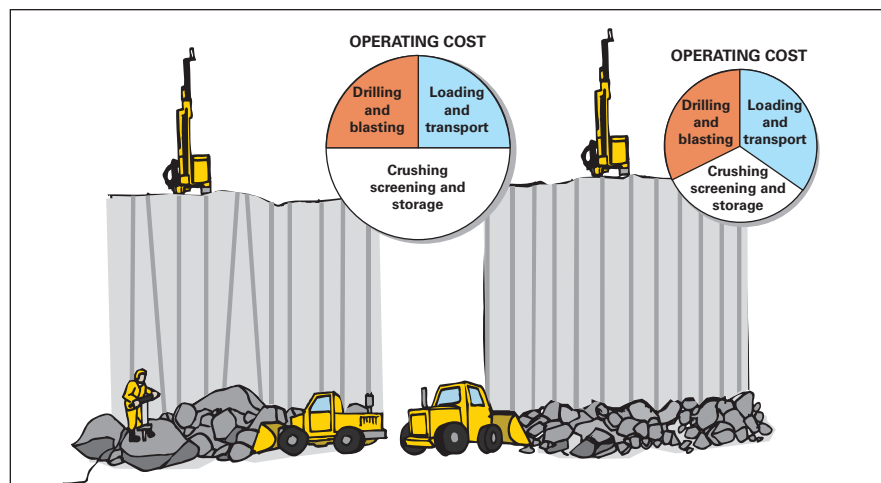


Figure 3: How different types of drilling equipment influence hole straightness.

Retrac bits are another alternative. These self-guiding bits act as a short guide rod directly behind the bit front to reduce deviation. By installing a guide rod or tube behind a retrac bit, more than half of the in-hole deviation can be eliminated, compared to a conventional tophammer drill string.

Total costs

DTH drilling with large diameter drill tubes, and COPROD with a combination of drill rods and large diameter drill tubes, will produce straighter holes than any type of tophammer drill string due to stiffer string and better hole guidance through the rock (figure 3). At comparable hole dimensions, however, tophammer with a conventional drill string drills faster than DTH, but not as fast as tophammer drilling with COPROD system.

Many contractors and site owners focus on minimizing drilling costs without taking into account the overall effects on blasting results.

However, when fragmentation and total handling and crushing costs are taken into account, it can be shown it is best to purchase drilling equipment that produces the least deviation, especially when hole depths exceed 10 m (figure 4).

The latest drill rigs from Atlas Copco, incorporating SmartRig technology, form an exceptional platform from which to drill straight holes.

Hans Fernberg

Correct selection of tophammer rock drilling tools

Optimizing penetration rates

In order to achieve best possible penetration rate, a bit should be chosen where the total contact area between the cemented carbide and the rock creates the best possible penetration per blow. As a rule of thumb, the following penetration rate index can be used: button bit with ballistic buttons, 130; button bit with spherical buttons, 115; insert bit, 100. However, when bits are compared for hole straightness, a different order emerges, with the insert bit on top, followed by the button bit with ballistic buttons, and lastly, the button bit with spherical buttons.

This article is intended to guide the driller through the range of bits, rods and shank adapters to assist with the best choice of rock tools for the particular job.

Criteria of choice

Since button bits are used for 99% of surface drilling applications, a bit with guiding wings on the bit skirt, the Retractable-type bit, should be chosen to give the straightest possible hole.

The bit front should not be allowed to take on a convex shape during service life, since this convex front has been shown to give more deflection than a flat or drop centre front.

When a button bit is worn, it is the gauge buttons that always show the most wear. This means that the gauge buttons lose more height during regrinding, leading to the tendency for the bit front to become convex. A drop centre bit, thanks to its lowered centre, will not become convex during the bit life, and is thus the best choice, wherever possible.

If the above criteria are taken into account, the choice of bit, in descending order, should be: Retractable button bit with ballistic buttons and drop centre front;

Retractable button bit with spherical button and drop centre front; Retractable button bit with spherical buttons and flat front; Insert bit, only used when very straight holes are required and nothing else works.

Bit designs

Flat front, standard



The standard bit is most suitable for medium-hard to hard rock, where it gives good performance and long service life in normal conditions. Standard bits are easy to regrind, as the front and gauge buttons usually are the same size.

Flat front, heavy duty



Hard rock, containing quartz and pyrites, often causes considerable wear to the gauge buttons. When drilling in rock with this characteristic, it is common practice to use Heavy Duty bits,

Model -20 or -21, where the gauge buttons are larger than the front buttons.

Extra heavy duty



Model -21 has better flushing characteristics, due to different clearance angle and shorter head.

Recommended in extremely hard and abrasive rock.

Drop centre



Excellent results are obtained with the Drop Centre bit in soft to medium hard rock, with high penetration potential. The Drop Centre bit has outstanding flushing characteristics, and the cuttings are distributed evenly around the steel body,

so minimizing steel wash. The drop centre part of the bit front produces a rock elevation or bump during drilling, which gives good guidance to the bit.

Bit designs and rock types

SOFT	MEDIUM	HARD
Full Ballistic		
DC Ballistic		
DC		
	DC XHD Ballistic	
	DC XHD	
	FF Standard	
	FF HD	
	FF XHD Ballistic	
	FF XHD	

DC = Drop Centre; FF = Flat Front; HD = Heavy Duty; XHD = Extra Heavy Duty.



Drop centre extra heavy duty

Gauge buttons are larger than the front buttons, there are no side flushing holes, and the head is shorter. Recommended in extremely hard and abrasive rock, but can also be used in medium hard rock.



Retrac bit

The Retrac bit has cutting edges at the rear of the bit, allowing it to “drill” in reverse. This is an important feature when drilling in loose, broken or fissured rock, where it can be difficult to retract the drill string due to hole collapse. In addition, the Retrac bit has deep grooves milled along the bit body for efficient cutting removal. The good guidance of this bit gives straighter holes.



Insert bits

These are very seldom used, except when very straight holes are required. Cross bits normally have cemented carbide inserts with a carbide grade for high wear resistance. X-bits normally have a carbide grade for improved toughness,

and are preferred where there is a tendency for squaring of the hole.

Drill rod selection

For bench drilling, three types of drill rods can be chosen: surface hardened rods, in which only the thread parts are hardened; carburized rods, where all surfaces, including the inside of the flushing hole, are hardened; and carburized Speedrods, having integrated couplings with male and female threads at opposite ends.

Surface hardened rods

Surface hardened rods are the toughest, and can take more abuse than the carburized rods, but they have the lowest fatigue strength. They are a good choice when drilling in faulted or folded formations, when driller abuse, or lack of care and maintenance, are factors.

Tiger Rods

The new M-F Tiger Rods from Atlas Copco Secoroc are specially developed for surface drilling applications. They are composed of selected steels to give increased service life and better performance. The female thread is fully carburized, while the rest of the rod is surface hardened. The new Tiger Rods are friction-welded, so that the best steel grade can be selected for each section.

This improved production technology reduces the risks of pitting on the threads, and rod and thread end breakage, while tighter thread tolerance improves the total service life of the whole drill string.

Carburized Rods

A carburized rod has better wear resistance and a higher fatigue life compared to surface hardened rods. Demands good treatment, and hole deflection should be limited by putting guiding equipment in the string, at least when drilling holes deeper than 10 m. Their life will be 20%-30% longer if they are handled correctly, and guiding equipment is used when necessary. When lighter drill rods are required for manual rod handling, the carburized hexagonal rod is recommended.

When drilling with a number of rods in a string, using standard rods and couplings, the loss of energy in every joint

is about 6%, if the connection is tight. If drilling with open threads, the energy loss at each joint can easily climb to 10%. Therefore, it is advantageous to use the maximum rod length possible.

Speedrods

If Speedrod carburized rods with integrated coupling are used, the energy loss per joint is less, since the mass (weight) of the joint is less than that of standard coupling joints. The energy loss is about 3.5%, which is 60% of that of standard joints.

In practice, the energy advantage of Speedrod joints compared to standard couplings is even greater, since it is easier to keep the Speedrod joint tight during drilling.

Field tests have shown that, when drilling 20 m holes with 4 m rods, the penetration increase is about 15% when using Speedrods.

The faster penetration and easier handling increase productivity, and due to better energy transmission, the joints are easily loosened.

From the point of view of drilling straight holes, rods that are as rigid as possible for the drilled hole diameter are best. For straight hole drilling, a guide rod or guide tube should be used as the first rod after the bit, to give the drill string guidance.

Further information about rods is available in the yellow technical specification pages in this reference edition.

Shank adapters

The task of the shank adapter is to transmit rotation torque, feed force, impact energy, and flushing medium. It is made from specially selected material to withstand the transmission of impact energy and rotation from the rock drill to the drill string, and is hardened through carburizing. Around 400 different shank adapters are currently available from Atlas Copco Secoroc. Shank adapters can be divided into three main types, based on the technique used to transfer the rotation motor torque to the drill rod.

Sture Stenquist

Full-ballistic button bits for soft rock

Atlas Copco Secoroc has extended the range of button bits for surface drilling with two new models for drilling in soft rock formations.

The new models are designated –21–66 and –47–66. The designation –66 means that all the buttons are full-ballistic in shape and protrude 20–25% more than standard ballistic buttons. Model –21 has larger gauge buttons whereas all the buttons are the same size on model –47.

The longer button protrusion helps the bit to penetrate deeper into the rock with each hammer stroke. Both model –21 and model –47 have excellent flushing capacity for the removal of the cuttings from the front of the bit head. The flushing is concentrated to four large flushing holes in the bit front plus equally deep and wide flushing grooves in the front and



Secoroc full-ballistic button bit (dia. 127 mm) model –47–66. Flat front with same size front and gauge buttons.

sides of the bit head. A shorter bit head and larger clearing angle also allow for better flushing of cuttings on models –21 and –47.

Increased penetration rate

During tests in soft rock in Korea, Malaysia and Australia, these new bits showed much higher penetration rates than standard ballistic button bits, while their service life remained the same.

Model –21–66 bits with drop centre front are available with T38 thread in sizes 76 mm (3 in) and 89 mm (3.5 in).

Model –47–66 bits with flat front design can be supplied with T45 thread in size 89 mm (3.5 in) and with T51 thread in sizes 102 mm (4 in) and 127 mm (5 in).

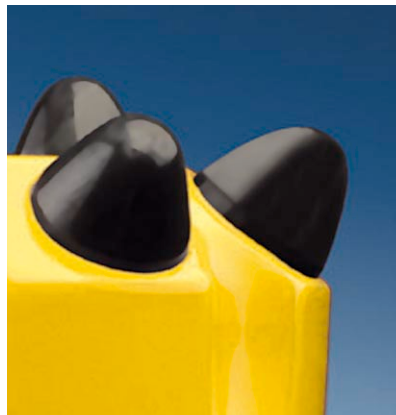
More sizes and thread combinations will follow.



Secoroc full-ballistic button bit (dia. 76 mm) model –21–66. Drop centre front with larger gauge buttons.



The full-ballistic buttons protrude more from the bit body, resulting in faster penetration in soft rock.



ThunderRod T60 – for the most powerful tophammer drill rigs

Atlas Copco Secoroc has launched ThunderRod T60, a heavy-duty top-hammer drill string designed for greater productivity. Specially designed with a bigger rod cross-section for 102–152 mm holes, ThunderRod T60 is built to handle the most powerful hydraulic rock drills, delivering higher power output for optimization of the drilling pattern. The entire drill string is more rigid, offering increased hole straightness, higher penetration rate and a welcome boost to drilling productivity and economy. Fewer, but larger, drill holes per blast means higher productivity. Straighter holes result in improved fragmentation and far less secondary drilling and blasting.

The threads on ThunderRod T60 are designed to make the coupling sequence as easy as possible, while at the same time keeping energy losses to an absolute minimum. Featuring a cross-section 40% bigger than standard T51 rods, the new ThunderRod is designed to reduce hole deviation in all rock formations. The flushing hole is also bigger, ensuring a 10% increase in flushing capacity for up to 30 m-deep holes.

The new shank adapters for ThunderRod T60 are optimally hardened, with a balance of core and surface properties designed to withstand the high impact power of modern rock drills such as Atlas Copco COP 2560, COP 2560EX and COP 4050. This leads to unparalleled fatigue and wear resistance.



COPROD combines the best of DTH and tophammer drilling

The rock driller's dream

Drillers always dreamed of a system that would combine the straightness and accuracy of down-the-hole drilling with the enormous capacity of hydraulic tophammer drilling. Efforts to combine the advantages of the two techniques were unsuccessful, until the development of COPROD by Atlas Copco.

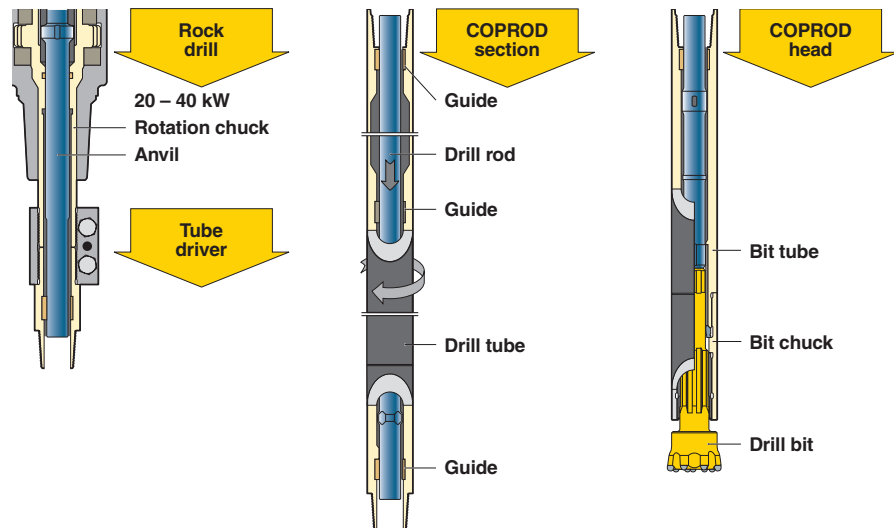
COPROD is not only a combination of positive features, it also integrates two types of drill string for percussive drilling by means of a tophammer. Inner drill rods transmit power and thrust to the drill bit and outer tubes transfer rotation, adding stiffness to the string and improved flushing efficiency. These assets achieve high tophammer drilling rates and large hole diameters.

The rods in the COPROD system have no threads and are simply stacked one on top of the other. Laterally, they are centred by the guide bushes in the tubes which surround them, and longitudinally, contact between rod ends is maintained by the thrust from the top. Thanks to the unique double recoil damping system of the COP rock drills, the rod ends remain in permanent contact, energy losses are almost nil, and drilling efficiency is maintained from start to finish of the hole.

Introduction

In the simplest of terms, percussive drilling systems go back to manually hitting a steel rod with a bit at one end and, as recoil makes the rod jump back, rotating it at a small angle between blows to ensure that the hole is round.

Most drilling for benching operations has been carried out with tophammers, using extension rods connected by threaded coupling sleeves, and an exchangeable drill bit at the bottom end. This



COPROD drilling head arrangement.

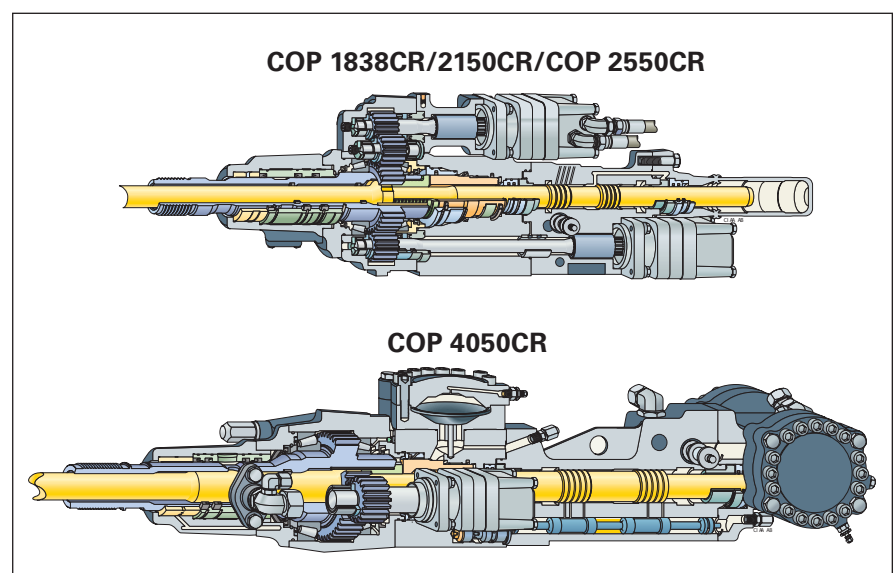
equipment works well for smaller hole diameters in solid rock, but it is not so effective in larger hole diameters, or in deteriorating ground conditions. There are problems in transmitting sufficient energy to the bit, especially in deeper holes, and in obtaining satisfactory flushing.

In tophammer drilling, the thrust has to be applied from the top to keep the

bit in contact with the bottom of the hole. This can cause the relatively slender drill string to bend, steering the bit off its intended alignment.

Increasingly powerful hydraulic rock drills send more percussive energy down the drill string, allowing larger hole diameters in benching. However, due to the microscopic movements between mating parts in the threaded drill string,

COP1838 CR/2150CR/COP 2550CR and COP 4050CR rock drills.





ROC F9CR retrofitted with second generation COPROD drilling in Belgium.

energy is lost and heat develops. The energy loss may be considerable by the time the shock wave reaches the bit, and there will be thread wear and reduced life of the drill string components.

The down-the-hole (DTH) system was developed to overcome some of the problems associated with hole straightness suffered by top-hammer drills. Rigid guide tubes, with a large outer diameter, were developed to keep the drill string on a straight course, and improve flushing. With a DTH hammer, a series of tubes offers far greater stiffness, and runs closer to the hole walls,

resulting in considerably less deviation than with a top-hammer drill string.

Power with rigidity

The COPROD system combines the power of the top-hammer with the rigidity of the DTH drill string. COPROD rods move longitudinally within each tube, transmitting the rock drill energy to the bit. Lugs on the rods prevent them from sliding out during handling.

During drilling operations, if the bit enters a cavity and drops down in its

splines in the bit chuck, the hammer senses it, and percussion is interrupted. Rotation is maintained, however, and percussion restarts automatically when the bit meets resistance again.

Flushing air enters the bit via a centre channel, which connects to the cylindrical surface in the bit rod. A small amount of air, containing a little oil, escapes via the splines in the chuck and the bit, and lubricates them. On its way up, the flushing air travels between the smooth outside of the tubes and the hole wall, providing a constant cross section, and ideal conditions for flushing the drilling fines.

COPROD offers unique features for drilling holes fast and straight. And the more troublesome the ground becomes, the more the incomparable drilling system comes into its own.

Thanks to the unique double recoil damping system of the rock drills developed for use with COPROD, the rod ends remain in permanent contact with each other. Thus, there are near-zero energy losses at rod joints, and drilling efficiency is maintained at virtually the same level from the start to the final depth of the hole.

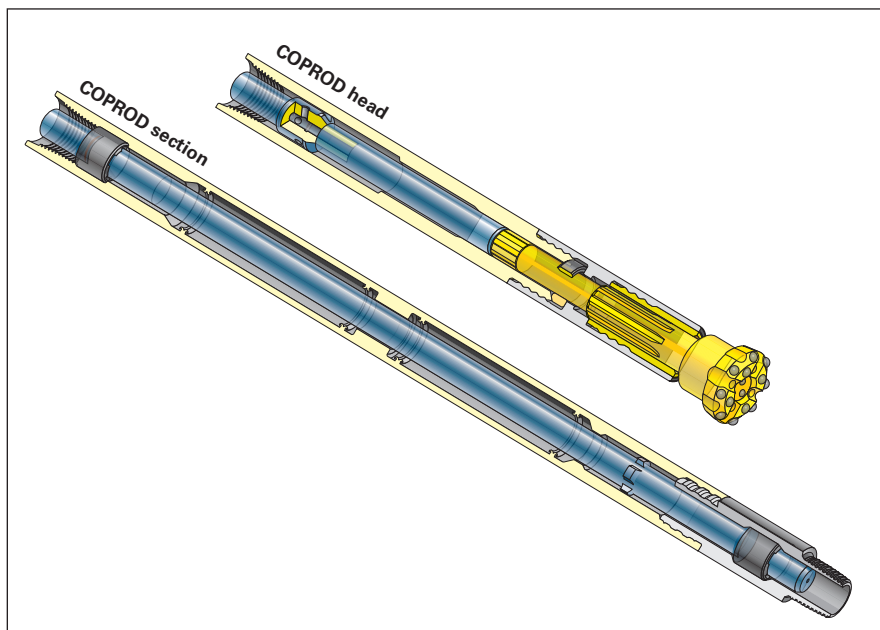
Latest on COPROD

The new COPROD drill string features a wide range of improvements. The thickness of the drill tube has been increased to 8.8 mm with a new, stronger female thread connection to the end piece. This results in increased service life, virtually eliminating tube breakage, and helping to limit in-hole deviation.

The end piece of the COPROD section has been made shorter and redesigned with a new male T-thread connection to the drill tube, eliminating thread breakage. The diameter of the CR 76 inner rod has been increased and the end diameter of the CR 89 inner rod matches the anvil to optimize service life and penetration rate.

In the COPROD head, the bit rod has been redesigned to eliminate the rod guide. Closer tolerances reduce air passage in the bit spline area to a minimum, preventing shank breakage, while improved airflow reduces plugging of the bit. The drill bit itself is now

The COPROD drill string provides long service life and high penetration rate.



made of a new grade of steel with high impact and fatigue strength.

The outer diameter of the 89 mm COPROD tube can be worn down to 80 mm before replacement, and, with low air pressure of only 12 bar, less airflow in the annulus results in up to 50% longer life.

Fractured rock in Austria

Asphalt & Beton GmbH, the quarrying division of Austria-based Strabag, produces 18 million t/y at 57 quarries in 11 countries. An Atlas Copco ROC F7CR forms the backbone of the operation at the company's 650,000 t/y Jakomini quarry located on an Alpine slope in the Bleiberg region of southern Austria. The operation, which is mainly quarrying fractured metamorphic diabase of 140-150 Mpa hardness, features seven benches, each around 20 m high. Blasthole depths range from 20 m to 26 m, angled at 80 degrees. Presplit drilling is carried out to maintain slope stability of the benches.

The ROC F7CR drills 92 mm diameter holes, using an impact pressure of 120 bar during collaring, and working pressure of 200 bar. Nett penetration is 1 m/min, and each hole takes around 20-30 minutes to drill. After 10,000 drill metres, the wear on the drill tube was 0.5 mm, and five bits had been consumed.

The benches are reached by steep gradients, with inclines of up to 30%, a real test of tractability and stability for any drill rig, but one in which the ROC F7CR excels.

The COPROD system of straight hole drilling is ideal in the fractured rock, which is subject to water influx while drilling. It is also very fuel-efficient at 0.7 litre/drillmetre, just half of that expected from DTH rigs. Within a month of delivery in 2005, the ROC F7CR was averaging 25 m/h, and has since achieved consistent monthly performances of over 31 m/h.

Abrasive rock in Belgium

Belgian company DGO M3 is a member of the French EPC Group, and one of the largest drilling contractors in Europe. With an annual production



ROC F7CR in the Jakomini quarry.

of up to 115,000 drillmetres from 24 quarry sites around the country, the company is heavily reliant on continuous drill rig availability and production. It has a fleet of Atlas Copco rigs, comprising a new ROC F9CR, a second ROC F9CR retrofitted with the new COPROD system and COP 2150 rock drill, a ROC F7CR, and a ROC L6H DTH rig.

The COPROD rigs equipped with 127 mm diameter bits are used for hole depths up to 30 m, while the ROC L6H can go down to 45 m deep. A wide variety of rock types and formations is drilled, ranging from medium-to-hard limestone and sandstone to granite, porphyry and grit.

With COPROD, the company can drill at any of its operations, giving it the necessary flexibility to obtain very high efficiencies. Using the lower air pressure of 12 bar, the flushing air and cuttings do not destroy the hole collar, and a 20 % higher productivity is obtained compared to the 25 bar DTH rig. Rapid bit changeover times also ensure that regrinding and frequent bit

changes do not cause undue delays. At the sites, every drill pattern and blast is designed with Geolaser profiling of the bench, and hole alignment is checked with the Pulsar system.

There are currently ten COPROD drill rigs operating in Belgium, nearly all of which are located in the French-speaking Walloon province. These are served by Atlas Copco distributor SEMAT, based at Spy, near Charleroi.

SEMAT carries out any major repairs and overhaul work for DGO, whilst the contractor does its own weekly servicing. DGO reports that, over the last two years using the new COPROD system, it no longer breaks tubes, and has recorded a 50% improvement in service life of the drill string. Every six months, each rig is taken out of operation for one week for a major service, usually coinciding with a period of slack demand. Nearly all COPROD rig owners have increased the diameters of their drill bits due to increased confidence in maintaining correct hole alignment, allowing less holes to be drilled for the same output.



Ho Ping quarry is located 1,000 m above sea level.

Limestone in Taiwan

Ho Ping limestone quarry, at Hualien in Taiwan, has a fleet of six Atlas Copco ROC F9CR crawler drill rigs equipped with the COPROD system and COP 1838 CR rock drills. In operation since 1981, Ho Ping is owned by Taiwan Cement, and produces 12 million t/y of limestone, making it the largest cement quarry in Taiwan.

Located about 1,000 m above sea level, the quarry is one of a number operated by Chien-Kuo Construction Co on behalf of the country's major cement

companies. The company also operates in the People's Republic of China, Vietnam, Indonesia and the Philippines.

Four Atlas Copco ROC F9CR rigs joined the production fleet in 2001, and another two units were delivered in 2002.

They are proving to be highly productive at 25 drillmetres/h, and eminently suited to the type of rock being mined, which is loose and fractured. They are capable of drilling holes to depths of up to 30 m, and diameters up to 127 mm.

Site layout at Ho Ping is designed to keep noise, vibration and visual impact

to a minimum, by downward excavation from the hill. To reduce the noise, dust and danger associated with truck movements, the rock is fed through gyratory crushers, and transported along a system of shafts and conveyors to a stocking area at the bottom of the hill. There are three 6 m diameter vertical shafts, and one 900 m long tunnel and two 1,100 m long tunnels.

The altitude causes the quarry to be shrouded in mist quite often, and it can be damp and cold in the winter, affecting the hours and safety of work. Chien-Kuo carries out two blasts each day, 28 days a month.

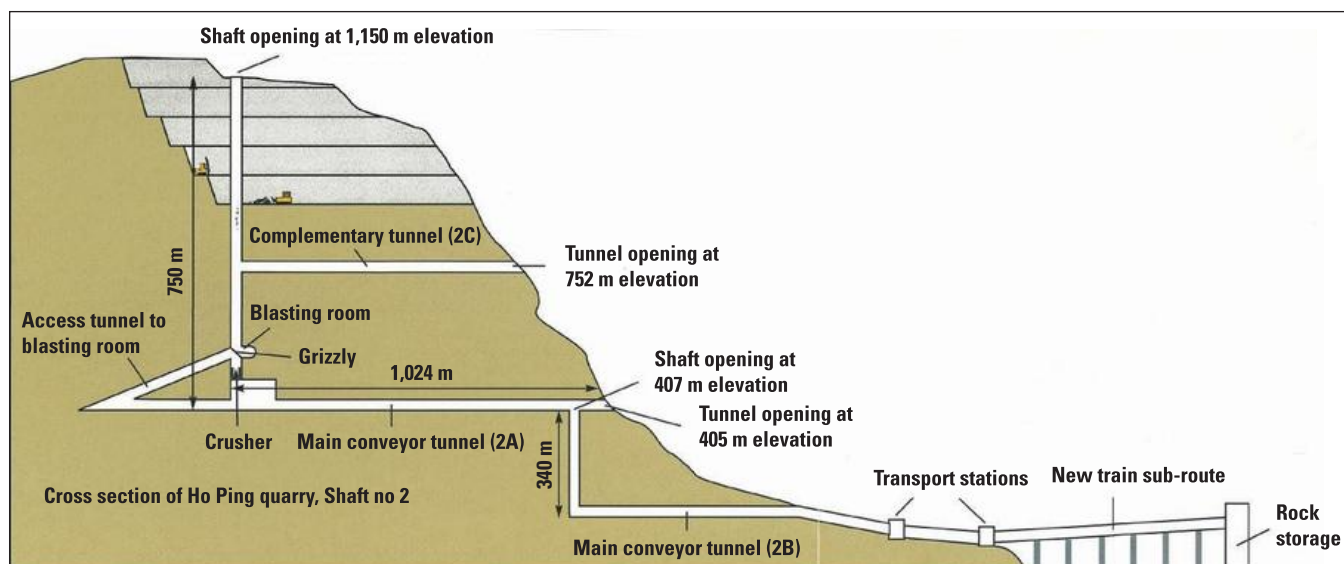
Conclusion

Statistics prove that the COPROD system, in spite of its higher initial cost, offers improved economy, and is sometimes the only solution worth considering when drilling becomes difficult due to demanding ground conditions.

COPROD's superior penetration rate contributes to a lower cost/m drilled than for DTH. In comparison with top-hammer drilling with extension steel, COPROD's better gross penetration and hole quality provide lower cost/t in difficult rock formations.

Summing up, COPROD offers unique features for drilling holes straight and fast, and it comes into its own in troublesome ground. Due to the number of components involved, a COPROD

Idealized section through Ho Ping quarry.





Immaculate conveyor tunnel at Hualien.

drill string carries a higher price than comparable extension rod, or DTH, strings.

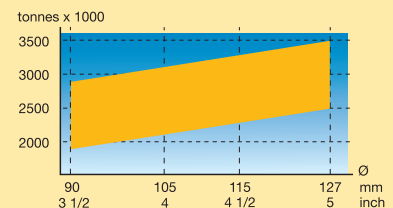
However, because the holes are drilled fast and without deviation, permitting the drilling pattern to be opened up, COPROD leads to lower costs per excavated volume of rock. Time is also saved in retracting the drill string in broken ground, or through blasting debris left on top of the bench.

The latest COPROD system improves on these advantages, offering longer drill string life and better availability than ever before.

Peter Gunnarsson

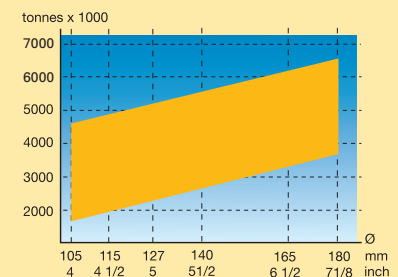
ROC F9CR COPROD system

Hole range	90-127mm 3 1/2"-5"
Rock drill	COP 2550CR
Drill string (3.66 m/12 ft)	CR 76, 89
Cat engine	224kW 304hp
Compressor FAD at 12 bar (174 psi)	210l/s 445cfm



ROC L7CR COPROD system

Hole range	105-180mm 4 1/8"-7 1/8"
Rock drill	COP 4050ME-CR, COP 4050HE-CR
Drill string (3.66 m/12 ft)	CR 89, 102 (short feed)
Drill string (6.1 m/20 ft)	CR 89, 102, 127, 140 (long feed)
Cat engine	328kW 417hp
Compressor FAD at 12 bar (171 psi)	254l/s 540cfm



Strong points of different bench drilling methods

Tophammer

- Unbeatable under good drilling conditions
- Low fuel consumption
- Low investment in drill string

DownThe Hole

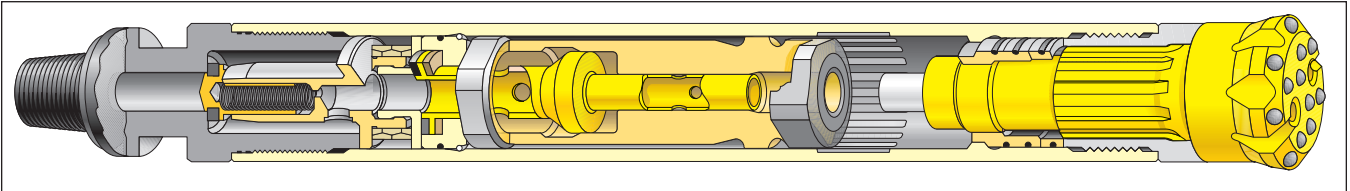
- Straight holes
- Deep holes
- Very simple method for the operator

COPROD

- Unbeatable under difficult drilling conditions
- Straight holes and high productivity
- Good penetration rates



Increased productivity with DTH drilling



DTH growing in popularity

The DTH drilling method is growing in popularity, with increases in all application segments, including blasthole, water well, foundation, oil & gas, cooling systems and drilling for heat exchange pumps.

DTH competes favourably with rotary drilling in open pit mines, mainly thanks to increased productivity and flexibility. Open pit mining has adopted smaller holes where rotary drilling has either been replaced by DTH, or where DTH has been introduced to create a better finish to the pit wall, as the method is also perfect for pre-splitting and smooth blasting, which avoids back-cracking.

DTH drilling offers increased productivity, and is favoured by contractors for production drilling. In larger quarries, the optimum hole size is 110-140 mm. With today's demands for strict hole control for safe blasting in populated areas, DTH drilling is a popular choice among quarry operators.

Quality holes

In the hole range 100-254 mm, DTH drilling is the dominant drilling method today. The main features of DTH drilling in this hole range are: excellent hole straightness within 1.5% deviation without guiding equipment; good hole cleaning, with plenty of air for hole cleaning from the hammer; good hole quality, with smooth and even hole walls for easy charging of explosives;

deep hole drilling capacity, with constant penetration and no energy losses in joints; and efficient energy transmission, with the piston striking directly on the bit.

The COP 34-64 series of hammers was introduced from 1992, and immediately became the benchmark for productivity within DTH drilling. Over the years, the increase in average drilling pressure, from 17 bar to a current market standard of 30 bar, has improved hammer performance, and productivity has increased proportionally to air pressure. The introduction of the Atlas Copco ROC L8 and L6 series of high-performance, high-pressure DTH rigs gave another boost to the sales of

Cutaway section of Secoroc COP 64 Gold.

hammers. The flexibility, productivity and manoeuvrability of these rigs, when equipped with a COP hammer, makes them the most productive combination on the market today.

COP 64 Gold

The increase in drilling pressure also had some negative impact on the internal components of the DTH hammer, as the increased stress promoted the

New Secoroc hammer and bit ready for action on an Atlas Copco drill rig.



risk of premature failures. So, in 1998, Atlas Copco Secoroc decided on a long-term strategy to improve reliability, while retaining the benchmark status of the COP 64 DTH hammer.

Stage One of this strategy was the development of the second generation six-inch hammer, COP 64.2, introduced in October, 2000, which incorporated newly-designed steel disc spring and lower buffer. Performance was vastly improved, thanks to a drastic reduction in the number of internal failures. It was also possible to rebuild the hammer without diminishing its performance, making it even more attractive.

Stage Two was the introduction of the third generation COP 64 hammer, COP 64 Gold, which was unveiled in August, 2001. This version offers sustained performance and improved longevity of the external parts. The COP 64.2 resolved internal component reliability, while the COP 64 Gold has experienced a dramatic drop in the number of cylinder failures.

COP 64 Gold also boasts improved sustainable efficiency, maintaining an average of 96% of original performance throughout its service life, which is a further improvement on COP 64.2.

Durability improvements, thanks to the higher tensile strength of the new steel grade, are especially noticeable when the cylinder approaches minimum thickness limits. COP 64 Gold enjoys a greater durability margin than its predecessor.

With the introduction of COP 64 Gold, hammer life will increase substantially. Less internal and external wear, together with a reduced minimum cylinder wear limit, are key contributing factors. The hammer is virtually

	COP 64.2 steel	COP 64 Gold steel	Improvement
Yield point ReL(Mpa)	700	1400	100%
Breaking strength Rm(Mpa)	1000	1950	95%
Hardness (HRC)	32	42	31%

Table 1 reveals not only that the yield point for the new steel grade is twice as high, but also that breaking strength has been almost doubled.

Table 1 Comparison of COP 64.2 and COP 64 Gold steel.

maintenance-free, with no need for an economy kit in most applications. Ultimately, this means customers can look forward to increased drill rig availability.

The sum total of these improvements shows COP 64 Gold to have more than 50% greater service life, in abrasive rock conditions, than its predecessor.

The customer benefits from lower cost/metre drilled, thanks to less downtime and greater abrasion resistance, and 30-50% longer life of external parts.

Higher availability results from less breakage in the threads of top sub and chuck-ends of the cylinder, and there are fewer stoppages for service and maintenance. Improved penetration rate and higher efficiency are a result of reduced friction of the piston, and a greater life cycle penetration rate is the overall reward.

To sum up, the customer can drill more holes per hammer than previously.

Applications

COP 64 Gold is a high-pressure hammer, where performance is related to air pressure. A lower limit of 12 bar for deep hole applications is a good rule of thumb. The hammer is designed for

the same types of application as COP 64.2, with special focus on high-pressure applications.

In abrasive formations, performance will be up to 50% better than COP 64.2, in what is an ideal application for COP 64 Gold.

In soft unconsolidated rock drilling, the 12-spline chuck concept and the improved durability make COP 64 Gold the perfect hammer. High pressure yields higher productivity, and drilling pressures of 28-30 bar are not unusual.

The COP 64 Gold hammer concept offers customers a tool to meet the most exacting requirements.

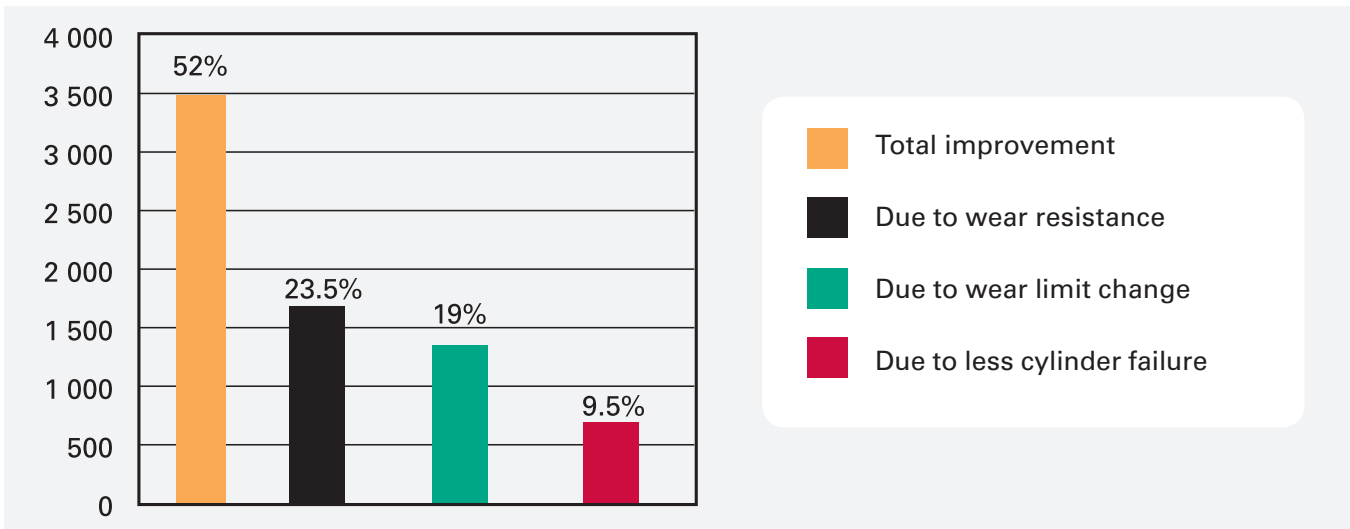
Hammer cylinder

The new cylinder has been redesigned in a number of important ways. COP 64 Gold boasts a cylinder made of low alloy wrought and toughened steel, a new grade with a higher combined Molybdenum and Vanadium content (4.8%) than its predecessor. The result is greater impact strength and higher wear and temperature resistance. All in all, this means greater resistance to breakage, impact, temperature and wear for the new hammer cylinder.

Thanks to the new steel grade, cylinder properties have been greatly

Secoroc COP 64 Gold.





Increase in service life of COP 64 Gold, which has a 50% longer life than its predecessor.

improved. Wear has been reduced, both internally and externally. Cuttings and moving parts no longer cause the problems they once did. In effect, the service life of the cylinder has been extended considerably.

The new steel grade possesses greater tensile strength, which means the minimum wear limit can be decreased from an overall cylinder diameter of 132 mm, to 130 mm.

The result is a hammer that maintains performance far longer than its predecessor, while being, in effect, maintenance-free.

Longitudinal milled slots have replaced the circular undercut found in COP 64.2. The piston now enjoys 100% guidance throughout its stroke,

as opposed to the older undercut that let it partially move freely at the end of the downward stroke. Thanks to these slots, wear on the porting edges of the cylinder undercuts and piston has been eliminated. That means air leakage is down to a minimum, and so are noise levels!

The polygon-shaped piston provides a ten-point guide system, while retaining excellent force on the bit. It is sturdier than its forerunner, fitting hand-in-glove with the milled slots to provide superior guidance and airflow all the way through the hammer.

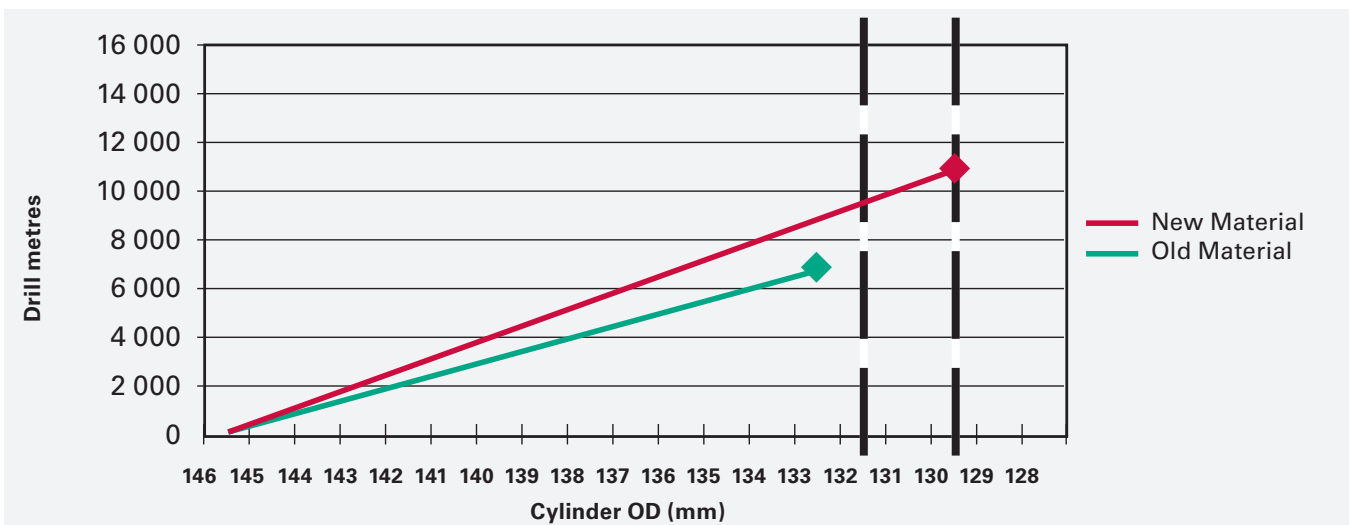
The QL 60-style chuck, together with a 12-spline bit, add up to a stronger bit shank. This is especially useful in soft and unconsolidated rock conditions,

where bits tend to move axially in and out in the chuck during drilling. This may lead to greater friction between chuck and splines, causing premature spline wear. Furthermore, the increase in the number of splines, from eight to twelve, leads to greater surface contact between bit and chuck, lessening stress on the splines.

The high demand for COP 64 Gold hammers, particularly in applications where performance and reliability are major considerations, has led Atlas Copco Secoroc to add the COP 54 Gold to this increasingly successful range.

Leif Larsson

Results of comparative tests with COP 64.2 and COP 64 Gold. The COP 64 Gold drilled 50% further.



Jahan Compressor



Breakers reduce blasting

Blasting alternative

Heavy hydraulic breakers are used in rock mining to reduce explosives consumption, and this technique is a worthwhile consideration in many quarries. These machines may complement, or even substitute, the drilling and blasting method. However, after the technical and operational requirements have been decided, economic efficiency depends not just on a high production output. High availability of the equipment is necessary, and key to this is quick and professional customer support service. Atlas Copco has many years of experience in hydraulic breakers, and this, combined with knowledge of open pit and quarrying methods all over the world, puts the company in a unique position to assess hydraulic breakers as a practical alternative.

Hydraulic breakers

Restrictions and regulations imposed by the authorities in many countries are generating discussions about mining and quarrying methods that rule out the use of explosives.

Reasons for switching to non-explosive methods may be: changes in the law; environmental requirements; safety considerations affecting explosives; avoiding constraints on operations; simplifying the renewal of mining permits; maintaining profitability; increasing demands on product quality; and extending the mining area or specific mining activities within a deposit.

There are three mining methods that make no use of explosives: ripping with hydraulic excavators and crawlers; cutting with surface miners in medium-hard rock; and hydraulic breakers.

The decision in favour of a method using no explosives always depends on the particular circumstances. Every company has to examine hydraulic breakers as a practical alternative, because there are no two identical quarries



Hydraulic breaker HB 7000 at work.

anywhere in the world! Future requirements must also be taken into account, and planned investments may need to be reconsidered. The quarry may have to move to smaller bench heights to provide optimum working conditions for breaker/carrier units, and subsequent restoration must also be taken into account.

There are four areas of potential benefit from the use of hydraulic breakers, as follows.

Productivity

Continuous operations without interruptions for blasting and clearing enhances productivity; optimal yield is obtained from the approved mining volume; the load on the primary crusher

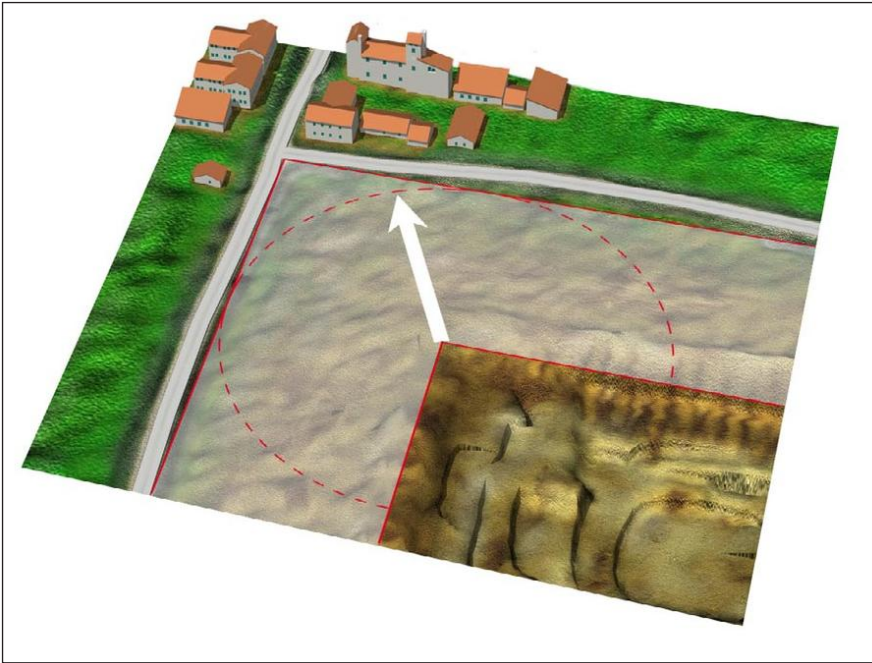
is reduced by way of preliminary reduction by the hydraulic breaker; primary crusher throughput is increased; and more flexible planning is possible.

Minimizing costs

Security outlay for explosives storage is reduced; primary crusher may be downsized or eliminated; continuous conveying systems may become possible; and approval procedures with authorities may be simplified.

Improving quality

Amount of fines is reduced and sales revenue increased; grain size distribution is better controlled; quality is reproducible; and selective quarrying of deposits is possible.



Open-pit mine and surroundings.

Reducing environmental pollution

Blasting emissions are eliminated; mining of existing resources is simplified; and site restoration is easier.

For nearly 40 years, hydraulic breaker attachments from Atlas Copco Construction Tools have stood the test in varying applications. The hydraulic breaker has found its way into the quarry through reduction of oversize boulders for the secondary crushing operation. These breakers have also frequently been used for making ramps. Often the results were not satisfying, because early

generation breakers simply did not have sufficient capacity.

Quarrying unit

Heavy hydraulic breakers have been used in direct mining for 25 years, and have been a valuable source of know-how for Atlas Copco. Consistent development effort over the years has resulted in an efficiency standard compatible with the operational requirements of quarries. Breakers are attached to carriers, such as hydraulic excavators,

to form quarrying units, and are powered by the onboard pumps. Atlas Copco manufactures hydraulic breakers with service weights ranging from 35 kg to 7 t for attachment to carriers from 0.3 t to 120 t.

Only the most powerful breakers, with a service weight clearly above 3 t, are used for quarrying without explosives. For selective mining applications, a service weight exceeding 2 t may be sufficient.

Heavy-duty hydraulic breakers usually comprise two main components: the percussion mechanism and the guide system.

The hydraulic percussion mechanism converts hydraulic input into mechanical output. The efficiency of this function determines the breaker's economy.

The guide system, or hammer box, is needed to guide the percussion mechanism and protect it from wear and external forces. It also damps the power feedback to prevent it from reaching the carrier's attachment system, and silences the noise produced by the percussion mechanism.

For a hydraulic breaker, the job of rock quarrying without blasting is a tough one. The mining unit is an important link in the production chain for which maximum performance and reliability are needed.

Design solutions have been developed which ensure that these requirements are met. The appropriate characteristics are listed in the box below.

AutoControl	AutoControl is a combination valve system allowing the hydraulic breaker to adapt to different working conditions. The ratio of impact energy to impact rate is controlled to ensure maximum percussive performance at all times
StartSelect	Depending on the application either the starting mode "AutoStart" or "AutoStop" can be selected (e.g. when changing from reducing oversize boulders to direct mining and vice versa). The "StartSelect" system allows the start-up and shut-off behaviour of the breaker to be set in line with conditions.
Vibrosilenced	From a noise emission point of view the percussion mechanism is technically separated from the carrier's attachment system by means of elastic suspensions. Compared to other carrier systems the sound pressure level is reduced by approx. 18 dB (A). MB and HB hydraulic breakers are fitted as standard with the efficient "VibroSilenced" noise and vibration damping system. Elastic elements between percussion mechanism and guide system provide full acoustic insulation.
DustProtector	Permanently prevents dust and dirt from penetrating the breaker. The amount of grease needed and the wear are substantially reduced. Prevents dust penetration on the hydraulic breaker.
ContiLube II	Lubrication of wear bushes and insertion tool (to reduce wear). Automatic lubrication unit mounted directly on the breaker.

Hydraulic breakers in quarrying

Depending on the deposit, operation and carrier unit, recommendations can be made for test runs of hydraulic breakers. Atlas Copco includes consultation on applications in its range of services. Working above track level is a good example of the breaker as a primary production tool. The quarrying unit stands at the base of a slope facing the quarry face, allowing the breaker to work its way up. First of all, the base of the slope is broken up to create a stratum that is as level as possible. After the stratum has been prepared, the quarry face is broken up stepwise from the bottom to the top. The broken up rock slips down to the base of the slope. This is continued until the upper edge is reached. The height of the face is limited by the size of the carrier unit, and ranges from 1.0 m to 13 m.

The excavator can mount the heap of rock to safely work on the upper edge. The face height should be such that there is no risk of burying the quarrying unit. Mining below track level, where the unit is standing on top of the rock to be quarried, is not advisable.

Loading the rock requires a separate machine in order to avoid repeated changes of the excavator from a hydraulic breaker to a rock shovel.

Integration in existing quarries

A successful changeover of quarrying operations to hydraulic breakers requires a number of conditions to be checked. The characteristics of the deposits such as the type of rock, the rock arrangement, and the volumes to be handled have to be considered, as do the existing fleet of machines, the staff and the quarry layout.

The quarry faces may need reconfiguring to create optimum working conditions for the quarrying unit. Hence, the change in working method is particularly convenient for new opening cuts or quarry extensions where the face heights are still to be determined.

Developments, such as future investments, should be taken into account, as



Hydraulic breaker HB 5800 attached to a 60 t excavator.

must eventual restoration of the landscape.

Selective quarrying

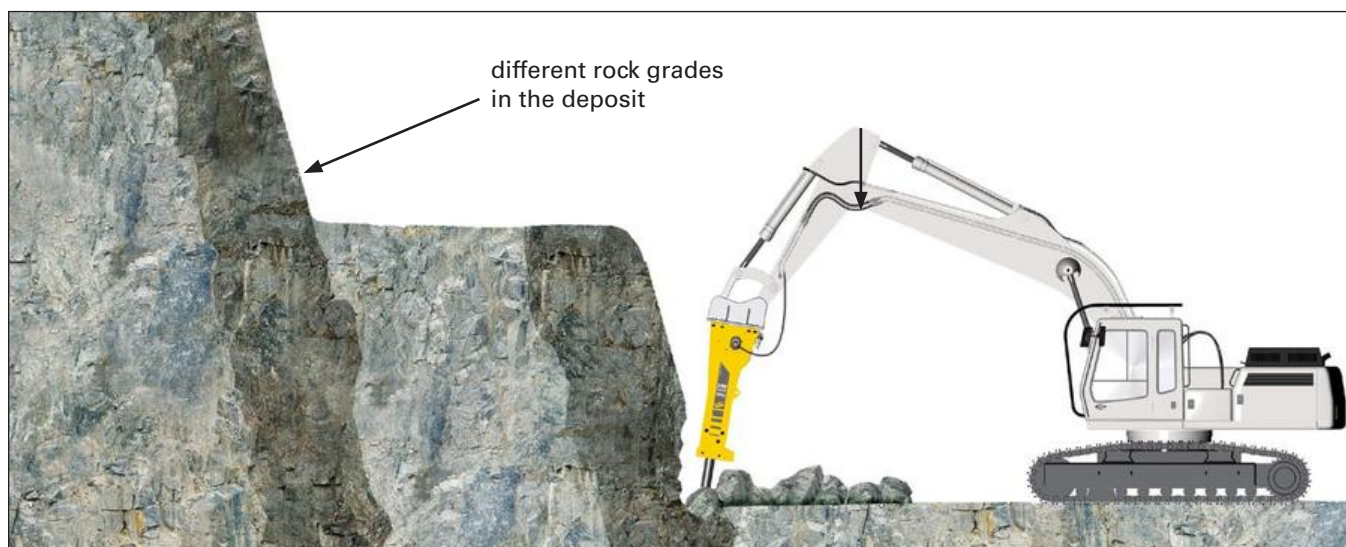
Selective mining allows different rock grades to be removed separately from a non-homogeneous deposit. Deposits with high impurity levels and distinct fault zones can be very difficult to quarry, resulting in sharply differing grades. However, technical and economic

requirements call for a flow of material from the quarry of largely consistent quality. Add to this the need to obtain the maximum yield from a deposit, and systematic quality control assumes an increasing importance for quarrying operations.

It is difficult to quarry rock selectively from damaged, fissured or complex seamed deposits by drilling and blasting. Drilling and loading costs are increased, and there is a significant risk

Rock breaking and mucking.





Selective mining.

of damage or injury from flyrock. Blasting mixes the rock grades together, and makes it impossible to extract the higher value grades separately, say in limestone or gypsum. Heavy duty hydraulic breakers can be used for selective quarrying at installations that already use blasting or other methods, such as ripping. This can be carried out regardless of the complexity or direction of the seams. Breakers are far more adaptable to operating conditions than rippers, and cause a lower percentage of fines than blasting.

Overburden removal

Overburden is removed either continuously or in phases.

As this work frequently takes place in the border area of the mine, drilling and blasting involves a considerable expenditure.

With no benches to work from, it can be difficult for the drill rig to access the overburden, which can be several metres deep.

Using a heavy-duty hydraulic breaker, the costs of removing overburden can be reduced, and the work carried out faster, with more flexibility.

Performance and costs

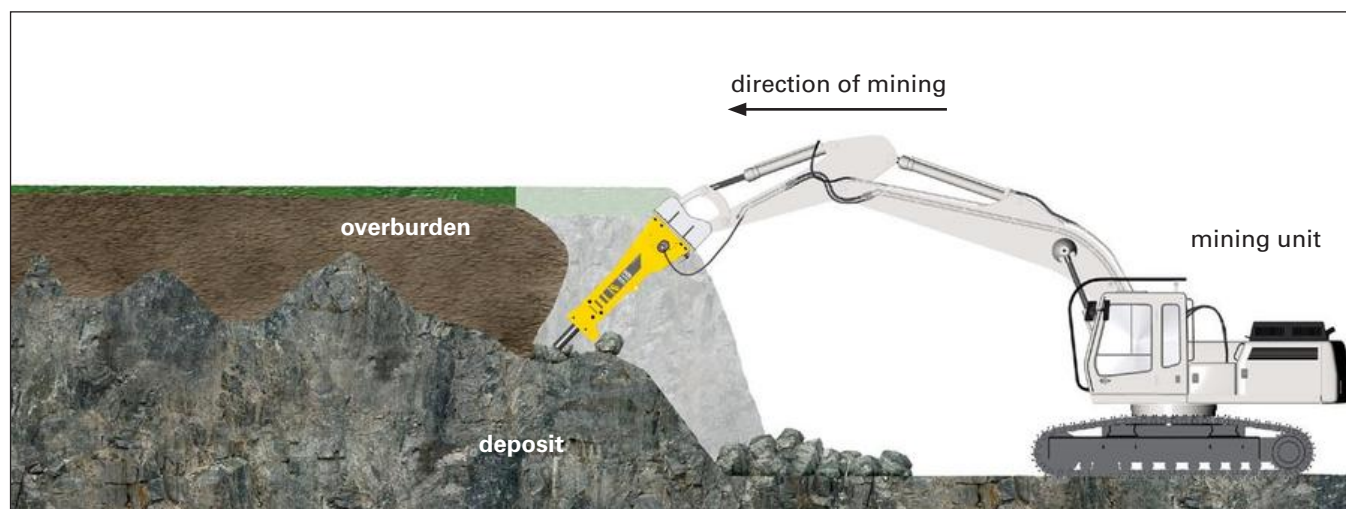
The breaking behaviour of the rock, its cleaving grade and resistance to pressure, and the consistency of the rock formation, are taken into account in

assessing the extraction performance. Factors which have a major impact on the efficiency of the hydraulic breaker are: the rock and deposit distinctly influence the working performance and wear; the operating conditions have a major impact on the economy; and the experience of the operator.

For an individual assessment of the extraction costs, Atlas Copco Construction Tools can reflect on many years of experience. The entire production process, from rock extraction to end product is appraised, so that all relevant aspects can be taken into consideration.

Jörn Jakob Weise

Removal of overburden.



Selecting the right DTH drilling tools

Covering every application

Atlas Copco Secoroc now has the most comprehensive range of DTH hammers, bits, and related equipment of any supplier in the world, backed by the strongest support network in the industry. Whether the call is for reliable hammers to keep investment to a minimum, or for the highest productivity to ensure maximum rig output, Atlas Copco Secoroc has the solution. The company is the only manufacturer to offer both first and second choice solutions in almost all typical DTH applications on a price vs performance basis. For premium performance and advanced technology, Total Depth and COP Gold hammers are offered. For an optimum blend of features and cost, COP and Quantum Leap can be the solution, and for high reliability at economical price, nothing beats Fusion hammers.

Total Depth, COP Gold, Quantum Leap, and COP and Fusion hammers are also energy efficient, consuming less fuel and with lower energy cost per drilled metre than other DTH hammers.

This enormous choice of DTH drilling tools is backed by a reliable network of distributors and customer centres that offer a complete range of parts, service and support.

Relevant applications

Quarrying

Companies producing in non-abrasive rock formations should consider hammers such as Secoroc Quantum Leap or Secoroc COP. Both are time-tested and field-proven designs offering good productivity and ease of service.

Producers demanding the highest productivity and/or drilling in abrasive formations should consider either the Total Depth or Secoroc COP Gold hammers. These incorporate the latest technology



Quarrying application.

and are the most reliable and productive hammers on the market. For customers who are happy with rebuilds, Total Depth is recommended, while for those who typically run hammers until they wear out, Secoroc COP Gold has unbeatable wear resistance and will be the first choice.

Dimensional stone quarrying demands consistent hole straightness, and such operations typically use smaller size holes of 85-90 mm in limestone, granite and marble. Here the TD 35 and COP 32 hammers are the best choice.

Construction

Civil engineering drilling subcontractors and drilled foundation contractors will be attracted to the improved performance of both Secoroc Quantum Leap and Secoroc COP hammers. Both of these balance good productivity with ease of service. For applications

demanding the finest performance, the choice will be between Total Depth and Secoroc COP Gold hammers. At the other end of the scale, rental companies will appreciate the Secoroc Fusion as a tried and tested hammer that is rugged, reliable, and easy to repair or replace.

Mineral exploration

Mineral exploration generally occurs in very remote locations, requiring robust hammers capable of running high pressures, in sometimes dirty environments.

For true reverse circulation drilling with face collection in mineral exploration and in-pit grade control, the Secoroc RC50 Reverse Circulation Hammer, incorporating the Quantum Leap cycle, performs particularly well.

Geotechnical Environmental monitoring applications will appreciate the Secoroc Fusion, or possibly the Secoroc Quantum Leap or COP hammers.



Changing a Secoroc bit.

Drilling of holes for foundation, anchoring or drainage demands reliable, inexpensive hammers like the Secoroc Fusion range.

Open pit mining

Mining operations typically have high equipment utilization, drilling up to 80% of the working day with DTH. The typical applications are normal 130-203 mm-diameter blast holes, 140-165 mm buffer holes, or 115-140 mm

pre-split holes. Companies should consider either the Total Depth or Secoroc COP Gold hammers. These incorporate the latest technology, and are the most reliable and productive hammers on the market. For customers who are happy with rebuilds, Total Depth is recommended, while for those who typically run hammers until they wear out, Secoroc COP Gold will be the first choice.

Well and geothermal

Water wells generally use a larger diameter, cased and sealed surface section, followed by a 70-250 m-deep and 4.5-6.5 in-diameter drilled well bore. For smaller, family-run companies, the ideal hammer will last as long as possible, with minimum maintenance. For larger companies with more rigs, performance, reliability, and availability of service and support become more important.

Geothermal drilling is similar, but may be carried out in remote locations, so the emphasis may be on the need to keep the hammer working as much as possible.

Once again, Total Depth, with its Air-Select System, is the fastest and most reliable, while Quantum Leap and Secoroc COP offer excellent performance with minimum maintenance.

Shallow oil and gas (CBM)

In this application, the customer uses a larger diameter 12.25 in - 17.5 in cased and sealed surface section, followed by a 500-2,500 m-deep drilled

well bore with final diameter of 6.5 in. For these projects, performance, reliability and availability of service and support become most important.

Once again, Total Depth, with its Air-Select System, is the fastest and most reliable, with a minimum of maintenance.

Selecting the right hammer

The optimum range of hole size for DTH drilling is 90 mm to 254 mm. Smaller holes are generally drilled using top hammer, and larger holes generally use rotary machines. However, DTH has an expanding position in the larger hole sizes up to 750 mm. As a rule of thumb, the smallest hole diameter a DTH hammer can drill is its nominal size. A 4 inch hammer will drill a 4 inch (102 mm) hole. The limiting factor is the outside diameter of the hammer, because, as hole diameter reduces, air-flow is restricted. Maximum hole size for production drilling is the nominal hammer size plus 1 inch, so for a 4 inch hammer the maximum hole size is 5 inch (127-130 mm).

Choosing the right hammer is largely determined by hole size and type of rock formation. Ideally, the size of the hammer should match the required hole dimension as closely as possible, leaving just enough space for cuttings to evacuate the hole.

Secoroc hammers are purpose-matched for all rock types and applications. Where high performance is the main criterion, Secoroc COP Gold and Secoroc Total Depth hammers are recommended.

In deep hole drilling applications, the Total Depth hammer has proven superior performance and adaptability to different air requirements, thanks to the Air-Select System.

Where proven technology is required, the Secoroc COP and Quantum Leap hammers are known for their reliability and longevity, and for a reliable work-horse, the Secoroc Fusion is practically bullet proof, with a 30 year history of continuous improvement.

The Standard design for COP 54 and COP 64 Gold hammers can be used down to a depth of 330 ft (100 m) using a Standard bit size, making it

Clusterdrill for construction work



useful for production drilling in quarries, shallow waterwell drilling, and underground blasthole drilling. HD is similar to Standard, but with heavy duty chuck and wear sleeve, and a top sub fitted with tungsten carbide buttons for wear protection in harsh and abrasive conditions. These also protect the top sub from excessive wear when rotating out of the hole through broken rock.

Selecting the right bit

Atlas Copco Secoroc has a comprehensive range of DTH drill bits to match all conceivable applications. Each bit is made from quality alloy steel, and has been precision machined to produce a perfect body, heat treated to the required hardness, given surface compression for fatigue resistance, and fitted with precision buttons manufactured in-house.

Five basic designs are available: CV Bit, FF Bit, SpeedBit, CC Bit, and Rocket Bit. These are designed for specific applications for all rock types, hardnesses and conditions.

Bit life and rate of penetration are the most important criteria in selecting the right bit for a particular application. In most cases, the focus is on productivity, so the fast cuttings removal features of the SpeedBit and Convex/



Waterwell drilling.

Ballistic designs are preferable, to ensure the buttons are cutting clean, with the minimum of re-crushing.

In hard and abrasive formations, however, the flat front (FF) HD design offers best bit life, having strong gauge rows with large spherical buttons which are easy to regrind and maintain. The SpeedBit offers improved productivity with the same gauge as the FF HD, but with ballistic buttons in the front for faster penetration. An alternative is the Concave design with spherical buttons. The Rocket Bit can be dressed with

ballistic buttons for use in soft to medium hard formations where fractured rock can be expected, or can be supplied with spherical buttons for hard and abrasive formations.

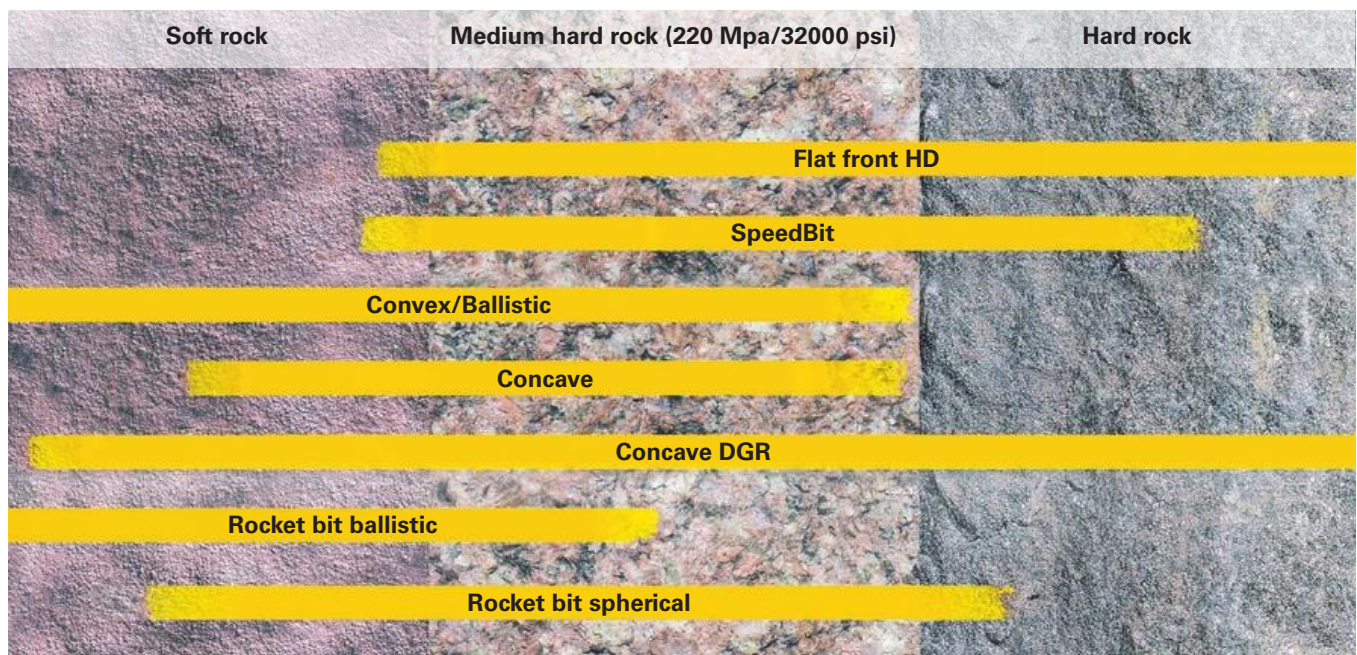
Bits are manufactured to match all diameters of Atlas Copco Secoroc hammers.

Secoroc hammers

Highest performance

The Secoroc COP Gold and Total Depth hammers are designed for the most

Bit designs and rock types.



Bit designs	Facts
	Convex/Ballistic front design Convex front with large cutting grooves and ballistic gauge and centre buttons. For soft to medium hard non-abrasive formations. The bit is designed for maximum penetration rate. Also, an alternative in hard abrasive formations, if high penetration rate is called for.
	SpeedBit Flat front design/ballistic centre buttons. Flat front with spherical gauge buttons and ballistic centre buttons. For high penetration in medium hard to hard abrasive formations.
	Flat front design – HD Flat front with large spherical gauge buttons for hard and abrasive formations. Also, front flushing grooves for efficient cuttings removal.
	Concave front design Concave front with spherical buttons. Perfect choice for medium hard to hard, less abrasive, fractured formations. Minimizes effect of hole deviation.
	Concave front design – HD Concave front with spherical buttons, with larger gauge buttons. Ideal for medium hard to hard, abrasive and fractured formations.
	Concave DGR front design Concave front with double rows of spherical gauge buttons. Only available for 8 in bits and larger. The reinforced gauge gives superior protection in medium hard to hard, abrasive and fractured formations.
	Rocket bit Super high penetration in soft to medium hard formations with low silica content. The Rocket bit also handles difficult formations with clay intrusions where other bit designs will not work.
The Secoroc range of DTH bits ensures that every driller can demand a solution for every application.	

demanding drilling conditions and for those applications requiring premium performance. These hammers feature state-of-the-art technology and deliver both maximum productivity and profit.

Secoroc COP Gold

- Superior longevity and reliability.
- Easy to service and rebuild.
- Best suited for production drilling because of its excellent external wear resistance and longevity.
- Internal components coated for wear and corrosion protection. Permits multiple rebuilds.
- Three start chuck thread for easy bit changes.
- Bit replacement possible without using drill rig break-out chains and wrenches.
- Unique air cushion reduces wear and tear on drill string and rig.

Secoroc total depth

- Provides the industry's highest power output.
- Best suited for deep hole applications.
- Industry-leading simplicity and serviceability, resulting in very low operating costs.
- Features modular components, snap-in cylinders, a reversible casing, backhead saver sleeves, and many options.
- The hybrid valved/valveless design maximizes air compressor productivity.

Proven technology

Secoroc COP and Quantum Leap® hammers combine strong performance with years of field proven technology. These hammers are known for reliability and longevity.

Secoroc COP

- Mainly used in mining, including underground, quarrying, and geothermal well drilling.
- High reliability.
- Internal components coated for wear and corrosion protection.
- Can be rebuilt frequently for longer service life.
- Three start chuck thread for easy bit changes.
- Unique air cushion reduces wear and tear on drill string and rig.

Secoroc Quantum Leap®

- The industry's first hybrid-combination of valve and valve-less air cycle.
- Mainly used in water well deep hole, production drilling and large diameter construction projects.
- Wide range of available diameters.
- Many options, including Hydrocyclone® and bit retrieval systems for application flexibility.

Reliable workhorse

Secoroc Fusion hammers are practically bullet proof, having been proven by continuous, successful operation in the industry for over thirty years.

Secoroc fusion

- Many parts are common to those used in the Secoroc Quantum Leap®.
- High reliability.
- Cost-effective.
- Time-tested performance

Selecting the right tube

Key features of a high quality DTH tube are durability, accuracy and manageability. Atlas Copco Secoroc tubes are made from cold drawn tubing, providing a superior surface finish and tolerance compared to conventional tubes made from hot rolled tubing.

This drastically reduces the risk of scaling from the tubes entering the hammer, a major cause of premature hammer failure.

The joints are friction welded to achieve maximum strength, and the threads of the end-pieces are heat treated for optimum durability and strength of the thread profile. This not only ensures long thread life, but also makes coupling and uncoupling quick and simple, reducing drilling time.

Tube diameter should be close to the hammer diameter to provide optimum flushing, reducing the chances of getting stuck.

In most applications, Atlas Copco Secoroc standard API threads will be the best choice.

Atlas Copco Secoroc also offers a wide range of subs and crossover subs to meet an array of demands, all manufactured to the same standards as the tubes.



Secoroc COP 54 Gold Express - the production driller's best friend.

Quality API grade N-80		Standard tubes	End pieces and adapters
Lower yield limit	N/mm ²	min 550	min 550
Tensile strength	N/mm ²	min 650	min 700
Elongation A5	min %	18	21
Core hardness	HB	190-230	210-250
Surface hardness	HRC		58-62

Drill tube OD (mm)	Wall (mm)	RD 50	2 3/8" API Reg	2 3/8" API IF	2 7/8" API Reg	2 7/8" API IF	3 1/2" API Reg
70	3.6	■	■				
76	3.6		■				
76	5.6		■				
89	3.7		■				
89	5.7		■	■	■		
102	5.7				■		
114	4.3					■	■
114	5.7						■
114	7.9						■



With on-site support, the choice of DTH equipment is even easier to make.

COP Backhammer

The COP Backhammer is a tool that can save and recover a drill string stuck in a hole. It can be easily fitted in a suitable tube joint between the drill support and the rotation head to provide an effective combination of backward hammering and vibration to loosen stuck drill strings.

Service and support

Atlas Copco Secoroc service, support and training follows every purchase,

to ensure that customers extract maximum productivity from their drilling operations. Having a knowledgeable and available Secoroc drilling engineer on site or on-line makes the difference between going it alone and tapping the experience and know-how of a world-class partner. For example, Secoroc knows that using higher productivity bits reduces the cost of each drilled hole, and the simplest way to cut costs is to drill holes faster. This has been a focus of product development, and is at the core of Secoroc technology, ensuring that every generation of products

drills faster and more efficiently. It takes a support team to apply this knowledge, so that customers can be assured they run a profitable and efficient drilling operation in an increasingly competitive business climate.

The bottom line is that the customer can count on Secoroc service and support, supplied by the largest, most dedicated manufacturer of DTH drilling tools in the world.

Leif Larsson

The economic case for routine bit grinding

Cutting hole costs

The button bit was originally developed to do the job of an insert bit, without the necessity for frequent grinding. However, it was soon found that the service life of a button bit increased considerably if the cemented carbide buttons were ground.

Nowadays, it has become extremely important to grind button bits at proper intervals, in order to extend the service life of the rock drilling tool, maintain penetration rates, and drill straight holes.

In all rock excavation operations, the cost is usually expressed in cost per drilled metre (cost/dm), in cost per cubic metre (cost/cu m), or in cost per tonne.

The cost to produce a hole depends on how fast it can be drilled, and how many tools will be consumed. The cost to produce a cubic metre of rock is dependent upon the cost of the hole, and the cost of blasting. If the blasthole is of poor quality, then more explosives will be consumed in blasting the rock. Unsharpened bits very often give a poor quality hole with deviation.

Grinding constitutes around 2% of the costs of the entire drilling operation. To run the business without grinding could multiply this cost, with up to 100% added when production losses are taken into account. Labour and material are the highest costs, while the machine investment cost is low when utilization is high, with a large number of bits to be ground.

Grinding methods

There are two different methods of bit grinding to restore the buttons. The preferred method uses a diamond coated profiled wheel, and the other, a grinding cup.

The profiled wheel provides a smooth and efficient grinding operation, which,



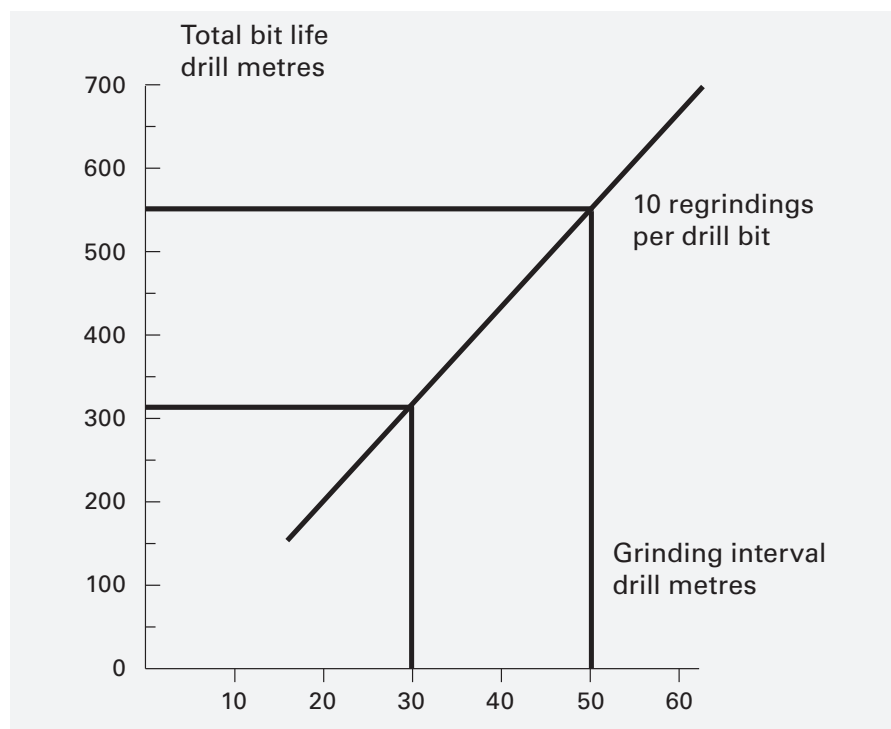
The Secoroc Grind Matic BQ2 grinding machine can handle drill bits up to 127 mm in diameter.

throughout its life, maintains the correct button shape and protrusion. It features correct centring on all buttons, producing a high quality cemented carbide surface, with no risk of cemented carbide nipple. Long bit life, and higher penetration rates, will result from good grinding quality.

Disadvantages of using the grinding cup are that it may produce an incorrect button shape and protrusion. It is difficult to centre the grinding cup over the gauge button, and there is also a risk of producing a sharp cemented carbide nipple on the button, and a possibility of scratches due to the larger diamond grain used. Reduced bit life will result from poor grinding quality.

Several tests have been carried out to find which method gives the best bit performance. The grinding wheel gives the correct shape to the button, regardless of the amount of wear on the wheel, ensuring that the bit will achieve

Diagram 1: Typical bit life grinding at different intervals.



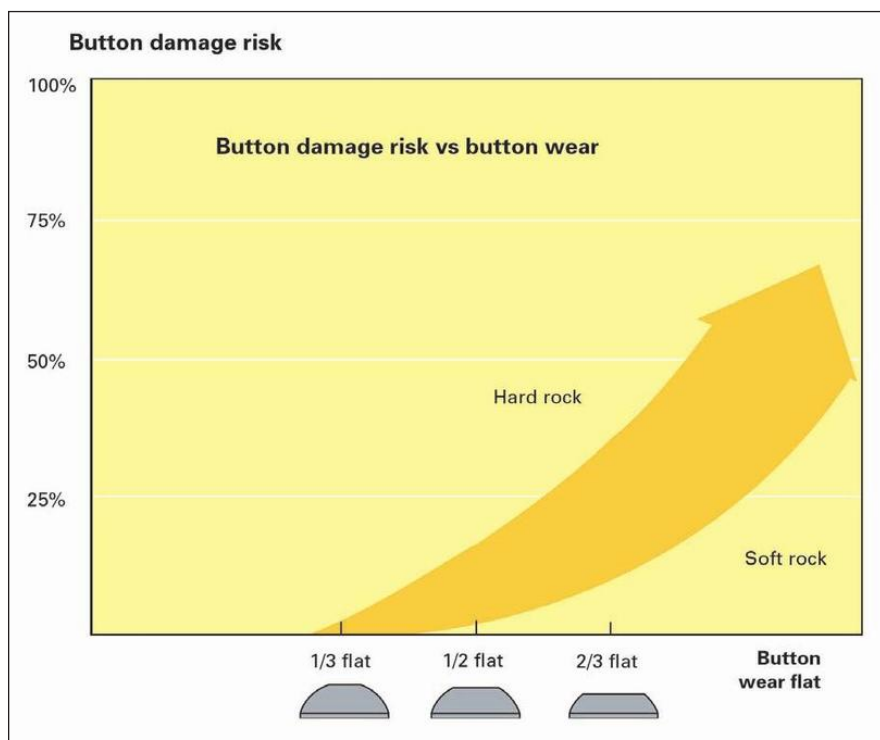


Diagram 2: Risk of total loss when a bit is overdrilled.

standard penetration rate throughout its entire life. It has also been shown that bit life is increased considerably when grinding wheels are used, rather than grinding cups. Wheels also excavate steel around the button, simplifying the grinding task, and giving the bit a more exact profile.

Bit life

With so many parameters involved, it is difficult to estimate bit service life. First, a proper grinding interval must be established, preferably at the stage when the button has a wear flat of one third of the button diameter. When the number of drilled metres to reach this stage has been established, then a calculation of bit life can be made, by multiplying by the number of times it can be reground. As a general rule, a bit can be reground 10 times, but smaller bits may achieve slightly less than this figure, while larger bits may achieve more. So, if the grinding interval has been established as 60 drill metres, then the average bit life will be 660 drill metres (diagram 1). If a bit is overdrilled, and the wear flat is more than half of the button diameter, there is a tendency towards cracked buttons.

There is always a sharp edge created on the button, and this becomes sharper the more the bit is overdrilled. This sharp edge, especially on ballistic buttons, is very brittle. Once the edge cracks, pieces of cemented carbide

break away and circulate in the hole, causing secondary damage to the buttons.

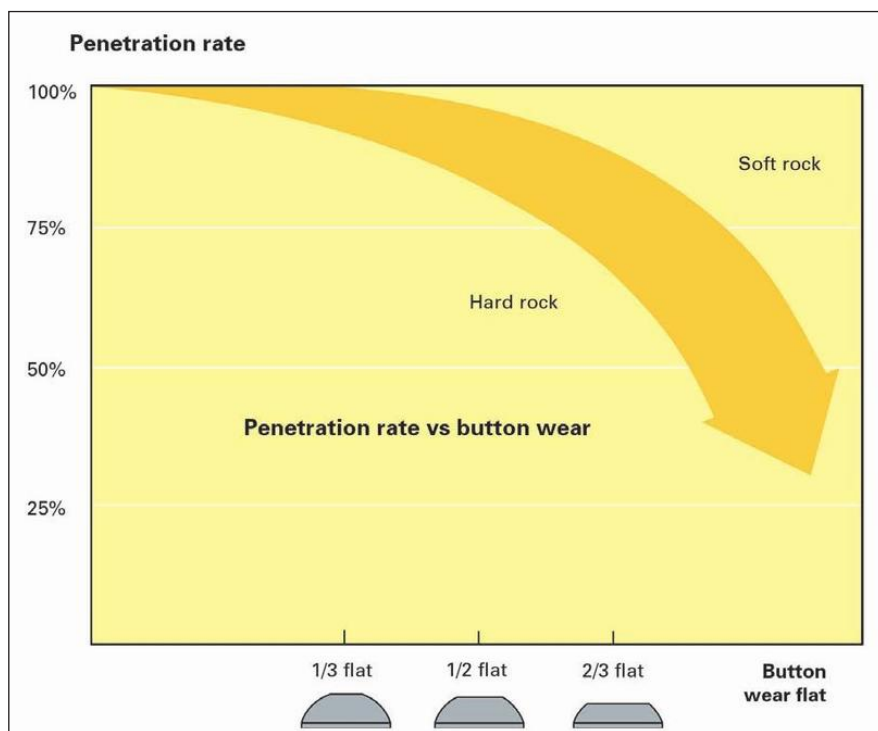
When a bit doesn't show any visible wear flat, it may be suffering from micro cracks on the cemented carbide surface. This is known colloquially as snakeskin, and can be clearly seen when using a magnifier. In this case, the surface has to be ground away, otherwise the micro cracks lead to more severe damage on the buttons.

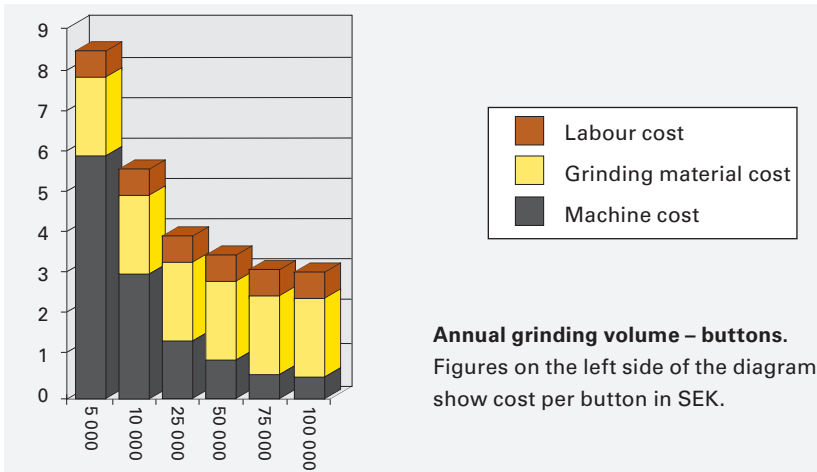
Likewise, buttons which protrude too much must be ground down to avoid damage (diagram 2).

Penetration rate

When the right bit has been chosen for the rock condition, it will provide maximum penetration rate, along with acceptable hole straightness. In rock conditions like Swedish granite, with a compressive strength of around 2,200 bar, the bit gets a wear flat after just 10-20 drill metres, accompanied by a small drop in penetration rate. When it has a wear flat equivalent to one-third of the button diameter, the penetration will have dropped by 5%. If the bit is used further until it has a two-thirds wear flat, the penetration will have

Diagram 3: Penetration rate drops as the button profiles flatten.





Cost of grinding reduces dramatically with volume.

dropped more than 30% (diagram 3). When a bit has a heavy wear flat it tends to deviate, and, by the time it reaches the bottom of the hole, it will have deviated far more than planned. As a result, the blast will produce coarse fragmentation, and much secondary blasting may be required.

In slope hole drilling, it is of utmost importance that the holes are straight. If the holes deviate, the slope walls will be uneven, making rock reinforcement more difficult than expected.

Rock formations with different layers and joints are often characterized by heavy hole deviation, putting extra stress on the remaining rock tools in the drillstring. A sharp bit always cuts

better, and will prevent both deviation, and its disadvantages.

Grinding machines

Two parameters guide the selection of the right grinding machine: the number of bits to be ground; and whether the machine should be portable or stationary. Several kinds of grinding machines are available to satisfy these parameters. In most cases, a simple machine will suffice for a small operation, grinding only a few bits.

The semi-automatic machines are more suitable for larger operations, such as mines and construction sites, where the machine can be stationary, and the

rocktools can be brought to it. Secoroc Grind Matic HG is a water or air-cooled handheld machine for grinding cups. Both spherical and ballistic cups are available. The machine is driven by up to 7 bar compressed air, and is suitable for a small grinding operation.

Secoroc Grind Matic Manual B is an air-driven portable grinder using diamond-coated grinding wheels for spherical and ballistic buttons. The machine is mounted in a box fitted with wheels and handles for easy set up. It is mainly for threaded button bits, but small down-the-hole bits can be ground in this machine. A steel spring is mounted in the profile of the grinding wheel, where it functions as a centring device, allowing for easy grinding.

Secoroc Grind Matic Manual B-DTH is similar to the Secoroc Grind Matic Manual B. It is mainly intended for down-the-hole bits, but can also be used for threaded bits with a special bit holder. As an optional accessory, the machine can be equipped with a belt grinder for gauge grinding.

Secoroc Grind Matic BQ2 is the latest semi-automatic machine, with many features such as auto-indexing device, timer control, automatic feed, and an automatic centring arm. These features, coupled to an ergonomic design, ensure high productivity, and the machine is designed to handle large volumes of threaded button bits. Cooling

Diamond grinding wheels.



Secoroc Grind Matic Manual B.





Secoroc Grind Matic Manual B-DTH.



Secoroc Grind Matic BQ2-DTH.

water is recycled after the waste product has been separated in a container. Secoroc Grind Matic BQ2-DTH is the latest grinding machine for mainly

down-the-hole and COPROD bits. It can also be used for threaded bits with a special bit holder. The machine has the same features as Secoroc Grind

Matic BQ2, and can grind bits up to 180 mm (7 in) diameter.

Grinding advice

The Secoroc Grind Matic machine's secret of success is that both the grinding table and the diamond grinding wheel rotate. The result is perfectly ground button surfaces, regardless of whether the buttons are spherical or ballistic.

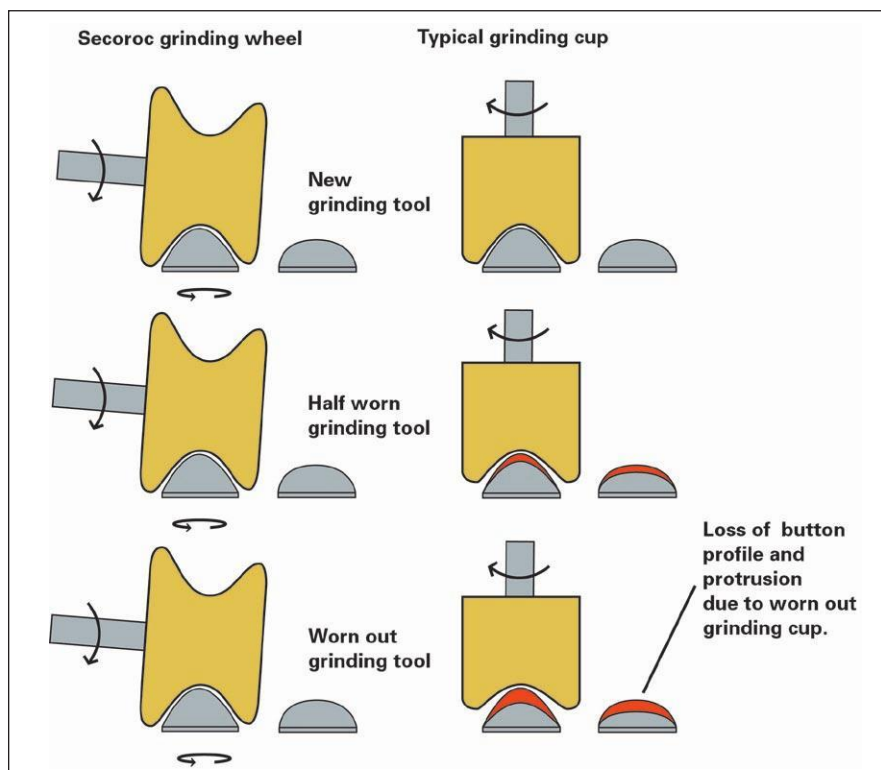
In addition, the machine's unique diamond grinding wheel is designed to ensure even wear on its grinding surface, while still retaining its profile. This, in turn, guarantees the button shape throughout the life of the wheel.

Secoroc's advice is to use Secoroc Grind Matic grinding machines, with profiled diamond grinding wheels, for grinding button bits. It is the only solution able to consistently deliver perfectly shaped buttons on customers' bits.

Correct grinding is important for every drilling operation, particularly in these days of cost consciousness and fierce competition. It can make a world of difference to the bottom line.

Bo Persson

Comparison of grinding wheel with grinding cup.



Secoroc Grind Matic Jazz

Rig mounted grinder

In today's world of professional rock drilling, where ever more powerful drill rigs and hammers are used, it has become extremely important to give the drill string all the necessary care and maintenance needed if optimum drilling productivity is to be achieved.

Regrinding the cemented carbide buttons of the bit at proper intervals increases the service life of the whole drill string. This, in turn, helps maintain penetration rates, while ensuring that holes are drilled straight and true.

Quick and efficient grinding of button bits in surface drilling applications, where the rig is constantly on the move from one job site to another, has been an elusive goal. However, Atlas Copco Secoroc has now come up with the solution, by developing a rig-mounted semi-automatic grinder. The Secoroc Grind Matic Jazz, equipped with a profiled diamond grinding wheel, achieves the same quality of grinding onboard the rig as that previously associated with static workshop models.

Development

Atlas Copco Secoroc has gained extensive knowledge and experience of regrinding large volumes of button bits with stationary grinders, such as the Secoroc Grind Matic BQ2 and Secoroc Grind Matic BQ2-DTH. These, together with previous generations of similar grinders, have all used profiled diamond grinders for working on spherical and ballistic buttons. However, onboard grinding machines have always been fitted with diamond grinding cups, which have proved to be less efficient than profiled diamond grinding wheels.

The new Secoroc Grind Matic Jazz grinder, which is equipped with profiled diamond grinding wheels, will consistently deliver the same perfectly shaped spherical and ballistic buttons

Secoroc Grind Matic Jazz can easily be set up on the drill rig.



after regrinding. This is increasingly important in relation to ballistic buttons, which are becoming more and more popular.

Secoroc Grind Matic Jazz

The air-driven Secoroc Grind Matic Jazz helps optimize the performance

Secoroc Grind Matic Jazz ready for grinding.





Secoroc Grind Matic Jazz for correct and professional grinding.

of the rock drill and drill string, without the bit leaving the rig. It is user friendly, is designed for economy of air consumption, and can easily be retro-fitted to most rigs in current use. It is delivered with an attachment for bolting on to existing rigs, which allows the operator to fold away the grinder when not in use. It will also be available through the sales companies as an option on new Atlas Copco drill rigs. To make the grinder ready for work, it is simply a matter of hooking up the air hose, connecting the electricity, and filling up the water tank for the mist cooling.

The low air consumption of the Secoroc Grind Matic Jazz makes it possible to grind bits without interrupting drilling operations. The grinder is semi-automatic, and features an automatic centring device for placing each

button in the correct position under the grinding wheel. An indexing bit holder is used for the gauge buttons, and there is a handy time relay for setting grinding time.

Secoroc Grind Matic Jazz is a very flexible grinder that will have a beneficial influence on drilling economy. It will grind spherical and ballistic buttons, on threaded or tapered button bits, as well as big DTH - and COPROD bits from 35 mm (1 3/8 in) to 254 mm (10 in) in diameter.

Grinding the button bit in a professional way makes sense, because grinding accounts for only a fraction of the cost of the entire drilling operation. When a drilling programme is carried on without correct service of the bits, drilling output and productivity will be significantly lower, and costs may escalate.

Bo Persson

Secoroc Grind Matic Jazz

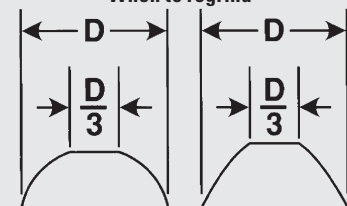
Technical Data

Air pressure, maximum	7 bar (102 psi)
Air pressure, minimum	6 bar (87 psi)
Air consumption	25 l/sec
Coolant container	3 l
Air tool oil consumption	1.8 cl/hour
Output, spindle motor	1 kW
Speed, spindle	15,000 rpm
Voltage	24 V
Weight, exclusive of packing	90 kg (198 lbs)
Transport dimension	800 x 500 x 700 mm

Grinding Capacity

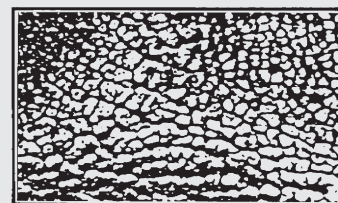
Maximum distance between bit holder and grinding wheel	250 mm (9 7/8")
Maximum diameter of drill bit	254 mm (10")
Minimum diameter of drill bit	35 mm (1 3/8")
Minimum distance between buttons	3.5 mm (5/64")

When to regrind



Button bits should be reground when the penetration rate drops, or if any of the cemented-carbide buttons are damaged (fractured buttons should be ground flat). It is both practical and economical to redress the buttons when the wear flat reaches about 1/3 of the diameter of the button.

Look out for "snake skin"



If microscopic fatigue cracks — so called "snake skin" — begin to appear on the cemented carbide buttons, the cracks must be ground away. In any event, bits should be reground after 300 metres of drilling at the most.

This should be done even if there are no visible signs of wear and the penetration rate continues to be good. If snake-skin is not removed, the cracks will deepen and ultimately result in button fracture.

Do not grind away too much cemented carbide



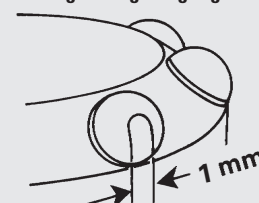
Do not grind too much on the top of the buttons. Let a few millimetres of the wear flat remain on top of the button.

Always grind broken buttons flat

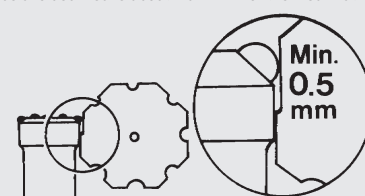


A drill bit can remain in service as long as the gauge buttons maintain the diameter of the bit. Fractured buttons must always be ground flat to prevent chips of cemented carbide from damaging the other buttons.

Avoid grinding the gauge



Gauge button anti-taper has to be removed by grinding, although excessive reduction of the bit diameter should be avoided. Leave about max 1 mm of the wear flat.



If necessary, remove some of the bit-body steel below the gauge buttons, so that a clearance (taper) of 0.5 mm is maintained. If the flushing holes start to deform, open them up with the aid of a rotary burr or steel file.

Grinding instructions for button bits.

King of cabs

Staying in the front seat

The operator and his working environment was given top priority when Atlas Copco set out to redesign the new cabins on its latest range of ROC drill rigs. Starting early in 2005, a survey was carried out among operators in a number of different countries to find out their views on the merits of the existing cabs in the ROC D, F and L series, and how they could be improved. The feedback was appraised against a background of the latest available technology, and the designers added a few of their own ideas. The result was a range of innovative solutions that produced the most comfortable and practical cab yet seen, already described as the next generation workplace for drillers.

Fruitful consultation

Talking and listening to the professionals who would ultimately occupy the new cabs proved very fruitful. Mats Berger, who headed up the project at Atlas Copco's surface drilling division in Örebro, Sweden, got a great number of suggestions. Drillers commented on everything, from repositioning the controls to requesting television screens. Even the wilder ideas were considered and evaluated as research input. By merging the operator's comments with the Atlas Copco concept of what was needed, a list of specifications for the new product was gradually built up.

The next step was to engage an outside design specialist that could assist in driving the concept from drawing board to reality. For this work, Atlas Copco engaged Bosul-Sekura, a Danish cab manufacturer renowned for designing cabs for forestry machines, trucks and other industrial equipment.

With the operators' wishes uppermost in their minds, the two companies agreed on three main objectives: increase the amount of interior space;



The new crawler rig cabin.

raise the ergonomic standard; and improve the overall in-cab environment.

Tough challenges

Each objective involved tough challenges, primarily because the basic dimensions of the cab could not be altered due to the designs and sizes of the drill rigs. Not only that, each proposed alteration had to meet strict specifications from Atlas Copco for high quality, compatibility with modular assembly and two different ROPS (Roll Over Protection Structure) weights of 19 t and 30 t.

The team started by generating design sketches and visuals, and over the next 18 months a number of solutions began to emerge. These were then assessed by a number of customer clinics where

invited groups of customers gave their opinions of the various mock-ups that were made. This proved to be very beneficial to the project, enabling the team to check they were on track at each crucial stage of the design process.

Design changes

Atlas Copco ROC crawler rigs are designed to be as compact as possible. The boom, which carries the feed, determines the cab width. The width is also determined by the standard transportation width of 2,500 mm of the engine compartment and its power pack. The length is dictated by the rig's design. In addition, the swing of the feed, and the articulation of the tracks when tramming in rough terrain also impact on the amount of space available for the cab.



Stepping up: A service platform, which is also a toolbox, gives access to the windscreen; steps, grab rails and front mounted cab door make getting in and out easier; a single-moulded mat for easy cleaning.

Lastly, the cab height is limited by the overall transportation height.

Given these restrictions, the designers came up with a solution based on a redesigned cab shell shape, as well as a repositioned, redesigned door and modified instrument and control positioning.

For example, the corner doorpost has been moved forward to the front. It is now also narrower at the bottom than it is at the top, yet still wide enough for the biggest boots to step in comfortably. This greatly improves access, and also makes it easier to step across to the front service platform from where the operator can clean the windscreen and roof glass, or change the wiper blades.

An outside grab-rail, and another on the inside of the door, make it easier for the operator to pull himself up, and an integrated, push-button opener saves a little more space.

Storage space was also a big issue, and a range of smart solutions have been developed in the interior, including document holder, flask, bottle and cup holders, large day-bag holder, oddment trays, and optional lockable glove box. There's even space for a small cooker and a coolbox. The storage trays have also been moulded in the same durable,

polyurethane rubber to minimize noise from the vibration of objects that may be placed in them.

Better visibility

The design changes also led to improved visibility, which in turn, contributes to safety. The large windows give good all round visibility and the front windscreen is slanted inwards, which helps to keep off the rain and dust.

This design, together with the new skylight in the roof and repositioned instrument panel, enables the operator to see the whole drilling process, from surface collaring to the top of the feed.

The negative slope of the windscreen eliminates the need for a protective grille, and the standard 10 mm thick laminated glass can also be replaced with 24 mm thick glass for especially demanding and dangerous worksites.

An added bonus is the new finger-touch instrument panel. This is aligned with the right hand pillar, and placed in such a way that the switches can be seen without the operator having to take his or her eyes off the drilling feed.

The new cab is also easier to keep clean, and is with single-moulded rubber

mats, designed so that dust and debris can be swept out of the door.

Improved environment

As operators often have to remain in their cabs for lengthy shifts, the designers have paid close attention to ergonomics and comfort. For example, the controls and instrumentation panels have been repositioned to make them as easy and as comfortable as possible to use.

Sometimes only slight adjustments have been made, but with important ergonomic results. For instance, the three main joysticks on the right hand side used to control the boom, feed and rock drill, have been moved forwards just 150 mm. This small change eliminates the need to twist the body and arm in order to perform certain functions.

The atmosphere inside the cab is a key factor for the operator's overall comfort and well being, and not least, for productivity. The new cabs feature an improved ventilation system that includes a relocated air intake, two-stage filtering and more effective heating and air conditioning. This results in a pleasant working environment, even in the harshest of conditions.

The air conditioning system is designed for providing a temperature of +23 degrees C in outdoor temperatures of -25 degrees C.

In hot climates, it will keep the interior to +25 degrees C despite an ambient temperature of +50 degrees C. With nine settings to choose from, this should be sufficient to keep operators cool under any circumstances.

An added advantage is the smart placing of the air conditioning filter. It is now accessible from a hatch on the outside of the rig, making it easy and fast to change

Objectives met

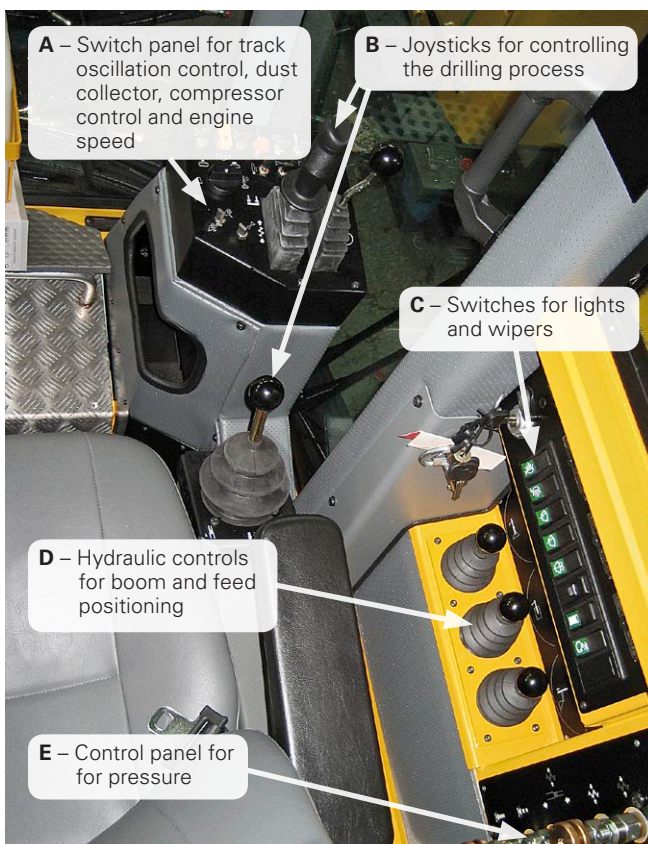
There's no denying that the new cab is a major all-round improvement on previous models. A great deal of time has been spent on testing, not only involving operators, but also service personnel, marketing and sales representatives, as well as distributors and importers. Their input has heavily influenced all



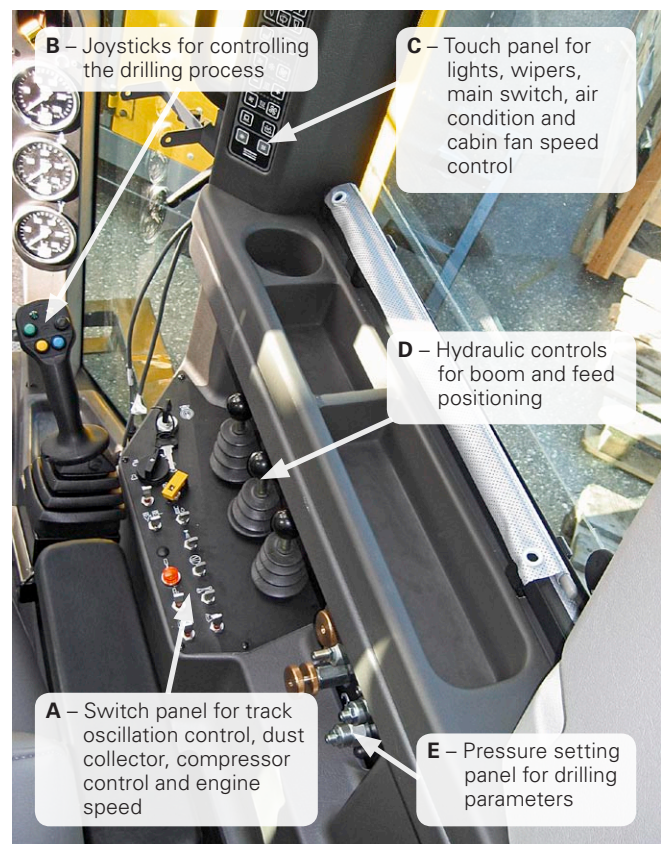
Old cabin – left side



New cabin – left side



Old cabin – right side



New cabin – right side

aspects of the design process, with the aim of making the final product as good as it can be.

David Bowler, designer at Bosul-Sekura, believes it shows what can be achieved when enthusiastic and experienced people work together as a team with a desire to keep Atlas Copco at the forefront of drilling solutions around the world.

Not only have the three main objectives been met, but there is also a whole range of optional extras on offer to make the operators even happier. DVD and

CD sound systems, Internet access, TV and satellite connectivity, Xenon headlights, and more are all available.

According to Mats Berger, this cab is not the ultimate design, but is a step in the constant evolution of Atlas Copco products. It will last for quite some time, but demands change and there will always be room for further improvement.

The new cabs are available on all ROC D and ROC F and ROC L-series drill rigs. Many of these rigs have already been delivered, and the response from worksites has been positive.

Among other things, the new cab is much easier to climb in and out.



These include tophammer, DTH (down-the-hole) and COPROD equipped drill rigs, all designed to give maximum productivity and good overall economy. Over the years, these rigs have built a solid reputation for setting new standards in stability, manoeuvrability and safety.

The ROC D-series with cab, equipped exclusively with tophammer rock drills, covers hole diameters ranging from 64 mm to 115 mm (2.5 in to 4.5 in).

The ROC F-series comprises tophammer and DTH, as well as COPROD versions, covering the hole ranges of 76-140 mm (3 in to 5.5 in). The control systems match the systems used on the ROC F6 and ROC F9, as well as the SmartRig computerized rig control system used on SmartRig ROC F9C.

The ROC L-series includes rigs featuring all drilling systems and covers all hole diameters from 92-203 mm (3.625 in to 8 in). Both the ROC F and ROC L-series have a different hydraulic control system to the ROC D-series, and electric controlled tramming as well as more extensive engine and electric system monitoring, including hole depth and hole inclination measuring in a 6.5 in colour display.

The new cab will ultimately be available on most ROC surface drill rigs, including CM/ECM 400, 500, 600 and 700-series.

Cabs are not fitted to some models of hydraulic rigs such as the ROC D3, ROC D7RRC and ROC D9RRC. Designed for drilling in urban areas in rough terrain, the ROC D3 handles 41-89 mm holes (1.625 in to 3.5 in). RRC rigs are operated via radio remote control, while on other versions the operator stands up on the rig to control it. Compressed air rigs vary even more, and can require up to three operators.

Acknowledgements

Atlas Copco thanks all owners and operators who provided comments in the design process for the new ROC cabs. All illustrations in this article, a version of which first appeared in Mining & Construction magazine 3-2007, are reproduced courtesy of D Bowler 04/ Bosal Sekura Industries.

SmartRig takes control

Computer control

Ever since Atlas Copco developed Hydraulic Control System (HCS) in the 1970s, the search has been on for its successor. Programmable Logic Control (PLC) saw us through the 1990s, along with the VME-system, but it was in 2006 that SmartRig took over. SmartRig is a computer based control system intended for all kinds of automation in simple and advanced drill rigs. The hardware is designed to operate in every possible weather condition, and the software can be upgraded at site. SmartRig has built-in logging and monitoring functions, together with support for diagnostics and faultfinding. The control system is used in all Atlas Copco product families, in both in underground and surface crawlers, making it easy to move functions and improvements between different products.

The range of SmartRig ROC D7C, D9C and F9C drill rigs offers valuable features such as high shift capacity, low energy consumption, and innovative modules that improve productivity by more efficient planning, streamlining the drilling and blasting process and documenting each hole. Better design means less risk for oil leakage; less noise with the Silenced SmartRig; and lower fuel consumption. That's smart!



Silenced SmartRig ROC D9C

Control system

Via computer software, the SmartRig control system generates electrical signals to control the hydraulic valves. This introduces the concept of a “dry cab”, with no hydraulic pipework and gauges, considerably reducing noise for the operator.

The number of hydraulic components has been reduced by 30%, compared with Hydraulic Control System, HCS, resulting in higher efficiency. The need for electrical cables is also reduced.

Control gauges and instruments are replaced by a display unit. This releases

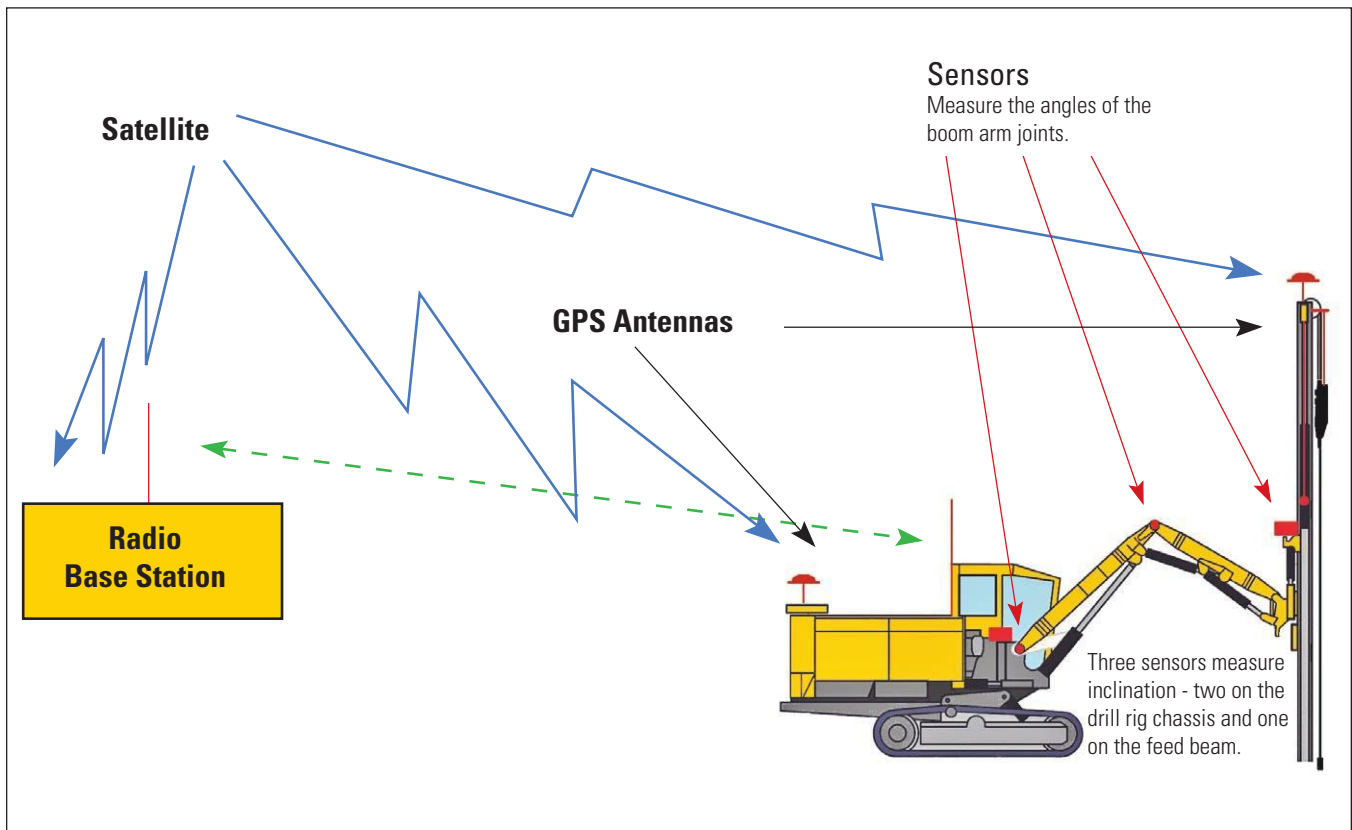
space in the cab, increasing visibility, and improving operator ergonomics.

The fundamentals of the rock drill control system are RPCF control and anti-jamming functions. RPCF, or Rotation Pressure Control of Feed pressure, adjusts the feed pressure according to the measured feed pressure. This keeps the joints correctly tightened and saves drill steel. Anti-jamming uses the rotation pressure to detect a jamming situation, and will reverse the feed of the rock drill and initiate a replacement hole collaring.

Together, this advanced system of drilling control gives maximum life to the entire drill string, while ensuring high penetration rates and easy rod extraction.

Automation in surface drilling

The rig can be equipped with a laser plane receiver to give an accurate reference height so that all holes can be drilled to the same depth, thereby reducing drilling, blasting and crushing costs by



A typical hole navigation system showing satellite, sensors, GPS antennas and radio base station.
The hub at centre of this data is the Atlas Copco Rig Control System.

way of better fragmentation, and cancelling the need for secondary blasting. A flatter, more uniform bench surface results, making loading and transportation easier.

Automatic feed alignment reduces set-up time and cancels out operator error by setting the feed to predefined angles at the touch of a button. More parallel holes result in better blasting and smoother bench bottoms. The longer the hole, the bigger will be the impact of even a small deviation on blasting. For instance, a one-degree error will produce a deviation of 35 cm at the bottom of a 20 m hole.

The automatic rod adding system, AutoRAS, enables the operator to drill a hole automatically to a given depth, allowing him to leave the cab to carry out other duties such as maintenance checks or grinding bits, while keeping the drill rig in sight. The drilling is supervised by the drill steel break detection system, which shuts down the drilling operation if a breakage is detected. The result is better rig utilization, evidenced by a couple of extra holes/shift.

MWD and ROC Manager

Measure While Drilling, or MWD, is an optional instrumentation and software package for recording and interpretation of drilling data, and enhanced presentation of geomechanical variation of rock properties.

A number of parameters, such as hole depth, penetration rate, and damper, feed, percussion and rotation pressures are logged at requested intervals while drilling, and this provides input to analysis of the rock properties.

Date, time, hole length, feed angle, and rig identity are logged once for each hole. MWD data can be recorded for every second centimetre up to a maximum penetration rate of 3 m/min. In this way, data is extracted from every production hole to provide very high-resolution rock mass characterization. Typical parameters being reported are rock hardness and fracturing.

Detailed information on rock mass properties is available immediately after drilling is completed, without disturbing production, since logging is carried

out automatically during the normal drilling process.

ROC Manager runs on a standard computer and is used for making drill plans, measuring hole deviation, and logging, presenting and reporting drilling data graphically. This information can be presented individually or in combination with other parameters, and used both during drilling operations, and by transferring logged data from the rig. ROC Manager can be used to consolidate data about multiple rigs at different worksites.

Advanced MWD analysis is also possible as an option. Both the SmartRig and ROC Manager 2.0 support the IREDES format for data exchange on performance, quality and MWD logs, and on drill plans.

In ROC Manager, the MWD data can be illustrated in slices through the bench, with the rock properties identified by contrasting colours, providing a map of the mineral qualities and types. This facility differentiates between good rock and poor rock, for instance, allowing the quarry or mine operator to select

rock for excavation, and to prepare for loading and hauling before blasting takes place.

Hole Navigation System

Hole Navigation System, HNS, offers the highest possible drill rig navigation accuracy, to within 5 cm in most situations. With HNS there is no need to mark out holes, and the accuracy is such that all holes will be parallel, if required, resulting in a controllable product with better fragmentation and less boulders. All drilling functions are monitored and controlled to provide a record of hole alignment, burden and spacing. Originally developed for road construction applications, HNS can now be used in any type of drilling operation.

Using information on his display, the operator can navigate the rig to the coverage position for a given hole, and the computer will provide the information to place and align the feed exactly over the collaring position, thus reducing setup time.

The drillplan can be provided by ROC Manager and transferred to the rig via a memory card. The time saved by not having to aim visually to set angles, and by being able to drill more than one hole from a single setup, results in better rig utilization.

The precision of the navigation system optimizes drilling and blasting results, improves fragmentation, and decreases the amount of explosives needed, substantially lowering overall production costs.

Silenced for noise sensitive areas

The sources and characteristics of noise are complicated, and have to be identified and analyzed in order to define their spectrum. Atlas Copco testing using prototype drill rigs confirmed that noise was not just created by the drilling cycle, but also by elements of the carrier, such as cooling fans, hydraulic system components, and the diesel engine.

Silenced SmartRig incorporates the lessons learned, and is being used successfully at worksites in situations where noise levels have to be controlled, such



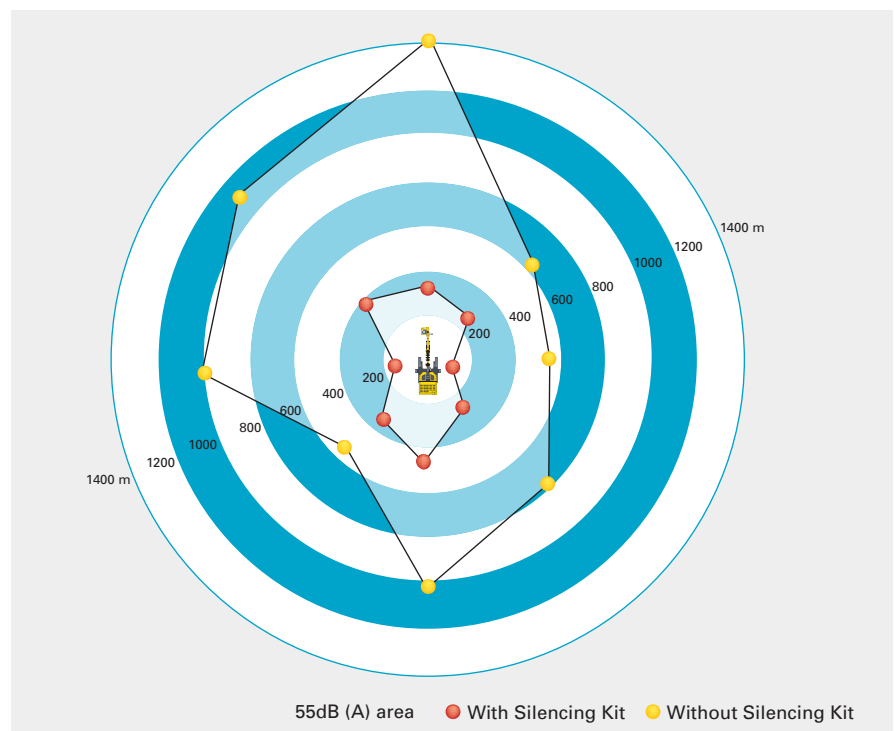
Silenced SmartRig ROC D7C feed.

as in restricted urban areas. Substantial efforts have been put into redesigning components, systems and soundproofing enclosures, resulting in a 10dB(A) external noise reduction. The most visible difference between the Silenced SmartRig and other SmartRig units is its patented feed enclosure. The frame and panels of the enclosure are formed

from lightweight aluminium. There are four access doors, which are hydraulically operated from the cab. A rubber sliding skirt at its base encloses the hole, and this can be hydraulically raised for collaring. The whole enclosure is designed for demounting when not needed.

Because the SmartRig system delivers the right amount of power for each

The noise carpet shows the difference with and without a Silencing Kit.



phase of the drilling operation, it can reduce fuel consumption by up to 30 percent. Add this to the productivity increase from automatic rod adding and auto feed alignment, and Silenced SmartRig is a really sound investment! There are three SmartRig crawlers to choose from, designed for a range of quarrying and construction scenarios.

The SmartRig ROC D7C has power, flexibility and excellent rough terrain capabilities for drilling holes in the 64-115 mm, 2.5-4.5 in range. It has characteristics that elevate surface drilling to impressive new levels of quality, productivity and cost effectiveness, making it ideal for construction and quarrying.

The SmartRig ROC D9C has all the advantages of SmartRig ROC D7C, but with more powerful rock drill and more flushing air, making it the perfect choice for high productivity jobs requiring holes in the range 76-115 mm, 3.0-4.5 in.

SmartRig ROC F9C is a powerful top hammer rig with high power and remarkable versatility that make it suited to large scale quarries and construction work requiring holes in the range 89-127 mm, 3.5-5.0 in.

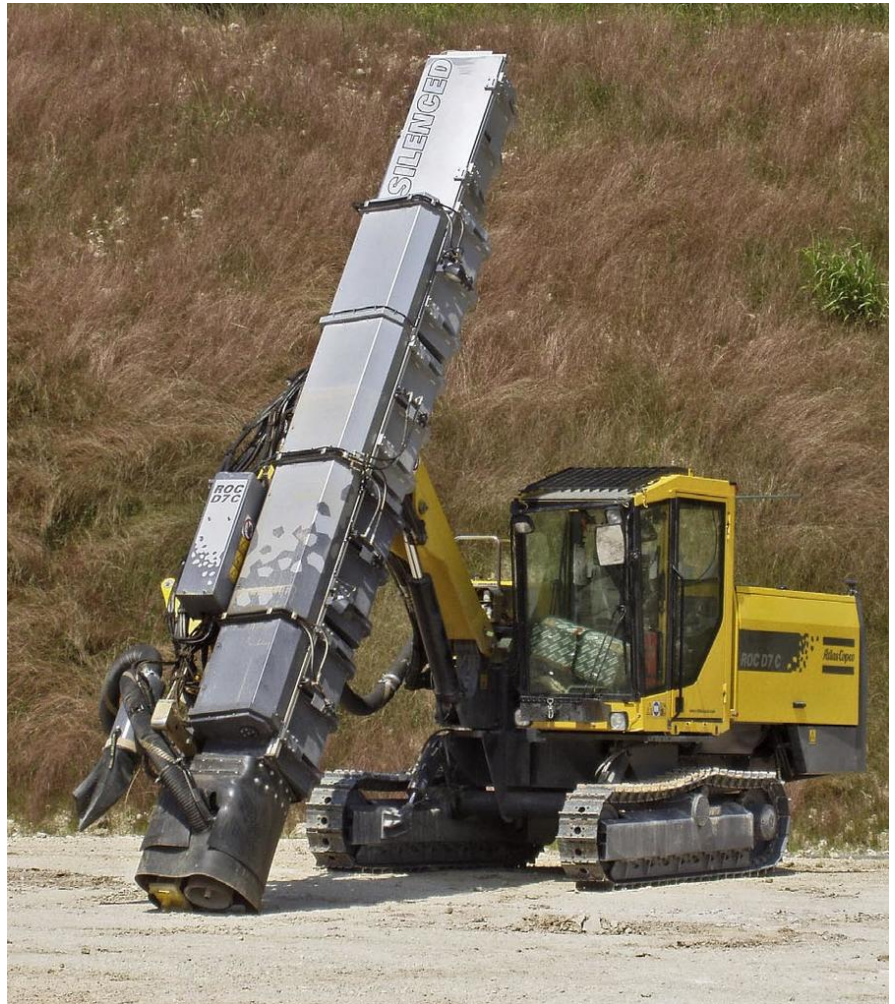
Both SmartRig ROC D7C and SmartRig ROC D9C are available in Silenced SmartRig versions.

Case studies

The Norwegian contractor Mesta improved the efficiency of its blasting operations by using SmartRig ROC drill rigs equipped with HNS Hole Navigation System on the Romarheim road improvement project, 50 km northeast of Bergen, Norway.

On this first use in drilling for road construction in Scandinavia, HNS provided pinpoint accuracy in hole positioning, ranging from +/-100 mm to +/-50 mm, depending on the number of satellites in view.

The display screen in the rig cab shows standard codes that the operator can follow, and by logging the position coordinates provided by the HNS, there is no need for road boundaries to be marked out prior to blasthole drilling. The system also allows the operator to optimize positioning, so that the maximum number of holes can be drilled from one setup.



Atlas Copco's Silenced SmartRig ROC D7C is a sound investment with a noise level of approximately 10 dB(A) below that of other rigs on the market.

At the Norcem Bjørntvet open-pit quarry, 10 km from Brevik, an Atlas Copco SmartRig ROC F9C equipped with HNS and the automatic rod adding system AutoRAS, is at the core of the operation. The SmartRig control system provides automation to the drilling process, resulting in higher penetration rates and longer service life for drill string components, reducing costs. SmartRig also enables the rig to drill automatically to a predetermined depth, while allowing the operator to carry out other tasks.

Norcem management observed that the SmartRig ROC F9C has improved performance in three dimensions. Distribution of the explosives is better; drilling to correct depth is achieved every time; and holes are parallel. As a result, use of explosives has been optimized by lower specific charging, better fragmentation and increased blasting safety.

NCC Roads came to two important conclusions about their Atlas Copco SmartRig ROC D7C: the drill steel lasts approximately 20 percent longer; and the life span of the shank adapter has increased from 17,000 to 30,000 drill metres. Adjustments to percussion pressure and rotation pressure, which are features of SmartRig ROC D7C, have made drilling much smoother, and the holes straighter.

The NCC Roads drill rig operator uses all of the automatic functions to maximum effect. As a result, drill rods are discarded because of wear, rather than breakage.

Smoother drilling, by optimizing drilling parameter settings, also increases the life of the shank adapter.

Hakan Aytekin

ROC T15 for tough drilling situations

Small but beautiful

When small holes means big business, the brand new self-propelled, four-wheel drive ROC T15 from Atlas Copco makes very good sense. It is the smallest hydraulic surface drill rig in the range, for hole diameters of 23-45 mm (0.875 in to 1.75 in). With horizontal coverage of more than 18 sq m, ROC T15 is perfect for urban construction jobs, dimensional stone cutting, and unique applications such as self drilling anchors, bolting holes and boulder blasting. It is equipped with easy to operate full radio-remote control for tramming and drilling safely and efficiently in difficult places without putting the operator at risk.

Large coverage

ROC T15 is fitted with a high productivity Atlas Copco rock drill matched to the required hole size, and has the same type of long reach, stiff folding boom and durable aluminium feed as its bigger cousins in the ROC family.

Three different rock drills are available for various applications. The Atlas Copco COP 1019HF rock drill can handle 19 mm (0.75 in) hex integrals and tapered equipment, while the COP 1022HF takes 22 mm steels. The COP 1022HF also facilitates extension drilling using a short 22 mm hex shank end rod with R25 threads. Likewise, a COP 1028 can be mounted and equipped with a Secoroc Magnum SR28 or R32 shank.

Applications

ROC T15 can replace hand held drills in small aggregate quarries. It can excavate building foundations and be used in trench blasting and road and railway construction. It can install self drilling anchors, and drill for rock bolts and boulder blasting in both surface and underground environments. ROC T15 can also be employed drilling out



Atlas Copco ROC T15 is the smallest hydraulic rig in the range.

blocks of dimension stone in specialized quarries.

Equipped with a hydraulic drill steel support, the rods can be retracted and uncoupled using the remote control.

A hydraulic winch is fitted for working in extreme conditions, and where it is necessary to anchor the rig or to secure safe tramming. Specially designed front support legs help tramming

over rough terrain. The mechanical hole inclination instrument, ROC Angie, will result in lower blasting costs, correct inclination and better fragmentation.

The Deutz engine fitted to ROC T15 meets Tier III exhaust emission limits, and the rev/min can be adjusted via the radio-remote control to minimize fuel consumption. The dust collector is built-in to reduce hose damage.



ROC T15 is a versatile and compact hydraulic drill rig for 22-45 mm diameter holes.

Secoroc Magnum SR28 drill steel for COP 1028 extension drilling.



A large coverage area makes ROC T15 suitable for many construction applications, and stable tramming makes for speedy and safe movement under all floor conditions. On the highway it can be easily transported on a small truck, or a trailer with the boom folded to very compact dimensions.

Hakan Aytekin

Quarrying for profit

Finding the best combination

Large quantities of raw material are produced in various types of surface operations. Where the product is rock, the operations are known as quarries. Where metallic ore or non-metallic minerals are involved, they are called open pit mines. There are many common parameters in design and choice of equipment, and in the process of finding the best combination of drilling and blasting methods. Atlas Copco has the advantage of long experience derived from all types of surface drilling operations, with a product range to match almost any application. With its history of innovative engineering, the company tends to think forward, and is able to advise the user on improving design elements of the operation that will result in overall cost savings.

Rock for concrete

This article focuses on quarries producing aggregates for various types of construction works and limestone for cement manufacturing and other industrial purposes.

A major difference between open pit mining and quarrying is the geological conditions and the demand characteristics on the blasted material. Whereas quarries deliver the majority of rock via the crushing and screening plant in various size fractions, the open pit mine attempts to deliver the ore as pure as possible via crushers to the dressing plant, consisting of mills, separators, flotation and biochemical systems, then finally to smelters in order to convert minerals to metals. The size of holes is commonly larger in open pit mining, and each blast often exceeds a million tonnes of rock. The presence of fines is normally beneficial to the mineral dressing process, which means that a multiple of holes and rows of holes are blasted simultaneously.

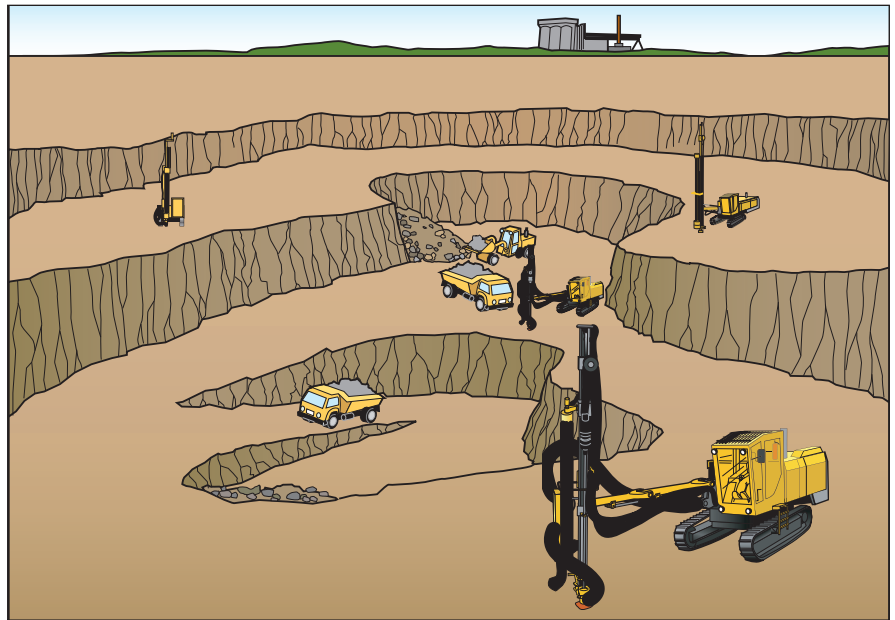


Figure 1: Typical quarry layout.

Quarries

A quarry is a factory that converts solid bedrock into crushed material. From an operational viewpoint the quarries can be split into two major groups.

In the first group are quarries for the production of aggregates, where the rock is crushed, screened, washed and separated into different sizes. These are sold as raw material for concrete aggregates, highway construction and other civil engineering projects, so the amount of fines should be kept to a minimum.

In the second group the final products are used as raw material for chemical plants, such as limestone for cement manufacturing, paper and steel industries, and clay shales for building materials.

Aggregates

Not all types of rock are suitable as raw material for crushed stone. The material must have certain strength and hardness, and the pieces acquire a defined shape, quite often having a rough surface. Consequently, soft sedimentary

rock and similar material, which breaks into flat, flakey pieces, are unacceptable. Igneous rock, such as granite and basalt, as well as old Precambrian highly metamorphic rock, such as gneiss, are well suited. The crushing and screening process are adapted to give the desired shape and size fractions to the end-product. Cubic shaped particles are desired for asphalt, to give a stable road surface, whereas spherical shape is preferred for concrete mix, in order to save on cement. Minerals, being crystals, have a tendency to break into endless numbers of sizes and shapes every time they are exposed to energy. The solution lies in the art of limiting the number of over and under sizes produced during reduction. If this is not controlled, the mineral will follow its natural crystal behaviour, normally resulting in too many fines.

Quarry operators normally sell their products to local contractors and road administrators. Hence, in areas where construction activities are high, several competing quarries could be established.

Apart from environmental aspects, such operations can disturb the neighbouring area in the form of noise from

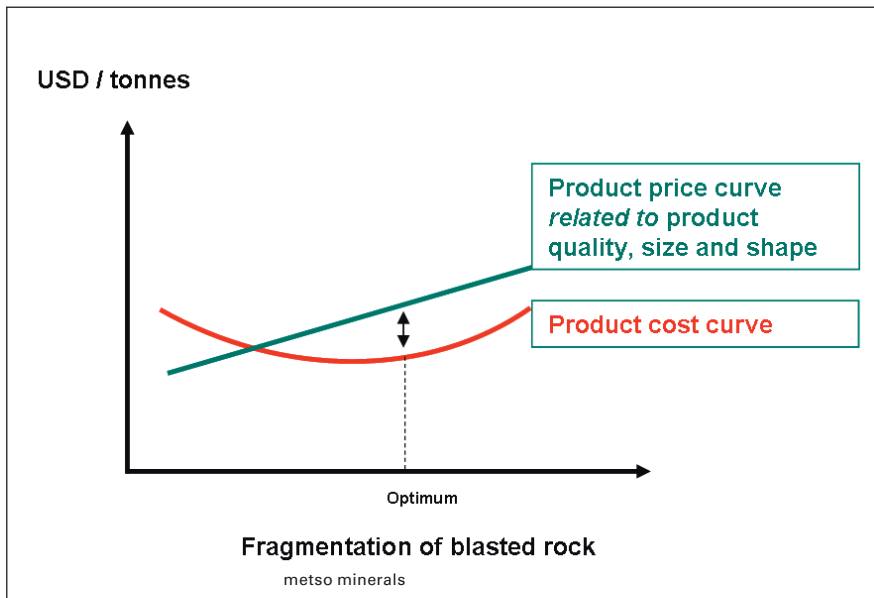


Figure 2: Operational targets for a typical aggregate producer.

drilling, vibrations from blasting, and dust from crushing and screening. Quarries, wherever possible, are therefore discreetly located, as close as feasible to the construction area, because the products are transport cost sensitive. The maximum transport distances do not normally exceed 50 km.

Quarries can be either of the common pit type or, in mountainous terrain, the hillside type.

Pit type quarries are opened up below the level of surrounding terrain, and accessed by means of ramps (figure 1). The excavation is often split into several benches, depending on the depth of the operations. In its first stage, when the terrain is rough and bulldozers cannot provide a flat floor, a top-hammer construction type drill rig can be used to establish the first bench. Once the first bench is prepared, production drilling is preferably carried out using DTH- or COPROD techniques.

Lower benches

Whereas high benches, above 30 m, were previously quite common, nowadays they are shallower, for improved safety and economy. The width of the bench should be sufficient both to accommodate the spread of rock blast, and to provide space for the equipment. The height of the working face in hill type quarries is determined mainly by

the topography. A typical work cycle in a quarry consists of a number of elements. Drilling of blast holes is undertaken in a predetermined pattern, followed by plugging the drill holes with wooden or plastic plugs to prevent entry of debris. When the round has been drilled, preparations for blasting will start. The holes are blown clean with compressed air to remove water and rock fragments, and are then charged with a booster bottom charge, detonators and explosives. Stemming is inserted into the top of each hole, and the detonator leads are connected. Where electric detonators are used, the circuit resistance is checked with an ohmmeter. The area is evacuated, equipment is moved away, and the round is fired.

Before loading, the lower quarry floor is cleaned of fly rock with a wheel loader. Blasted rock is then loaded into trucks, and transported to the crusher station. Large boulders are pushed aside, and stockpiled for subsequent secondary breaking, usually using excavator-mounted hydraulic breakers. Rock is discharged directly, or via a grizzly for size control, into the primary crusher.

The rock is then transported by conveyor belt to secondary crushers, and possibly tertiary crushers.

The different products, comprising rock fragments of certain size ranges,

are recovered from the process by vibrating screens, and transported to storage silos or bunker piles on the ground.

Optimum efficiency

There are various factors to be considered when trying to achieve optimum efficiency and overall economy from quarrying operations. The difference between revenues from products and the production costs must be maximized. Operational targets for Metso, a leading manufacturer of crushing and screening equipment, are shown in figure 2.

For aggregate quarries, the fines should be avoided, as the finest fractions are of no value. Figure 3 illustrates a typical cost distribution between drilling and blasting, loading and haulage, and crushing, including screening and storage. It should be noted that crushing, screening and storage represent almost half of the costs, whereas drilling represents less than 15%. More often than not, the crushing operation is the bottleneck in the total work cycle. It is sometimes the case that extra expenditure in drilling and blasting might be the only way to assure free flow through the crusher, in order to utilize full capacity in the plant, and improve overall economy. Even fragmentation, and smooth benches, will also have a positive effect on loading and transport equipment.

In the 1980s, there was a trend amongst rock producers away from large diameter holes, which produced more boulders and more fines, in favour of medium size 89-165 mm (3.5-6.5 in) holes (figure 4).

Also, limiting the blast size reduces micro cracking, and hence the production of fines. The opposite situation occurs in open pit mining, where the generation of fines is favourable, as these will pass through the mill with a minimum of costs.

The trend is to larger crushing equipment, enabling boulders to pass through the primary crusher.

However, large crushers are primarily designed to handle large volumes of rock material, rather than large size material. Therefore, it is worth assessing the rock fragmentation derived from

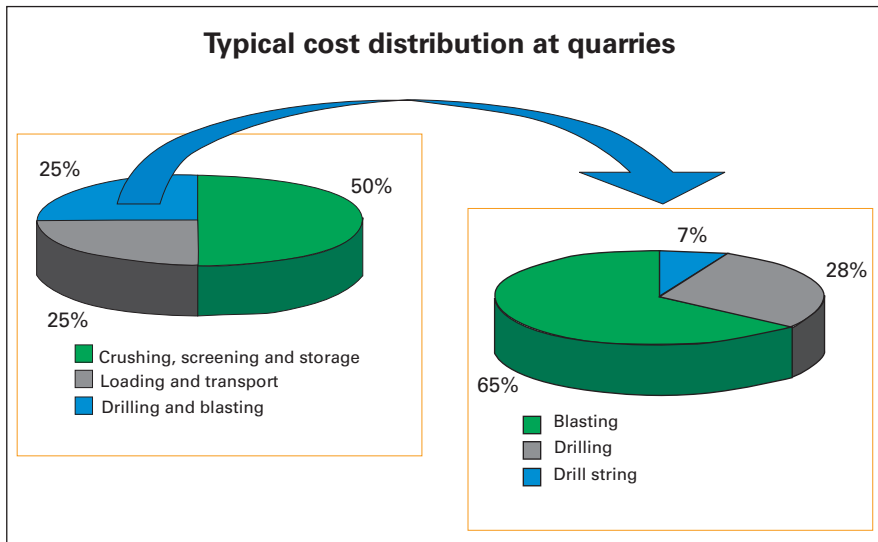


Figure 3: Operational cost distribution at quarries.

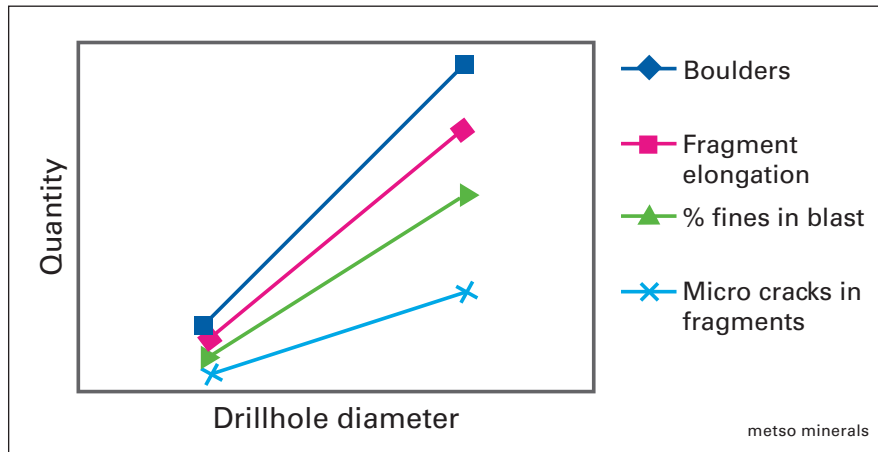


Figure 4: Quantity vs drill hole diameter.

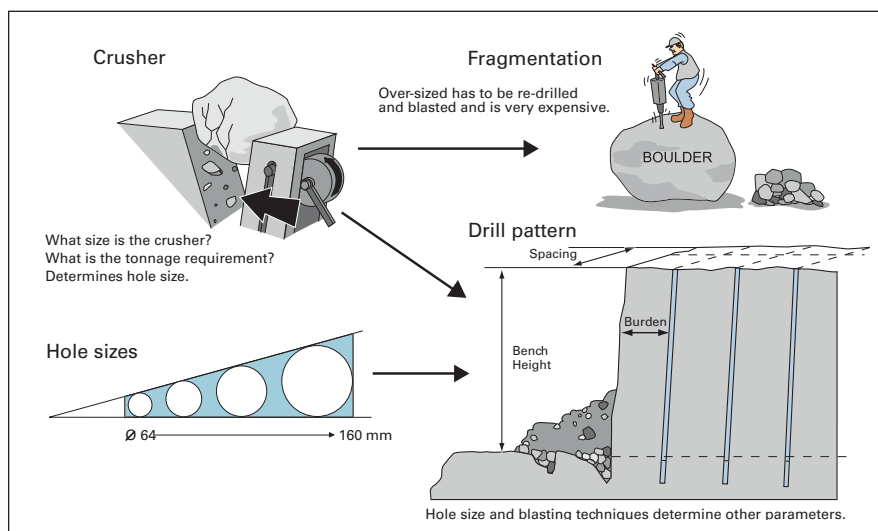


Figure 5: Fragmentation in quarries.

the drilling and blasting cycle, in case some additional investment in drilling could be the answer (figure 5).

The whole chain of activities leading to the final product of crushed material must be considered when optimizing total costs.

Drilling costs depend upon the hole size and drilling density, in which accuracy of drilling is a factor; blasting costs depend on the amount and type of explosives, and number and type of detonators; and loading, transport and crushing costs depend on quarry floor roughness, and fragmentation.

For most drilling applications, the optimum ratio between bench height and burden seems to be in the range of 3 to 4, indicating that hole diameters of 125-165 mm (5-6 in) are best for a bench height in the order of 18 m.

Regarding drilling method, there is a clear movement towards hydraulic topammer, COPROD-drilling and DTH, and away from pneumatic and rotary drilling.

Limestone quarrying

Four percent of the earth's crust consists of limestone containing the minerals calcite (calcium carbonate) and dolomite (magnesium-calcium carbonate). Limestone is formed by sedimentation at the sea bottom, sometimes evidenced by remnants of organisms with calcareous shells.

The physical properties correlate strongly with the geological age. Most limestones are between 40 and 2,000 million years old. Limestone is the most extensively mined industrial mineral in the world, with more than 1 billion tonnes mined annually. There are many different types, and no single limestone deposit can fulfil the quality requirements for all products. There are many uses, of which cement manufacture is the most important. Other products are: building materials such as sandlime bricks, soil stabilization, and asphalt filler; metallurgy as in purification of pig iron, desulphurization of steel, mineral processing, adjusting pH in flotation, and gold leaching; food industry in the purification of sugar beet juice with lime and fodder for chickens; agriculture in soil and lake improvements;



Figure 6: Limestone quarrying at Pargas, Finland.

environment in desulphurization of fumes and gases from power plants, water purification and waste water treatment; and whiteness in various products and applications.

Cement

Cement manufacture begins in the quarry, with mining of raw materials and their transport to the plant. Around 1.6 t of limestone are required to produce 1 t of cement. Quarrying may be carried out by ripping, hydraulic breaking, or, more commonly, by drilling and blasting. Basic raw materials for cement are limestone, which is supplying the average required content of calcium carbonate, and clay minerals in the form

of clay, shale and schist that supply the required quantities of silica oxide, aluminium oxide and iron oxide. In these basic cement raw materials there are always minor chemical components present, such as magnesia, alkalis, and sulphur. These can be tolerated up to certain concentrations without affecting the quality of the cement clinker, or the process of cement making.

Marginal changes in blending ratios of the raw material components and process parameters permit the production of a wide range of cements for special purposes. Today, the dry process is most common in the cement industry, requiring well-defined cement raw materials with stringent chemical and physical properties.

Selective excavation

Detailed geological mapping forms the basis for planning the excavation in a selective way. As the limestone properties show great variations throughout a quarry, the sizes of blasts are normally limited to a few thousands of tonnes. Bench height is typically around 15 m. Before sequence and size of blasting are decided, a detailed geological survey is carried out (figure 7). The deposit is then divided into blocks, 15m x 15m x 15m, in relation to their properties (figure 8).

Most users, apart from cement kilns, prefer fragmentation of more than 20 mm. Minimizing the proportion of fines, as well as utilizing them, is essential for the economy of most limestone quarries. The required fragmentation will govern the optimum combination of hole burden and spacing and hole diameter. Larger holes give generally more variations in fragmentation, more large blocks and more fines.

As limestone is softer, and much less abrasive, than the typical aggregate material granite and gneiss, the costs of drilling consumables are relatively low. However, highly porous limestones might contain high amounts of water, more than 15%, giving problems with drilling and blasting.

Hans Fernberg

Figure 7: Pargas quarry, vertical section, diamond and percussion drill holes.

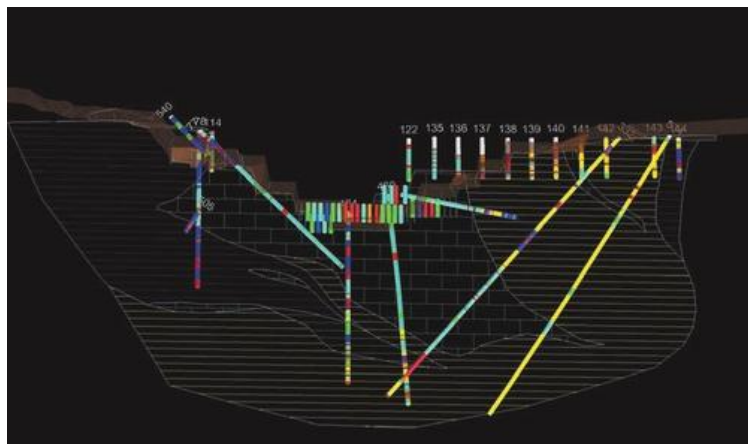
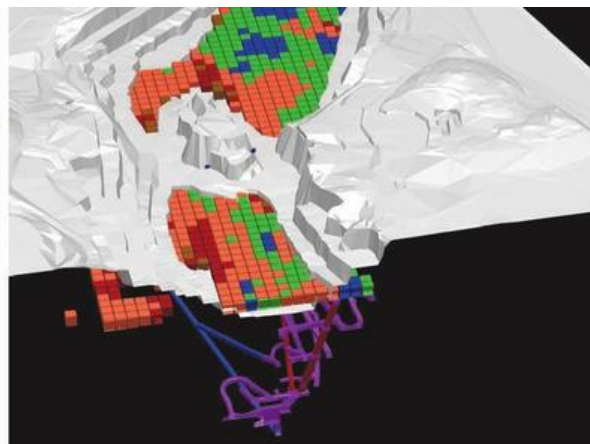


Figure 8: Pargas limestone deposit divided into blocks for planning sequence of excavation.



Rock excavation in civil engineering

Construction in rock

In civil engineering, as well as in the building industry, rock is removed to make place for new roads and railways, house foundations, ports and airports, trenches and pipelines, or to provide material for breakwaters and concrete aggregate. These types of construction projects differ from quarrying and open pit mining, in that bench heights vary continuously. Drilling is often performed from a rugged and steep rock surface, which means that the equipment used must have good terrain travelling characteristics. Also, as several holes are drilled from one rig set-up, folding booms having good coverage in various directions and planes are the preferred equipment. Atlas Copco has a complete range of drillrigs for this type of work, from heavy crawler rigs to lightweights that can be craned into position, if necessary. The whole spectrum of drilling methods is also available, from pneumatic handheld to hydraulic topammer, COPROD and DTH.

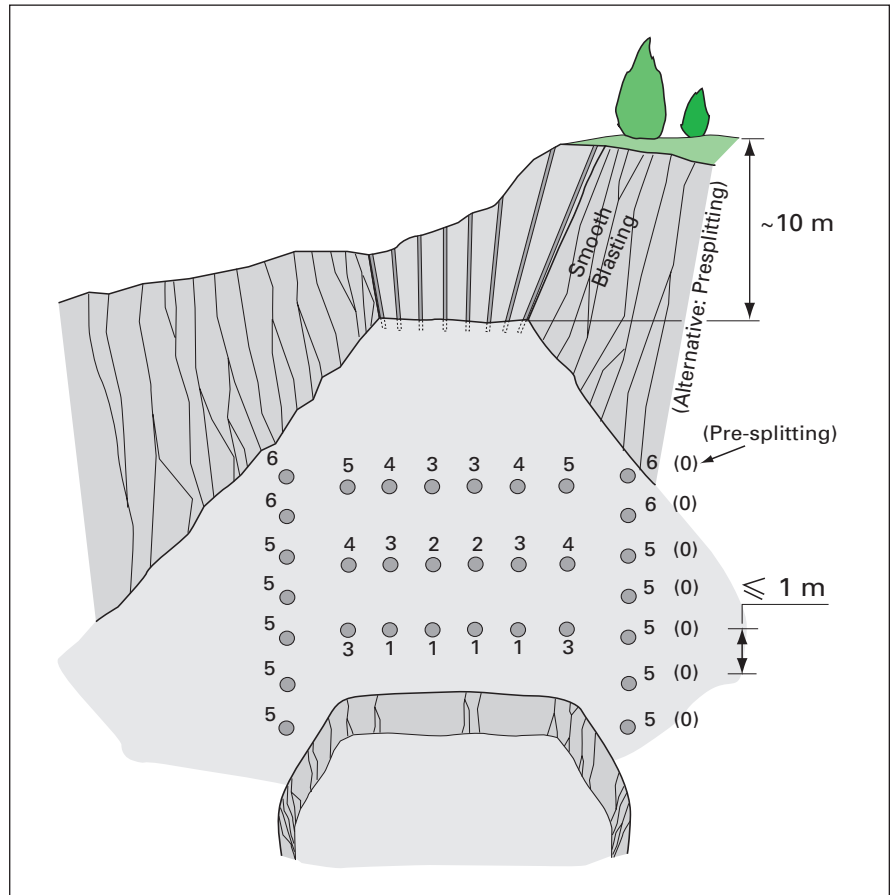


Figure 1: Drilling pattern for road cut.

Accurate tendering

Before a new project is commenced, it is normal routine that a design and preinvestigation is conducted, coupled with allocation of financing. Most civil engineering projects are subject to a tendering procedure, where scope of work, bill of quantities, drawings, geological information and time schedule are disclosed, to give all interested parties standard information on which to base their bids. The contractor, or a consortium of contractors, makes its calculations based on evaluating equipment requirements, methods, availability of skilled labour, time schedule, local conditions and regulations, as well as cost estimates. Past experience

derived from similar projects plays an important role in estimating future costs.

A project involves a wide range of equipment, and clever selection is important to achieve overall optimum performance. For blasthole drilling, the variation and complexity of blasting parameters might require both heavy crawler drills and hand held rock drills.

The equipment should, however, be selected to cover a wide range of applications, which will improve spare parts handling and maintenance procedure, and the prospects for usage in subsequent projects. Tophammer drilling rigs are normally the first choice, due to their flexibility, versatility and ability to drill holes of small diameter.

Road excavation

Figure 1 shows a typical drilling and blasting pattern for a road cut where special emphasis is placed on the final rock wall contour. Smooth blasting, or presplitting, are commonly used, and quite often specified in the tendering documents, to obtain smooth and stable side contours. Contour holes are normally not larger than 64 mm, with spacing of less than 1 m, and charging is carried out using special, light explosive to minimize the effect of shock waves. Initiation is frequently by detonating cord.

Presplit holes are fired simultaneously ahead of the other holes, whereas smooth blasting uses the highest number of detonator delay.

Presplitting creates an artificial plane along the perimeter of the excavation, against which the subsequent main blast may break, resulting in a smooth wall, with little or no overbreak.

Some of the shock waves from the subsequent main blast are reflected against the presplit plane, preventing them from being transmitted into the remaining rock. This also tends to reduce ground vibrations. Drilling with high precision is of utmost importance for the final result.

Slope stabilization should normally be carried out as an integrated part of the excavation process. Horizontal drilling, anchoring, grouting, and meshing using elevated working platforms could cause excessive costs and delays, where they have to be conducted at a later stage (figure 2).

Urban blasting

Several precautions have to be taken when excavating in built-up areas close to population, infrastructure, buildings and installations (figure 3).

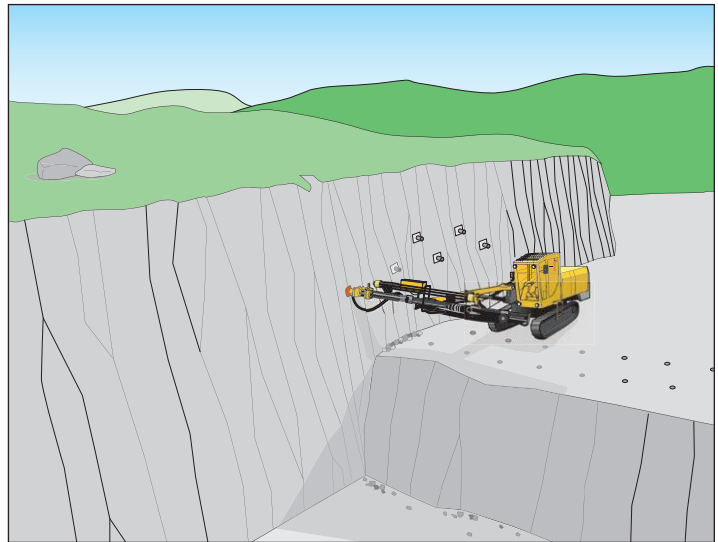
It is quite common that special blasting consultants are involved, to assist the contractor with vibration control and design of drill patterns, as well as a thorough survey of adjacent structures before the work can commence. To minimize ground vibrations, the drill holes are kept as small as possible, normally 30-50 mm diameter. To eliminate the risk of fly rock, the blasts are covered with heavy mats made of logs, rubber, or tyres, cut into sections and twined together with steel wires. These mats, of around 1 t weight, are energy absorbing. The gases produced by the blast ventilate through the mats without displacing them.

Trenching

Trenches are excavated for installation of oil, water and sewage pipelines, as well as for cables. Blasting of trenches differs from common bench blasting, because the width of the round is considerably smaller than its length. Trench blasting is defined as rounds with a width of less than 4 m.

A trench blast is more constricted than a normal open pit blast, which

Figure 2: Slope stabilization using drill rig.



results in higher explosives consumption per cubic metre of blasted rock. The diameter of the blast holes is normally smaller, which provides better distribution of the explosive in the rock, and avoids excessive overbreak outside the theoretical contour. As a rule of thumb, the hole diameter should be one sixtieth of the width of the trench, so if the width is 2.0 m, the diameter of the hole should be 33 mm.

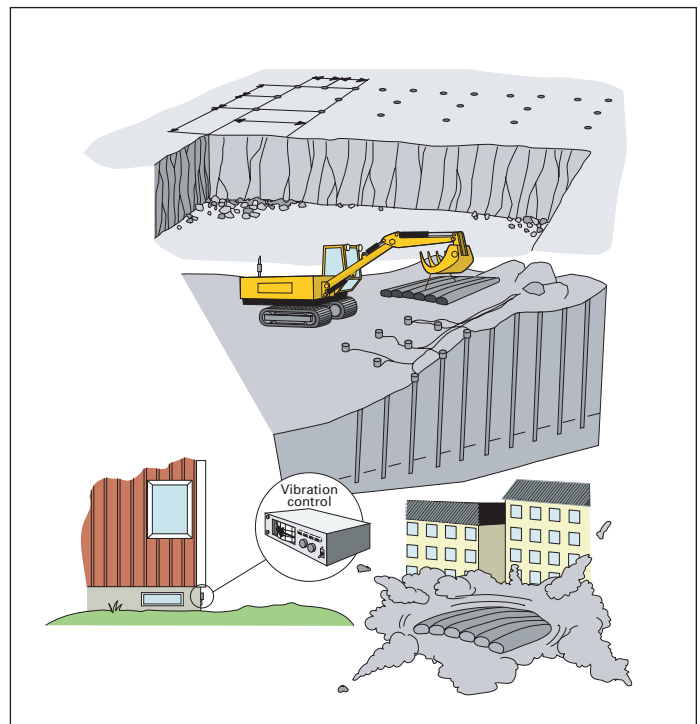
Two methods are used for trench blasting: traditional and smooth wall. In traditional trench blasting, the middle hole/holes are placed in front of the lateral holes. All holes are charged

with the same amount of explosives. In smooth wall trench blasting, all holes in each row are in line. The middle hole/holes are quite heavily charged, while the edge holes have light charges.

Blasting of trenches in urban areas requires careful planning and precautions. A typical drilling pattern and blasting sequence is shown in figure 4 overleaf.

Overall project costs and tight time schedule are of highest priority when conducting pipeline projects for oil and gas distribution in unpopulated areas, and larger blastholes are used, as shown in figure 5 overleaf.

Figure 3: Precautions for blasting in urban areas.



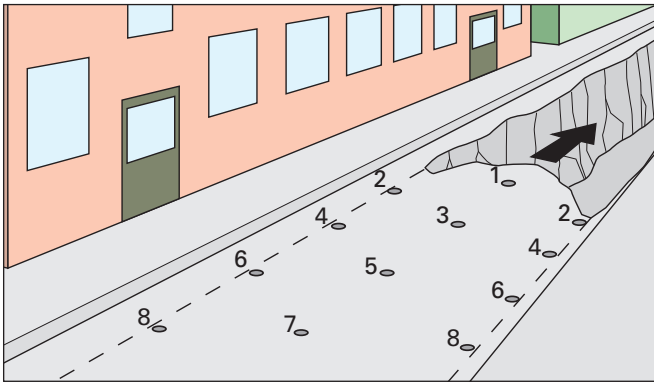


Figure 4: Small diameter blasting in urban areas using 30-45 mm holes.

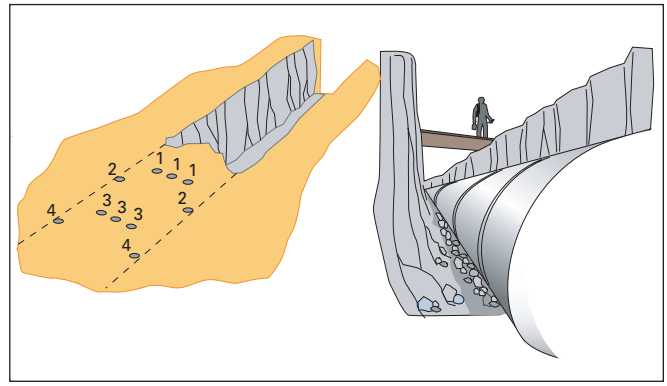


Figure 5: Trenching for pipelines outside urban areas using 51-89 mm holes.

Ports

Frequently, large size fragmentation is required for the construction of breakwaters. It might be equally as difficult to produce large size rock as it is to produce small size fragmentation. The greatest obstacle is the geology, where homogeneous rock is preferred to fissured rock. The specific charge should be low, 0.2 kg/cu m, and just sufficient to loosen, but not move, the rock. The charge must be well distributed, with a reasonable, smaller than normal, bottom charge. Spacing/burden ratio is between 0.5 to 1, and blasting is carried out one row at a time, without delays between the holes.

There has been a trend to use larger and larger vessels within the seafreight business, with demands for extended water depth in many ports. Rock excavation underwater requires implementation of special blasting techniques and equipment. Traditionally, drilling and blasting is carried out from a platform having supporting legs, or from a floating platform or barge. At greater water depth, divers may be the only possible alternative (figure 6).

Where drilling cannot be performed, special shaped charges for crater blasting can be used.

Importance of accuracy

Productivity, and the need to control ground vibrations, means that capable and precise instruments are required to guide the driller. Faults in blasthole direction, hole deviations, and variations in hole depths must be minimized if efficient production is to be obtained.

Instruments for angle setting and hole depth control increase drilling accuracy, and reduce human error.

Improved accuracy in the application of the drilling pattern saves time, drill-metres, and explosives. It is crucial to collar the hole on the right spot, maintain the correct alignment, and drill to a pre-determined level. Modern hole alignment instruments offer: more precise drilling with a reduction in cost/hole; automatic depth control; better fragmentation; automatic drill feed stop; flat benches after blasting; and less overdrilling.

The alignment instrument confirms the hole angle, while a laser sensor monitors drilling to the proper depth, regardless of the surface conditions.

All this comes together for a successful blast, breaking rock to a level floor, with minimum ground vibration, and even fragmentation.

A more sophisticated instrument features automatic compensation regardless of the drilling surface ground conditions. A beacon, mounted on a tripod, generates a horizontal reference plane

on a 350 m radius across the worksite by a rotating laser beam.

A sensor, fitted to the rock drill cradle, reacts to the signal generated by the rotating laser beam, and provides a reference plane for all holes, automatically adjusting hole depth to match the plan, with an accuracy within 5 cm. Blasting creates a bottom elevation with an optimum flat surface.

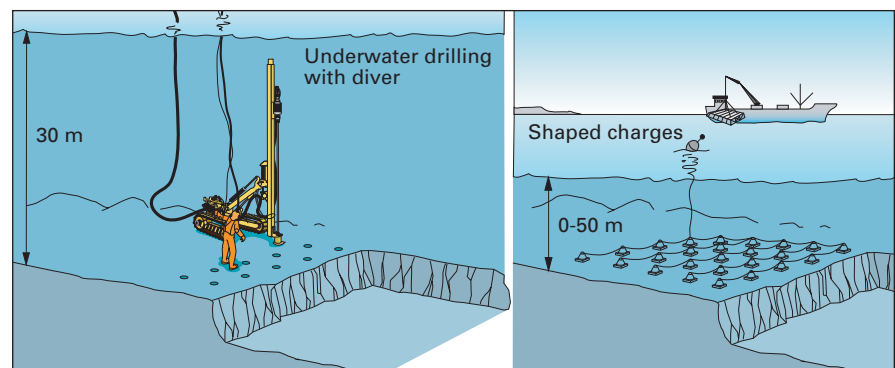
Atlas Copco ROC crawlers are designed for stable and accurate positioning of the drill holes, featuring a rugged carrier with a flexible boom system mounting a rigid feed beam with double drill steel supports for the drill rod.

The TAC-tube guide contributes to drilling accuracy, for best overall economy.

Fitting a double drill steel support allows the operator to raise the sliding support for better visibility of the collaring surface, and for simplified evacuation of water from the drill holes.

Hans Fernberg

Figure 6: Underwater drilling techniques.





Slope stabilization with Self Drilling Anchors

Soil nailing for reinforcement

Soil nailing is used to reinforce and strengthen ground which has questionable stability. Soil is generally a poor structural material because it is weak in tension. Steel, on the other hand, is strong in tension. The fundamental concept of soil nailing is to effectively reinforce soil by installing closely spaced grouted steel bars into a slope or excavation, as construction proceeds from the top down. A soil nail is therefore commonly referred to as a "passive" anchoring system, meaning that it is not pre-tensioned, as is normal with ground anchors.

Unstable slopes or excavations consist mostly of unconsolidated soils or deteriorated rock formations. To install conventional soil nails, a cased borehole drilling method is required to overcome such difficult and unstable ground conditions. An alternative is the MAI Self Drilling Anchor (MAI SDA), which is specially designed for use in ground where the boreholes tend to collapse during the drilling process if casings are not used.



Installation of SDA R38 N with ROC D7 at Carriere d'Arvel, Switzerland.

Advantages of Self Drilling Anchors

Since the slow cased borehole drilling methods were superseded, the speed of installation has increased considerably, up to 20-30 soil nails/day using MAI SDA, and the risk of redrilling time spent cleaning collapsed boreholes has been eliminated.

The selection of the drilling equipment for MAI SDA installation is also more flexible, especially for working in confined space. MAI SDA rods are manufactured with a continuous ISO

standard thread, affording the flexibility to adjust the nail to the actual requirements on site, without waste or delay, as construction proceeds.

Transportation and handling of MAI SDA to and on site is safe and economical, because of the commonly used rod length of 3 m or 4 m.

These can be extended using couplings to allow installation of soil nails up to 15 m depth, depending on the geology. There is also the option to use simultaneous drilling and grouting installation techniques.

Method of installation

Self Drilling Anchors are installed with air driven or hydraulic rotary percussion drilling equipment, using a borehole flush medium suitable for the specific ground conditions.

There are three types of borehole flush: water flush for long boreholes in dense to very dense sand, gravel formation or rock conditions, for a better transportation of large cuttings and cooling of the drill bit; air flush for short boreholes in soft soil such as chalk and clay, where



Galvanized MAI-SDA R 25 and R32 anchors installed into loose and collapsing ground using simultaneous drill and grout at the Shortlands Junction, Bromley, Kent, UK.

without extraction, until the design depth is reached. To reach a required nail length of 12-15 m, the 3 to 4 m standard rod lengths are easily coupled together.

When using the first two flushing media for the drilling operation, the soil/steel interface has to be created by grouting through the hollow stem of the anchor. The grout exits through the flush holes of the drill bit, and backfills the annulus around the nail that has been cut by the larger diameter of the drill bit.

For the third operation, the flushing medium is already a grout mix, which has the ability to harden after the installation process is completed.

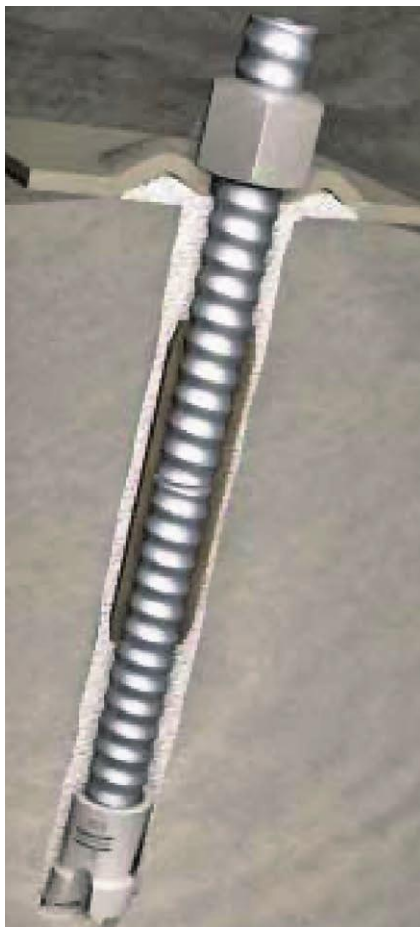
A typical application of SDA is currently being carried out by the open cast mine Carriere d'Arvel in Switzerland. Here an Atlas Copco ROC D7 drill rig, equipped with a IRIA (integrated rotary injection adapter) and a rod handling system, is being used for SDA installation.

The ROC D7 feed reaches to a height of 7 m, allowing installation of two rows of SDA from one position.

The rod handling system contains at least two sets of three 3.5 m long

water spillage is to be avoided; and simultaneous drilling and grouting (SDG) for

Principle of the MAI Self Drilling Anchor.



all lengths of boreholes in all unconsolidated soil conditions.

Using SDG, the grout stabilizes the borehole during installation, providing a better grout cover along the nail shaft. The grout has good penetration into the surrounding soil, so higher external friction values are reached, and the installation is completed in a single drilling operation, saving time.

By utilizing a sacrificial drill bit, the MAI SDA is drilled continuously forward

Installation of MAI Self Drilling Anchors with a ROC 442PC and a MAI grout pump m400NT.



R 38 N SDA rods, facilitating installation of two complete 10 m long Soil Nails without having to manually feed extension rods at these extreme working heights.

The newly developed integrated injection adapter (IRIA) can be used for either simultaneous drilling and grouting, or as in this case, first drilling to full depth with an air flush and then grouting the annulus of the borehole. The SDA installation becomes a fast continuous mechanized process with high grouting quality in a safe working environment.

Similar methods were used to stabilize the slope at Shortlands Junction, Bromley, Kent, UK, where loose and collapsing ground was affecting operation of the railway.

Installation using ROC drill rigs

The use of self drilling anchors for stabilization and reinforcement work in soft rock is common both in the underground world of mines and tunnels, and for a wide variety of applications on the surface.

On surface, it is generally poor quality ground and soil that threaten the stability of installations or landscapes. Embankments along roads and railways, various types of foundations and hills prone to landslide, and the sidewalls of cut-and-cover tunnelling are just a few examples.

Field tests have shown that the Atlas Copco ROC D-series of drill rigs can be used to install self-drilling anchors (SDAs), as well as for blasthole drilling. Hence, contractors who own one of these crawler rigs for quarrying operations are perfectly equipped to take on stabilization jobs.

A simple conversion kit enables this rig to be converted to an SDA installation unit, without losing the advantages of the ROC D7 standard, high-tech features.

The rock drill is fitted with a kit consisting of an IRIA (integrated rotation injection adapter), swivel and brackets to replace the standard shank adapter. The SDA shank adapter is a female shank having integrated coupling sleeve to ease uncoupling. Available for

Atlas Copco ROC D7 installing MAI SDA for soil reinforcement using MAI m400NT grout pump.



R32 and R38 anchors, it requires a flushing head with inner diameter of 53 mm, normally used on surface crawlers, because of the size of the female front part of the shank adapter.

The IRIA is a SDA shank adapter combined with a separate swivel providing flushing media and grout. The swivel is mounted on the rock drill with a bracket and has two separate inlets. The Shank Connector is a coupling sleeve locked to the shank adapter. To provide the locking function a special male T38 shank is required. This is an alternative to SDA-shank, when installing R51 or T76 anchors, and when alternation between bolting and blast hole drilling is required. A flushing head with inner diameter of 53 mm is needed.

The Rod Handling System RHS 52 is used for carrying bolts on surface crawlers. The system is equipped with SDA bushing halves in the gripping arms and the star wheels carrying the rods.

BSH 110 is a hydraulic drill steel support providing gripping and guiding function. To drill SDA it is equipped with the rubber bushing and steel bushing halves to match the anchor size.

The grout pump m400NT, available from Atlas Copco MAI, is also recommended.

Two-man operation

Only two people are needed – one to handle the drilling, and one to handle the pump. The SDAs, with their R threads and sacrificial bits, are installed and grouted in one operation.

These easy adjustments will enable ROC D7 owners to get the best, and the

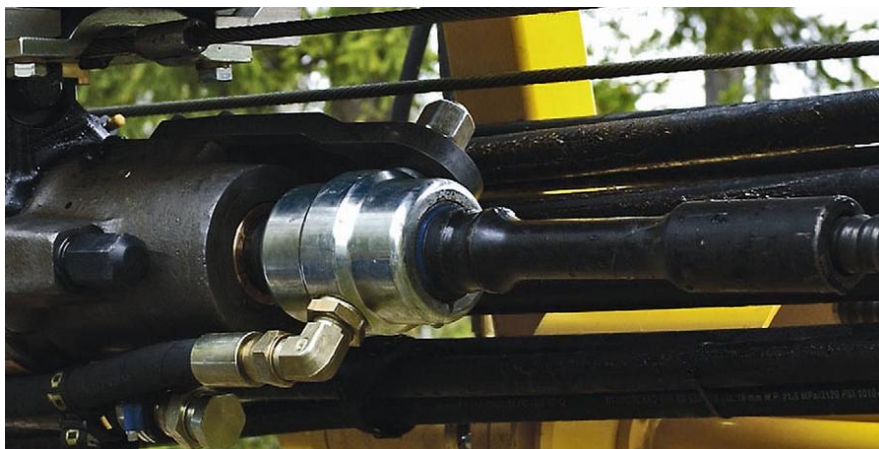
most, out of their equipment. For some, it may open up whole new markets that they have previously not even considered.

The beauty of being able to adapt the ROC D7 for such applications is that the contractor can make full use of the rig's powerful and flexible hydraulic system. The folding boom, for example, can be positioned up to a height of 7 m beside a slope, or very low for horizontal toe-hole drilling. It can also be positioned at extreme angles, enabling SDAs to be used in very inaccessible places.

Connecting grout pump and IRIA adapter

Most of the time there is a need to alternate between flushing with water and grout. In surface SDA installation, it may be inconvenient to grout during drilling, as this may contaminate the feed with the grout, or minimize spillage during collaring. The alternative is to flush with water when drilling-in the anchor, and then grout it through the IRIA. This would be the final step in the installation sequence, prior to uncoupling the last rod from the rock drill. To alternate between water and grout, connect the grout pump and water hose to a Y-coupling equipped with two valves, so that water or grout may be selected. The hose from the Y-coupling is then connected to the IRIA, either direct or by letting it run on the feed through the hose tree and over the hose drum. This type of Y-coupling requires manual switching between water and grout.

When installing SDAs using a surface drill rig, some contractors have



COP 1838 rock drill with IRIA adapter.



Standard rod handling magazine with SDAs and couplings.



The special bushing halves prepared for firm gripping of the SDAs.

chosen to drill and grout simultaneously, using only grout as the flushing medium. This has the advantage that, once the anchor is completely drilled into the ground, it is fully grouted and ready to be attached to the face plate. This makes the connection between the grout pump and the IRIA straightforward, needing only a single hose. It

is possible to replace the hose for air flushing by the grout hose by attaching it to the hose tree and letting it run over the hose drum to the rock drill.

To simplify the system further, and to reduce the number of people needed to do the installation, two hoses can be connected to the IRIA, one to the grout pump and the other to the water flushing system

on the rig. The water supply hose should be equipped with a non-return valve at the connection to the IRIA, in order to prevent grout from entering the water system. The two hoses can be put on the feed over the hose drum.

This system makes it easier to control both water and grout flushing, with the water controlled by a valve on the rig, and grout flow by starting and stopping the pump. The grout pump can be controlled remotely by the rig operator, or by the pump operator on demand from the rig.

SDA installation cycle

The optimal SDA installation cycle comprises the following steps:

1. Drill first SDA rod, either with simultaneous drilling and grouting or with conventional air or water flush, guiding with the Drill Steel Support (DSS) in open position.

2. When the rod has fully penetrated into the soil/rock, stop the flush and loosen the rod end connection to the drifter by clamping the DSS and unscrewing the female shank adapter. Uncouple before retracting the rock drill.

3. Extend with next rod using the rod handling system, open DSS and commence flushing, then resume drilling.

4. Repeat rod-adding sequence until final design length of the anchor has been drilled.

5. If simultaneous drilling and grouting modus has been used, then the installation cycle is now complete, and the feed can move to the next anchor position.

6. In air- or water-flush modes, switch over to grouting mode and, while maintaining a slow rotation of the anchor, commence grouting until the hole is full. The *in-situ* rotation mixing process of the grout guarantees a homogeneous filling of the annulus, improving corrosion protection and external friction values of the rock-grout interface.

7. The installation cycle is completed, and the feed can move to the next anchor position.

Mark Bernthaler

Radio Remote Control

Automation overview

Automation of surface drilling operations may have different focuses, depending on individual circumstances, but safety, ergonomics, quality, and productivity are major considerations.

Safety is required to minimize the risks for operators, while ergonomics improves the working environment.

Quality in hole positioning and straightness will result in better fragmentation, producing less waste rock compared to the theoretical drill plan.

At construction sites, remote guided access to difficult drilling positions is faster, because the driver can obtain the best view of the route.

Above all, a successful automation project should lead to increased productivity.

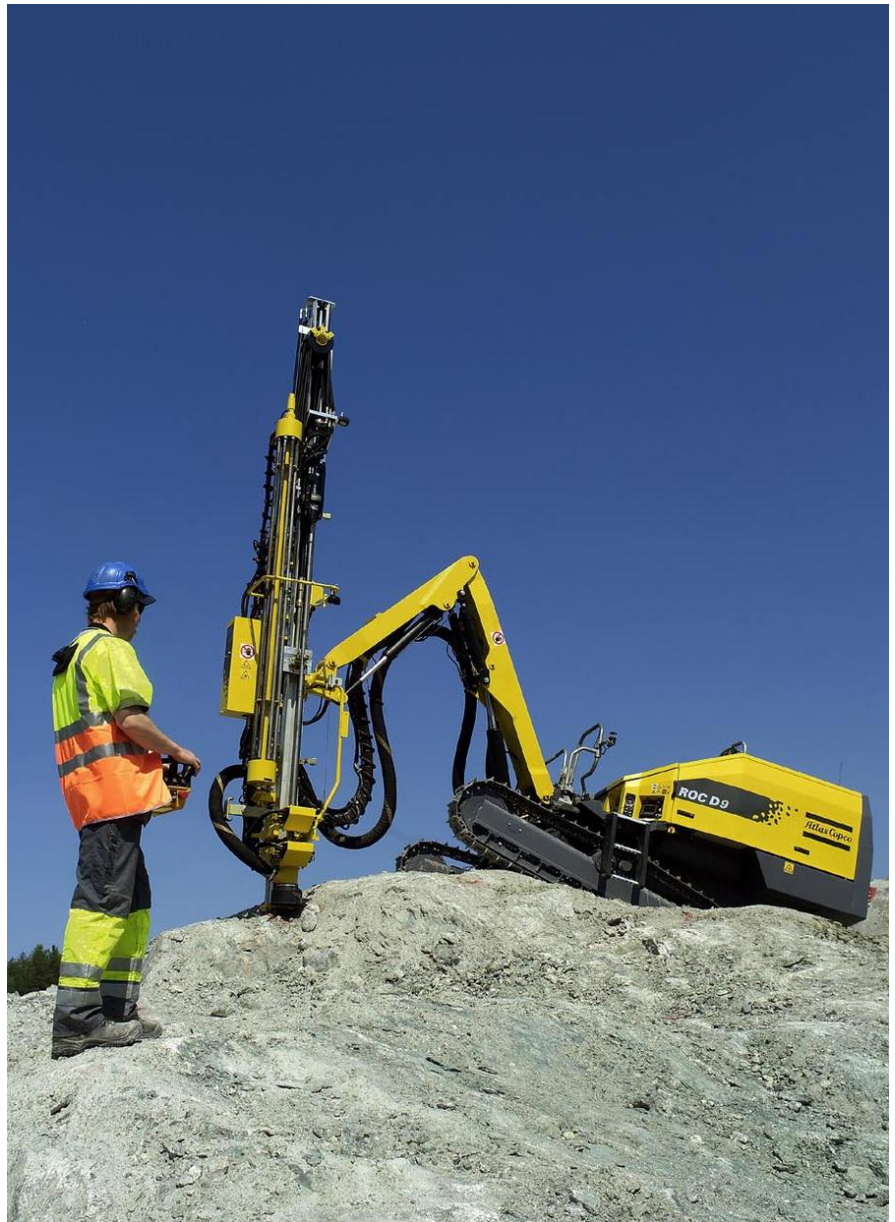
Requirements for remote control capabilities are growing, especially in the market for non-cab surface drill rigs with remote controlled tramming and drilling.

Since its introduction, more than two hundred RRC rigs have been delivered to customers around the world.

Introduction to remote control technology

The operator can see the rig or vehicle, and has instrumentation on the radio remote control (RRC) unit corresponding to the set-up in the cabin. The RRC-system consists of two hardware units: one for the operator with all controls and indicators, and the other mounted on the machine, integrating the RRC-unit to its electrical system.

Some RRC-units are also available with a cable, but this is a limited system which can only be used for control of rig tramming and not for drilling. For line of sight applications, standardized RRC-solutions are available, and customization to the actual application is



Atlas Copco's new ROC D9RRC and ROC D7RRC drill rigs are fully radio remote controlled for safe, efficient operation in most conditions.

a matter of defining how joysticks, indicators and pushbuttons should be positioned. The integration of RRC-units to the rig governs the cost and performance of the system. The new generation of Atlas Copco drill rigs are equipped with RCS Rig Control Systems, which offer a clean, straightforward CAN-bus interface between the rig and the RRC-unit. Control information, such as joystick positions, activated pushbuttons,

and alarms, is transmitted as serial data messages on the CAN-bus to the rig. The information is then interpreted by RCS, and executed. On a rig without an electronic control system, the RRC-unit has to be interfaced to the dashboard and the electro-hydraulic system, and logic must be programmed in the RRC-unit. This integration means a more extensive wiring and programming of the RRC-unit.



Terrengtransport ROC D7RRC working at Lindesnes, Norway.

Radio Remote Controlled drill rigs

Improved operator safety and increased productivity were the most important reasons for developing RRC drill rigs. Both of these goals have been fully realized in the new Atlas Copco ROC D9RRC, and the ROC D7RRC, with a hole range of 64-115 mm.

These two rigs belong to the same family, but are equipped with rock drills that provide different production capabilities. Their principle strength lies in combining radio remote control with a well balanced design that has excellent stability and high productivity in all types of terrain.

The new design is well thought through. The boom is centrally placed, with a low mounting point for optimum stability and maximum coverage. Ground clearance is a full 455 mm (17.5 in) to provide great manoeuvrability in the roughest of conditions. These features, combined with the onboard Atlas Copco compressor and rock drill, driven by a powerful Caterpillar diesel engine, produce a remarkably capable drill rig.

Tramming, positioning and drilling

Both the Atlas Copco ROC D9RRC and ROC D7RRC are fully radio remote controlled. The operator is able to manoeuvre the drill rig from a safe distance, choos-

ing the best possible view. All principal functions, such as tramming, drilling and rod handling, are controlled from the RRC, and stepless controls allow smooth positioning of the rig.

A new feature of both these drill rigs is the Atlas Copco patented Automatic Drill Stop. This function automatically stops the drilling at a preset depth, and loosens the rod threads. This increases the overall quality of the drilling, while reducing the time required to retract the rods and move to the next setup.

Atlas Copco's unique folding boom provides both the ROC D9RRC and ROC D7RRC with exceptional reach and coverage. The versatile boom head permits the drill feed to be positioned to drill rockbolt holes to secure unstable

side walls, or to carry out horizontal drilling operations.

The ROC D series are fitted with a C7 Tier III/stage 3 Caterpillar diesel engine with 168 kW (225 hp) of power.

The engine has been sized with generous power reserve, to reduce fuel consumption, exhaust emissions and noise. The extra power also allows the rig to work in a wider range of conditions, and increases the life of the engine.

Remote in Norway

Treacherous autumn conditions at Lindesnes, on the southernmost tip of Norway, were overcome by Terrengtransport AS, one of the first contractors to adopt radio remote control technology for surface drilling operations. With a workforce of 110 people, the company specializes in drilling and blasting for roadbuilding, trenching, preparation of construction and property sites, industrial contracting and even small-scale tunnelling.

Expansion means they have to invest in productive equipment and new technology, and they were interested in the concept of radio remote control from inception.

At Lindesnes, Terrengtransport was preparing the ground for a new chemicals production facility. Here, they took delivery of an Atlas Copco ROC D7RRC radio-controlled crawler, equipped with a COP 1838HE rock drill and 127 lit/sec compressor, for drilling 76 mm holes.

Many of their jobs include both drilling and blasting, and radio remote control allows the driller to charge holes, or prepare for blasting, while the actual drilling is in progress. Another benefit is that the driller can stand at a safe distance away from the rig when driving it into position, using superior line of sight to negotiate the best route over rough ground.

Terrengtransport has since taken delivery of a second RRC rig, and others have been delivered to contractors throughout the world.

Jörgen Appelgren

Radio frequencies

For surface applications there are a limited number of frequency bands that a Radio Remote Control can use. These are the most common frequency bands used in Europe and USA:

Europe (MHz)	USA (MHz)	
400-475	400-469	
868-870	902-918	
1880-1900		DECT
2400	2400	WLAN/ Bluetooth

CARE for benching

Choosing rationally

For a quarry owner or drilling/blasting contractor working with surface excavations, it is not always easy to find the optimum tool for the drilling task. Suppliers offer a wide range of rigs with variable capabilities such as hole dimensions, rock drills, and different degrees of automation.

In addition to this, comes a choice of blasting agent and detonating system. There are so many input parameters to deal with that it can be difficult to make a rational choice. Sometimes, the customer ends up selecting the same rig as last time, simply because he knows what the output and costs will be. In many cases, this choice may be the correct one. But in others, a different rig might well have given better drilling and blasting economy.

In order to solve this dilemma by evaluating all the input data from both drilling and blasting, a special Lotus Notes-based calculation program was developed by Atlas Copco under the banner Computer Analyzed Rock Excavation (CARE), a mainframe program first developed and used in the 1980s. Since it was updated in 2006, the CARE program has been described as the most comprehensive of its kind available.

Overcoming limitations

The previous CARE had similar capabilities but more limitations, and like many other computer programs, it had not been properly modernized or upgraded, so eventually it became obsolete.

So what are the specific benefits of this new, upgraded version of CARE for bench drilling? Firstly, it is based on knowledge of bench blasting engineering dating back to Langefors, in common with most other bench-blasting programs. The reason for spending time and effort on creating another program is that none of those currently in existence cover all of the

PROJECT PARAMETERS CARE			
Rock type:	Limestone	Rock density:	2,60
Compressive strength:	1 400 bar		
Volume of excavation:	3 000 000 tons	1 153 845 m ³ solid	
Excavation period:	12 months		
Target production:	96,154 m ³ solid per month		
Type of Drilling:	☒ Tophammar / Rotary / DTH ☒ Coprod		

Entry of rock characteristics and the required annual output.

WORKINGTIME PARAMETERS CARE			
	Case 1	Case 2	Case 3
Hours per shift	8	8	8 hrs
Shifts per day	1	1	1 shifts
Working days / month	22	22	22 days
Working months / year	10	10	10 months
Non-operative time	1	1	1 hrs/shift
Long term utilization	80	80	80 percent

Entry of working time data such as hours per shift, shifts per day, working days per month, etc.

DRILL RIG PARAMETERS CARE			
	Case 1	Case 2	Case 3
Crawler drill rig	ROC D7-11	ROC F9 CR	ROC L6 ³⁰ model
Rock drill	COP 1840	COP 2550	COP 44 model
Air pressure	10,5	10,5	25 bar
Hole diameter	89	105	115 mm
Estimated penetration	1,70	1,40	1,10 m/min
Drill rig availability	90	90	90 percent
Drill rod/tube	T51	CR89	89 type
Drill rod/tube length	3,66	3,66	5,00 meter
Holes per rig set-up	2,0	1,0	1,0 nos.

Entry of drill rig data such as rig type, hole diameter, expected penetration rate, etc.

drilling parameters required when estimating the drilling cost and output capacity of a rig.

The optimization of the whole drill and blast operation is also accounted for, and the input of the explosives and detonation system is included in the calculations.

Fragmentation of blasted rock is difficult to predict, as it is the result of prevailing geological conditions and a number of other factors, such as hole alignment and straightness, overdrilling, blasting practices and drill patterns. Due to the complexity of predicting a calculation of the

fragmentation, this has not been included, but a program which can estimate this parameter should be available within a couple of years.

Using the CARE program

After entering worksite data, three different drilling alternatives can be compared by inputting more specific data in the following mode: a general description of rock characteristics, required annual output in terms of cubic metres or tonnes, and the currency to be applied; working time conditions in terms of working hours

Entry of blasting data such as bench height, blastability factor, hole inclination.

BLASTING PARAMETERS		CARE		
	Case 1	Case 2	Case 3	
Bench Height (m)	12,0	15,0	18,0	
Blastability factor (kg/m ³)	0,35	0,35	0,35	
Burden (m)	- Calculated -	- Calculated -	- Calculated -	
Hole inclination (degrees)	11,00	11,00	11,00	
Stemming height (m)	- Calculated -	- Calculated -	- Calculated -	

Entry of explosive characteristics such as type, weight strength and density of explosive.

EXPLOSIVES PARAMETERS		CARE		
	Case 1	Case 2	Case 3	
Bottom charge				
Type	☐ ANFO ☒ Emulsion explosives ☐ Gelatin	☐ ANFO ☒ Emulsion explosives ☐ Gelatin	☐ ANFO ☒ Emulsion explosives ☐ Gelatin	
Height bottom charge (m)	- Calculated -	- Calculated -	- Calculated -	
Column charge				
Type	☐ ANFO ☒ Emulsion explosives ☐ Gelatin	☐ ANFO ☒ Emulsion explosives ☐ Gelatin	☐ ANFO ☒ Emulsion explosives ☐ Gelatin	

Result of drill and blast calculation such as burden, spacing, drilling and charging density.

CALCULATED RESULTS		CARE		
	Unit	Case 1	Case 2	Case 3
Burden	meter	2,96	3,76	4,05
Spacing	meter	3,70	4,70	5,06
Drilling density	drill m/m ³	0,10	0,06	0,05
Charge density	kg/m ³	0,48	0,41	0,42
Est. rig production	drill m/month	2 270	4 784	5 451
	m ³ /month	61 986	76 556	101 916
	tons/month	161 164	199 045	264 981
Drill rigs required	units	1,60	1,30	0,90

Result of the estimated cost for drilling and blasting.

COST ESTIMATES		CARE		
Rock drilling cost	SEK / m ³	2,34	2,29	1,93
Rock blasting cost	SEK / m ³	5,05	4,22	4,35
Drill+blast cost	SEK / m ³	7,39	6,51	6,27
Rock drilling cost	SEK / ton	0,90	0,88	0,74
Rock blasting cost	SEK / ton	1,94	1,62	1,67
Drill+blast cost	SEK / ton	2,84	2,50	2,41

per day, and effective hours; drilling data such as type of drill rig, method, rock drill, hole diameter, rod length, penetration rate and time split of the various drilling activities; geometry of the bench such as height, inclination, errors in hole collaring and in-hole deviation (it is also possible to preset spacing and burden as well as stemming and sub-drilling – these can be calculated by the program, if not

entered); explosives data such as type, density and weight strength (this can also be entered or calculated); cost of explosives and detonators; service life of rock drilling tools; prices of rock drilling tools; and all remaining costs such as price and depreciation of drill rig, interest rate, parts, labour, and fuel. Having entered all of this information into the calculation program, a menu of various estimated results can be

extracted, of which cost/t or cost/cu m might be of prime interest.

Naturally, the computed results will never be better than the quality of the input figures, and it should be emphasized that the program does not strive to arrive at exact figures. Its main feature is to display a fair comparison between alternative approaches to the drilling and blasting parameters, to assist the user in selecting optimum equipment, bench geometry and other working conditions.

The comparison is normally repeated several times by making minor input data changes to the best initial alternative.

Who can use this program?

CARE is a tool primarily for joint use by the Atlas Copco salesperson, together with the customer. The idea is that they sit down together, and discuss the prevailing conditions at each individual site, agree the input figures, and define the span of uncertainties.

After that, they jointly enter their characteristic figures into the program. They analyze the results, and probably make a few more calculations with adjusted figures. Hopefully, after a couple of hours, they end up with a result that points them in the right direction.

It is an advantage if the customer has some experience from the actual site where the drilling will take place. After the selected equipment has been started up on the site, production results, as well as consumption of consumables, should be closely monitored, with the aim of checking that the primary estimates on which the purchase of equipment was made were reasonably correct.

By changing parameters in any section, the program automatically recalculates and presents a new result. This provides the user with an almost infinite number of alternative solutions.

Gunnar Nord

The power of repowering

Solve problems by upgrading

There are times when drill rigs fail to live up to their owner's expectations. The reasons can be many and varied, resulting in slow progress, frequent breakdowns and higher costs in terms of increased drill steel consumption and overall downtime.

In situations like these, which naturally impact total project economics, it is understandable when drillmasters wish they had better equipment at their disposal. However, if an investment in new and better equipment is not an option, all is not lost. The performance of an old drill rig can sometimes be significantly enhanced, simply by upgrading its rock drills.

This is known as repowering, and is becoming an increasingly popular way to solve short-term rock drilling problems. Another reason for repowering could be a change in drilling conditions, such as hole diameter or type of rock, where existing equipment is not sufficient.

Developed for performance

Atlas Copco rock drills, which are widely considered to be amongst the best in the world, are developed and manufactured for optimum performance, along with the drill string and rigs.

Hence, there are many instances where customers have chosen to fit Atlas Copco rock drills to their rigs, irrespective of their make, with vastly improved results. Continuous product development ensures that each generation of rock drills is an improvement compared to their predecessors, making new Atlas Copco rock drills an alternative to old Atlas Copco models in repowering.

In all cases, they report improved penetration rate, lower drill steel costs, fewer regrinding operations, fewer servicing intervals and drastic reductions



ROC 542HP repowered by COP 1640.

in downtime compared to before. Different drill rigs require different solutions before they can be equipped with new rock drills.

First, all data must be collected regarding the capacity of the power pack, the hydraulic system and so on.

Atlas Copco uses its specially-developed Diarot software program to simulate the sort of performances that customers can expect, including a recommendation for the most suitable drill string and settings of the drilling system. The program is based on more than 20 years rock drilling research, and experience and analysis of real cases from all over the world.

Modifications

The most common way of repowering a drill rig is to use a rock drill of the same brand as the rig. Changing the rock drill might require modification of the cradle

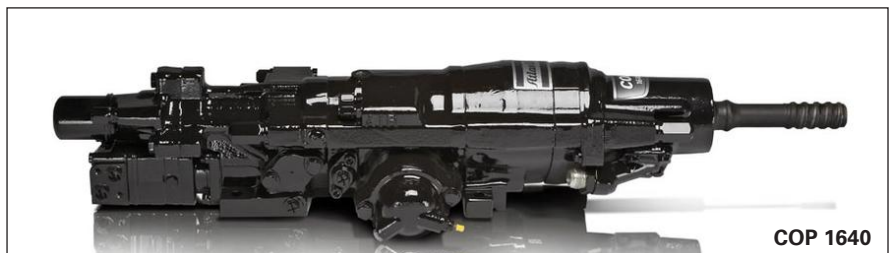
and drill steel support, hose layout and addition of hydraulic valves.

For example, to change from a COP 1238ME 12 kW rock drill to a double-dampened rock drill like the COP 1640 with 16 kW impact power, requires no modifications to the cradle, and only the addition of one hose for the damper oil supply.

However, changing from a COP 1432ED 14 kW rock drill to the COP 1640 16 kW rock drill requires another cradle.

Atlas Copco has the experience to carry out these modifications effectively, with a view to significant improvements in productivity and drill steel life.

It must be clear, however, that to mount an advanced rock drill onto a rig of another make is not an easy task, and that it is not accomplished in just a few hours. Rig modifications are often required, especially to the hydraulic



COP 1640

COP 1640

Impact power, max	16 kW
Hydraulic pressure, max	200 bar
Impact rate, max.	60 Hz
Lubricating air (at the drill), max.	3 bar
Flushing water	5.5-25 bar
Flushing air, max.	12 bar
Weight, without adapter	193/237* kg
Length, without adapter	1 048 mm/ 1 245 mm
Width, without connectors	317 mm
Height above feed sled	223 mm
Height above drill centre	88 mm

Adapters

Male adapters, Ø 38 mm,
Thread type, order number

R32, length 565 mm 403-13302-05,00

T38, length 565 mm 435-13302-05,00

T45, length 565 mm 436-13302-05,00

system, including settings and controls. Atlas Copco sales companies will advise on what is possible, with assistance from the product company in Örebro, Sweden. After repowering, the rig and new rock drill must be thoroughly tested before returning to full-scale operation.

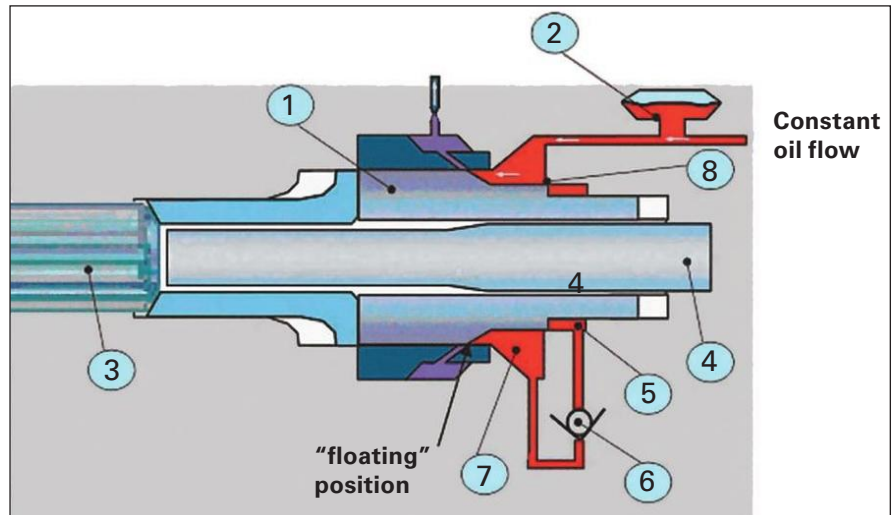
Successful rejuvenation

Repowering can be the ideal way to increase productivity, particularly for short-term projects where time is limited, and where an investment in a brand new rig is not economically justifiable. In this way, contractors can gain access to Atlas Copco's advanced rock drill technology precisely when they need it, and at a modest price.

The first step to repowering is to investigate the pressure, flow and power capacities on the rig. Will they match the requirements of the new rock drill in mind?

Next, ask Atlas Copco for a free Diarot simulation. The following data is required: model of rock drill; impact pressure; rotation rate; bit type and diameter; average regrinding wear flat diameter; and average penetration rate. From these data, an accurate prediction can be made for the new equipment.

It is necessary to investigate if the cradle, drill steel support, and other components need to be modified. Then, Atlas Copco will quote for the equipment necessary, together with a



Atlas Copco COP reflex dampener system.

performance estimate from which the customer can calculate the payback time for his investment.

Cool joints and fast drilling

The Atlas Copco concept of repowering was born in the mid-1980s, when it was realised that some drilling operators wanted better performances from their existing rigs.

In 1992, Atlas Copco began to produce a new generation of rock drills equipped with double dampeners, COP 1838 and COP 4050. These machines were soon joined by the COP 1432ED, COP 2150 and COP 2550. Today's range of rock drills with double dampening consists of COP 1640, COP 1840, COP 2560 and the COP 4050. These machines have double dampeners, which not only dampen the shockwave recoils in the drill string, but also absorb the excess energy from the returning shockwave, giving lower coupling temperatures and longer life of the drill string. In addition, the drillstring joints are kept at an optimal tightness, enabling the bit to maintain full and constant contact with the rock throughout the drilling process, resulting in higher penetration rate.

Double dampening

Over many years, Atlas Copco has acquired considerable knowledge of how shock waves from the piston are reflected from the bottom of the hole back to the rock drill. If large reflex shock

waves are reflected up the drill steel and into the rock drill, they will then be transmitted to the feed and the boom, causing serious damage.

Hence, Atlas Copco rock drills have dampening systems, which effectively absorb these shocks. This function also ensures that the joints in the drill string are kept tight and do not overheat, which is an extremely important factor in bench drilling. Dampeners not only provide protection for the rock drill, they also safeguard consistent and continuous feeding of the drill steel to ensure that the bit maintains constant contact with the bottom of the hole. This also contributes to increased drill steel life and higher penetration rates.

Referring to the diagram, the basic reflex dampener system consists of a dampening piston (1), accumulator (2) and shank adapter (3). The impact piston (4) hits the shank adapter which creates a shock wave in the drill string, when the reflected shock wave knocks the damper piston backwards (to the right), the pressure rapidly rises in the chamber (5) as the check valve (6) is closed. This forces oil in chamber (5) to be released to the oil volume (7) over the edge (8). This absorbs the energy by means of heat. At the same time, the accumulator (2) is charged, which provides a fast movement of the damper piston back to establishing contact again with the shank adapter (3).

Joakim Zander

Reduction of oversize boulders with hydraulic breakers

Secondary breaking

Although the reduction of oversize boulders is not one of the main quarrying operations, the process generally has a significant impact on overall costs and efficiency. These lumps of rock are too big to be transported, and cannot be tipped into the crusher unless they are broken up. Their reduction is increasingly being handled by excavator-mounted hydraulic breakers, with service weights ranging from 300 to 7,000 kg. These can be operated at the quarry face, at storage areas, or at the crusher. Hydraulic breakers offer numerous advantages, and can be used for many different quarrying applications.

Maximum lump size

The first link in the chain of processes is the most important criterion. This may be the loading process, the quarrying operation, or the primary crusher. In the past, the size of the rock to be broken was often restricted by the capacity of the loader. However, these units have grown over the years, so that the maximum lump size is nowadays more often determined by the capacity of the primary crusher.

The upper limit lump size does not necessarily depend on technical parameters. There are economic criteria that must be taken into account as well. For instance, not producing oversize boulders in the first place might seem to be economic, but the rise in drilling and blasting costs eats away at any gains.

The amount of oversize boulders, or the distribution of lump sizes in the heap of rock in general, is mainly influenced by the drilling and blasting parameters, as well as the conditions of the deposit.



An HB 2500 used in secondary breaking.

A distinction has to be made between the impact strengths which the rock and the bedrock have.

The tensile and compressive strength, or impact strength, are the most prominent rock features. These influencing factors are compensated by modern

drilling and blasting methods. On the other hand, it is not possible to fully compensate the bedrock features that have an impact on the production of boulders.

The production of boulders depends on the interface structure, interface



An HB 5800 breaking up a large oversize boulder.

characteristics, and non-homogeneities of the bedrock. Non-homogeneities, in particular, have a significant impact, because there is no way in which the drilling and blasting parameters can be adapted in a flexible manner in such small areas.

The oversize breaking performance depends on the breaker efficiency, type of rock, carrier unit, operator, and the organizational structure of the quarry.

Achievable performance is affected by the scatter of the non-homogeneities in the strata and the pre-stress levels in the lumps resulting from the blasting operation. The scatter is particularly large in small boulders, where defects have a stronger impact.

The time needed to position the oversize boulder for breaking mainly depends on the operator's training and motivation. Skilled operators recognize the structure of the material much better, and achieve much higher breaking performances.

Mode of operation

When using hydraulic breakers for secondary breaking operations, a distinction

can be made between different organizational structures.

Secondary breaking can be carried out directly at the quarry face, in a central breaking area, or at the crusher.

Central breaking areas are needed when secondary breaking is only carried out occasionally. In most quarries, secondary breaking is carried out directly at the quarry face. The use of hydraulic breakers at the crusher for quickly breaking stuck lumps is widespread.

a) Breaking oversize boulders at the quarry face

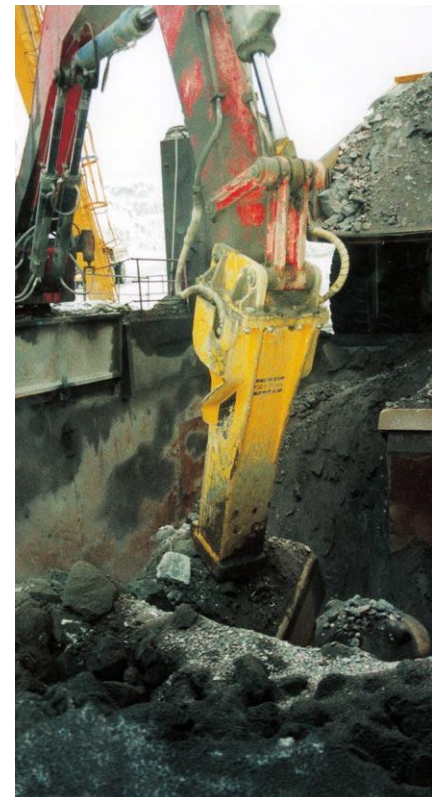
Often, the crushing of oversize boulders directly at the quarry face is the most economical solution. The heap of rock, which is often too coarse, originates from the edge areas of the blast, or from the stemming zone. The oversize boulders are usually positioned where they are easily accessed by the carrier unit with breaker, and can be broken on the spot.

b) Sorting out oversize boulders and breaking them before loading

If oversize boulders are irregularly spread throughout the heap of rock,

they can be sorted out during loading, and broken up separately. This may be

HB 3000 at a crusher.



useful in heavily dislocated and fissured deposits.

c) Central oversize breaking area

Use of a central area definitely allows a higher number of oversize boulders to be broken up. The central breaking area offers the advantage that the quarrying processes can be disentangled.

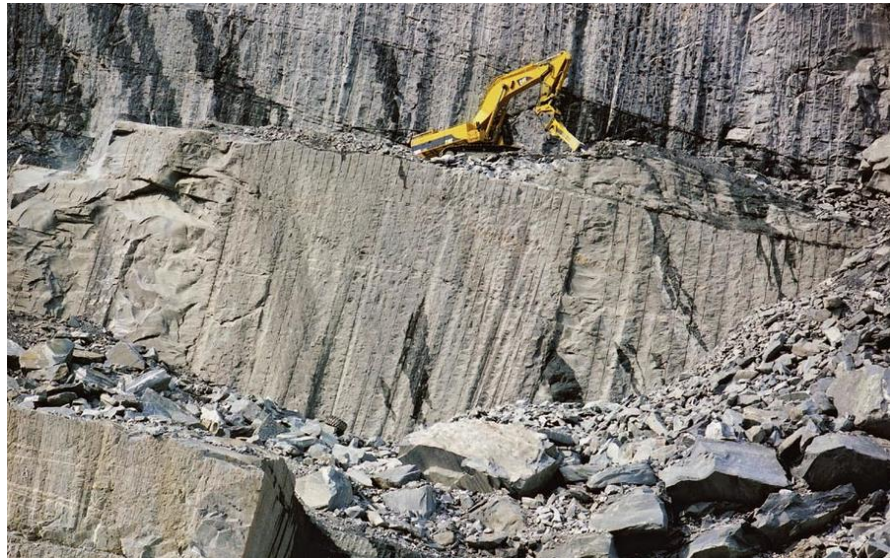
Most oversize boulders are best in material quality, and feature the highest strength. In many cases, they can be sold profitably for use in embankments and dry walls, or as breakwater rocks. In suitable rock types, hydraulic breakers can be used to create appropriate blocks.

Another important application for hydraulic breakers is in ripping, clearing and trenching.

If necessary, quick-couplers allow the breaker to be rapidly detached from the carrier unit.

Conclusion

Although the reduction of oversize boulders is not a main quarrying operation, these boulders have a significant



Breaking boulders at the quarry face with an HB 7000.

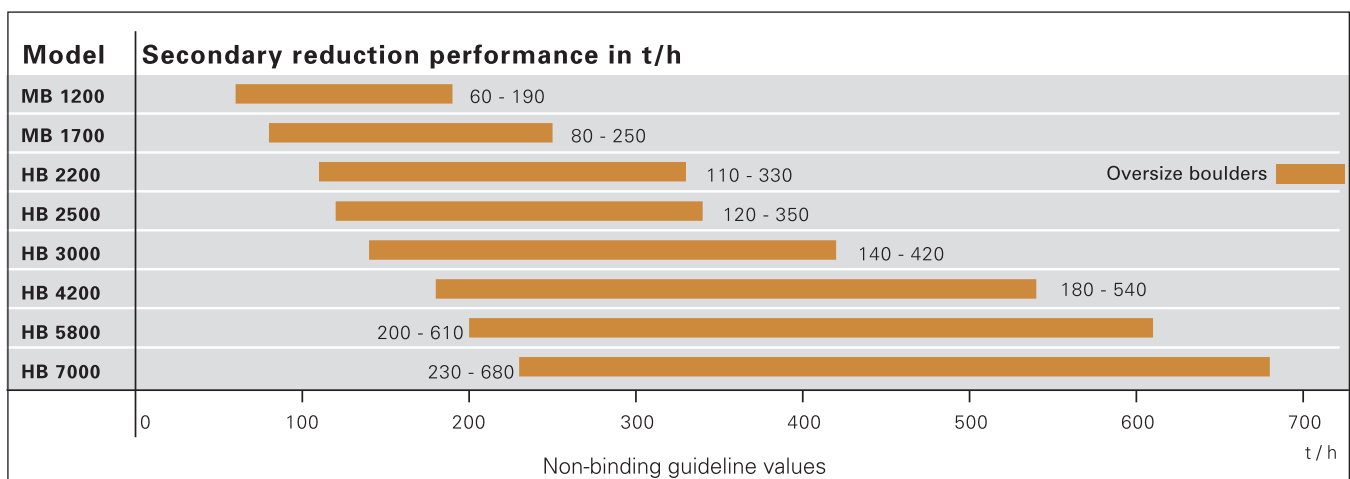
impact on the processes. Secondary breaking in open-pit mining is often sub-contracted. From the quarry operator's point of view this offers the following advantages:

- low oversize breaking costs
- no investment in equipment that is otherwise hardly ever needed
- no need to employ breaking personnel

- full cost transparency
- no machine breakdown risk and
- a source of specialized and motivated machine operators.

Additional jobs, such as building ramps, can also be undertaken using the hydraulic breaker.

Guideline figures which can be achieved using hydraulic breakers for secondary reduction.



The figures are based on performances achieved in practical operations.

Secondary reduction performance	Examples of rock type
High	Shell limestone, sandstone, slate, gneiss, marble
Average	Limestone, dolomite, greywacke
Low	Lava, porphyry, diabase, basalt, granite



New upgraded D-series drill rigs

New family

Atlas Copco has created a new, upgraded family of D-series rigs, and this article overviews the many changes made to the range. The ROC D-series is celebrating 9 years since initial launch.

The first rig, delivered in October, 1999 heralded great success in the marketplace, as a result of which D-series rig number 1,000 was delivered to the US in late-2005. Today's ROC D7 is better than ever, and the ROC D9 now offers a more powerful rock drill and improved flushing.

Recent additions to the range, such as the ROC RRC radio remote controlled rig, and the Silenced SmartRig ROC D7C/D9C, have ensured the future of this popular series well into the next generation of drillers.

General upgrades

An even stronger and stiffer boom design on the new D-series rigs facilitates perfect collaring and stable drilling. It is designed to carry optional equipment, such as the Silencing Kit.

A durable cylinder-operated aluminium feed system gives optimal penetration and drill steel life.

A new engine with variable rev/min, which meets the exhaust emission limits in Tier III/Stage 3, ensures lower fuel consumption. A bigger fuel tank is fitted, to allow 12 h continuous operation, while an upsized generator and batteries secure start-up of the rig.

Improved design of the hydraulic support leg avoids getting stones stuck between leg and engine.

All Atlas Copco ROC D7 drill rigs now have a larger, more comfortable and quiet cabin with better ergonomic controls.

The cabin version has considerably improved balance and stability for tramming in the roughest terrain, for which the track frames have been moved forward and sideways. A new higher capacity air conditioning/heating system



Atlas Copco ROC D-series are tough on rock and friendly to the environment.

offers yet more comfort for the operator. ROC D7 is now also available in a LF (Long Feed) version handling 6.1 m starter rod and one 4.3 m rod in the RAS (Rod Adding System), a great time saver when drilling holes shorter than 9.6 m.

SmartRig ROC D7C/D9C improvements

SmartRig ROC D7C/D9C have been upgraded with a new version software which adds more drill control functions such as control of impact and feed force by feed rate.

By far, SmartRigs offer the best drilling control for top-hammer drill rigs in the market today. The optional Silencing Kit enables the rig to be used in restricted urban areas.

Major changes have been made to the list of standard and optional equipment. A water mist system is available

to stabilize the hole walls when drilling in poor rock. It comprises a 120 litre-capacity pressurized water tank connected directly to the flushing air. The hole inclination and hole depth instrument, located inside the cabin, assures the drilling of straight, inclined holes and fast feed positioning, increasing safety and reducing production costs. A robust, hydraulically operated support leg is available for stable set-up when drilling, and can also be used to stabilize the rig when moving in rough terrain.

Today it is possible to get Hole Navigation System (HNS) as an option on SmartRigs which guides the operator to find the right drill location of a hole from a designed pattern within 10 cm accuracy.

GPS compass is another option that can be found in all versions of ROC D7/D9 and F9 rigs which replaces the aiming device. With the help of GPS, the operator can align the holes with better accuracy.



The optional Silencing Kit enables the SmartRig ROC D7C to be used in restricted urban areas.

Radio controlled ROC RRC

The Radio Remote Controlled ROC RRC rig from Atlas Copco reduces hard work, drilling safely in places where operators cannot go. It has a remote controlled rod handling system that saves time and increases production. The powerful rock drills easily adapt to various rock conditions for best penetration rate.

Accurate collaring is possible in rough terrain by virtue of the total flexibility of the operator position.

The ROC RRC is exceptionally stable, with its low centre of gravity and rigid hydraulic support leg.

It has a long reach and stable drilling, thanks to the strong and stiff boom design.

The boom anchor point is located in the middle of the frame to give a perfect balance and low centre of gravity. The powerpack is mounted at the rear of the machine to provide balance and stability.

All components are easily reached from separate inspection ports.

ROC RRC rigs are the result of combining well-designed components and systems, for a drill rig that enhances safety, reduces workload, and increases rewards.

The rigs are equipped with engines that meet all the new exhaust emission limits in Tier III/Stage 3. The rigs deliver exactly the power needed in each phase of the operation, which considerably reduces fuel consumption. A large fuel tank allows 12 h of continuous operation, and easy start-up is secured

through powerful generator and batteries.

Radio technology is revolutionizing rock drilling. The ROC RRC separates the operator and rig, improving safety for both man and machine. The drill rig is controlled by radio waves, and the operator can stand on a safe spot, even when the rig is in a challenging position. It is slightly different to operate than a conventional rig, but many ROC RRC customers have reported that it just took a couple of days before the operators were drilling more holes than ever before.

The ROC RRC rigs are not only the perfect choice for drilling in challenging

terrains in general. Owners are well placed to take on stabilization jobs, installing self-drilling anchors using a simple conversion kit. The folding boom can be positioned up to a height of 7 m beside a slope, or very low for horizontal toe-hole drilling. It can also be positioned at extreme angles, enabling stabilization drilling to be carried out in almost inaccessible places.

The ROC RRC rig is perfect in places with extremely restricted space and difficult access, for example when working close to, or even directly above, road or railway traffic. At various types of foundations, and hills prone to landslide, the ROC RRC rig can be used for completing the job efficiently and safely.

An optional hydraulic winch can be specified for working in extreme conditions, and where it is necessary, to anchor the rig. It also secures safe tramming. The optional toe-hole drilling kit gives the rig a versatile boom head allowing easy service access to the rock drill and good reach for horizontal drilling.

As in the cab versions, the optional robust, hydraulically positioned support leg can be specified for stable set up when drilling, and used to stabilize the rig when travelling in rough terrain.

Hakan Aytekin

Nothing stops the ROC RRC.



Combining drilling simplicity with efficiency

Filling the gap

Rapid development of the Atlas Copco ROC series of crawlers has resulted in drill rigs with output capabilities that outstrip the requirements of smaller operators.

A range of smaller, simpler hydraulic rigs is available to operators who no longer wish to suffer the higher costs and lower efficiencies of pneumatic systems.

Backed by the legendary quality and support associated with all Atlas Copco equipment, the 470 series of surface crawlers is designed to fill this gap.

Beating pneumatics

The Atlas Copco 470 series of hydraulic crawlers has proved popular at smaller operations, where hydraulic is replacing pneumatic for reasons of economy.

Quite simply, the 470 series offers up to double the penetration rate, combined with much lower fuel consumption, down to one third compared with equivalent pneumatic rigs.

Worldwide sales of the two models in the range, the CM 470, which have cabin, and the CM 470LC, which has a side-mounted operator panel on the left side over the tracks, have exceeded 350 units to date.

The 470 range is ideal for pre-splitting in urban construction, trench



Atlas Copco CM 470 hydraulic drill rig features top specification.

blasting, rock excavation in road and railway cuttings, slope stabilization, and production blasting in construction mines and small quarries.

The CM 470 and CM 470LC drill rigs combine simplicity and flexibility with low running cost, while being easy to learn and operate, and capable of both vertical and horizontal drilling.

General layout

Direct hydraulic systems on the 470 series drill rigs means less time spent on maintenance and servicing, and more time spent drilling.

Complex electronics have been avoided in the interests of simplicity of maintenance, and simple on/off electronics are used on the automatic rod-changer, with unit mechanical indexing system. This eliminates components such as indexing motor, inductive sensors and other electronics, reducing the total number of components and giving

the operator an easy time with soft touch joysticks.

The CM 470 is fitted with ROPS/FOPS approved cabin. The cabin, which is the largest in its class, gives good visibility through a wide front window, and is pressurized by air conditioning, which uses external filtered air. The CM 470 has indexed drill guide covering 20 degrees.

There is no gearbox in the power train, and the rod changer has a simple structure, both of which contribute to the overall reliability of the drill rig. All relief valves are concentrated in one easily accessible position, and shorter uniform hoses and efficient hose routing contribute to sensible hose management.

Each model is equipped with a Cummins 107 kW diesel engine with standard consumption of 16 lit/h. Oil and filter changes are required at 500 h intervals, while the engine overhaul period is between 8,000 h and 10,000 h.

CM 470 benefits

- Low running cost
- Easy to learn and operate
- Flexibility drilling both vertical and horizontal

Combining simplicity and flexibility



View of a cement quarry in Japan.

A direct drive power train is achieved by coupling the air end to a fly-wheel, while the engine PTO drives two tandem gear pumps, and another three are coupled to the crankshaft. This five-pump system permits less electronics over hydraulics, less maintenance on the power train, and less concern about possible oil leaks. Inspection and maintenance of the gear pump system is unnecessary: it is not sensitive to oil contamination, and the direct control leads to low cost and easy fault finding.

The engine cooling fan has a 52 degrees ambient temperature capability, and the engine and pump compartment has fully opening doors for maximum serviceability. The drill rigs have ISO9001 quality certification.

Technical specifications

The CM 470 weighs 8.95 t and has overall length of 8 m, width of 2.65 m, and tramming height of 3.07 m. The width of the track links is 300 mm, track oscillation is 10 degrees up and down, and ground clearance is 420 mm. Tramming speed is 0-3.0 km/h with grade ability of 30 degrees from horizontal. The drill rig is equipped with a screw compressor producing 83 lit/sec at maximum pressure of 0.78 MPa.

The rock drill features impact energy of 363 J, frequency of 50 Hz, rotation

torque of 451 Nm, and rotation speed of 0-180 rev/min.

On the CM 470 the overall length of the feed is 6.55 m, with actual feed length of 4.17 m. Feed force is 17.65 kN, and fast feed is 36 m/min and slow feed a maximum of 10 m/min. Feed dump angle is 180 degrees, and swing angle is 45 degrees each side of centre. A feed extension of 1.3 m is possible. Boom overall length is 2.1 m, and lift angle 50 degrees upward and 25 degrees downward, with swing angle right 60 degrees and left 10 degrees.

The hydraulic tank on all models holds 200 litres, and the fuel tank 290 litres.

Rod handling

The rod changer on the 470 series models is constructed with a limited number of components, without hydraulic motor, gearbox or rollers. It has two arms with hydraulic cylinders, two clamps with hydraulic cylinders, a swing shaft and a sleeve retainer, each with a single hydraulic cylinder. A set of solenoid valves actuates the hydraulic cylinders, with on/off switching.

As a result, the rod changer performs with fewer motions, accomplishing arm swing, arm slide, clamp opening and closing, and sleeve retainer in and out. The simple structure, combined with

small number of movements, results in fewer adjustments, and offers easier servicing. The capacity of the rod handler is five T38 rods as standard, with the option of four T45 rods. Drill steel lengths are as starter rod 4.27 m (14ft) or 3.66 m (12 ft) and as extension rods 3.05 m (10 ft). Drill bits in the range 65-89 mm can be fitted.

Hydraulics

Hose management is designed to enhance front facing toe hole forward capability, with the operator able to achieve a lower angle without pinching the hoses. In addition, hoses are designed in uniform lengths to minimize maintenance costs and heighten serviceability, and percussion hoses are separated from other non-vibrating hoses to reduce wear and damage.

To further enhance the serviceability and maintainability each hose connection at the bulkhead is separated for easier access and less risk of dirt in the hydraulic system. The sliding hose reel, with separate rollers for each hose to reduce the internal hose contacts is designed to increase the life of the hoses. The maintenance sliding hose brackets, which are detachable and swingable, and sliding steel sections all contribute to the overall reduction in wear and tear.

Dust handling

The dust handling system on the 470 series drill rigs is based around polyester synthetic filters, which are more water resistant than paper filters. They have a large filtration area of 13.8 sq m, which, combined with suction capacity of 18 cu m/min, means less chance of clogged filters. Longer fan life is possible because the hydraulic system stops the fan hydraulic motor from running during rod changing, while maintaining the dust removal pulse. The lightweight aluminium fan requires less time to reach maximum speed when the motor restarts.

Bo-Göran Johansson

Compressed air for drillers

Pressure means efficiency

Drillers are always looking for better efficiency, using higher pressure and more capacity. On modern DTH drill rigs, for instance, the onboard compressor both powers the hammer and flushes the hole, using most of the energy generated by the engine. Having the most reliable and efficient compressor makes the difference. Towed compressors are just as important, with fuel economy high on the agenda. With Oiltronix electronic oil management system, and FuelXpert™ economy, the Atlas Copco Portable Air Division offers the most reliable compressors on the market, with best efficiency.

Coupled to the COSMOS™ remote monitoring and transmission system, compressors can be located, and maintenance can be condition based, planned in advance of the technician's visit.

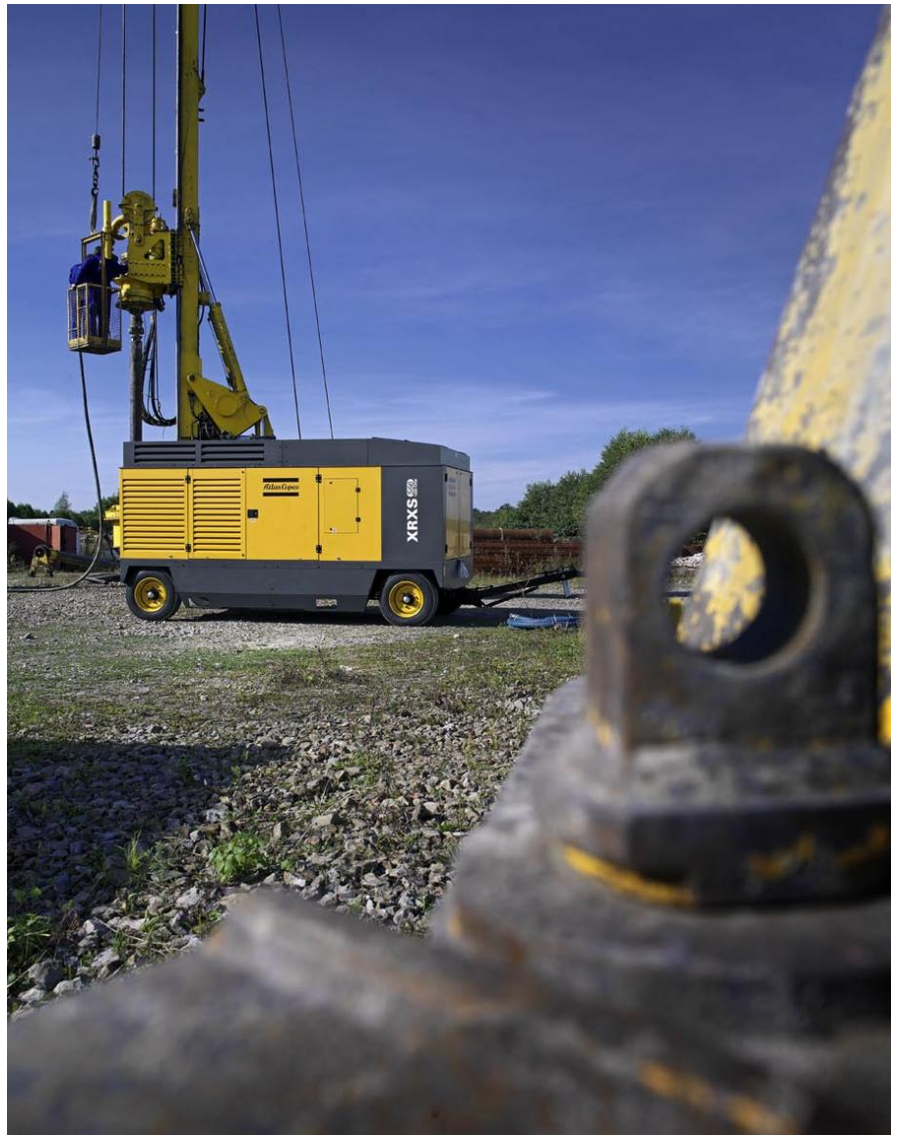
Drilling methods

Surface drilling methods using compressed air can be summarized as follows.

Drifting uses holes of less than 74 mm diameter (3 in), mainly in dimension stone quarries for cutting blocks of marble and granite. Compressed air is used to drive the hammer.

Tophammer drilling is for hole diameters 64-152 mm (2.5-6 in.) Generally, compressed air at 8.6 bar (125 psi) is required for flushing. This method has the fastest penetration rate, lowest fuel consumption and highest production capacity for holes up to 30 m deep (98.4 ft). However, because of difficulty controlling hole straightness at depth, and energy losses in the rod couplings, tophammer drilling is not used for deeper or bigger holes.

Down-the-hole (DTH) hammers are used in a wide range of applications as an alternative to tophammer drilling. The holes are straighter and, because



Atlas Copco XRXS compressor in drilling application.

hammering is done at the bottom of the hole, there are less energy losses. For efficient DTH a higher pressure is recommended. The higher the pressure, the higher will be the penetration rate. Also, high volume Free Air Delivery (FAD) is important for optimal flushing. If flushing is poor, efficiency is lost at the bit by recrushing the cuttings. DTH hammers have a lower noise level, and a longer life, than tophammer rock drills.

However, DTH penetration rates drop drastically when reaching the water table,

if there is backpressure from the water level. Every 10 m (32.8 ft) of water produces a backpressure of 1 bar.

The hybrid COPROD system combines the speed of tophammer drilling with the precision and long service life of DTH. Most Atlas Copco tophammer, DTH and COPROD rigs have an Atlas Copco compressor onboard, provided by Portable Air Division.

Rotary drilling is for diameters 73-445 mm (2.9-17.5 in) in soft rock, using Secoroc tricone bits, with compressed air flushing. Fully pneumatic rigs, known



Operating a rig using a towed compressor.

as small crawlers, use towed portable air compressors. The larger rotary rigs also use portable compressors when there is no onboard unit.

Performance

Availability can be summed up as reliability plus service, and is a most crucial factor in the profitability equation. A rig owner who is paid EUR 25 for each metre drilled, and normally drills 200 m/day (656.2 ft), will lose EUR 5,000/day if his machine is out of operation. An Atlas Copco ROC drill rig, equipped with an efficient and reliable Atlas Copco compressor, and first class service, ensures availability and underpins profitability.

The 30 bar (435 psi) compressor with 560 lit/sec (1200 cfm) is job-matched to drill a 5 in (127 mm) hole, while the 25 bar (365 psi) compressor with 601 lit/sec (1250 cfm) is the best for holes of 6 in (152 mm). There are two choices available for drilling: a portable silenced compressor (XRHS, XRVs, XRXS) or OEM (ORV & ORX). Onboard compressors are used in Atlas Copco ROC hydraulic rigs. Selection of a compressor depends on hammer size and depth of

hole. When drilling in very hard rock, very deep, or with high back pressures, a 30 bar unit offers higher efficiency. If a rig is drilling at 0.6 m/min (23.6 in/min) with 20 bar (290 psi) pressure, it will drill at 0.8 m/min (31.5 in/min) with 30 bar (435 psi). When below the watertable, a 30 bar (435 psi) machine will maintain better penetration rates.

For example, a driller capable of 150 m/shift (492.1 ft) will drill 200 m (656.2 ft) with a 30 bar (435 psi) machine. This is especially significant for heat pump holes, because 200 m (656.2 ft) is the standard depth. Likewise, a mine driller can increase his output from six holes/shift to eight holes/shift. Drilling faster also means more metres drilled for less fuel. Higher productivity means higher efficiency.

In drilling operations, 80% of the compressor cost goes to fuel consumption, while the driller's wages generally constitute less than 5% of the total cost.

Oiltronix

Atlas Copco expertise in electronics, compressor regulating systems and oil systems are combined in its Oiltronix electronic oil management system, which

steers the oil injection temperature to its optimal point. The system offers the customer greater security of operation, while releasing him from daily draining and high replacement costs due to condensation.

Water caused by condensation is known to have a harmful effect on compressor components and oil, entailing high service and replacement costs.

Condensation occurs whenever air is compressed at high pressure and low temperature. In a conventional system, to avoid condensation, a thermostat keeps the oil temperature high. However, the thermostatic valves react slowly, and control oil injection temperature without reference to load condition, or ambient conditions such as temperature and humidity.

As a consequence, at partial load, the cooling exceeds that strictly needed for compression. The result is condensation, reducing the life of the bearings. If oil contains 1% of water, bearing life may be reduced by 40%.

Oiltronix provides an optimal oil injection temperature that eliminates condensation of water into the oil. Depending on the load condition, a low oil temperature is provided for low ambient



Portable silenced compressor in operation.

temperature and low humidity, and a high oil temperature for high ambient temperature and high humidity.

A logarithm uses these parameters to define the optimal oil injection temperature, and sends the signal to a stepper motor controlling a valve.

The Oiltronix electronic controller reduces the average oil injection temperature to 75 °C (167 °F), whereas a conventional system has an average oil temperature of 105°C (221 °F). This reduction in oil temperature increases the theoretical bearing life by 300%, and the lifetime of the oil doubles with every 10 degrees C decrease. Servicing intervals are reduced as a result, with cost savings on materials.

In very hot and humid regions, Atlas Copco recommends fitting Oiltronix to all compressors working above 20 bar (290 psi), and in hot and humid regions, above 25 bar (365 psi).

FuelXpert™

Atlas Copco portable compressors already have a reputation for fuel economy, particularly at high air demand and full load. However, it has been difficult to realize fuel savings at partial load.

The innovative new Atlas Copco FuelXpert™ system regulates engine speed and air inlet with a view to optimizing fuel consumption for each working condition. It combines hardware such as regulating valve, inlet throttle and regulating system with software, which electronically measures regulating pressure and adjusts engine speed.

Even if the air demand is lower than the capacity needs, the system ensures the correct capacity for the application needs.

FuelXpert™ gives separate signals to the engine and air inlet so that, for every individual part, the optimal position is calculated. This ensures a stable regulating system that guarantees savings on fuel consumption. The system also aids cold weather starting, by closing the inlet until air is required.

FuelXpert™ was rolled out with the new Atlas Copco 2006 range.

COSMOS™

Mobile compressors and generators have a tough life, and it is frequently difficult to keep track of their whereabouts, let alone service history and performance.

Atlas Copco COSMOS™ is a remote monitoring system that collects, transmits and manages all operational data. The system provides information on machine utilization, service interval, history, position and all available measuring points and parameters, allowing real time messaging when required.

COSMOS™ outperforms every other similar system, with remote diagnostics facilitating condition based maintenance, and allowing interventions to be prepared in advance and executed more efficiently. Technicians can go to the right place at the right time, allowing timely and accurate delivery and pickup, more uptime, insight into job costing, better invoicing, and evaluation of appropriate machine and fleet size.

COSMOS™ contributes to the efficient management of service contracts and reduces warranty claims. As a result of managing the equipment more efficiently, COSMOS™ reduces cost of ownership, increases revenue, and allows better customer service. It is offered as a plug-and-play solution with three components: hardware, communication, and software. The module has to be installed, configured, set up and linked to the customer's office.

COSMOSTM is designed for global operation, to support all Atlas Copco compressors, whether new or already operational. It provides real time communication with excellent coverage, using satellite technology, and also includes GPS for tracking units worldwide.

An open interface allows COSMOSTM to be integrated with customer business systems, but access to the office information is highly protected. Sessions using the wrong format are systematically shut off. The hardware module is robust, weather resistant, and impervious to water and dust.

Aftermarket services

Atlas Copco has compiled a portfolio of aftermarket services that guarantees to protect clients' investments in their compressors, with the highest quality of service, both locally and worldwide. Parts kits can be delivered, individual service calls arranged, and service plans tailored to specific needs.

The Atlas Copco service organization is established in 150 countries, in each of which trained personnel deliver top class support through a single point of contact. This service operates 24 h/day, 7 days/week. Local centres and fully-equipped service vans are an integral part of the global Atlas Copco aftermarket network. The logistics organization that supports the service activities includes worldwide direct daily deliveries for genuine parts.

More than 1,700 service technicians are continuously trained and updated on the latest developments in products and servicing. Service plans range from inspections, through periodic servicing to total responsibility. The inspection plan provides regular inspection and reports, together with service recommendations for the client.

The preventive maintenance plan offers periodic servicing cover, including parts, labour, travel, accommodation and complete diagnostic report.

The total responsibility plan gives complete peace of mind, with full coverage of the unit.

There is also a fixed-price service for individual repairs, ranging from a simple inspection and diagnostic check to

a full service. To facilitate preventive maintenance, service kits containing recommended replacement parts, such as air filters and seals, are available. These are tailored to match specific service intervals.

It is of great importance that all servicing is carried out using Atlas Copco genuine parts, which are made to the same exacting standards as their compressors and generators, having passed the same endurance tests.

Portable air

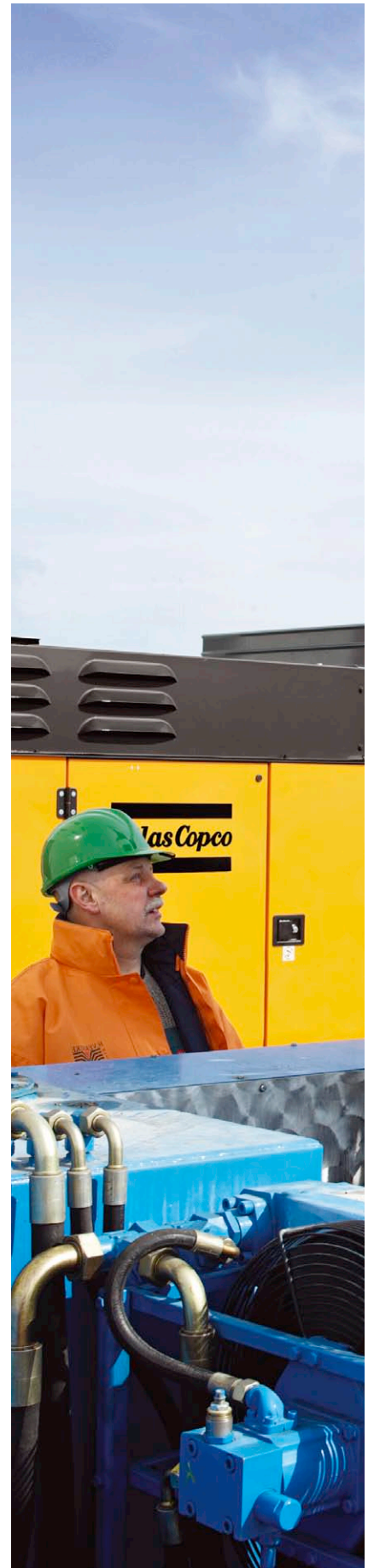
Atlas Copco is the world leader in the supply of portable air compressors, with a long history of product innovation. The current series has built on that experience to produce heavy-duty compressors that work, and work hard. Above all else, these machines are built for extremes, and are absolutely reliable in difficult and extraordinary conditions. They are engineered to withstand the rigours of arduous terrain and all manner of climatic extremes.

XS-series outputs range from 296-545 lit/sec (17.8-32.7 cu m/min, 628-1,155 cu ft/min) at 7-25 bar, or 102-365 psig. All have high quality build with advanced specifications, making them the ideal workhorse for the big jobs, with top fuel efficiencies at all loads. The electronic control panel provides full diagnostics on the engine, compressor and oil system to help in maintaining peak performance and best fuel economy. All Atlas Copco compressors are now fitted with Caterpillar ACERT engines for clean running, reliability, and comprehensive after sales service.

The screw system at the heart of every Atlas Copco compressor is precision engineering at its very best, with perfect synchronization producing maximum pressure to deliver more air with less energy.

The infinitesimal tolerance margins in this type of engineering require continuous investment to keep abreast of evolving manufacturing techniques, and this is how Atlas Copco maintains its leadership in screw technology.

Gathuru Mburu



Protection by ROC Care

Scheduled service

Nowadays, drill rigs are considered to be a major capital investment, and their owners, whether one-man contracting businesses or large corporations, have to be satisfied that their investment is being correctly serviced. In this way, they can get the best possible return on investment by maximizing availability and producing the lowest possible cost/t of rock, while preserving the long-term value of the asset. This is where ROC Care, the popular value-for-money service package for Atlas Copco surface drill rigs, comes into play.

Key ingredients

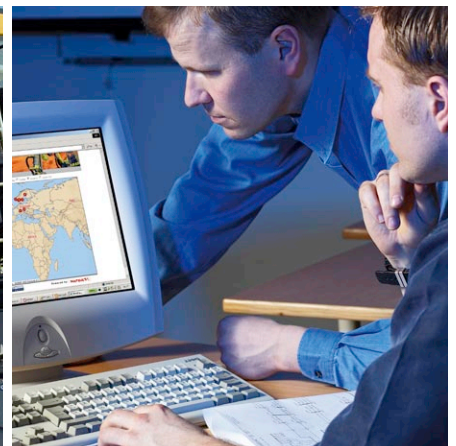
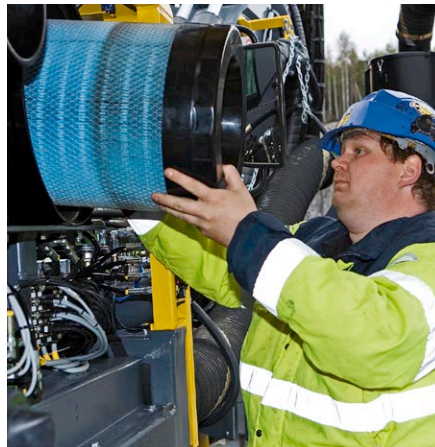
ROC Care scheduled service ensures consistent drill rig performance, hour after hour, day in, day out. Supported by inspection protocols with recommended actions, and extended warranty to protect against the risk of extra costs if a major component fails, the customer is given the required service at the recommended intervals over the full duration of the agreement, for which he is invoiced at the agreed low monthly amount.

This translates into scheduled service without financial penalty, encouraging both parties to concentrate on preventive maintenance rather than risk costly breakdown.

ROC Care is tailor-made for the quarry and construction business, protecting all that is essential to the drilling operation. It extends the warranty and guarantees regular inspections and service, giving security and peace-of-mind for at least 5,000 engine hours of drilling. By focusing on breakdown prevention rather than unplanned repair, it helps keep operating costs to a minimum.

Scheduled service

Scheduled inspection and maintenance is a key element of ROC Care, with the drill rig being serviced according to



The four cornerstones in the Atlas Copco ROC Care service agreement are scheduled service, extended warranty, inspection protocols and satellite monitoring.

each original equipment manufacturer's maintenance scheme. ROC Care covers all parts needed for scheduled maintenance, including oil filters, air filters and fuel filters. The service is carried out by fully-trained and professional Atlas Copco engineers, who know every part of the equipment, and can submit recommendations to prevent potential future problems. Indeed, at each service occasion, the engineer hands the customer a detailed rig inspection protocol, reporting the rig condition and identifying any corrective measures. These can then be carried out at the next scheduled service, or at a time chosen for least disruption to production. Such measures minimize breakdowns and contribute to savings in overall cost of ownership. In addition, the inspection protocols and service book provide verified

maintenance documentation that enhances the resale value of the rig.

The general extended warranty that accompanies every ROC Care agreement provides protection against the breakdown of key components such as the diesel engine, compressor, hydraulic pumps, feed motor and cylinder, traction motor and traction gears. In addition, all major fabricated mechanical components such as the wagon frame, track frames, boom support, booms, boom head and feed holder are included. Rock drill and wear parts are excluded.

Satellite based monitoring

ProCom, included in ROC Care, knows when each drill rig next needs service. It is a global, satellite-based system that monitors rig location and status,



ProCom knows when drill rigs next need service, allowing efficient forward planning.

facilitating remote viewing of engine hours, impact hours, and time-to-service. On certain models such as ROC D-RRC, ROC F-series, ROC L-series and SmartRigs, ProCom also transmits details of drilled metres. The system works worldwide, monitoring rigs wherever they are located. By knowing exactly when each rig next needs attention, Atlas

Copco can schedule service with minimum disruption to drilling and provide valuable rig performance data to support the owner's costing and billing.

Because every effort is made to plan the ROC Care visits to cause as little drilling downtime as possible, Atlas Copco service engineers are conscious of a happier reception at site. In turn,

they no longer have to plan their working lives around emergency breakdown callouts, resulting in a decrease in stress for both customer and engineer, and more satisfaction all round.

Joakim Zander

ProCom monitors rig status around the world.





First impressions on new cab

Initial response

Atlas Copco involved its clients in the design process for its new ROC cab, evaluating their views on how improvements could be made. The new cabs are now in the field with some experienced rig operators, so it was a good opportunity to test their initial response. They find the cab to be more spacious and the new layout extremely user friendly. The extra space is put to good use to stow more of the necessities of life, and the cabs are proving easier to keep clean. Above all, the objective of improving the operator environment has been met, to the satisfaction of all concerned.

Swedish experience

Björn Nordahn operates an Atlas Copco SmartRig ROC D9C, fitted with the new cab, for contractor Bohus Bergsprängning AB in Sweden.

He states "This new cab is a big improvement. The extra space is great. There's room for everything, from lunch-box and stove to sprays and drill bits. Some of my colleagues say it's now so big that it echoes!

I think the controls are now positioned much better. It's really very easy to get to them when you want to change the angle of the boom or drive the rig to the next hole. I think the repositioning of the controls is the best improvement.

The placing of the control buttons is good too, but I prefer small switches as it can be difficult to feel your way across the smooth buttons to find the right one. This can be a bit tricky when, for example, you are using the rig's support legs and you need to have your eyes totally focused on what you are doing.

I have only had this rig over the summer this year, so I can't say anything yet about the climate control system, but the air conditioning has worked well.

It's also easy to keep this cab clean – and the vacuum cleaner is a great idea! We thought it was so good that we have



"The new cab is a big improvement." Björn Nordahn, operator, Bohus Bergsprängning AB.

also installed one in our ROC D7. And it's easy to keep the storage compartments clean because they are large and straight.

In the old cab there was just a little place at the front where you could put a few tools down temporarily. Now there's a whole toolbox there, which is great. All-in-all, I think the new cab is good, even though there are a few small things that can still be improved."

Nordahn finishes with a word on drilling with the SmartRig: "It's almost too easy, and can make you a bit lazy," he says. "Almost everything is automatic, so once you've thought about the job, ground the bits and cleaned up – there's not much left to do!"

Winner in Spain

Maite Santamarta, application engineer at Atlas Copco in Spain, confirms that the new cab is a winner among operators in Spain. "All our customers are very happy with the new cab because it is just so comfortable," she says. "Another advantage is that the placing

of the steps and grab-rails on the door make it very easy and safe to climb in and out of the cabin. The air conditioning is good too, and everyone is very happy with the new positioning of the joysticks."

Cabs vs open air

Some of the range of Atlas Copco hydraulic surface drill rigs are cabless, for different applications and specific situations. For instance, the ROC D3, ROC D7RRC and ROC D9RRC series are cabless rigs. RRC rigs are operated via radio remote control for use in difficult or dangerous drilling positions, while on some versions the operator stands up on the rig to operate it.

Acknowledgements

Atlas Copco is grateful to its clients operating rigs with the new ROC cab for the feedback on which this article is based. A version of this story first appeared in Mining & Construction magazine 3-2007.





Czech contractors choose SmartRig

Large concentration

When Atlas Copco launched the SmartRig concept, it was expected that contractors would need time to appraise its drilling characteristics and performance.

However, in 2006, six Czech drilling contractors took delivery of eight SmartRigs. More orders followed to keep pace with the ongoing construction boom in the country, with its gargantuan consumption of aggregates and cement. The attraction of SmartRig is its drilling efficiency, resulting in more output for less input. The experience with two of those early SmartRig machines is described below.

Destrukce Trebic

Destrukce Trebic was set up in 1999 by two directors who have 40 years experience in quarries, dam construction and motorway building. Some 70% of its work is now concentrated in quarries owned by Colas, the French supplier of aggregate.

The forerunner of Destrukce was Ingstav Brno, set up in 1952 for dam construction in the old Czechoslovakia. Ingstav Brno purchased an Atlas Copco ROC 601 air-powered rig in 1974, followed by a Drillmaster DM4 in 1975, and eight ECM 350 air-powered rigs over the ten years from 1977. In 1989 they bought an ECM 360 rig, which is still in ownership, and in 1990 a ROC 460 pneumatic.

In 1992, the first rig of the new era arrived, an LM 100 with Atlas Copco XAS 175 towed compressor. This was followed in 1994 by a new ROC 742 HC, and a further ROC 742 HC was added to the fleet in 2001.

Present day

The first cabin rig, an Atlas Copco ROC D7 was purchased in 2002, and a



The crushing and screening plant at the Cenkor quarry, owned by Colas.

ROC L6 followed in 2004. The latter is equipped with 25 bar compressor for use with a 105 mm diameter COP 34 DTH hammer. It is employed on long holes for 25 m high benches in a quarry featuring non-homogeneous rock.

The current fleet comprises two computerized SmartRig ROC F9Cs, the ROC L6, and a ROC 742 HC equipped with a COP 1238 rock drill. The fleet works across 17 quarries in the Czech Republic, transported between sites by a company-owned low loader.

Quarry outputs vary, but two sites are producing around 500,000 t/year, and the remainder have outputs of 150,000 t/year and below. Rock quality varies from site to site, and broadly comprises limestone, basalt, granite and sandstone. All rigs work equally well in all of these strata, so bench height is the deciding factor as to which machine will work in which situation. The ROC L6 works in three quarries around Prague.

In addition, Destrukce operates four hydraulic breakers to reduce large boulders ahead of the primary crushers. These

are two Krupp 1700 breakers, one Atlas Copco 900, and one Montabert 900.

SmartRig ROC F9C

Two Atlas Copco SmartRig ROC F9C rigs were delivered to Destrukce in 2006. One has a folding boom and the other a fixed boom. Atlas Copco services both rigs under a maintenance contract. The machines work at 12 quarries, where Destrukce is usually both drilling and blasting contractor. The average stay is three days, during which time 1,000-1,500 metres will be drilled. At a couple of quarries working fractured basalt, slurry explosive has to be pumped into the drill holes. Elsewhere, cartridges of emulsion are generally used, with dynamite primers and millisecond delay detonators. In four of the quarries, Nonel detonation is required to limit vibration due to the proximity of local habitation.

The SmartRig ROC F9C working at Cenkov quarry, owned by Colas and situated 15 km from Prague city centre, has a folding boom and is mounted with a COP 2560 tophammer rock drill. It is



SmartRig ROC F9C with folding boom.

working two shifts/day in basalt and metamorphic granite. It drills 8,000 metres/month using Secoroc 102 mm diameter spherical button bits, which have to be reground after 40 m. Bit life is around 10 regrinds, or 440 m.

A Secoroc Jazz grinding machine is installed in a workshop at Destrukce offices, to where bits are sent back daily from each rig in colour-coded boxes for grinding. This allows the company to keep track of costs at individual quarries and on each rig. The SmartRig at Cenkov quarry is drilling 13-16 m benches using 3.66 m long Secoroc

Speedrods in a 1+7 carousel. A maximum of five rods is used in each hole. The drilling grid is normally 2.5 m x 2.5 m. The first rod is drilled under manual control, and then the rig computer takes over to complete the hole.

The two operators rotate shifts, and vary their shift times according to demand. In winter, the shifts can be as short as 5 h.

However, in summer, peak demand can sometimes result in 12 h operating shifts. It is at times like these that a comfortable cab is a bonus.

The quarry has a Nordberg Metso primary crusher feeding a Metso secondary crusher with six-product screening plant.

Recent history

The recent history of the company can be summed up in its annual metres drilled. In 1999, production was 40-45,000 drill metres for 500,000 t using two rigs. In 2006, Destrukce drilled 210,000 metres for 3.8 million t using four rigs. The metres drilled have increased by 500%, while there has been an eight-fold improvement in tonnages. This can be attributed to deeper, more accurate drilling. The SmartRig ROC F9C is the key, and the directors admit that, without these machines on fleet, it would be impossible to carry out the present

workload. Indeed, when the ROC D7 was sold in 2006, the second SmartRig ROC F9C was purchased just two hours later. The new machine drills 40% faster for the same fuel consumption as the ROC D7, and is more economic on tools.

Indeed, the company fleet average for 2006 was 23 drillmetres/hour, enhanced by figures of 30 dm/h for the first SmartRig ROC F9C and 35 dm/h for the second.

Bearing in mind that the two SmartRig ROC F9Cs are working in the hardest material, and are moving between sites for a higher proportion of their available time, these are exceptional performances. The litres of fuel consumed for each drill metre are also significantly below the company fleet average.

All in all, it is easy to believe Destrukce directors when they assert that they simply could not carry out their present workload without their two computerized machines.

Acknowledgements

Atlas Copco is grateful to the directors and management of Destrukce for their assistance with the preparation of this article, a version of which first appeared in Mining & Construction magazine 1-2007.

Compact TV fitted into cab of
Destrukce SmartRig ROC F9C.





Cementing relationships with SmartRig

Successful partnership

Atlas Copco is a familiar name in the cement industry, with a strong reputation for supplying quality quarry equipment. The company has forged a long-standing technical partnership in Norway with Norcem, a Heidelberg Cement subsidiary, where a new generation of limestone quarrying and mining equipment has been tested. The latest offering is the new GPS-based Hole Navigation System (HNS) developed by Atlas Copco for its SmartRig, a product that is poised to lead the way for faster, more efficient and safer drilling.

Sole producer

Norway has a small, but well-established, cement industry, with Norcem as the sole producer. The company operates two integrated works, one located at Brevik, near Porsgrunn in southern Norway, and the other at Kjepsvik in the north. Both plants have marine locations, and three bulk carriers take care of cement supply to some 30 ports and terminals along the Norwegian coast. Cement capacity from both factories amounts to 1.9 million t/y, serving a strong domestic market worth around 1.4 million t/y. Additionally, the company uses its strategic locations and deep water quays to serve its overseas markets.

Located alongside the picturesque waters of the Eidangerfjord on the southern coast of Norway, Norcem Brevik is the larger of the two plants, with a clinker production of 1.05 million t/y, and a cement production capacity of 1.25 million t/y.

Originally built in 1918, the plant is now operating kiln No 6. Operationally, Brevik is a plant of great interest. It has access to limestone from two separate geological formations, including high quality limestone extracted from



One of Norcem's trucks, used to transport limestone at the Bjørntvet quarry.

the Dalen underground mine, and the factory is able to produce no less than three types of clinker and seven types of cement. Management at the plant have consistently sought to improve and refine operations throughout the production chain.

Valuable advances have been made in the area of quarry operations as a result of the longstanding and fruitful relationship between Norcem Brevik and Atlas Copco. Over the last two years, Atlas Copco has used Brevik's surface quarry to field test and refine a range



Statistics from the Bjørntvet quarry show a 25% reduction in use of explosives and a 40% drop in secondary blasting with SmartRig.

of drilling rigs, one of which is the GPS-equipped SmartRig surface crawler.

Bjørntvet quarry

Nearly half the limestone used by Norcem Brevik is produced by the Bjørntvet openpit quarry, located 10 km from the Brevik plant, and served by a dedicated rail link that shuttles limestone to the factory several times each day.

The quarry has produced a total of 46 million t of limestone since it opened,

back in 1954. It has another 20 million t of remaining reserves. The Bjørntvet quarry requires a workforce of eight working one shift/day to produce 0.7 million t/y of crushed limestone. In terms of quarry equipment, a CAT 990H wheel loader loads two dumptrucks with blasted limestone, for transport to the primary crusher a 1954-vintage Allis Chalmers 42-65 gyratory crusher which is still going strong. Impressively, the unit is fully operational, only requiring new wear plates every four or five years.

Increasing productivity

An Atlas Copco drill rig is at the heart of operations. This is a single Atlas Copco SmartRig ROC F9C, which was developed over two years, and field tested at Bjørntvet. This revolutionary surface crawler is now equipped with Hole Navigation System, in addition to unparalleled automation features.

The SmartRig control system provides a high level of automation to the drilling process, resulting in higher penetration rates and service life for drill string components. By using the laser plane as a reference height, all holes are drilled to the same depth, leading to improved fragmentation of blasted rock and smoother benches. Hence, the costs for secondary breaking, crushing, loading and haulage are considerably reduced.

Automatic Feed Positioning reduces setup time, and cancels out operator error by setting the feed to predefined angles at the touch of a button. As a result, the rig is capable of drilling a series of exactly parallel holes, which also contributes to the safety of the operation.

The SmartRig is also equipped with the automatic rod adding system, Auto-RAS, which enables it to drill automatically to a predetermined depth, while allowing the operator to leave the cab to carry out other tasks, such as maintenance checks or grinding bits.

Measure While Drilling (MWD) is a powerful tool that logs a number of parameters at requested intervals while drilling, such as hole depth, penetration rate, and damper, feed, percussion and rotation pressures.

The SmartRig is also accompanied by ROC Manager, which is a stand-alone, PC-based tool for making drill plans, measuring hole deviation, and logging, presenting and reporting drilling data graphically. In ROC Manager, the MWD data can be illustrated in slices through the bench, with the rock properties identified by contrasting colours.

Hole navigation system

The latest function to be added to the SmartRig, and one that is now being used at the Bjørntvet quarry, is the integration of real-time Global Positioning



Norcem's mine manager Trond Kaasa.

System (GPS). This Hole Navigation System feature allows for the accurate positioning of the rig in relation to drill holes, according to a predetermined blast design, and completely eliminates the need for surveying or staking. Apart from saving time, this results in an altogether more precise drilling process, with less than 10 cm deviation, regardless of weather conditions.

The drill plan, with blast angles, hole depths and other drilling data, is drawn up on a PC using ROC Manager and exported to a PC card for transfer to the computer on the SmartRig. Using information from the drill plan on his cab display, the operator can navigate the rig to the coverage position for a given hole, and the computer will give him the information to place and align the feed exactly over the collar position. There is no need to mark out holes manually, saving valuable time.

At the drill location, the operator display switches to a second screen showing the coverage area, calculated hole start and other relevant information. Once the rig is set up, the operator doesn't

even need to aim it, because the system runs it. Multiple holes can also be drilled without moving the rig. Should the operator find that he needs to deviate from the plan, for example, to drill another hole in a series, he can simply press the 'Add hole' on the dialogue screen at any point.

During operation, accurate drill logs are automatically documented and stored on the PC-card, downloadable in a Microsoft word document. At the end of the shift, the operator returns the PC card, with the drilling log, to the office computer, so that the latest data can be used for the next drill plan. Quarry managers and operators are thus provided with all the information they need to plan the most effective, productive and safe drilling patterns.

The SmartRig ROC F9C is now fully operational at the Bjorntvet quarry, where the management is in no doubt that this new generation of surface crawler rig represents an important step forward.

The new rig has improved performance in three dimensions. Distribution

of the explosives is better; drilling to correct depth is achieved every time; and each hole is parallel. The result is improved safety and less explosives needed to achieve the same result. The documentation function also helps meet regulatory requirements in Norway.

The most noticeable improvement on all SmartRigs is the reduction in hydraulic components by 30%. This results in greater drilling efficiency, and releases space in the cab, improves operator ergonomics, and reduces noise. The Silenced SmartRig is available for use in noise sensitive areas.

SmartRigs are available in three different models, the SmartRig ROC D7C, SmartRig ROC D9C, and SmartRig ROC F9C.

Acknowledgements

Atlas Copco is grateful to Norcem for facilitating the site visit upon which this article is based, and to Tom Armstrong of ICR Research, who wrote the original article.





Accurate drilling in Norway with Hole Navigation System

Improving efficiency

Norwegian contractor Mesta is improving the efficiency of its blasting operations at the Romarheim road improvement project, 50 kilometres north-east of Bergen, Norway. Using Atlas Copco SmartRig ROC D7C GPS-guided drill rigs, Mesta is achieving a level of speed and accuracy with drilling and blasting that is resulting in a reduction in the traffic disruption normally associated with this type of operation. This is proving crucial to keeping this important road open for traffic in the absence of an alternative route.

Pinpoint accuracy

The EUR18.5 million Romarheim road improvement project represents the first application of Hole Navigation System for surface drilling on a construction project. To facilitate the exercise, a Hole Navigation System was retrofitted to a SmartRig ROC D7C rig originally supplied to Mesta in 2005.

As the SmartRig ROC D7C was the forerunner of the current SmartRig range of rigs, it was already prepared for upgrading with the new technology.

Mesta is typical of Norwegian contractors, who are quick to adopt innovative drilling technologies

The Romarheim road development involves construction of 7.2 km of new road, which requires blasting some 225,000 cu m of hard rock and moving 350,000 cu m of earth. The overburden has to be shifted along the existing narrow road, a logistically difficult task because the contractor's trucks have to operate at the same time as normal vehicle traffic is flowing. The job also includes a 950 m tunnel and four small bridges. The tunnel will have two lanes, and will have a cross-section capable of accommodating large trucks.



Atlas Copco SmartRig ROC D7C working at Romarheim road improvement project.

For much of its length, the gradient will be 4%, with a stretch of 6% gradient before entering the portal where there will be an additional lane for heavy, slow-moving vehicles.

Drilling for the tunnel construction started in early-2007.

Safety paramount

Around 4 km of the new road runs along the line of the existing road, although the new stretch will be raised on a bed of rock blasted from the cuttings. The remaining 3 km of road, as well as the tunnel, will be completely new. The existing road carries an average of 1,500 vehicles/day.

The busy road is being upgraded because it is now too narrow for the amount of traffic it carries, and is subject to dangerous rockslides in winter. Blasting takes place every day, and safety is paramount. Each time a blast is

scheduled, Mesta has to close the road for one hour for the clear-up operation.

The Hole Navigation System can be used on any type of Atlas Copco SmartRig. It features real time (RTK) GPS, offering accuracy ranging from +/-100 mm to +/-50 mm, depending on the number of satellites that are in view. The customer supplies the external GPS equipment such as the receivers, antennas and modems.

Anmask software

On the Romarheim project, the system is using Anmask mapping software, a commonly-used tool in Norway's construction sector, as it has data on the geology of the entire country. This software requires some additional hardware, and there is an extra PC in the cab. All drilling data is taken straight from the Anmask package, so drill plans are not necessary.



The display screen in the rig cabin shows standard codes that the operator can follow, and by logging the position coordinates provided by the Hole Navigation System, there is no need for road boundaries to be marked out prior to drilling the blastholes.

The cab display shows exactly where each hole has to be drilled, and the software takes account of variations in the surface height of the rig. Every time the operator repositions the drill rig for the next hole, Anmask tells him how deep to drill, and at what angle.

The operator's skill in moving the rig is key to reducing set-up times, and the Hole Navigation System's most obvious benefit is its ability to ensure accurate hole positioning. It is vital to get the accuracy, especially at the sidewalls of the road cuttings.

Level bottom

A major benefit of using HNS is that it ensures that the bottoms of the holes are level, leaving a flat floor after blasting. Meanwhile, ensuring that the blastholes lie in the same orientation maximizes blasting efficiency, and reduces the need for costly and time-consuming secondary breaking of oversized material. Parallel holes and flat benches translate into reduced use of explosives.

The system also allows the operator to optimize positioning, so that the greatest number of holes can be drilled from one set-up without moving the entire rig, maximizing productivity.

The combination of these advantages reduces clear-up time and cuts wear and tear on loading and hauling equipment by controlling the fragmentation of the blasted rock. In addition, floors are smoother, which reduces wear on tyres and transmissions. As the holes are more parallel, the risk of fly-rock is also reduced, providing added safety. Documentation is improved too, as all the data is logged and can be stored for analysis.

Acknowledgements

Atlas Copco is grateful to contractor Mesta for help received in the production of this article.



SmartRig ROC D7C with HNS system.



Oman mountain challenge

Major projects

In two major road construction projects in the Sultanate of Oman, the contractor Consolidated Contractors Co Oman LLC, known as CCC, has chosen six Atlas Copco ROC D7 drill rigs to cut through rocky hill barriers under tough conditions. Availability and output of the rigs has been higher than would normally be expected, mainly due to the service support provided.

Muscat bypass

The 35 km long Bjwr Bandar-Jissat Witti (BBJW) road will bypass Muscat, the congested capital of Oman. The alignment passes through high, rocky hills to link two existing roads to the Baj resorts and replace the existing old roads, which are in poor condition.

The route passes through a limestone ridge, where a cutting is being excavated in a series of 10 m benches. Three Atlas Copco ROC D7 drill rigs with COP 1838 top-hammer rock drills equipped with Secoroc T38 1.5 in diameter rods are drilling 64 mm blastholes.

Holes are typically 11 m deep, including a metre of subdrilling. Each rig drills 25 to 30 holes per 10 h shift, averaging a steady 25 m/h, using Secoroc flat-faced bits with spherical button inserts.

The drilling pattern comprises a grid of 2.5 m burden x 3 m spacing, with a 15 degree inclination. Presplit holes are drilled at the back of the bench, with a 27 degree inclination.

Service and support

The rocky hills of the ridge present a challenging working environment, with arduous tramming of the rigs and difficult positioning. Extreme temperatures, which often rise to 50 degrees C in the summer months, are the highest under which drill rigs work anywhere. Nevertheless, the ROC D7s have suffered no major technical problems.



ROC D7 copes well with rough terrain near Muscat.

The local Atlas Copco distributor, Bin Salim Enterprises LLD, carries out all rig maintenance, servicing and repairs according to a planned maintenance schedule drawn up by Atlas Copco.

The area plant manager at CCC asserts that Atlas Copco is the best choice in these harsh conditions. Their performance on the road contract has persuaded him to buy similar rigs for ongoing requirements.

The CCC worksite manager complains that he suffered 30 percent less productivity due to breakdowns with the previous fleet, and that no service support was provided on site by the supplier. All of that changed for the better with the arrival of the ROC D7 fleet.

Atlas Copco manager Andreas Papadopoulos, who is based in Greece and is responsible for Oman, agrees that good service support from both Bin Salim Enterprises and Atlas Copco on this project has been a major factor in maximizing the performance of the ROC D7 rigs and in keeping them at full productivity.

Sojar to Al Burin

CCC's other road construction project, from Sojar to Al Burin, is arguably even tougher. The remote 80 km long route, some 200 km from Muscat, will pass through mountains for half of its length. The prevailing limestone and gabbro is harder here than that encountered at the



The 18 kW hydraulic rock drill COP 1838.

Muscat bypass, and there is also some fracturing that can make drill hole deviation control difficult. The contractor has another three ROC D7 rigs

equipped with COP 1838 rock drills and T38 rods working at this site, where they are successfully meeting the challenges. The ROC D7s are supported by

Secoroc equipment for bench drilling. Button bits, extension and guide rods and coupling.



an older IR LM 401 rig. The standard drill pattern is 3 m x 3.5 m with a 15 degree hole inclination. Hole diameters are either 64 or 76 mm depending on the hardness and fracturing of the rock, and bench heights are set at 10 m with one metre of subdrilling.

Despite the tough conditions, each rig drills 180-230 m per shift. Sixty percent of the working time is taken up tramming and positioning the rigs, making these outputs more than acceptable. As in the BBJW road project, local factory-planned servicing and training are provided by Bin Salim Enterprises.

CCC's experience with the Atlas Copco rigs has been much the same on this difficult project as on the BBJW road construction. The project plant manager considers Atlas Copco as a partner of CCC, in the same way as Mercedes, Caterpillar and other big companies.

Acknowledgement

Atlas Copco is grateful to CCC for its assistance in the preparation of this article, a version of which was first published in Mining & Construction magazine 2-2007.



ROC D7 rigs on top in Turkey

Brand loyalty

A surge in construction activity around the capital, Ankara, combined with technically advanced drilling products and dedicated attention to customer needs, has brought Atlas Copco one of its best years in Turkey. Activities in two major Lafarge quarries in central Turkey demonstrate how contractors and quarry operators rely on Atlas Copco products and aftercare, and also highlight the major technical improvements found in the ROC D7 Mk II drill rig compared to a Mk 1 still catering for high production requirements.



The new ROC D7 is designed for greater stability; a great advantage when developing the new top benches at the Bunyan Quarry.

Construction activity

Cement and aggregates are valuable commodities around Ankara, where construction activity can be seen in all directions. Although much of central Turkey is built on limestone, it is important to work the best materials for concrete production, asphalt and hardcore, resulting in many quarries being spread out around the area. As this increases transport costs, and Turkish business complains of the highest priced fuel in Europe and the Middle East, overall costs control is vital. Contractors are striving for true economy in their operations, and this often means adopting astute working practices rather than simply buying cheap.

A leading example of these trends in Turkish quarrying is the family construction business Çiftay. The company has been in operation since 1987, but the family's involvement with rock excavation, and a close association with Atlas Copco, goes back many years.

Headquartered in Ankara, Çiftay works throughout the country and operates quarries of its own, as well as providing excavation contracting services to other quarries, including those operated by Lafarge. Four of Çiftay's six quarries supply cement works exclusively for ready-mix concrete, while the others have a multiple range of products for

hardcore, asphalt, and concrete aggregates.

Ten ROC drill rigs

The Çiftay drill rig fleet comprises eight Atlas Copco ROC D7 rigs currently working, with another on the way, and a ROC F7 COPROD. The latter is used for occasional deeper

hole work, and in particularly difficult geological conditions, by virtue of the versatile COPROD drilling system.

The reputation of Çiftay and its fleet of equipment is reflected in the fact that Lafarge invited them to bid to work its quarries in Turkey.

The Bünyan Quarry, lying near the city of Kayseri in Cappadocia, is one of the more recent star performers. It is

Close relations: Çiftay management and Atlas Copco representatives at the Çiftay headquarters in Ankara. Foreground: Zia Aydın - managing director of the Çiftay group. L to R: Medet Atilla Aydın; Suat Güven; Mustafa Cecil Yüce - Atlas Copco Turkey Ankara works manager; Yavuz Akkaya; Münir Tertemiz - Atlas Copco Turkey CMT sales engineer.





The larger canopy doors on the new ROC D7 rig enhance service access.

situated in the foothills of the Tahtali Dağları mountains, about four hours drive southeast of Ankara, and is overlooked by Turkey's fourth largest mountain, the 3,734 m-high Mount Erciyes. The elevation of the quarry itself is about 1,700 m, and the area licensed for extraction extends over 600 hectares.

The quarry supplies two cement factories and a ready-mix concrete batching

plant, and Çiftay is responsible for all production up to the crusher.

The quarry produces 1 million t of limestone a year, which is double that obtained by the previous contractor using Japanese rigs. This output has to be reached during only eight months of the year, because the snow lies too thick for proper access and normal operations during most of the winter. The area is

subjected to extremes of temperature from +30 degrees C to -30 degrees C.

The success of the quarry is also a result of improved marketing of the limestone, and strict quality control.

All of the dolomitic limestone, defined as 18+% magnesium content, within the licensed area is usable. Samples of all rock for delivery are analysed at an on-site laboratory, and the results transmitted to the customer's batching plant, and to Lafarge.

Despite a fairly remote location, the future looks bright for the quarry, which is capable of 2 million t annual production in a growing market.

All production drilling is carried out by a single Atlas Copco D7 rig, which Çiftay placed on the site new in April, 2006. By September that year, the rig had drilled 32,000 m.



The stiffer square-section boom of the new ROC D7 aids more accurate collaring.

Economy and stability

The new ROC D7 is equipped with a new generation of diesel engine in which exhaust emissions and fuel consumption are major design priorities. Çiftay reports relative fuel consumption of 0.70 litre/drillmetre, which is considerably less than that of the old generation ROC D7. The new rig is also equipped with a larger fuel tank for 12 h operation, so



Demonstrating the steepness of the slopes on which Çiftay and Yibitis-Lafarge plan to use the new ROC D7 in future.

it does not have to be brought down for refuelling so often from its relatively inaccessible location.

The ROC D7 is working new benches at the top of the hill overlooking the preparation plant, where the natural slope can be 45 degrees. Çiftay believe that no other machine can work such slopes without a special safety line.

The improved stability of the new ROC D7 can be an important consideration when working virgin ground and steep slopes such as at Bünyan Quarry. The chassis is located further forward to offer improved balance which, coupled with a greater width, gives more stability in transit. The 2-piece folding boom is of square section, its extra rigidity making it easier to position the feed correctly for collaring.

Improvements

The cab of the new ROC D7 is equipped with both heating and air-conditioning, coupled with a positive pressure ventilation system. Whilst the full advantages of heating and air-conditioning have not yet been experienced, the positive ventilation has a great effect on working conditions.

The cab lets in less dust, and the cab ladder with new pin rather than bolt

fixing is much easier to use, and to remove when not needed. The improved ROPS/FOPS-approved cab includes a protective plate beneath for better safety.

There is also improved access for servicing of important items within the engine canopy and, in particular, a new side doors layout. The central lubrication system has been relocated, and there is improved access to the compressor oil drainage point.

The preparation plant is worked on two shifts of 8-9 h between 07.00 h and

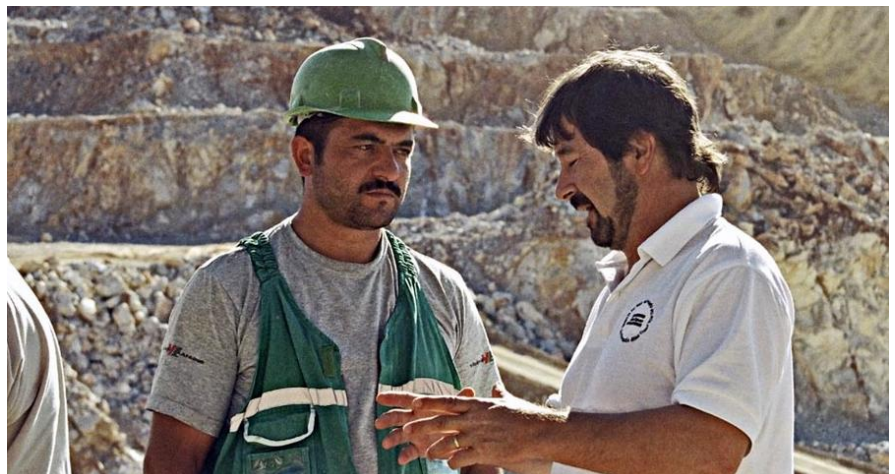
midnight, but the quarry only has to work one shift to keep up production.

Flexible drilling

The standard bench height varies, depending on surface contours, between 12 m and 21m. At present there are six benches in the central main part of the quarry, and three on the sides.

The ROC D7 drills vertically with a one-metre overdrill below the bench. The average penetration rate achieved is 30 m/h.

On-site support: Çektas' ROC D7 operator, Omer Altun, and Atlas Copco Turkey's manager of training & technical development, Yavuz Akkaya, discuss finer points of production drilling.





Çektas' old generation ROC D7 has been giving long, high-production service at the Yibitis-Lafarge Lalahan Quarry near Ankara.

The new ROC D7 is equipped with the COP 1840HE hydraulic tophammer drill with double dampening. The drill tools used are Atlas Copco Secoroc 89 mm diameter Retrac spherical button bits with T51 Speedrods of 3.66 m length. Çiftay has tested other brands, but prefer Secoroc because the drill string life is better. They buy centrally for all their operations, and supply all quarries from a central store.

Two main drill patterns are used, with staggered hole alignment, depending on the fracturing and hardness of the rock. For hard rock, an overburden of 3.25 m is used with 2.75 m hole spacing. For softer, or more fractured strata, a pattern of 3.5 m x 3.0 m is adopted.

ANFO explosive with Dynamit primers and electronic delay detonators are used for blasting.

Çiftay's own on-site artisans carry out drill rig maintenance, but an Atlas Copco contract maintenance service is under consideration.

Lalahan quarry

One of Çiftay's partner companies, Çektas, is working in Yibitis Lafarge's Lalahan Quarry on the outskirts of Ankara. The limestone is not such high

quality as at Bünyan, and is slightly softer and highly fractured. The products are mainly aggregates for concrete production, plus some raw materials for a nearby cement works, with a total output of 150,000 t/month, or 5,000 t/day. Aggregates go to an adjacent Lafarge premix concrete plant, and for manufacturing precast products such as pipes.

The old ROC D7 rig at Lalahan has worked for 10,272 engine hours with no defects. Both drill rig and quarry work one 10 h shift/day. The quarry operates 10 m high benches at the top elevation, and 12 m on the lower sections.

Efficiency tests revealed that three 3.66 m rods is the best combination for these bench heights. Including connection time, the first rod takes 1.5 minutes, the second 3 minutes and the third 6 minutes. Four rods are only ever used on the top bench where the surface is uneven, to avoid unnecessary fatigue in the drill string.

Rods last 6,000 m on average, with some breakages in the hole in very fractured rock. The Atlas Copco Secoroc 89 mm diameter Retrac button bits last 8,000 m on average, with the odd lost bit in the hole. The ROC D7, equipped with a COP 1838 rock drill, achieves

230 m/day at penetration rates of 40-45 m/h, excluding rig moving time.

Çektas carries out regular maintenance every 400 h, leaving 600 h leeway on the maximum interval of 1,000 h.

Drill rig fuel consumption is just 0.92 litre/drillmetre, and 0.04 litre/min, which is very low. Çektas gained its contracts on low margins, so costs are very important to them. Although competing contractors use similar drilling equipment, they use them to full capacity, incurring high fuel and consumables costs.

The normal drill pattern has 3.1 m burden and 3.2 m hole spacing. Blasting is by ANFO with Dynamit primers, and non-electric Nonel detonation.

This comparison of the new and old generation ROC D7 drill rigs in similar circumstances shows that, although the old rigs continues to give reliable service after many hours of working, the new rigs have been well received, and its design improvements appreciated.

Acknowledgements

Atlas Copco is grateful to the directors and management of Çiftay and Çektas for permission to publish this article.

High dam rising at Bakun Hydro

Tropical rainfall

The Bakun Hydroelectric Project (HEP) is located in the island of Kalimantan, formerly Borneo, one of world's largest islands. The main infrastructure is located in a gorge on the upper course of the extensive 900 km-long Rejang River. The attraction and motivation of the Bakun HEP is the catchment area of 14,750 sq km with an average rainfall of 4,100 mm in a tropical rainforest. The water reservoir will cover an area about 695 sq km. The nearest major town with an airport is Bintulu, which is about 180 km distant along a tarred road.

Dam history

The design is for a Concrete Faced Rock Filled Dam (CRFD), built to a height of 205 m. This will be the second highest CRFD in the world after the Sibuya dam of China. It will have a powerhouse with turbines fed by eight tunnels to produce a total output of 2,400 MW.

Work started in 1997 under a contract awarded to Ekran Corporation Bhd, but was almost immediately delayed by the Asian economic crisis. By this stage, a substantial amount of work had been done in developing the site roads, base camp, and offices, together with three concrete-lined diversion tunnels of 12 m diameter and lengths of 1,300 m to 1,470 m subcontracted to Dong Ah Construction of Korea.

The project was taken over and re-started by the government in 2001. It is now divided into packages, with construction of the auxiliary cofferdam awarded to Global Upline Sdn Bhd.

They completed the 70 m high rock-filled embankment, with an upstream sealing layer constructed from residual, impervious soils.

Construction contractors

The main CW2 civils construction began in October, 2002 with the main



The ROC F7 working on one of the many benches at Bakun.

civil work awarded to a Malaysian and a Chinese joint venture named Malaysia-China Hydro Joint Venture (MCH JV). MCH JV comprises mainly China National Water Resources and Hydro-power Engineering Corporation and Sime Engineering Sdn Bhd together with smaller Malaysian companies like WCT

Engineering Bhd, MTD Capital Bhd, Ahmad Zaki Resources Bhd, Syarikat Ismail Ibrahim Sdn Bhd, and Edward and Son Sdn Bhd. From this joint venture group MTD Capita and WCT Engineering Sdn Bhd formed a company called Intraxis Sdn Bhd to undertake Package 1A of the civil works. This

Statistics for the Concrete Faced Rockfilled Dam (CFRD):

Crest level	EL 235 m asl
Slopes	1V : 1.4 H
Height above foundation	205 m
Crest length	740 m
Crest width	12 m
Maximum width at base	560 m
Volume	5.8 x 10,000,000 cu m
Concrete face area	~ 120 sq m
Power/pressure conduits	8 steel lined shafts (diameter 7 m) and 8 tailrace tunnels (diameter 8.5 m), total length of 680 m
Power house	8 x Francis type 315 MW



Clearing bedrock for dam foundation.

involved the clearing and removal of overburden for the main dam and quarry area and associated works.

Drilling and blasting

Specialist drill and blast contractors Fong Mook Seong Sdn Bhd (FMS) were assigned to carry out the drill and blast at the lower spillway and powerhouse,

and general rock clearance along the banks of the river downstream of the dam. Most of the work was carried out using the ROC D7, which proved to be a versatile machine, handling varied demands at the difficult site.

In some instances, the bund width was narrow and the slope was steep, but the ROC D7 was able to handle these jobs efficiently. The two ROC D7s

were mainly used for drilling 76 and 89 mm holes to various depths, depending on the situation, using Atlas Copco Secoroc rock tools.

FMS also have the ROC F7 and the ROC L6 to handle the bigger jobs, especially where 102 mm holes are needed.

These two machines proved to be very productive on huge volume blasting. During an 8 hour shift, each machine is capable of drilling more than 300 m. FMS also used a couple of “old faithful” ROC 742s during the initial stage of the job, proving this is still a very productive machine for the particular jobs assigned to it.

Datuk Puspanathan, Managing Director of Overseas Tunnelling and Construction Sdn Bhd.



Upper spillway

The upper spillway was originally covered with various sizes of boulders and weathered rocks providing a challenging drilling assignment for Overseas Tunnelling and Construction (OTC). Their three ROC D7 and one ROC D5, complete with folding boom and long or high reach, helped tremendously on this tricky job. The blast holes were generally drilled using 89 mm bits from Secoroc. OTC achieved a high utilization rate for the drill rigs, despite using them to drill rockbolt holes as a cost

Drill rig performances

Model	Hole dia	Drill tube	Secoroc bit type	Drillmetres
ROC D5	76 mm	T45	flat front spherical	250 m/day
ROC D7	89 mm	T45 and T51	flat front spherical	250 m/day
ROC F7	89-102 mm	T51	flat front spherical	300 m/day
ROC L6	112 and 115 mm	COP 45	concave front	300 m/day
ROC 742	76 and 89 mm	T45	flat front spherical	200 m/day

and time saving measure. These bolt holes were mainly horizontal, and up to 15 m deep, and drilling them at the same time as the blast holes significantly reduced the work cycle times.

Preparations for the dam foundations were carried out by drilling and blasting contractor M K Ting using the ROC D7. These involved precise and controlled blasting to deliver a high quality platform for further foundation work.

This contractor also has a ROC F9 available to drill 102 mm holes. They faced very challenging geology in the predominantly conglomerate sandstone greywackes with interbedded shale and mudstone, mostly folded at more than 45 degrees. In this type of rock the driller has to recognize changes in rock condition in order to change drilling tactics.

During the early stages of the project, there was high cost due to premature breakage of drill rods. This was corrected by training the drillers in appropriate drilling techniques and paying attention to the drill rig parameters. The anti-jamming and RPCF systems were explained in detail so that the drillers could obtain maximum benefit from these advances.

Service contract

Atlas Copco maintains a fully equipped workshop at site to carry out maintenance, repairs and overhauls. Adequate supplies of rock tools and spare parts are held on stock to reduce the turnaround time. Two technicians are at the jobsite fulltime, with administrative support from the head office.

The ROC D7 is a multi-purpose machine designed to handle a variety of tasks at construction and quarry sites. The large drilling area and very high

coverage were definite strong features of the machines, with COP 1800-series rock drills capable of handling up to 115 mm diameter drilling in all rock conditions. The rock drills also have a unique reflex double damping system that keeps the drill bit in optimum contact with the rock at all times.

The ROC D7 is easy to set up for drilling straight, quality holes utilizing double drill steel support, hydraulic feed, and intelligent hydraulic system. The Atlas Copco hydraulic drilling system increases penetration rates while reducing drill steel costs to improve productivity and overall drilling economy.

Added to similar features as the ROC D7, the ROC F7 also has a more powerful engine on board to provide increased hydraulic power and compressed air for larger diameter drill holes.

While the topammer drill rigs were capable of handling most of the work at the dam, a higher capacity machine was required for the big volume blasting. The DTH system is capable of handling drill holes where up to 20 m deep is the norm, satisfying the demand for volume drilling.

All drill bits are reground at specific intervals using an Atlas Copco Grind Matic Manual B.

All the drill rigs are equipped with CAT engines, known for their reliability, and a Caterpillar service centre is located at the dam site.

Other Atlas Copco equipment at site includes portable air compressors models XAMS 326 Md and XRHS 355 Md for shotcreting and DTH drilling of long drainage holes.

By end-2005, construction of the dam filling was at the 126 m level, with about 40% volume completed. The completion level of 205 m was reached at end-2006. The completion of the dam

project is expected to be end-2009, after which it will require two years to fill.

The cost of implementation of this project is expected to be about USD 1.84 billion.

Acknowledgements

Atlas Copco is grateful to the contractors at Bakun Hydro who contributed to this article.

Atlas Copco COP 1838 rock drill being prepared for overhaul at the jobsite.







Hydro construction in Laos

Landmark project

Construction of the Nam Theun 2 hydroelectric plant is a landmark project in Asia. It is the largest Independent Power Producer (IPP) project in the region, and the biggest construction project ever undertaken in Laos. Upon completion, the NT2 hydroelectric plant will have the capacity to generate 1 070 MW of electricity, of which 93.5 % will be exported to Thailand. Landlocked and heavily forested, the location of the site presents huge logistics challenges to the constructors. However, experienced contractor Nishimatsu, using Atlas Copco equipment with first-class service and support, has produced superb drilling performance, averting some of the potential problems normally associated with such difficult conditions.



Power house work at Nam Theun 2 dam.

Power generation

Work on the Nam Theun 2 hydroelectric project officially started in May, 2005, one month after Electricité de France (EDF) signed the construction contract. EDF then divided the work into three separate subcontracts for tunnelling, power station, and dam construction.

Site preparation work in 2004 began with the creation of access roads. In June, 2005 work started to drive the tunnels, and over 3,000 workers now populate the site. The scheme includes construction of a 39 m high by 436 m wide dam wall at the Nakai flood plain, which will create a reservoir of 450 sq km.

A channel will carry the water 70 km to the intake tunnel for the power generating plant. From here, a downhill gradient of 10 % will take it into the 200 m-high vertical pressure shaft. From the base of the shaft, it will reach the turbines through a 1.43 km long, steel-lined pressure tunnel with 90 sq m cross section. This will reduce to 60 sq m as the tunnel narrows before joining a manifold which will split the flow into four streams, one for each turbine. The water will run a total distance of 2.75 km

from headrace inlet to turbine, before running 27 km in a downstream channel to the Xe Band Fei river, which ultimately joins the Mekong. The NT2 project also involves the construction of a 138 km long, 500 kV transmission line to the Thai border, to facilitate the export of electricity.

Skilled partner

The Japanese company Nishimatsu Construction was awarded the tunnelling contract and looked for a partner that could provide reliable drilling and maintenance services for the project. Most important to Nishimatsu was that the winning partner could provide a fixed-cost service, and had the infrastructure and expertise to offer reliable maintenance in what is a very demanding environment.

Landlocked and with poor accessibility to the worksite, the chosen partner would need to operate self-sufficiently, and ship in all the facilities and spare parts it might need during the contract.

It was never going to be an easy task for any company to provide the drilling

equipment and associated maintenance. In the wet season, the near-constant rainfall complicates the simplest of operations, and the remote location means that, if a part or tool is not available, everything has to carry on without it.

Nishimatsu chose Atlas Copco. Having worked together on many previous projects, Nishimatsu were very confident of the ability of Atlas Copco to deliver the drilling tools and quality of service demanded.

The pay-for-performance drilling contract means that only drilled metres will be paid for, and at a guaranteed, fixed price. As a result, Nishimatsu can be sure their rock faces get drilled as and when needed, allowing them to concentrate on other things rather than spend time dealing with maintenance issues.

Set-up phase

An Atlas Copco Senior Service Advisor from the Hong Kong office was called in to assist with setting up a base close to the worksite, and training the operators on the drill rigs and associated equipment. As the local population comprises mainly subsistence farmers,



Atlas Copco service team at Nam Theun 2.

drill rig operators and other skilled workers had to be imported. The operators brought in by Nishimatsu were very

experienced and highly skilled, so it was just a question of showing them the latest features on the rigs.

Atlas Copco Boomer L2 C rig at the face.



At damsite, Atlas Copco has three Boomer L2 C twin boom drill rigs, one Boomer 352 and one Boomer 322. The onsite camp that carries out service and maintenance of the rigs houses a self-contained unit comprising a hose workshop, regrinding facility, administration office and spare parts centre. A complete spare rock drill was also brought in at the start of the contract to provide a backup, but has not been needed so far.

In fact, apart from routine servicing, the fleet has had no significant problems, and has maintained an effective availability of 100 %. This is testament to the investment in the maintenance facility, and the thorough preparation of the infrastructure to cope with the remoteness of the site.

Service at the site is provided around-the-clock by a team of eight maintenance engineers and several assistants. Each rig is allocated a service engineer, who is responsible for keeping it ready to drill at the face, regardless of the time of day or night.



Blast and bench

Tunnelling on the project consists of progressing four faces through predominantly sedimentary sandstone and mudstone rock, amounting to a total of 4 000 m excavation. The headrace tunnel is being advanced from either end, along with a service tunnel and a high-pressure tunnel.

The tunnels are created in two stages, with Boomer L2 Cs advancing the crown of the face by drill/blast, following which surface crawler rigs bench blast the floor to create the final profile.

Drilling of one round of blast holes with the Boomer L2 C drill rigs takes between 90 and 100 minutes, after which they are charged with ANFO emulsion. Penetration rates range from 2.5 to 4 m/min, resulting in rates of advance of 150 m/month at each face.

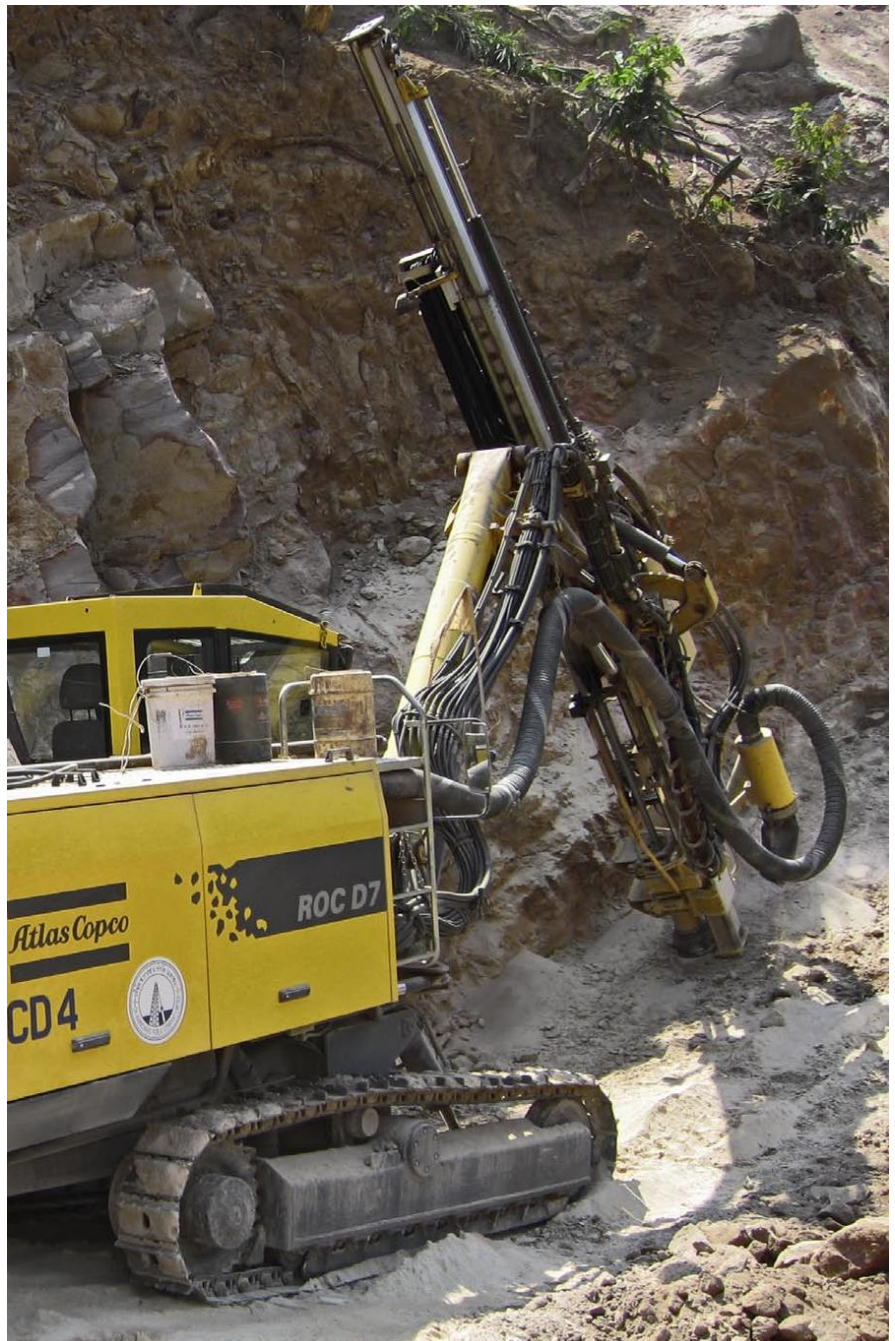
Both 45 mm and 48 mm ballistic button bits are used, with 4.3 m and 4.9 m rods. Holes in the centre of the blast pattern are reamed to a diameter of 102 mm, using domed bits, to create a breaking face for the initial detonation of each round. Four regrinds at the on-site facility is enough to get the bits through their 1 000 m drilling life, with each shank adapter lasting for more than 6 000 h. The hauled waste is removed, and used around the site to improve its infrastructure.

Reinforcement in the tunnels is achieved with 3 m and 4 m Swellex bolts installed into 43 mm holes drilled by the Rocket Boomers. Shotcrete, mesh and, where necessary, reinforced arches are also installed.

Nam Ngum 2 project

Atlas Copco equipment is also being used to drive the 4 km long diversion tunnel upstream. The tunnel will be used to regulate reservoir levels, and allow drainage of the water for periodic inspection of the dam shields.

Contractor C K Lao has assembled a fleet of Boomers and surface crawler rigs, including 8 x ROC D7, 6 x CM 348, 3 x ROC 203, 2 x ROC 642 and 2 x CM 35 with two MB1600 hydraulic breakers completing the excavation fleet. The tunnel is being driven using drill/blast in sandstone and siltstone.



Atlas Copco ROC D7 rig working at Nam Ngum 2 site.

As with the tunnels at NT2, the Boomers clear the upper 8 m of the tunnel profile before the ROC 642 HC crawler rigs move in to bench blast the floor, removing a further 5 m of rock. The team has had good experience with Atlas Copco from previous projects, and so is familiar with the machines.

Working two drilling shifts, C K Lao is aiming to advance at the rate of 4.2 m/day employing 136-hole rounds. The charge holes are 4 m deep in normal conditions. Keeping progress up to speed

on the site is critical for the contractor, as the diversion tunnel must be ready by the end of the next dry season, when the river will be diverted and the dam created.

Acknowledgements

Atlas Copco is grateful to the contractors at Nam Theun 2 and Nam Ngum 2 for their help in the production of this article.

Jahan Compressor





Drilling the seabed for underwater blasting

Improving the sea lanes

Since the mid-1980s, the Norwegian government has been upgrading the coastal harbours and sea lanes of Norway to facilitate the passage of larger vessels. From Nordkapp in the north, to Lindesnes in the south, a remarkable job is being carried out by teams of drillers working from platforms positioned using D-GPS satellite navigation in order to locate each worksite. These teams are responsible for the entire process, including getting the platform into place, drilling underwater into rock, charging the holes with dynamite, blasting and dredging the rock mass, and hauling it away on barges. Needless to say, the task is highly challenging and requires a multitude of skills and precision, and supremely reliable drill rigs.

Drilling platforms

Kystverket, the Norwegian Maritime and Coast Guard Agency responsible for the ports project, expanded the capacity of their drilling platforms in 2002. At this time, they introduced new, more effective Atlas Copco ROC drilling equipment on two out of their three existing platforms. B/R Nyhavn is a semi jack-up platform, while B/R Vestbor is a full jack-up platform, which can be raised as high as 5.0 m above the water-line. The different characteristics of the two platforms demanded separate solutions for each drilling operation, so a ROC D7 was purchased for B/R Nyhavn, and a ROC D5 for B/R Vestbor. The third platform in the fleet is expected to be updated, with the addition of a ROC drill rig in the near future.

The B/R Nyhavn drillers got acquainted with the ROC D7 rig in the calm waters of Torangsvåg, Bergen, a harbour on the south-east coast of Norway. Before the introduction of the rigs, the



B/R Nyhavn with the Atlas Copco ROC D7 drill rig aboard.

team underwent comprehensive familiarization training, while adjusting to their new living accommodation aboard a separate pontoon, anchored closer to the shore. The drilling itself was handled by Kystverket's own production unit, Kystverket Produksjon, whose drillers

worked in shifts of two to three weeks, in teams of three plus one foreman.

The changeover on B/R Nyhavn proved very successful, with the rig functioning according to plan, and the project finished on time and within the stipulated budget.

Using a D-GPS satellite navigation system, the platform can anchor at the exact location of the worksite.





Blasting in Torangsvåg, Bergen.

All-weather operation

The projects are operational all the year round, although occasional snow and ice at the height of the winter has briefly halted the drilling process.

However, weather conditions are generally not a problem, and the ROC D7 has proved equally functional on a platform when drilling in water into the seabed, as when it is drilling on land. Equipped with a COP 1838 HE rock drill, T45 Speedrods and a Secoroc spherical drop centre bit, the ROC D7 drills 76 mm holes at a maximum penetration rate of 2.5 m/min.

This enables a total excavation capacity of two full-size barges of spoil per 10-hour shift.

The drilling work in Torangsvåg was completed in December, 2002, when the platform equipped with the ROC D7 rig was transported northwards along the coast to start work at a new site at Lofoten.

Rig modifications

The different systems utilized on the two platforms have demanded individual modifications to the drill rigs.

On B/R Nyhavn, the ROC D7 has a wave change compensator fitted onto its feed. This enables the unit to maintain contact with the rock, even though the platform may be rolling on the waves.

The full jack-up platform of B/R Vestbor is supported by four iron pillars anchored on the seabed, a system which makes it very stable, and compensates for waves as high as 1.5 m.

The positive effect of the modifications on both platforms has encouraged the team to extend the capacity of the rigs even further. Drilling is currently restricted to 12 m below the surface of the water, but new modifications on the rigs will increase the maximum drilling depth to 20 m.

Since the success of the project at Torangsvåg, Kystverket sees new possibilities ahead in connection with a plan to privatize its services. Thanks to the reliable performance of the Atlas Copco equipment, they have gained the confidence to expand, and in future expect to be competing for drilling projects in coastal waters around the whole of Scandinavia. A fourth platform ordered by Kystverket has been designed with living accommodation incorporated onboard.

Acknowledgements

Atlas Copco is grateful to the management of the Norwegian Maritime and Coast Guard Agency and its operating subsidiary Kystverket, for their help and assistance with this article about unusual applications of ROC drill rigs.

The ROC D7 feed is fitted with a wave change compensator.





Underwater blasting for Leixoes harbour

Three barges, six rigs

Leixoes harbour, at Matosinhos, north of Porto in Portugal, is being deepened in order to handle larger ships. This involves drilling and blasting some 200,000 sq m of seabed to remove 250,000 cu m of rock. Three barges are employed, two mounting Atlas Copco ROC D7 drill rigs, and the third with three purpose-built pneumatic rigs equipped with Atlas Copco rock drills. Comparisons between the two systems are inevitable, but it can be safely said that the pneumatic rigs use more manpower than the hydraulic rigs. It remains to be seen what the comparative costs/m will be.

Leixoes harbour

The Leixoes harbour deepening involved drilling and blasting sea floor that was previously at -6 m to -8 m, and lowering it to -10 m. Sea floor that was already at -10 m was lowered to -12 m. When the harbour project is completed, ships of up to 215 m long and with drafts up to 11 m will be able to berth at Leixoes, modernizing its capabilities to present-day standards.

The seabed is uneven, with steep undulations in places, making collaring, and holding position, difficult. Drilling was in granite and schist, and some altered strata. The contract was paid on cubic metres excavated to the required levels, so the performance of the drill rigs was crucial to success.

The contractors who used the barges equipped with Atlas Copco ROC D7 rigs were Etermar and Somague, who work together on various similar projects. On this occasion, Etermar was the leader.

Their barge Porto de Aveiro was equipped with two ROC D7 with folding booms and 6 + 1 cassettes mounted on rails along one side. These machines



Etermar/Somague barge Porto de Aveiro with two rail mounted ROC D7s.

are owned and operated by drilling subcontractor Dipax, a key client of Atlas Copco Portugal. They use 3.7 m Secoroc T45 Speedrods with Secoroc 76 mm ballistic button bits, with an expectation of 15 holes/shift for each drill rig.

Porto de Aveiro was moved and positioned in the drilling area by tugboats. Once in position, it dropped four seabed anchors, and used its onboard winches to move across the drilling area. At each drilling position, it extended its two legs to the seabed to steady itself, slacking off its anchor cables until they lay on the seabed, out of danger of snagging.

Their second barge, Eng S A Nogueira, is self-powered. It has a single ROC D7 mounted on rails so that it can traverse the entire length of one side. The barge has two retractable legs to help maintain correct drilling position, allowing a single row of 14 holes to be drilled along its length for each setup.

The third barge, Pocinho, was operated by Rockfall as subcontractor. It

has three specially fabricated tower rigs equipped with Atlas Copco gravity-fed BBE 57 pneumatic rock drills powered by a trio of Atlas Copco XAHS 365 mobile compressors, each delivering 12 bar pressure at 365 lit/sec FAD. The BBE 57s use 2 m rods, with coupled 4 m lengths being inserted into the drill string from platforms on each drilling tower.

The Eng S A Nogueira ROC D7 drilled 15 holes in each 16 hour shift, and each BBE 57 on the Pocinho Rockfall barge drilled 15 holes in each 12 hour shift using 76 mm diameter drill bits.

The drill rigs were washed off every day using fresh water to prevent salt-water corrosion.

Wave compensation

The ROC D7 on the Etermar/Somague barges were equipped with a specially developed Atlas Copco balancing wave



Etermar/Somague barge Eng S A Nogueira with one rail mounted ROC D7.

compensation system. This comprised a hydraulic valve bank located in the cabin, which kept the rock drill feed pressure constant despite the wave condition.

A drilling tube developed by Etermar afforded 1.5 m of flexibility to keep it in contact with the seabed.

The drillplan evolved by the joint venture was on a grid measuring 2.5 m x 2.5 m, and to datum depths. Each hole was located using GPS, and the rigs then moved laterally along the barge, using their folding booms to reach out to the hole position. The area of operations stretched from 500 m to 1 km

Rockfall barge with three tower rigs mounting BBE 57 pneumatic rock drills.



off the service quay, so a number of vessels were employed ferrying men and materials between the barges and the shore.

The contract commenced in October, 2005 and was completed in November, 2006. Work was carried out 24 h/day, with the exception of Sundays.

Blasting could take place at any time during the dayshift between 08.00h and 18.00h, with an embargo at lunchtime from 12.00h to 14.00h. At the end of each dayshift, the remaining drill pattern was charged and blasted in case there was need to move the barge.

The standard 500 kg gelignite charge was made up in plastic pipes, which were lowered into the holes. Adjacent holes were wired up in sequence, and fired using millisecond delay detonators. The nightshift drilled for 12 hours and blasted at 08.00h. The result was around one cubic metre of blasted rock for each kilogram of gelignite. The required explosives were delivered to the quay every day by supplier SPEL.

The harbourmaster was informed ahead of blasting and could direct shipping away from the operation, if necessary. If a barge was in the way of a ship, the ship was held back for a short time while blasting operations were undertaken.

Vibration monitoring instruments were positioned to protect port installations. Up to 10 mm/sec of vibration was allowable, but the range experienced was only half of this maximum, so no problems occurred.

The spoil from the blasting operations was excavated by a long-stick backhoe into a curved bottom barge. When sea conditions were good, the spoil was taken out at least 6 km to a designated offshore dumping area. At other times, it was brought ashore and transported to a landfill site owned by the Port Authority. Two self-powered spoil barges were used, each in excess of 600 cu m capacity.

Acknowledgements

Atlas Copco is grateful to the managements of the contractors and subcontractors at Leixoes harbour for their help and assistance in producing this article.

Excavation without blasting

Breakers fit for purpose

Every quarry has its hydraulic breaker, usually employed for trimming benches and faces, and dealing with oversized boulders. However, the advent of large, efficient Atlas Copco hammers equipped with patented ContiLube II automatic lubrication projects this rockbreaking technique into a new league. Contractors and quarry owners are finding novel applications for hydraulic breakers, either as prime production tools or as backup for other production techniques. Mounted on a suitable excavator, these machines offer production flexibility at acceptable cost, and in some situations are proving to be more economic than drill/blast. Certainly, if the overall economics of an operation are studied, hydraulic breaking has to be considered as a viable option.

Mountain view, Australia

Mountain View is a basalt quarry located just behind the Avalon Airport, near Melbourne, Victoria, Australia, which produces aggregate and road base for the many construction works around the area.

Owned by the Barro Group, the quarry is one of nine company operations in the Melbourne region. The quarry uses an Atlas Copco HB 3000 hammer for oversize breaking.

The decision to buy the HB 3000 was based on the company's previous experience with Krupp equipment, having found them to be totally robust. The new hammer is fitted to a CAT 350 excavator, which the owners find to be a very good match.

Like most quarries, Mountain View uses its HB 3000 to break the oversize boulders left after blasting. The HB 3000 hammer replaced a similar hammer, and had an immediate effect. The previous model was similar size to the HB 3000, but took two shifts to do



With HB 3000 Paul Riemer (right), quarry manager at Mountain View.

the work that the HB 3000 now does in one and a third shifts. This frees up resources on the second shift for other work, and represents a good saving.

The quarry is also saving on maintenance costs. The old hammer required monthly bush changes, and retainer rotation for even wear, whereas the HB 3000 needs little maintenance. So little, in fact, that after nearly 11 months of continuous use, the quarry got concerned and ordered a precautionary service for the hammer. Having found nothing wrong, the fitters simply changed the bush to ensure another year of trouble-free service. Mountain View Quarry's HB 3000 is fitted with ContiLube II,

the automatic greasing system standard on all HB breakers. It is a feature with which the company is particularly impressed.

The previous hammer had to be manually greased, a job which fell to the operator, who had to leave his cab to carry out the service.

The ContiLube cylinder, on the other hand, is fitted onto the hammer to get auto-greasing all day. The operator, who used to wear ear plugs all day long in the cabin of the excavator when operating the old hammer, now finds the noise element has decreased to the point where he doesn't need ear protection.



Atlas Copco HB 7000 breaker mounted on CAT excavator at Arthur Kill River.

Lac du Chevril, France

When building the tunnel tube through the Lac du Chevril, France, some 700 cu m of granite had to be cut out of the rock faces lining the approach road to straighten several dangerous bends. Figuerre Entreprise used the new Atlas Copco HB 4200 breaker on the job, finding it much quieter and vibrating less than other breakers the company has used.

The HB 4200 breaker proved as reliable and with the same high breaking capacity as their existing fleet of Krupp and Atlas Copco breakers. However, it is the first time they have used the ContiLube II automatic lubrication system. This fully automatic system saves a lot of operator time, because work is not interrupted while lubrication is carried out by hand. As a result, Figuerre Entreprise has noted a clear improvement in productivity.

The ContiLube II unit is coupled to the breaker, and delivers lubricant only when the breaker is in operation. It ensures that the breaker is always supplied with the optimum quantity of chisel paste.

Unlike other systems, the ContiLube II is directly mounted on the breaker box, where all connections are very well protected. There are no long hoses running over the excavator boom up to the lubricant tank. The lubricant cartridge can be refilled and quickly replaced, without need for any special tools.

Figuerre Entreprise also used the Atlas Copco HB 4200 breaker on its recent contract terracing a site in limestone at Marseille, in the south of France.

Cave Onsernone, Switzerland

Cave Onsernone quarry, in the Swiss Ticino Alps, is owned and run by the Pollini family. The quarry produces the most exquisite gneiss in the region, used to make stone tiles for facades, pathways, interior floors and kitchen walls.

Naturally, extraction from the quarry face requires special skills, lithology expertise, and a great deal of inherited wisdom. Every year, some 15,000 cu m of material is quarried, even though production is only possible in snow-free months.

In the past, extraction was primarily by blasting, a method that took a great deal of time. Drilling the shot holes, closing off the area for blasting, and cleaning up afterwards was costly in terms of time and the number of people involved. However, these costs have been minimized by introducing an Atlas Copco HB 7000 hydraulic breaker as the principal production unit, backed up by two existing Atlas Copco MB 1200 hydraulic breakers.

The company is fully satisfied with the HB 7000, which is the largest hydraulic breaker currently available.

The 7,000 kg breaker clears the blocks from any loose surrounding rock, and then cleaves them into easily transportable crude blocks.

A sure eye for the proper selection of blocks, and the accuracy with which work is carried out, are of utmost importance, since fissured or cracked blocks cannot be sold.

The local Atlas Copco dealer has come up with a special adapter that allows the breaker to be used horizontally with the boom lowered, so the operator in the cab always has an excellent



Atlas Copco HB 7000 with underwater kit.

view of the rock structure. The efficient sound and vibration damping system on the breaker ensures there are no disturbing effects on the operator, carrier, or environment. The excavator operator reports that the HB 7000 produces absolutely no vibrations in the cab.

The proven economy and high reliability of the HB 7000 breaker is already helping to guarantee the future of this family-owned business.

Arthur Kill River, US

The amount of trade and cargo moving through American ports has increased, along with the size of vessels required to sustain this activity. Larger ships require deeper channels through which to navigate to ensure that traffic flow is uninterrupted.

In 2003 Donjon Marine began work on a project to deepen the Arthur Kill River channel that separates New Jersey from Staten Island. It was calculated that the channel needed to be deepened from 11.4 m (38 ft) to 12.9 m (43 ft). This required removal of 46,000 cu m of rock, for which Donjon decided to

use an Atlas Copco HB 7000, the most powerful breaker on the market, equipped with an underwater kit.

Following consultation with the local Atlas Copco equipment supplier, this was installed on a CAT 385B hydraulic excavator mounted on the company's dredge Newark Bay.

The combination of immense power and light weight was perfectly matched to the job, and the HB 7000 proved very capable in the underwater environment.

Atlas Copco's underwater system applies compressed air to the percussion chamber to keep a positive displacement of air constantly coming out of the bottom of the breaker. Without this compressed air, the piston would draw water into the percussion chamber on its upstroke when the breaker was submerged. If the piston comes down on water, it can pressurize the water enough to break internal components and cause catastrophic damage.

A GPS unit creates a map on the cab screen to help operators to position the breaker in the dredging area. The HB 7000 StartSelect system can

be set to Auto Stop, so that the breaker will not function until it comes up against a solid object. This helps the operator to avoid hitting soft areas, reducing the risk of possible internal damage caused by blank firing, and increasing the life of the breaker.

Acknowledgement

Atlas Copco is grateful to its clients in Australia, France, Switzerland and the US for their help in the production of this article.



Jahan Compressor





New York solution

Rock removal

Manhattan translates from the Lenape language as “island of many hills.” In reality, the island of Manhattan in New York City doesn’t have many hills any longer, having replaced them with skyscrapers. Over the centuries, massive amounts of rock have been removed and excavated to create one of the largest commercial, financial and cultural centres in the world. At the busy corner of Madison Avenue and 53rd Street an excavation is being made in the notoriously hard country rock without blasting, and an Atlas Copco ECM 590 drill rig is drilling the thousands of closely spaced holes required.



ECM 590 drill rig hard at work in Manhattan.

Following tradition

John S. Civetta of Civetta & Sons, Inc, specialists in excavation and foundations from the Bronx, NY, is following in the tradition of removing rock from Manhattan, only he is doing it a bit differently.

When an old eight storey building on the corner of Madison Avenue and 53rd Street was demolished to make way for a 30 storey building with 350,000 sq ft of office space, Civetta was called on to remove rock 6.4 m (20 ft) to 11 m (35 ft) below the city surface.

Since 2001, blasting in Manhattan has become a very cumbersome process. Proximity of a subway tunnel also militated against blasting, so Civetta had to be creative. To crack the rock he turned to a chemical product called Damite.

Necessary upgrade

To pull off the job on Madison Avenue, Civetta, who previously had been using a first generation hydraulic drill rig, needed something more powerful and versatile. Accordingly, he employed an ECM 590 drill rig from Atlas Copco to drill all the holes necessary for excavation.

The ECM 590 was a much-needed upgrade for Civetta. He would be drilling hundreds of 63 mm (2.5 inch) holes 4.8 m (15 ft) deep to hold the chemical mixture that would break up the bulk of the rock. The drill rig would also have to line drill 100 mm (4 inch) holes 200 mm (8 inch) apart around the perimeter of the foundation.

This is a sizeable undertaking for any drill rig, but he found that the ECM 590 handled it without difficulty.

Rock splitting

Drilling in the rock of Manhattan is a challenge. The pegmatite and Manhattan schist that support large concentrations of skyscrapers is extremely hard. It cannot be broken with a hydraulic hammer, and any alternative to blasting has to be very efficient to be successful.

The Daigh Company of Georgia distributes Damite, a highly expansive, rock-splitting mortar.

When it is mixed and poured into a hole, it creates 18,000-20,000 psi of pressure after 24 hours. If it sits for several days, 40,000-50,000 psi of breaking force can be generated.

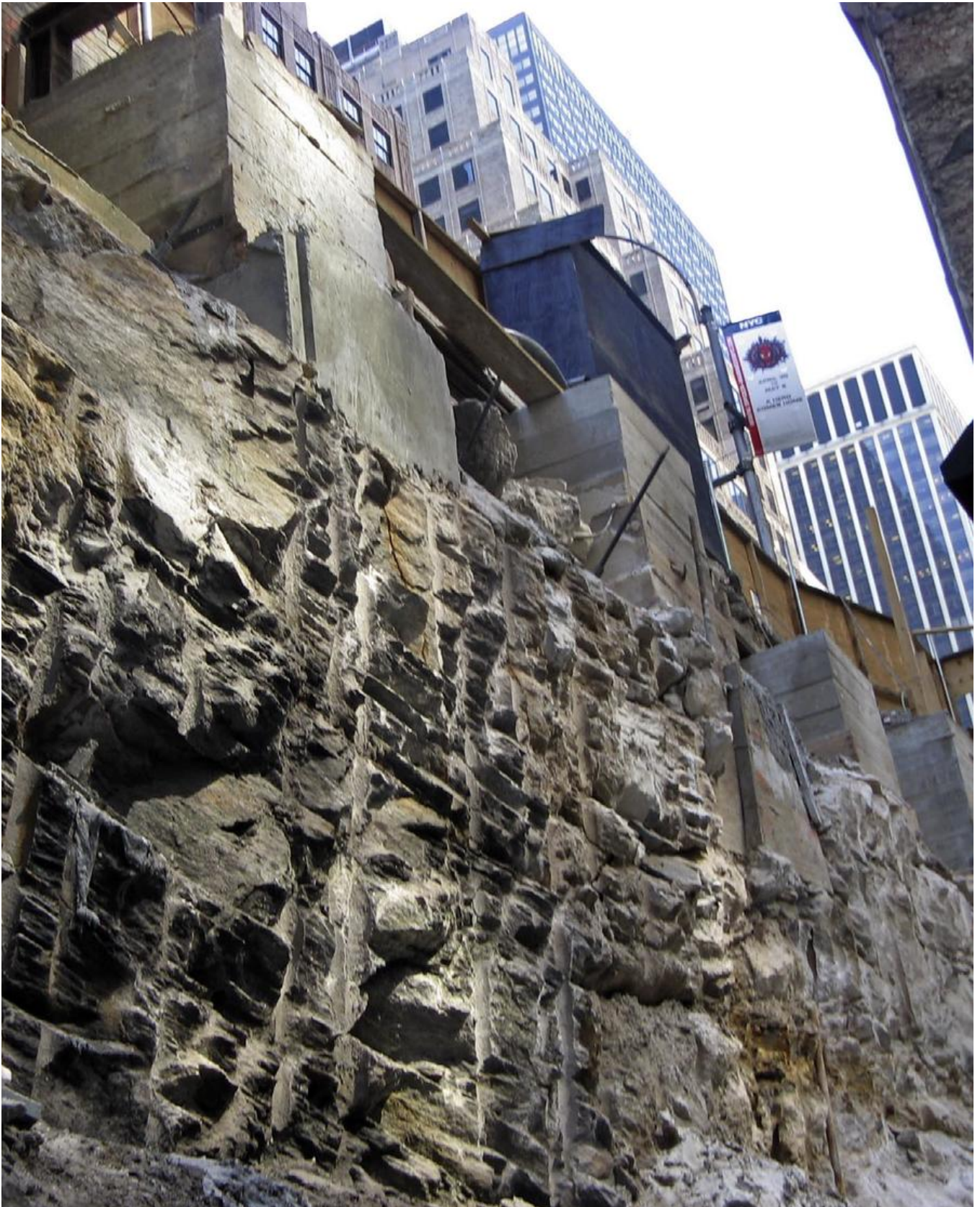
Civetta required every ounce of power that the chemical could muster. Rock splitting holes were generally drilled 80 cm (2.5 ft) apart for most of the project. In softer rock the spacing can be opened up to create a larger pattern, but there isn't much soft rock in Manhattan.

After the chemical is charged, a large steel slug is placed in the hole, and blasting mats arranged to cover the area. After the rock cracks, it is hit with a 5 t (12,000 lb) hammer to break it into pieces.

The ECM 590 was part of a rental purchase agreement in which some of the rental payment is used as equity for a down payment. The financial arrangement is just one of several flexible financial solutions offered by Atlas Copco Customer Finance.

Acknowledgements

Atlas Copco is grateful to the directors and management of Civetta & Sons, Inc for their assistance in the preparation of this article, a version of which first appeared in Mining & Construction USA magazine 1-2008.



The word "Manhattan" translates from the Lenape language as "island of many hills." The island of Manhattan in New York City doesn't have many hills any longer. Over the centuries, massive amounts of rock have been removed and excavated to create one of the largest commercial, financial and cultural centers in the world. John S. Civetta of Civetta & Sons, Inc., specialists in excavation and foundations from the Bronx, N.Y., is following in the tradition of removing rock from Manhattan, only he is doing it a bit differently.



Supporting downtown Charlotte

Urban dig

Taking a street-level parking lot down vertically more than 20 m in busy downtown Charlotte is a job for the professionals. Because of variations in the rock formation, and complications working around existing structures, the process has required many types of ground engineering. These include retaining walls, mini piles, and soil anchors for securing the walls during excavation. Specialist contractor Hayward Baker is using two Atlas Copco ECM 780 drill rigs to handle the changing ground conditions efficiently.

Parking underground

The former parking lot is in the process of becoming an 18 storey Ritz Carlton hotel and a 33 storey office building, with a multi-level parking deck below the two structures.

At one time, Hayward Baker, a Keller Company, had as many as five rigs drilling at the site. Currently this number has reduced to two, both of which are Atlas Copco ECM 780 rigs. On this project the crew has run into every kind of rock that North Carolina has to offer.

The new structures to be built on the site are at the end of the block, with an existing parking deck on the one side. This needs to be tied below street level into the new parking ramp, which is yet to be built. During construction, mini piles were installed along the existing parking deck columns to keep the structure stable while excavating for the new buildings.

Retaining walls

Hayward Baker's part of the job includes earth retention during excavation of the pit, where the grade is being taken down in 1.6 m lifts using hydraulic breakers, with excavators to load out the rock.

After the material is removed, the crew shores up the exposed wall. For



The ECM 780 drilling anchor holes in the excavated wall.

the street sides of the pit, soil nails are installed 4.8 m to 16 m deep at 15 degree angles, then lagged on a wood retaining wall with 3 to 4 strand tiebacks each. The nails were tested to 28 KIPS after three days.

Under the existing parking garage, 8 m to 19 m soil nails were installed at 20 degree angles and tested to 80 KIPS. To seal up the wall, mesh is wired to the rebar and shotcrete is sprayed on to complete the process.

Good combination

To drill the holes, the ECM 780s are equipped with QL40 hammers, a combination that has given no problems with drilling. In total, between 800 and 1,000 of the 11.25 mm (4.5 inch) holes will be drilled on the project.

The job was engineered to utilize Nos 8, 11, 14 and 18 threaded bar anchors at various locations on the site. The type and spacing of these anchors is dependent on the nature of the formation at each place. For example, on the east wall, anchors are installed on 1.6 m centres,

while on the west wall they are installed on 2.55 m centres.

Reflections

Hayward Baker superintendent Reggie Goodchild likes how the drills can handle it all. He has been with Hayward Baker since 1984, and for the last 19 years has been a superintendent. During his long career, he has operated every type of equipment they have, including all of their drill rigs. In his own words, Goodchild finds the ECM 780 very nice and easy to run, and good on rough terrain. The rigs can also be successfully applied to a wide range of jobs, such as installing shear anchors, rock anchors, tiebacks, and soil nails.

Acknowledgements

Atlas Copco is grateful to the management and staff of Hayward Baker for their assistance in the production of this article, a version of which first appeared in Mining & Construction USA magazine 1-2008.



An ECM 780 tramming down the bank after finishing a line of holes.



Flexibility and economy with COPROD in Austria

Simply the best

The management at the Jakomini Quarry in the Bleiberg region of southern Austria has experience of all types of drilling, including top-hammer and DTH. However, when an Atlas Copco ROC F7CR equipped with the patented COPROD system started work at the quarry, they unanimously decided that it was the best drill rig on the market for their conditions.

Large operation

Bauholding Strabag has 40,000 employees, making it one of Europe's largest construction companies. Its quarrying division Mineral Abbau GmbH employs 800 operatives and produces 18 million t/year at 57 quarries in 11 countries.

One of these is the 650,000 t/year operation at Jakomini Quarry, located on a Bleiberg alpine slope in Austria. Jakomini Quarry has seven benches, each around 20 m high.

A small fleet of three drill rigs includes an Atlas Copco SmartRig ROC D7C and a new ROC F7CR. A team of 25 people work at the quarry to cover all operations, including drilling, blasting, loading, crushing, processing and administration. Of these, three rig operators spread their time over two 8 h shifts/day from 06.00 to 22.00, operating the rigs between 08.00 and 20.00 to avoid unduly disturbing local residents.

The ROC F7CR is making a valuable contribution to production efficiency, drilling fast, straight holes. The operator has a perfect view over the drill-plan area and, when tramping between the benches on steep hills with inclines of up to 30%, feels safe in the ROC F7CR, with its centre of gravity towards the front of the rig.

The flushing air on the ROC F7CR is optimized to take care of the cuttings



Jakomini Quarry is located on an alpine slope in the Bleiberg region of Austria.

in the mainly metamorphic diabase, which is quite hard rock of 140-150 MPa. At the same time, the strata is very fractured and subject to water influx when drilling, making blasting a challenging task.

The blasthole depth varies between 20 m and 26 m and the slope/drill holes are drilled at an angle of 80 degrees. Pre-split drilling is carried out to maintain the stability of the walls.

The ROC F7CR drills 92 mm holes, the optimum hole diameter for the type of rock in this region, and for the production needs. The impact pressure during collaring is 120 bar, and working pressure is 200 bar. Net penetration is 1 m/min and it takes around 20-30 minutes to drill one hole. At 10,000 drillmetres, the wear on the drill tube is 0.5 mm, and one bit lasts around 2,000 m.

Second generation COPROD

COPROD is Atlas Copco's patented system for fast, straight drilling in demanding rock - a system that has proved its

worth in the field for more than 15 years. It is aimed at quarries with a high demand for productivity, and specifically designed to provide the best possible overall economy in terms of cost/t of rock drilled.

The COPROD system combines the high penetration rates of tophammer drilling with the hole quality of DTH drilling. The unique dual-string design of COPROD allows more energy to be transferred to the drill bit through the jointless inner rods. The second generation of COPROD, introduced in 2005, has been improved to increase both precision and reliability. A thicker, 8.8 mm drill tube wall with a new, stronger female T-thread connection to the end piece virtually eliminates the risk of tube breakage, and helps to prevent in-hole deviation. In addition, the end piece's new male T-thread connection to the drill tube eliminates the risk of thread breakage.

In the COPROD head itself, the bit rod has been redesigned to eliminate the rod guide, closer tolerances prevent the risk of bit shank breakage, and



Atlas Copco ROC F7CR at Jakomini Quarry.

the improved air flow reduces the risk of the bit becoming plugged.

The bit is also made of a new grade of steel with higher impact and fatigue strength.

Straight holes

Straight holes are crucial in order to control the burden and distance between the holes at Jakomini Quarry, and also to make it easier to install the explosive charges, which are sunk down in the partially water-filled holes. Sometimes the quarry also uses toehole drilling, which is a common technique in Germany, Austria and Japan. This clears the bench walls from excess burden, and makes sure that the bench is level after blasting.

The COPROD system, together with the ROC F7CR rig, is ideal for the conditions and type of drilling carried out at Jakomini. It is efficient and flexible, has much lower fuel consumption than the DTH method, and features the percussion rate of a tophammer drill rig.

The fuel consumption of the ROC F7CR is only 0.7 lit/drillmetre, while DTH rigs commonly consume 1.4-1.6 lit/drillmetre in the experience of the management.

A tophammer rig can get stuck when it hits clay, whereas COPROD works everywhere, giving it the flexibility to be used in all Mineral Abbau quarries, and in all rock conditions.

Soon after delivery in 2005, the ROC F7CR was drilling an average of 25 m/h, with a best performance of 31 m/h.

A further improvement in both performance and productivity is expected when the quarry brings in computerized

drill planning and adopts hole alignment monitoring.

Acknowledgements

Atlas Copco is grateful to the management at Jakomini Quarry for consenting to the site visit on which this article is based, and for their help and assistance in its publication.

Mineral Abbau GmbH has 57 quarries in 11 countries.





COPROD boosts contractor flexibility

Top driller

DGO M3, a top drilling contractor in Belgium founded in 1993, has a long association with the development of the unique COPROD drilling system, culminating in its order for the first of the new generation system, on a ROC F9CR. This is hard at work in quarries throughout southern Belgium. DGO is part of the French ECP Groupe, and drills 90-115,000 m of holes per year, nearly all for quarry production work.

Difficult formations

As a drilling contractor, DGO is keen on adaptability, speed, and reliability in its drill rigs, including the ability to successfully tackle difficult formations, which can play havoc with hole alignment.

As is common in Belgian quarrying, DGO is paid by the cubic metre excavated, and so can adapt the drill pattern for maximum drilling efficiency.

The contractor drills a wide variety of rock types and formations, including medium-to-hard limestone, sandstone and diorite intrusions. Bedding of the limestone, in particular, can be very contorted, tending to divert top-hammer systems. However, it is in rock such as this that the COPROD system excels.

New generation comparison

When DGO M3 started working with Atlas Copco on the testing and introduction of COPROD, the COP 1850 rock drill was used on the ROC F7CR. However, the latest models use the higher powered COP 2150 rock drill which, together with the COPROD system, improved performance considerably.

DGO's current drill rig fleet comprises two ROC F9CR with new-generation COPROD, and a ROC L6H with



First in the fleet: the five-year-old ROC F9CR, now fitted with the second generation COPROD.

25 bar air pressure. Generally, 127 mm bits are used on the F-series rigs, with 115 mm and 140 mm bits on the ROC L6H.

Quarry customers in Belgium generally prefer higher benches. The ROC F9CR rigs are capable of drilling down to 30-32 m depth, which accommodates the requirements of most quarries, but the ROC L6 can cover the maximum requirements, which can be for as much as 45 m drill depth.

Although the rig carousels can hold eight drill sections, DGO always operates with a ninth on the feed. In contrast, blasters tend to prefer smaller benches of 15-20 m depth to safely achieve adequate fragmentation. The drill accuracy of COPROD is an important factor over greater depths.

Normal bench height is 15 or 24 m, for which the ROC F9CR average penetration rate has been 55 m/h. The speed of the controls and operation has proved attractive to the operator.

The ROC F9CR is equipped with triple-bar grousers on the crawler track instead of deeper, single bars. This improves tramming speed and protects sensitive materials on some quarry benches.

As a responsible contractor with work at many locations, DGO makes sure each job is completed properly. All holes are measured and alignment checked before 'signing off', and any bad holes are redrilled immediately.

Blasting

Charging and blasting activities are the responsibility of Dynamichaines, another member of the ECP Groupe, but DGO staff assist as a team. DGO has 22 employees, including staff for administration, artisans and explosives control. Of these, 12 are involved in drilling and blasting, most of which share the duties between both companies. The main explosive is Nitrochimie bulk ammonium



Rapid changeover: Paulo Ferlisi shows how the bit is changed in a few seconds.

nitrate/fuel oil, prepared in an ECP Multiblend mixer truck and poured into the holes manually. Each hole has a basal Nitro Bickford Dynaroc 9 cartridge as an initiator, with electronic detonation and Daveycord detonating cord.

DGO works on 24 sites in Belgium, including 15 large operations, and also cooperates on Group work in The Netherlands and northern France. As well as limestone, they drill harder rocks such as granite, porphyry and hard sandstone and grit.

DGO started in blasting, and then moved into drilling, so has a different approach to contractors who are only interested in metres drilled. They maintain that 80-85% of a good blast is down to the drilling pattern and its implementation. When they start at a new quarry, they rarely change anything straight away, preferring to use the in-place drilling pattern and explosives. Any changes can then be made on the basis of experience.

Using COPROD, DGO finds it can drill anywhere, with no problem. For the first line of shots in bad ground, they use the lower pressure of 12 bar rather than 25 bar, so that the air and cuttings do not destroy the hole collar. The ROC F9 has a 20% increased performance compared with the ROC L6H. The main limitation is the hole diameter, for which the ROC L6H is available for larger holes. Only 127 mm ballistic button bits are used with COPROD, with frequent grinding to maximize bit life. The hole spacing is adjusted to suit the actual diameter of the bit, especially in hard rock. Some 35-40 bits are stocked for each drill rig, keeping five or six at the machine so they can keep the same diameter for the whole round.

Grinding

DGO uses an Atlas Copco Secoroc Grind Matic BQ2 grinding machine to keep the bits in top condition, finding that the bits last longer and give good overall performance. In sandstone, they re-grind every 60 m of drilling, finding they can put the same pressure on a ballistic bit as on a spherical button bit, without deviation. Rapid bit changeover with the COPROD system, compared to the DTH systems, ensures that regrinding and frequent bit changing does not cause any undue delay.

Every drill pattern and blast is designed using Geolaser laser profiling of the face, checking hole alignment with the Pulsar system. COPROD results are very good in terms of deviation, and they can charge the holes with confidence. They find that the new COPROD section is good for maintaining alignment, but state that 80% of correct alignment comes from the hole collar, and machine position and inclination.

New COPROD

DGO has been using the latest version of COPROD since May, 2003 when the ROC F7CR was converted to its use, and the drill was changed to the COP 2150. The improvements in the tubes and the COPROD head brought about optimal availability, with no broken sections in the first 60,000 metres drilled. Compared to high-pressure systems there is

less airflow in the large annular space, resulting in less wear on the tubes. Also, the diameter of the COPROD 89 tube can wear down to 87 mm without problems.

Another important consideration in an optimum blast is low vibration, achieved through experienced charging and detonation of the holes. Acceptable vibration levels have been steadily reduced, and are particularly important for community relations if the quarry has close residential neighbours.

Correct blast design and execution has been facilitated by the accuracy achievable with electronic detonation DGO was one of the first to use it in quarrying, and all its blasts now use this method. Electronic detonation is more consistent, and misfires can be detected more easily. Vibration can be reduced to about 2.5 mm/s from 5-6 mm/s for non-electric blasting.

Up to nine COPROD rigs are currently operating in Belgium, nearly all in the Walloon, French-speaking province, and served by Atlas Copco Forage et Demolition, based near Paris, through the Belgium agent SEMAT, based in Spy, near Charleroi.

SEMAT carries out major repairs and overhaul work, whilst DGO does its own weekly servicing. Every six months, each rig is taken out of operation for one week for a major service, usually to coincide with a slack period around holidays such as Christmas/New Year and July.

DGO uses genuine Atlas Copco parts as a matter of course, finding they are the best defence against lost production due to breakdown.

Nearly all COPROD users in the region have increased the diameters of their drill bits, due to increased confidence in maintaining correct hole alignment. This means that they need less holes to blast the same amount of rock.

Acknowledgements

Atlas Copco is grateful to the management of DGO for permission to visit their sites and for their kind help and assistance in the production of this article.



Replacing rotary in iron ore

Small is beautiful

The large Shuichang open pit iron ore mine is located near the Luan River, about 200 km east of the Chinese capital, Beijing. It is one of the major sources of raw materials for the Capital Iron & Steel Company, and was once the largest open iron mine in Asia, with an annual output around 15 million t of ore, and 45 million t waste stripped. Shuichang is a subsidiary of the Mining Company of Shougang Corporation, and is a state-owned enterprise.

For some 30 years, large rotary rigs had formed the main drill rig fleet, when two Atlas Copco ROC F9 crawlers were introduced. To the great surprise of the local operators, they outperformed the rotary rigs, resolving presplitting problems in the very weathered rock, while creating a much safer loading and hauling environment.

Geology and operations

Shuichang started operation in the early 1970s, mining magnetite as the primary mineral in the ore, with martite as a secondary product. The natural ore deposit is composed of four constituents: magnetitic quartzite, pyroxene-magnetitic quartzite, magnetitic pyroxenolite and hematitic quartzite. Mineral size in the ore is usually 0.062-0.5 mm, with a moisture content generally between 0.10% and 0.20%, averaging 0.143%. The average porosity of the ore is 4.08%, and its average weight/unit volume is about 3.24 t/cu m.

Shuichang Iron Mine is rated as a lowgrade iron deposit. The average geologic grade is 26.71%, and the average iron silicate content in the ore is 1.73%. From these data, the Fe grade is calculated to be about 28.44%. Geologic grade varies greatly with depth.

The main associated gangue minerals are quartz and muscovite, with hypersthene, hornblende, garnet and black mica as secondary constituents.



Atlas Copco ROC F9 crawler rig, one of four working at Shuichang iron ore mine.

More than ten rotary drilling units have been used from time to time for presplitting and production work. The bench height is about 12 m, and the hole diameter drilled by the rotary rigs is about 310 mm.

Two ROC F9-11 folding boom crawler rigs were delivered to the jobsite in November, 2002. These were equipped for drilling 115 mm holes to nearly 30 m depth. At first sight, the mine staff had great difficulty in accepting that the ROC F9-11, which is physically a much smaller rig than the equivalent rotary machine, would be a suitable replacement.

However, the new rigs soon proved their worth and, after six months operation, the customer was very satisfied with their flexibility and performance. The operators are very happy with the ergonomic layout of the cab, finding

it comfortable, and making it easy for them to operate the rig. The management has expressed satisfaction with the high penetration rate, and the output of almost 400 m/day. They have also found the rigs to be very flexible, drilling at all angles to meet their presplit requirements.

The dieseline consumption is also much lower than expected, leading to better overall costs.

As a result, the company has taken delivery of a further two Atlas Copco ROC F9 rigs, and another five iron ore producers in the region have expressed interest in buying this type of rig in the near future.

Acknowledgements

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ROC F6 boosts production in soft limestone

Choosing well

Turkish contractor Ozturk Yapi needed to find a way to increase its monthly production capacity of 165,000 t. Careful investigation of the available models of drill rig from various manufacturers led to the choice of an Atlas Copco ROC F6 to replace two ageing wagon drills. In one move, the company not only restored its current productive capacity, but also created spare time that can be utilized on new contracts. Operator productivity has also improved greatly, an important consideration in a country where the social costs of employment account for more than 50% of the overall total!

Wagon drills

Ozturk Yapi was established in 1982 and specializes in drilling, blasting, loading and transportation contracts for cement factories. It started drilling operations with two locally made wagon drills, which until recently formed the main production fleet. However, in recent years the wagon drills have struggled to meet production targets and have suffered increasing amounts of downtime.

This was at a time when business was developing to support the ever-increasing need for cement in the Turkish construction industry and, as a result, Ozturk Yapi came under pressure to increase its drilling capacity. The search for modern, advanced drilling equipment technology with high production capabilities to replace the ailing wagon drills started by researching products from different manufacturers to form a reference on which the directors could make their decision. Having produced a comprehensive overview of the various models available, they were left with the choice between topammer or down-the-hole drilling.



ROC F6 owner Ali Ozturk with Atlas Copco SDE Business Line Manager Cetin Kara.

DTH flexibility

The decision was complicated by the fact that the company works two main sites, both of which have very different rock formations. One of the job sites has solid soft and humid limestone formations, which are probably the softest in Turkey. Drilling with topammer is not as efficient as in hard rock, and mechanical excavation is not economic, so DTH would be the wise option. The second site has dry and hard limestone

with some cavities, in which both DTH and topammer could be employed.

The DTH down-the-hole drilling method was duly chosen as the more compatible with the geology, and the shortlist was whittled down to two possible models. The eventual winner was the popular Atlas Copco ROC F6, which was delivered in early-2008.

The ROC F6 set the original standards for a modern crawler in the quarry market and is still widely appreciated thanks to its functionality, safety and



Atlas Copco ROC F6 achieves 3 m/min in soft limestone at Pinarhisar.

ergonomics. For the Turkish weather, it has a comfortable cabin. It is equipped with an efficient 8-tube handling and breakout system for drilling 85-130 mm blast holes to a maximum depth of 36 m using a range of COP hammers.

Surplus capacity

Ozturk Yapi employs six people in five shifts, working 16 and 24 h/day of operations at the two different job sites. The wagon drills each drilled 25 m/hour, and about 200 m/shift.

Prior to purchasing the ROC F6, they could hardly complete their target production, even under the best weather conditions.

In some circumstances production slowed, and sometimes stopped, due to sudden changes in weather. Heavy rain or high temperatures in summer, and very low temperatures in winter, affected both the wagon drills and their operators. Now, the company finds that, using only its new ROC F6, it can easily exceed the combined level of production of the two wagon drills.

The ROC F6 is equipped with a Secoroc COP 44 hammer and 89 mm drill tubes to produce good hole quality without deviation.

It is drilling 115 mm diameter holes to a depth of 11 m to produce a finished bench height of 10 m. Hole burden is 4.5 m with spacing of 5 m on a rectangular grid with drilling angle 15 degrees off vertical. The time to complete each hole is 3 minutes. The blast holes are charged with ANFO or emulsion explosives which are detonated using Nonel. Since the arrival of the ROC F6, production capacity has risen to 2 million t/year, and the machine has proved it can easily handle up to 4.5 million t/year in the current geology. This puts the company into a very comfortable position, with ample spare capacity for potential future projects.

Footnote

Ozturk Yapi chose Atlas Copco as its supplier because the brand name has a high profile in Turkey and is associated with top quality manufacture. Their

research revealed that spare parts availability is good, and the second hand value of Atlas Copco rigs is high, especially when the rig has been maintained under a full service agreement. The company complimented the Atlas Copco sales team on the fact that they managed the sales process very well with their positive approach. As a result, Ozturk Yapi opted for an Atlas Copco service agreement that includes Procom.

Acknowledgements

Atlas Copco is grateful to the management of Ozturk Yapi for their assistance in the preparation of this article, a version of which appeared in Atlas Copco Surface News 2-2008.



Upgraded ROC L6 gives satisfaction

Good decision

Jürgen Kunze, the owner of Polish contracting company Geo Blast, was so pleased with his existing Atlas Copco ROC L6 drill rig that he decided to buy another. The impact that the new, upgraded version of the ROC L6 had on production quickly affirmed his good decision.

Increased capability

Geo Blast operates in three quarries in Poland's Nowa Ruda region, which together produce a total of 5 million t/year.

The new generation ROC L6³⁰ is a high capacity down-the-hole surface crawler. It is primarily designed for quarry blast hole drilling in virtually all types of rock formations. Among other improvements, the upgraded rig benefits from increased percussive capability, improved coverage area and increased mobility. However, the extra 5 bars of pressure make a big difference to productivity, according to the new owner.

The increase in performance is about 30 percent. In the prevailing rock conditions, this makes a difference of 15 extra m/hour, which is a very satisfying result. Over three shifts, Kunze is drilling an extra 200 m/day.

Straighter holes are achieved thanks to the rigidity of the aluminium feed, while the rig also benefits from a new environmental Tier III diesel engine, a better dust collection system, improved filtering volume and redesigned, ergonomic cabin.

Satisfaction rewarded

The contractor is drilling 110 mm diameter holes at 10 degrees off vertical using COP 44 DTH hammers with 76 mm diameter drill tubes. Hole depth is generally 20-25 m, with 3.5 m burden and 4.0 m spacing, and 2-4 rows are blasted at any one time. With two speed



ROC L6 on the benches at Nowa Ruda.

traction motors, it takes only 3 minutes to relocate the rig for its next hole.

The ROC L6 is designed for a hole range of 90-154 mm using various COP hammers. It is a high capacity DTH crawler for quarrying in soft, medium and hard rock, with a power unit that delivers compressed air at a full 30 bar. The tube handling system has a capacity of 8 tubes, and the ergonomic cabin has air conditioning.

Kunze is so satisfied with the performance of his two ROC L6 drill rigs

that he has ordered a further two rigs. He is very pleased with Atlas Copco, having worked with their machines for about eight years. There are no problems with the ROC L6 rigs, and the service is good.

Acknowledgements

Atlas Copco is grateful to Jurgen Kunze for his assistance in the preparation of this short report and permission to publish.



From left to right: Wacław Garnzarz, Blasting Engineer; Edyta Wisniewska, Assistant Manager; Jürgen Kunze, Owner; and Edward Sadlak, Quarry Manager.



High productivity quarrying in Ireland

Drilling on the move

Away from the coast, Ireland is a country of small towns, each with its own particular demands for building aggregates and mineral inputs to manufacturing industry. A lack of motorways across the country means that transportation is slow, so, where bulk commodities are concerned, it is better to produce close to the market. In the quarrying industry, this has spawned large numbers of small operators, who may only need a couple of days of drilling each month to meet their output demand. Using the new breed of self-contained Atlas Copco ROC drill rigs, they can set up and drill within minutes of arrival at site. High productivity and efficient utilization are transforming the Irish quarrying industry, to everybody's benefit.



Hogan ROC L6 drilling at Tobin's Quarry, Limerick.

Hogan Drilling

Family concern

Eddie Hogan Sr has his roots in mining, having worked at Silvermines, Nenagh during the entire lifetime of the underground operation. He started as a shaft-sinker, took his blasting licence at an early age, and worked through the 1970s as a shift boss. When the mine eventually closed in 1982, Eddie had been mine captain for four years, supervising the second and third production levels.

Hogan Drilling was set up in September, 1983 with a single secondhand rig powered by a 120 psi Atlas Copco 700 compressor. Twenty five years on, the company has flourished, and now has a fleet of drill rigs, including one Atlas Copco ROC 460, two ROC L6 rigs, five ROC L6H rigs, and two CM760.

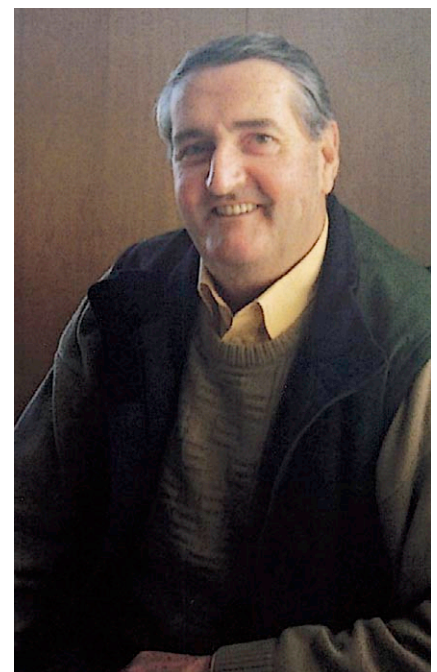
Hogan Drilling has developed into a family operation, with Eddie's son Edward now a quarry engineer, and daughter Ann as office manager. The

company undertakes operations in quarries, surface mining, civil engineering projects and on road construction sites, employing the latest technology such as laser profiling and vibration monitoring. This allows changes in drilling patterns, and redesign of blasts to limit the effects of vibration, and to protect surrounding properties and installations.

ROC L6 experience

The changing nature of the quarrying industry has made safety a major factor of every operation. Efficient drilling, low fuel consumption and controlled labour costs are also high on the operator's wish list. For Hogan, the ROC L6 machines have improved overall drilling productivity from 16 m/h to 25 m/h for 110 mm holes, with 30 m/h as the maximum recorded. These figures are based on a 50 h week, and include time spent moving from quarry to quarry.

Eddie Hogan Senior has been excavating rock for most of his life.





Stephen Lydon operates four ROC F9 rigs with COPROD and two ROC L6 rigs with DTH.

The ROC L6s are currently working at 20 quarry locations, and are used anywhere that the terrain is suitable. Clients' outputs range from 50,000 t/y to 700,000 t/y at each location, with an overall total of 6.5-7.0 million t/y, nearly all of which is drilled and blasted by Hogan Drilling. The standard 110 mm holes are drilled up to 20 m deep, using DTH hammers with 4 m and 5 m rods. Under special circumstances, 30 m holes may be drilled, subject to exemption by the local inspector of quarries. Hogan Drilling, for the last few years, has used bulk emulsion and Nonel detonators supplied by Irish Industrial Explosives. Experience with the ROC L6 has shown increased production rate, lower labour cost, and greater customer satisfaction. Hogan Drilling advertises a cost-effective, fuel-efficient and environmentally-friendly service using its Atlas Copco drill rigs, with equipment suited to drilling holes in the diameter range from 2.5 in to 5 in. The company also specializes in controlled low vibration blasting for road construction. Objectives are to work safely, and achieve best results, within an agreed budget, as a one-stop drilling, blasting, profiling and vibration measurement contractor.

Stephen Lydon drilling

First COPROD

Stephen Lydon still operates the first COPROD drill rig to work in Ireland, and is very proud of the fact. He has a number of major clients, with a spread of quarries, and aims to drill 2,500 m/week with his eight Atlas Copco rigs. His company, Stephen Lydon Drilling, owns four ROC F9 equipped with COPROD, two ROC L6 with DTH, one ROC D7 RRC and one ROC 460. The Atlas Copco ROC F9 is a tophammer drill rig, which can be equipped with either the fast drilling COPROD or conventional systems. Both the 188 lit/sec compressor and 231 kW engine provide enough power to drill straight and fast. The ROC F9 features a state-of-the-art cabin with air conditioning, and drilling controls in the armrest to allow a clear view when tramming or collaring. It has heavy-duty tracks for safe and fast movement. The ROC F9 hole range is 89-127 mm to 30 m depth using COPROD. It drills mainly 105 mm holes using 85 mm tubes and a COP 2550 rock drill. Stephen rates his rigs as extremely versatile, but the ROC F9 is more tractable due to its smaller compressor. He finds that a 12 bar compressor is sufficient

for air flushing, and COPROD penetration rate is 50% faster than DTH. Most drilling is 20 m deep, using five rods, but 30 m holes are easily achievable. Grids range between 3.8 m x 3.8 m and 4.5 m x 4.5 m. He reports that the small shoulder on COPROD does not stick so often as the larger shoulder on the DTH hammer, probably as a result of the Rotation Pressure Controls Feed (RPCF) fitted to his COP 2550 rock drills. This system limits the rotation pressure, ensuring that the torque produced doesn't overload the COPROD tubes.

Service accessibility is much improved over the ROC F7, and help can be quickly arranged for any maintenance or breakdown problems. He observes that the engines on his latest rigs have no problems with 2,000 rev/min operating speed, and are very economical to run, with a worthwhile saving on diesel.

DTH fuel efficiency

Stephen Lydon's Atlas Copco ROC L6s are high-capacity down-the-hole crawlers with power units that deliver compressed air at up to 25 bar. They have a range of hole diameters from 92 mm to 152 mm with different hammers, and the standard tube handling system has a capacity of eight 4 m long tubes which, together with the starting tube, gives a maximum hole depth of 36 m.

The onboard Atlas Copco screw-type XRV 9 compressor offers 295 lit/sec of free air delivery. The novel feature of the ROC L6 is its boom concept, which gives the rig excellent flexibility for vertical, horizontal and angle drilling. The ability to drill at different angles, and to accurately set the inclination and control the depth of the hole, contributes greatly to the overall economy of the operation. Fuel consumption is only 0.6 – 0.8 lit/m, making the ROC L6 as fuel efficient as a tophammer rig. The water-cooled diesel engine, rated at 272 kW, is understressed at full production, with nearly 25% of its power in reserve. The standard feed length is 7.55 m with a travel of 4.6 m, and a 1.3 m feed extension is available. Feed rate is up to a maximum of 0.92 m/sec at a maximum feed force of 20 kN and tractive pull of 30 kN. The rotation speed is 30-80 rev/min, with two rotation units



offering a choice of 2,400 Nm or 3,250 Nm of torque. The ergonomics of the ROC L6, and its control layout, are more amenable to long hours of working. It has a tramming speed of 3.4 km/h, with traction force of 110 kN. It can climb hills at 20 degrees using its two-speed traction motors, and, with a 10/8 degree track oscillation, is able to maintain ground contact in the worst underfoot situations. Ground clearance is 405 mm. The drill rig has a ROPS/FOPS cabin as standard, and is fitted with electronic hole inclination and depth control instruments. One of the most attractive features of the ROC L6 in the Irish working environment is that its transport dimensions comply with European road regulations for normal loads. It weighs around 18.5 t, and, with the feed in the forward position, is 2.49 m wide, 12.7 m long, and 3.15 m high.

Rocdrill

Huge utilization

Raymond Ballantine is the proud owner/operator of four Atlas Copco rigs, comprising one Atlas Copco ROC L6, one ROC L6H, one ROC F9 COPROD and one ROC L8²⁵. Raymond works for some twenty quarry clients within a 150-mile range of his home base in Londonderry. He drills more than 150,000 m/year, some two-thirds at 110 mm and the remainder 121-140 mm. His rigs spend more than half of their available time drilling. He reckons to get nearly 50% more work/year out of his first ROC L6 than he did with his previous rig, with comparable service costs, and reckons to save 25% on fuel.

The rock that Raymond drills is hard and abrasive, some of it whinstone, in which he admits that he could not get a hole started without the water mist system. He is conscious that he drills less than his southern counterparts, but this is due to different rock characteristics and larger holes. He is thankful for the excellent parts and service offered by Atlas Copco, because this would otherwise be a worry.

The bulk of Raymond's drilling is in limestone, at 110 mm diameter. He expects 0.2-0.6 m/min in whinstone, with a bit life of 250-400 m, and 1 m/min in limestone, where the bit life is



Langan Drilling

Langan Drilling Ltd is a family-run business based in Galway, with 20 years experience of drilling and blasting rock. The company specializes in civil engineering and site clearance. At present, Langans' Atlas Copco ROC D7 is the only construction drill rig in Ireland with the capacity to drill holes in the range 32-102 mm diameter.



Perfectly straight vertical 22 m deep x 140 mm diameter hole drilled by the ROC L6 with COP 54 at Roadstone Quarry, Ballintra.



ROC L6 drilling in whinstone at Churchill Quarry, Donegal prior to addition of water tank.

McCaffrey's Quarry, Donegal uses 9 m-deep x 110 mm diameter holes drilled by the ROC L6 on a 3.8 m x 4.1 m grid to achieve this beautiful fragmentation.



increased to 2,000 m. He undertakes between 300 m and 450 m of drilling at each location, normally using 4-5 x 5 m rods for 20-25 m deep holes. Of the ROC L6 owners in Ireland, Raymond reckons to have the roughest ground underfoot, and is amazed at just where his rigs will safely go.

Raymond spends a lot of his available time moving the drill rigs between quarries, spending an average 36 hours at each location.

The single greatest saving for him is that the ROC L6 is self-contained, and can drive off the low loader and start drilling straight away.

His previous rig towed a compressor, and took two hours setting up at each job. The ROC L6 engine is easier to service, and oil changes for the engine and hydraulics can be completed in 2.5 h, compared to a whole day previously. The tap and pump for hydraulic oil on the ROC L6 make life much easier.

Water infusion

All of the ROC drill rigs are plumbed for air and water, and Raymond finds that water infused holes are far superior to those drilled using air alone. The air pressurizes the water and drives it into the rod, where the 25 bar pressure to the DTH rock drill creates a mist. He adds a foaming agent when drilling in loose ground, where his time/hole has reduced from an hour to around 20 minutes. He also now drills holes in poor ground that previously were impossible.

This method is used at the housing stone quarry near Meenaneary in Donegal, where the rock is quartzite, and is amongst the hardest and most abrasive that he currently drills. Here, the objective is to ease out the building stone in useable blocks, so a 3.2 m x 3.2 m grid is sufficient.

Acknowledgement

Atlas Copco is grateful to the ROC operators in Ireland who contributed to this article.



Spearheading aggregate output in Bulgaria

ROC L6 takes over

A couple of years ago, Bulgarian aggregate producer Andezit was faced with a sudden output demand on its quarry operation at Burgas, on the Black Sea coast. Expansion of the port facility at Burgas required 2.5 million t of rock, and Andezit's Gorno Ezerovo quarry was well-placed to supply. The company marshalled its resources, which comprised mainly archaic equipment from the late-eighties, and bent to the task. Output increased from 256,000 t in 2001 to 700,000 t in 2002, and 1.47 million t in 2003. By 2004, with its financial situation secure, the company felt able to re-equip, and went shopping. In a position to buy what-ever they pleased, they chose an Atlas Copco ROC L6. A couple of years later, they can be congratulated. The ROC L6 has displaced three pneumatic rigs, and handles the entire output of the quarry, using just one third of the fuel.



Pleased with the ROC L6: From left, Vesselin Slavov, Drilling Manager, Stefan Dimitrov, General Manager, and Stoyan Pavlov, operator.

Painful privatization

Until 1992, aggregate production in Bulgaria was controlled by the State by way of quotas. Since privatization, small companies have sprung up in geographical regions, and these are now operating as private companies. Immediately after privatization, the market dissolved, and most companies mothballed their equipment fleets, expecting renationalization at any time. The uncertainty lasted until 1998, and as a result Andezit only completed the privatization process in 2000. As far back as 1993, Andezit was split into two companies, with Andezit Ltd responsible for mining, drilling and quarrying, and its sister company Andela PLC handling mineral preparation. Each company has its own marketing and sales organizations. Since 2001, Andezit has been supplying Andela with rock.

Andezit concessions

In 2001, concessions for four quarries were transferred to Andezit: the deposits of volcanic rock at Gorno Ezerovo, Bulgarovo, and Karnobat; and the Pliocene sands at Novoseltsi.

Gorno Ezerovo, near the Black Sea port of Burgas, is the largest operation, producing 1.37 million t in 2004.

Bulgarovo and Karnobat each produced 40,000 t, while 454,000 t of sand was extracted at Novoseltsi No 3 ballast pit. Bulgarovo features a trachean andesite of 180 Mpa hardness, 2.44 t/cu m density, which is softer than that at Gorno Ezerovo, and red in colour due to the presence of potassium and sodium.

This has been defined as a new type of rock and given the name bulgariti.

Bulgariti could be used in glass production, but is presently supplied to Bulgarian Railways for track ballast.

Karnobat is also predominantly andesite, hardness 160 Mpa and density 2.8 t/cu m, which is suited to concrete and for road construction asphalt. It does not polish with use, and maintains its coefficient of friction within the prescribed specification. In 2001, an order for 200,000 t of railway ballast was received from Greece, heralding Andezit's entry into the export market, and another 40,000 t was sold into Athens airport rail link in 2003.

Burgas port expansion

Output at Gorno Ezerovo has increased spectacularly, multiplying six-fold between 2001 and 2003, mainly driven by



Atlas Copco generators are used on the Burgas port construction barges.

the expansion and renovation of the nearby port of Burgas, and the construction boom along the Black Sea coast.

The port job started in 2002 with the erection of new sea defences, and

continued with rock filled caissons and a new harbour wall. Andezit supplied nearly 70% of the total 2.5 million t rock demand for the Burgas port, which was constructed by Mitsubishi Penta Ocean and financed by the Japanese Investment

Bank. Stage One of the west port was completed in 2005, while the 1.3 km-long sea protection wall was completion in mid-2006. Stage Two will double the area of the port, and Stage Three involves construction of a container terminal.

Mitsubishi Penta Ocean purchased two Atlas Copco generators QAS 168 and one QAS 138 for use on its construction barges.

To date, Andezit has supplied the port construction with 384,000 t in 2002, 769,000 t in 2003, and 466,000 t in 2004, and 131,000 t in 2005 in three sizes of aggregate and three types of boulder.

Gorno Ezerovo

The Bulgarian government has awarded a 35-year concession to Andezit for production at Gorno Ezerovo. The standard bench height is 27-28 m under a special dispensation from the quarries inspector, who has taken into account the high standard of work and good safety record of the company when agreeing an increase from the normal maximum of 18 m.

Crushing and screening plant at Andezit's Gorno Ezerovo quarry.





Atlas Copco ROC L6 drilling at Gorno Ezerovo quarry.

An Atlas Copco ROC L6, delivered in July, 2004, drills the bulk of the output. Holes are laid out on a grid varying from 3.6 m x 3.6 m to 4.2 m x 4.2 m, and are generally drilled at 75 degrees from horizontal. The rig is equipped with a 25 bar compressor and 8+1 x 5 m long, 89 mm diameter tubes.

Between full commissioning in August, 2004 and end-January, 2005, the ROC L6 drilled 33,000 m with its COP 44 hammer equipped with 110 mm Secoroc bit. It logged 1,200 engine hours in this period, and no breakdowns. Minor repairs were undertaken during scheduled downtime, so 100% availability has been achieved.

Atlas Copco maintains a basic service contract, supplying consumables and spares on demand from its Burgas office.

Production for the Burgas port expansion was moved around the quarry according to quality demands. Blasting generally takes place 3-4 times each month, using explosives which are delivered ready for use by Eskana Invest, a company in the same group as Andezit. The quarry works 12 h/day, 7 days/week. Gorno Ezerovo has two crusher/screening systems in parallel, with combined

output of 120,000 t/month in four products. Andezit has 36 employees at the Gorno Ezerovo site, four of whom are trained to operate the ROC L6, and Andezit and Andela together have a total workforce of 300.

Comparisons

The Atlas Copco ROC L6 is a high-capacity DTH crawler for quarry drilling in soft, medium and hard rock. It is equipped with an Atlas Copco XR V9 screw compressor that delivers 295 FAD at 25 bar pressure. The diesel engine has a rated capacity of 272 kW at 2,000 rev/min. The ROC L6 can handle hole depths of 45 m and hole diameters up to 152 mm, using drill tubes of up to 102 mm and 5 m long. The hydraulic rotation unit DHR 48H-45 offers maximum 112 rev/min and maximum torque of 1,800 Nm. The tube handling system has a capacity of eight tubes.

The basic weight of the ROC L6 is around 19 t, and its length of 10.65 m, width of 2.5 m, and height of just over 4 m comply with European regulations for unescorted loads. The height can be reduced to 3.11 m by lowering the feed from the canopy to the forward position,

but the loading length in this configuration increases to 13.6 m.

The ROC L6 was joined by an Atlas Copco CM 760 rig in 2005, equipped with the same COP 44Q hammer and Secoroc 110 mm bits.

The rock at Gorno Ezerovo comprises very hard volcanic andesite basalt of 320 Mpa with 2.55 t/cu m density and 55-66% silica content. Nevertheless, the Secoroc bits are returning 2,200-2,700 m life, with 3,000 m reached on occasion. Meantime, the COP 44Q achieves 9,000 m on its first life, extended to 17,000 m with a service kit. The bits are reground at site using a handheld Secoroc Grind Matic machine.

Andezit is happy with the overall fuel consumption of both ROC L6, and CM 760, currently 1.7 litre/drilled metre, including movements. This compares with 3.5 litres/drilled metre for the original pneumatics.

Acknowledgements

Atlas Copco is grateful to the directors of Andezit Ltd for their kind assistance in the production of this article.





ROC L8 increases versatility

Reverse circulation sampling

Sampling work using the reverse circulation method is becoming increasingly common in open pit mines. So is the use of Atlas Copco drill rigs in order to get high performance and rapid results.

In the gold mines of Ghana, ore sampling, or grade control, is of vital importance to ensure mining efficiency and ore recovery, as well as accurate planning of the excavation.

The Atlas Copco ROC L8 surface crawler rig has a widespread reputation for versatility and efficiency in all types of surface mining, and West Africa is no exception. In the current boom, characterized by high gold prices and increased opportunities, mine operators and contractors in the region have not lost sight of the need for maximum efficiency. As a result, the ROC L8 is being used for rapid grade control work, as well as blast hole production drilling.

Golden Star

Golden Star group is a Canadian registered mining company based in Colorado, the USA and Accra, Ghana. In Ghana, the group has three main companies: Golden Star (Bogoso/Prestea) Ltd, Golden Star (Wassa) Ltd, and Golden Star Exploration Ltd. These companies operate six open pits, and have licenses to develop further sites, as well as two underground mines in prospect or development.

The Bogoso/Prestea operation uses one Atlas Copco ROC L8 drill rig on down-the-hole (DTH) reverse circulation grade control, while at Wassa there are two ROC L8 rigs, one of which has reverse circulation capability. The ROC L8 at Bogoso drills at approximate right angles to the orebody, which lies at about a 60 degree dip. The rest of the fleet comprises five ROC L7CR COPROD rigs on main production



The ROC L8 equipped with reverse circulation kit at the Golden Star Wassa mine.

drilling and a ROC F9 top hammer rig on pre-splitting. The other rigs employed in the Wassa operation are two ROC F9 rigs and a ROC L7CR which was recently converted to the COPROD 102 system. In addition to an average of 150 m/shift of reverse circulation for grade control, the Bogoso ROC L8 also drills 280 m/shift of conventional blast holes in softer oxide ore deposits

This results in a total drilling performance of about 10,000 m/month.

Reverse circulation sampling with the ROC L8 is carried out by using the powerful onboard compressor with 25 bar and 405 lit/sec FAD to blow air down the drill hole annulus. This forces the hole chippings up the centre of the drill pipe rather than via the hole annulus, allowing them to be passed through a suitable sealed rotary connection,

separated by a cyclone, and collected in a bag.

The bagged chippings samples are correlated to approximate drilling depth by the operators, collated and sent to the mine lab for analysis.

Easy changeover

The rigs are quick to change from one function to another because a qualified mechanic is not required to change the rotary seal for reverse circulation. According to the management, the circulation unit and high power compressor are definite good points.

Most open pit gold mines, including those in the Golden Star group, have comparatively narrow benches so that working space is at a premium. Therefore, it is important that grade



Professional bit grinding: training by Atlas Copco enabled Golden Star to set up its own bit grinding operations at the Bogoso/Prestea mines using the Secoroc Grind Matic machine.

sampling can be carried out as quickly as possible, both ensuring that the necessary information is available to progress mining when required, and to clear the bench for production drilling as soon as possible.

The turnaround of the ROC L8 is much quicker than with other rigs, getting in and out of the benches quickly to make room for the blasthole rigs. The pipe carousel improves safety.

Good mobility

Rig mobility is also an important issue as the ROC L8 at Bogoso/Prestea not only has to get on and off the benches quickly, it has to cater for the needs of five different pit locations spread over about 15 km. Both tramming and low loader transport are relatively easy.

The normal bench height is 9 m with one metre of subdrilling to obtain good blasting results. However, benches have been as low as 6 m in sloping surface areas. The degree of variation in ore grades and in the direction of the ore-body increases the importance of grade control drilling. Whilst the orebodies in

Golden Star mines have a fairly regular dip, gold grades can vary considerably. The average at Bogoso has been 1.50 g/t, but the benches sometimes show 2.64 g/t, and grades have been as high as 40 g/t in adjacent underground mines.

It is also important that the type of deposit, whether oxide or sulphide, is checked so that production can be tuned to the capacities of the preparation plants. A new bio-oxidation plant is currently being completed at Bogoso.

Drill string

At Bogoso/Prestea the ROC L8 employs Atlas Copco Secoroc drill string components, including COP 44 DTH hammer drills and 105 mm diameter spherical button bits. However, ballistic button bits are used for the softer oxide deposits and clays. Penetration rates vary greatly, depending on whether the superficial oxides, or much harder and abrasive waste or sulphide ores, are being drilled. The average times for a 9 m pass are 8-10 minutes in oxides and 10-14 minutes in sulphides.

For reverse circulation ore grade control at Wassa, the ROC L8 uses an RC hammer with 140 mm, or 5.5 in, drill bits. For blasthole drilling it uses a COP 44 DTH hammer with 115 mm, or 4.5 in, spherical button bits. The ROC L7CR uses the COPROD 102, drilling 127 mm holes with spherical button bits in fresh rock and ballistic button bits in oxides.

At Wassa, one ROC L8 is used similarly on reverse circulation ore grade control, with constant pressure on time.

Blasthole drilling

The ROC L8 is a very powerful machine, drilling single pass blast holes day and night. At Wassa, the rig drills 115 mm diameter holes, using the COP 44 DTH hammer and spherical button bits.

Another important aspect of the frequent grade control work at Wassa is the effect of blasting. Major movements of the bench rock can be generated from adjacent blasting. It can move about 2.4 m in the middle, less at the top, and is held firm at the bottom. Movement

in the horizontal plane is about 2 m in different directions, so the ore may not end up where expected.

With the expansion of operations at Wassa, Golden Star has taken delivery of two more Atlas Copco ROC L8 rigs to be used for both reverse circulation grade control and blasthole drilling.

Service support

Under a site service agreement, Atlas Copco has two mechanics and a support team on site at Bogoso where it holds all the necessary drilling consumables and spare parts. There is also additional service support available from the main depot at Obuasi, about two hours to the north-east in the central Ashanti mining area.

Training is also considered an important aspect of service. Atlas Copco has provided initial training for the drill rig operators and to enable Golden Star to set up its own bit grinding operations using a Secoroc Grind Matic machine.

There is also cross fertilization in training between the Bogoso/Prestea and Wassa teams. In addition, drill operators who were withdrawn from underground work at Prestea during a major refurbishment project have been retrained to operate surface rigs. The most recent training has been conducted by Golden Star's own senior operators, and there are currently 33 drill operators in the whole of the Bogoso/Prestea operation.

The Atlas Copco ROC rigs are easy units to train operators on, both due to the ease of controls and the available cab space. The controls are manual, assisted by guidance instruments.

The mine management puts great emphasis on the importance of their partnership with Atlas Copco, and their commitment to making things work through service backup, maintenance procedures, and the training of mine operators and management.

Acknowledgements

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ROC L-series drill rigs quarrying across the United Kingdom

Aggregate for the cities

Large quarries are located near railheads in the United Kingdom, so that aggregate can be shipped across the country with minimum inconvenience. All of these operations are governed by strict environmental regulations, particularly in relation to dust and noise. Less drilling for more production is a very attractive proposition, and that is what Atlas Copco rigs in various guises are delivering. Owned and operated by specialist drilling contractors of long standing, the drill rigs are worked hard and moved often. The four largest operating companies are featured below, and all of them endorse the Atlas Copco ROC L-series of hydraulic drill rigs that are setting the pace at every quarry in which they appear.



Sleeman Atlas Copco ROC L8 at Moons Hill quarry.

Sleeman

From its Frome base in England's West Country, W C D Sleeman & Sons, Ltd supplies drilling and blasting services to a total of 18 quarries in Somerset and Herefordshire.

Most of this output is crushed and screened at site, and railed to London on purpose-built trains.

Set up some 30 years ago with a single Atlas Copco pneumatic drill rig, Sleeman now operates a fleet of five Atlas Copco DTH machines, comprising a ROC L6³⁰, three ROC L6H, and a new ROC L8²⁵.

All of these machines are moved frequently between sites, because their individual productivity outstrips the capacity of any single client quarry. However, the combination of fast drill rigs and easy movement makes perfect economic sense, and is becoming increasingly popular amongst contractors working small and medium-sized quarries.

Since inception, Sleeman has offered a full drilling and blasting service to its clients. The company provides the drill rigs and site personnel, and undertakes the design and layout of the blasting grid, surveys the holes, carries out laser profiling of the face, and specifies the blast design.

At Moons Hill quarry, Somerset, in an extension of the main pit, a Sleeman ROC L6, equipped with a Secoroc COP 44 hammer, has been employed drilling 115 mm holes on a 4.0 m x 4.0 m grid. The bench height is 10 m, and the basalt is hard and loose jointed, a situation where DTH drilling excels. Face angle is normally 15 degrees, but this may be reduced to 10 degrees in certain areas.

Explosives are delivered on an as-needed basis, to avoid the potential problems associated with site magazine location and security. The lower 6 m of each prepared hole is loaded with

13 kg/m of Orica bulk emulsion and a 16L Pentolite booster primed using a Sureline non-electric detonator. The top 4 m of each hole is then stemmed using 14 mm chippings.

Every month, Sleeman brings in a 20 t excavator equipped with a hydraulic breaker to dispense with any build-up of oversize boulders.

The Sleeman ROC L6H rotate between drill and blast contracts with bench heights in the order of 14-15 m, which is close to the maximum height allowable in the United Kingdom without a full geological survey. Hole size is normally 115 mm, but some 20% are drilled at 127 mm diameter. In the limestone rock that characterizes most of their sites, a 4.5 m x 4.5 m grid is chosen, in order to reduce fly rock and concentrate the muckpile.

Planned performance for the ROC L-series machines is 1.5 m/min. The Secoroc Magnum premium quality drill



Sleeman ROC L8 bench drilling at 15 degree angle.

bits are lasting a minimum of 1,000 drillmetres, and are treated as consumables, so regrinding is not carried out. Sleeman produces more than 10 million t/y under drilling and blasting contracts.

Blasting Services

The first UK customer to invest in Atlas Copco's new, high-power, ROC L6H DTH crawler rig was Blasting Services Ltd of Alfreton, Derbyshire. The busy drilling and blasting contractor has since added another seven L6H rigs to a fleet that includes a three ROC L8, together with three new ROC D7 RRC radio remote control rigs for pipeline work and one ROC F9 COPROD.

Blasting Services felt the time was right for substantial investment in their

fleet to meet increasing customer demand for both production, and health and safety matters. They see Atlas Copco as a big player, and an excellent partner intent on providing the best service support now and in the future.

Blasting Services carries out contract drilling and production blasting in the Midlands, mainly at quarries in Derbyshire, Shropshire, and also North Wales. These quarries produce material from a variety of hard rock types such as limestone, granite, and sandstone, using a hole diameter range of 110 mm through to 130 mm. The average annual blasted tonnage is approximately 1.75 million t/machine, which is equivalent to around 48,000 drillmetres/year/rig.

The self-contained, high-performance ROC L6H, which combines proper-

ties of the proven ROC L6 and ROC L8 rigs, features a high-delivery 401 lit/sec of air from the onboard 25 bar Atlas Copco compressor, for increased drilling speeds in medium-strength to softer rock formations. The rigs provide high production capability for Blasting Services' quarry blasthole drilling operation, and also feature the flexibility needed for development work. For example, the mast, which accommodates 5 m long drill tubes, can be turned through 90 degrees to drill toe holes, as well as any angled holes in between. The hole inclination is controlled electronically, and instrumentation is provided to check on hole depth. A dust collector has a retractable suction hood and preseparator.

The rig is also highly manoeuvrable, with a tramming speed of 3.4 km/h, a grade climbing ability of 20 degrees, and a traction force of 110 kN from a two-speed drive. The ROC L6H is designed for drilling holes in the diameter range 92-152 mm using COP 34, 44 or 54 down-hole hammer drills. The typical maximum hole depth is 36 m, with a drilltube handling system to hold eight tubes. The drive is provided by a water-cooled diesel engine.

The Blasting Services machine features a central lubrication system, which, in conjunction with a daily and weekly maintenance regime, will ensure reliability of operation. The operator's cab, with full ROPS and FOPS specification, is equipped with air conditioning and a heater as standard.

The ROC L-series drill rigs are designed with easy transportation in mind, and the dimensions are well within the European guidelines for movement by low loader, so no permits are required.

Blasting Services also employ an Atlas Copco XRHS 396 MD portable compressor for use with their pneumatic crawler rigs.

For Blasting Services, health and safety is top priority and the company has together with Atlas Copco developed a number of safety features: sensors, safety steps and isolation switch. Sensors are motion detectors mounted on both sides at the rear of the machine that register static or moving people and other objects within a 6 m range. When objects appear too close, an alarm



is activated and the operator is alerted via monitors. The manoeuvre can then be stopped immediately and the safety hazard checked and eliminated before restart.

Safety steps are attached to the cabin steps when the rig has been loaded onto a trailer for transportation. They allow safe entry and egress from the cabin, overcoming the added height hazard. After use, they can be dismantled and easily stored for reuse.

The isolation switch is fitted into the seat switch electrical circuit and disables the hydraulics while the operator is out of the cabin. This ensures no uncontrolled rig movement.

Ritchies

Ritchies, part of the Edmund Nuttall group of companies, now owns five Atlas Copco ROC L6 drill rigs, one ROC F6, three ROC D7 RRC, three ROC 460, one ROC D9 RRC, one ROC L7⁴⁰ COPROD, one ROC L8²⁵ and one older ROC 860.

Geotechnical and drill-and-blast contractor Ritchies, based at Kilsyth, Glasgow, is engaged chiefly on quarry production drilling throughout the UK, with some geotechnical applications. Such is the importance of Ritchies' quarry production drilling that it is responsible for blasting over 36 million t/year in quarries working limestone, sandstone, basalt, and granite in the UK and overseas.

The Atlas Copco ROC L6 is versatile, and is designed to operate at 25 bar air pressure, which means faster and more productive drilling. It is the smallest of a range of three self-contained, hydraulically operated, main DTH rig models.

The onboard screw compressor produces hammer and flushing air at 25 bar and 295 lit/sec output. Drive power comes from a 272 kW Taia III water-cooled diesel engine.

The rig's versatility includes an ability to drill holes at all angles from the vertical to the horizontal, with accurate electronic control of both the angle and hole depth, for maximum production and economy.

The rig can form quarry face toe-holes, as well as near-vertical bench



Operating benches at Moons Hill Quarry.

blastholes. Another aspect of its versatility is manoeuvrability, with the dual-gear crawler undercarriage having a maximum tramming speed of 3.4 km/h and a maximum grade capability of 20 degrees. The traction force is 110 kN, and the track will oscillate by +10/8 degrees. The ROC L6 can produce holes of 92-152 mm diameter using COP 34, 44 or 54 hammers. Drill tubes

of 76, 89 or 102 mm can be handled with a capacity of eight pieces. The Ritchies rig can handle 5 m long tubes for a maximum hole depth of approximately 40 m. A breakout table is standard.

The fully protected ROPS and FOPS operator cab is equipped with air conditioning and a heater as standard. Dust is collected via a retractable suction hood and preseparator.

Ritchies ROC L6 wears the company's distinctive livery.





In addition to quarry and other drill-and-blast work, Ritchies is also engaged in ground stabilization drilling for anchors, grouting, and soil nails; site investigation; and tunnel renovation.

R&B Rockdrillers

R&B Rockdrillers of Doncaster have a fleet of three Atlas Copco ROC L8 drill rigs, to which they recently added two ROC L6H and a CM 780, demonstrating considerable faith in both the manufacturer and the products. The family drilling contracting business uses its drill rigs mainly in roadstone quarries producing limestone, granite and other aggregates.

A few short years ago, R&B Rockdrillers became one of the first companies to invest in the Atlas Copco ROC L8 self-contained DTH rig as part of a policy of gradual conversion from pneumatic crawlers. All five ROC L-series rigs work mainly around the Derbyshire area, including the Hope Quarry of Lafarge. R&B report that operation is easy, with the drilling process run electronically using sensors and computer control, and the good mobility is a major benefit.

The Atlas Copco ROC L8 is the largest of its DTH hydraulic rig range, and is designed for pre-splitting and large-scale production work in quarries and opencast mines. With a 25 bar onboard compressor delivering 405 lit/sec, it has ample power for high penetration rates. The tube handler for 6 m long tubes has sufficient capacity for hole depths down to 54 m. Drill diameter capability is 110-165 mm using COP 44, 54 and 64 DTH drills. The DHR 45H hydraulic rotation unit provides a maximum torque of 2,400 Nm and a speed range of 30-80 rev/min.

The rig features a breakout table, retractable suction hood for the dust collector, and a preseparator. A watermist system is optional. The R&B Rockdrillers rigs are equipped with electronic hole inclination and depth instrumentation.

Onboard power is provided by a watercooled diesel engine of 317 kW rating. The ROC L8 has a maximum tramming speed of 3.4 km/h and a maximum grade capability of 20 degrees on



R&B Rockdrillers' ROC L8 moving to new position at Hope Quarry.

heavy duty crawler tracks with +10/8 degree oscillation.

The full ROPS and FOPS operator cabin has optional air conditioning and a heater. Other options include central lubrication, an electric refuelling pump, an engine preheater and a service winch.

Rotation units

The Atlas Copco DHR series of rotation units for DTH drilling includes ten hydraulically-powered standard motors designed for longer life, superior wear resistance, and enhanced output. All are equipped with both fixed and moving adapters for all common types and dimensions of thread. Normal working torque is obtained at even a very modest hydraulic pressure, with a much

higher potential operating pressure, offering a good margin for more demanding drilling. Maximum hydraulic pressure on reverse and breakout is even greater, minimizing the risk of getting stuck. Engine speed and rotation direction are easy to set on all motors, and the superior design gives both quiet operation and minimal maintenance. There are three well-proven sizes of reduction gear with various gear combinations to suit all DHR series motor versions. They are strong, and designed for easy mounting.

Acknowledgements

Atlas Copco is grateful to its customers serving the featured UK quarries for their help and assistance in the formulation of this article.



High pressure ROC L8 joins a winning team

First for West Virginia

The ROC L8 series of drill rigs has been a popular choice for surface drilling applications worldwide since its introduction in 1999. The latest version, the ROC L8³⁰, with its 30 bar compressor, is proving equally popular. Geological Technologies (GTI), based in Falling Waters, West Virginia was the first US company to add the new rig to its fleet. With close to 80 employees, GTI has ambitious plans for growth based on its core activities of distributing blasting materials, engineering consultancy, safety training and drill and blast services. According to the owners of GTI, they share a synergy with Atlas Copco in that both companies put the customer first. Having the same goal of taking care of each other creates a win-win situation in which business will grow. Having the best equipment is the logical start point.

Partnering for profit

Although GTI offers its services to other contractors, they see themselves as forming alliances with their clients, rather than in competition. They help clients with their business, offering them services that they cannot source internally. GTI also covers for its clients when they are booked up and unable to provide a full service, creating a winning situation for everyone.

In turn, GTI requires first class service from its suppliers, so it's business agreement with Atlas Copco is more than just a traditional customer/vendor relationship, it is more of a partnership.

The right rig

When looking for a rig that was mobile, transportable and capable of drilling 5.5 in (140 mm) holes to depths of 177 ft



Atlas Copco ROC L8³⁰ drilling in West Virginia.

(54 m) to support its quarry operations, the ROC L8³⁰ matched the GTI list of requirements.

According to the owners, the drill rig is doing everything that has been asked of it. It is seen to be a very sound machine, which gives consistent day-to-day performance in quarry operations.

The management acknowledges that the ROC L8³⁰ gives good production and the high-pressure air package does an effective job of cleaning the holes in

difficult formations. The rig is equipped with a Secoroc COP 54 Gold Express DTH hammer, which produces straight holes for better blasting. Good maintenance accessibility to the service area of the drill rig is a major advantage.

Operator friendly

Drilling at a quarry near Mt. Hope, West Virginia, the GTI operator maintains that the ROC L8³⁰ is the finest drill rig



Good working environment in the cab: "This rig was designed to keep me working comfortably," says Wesley Neal, GTI drill rig operator on the Atlas Copco ROC L8³⁰.

he has ever worked with, citing the rod changer's smoothness and the configuration of the breakout jaws. Automation has taken the guesswork out of changing and adding tubes, and the increased air pressure is also a major benefit. Under normal operations, he keeps to around 427 psi (29 bar), but can push to 435 psi (30 bar) if needed.

He is also impressed by the dust collection system, which has design performance, removing the material well

away so that none of it goes back into the hole. He also appreciates the fact that the dust suppression control is at his fingertips in the cab for easy use. Overall, the positioning of the controls and monitoring on the ROC L8³⁰ is operator friendly. The diagnostic computer, rear camera monitor and joystick controls are all perfectly positioned for the operator, keeping his working situation as comfortable as possible.

The rig was purchased with the intention of drilling 1,000 ft/day (305 m). After only 16 impact hours, it was drilling 200 ft/h (61 m) with 1,200-1,500 ft/day (365-457 m) in prospect once the operation settles into routine.

Abrasive rock

The geology across the GTI region varies to include very hard, abrasive basalt to shale, with the Mt Hope quarry featuring hard and abrasive sandstone. When selecting a suitable hammer, GTI chose the Secoroc COP 54 Gold Express because of its durability in these harsh conditions.

Despite the high silica content of the rock, the hardened steel on the COP 54 Gold Express hammer holds up well. GTI gets some 10,600 m to 12,200 m from this hammer in these conditions, and will get another 6,000 m when working in the limestone quarries.

With the current productivity level and efficiency of the ROC L8³⁰, it is expected that GTI will have no problem getting the required 2 million t of material out of the quarry this year. Overall, GTI welcomes the changes and automation of the ROC L8³⁰, wishing to go with the best technology provided it keeps the hole straight and offers greater production. Speed, reliability and safety all add up to productivity, and that makes their business successful.

Acknowledgements

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Discussing rig performance: Robert Adams, President of GTI (right) with Jason Blais, sales representative, Atlas Copco.





Laying the groundwork in Qatar

On the waterfront

Rising from the sand, just north of Doha, the capital city of the State of Qatar, a new and luxurious waterfront city is taking shape. Lusail will eventually be home to 200,000 people. Before construction can start, a huge amount of ground preparation is required, and Atlas Copco rigs are being employed on drilling blastholes in the prevailing coral limestone. The productivity, manoeuvrability, reliability, and user friendliness of the fleet of ten rigs has resulted in their owner describing them as phenomenal. The USD 5.5 billion project is on time, and completion is scheduled for mid-2010.

Reshaping the coastline

Lusail city will cover 35 square kilometres when complete, and will feature entertainment, waterfront and business districts, as well as luxurious resorts, a marina and residential areas.

The amount of ground preparation work required for such a large project is formidable. The main contractor for the Lusail development, China's Sino Hydro, appointed Pearl NLC of Pakistan to the job, a company that has plenty of experience of similar projects.

In all, 10 million cubic metres of rock and earth will be blasted, at a production rate of more than 500,000 cu m per month. This volume will be taken from both the seabed and dry land to be used to reshape the coastline. Parallel to this, ground works are underway to create a network of seawater canals that will run through the city.

Pearl NLC selected Atlas Copco as the drill rig supplier for this contract because of their outstanding reputation and sound performance of their drill rigs. The initial order was for four CM 470 surface crawler rigs, and this was quickly followed by further orders for another six CM 470 machines to meet the construction schedule.

The rate of extraction requires a minimum of 1,200 blast holes, 89 mm in



A new and luxurious waterfront city is taking shape. Lusail will eventually be home to 200,000 people.

diameter to be drilled each day. Each hole, ranging from 2 m to 7 m in length, is drilled through the prevailing coral limestone.

Working two 8 h shifts/day, the drill rig operators and blast technicians face temperatures exceeding 50 degrees C in the summer months, and relative humidity of up to 95 percent.

Due to the high water table at the worksite, special care has to be taken by the rig operators. When water is encountered in a drill hole, the dust collection fan is switched off to prevent damage to the dust filters. Such holes are then air flushed and PVC piping inserted on completion to prevent collapse of their walls.

They are then charged with a special water resistant explosive.

Close support

To get the drill rigs into action as soon as possible, Atlas Copco sent service specialists from its Dubai Customer Center. Extensive on-the-job training was then given to Pearl NLC operators by local Doha-based Atlas Copco distributor Oriental Trading Company, which also provided a dedicated on-site service engineer for the startup phase.

The support from Oriental Trading has been very effective, with the company seen as cooperative and forthcoming when resolving maintenance issues, and providing tools and parts. K. Ramachandra, Business Manager, Surface Drilling Equipment, Atlas Copco is based in Dubai and is responsible



A minimum of 1,200 holes per day: after drilling through the coral limestone, PVC pipes are inserted to keep the holes open for charging.

for the Middle East and North Africa. He explains that the CM 470 surface crawler was selected for this project because it is a robust hydraulic rig that is easy to maintain in the extreme temperatures experienced in Qatar. The air conditioned cabins are indispensable, representing an oasis in the desert to the drill rig operators in such extreme outside temperatures.

Hot work: with temperatures exceeding 50°C and relative humidity reaching 95 percent, the CM470 air conditioned cabins represent an oasis in the desert to the drill rig operators.



First for Qatar

The CM 470 drill rigs are the first hydraulic rigs to be used in Qatar. They are equipped with Secoroc T38 and 89 mm drill bits. Each bit achieves 2,000 drillmetres before being discarded.

A very high pace is maintained on the production schedule, with the rigs achieving 270,000 drillmetres every

month, even though the operators face the challenge of drilling in ground that often contains cavities.

They have to be very careful to avoid deviation or stuck rods. Fortunately, they are able to feel on the joystick when a cavity is encountered, because the feed pressure drops and they can adjust the pressure accordingly. The CM 470 drill rigs are viewed as operator-friendly, not least because of their air conditioned cabins and easy-to-use controls. The contractor describes their performance with regard to penetration rate and manoeuvrability as phenomenal in the hard rock strata, leading to a remarkable experience. So far the project is on schedule, and the availability of the rigs, despite the extremes of the environment, has been excellent.

Acknowledgements

Atlas Copco is grateful to both Sino Hydro and Pearl NLC for their assistance in the preparation of this article, a version of which first appeared in Mining & Construction magazine 2-2007.



Expanding relations with China

Boosting quarry output

China's booming economy continues to race ahead at breathtaking speed. Unprecedented numbers of roads, railways, tunnels, power plants and other infrastructure developments are under construction. To keep pace with the demand, the cement industry is working at full capacity. Conch Cement, the largest producer in Asia, is leading the way, using Atlas Copco drill rigs in its numerous quarry operations. While Conch is expanding its output, the company is also keeping an eye on the safety and environmental considerations that are now paramount in China.

Listed company

More than 2,500 Mt of cement were produced globally in 2006, of which almost half was produced in China. Now, the country's cement industry is working harder than ever to meet domestic demand for its products and is rapidly adopting new technology to increase production and maximize productivity.

Conch Cement was founded on September 1, 1997 and mainly specializes in the production and sale of cement and clinker. It has several subsidiaries and organizations, which include Anhui Conch Cement Co Ltd and Wuhu Conch Profiles and Science Co Ltd, together with other businesses handling trade, logistics, hospitals, and schools.

Conch Cement's shares (H-shares) were listed on the Hong Kong Stock Exchange on October 21, 1997, making it the first company in the Chinese cement industry to be listed overseas. Its A-shares were listed on the Shanghai Stock Exchange on 7 February, 2002.

By the end of 2006, Conch Cement had 17 clinker plants, 21 cement grinding works and 36 clinker lines producing up to 70 Mt of clinker annually. The company is already into its next stage of development and has set itself new, ambitious goals to increase its annual



Happy days for the Chinese cement industry: Shouhui Liu, Assistant Director of Yingde Conch (right) with colleague at the Yingde Conch site in Guangdong Province.

production to 100 Mt; become one of the top three cement providers in the world within 3-5 years; and to complete another 31 clinker lines by 2010.

Part of the effort to achieve these goals is the recent purchase of a fleet of eight new drill rigs from Atlas Copco. These will operate in eight of the company's limestone quarries. Fusui, Yiyang, Shimen and Hunan quarries have each benefited from one CM760 drill rig, while Digang, Shuangfeng and Xing'an quarries have each received a DM 30 drill rig and Chizhou quarry a DM 45 drill rig. It is anticipated that the annual production by model will be 2.5Mt, 4.2Mt and 6Mt for the CM 760, DM 30 and DM 45 rigs respectively.

Conch has been using Atlas Copco hydraulic DTH drill rigs in its quarries since the 1990s, including ROC 860, CM 695D, CM 760D, DM 30HP and DM 45HP, and the new rigs will bring the company fleet to a staggering 45 units.

Experience at Tongling

The Tongling quarry, about 350 km east of Shanghai, is an important and typical Conch operation. This limestone

deposit was discovered in 1978 by a geological exploration team stationed in Anhui Province. Located at Datong Town, 12 km southeast of Tongling City, the deposit stretches in a northeast-southwest direction across an area of about 3.7 sq km and is estimated to have an effective operating life until May, 2032.

The rock here is mainly micrite, partly with calcrudite. The strata in the area are mainly in the form of anticlines, with eight faults in the Sanxing Mountain and seven in the Chishan Mountain.

Tongling quarry has proven reserves of 760 Mt, most of which consists of limestone layers. Bench drilling is used, a method which is considered highly efficient and also enables quick infrastructure development on the site.

There are two dry process 10,000 t/d clinker lines with an annual production of 15 million t, and a further two 12,000 t/d clinker lines are planned.

Since 1997, when Tongling quarry started using the Atlas Copco ROC 860, it has expanded substantially and now uses two ROC 860 and three DM45 rigs. The ROC 860 rigs have been in use for 11 years, and the DM45 for five years. The drilling record using any these rigs



Drilling at Yingde Conch: an Atlas Copco CM 760 D surface crawler.

is 16,000 hours, and the total length drilled is 32,000 m. On average, a rig drills about 16 h/day, with 6.5 h for each shift and rig. For each rig, four to five shifts are arranged every week.

Drilling is vertical and the holes are drilled in a triangle shape with a spacing of 9-9.5 m and a burden of 5.5 m.

The bench height is 15 m, and the width provides plenty of room for the drill rigs to manoeuvre. On a regular bench, an 18 m long hole can be achieved in a one-step operation. This amounts to 220 m for each rig shift, and 4,000 m every month.

The air pressure used for the DTH hammer is 24 bar (350 psi), and it takes 40 minutes to complete a 225 mm diameter hole with good quality and an accuracy of within ± 3 cm. Net penetration rate is 0.45 m/min using the DM 45.

The service life of the drill string is 6,000 m for main drill tubes; 8,000 m for auxiliary rods; 15,000 m for adapters; and 5,000 m for drill bits without regrinding.

For blasting, emulsion and water-gel explosives are used. Detonators include Huainan electric and Nonel, and Orica in-hole long delay and surface delay.

During the process, unstable rock conditions sometimes occur, requiring smaller scale blasts to give better fragmentation control.

Role of training

Today, there are 285 employees at the site, including 20 who are involved in

independent projects. Service and training by Atlas Copco have helped Tongling quarry fulfill, and even exceed, its production targets.

Three operators are required for each drilling shift. After training, the operators improved their skills, resulting in a corresponding increase in productivity and operation efficiency. Workers also greatly improved their contribution to rig service and maintenance.

Conch Group previously used Chinese DTH high pressure drill rigs, but find the Atlas Copco rigs offer bigger and deeper holes, higher penetration rate, higher productivity and better mobility. Overall, they have proved to be better quality and more reliable, and Atlas Copco aftermarket services, maintenance, and training have greatly improved the productivity, contributing to increased output.

About 600 km further to the south, in Yingde, in Guangdong Province, lies another huge Conch Cement limestone operation and cement production plant. Here, environmental considerations, as well as productivity requirements, played a part in the decision to choose Atlas Copco, whose products are ideal in a situation that demands higher standards for quarrying with regard to ecological protection and environmental pollution.

Safety and environment

Safety is a constant concern at Conch and the company has put strong measures in place to keep onsite incidents

to a minimum. It has established a safety management system and formulated safety management codes for the various operations. In addition, contingency plans are in place to cope with accidents, and training exercises are held on a regular basis to cope with possible incidents of fire, explosions, rock collapse, vehicle collisions, and so on.

Furthermore, site conditions each day are recorded, warning signs are used to indicate potential hazards, and State regulations on explosives management, standardized blasting procedures and design specifications are strictly observed.

Energy and emission reductions are also seen as priorities, and Conch is keen to contribute to state initiatives on environmental protection and sustainable development.

Conch has also been awarded ISO 14001 certification.

During excavation, large quantities of volcanic waste rock are created which are used as a mixing material for cement production. The measure not only saves the cost of purchasing mixing materials but also reduces the cost of transportation, dumping and storage.

By investing in technologically advanced equipment and production processes, Conch Cement has successfully achieved the local manufacture of 2,500 t/d lines, 4,000 t/d clinker lines, and part of the Group's 10,000 t/d cement lines, and has greatly promoted the development of cement processing equipment in China.

Atlas Copco facilities for local assembly as well as manufacturing of mining and construction equipment have been established in China since the 1980s. This local presence is extremely important to ensure quick deliveries and full aftermarket support, and facilitates easier adaptation of products to match the needs of the customer.

Acknowledgements

Atlas Copco is grateful to Conch Cement and its managers for assistance received in the preparation and publication of this article.



Maintaining uptime with ROC Care

Long experience

Emil Fredriksson has been in the rock drilling and blasting industry for 14 years. To get the best productivity from his drill rigs, he signed a ROC Care maintenance agreement for one of his machines. His feedback to Atlas Copco is representative of owners' experiences with these agreements, and makes some interesting observations, not the least of which is that the price that he will get for his rig when the time for replacement comes will be much enhanced by its full service history.



Emil Fredriksson, founder and owner of Emils Bergentreprenad, Sweden.

Four ROC rigs

Swedish contractor Emils Bergentreprenad specializes in rock drilling, blasting and rock reinforcement. The company has a fleet of four Atlas Copco surface crawler rigs comprising a SmartRig ROC D9C, a SmartRig ROC D7C, a Radio Remote Control ROC D7RRC and a ROC 642HC. This varied fleet allows Emils Bergentreprenad to cover nearly all types of surface drilling projects with its own resources.

Hole navigation and the hydraulic aluminium feeds are two features that are highly valued by the company's founder and owner, Emil Fredriksson. However, his first priority is maximum uptime, which is why he recently signed a ROC Care contract for his two-year-old SmartRig ROC D7C.

ROC Care is a service package providing scheduled service, inspection reports, extended warranty, and ProCom, an Internet-based satellite monitoring system. The package includes regular inspections and services, with an extended warranty for all major rig components. This is the basis on which contractors can secure problem-free operations for an expected 5,000 engine hours.

Service inspection and maintenance are key elements of ROC Care. At all inspections, the customer is provided with a detailed rig inspection protocol,

highlighting additional measures that will help prevent potential problems.

Clear benefits

Measures designed to eliminate breakdowns before they happen are usually simpler and cheaper than waiting until equipment fails. Unplanned and costly interruptions to operations can be prevented by a systematic approach to preventive maintenance.

The proven reliability of the ROC Care service package is so consistent that Atlas Copco includes an extended warranty in the deal. This improves drilling costs by extending the guarantee on all major rig components to 5,000 engine hours of drilling.

ROC Care also includes Internet-access ProCom software, a global, satellite-based system that monitors rig status. It lets the customer view engine hours, impact hours, drilled metres and time-to-service, and allows the rig to be monitored from anywhere in the world.

By knowing exactly when the rig needs attention, Atlas Copco can schedule service times with minimum disruption to drilling operations.

Peace of mind

Fredriksson has had his ROC Care agreement for nearly two years and is

convinced of the benefits. He confirms that ProCom really makes his business more effective. It helps him plan his drilling schedules, and he uses it when making cost estimates with customers.

He maintains that the job of his employees is to drill, and they don't have time to work on the machines. With the ROC Care agreement he earns about two weeks of production per year because his rigs and operators are more readily available.

It also provides great peace of mind to know that the rigs are under professional care, and it is economically worthwhile because regular servicing also increases the secondhand value of the machines.

No matter how technology and products develop in the future, Emils Bergentreprenad is the type of forward-looking company that will be among the first to try out new innovations. For instance, Fredriksson has declared an interest in the new silencing technology, which he believes can make a huge difference when it comes to working close to urban areas.

Acknowledgements

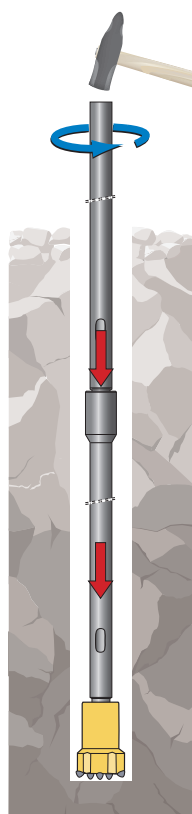
Atlas Copco is grateful to Emil Fredriksson for permission to publish the story of Emils Bergentreprenad, a version of which first appeared in Mining & Construction magazine 1-2007.

Drilling method guide

Different applications need different kinds of drilling equipment and performance. The drilling method has normally been established for some time, and well proven techniques are seldom replaced by new methods. This guide is an attempt to start a discussion around the method and equipment that might provide the ultimate solution for an application. Below, we compare three different percussion drilling methods on offer from Atlas Copco, and list their advantages. We also describe rotary drilling.

The tophammer method

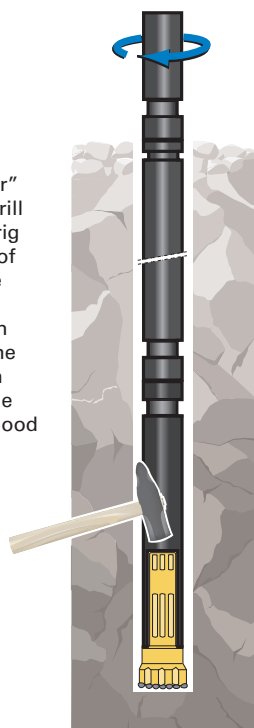
The classic tophammer method is renowned for high penetration rates in good drilling conditions. Atlas Copco is developing the method continuously. Exhaustive research into how impact energy can be transmitted into the drill bit in the most efficient way, with the least possible stress, has resulted in new generations of rock drills. Development has been focused on the key component in the rock drill – the piston. The piston length, mass, and geometry have resulted in even faster penetration. The effect is that more rock is crushed with each blow from the piston. Moreover, a double damping system reduces the load on components to give long service life, at the same time as drill steel wear is reduced. In other words, the positive results of faster drilling are not counteracted by higher drill steel costs. An extractor unit is available as a useful accessory for poor rock conditions.



Principle: As the name "tophammer" implies, the rock drill is situated on the rig and works on top of the drill string. The impact energy of the rock drill piston is transmitted to the drill bit in the form of shock waves. The method is fast in good rock conditions.

The down-the-hole method

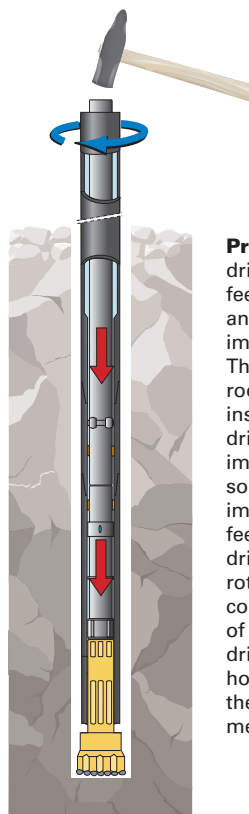
The down-the-hole method is a reliable way to drill both difficult and easy rock. The rock drill piston strikes the drill bit directly, while the hammer casing gives straight and stable guidance of the drill bit. This results in minimal deviation and greater hole wall stability, even in fissured or otherwise demanding rock. Since the annulus between the drill pipes and the hole wall is comparatively small, a high flushing velocity is maintained, which contributes further to hole quality. Good hole quality enables the burden and spacing to be increased, which saves time and money. Straight holes make charging easier and enable the amount of explosive to be reduced. The reliable DTH method is an easy way to produce deep, straight holes. From an environmental point of view, the noise emissions and vibration from DTH drilling are comparatively low. This is of particular advantage when drilling in densely populated areas.



Principle: The hammer is situated down the hole in direct contact with the drill bit. The hammer piston strikes the drill bit resulting in an efficient transmission of the impact energy and insignificant power losses with the hole depth. The method is widely used for drilling long holes, not only for blasting, but also for water wells, shallow gas and oil wells, and for geo-thermal wells. In mining it is also developed for sampling using the reverse circulation technique (RC drilling).

The COPROD® system

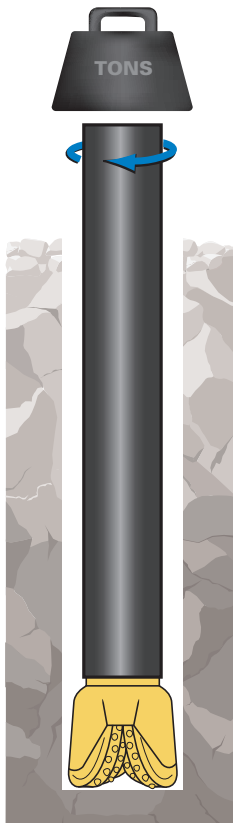
The COPROD system combines the speed of tophammer drilling with the precision and long service life of the down-the-hole method. Inside each rigid, threaded pipe section is an impact rod. It is furnished with stop lugs to hold it in place inside the pipe section. The COPROD sections are joined together via the drill pipes. Since the drill pipes transmit rotation force only, stress to the threads is minimal and their service life very long. All negative effects of the transmission of impact energy through the threads are eliminated entirely. The result is high impact power with minimal wear. Since the outer pipes are smooth and flush along the entire length of the drill string, it is almost impossible for jamming to occur. Practical experience with COPROD has been exceptionally good. The method gives good overall economy, particularly in large scale production drilling and when drilling in fissured or otherwise demanding rock conditions.



Principle: The rock drill is situated on the feed beam on the rig and impact energy is imparted from above. Threadless impact rods are stacked inside the threaded drill pipes. The impact rods are used solely to transmit impact energy and feed force, while the drill pipes transmit rotation. COPROD combines the speed of tophammer drilling with the hole straightness of the down-the-hole method.

Rotary drilling methods

The prime difference from other drilling methods is the absence of percussion. Rotary cutting, using fixed type claw or drag bits, is mainly used for soft rock which is cut by shearing. Rotary crushing uses tricone bits relying on crushing and spalling the rock. This is accomplished by transferring downforce, known as pulldown, to the bit while rotating in order to drive the teeth (commonly tungsten carbide type) into the hole bottom as the three cones rotate around their respective axis. The softer the rock the higher the rotation speed. The drill rigs need to be heavy to avoid lifting off the jacks, which means that they are less flexible and not very well suited for drilling at different angles. Generally, drilling below 152 mm (6 inches) is best accomplished by percussive drilling unless prevailing rock conditions are suited for rotary cutting. Rotary crushing is the prime choice for large diameter holes, above 254 mm (10 inches) in open pit mining, overburden stripping at coal mines, and deep well drilling.



Principle:

Rotation is provided by a hydraulic or electric motor driven gearbox, called a rotary head that moves up and down the tower via a feed system, generating the pulldown required to give sufficient weight on the bit. Flushing of drill cuttings between the wall of the hole and the drill rods is normally made with compressed air.



Drilling Method	Tophammer	DTH	COPROD
Penetration rate	★★★★	★★★	★★★★★
Straight holes	★★★	★★★★★	★★★★★
Hole depth	★★★	★★★★★	★★★
Production capacity (tonnes/shift)	★★★★	★★★★	★★★★★
Low fuel consumption (lit/drillm.)	★★★★★	★★★	★★★★★
Economic drill string life	★★★	★★★★	★★★★★
Low investment for drill string	★★★★★	★★★★	★★★
Suitability, difficult drilling conditions	★★★	★★★★	★★★★★
Suitability, good drilling conditions	★★★★★	★★★★	★★★★
Operator friendly	★★★★	★★★★★	★★★
Flushing flexibility	★★★	★★★★	★★★★★
Fair	★★★★		
Good	★★★★★		
Very good	★★★★★		
Visit www.surfacedrilling.com for more information			

BVB 25



A robust rubber tyre three wheeled wagon drill. Fitted with the robust powerful rifle bar rotated rock drill BBC 120F it covers the hole range 48-76 mm. BVB 25 offers an effective and inexpensive alternative as a first step in mechanisation of hand held drilling and features a hydraulic hand pump for boom lift, mechanical jacks, a pneumatic powered steering wheel with tow bar for tramming. With an optional conversion kit it's easy to convert BVB 25 for down-the-hole-drilling with 3" and 4" hammers for drilling of 90-130 mm (3½"-5½") blast holes.

Optional equipment

- Water mist flushing
- Hole incl. instrument
- DTH conversion kit

Technical data

Hole range	48 - 76 mm	(17/8" - 3")
Rock drill	BBC 120F	
Drill steel type	R32, T38	
Drill steel length	3.05 - 3.66 m	10' - 12'

Feed and boom

Feed type	Chain drive	
Feed length, total	5,430 mm	17' 9"
Travel length	3,940 mm	13'
Feed force	8 kN	1,800 lbf
Boom type	Single section	
Drill control panel	Side mounted	

Carrier

Traction type	Pneumatic wheel drive	
Tramming speed, max	2 km/h	1.3 mph
Traction force, max	7.8 kN	1,750 lbf
Hill climbing ability ¹⁾	20 degrees	
Track oscillation	N/A	
Ground clearance	310 mm	1'

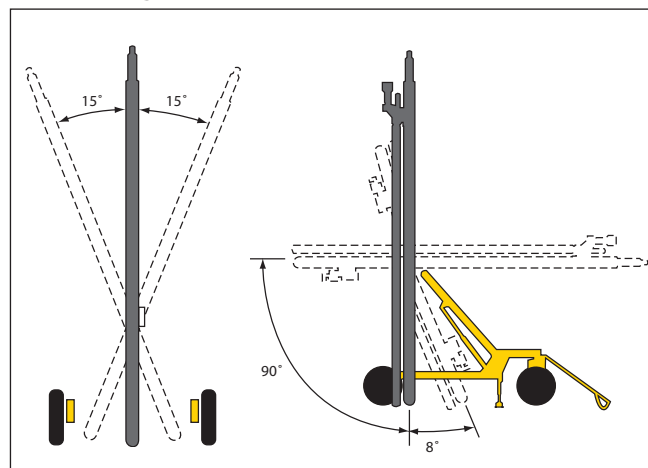
¹⁾Max allowable according to CE directives

Transport dimensions

Weight	1,340 kg	2,948 lb
Length, transport position	5,430 mm	17' 9"
Width	2,100 mm	6' 10"
Height	1,600 mm	5' 3"

Visit www.surfacedrilling.com for more information

Reach (degr.)



ROC 203



The tophammer version of the versatile ROC 203 is equipped with the robust powerful rifle bar rotated rock drill BBC 120F, which is well known for simplicity and reliability. Suitable for hole sizes from 48-76 mm (1 7/8"-4"), the ROC 203 tophammer crawler is an inexpensive but efficient choice for quarrying and construction works. With an optional conversion kit it's easy to convert the unit for down-the-hole drilling with 3" and 4" down-the-hole hammers for drilling of 90-130 mm (3 1/2"-5 1/8") blast holes.

Optional equipment

- Dry dust collector
- Water mist flushing
- Hole incl. instrument
- DTH conversion kit
- CE-approval kit

Technical data

Hole range	48-76 mm	(1 7/8" - 3")
Rock drill	BBC 120F	
Drill steel type	R32, T38	
Drill steel length	3.05 m-3.66 m	10'-12'

Feed

Feed type	Chain drive	
Feed length, total	5,430 mm	17' 9"
Travel length	3,940 mm	13'
Feed force	8 kN	1,800 lbf
Boom type	Single section	
Drill control panel	Side mounted	

Carrier

Traction type	Hydraulic crawler drive	
Tramming speed, max	2.5 km/h	1.6 mph
Traction force, max	18,8 kN	4,225 lbf
Hill climbing ability ¹⁾	20 degrees	
Track oscillation	±12 degrees	
Ground clearance	295 mm	11 5/8"

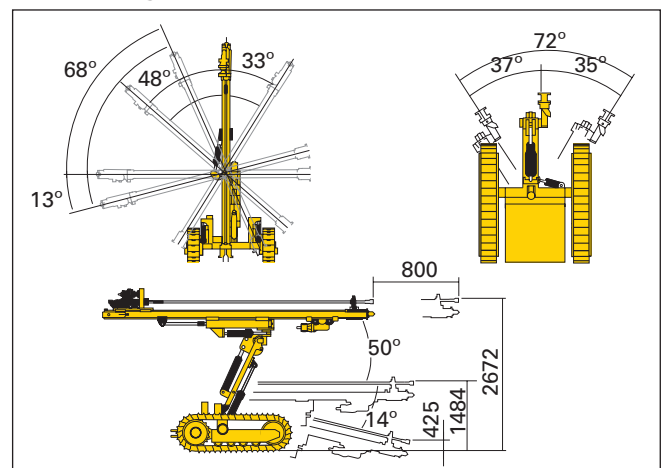
¹⁾Max allowable according to CE directives

Transport dimensions

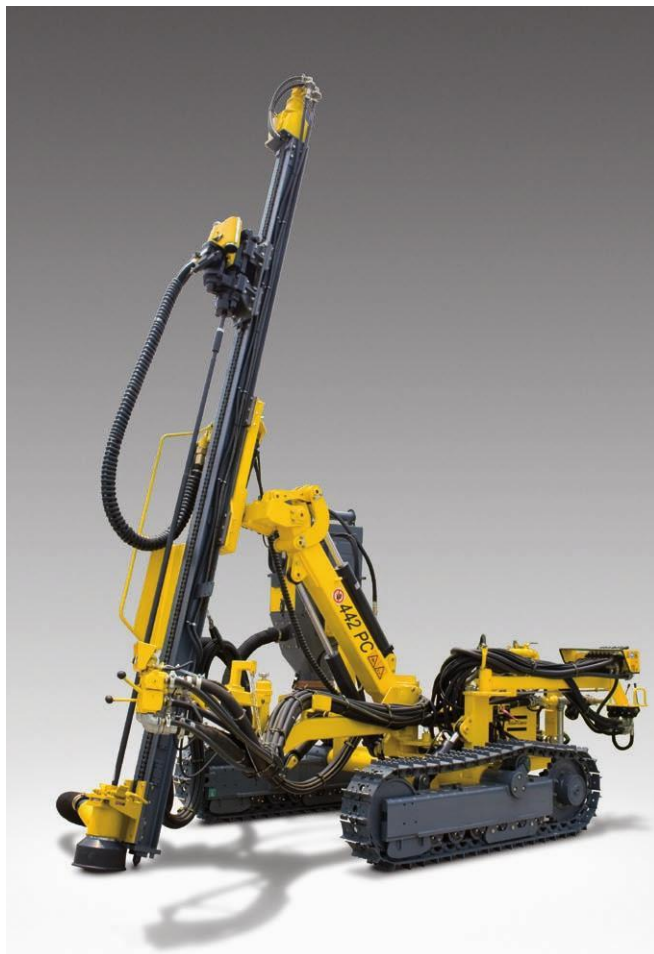
Weight	2,570 kg	5,664 lb
Length	5,500 mm	18'
Width	1,950 mm	6' 5"
Height	1,600 mm	5' 3"

Visit www.surfacedrilling.com for more information

Reach (degr.)



ROC 442



The ROC 442 pneumatic tophammer crawler drill is designed to meet toughest challenges, day after day. It comes with a modern, silenced and high capacity rock drill - COP 131EB for drilling with a variety of drill steel dimensions covering hole dimensions up to 89 mm (3½").

Optional equipment

- Dry dust collector
- Water mist flushing
- Hole incl. instrument
- Hyd support leg
- Feed mounted rod rack
- Swing arm drill control panel
- Work light set
- CE-approval kit

Technical data

Hole range	48-89 mm	(17/8" - 3½")
Rock drill	COP 131EB	
Drill steel type	R32, T38	
Drill steel length	3.05 - 3.66 m	10' - 12'

Feed and boom

Feed type	Chain drive	
Feed length, total	6,350 mm	20' 9"
Travel length	4,350 mm	14' 3"
Feed force	17 kN	3,820 lbf
Boom type	Single section	
Drill control panel	Feed mounted	

Carrier

Traction type	Hydraulic crawler drive	
Tramming speed, max	2.5 km/h	1.6 mph
Traction force, max	45 kN	10,100 lbf
Hill climbing ability ¹⁾	20 degrees	
Track oscillation	±12 degrees	
Ground clearance	350 mm	13 ¾"

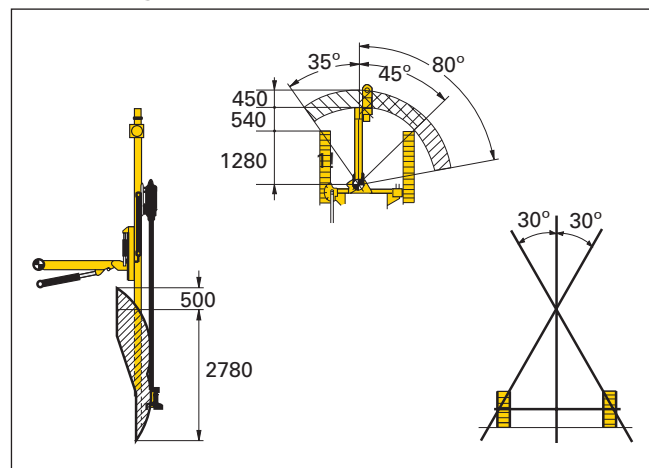
¹⁾Max allowable according to CE directives

Transport dimensions

Weight	5,000 kg	11,025 lb
Length, transport position	6,350 mm	20' 9"
Width	2,300 mm	7' 6"
Height	1,500 mm	4' 11"

Visit www.surfacedrilling.com for more information

Reach (degr.)



CM 348



Model CM 348 can drill 64 - 102 mm dia holes with the powerful gear type rotated top hammer VL 140. It has a varied application in quarry and construction works. It features powerful air driven propel motors, a boom and feed system for drilling in vertical and horizontal planes. The feed, boom and controls are held on a rugged main frame, which is mounted on a heavy duty track assembly with built in transmission brakes.

Optional equipment

- Water mist flushing

Technical data

Hole range	64-102 mm	(2 1/2" - 4")
Rock drill	VL 140	
Drill steel type	T38, T45	
Drill steel length	3.05 - 3.66 m	10' - 12'

Feed and boom

Feed type	Chain drive	
Feed length, total	5,732 mm	18' 9"
Travel length	4,275 mm	14'
Feed force	13,3 kN	3,000 lbf
Boom type	Single section	
Drill control panel	Side alt. feed mounted	

Carrier

Traction type	Pneumatic crawler drive	
Tramming speed, max	3.2 km/h	2 mph
Traction force, max	30 kN	6,680 lbf
Hill climbing ability ¹⁾	20 degrees	
Track oscillation	±10 degrees	
Ground clearance	254 mm	10"

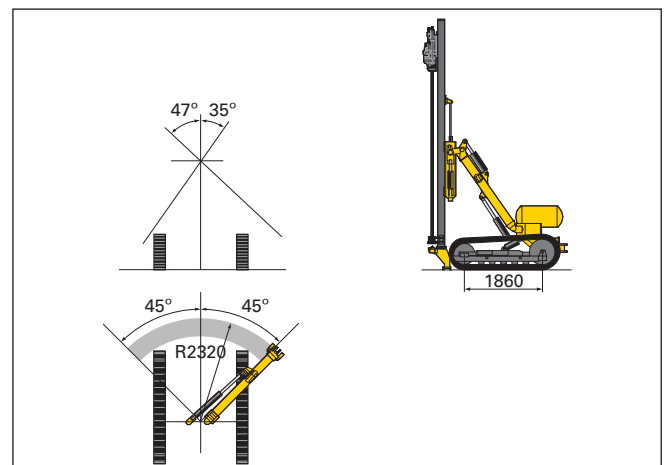
¹⁾Max allowable according to CE directives

Transport dimensions

Weight	4,600 kg	10,140 lb
Length, transport position	5,732 mm	18' 9"
Width	2,660 mm	7' 5"
Height	3,275 mm	10' 9"

Visit www.surfacedrilling.com for more information

Reach (degr.)



CM 350A



Model CM 350A is a pneumatic self propelled crawler drill fitted with the most powerful pneumatic tophammer drill in it's class. The rig is most suitable to tackle almost any terrain conditions with highest tramping performance. The flexible boom and feed system allow holes to be drilled in most required directions.

Optional equipment

- Water mist flushing

Technical data

Hole range	64-102 mm	(2 1/2" - 4")
Rock drill	VL 140	
Drill steel type	T38, T45	
Drill steel length	3.05 - 3.66 m	10'-12'

Feed and boom

Feed type	Chain drive	
Feed length, total	5,125 mm	16' 9"
Travel length	4,000 mm	13' 1"
Feed force	12 kN	2,700 lbf
Boom type	Single section	
Drill control panel	Side mounted	

Carrier

Traction type	Pneumatic crawler drive	
Tramming speed, max	3.0 km/h	1.9 mph
Traction force, max	20 kN	4,500 lbf
Hill climbing ability ¹⁾	20 degrees	
Track oscillation	±10 degrees	
Ground clearance	254 mm	10"

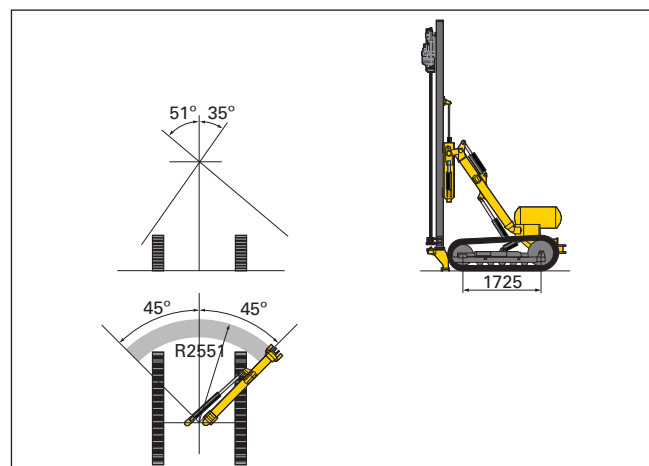
¹⁾Max allowable according to CE directives

Transport dimensions

Weight	5,300 kg	11,985 lb
Length, transport position	6,900 mm	22' 8"
Width	2,260 mm	7' 5"
Height	1,800 mm	5' 8"

Visit www.surfacedrilling.com for more information

Reach (degr.)



ROC T15



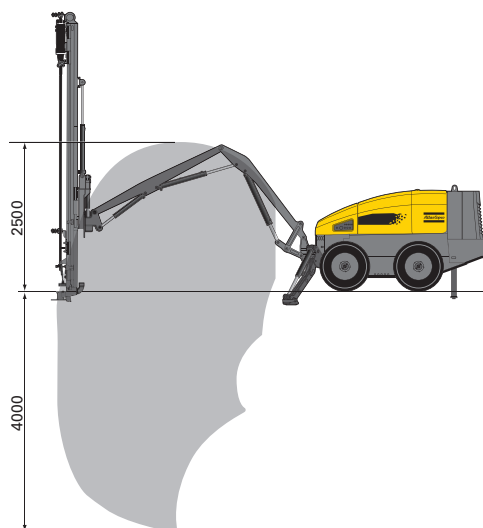
ROCT15 is our smallest hydraulic surface drill rig in the range. It is your best mate for demanding jobs and when transport is an issue. It is perfect for small construction jobs, dimensional stone industry and unique applications such as bolting, boulder blasting and trench drilling.

Standard equipment

Hydraulic rock drill, COP 1020 series, Deutz TD 2009 L04 diesel engine, On-board Atlas Copco screw compressor (C55), Aluminium profile feed beam, Rubber tyred carrier, Rod rack, Full remote control for all boom, drilling & tramming functions, Support legs, Air outlet with claw coupling.

Selection of optional equipment

Tropical ambient kit for 50° Celsius ambient temperature, Hydraulic outlet for grinding machine, Electrical engine heater, Hydraulic winch including wire with towing eye and wire guides, Electric refuelling pump, Service hand lights inside canopy, Hydraulic drill steel support (only combined with COP 1028), Mechanical hole inclination instrument (ROC-Angle).



Main specifications

Recommended hole range

Hole range	22-45 mm	7/8"-1 3/4"
Hole depth	Optimal up to 9 m depth	

Hydraulic rock drill

COP 1019 HF	4.5 kW	6 hp
COP 1022 HF	5 kW	6.7 hp
COP 1028	5.5 kW	7.4 hp

Atlas Copco C55 C106 GD, screw compressor

Working pressure, max.	8.5 bar	123 psi
FAD	23 l/s	49 cfm

Engine

Deutz, Diesel engine, TD 2009 L04, Tier III/stage 3

Rating at 2,500 rpm	46 kW	62 hp
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Boom variants

Folding boom system

Fuel tank

Capacity	70 l	18.5 US gal.
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Feed

Feed length, folding boom	4,443 mm	14'7"
Travel length	3,250 mm	10'8"
Feed extension	600 mm	1'11"
Feed force, max.	4 kN	899 lbf

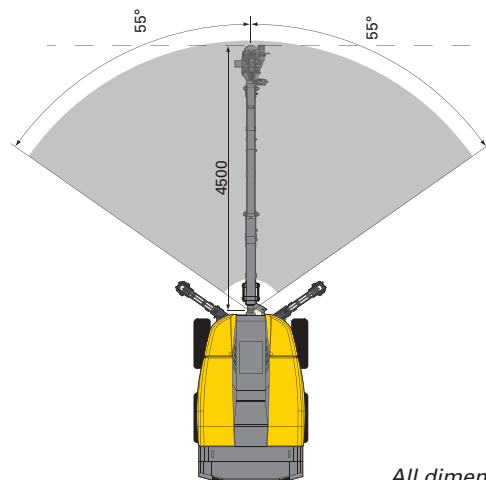
Tramming

Tramming speed, max.	3.5 km/h	2.2 mph
Traction force	20 kN	4,500 lbf
Ground clearance	230 mm	9"

Transport dimensions

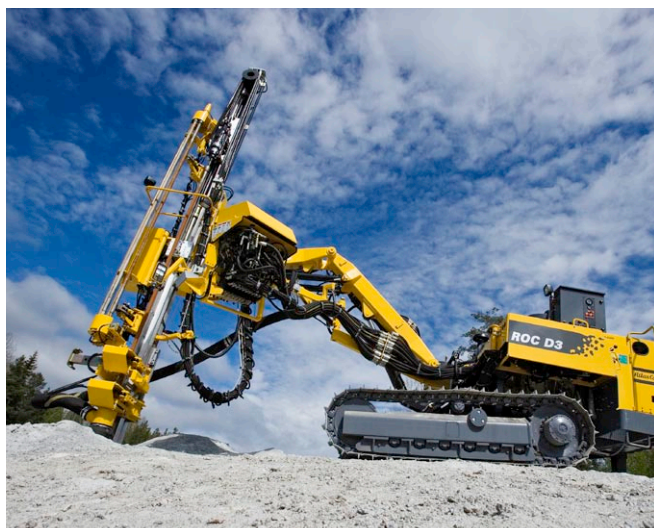
Weight approx, excl. options	2,800 kg	6,172 lb
Width	1,770 mm	5'10"
Length feed dumped	4,850 mm	15'11"
Height feed dumped	2,250 mm	7'5"

Visit www.surfacedrilling.com for more information



All dimensions in mm

ROC D3



Equipped with new Tier III Cummins engine and two different compressor selections ROC D3 has a completely new face now. ROC D3 is available in two series as it used to be with its old version, -01 folding boom and -03 long folding boom. -01 is equipped with a rod handling system that can equip four plus one 3,660 mm rods and -03 can be ordered with a rod adding system or a rod rack option.

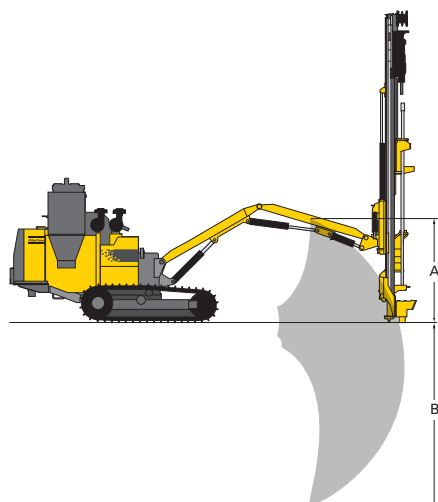
Two new rock drills, COP 1640/COP 1240 completes the family of robust rock drills for small to medium sized surface construction applications.

Standard equipment

Reduced impact pressure mechanism, Anti-jamming system, Automatic feed force control (RPC-F), Fuel saving device, Two-speed traction motors, Dust collector DCT 140 F, Hydraulic drill steel support, RHS 51 on -01, Rod rack on -03, Feed extension 1000 mm, Work lights, Electric refuelling pump, Air flow control switch.

Selection of optional equipment

Hydraulic winch, Hydraulic support leg, Mechanical inclination instrument, Anti-freeze equipment for external air outlet, Electronic hole inclination instrument HQS 9, Central lubrication, Water mist system, Cold start kit.



Main specifications

Recommended hole range (ROC D3-01)

R32, T38, T45	41-89 mm	1½"-3½"
Hole depth	17.5 m	57'

Recommended hole range (ROC D3-03)

R32, T38	41-76 mm	1½"-3"
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Hydraulic rock drills

COP 1240, Impact power	12 kW	16 hp
COP 1640, Impact power	16 kW	22 hp

Atlas Copco OIS, screw compressor

Working pressure, max.	8.5 bar	123 psi
FAD (-01 ver)	95 l/s	201 cfm
FAD (-03 ver)	80 l/s	170 cfm

Engine

Cummins turbo charged, diesel engine, QSB4.5, Tier III/stage 3		
Rating at 2,000 rpm	116 kW	156 hp

Boom variants

Folding boom system

Fuel tank

Capacity	270 l	71.3 US gal.
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Feed

ROC D3-01		
Feed length, total	7,140 mm	23'5"
Travel length	4,240 mm	14'
Feed rate, max.	0.5 m/s	98 ft/min
Feed force, max.	20 kN	4,400 lbf
ROC D3-03		
Feed length, total	6,000 mm	19'8"
Travel length	4,070 mm	13'4"
Feed rate, max.	0.33 m/s	64 ft/min
Feed force, max.	12 kN	2,160 lbf

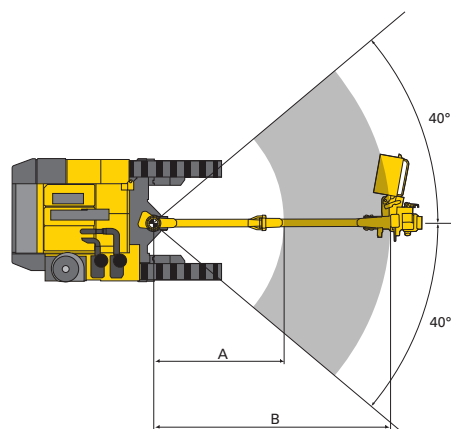
Tramming

Track oscillation	± 15°	
Ground clearance	340 mm	13.4"

Transport dimensions

ROC D3-01		
Weight, excl. options	10,500 kg	23,150 lb
Width	2,390 mm	7'10"
Length	10,050 mm	33'
Height	3,600 mm	11'10"
ROC D3-03		
Weight, excl. options	9,500 kg	20,950 lb
Width	2,400 mm	7'10"
Length	10,050 mm	33'
Height	2,900 mm	9'6"

Visit www.surfacedrilling.com for more information



All dimensions in mm

ROC D7/D9 RRC



The ROC D7/D9 RRC with Radio Remote Control, is a versatile, multi-tasking crawler drill rig for all kinds of drilling work. With its extraordinary rough-terrain mobility and articulate, long-reach boom, it is capable of drilling in places and positions well beyond the reach of conventional drill rigs.

Standard equipment

Radio remote control, Auto drill stop, RHS system, Two-speed traction motors, Fuel saving device, Dust collector, Feed extension, Air-flow control switch, Anti-jamming system, Valves for reduced percussion and air pressures for collaring, Retractable dust hood, Heavy duty tracks, Work lights, Electric re-fuelling pump. Biologically degradable hydraulic oil, Inclination instrument.

Selection of optional equipment

Thread greasing device with brushes, Thread greasing device (ECG), Hydraulic winch, Sleeve retainer, Engine pre-heater, Central lubricating system, Mechanical inclination instrument, Water-mist system, Extractor for rock drill, Toe-hole drilling kit, Hydraulic rear support leg, GPS compass aiming, Electronic hole inclination and depth instrument.

Main specifications

Recommended hole range for ROC D7 RRC

T38, T45, T51	64-115 mm	2½" - 4½"
Hole depth	21-28 m	69'- 92'

Recommended hole range for ROC D9 RRC

T45, T51	76-115 mm	3" - 4½"
Hole depth	28 m	92'

Hydraulic rock drill

COP 1840-series (ROC D7RRC)

Impact power, max.	18 kW	24.5 hp
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COP 2560 (ROC D9RRC)

Impact power, max.	25 kW	33.5 hp
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Atlas Copco OIS K-27-C106 GD, screw compressor

ROC D7RRC

Working pressure, max.	10.5 bar	152 psi
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FAD	105/127 l/s	215/270 cfm
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ROC D9RRC

Working pressure, max.	10.5 bar	152 psi
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FAD	136 l/s	288 cfm
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Engine ROC D7/D9

Caterpillar turbo charged, diesel engine, CAT C7, Tier III/ Stage 3

Rating at 2,200 rpm	168 kW	225 hp
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Boom variants

Folding boom system

Fuel tank

Capacity	330 l	87 US gal
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Feed

Feed length, total	7,140 mm	23'5"
Travel length	4,240 mm	14'
Feed extension	1,400 mm	4'6"
Feed force, max.	20 kN	4,400 lbf

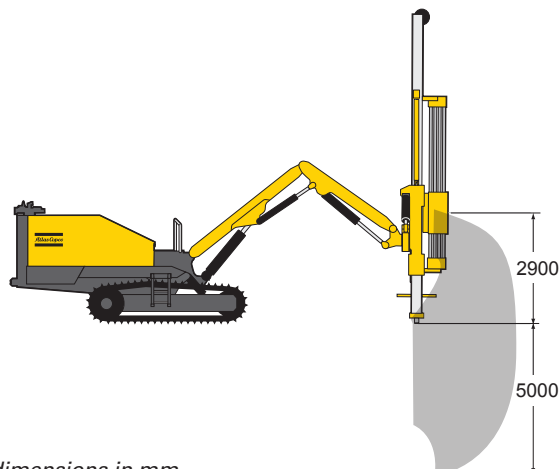
Tramming

Track oscillation	± 12°	
Ground clearance	455 mm	17½"

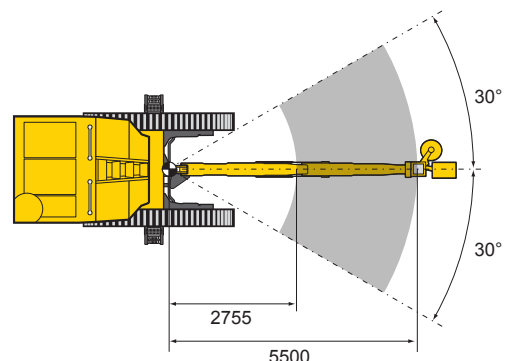
Transport dimensions ROC D7RRC/D9RRC

Total weight, approx.	13,500 kg/ 14,100 kg	29,750 lb 31,090 lb
Width	2,455 mm	8'
Length feed dumped (back/forward)	11,200 mm/ 11,300 mm	36'8"/ 37'1"
Height feed dumped (back/forward)	2,900 mm/ 3,500 mm	9'6"/ 11'6"

Visit www.surfacedrilling.com for more information



All dimensions in mm



ROC D7/D9



Designed both for construction and quarrying work, and based on extensive research at work sites throughout the world, the ROC D7/D9 are versatile rigs. A fuel efficient diesel engine delivers the power needed for quick penetration and efficient flushing.

Standard equipment

Operator's cab, ROPS and FOPS approved, RHS mechanized rod handling for 28 m (92') of rods, Double drillsteel support, Fuel saving device, Two-speed traction motors, Dust collector, Feed extension, Air-flow control switch, Anti-jamming system, Valves for reduced percussion and air pressures for collaring, Retractable dust hood, Heavy duty tracks, Work lights, Electric refuelling pump.

Selection of optional equipment

Thread greasing device with brushes, Thread greasing device (ECG), Hydraulic winch, Sleeve retainer, Engine pre-heater, Central lubricating system, Mechanical inclination instrument, Water-mist system, Extractor for rock drill, Heated operator's seat, Tinted windows, Laminated windows, Toe-hole drilling kit, Hydraulic rear support leg, GPS compass aiming, Electronic hole inclination and depth instrument.

Main specifications

Recommended hole range for ROC D7

T38, T45, T51	64-115 mm	2½" - 4½"
Hole depth	28 m	approx. 92'

Recommended hole range for ROC D9

T45, T51	76-115 mm	3" - 4½"
Hole depth	28 m	approx. 92'

Hydraulic rock drills

COP 1840, COP 1840EX (ROC D7)		
Impact power, max.	18 kW	24.5 hp

COP 2560, COP 2560EX (ROC D9)		
Impact power, max.	25 kW	33.5 hp

Atlas Copco OIS K-27-C106 GD, screw compressor

ROC D7		
Working pressure, max.	10.5 bar	152 psi
FAD	105/127 l/s	223/270 cfm
ROC D9		
Working pressure, max.	10.5 bar	152 psi
FAD	136	288 cfm

Engine ROC D7/D9

Caterpillar turbo charged, diesel engine, CAT C7, Tier III/stage 3		
Rating at 2,200 rpm	168 kW	225 hp

Boom variants

Folding boom system

Fuel tank

Capacity	370 l	98 US gal.
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Feed

Feed length, total	7,140 mm	23'5"
Travel length	4,240 mm	14'
Feed extension	1,400 mm	4'6"
Feed force, max.	20 kN	4,400 lbf

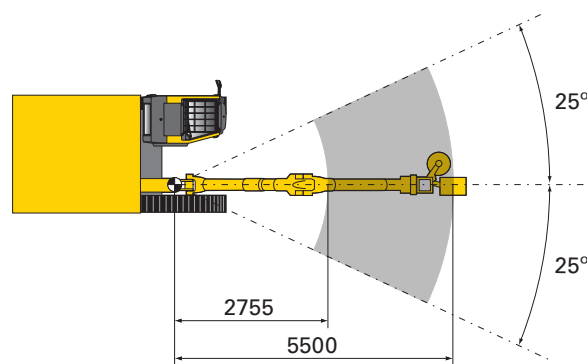
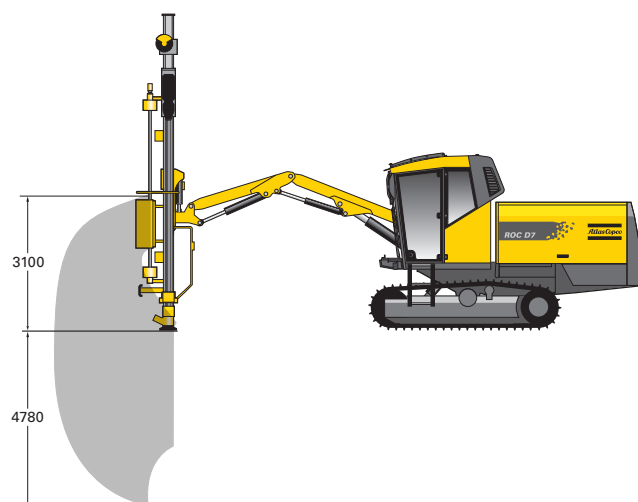
Tramming

Track oscillation	± 12°	
Ground clearance	455 mm	17½"

Transport dimensions

Total weight, approx.	14,500 kg/ 15,100 kg	32,000 lb/ 33,290 lb
Width	2,490 mm	8'2"
Length feed dumped (back/forward)	11,000/10,900 mm/ 11,200/10,900 mm	36'35'9"/ 36'9"/35'9"
Height feed dumped (back/forward)	3,200/3,500 mm	10'2"/11'6"

Visit www.surfacedrilling.com for more information



All dimensions in mm

SmartRig™ ROC D7C/D9C



The new SmartRig ROC D7C/D9C crawler drill combines the power and flexibility of the popular ROC D7 with the intelligence of RCS – computerized Rig Control System. RCS adjusts impact and feed to the rock conditions so as to achieve smoother drilling and less wear in the drill steel. Fuel efficient diesel engine delivers the power needed for quick penetration and efficient flushing.

Standard equipment

Rig Control System RCS, Operator's cabin (ROPS and FOPS approved), RHS mechanized rod handling, Aluminium feed, Double drill-steel support, Angle and hole depth instrument, Fuel saving device, Two-speed traction motors, Dust collector and pre-separator, Feed extension, Air flow control switch, Anti-jamming system, Valves for reduced percussion and air pressures for collaring, Retractable dust hood, Heavy duty tracks, Work lights, Electric refuelling pump.

Selection of optional equipment

Automatic feed alignment, Laser plane receiver, Automatic rod adding system, Hydraulic winch, ROC Manager – MWD, Measure While Drilling, Toe-hole drilling kit, Hydraulic support leg, Silencing kit, Hole Navigation System.

Main specifications

Recommended hole range D7C

T38, T45, T51	64-115 mm	2½" - 4½"
Max hole depth, approx.	28 m	92'

Recommended hole range D9C

T45, T51	76-115 mm	3" - 4½"
Hole depth	28 m	approx. 92'

Hydraulic rock drill

COP 1840-series (ROC D7C)		
Impact power	18 kW	24.5 hp

COP 2560 (ROC D9C)		
Impact power, max.	25 kW	33.5 hp

Atlas Copco C 106 screw type compressor

ROC D7C		
Working pressure, max	10.5 bar	152 psi
FAD	127 l/s	270 cfm
ROC D9C		
Working pressure, max	10.5 bar	152 psi
FAD	136 l/s	288 cfm

Engine ROC D7C/D9C Caterpillar water-cooled

diesel engine Stage 3/Tier III	CAT C7	
Rating at 2,200 rpm	168 kW	225 hp

Boom variants

Folding boom system

Fuel tank

Capacity	370 l	98 US gal.
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Feed

Feed length, total	7,140 mm	23'5"
Travel length	4,240 mm	15'
Feed extension	1,400 mm	4'6"
Feed rate, max.	0.92 m/s	180 ft/min
Feed force, max.	20 kN	4,400 lbf

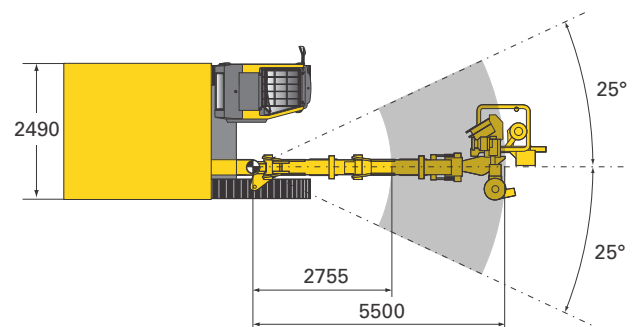
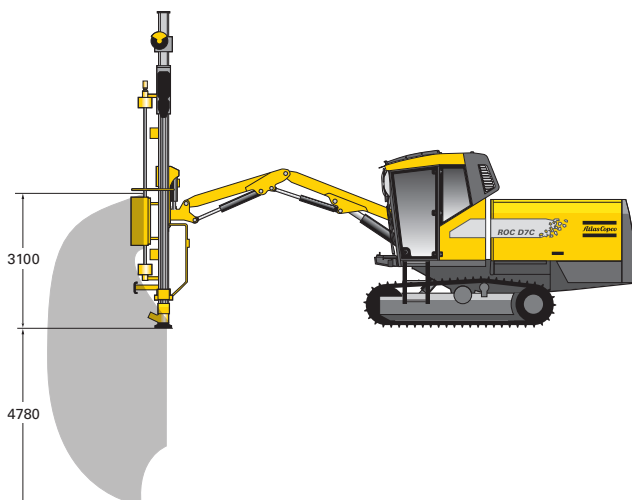
Tramming

Track oscillation	± 12°	
Ground clearance	455 mm	17½"

Transport dimensions

Weight, excl. options		
Width	2,490 mm	8'2"
Length		
(feed dumped back/forward)	11,200/ 10,700 mm	36'9"/ 35'9"
Height		
(feed dumped back/forward)	3,200 mm/ 3,500	10'2"/ 11'6"

Visit www.surfacedrilling.com for more information



All dimensions in mm

ROC F9/F9LF



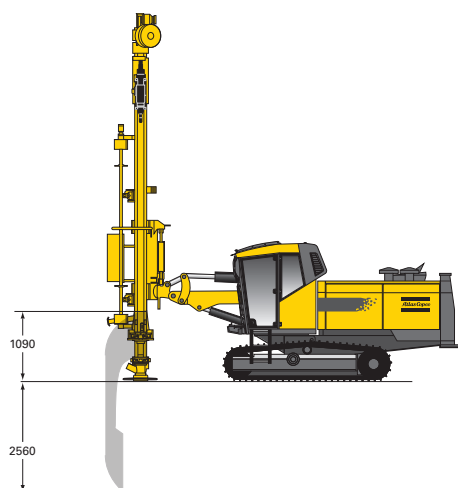
The ROC F9 crawler drill rig is very powerful in its class, with true 127 mm tophammer capability, and is available with single or folding boom for quarrying and construction. Features the 25 kW COP 2560 rock drill with T51 drill steel for fast penetration and perfect flushing, powered by a fuel-efficient diesel engine.

Standard equipment

Air conditioner, Reduced impact pressure mechanism, Anti-jamming system, Automatic feed-force control, Fuel saving device, Two-speed traction motors, Dust collector and pre-separator, Double hydraulic drillsteel support, Rod-handling system, Feed extension, Heavy-duty tracks, Operator's cabin, ECM, ROPS and FOPS approved, Air-flow control switch, Water mist system excl. tank, Toe-hole drilling kit, Inclination/depth instrument.

Selection of optional equipment

Hydraulic winch, Hydraulic support leg, Electric refuelling pump, Central lubrication system, TAC tube guides for precision drilling, Thread-greasing device, Rock drill extractor, Heater for cabin.



All dimensions in mm

Main specifications

Recommended hole range

T45, T51	89-127 mm	3½"-5"
Hole depth	28-33 m	92-108'

Hydraulic rock drill

COP 2560, COP 2560 EX		
Impact power, max.	25 kW	33.5 hp

Atlas Copco screw compressor

Working pressure, max.	12 bar	175 psi
FAD	213 l/s	450 cfm

Engine

Caterpillar Diesel Stage 3/Tier III	CAT C9	
Rating at 2,000 rpm	224 kW	300 hp

Boom variants

- 10, single boom
- 11, folding boom

Fuel tank

Capacity	400 l	106 US gal.
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Feed

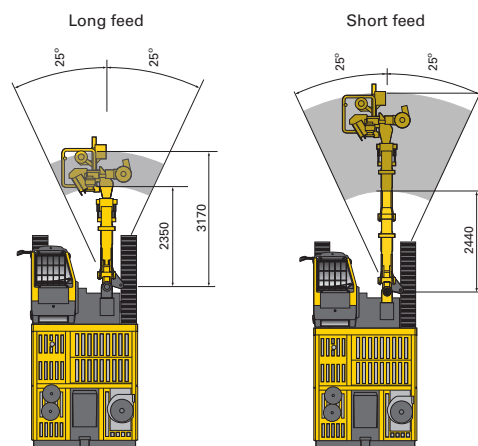
Feed length, folding boom	8,360 mm	27'5"
Travel length	5,110 mm	16'9"
Feed length, folding boom	7,700 mm	25'3"
Travel length	4,610 mm	15'2"
Feed extension	1,150 mm	3'9"
Feed rate, max.	0.92 m/s	180 ft/min
Feed force, max.	20 kN	4,500 lbf

Tramming

Tramming speed, max.	3.5 km/h	2.2 mph
Traction force	166 kN	37,310 lbf
Hill climbing ability	20° without winch	
Track oscillation	± 10°	
Ground clearance	405 mm	16"

Transport dimensions

Weight, excl. options		
ROC F9C single-section boom approx.	16,400 kg	36,150 lb
ROC F9C folding boom boom approx.		
ROC F9LF	16,200 kg	37,500 lb
ROC F9LF	16,600 mm	36,600 lb
Width	2,500 mm	8'2"
Length single-section boom	12,300 mm	40'4"
Length, folding boom (feed dumped back/forward)	11,300 mm/ 13,000 mm	37' 42'8"
Height single-section boom (feed dumped back/forward)	3,800 mm/ 3,200 mm	12'6" 10'6"
Height folding boom (feed dumped back/forward)	3,500 mm/ 3,200 mm	11'6" 10'6"



SmartRig™ ROC F9C



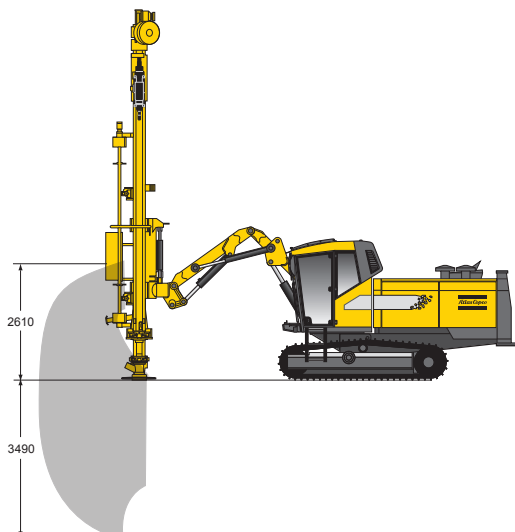
The new SmartRig ROC F9C crawler drill combines the power and flexibility of the popular ROC F9 with the intelligence of RCS – the computerized Rig Control System. RCS adjusts impact and feed to the rock conditions so as to achieve smoother drilling and less wear in the drill steel. Designed both for construction and quarrying work. Features the 25 kW COP 2560 rock drill with T51 drill steel for fast penetration and perfect flushing, powered by a fuel-efficient diesel engine.

Standard equipment

Air conditioner, Reduced impact pressure mechanism, Anti-jamming system, Automatic feed-force control, Fuel saving device, Two-speed traction motors, Dust collector and pre-separator, Double hydraulic drill-steel support, Rod-handling system, Feed extension, Heavy-duty tracks, Operator's cabin, ECM, ROPS and FOPS approved, Air-flow control switch, Water mist system excl. tank, Toe-hole drilling kit, Inclination/depth instrument.

Selection of optional equipment

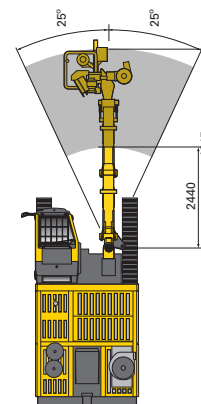
Automatic feed alignment, Automatic rod adding system, Hydraulic winch, Hydraulic support leg, Thread greasing device, Heater for cabin, Hole Navigation System.



SURFACE DRILLING

Main specifications

Recommended hole range		
T51	89-127 mm	3½"-5"
Hole depth	28-33 m	92'-108'
Hydraulic rock drill		
COP 2560, COP 2550EX		
Impact power, max.	25 kW	33.5 hp
Atlas Copco M-o1, screw type compressor		
Working pressure	12 bar	175 psi
FAD	213 l/s	450 cfm
Engine		
Caterpillar diesel Stage 3/Tier III	CAT C9	
Rating at 2,000 rpm	224 kW	304 hp
Boom variants		
single boom		
folding boom		
Fuel tank		
Capacity	400 l	106 US gal.
Feed		
Feed length, single section boom	8,360 mm	27'5"
Travel length	5,110 mm	16'9"
Feed length, folding boom	7,700 mm	25'3"
Travel length	4,610 mm	15'2"
Feed extension	1,150 mm	3'9"
Feed rate, max.	0.92 m/s	180 ft/min
Feed force, max.	20 kN	4,500 lbf
Tramming		
Tramming speed, max.	3.5 km/h	2.2 mph
Traction force	166 kN	37,310 lbf
Hill climbing ability	20° without winch	
Track oscillation	± 10°	
Ground clearance	405 mm	16"
Transport dimensions		
Weight, excl. options		
ROC F9C single-section boom approx.	16,400 kg	36,150 lb
ROC F9C folding boom boom approx.		
ROC F9C	16,200 kg	37,500 lb
Width	16,600 mm	36,600 lb
Length single-section boom	2,500 mm	8'2"
Length, folding boom	12,300 mm	40'4"
(feed dumped back/forward)	11,300 mm/13,000 mm	37'42'8"
Height single-section boom (feed dumped back/forward)	3,800 mm/3,200 mm	12'6"10'6"
Height folding boom (feed dumped back/forward)	3,500 mm/3,200 mm	11'6"10'6"



All dimensions in mm

ROC L7⁴⁰



The new ROC L7⁴⁰ drill rig offers an economic alternative with an extraordinary performance in its hole range. Large scale work sites, and quarries with high demand on productivity, are in focus. The standard drill rig is designed to operate within the most demanding production environment. We also provide the short feed version for the contract drilling and more difficult operating environments.

Standard equipment

RHS 102 Rod magazine, Stroke length selection in cabin, Engine monitoring, Hole inclination and drill depth instrument, Dust collector and pre-separator, Automatic cleaning system, 12 hours fuel capacity, Fuel tank in steel, Hydraulic oil – mineral, Manual hydraulic oil filling system, Stepless water mist regulation in cabin, Triple track chain grouser pads, Electrical outlet 12VDC, Feed lightening.

Selection of optional equipment

Service winch on feed, Thread greasing device, Diesel driven cabin heater, Sun shade kit for cab, Reversing camera, Compressor regulation heating kit, Fire suppression system Manual / Automatic, Central lubrication system.

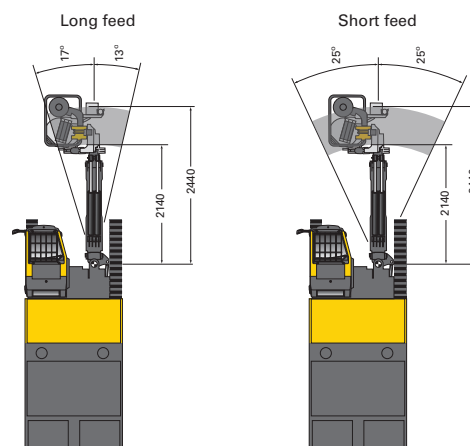


All dimensions in mm

Main specifications

Recommended hole range		
T51	89-127 mm	3½"- 5"
Hole depth	29-36 m	95-118'
Hydraulic rock drill		
COP 4050		
Impact power, max.	40 kW	54 hp
Atlas Copco screw compressor		
Working pressure	12 bar	171 psi
FAD	254 l/s	540 cfm
Engine		
Caterpillar Diesel Stage 3/Tier III	CAT C13	
Rating at 2,000 rpm	328 kW	417 hp
Boom variants		
Single boom		
Fuel tank		
Capacity	760 l	201 US gal.
Feed		
Feed length, total	11,560 mm	38'
Travel length	7,500 mm	24'7"
Feed extension	1,150 mm	3'9"
Feed rate, max.	0.9 m/s	177 ft/min
Feed force, max.	40 kN	8,992 lbf
Tramming		
Tramming speed, max.	3.5 km/h	2.2 mph
Traction force	166 kN	37,310 lbf
Hill climbing ability	20°	
Track oscillation	± 10°	
Ground clearance	405 mm	16"
Transport dimensions		
Weight, excl. options	21,500 kg	48,000 lb
Width	2,500 mm	8'2"
Length long feed	11,700 mm	38'5"
Height long feed	3,500 mm	11'6"
Length short feed	10,700 mm	35'1"
Height short feed	3,200 mm	10'5"

Visit www.surfacedrilling.com for more information



CM 470/470LC



The CM 470 is a rugged and simple crawler drill with direct hydraulic controls that are easy to learn and operate. They are suited for construction projects and site development work. This crawler drill combines simplicity with the flexibility to be used both for vertical and horizontal drilling. Both drill rigs can be used for drilling with T38 or T45 drill steel within the hole range 64-89 mm.

Standard equipment

50 hour filter set, Accumulator charge kit, Anti-jamming, dust collector with side opening hood, Engine auto throttle, full length track guard, JIS hose fittings, JIS to JIC adapter fittings set, Low level indicator for fuel & hyd. oil, Single grouser shoe, Standard tool set, Three sets manuals and parts books, Warning horn, Working light, Rod changer to handle 5 XT38 X 10' rod X w/auto greaser, Rear mirror.

Standard equipment only CM 470

Cab with air conditioner, Fixed boom with 20 degrees indexed drill guide.

Standard equipment only CM 470LC

Controls on the track frame, Front facing drill guide, limited ambient temperature : 52 deg. C

Selection of optional equipment

Anti freezing system, ARC lockout system, 4 XT45X10 rod handling system (63 mm coupling), Back up alarm, Drifter hour meter, Extra parts book, Hyd. pressure test kit, Pre skimmer, Reverse percussion system, Smooth drilling, Super rotation, Vertical sliding dust hood.

Selection of optional equipment only CM 470

Angle indicator 2-D lim, 4 XT45X10' rod handling system (66 mm coupling), Vaposol (less tank).

Main specifications

Recommended hole range		
T38, T45	64-89 mm	2½"-3½"
Hole depth T38	18 m	59'
Hole depth T45	15 m	49'
Hydraulic rock drill		
Yamamoto/YH70		
Impact power, max.	15 kW	20 hp
Compressor		
Working pressure, max	8 bar	114 psi
FAD	83 l/s	176 cfm
Engine		
Cummins B5.9-C		
Rating at 2,300 rpm	107 kW	144 hp
Boom variants		
Type	Single	
Fuel tank		
Capacity	290 l	~77 US gal.
Feed		
Feed length, total	6,550 mm	21'
Travel length	4,170 mm	14'
Feed extension	1,300 mm	4'3"
Feed rate, max.	0.6 m/s	118 ft/min
Feed force, max.	18 kN	4,047 lbf
Pull force, max.	18 kN	4,047 lbf
Tramming		
Tramming speed, max.	3 km/h	2.0 mph
Traction force	53 kN	11,915 lbf
Hill climbing ability	30°Track oscillation	
	± 10°	
Ground clearance	420 mm	16½"
Transport dimensions CM 470		
Weight, excl. o.e	9 tonnes	19,730 lb
Width	2.53 m	8'4"
Length	8.00 m	26'2"
Height	3.18 m	10'2"
Transport dimensions CM 470LC		
Weight, excl. o.e	8.5 tonnes	18,850 lb
Width	2.43 m	7'11"
Length	8.00 m	26'2"
Height	2.77 m	9'

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ECM 580



This tophammer crawler drill is small in size and big in performance. The ECM 580 designed for the hole range 64-102 mm, is featuring a 16.5 kW hammer, suitable for T45 and T38 drill rods. The boom is telescopic extendable for quarry and construction applications, as well as for drilling of horizontal holes on the left side of the rig. The air conditioned cab provides for operator's comfort in a demanding environment.

Standard equipment

50 Hour element kit, 90 deg. Indexed drill guide, Accumulator charge kit, Anti-jamming, Auto rod thread greaser, Auto throttle, Back mirror, Drifter hour meter, Dust collector with vertical sliding hood, Full length track guard, JIC hose fittings, Low level indicator for fuel & hyd. oil, Safety shutdown device on drill guide, Smooth drilling, Standard tool set, Triple grouser shoe pads, Three sets manuals and parts books, Warning horn, Working light (front; 3 / rear; 1), Limited ambient temperature: 52° C.

Selection of optional equipment

Angle indicator 2-D lim, Angle indicator 3-D lim, Anti freezing system, ARC lockout system, ARCT38 X 12' X 6, Back up alarm, Cold weather kit, Extra parts book, Hyd. pressure test kit, Pre skimmer, Reverse percussion system, Super rotation, Vaposol (less tank).

Main specifications

Recommended hole range		
T38, T45	64-102 mm	2½"-4"
Hole depth T38	18 m	59'
Hole depth T45	15 m	49'
Hydraulic rock drill		
Yamamoto YH80		
Impact power, max.	16.5 kW	22 hp
Compressor		
Working pressure, max	9 bar	128 psi
FAD	115 l/s	245 cfm
Engine		
Cummins B5.9-C		
Rating at 2,300 rpm	127 kW	172 hp
Boom variants		
Type	Extendable	
Fuel tank		
Capacity	290 l	~77 US gal.
Feed		
Feed length, total	7,380 mm	24'2"
Travel length	4,250 mm	14'
Feed extension	1,500 mm	4'11"
Feed rate, max.	0.7 m/s	132 ft/min
Feed force, max.	19.6 kN	4,400 lbf
Pull force, max.	19.6 kN	4,400 lbf
Tramming		
Tramming speed, max.	3 km/h	1.86 mph
Traction force	78.5 kN	17,640 lbf
Hill climbing ability	30° (in CE 20°)	
Track oscillation	(U/D) 8/10	
Ground clearance	420 mm	16½"
Transport dimensions		
Weight, excl. o.e	10.5 tonnes	23,150 lb
Width	2.42 m	8'
Length	9.20 m	30'3"
Height	3.30 m	10'10"

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ECM 585



Featuring an 18 kW rock drill with standard reverse percussion and an advanced auto drilling system, the ECM 585 offers the combination of high penetration rate, straight holes and long life for consumables. The extendable boom provides for easy and precise hole positioning, and the ROPS/FOPS approved cab with air conditioning for operator comfort. Suitable for T45 and T38 drill rods the ECM 586 can be used for the hole diameter range 64-102 mm in both quarry and construction applications.

Standard equipment

50 hour element kit, 90 deg. indexed drill guide, Arc T45 X 12' X 6 for 63 mm coupling, Auto drilling system (Montabert), Auto rod thread greaser, Back mirror, Back up alarm, Drifter hour meter, Dust collector with vertical sliding hood, Engine auto throttle, Full length track guard, Hc109 reverse percussion hydraulic drifter, JIC hose fittings, Low level indicator for fuel & hyd. oil, One lever ARC control, Safety shutdown device on drill guide, standard tool set, Three sets manuals and parts books, Triple grouser shoe pads, Two lever drilling controls, Two speed traction motor, Warning horn, Working lights (F:3/r:1), Limited ambient temperature: 52° C.

Selection of optional equipment

Accumulator charge kit, Angle indicator 2-d Lim, Angle indicator 3-d lim, Anti freezing system, Arc lockout system, ArcT38 X 12' X 6, ArcT45 X 12' X 6 for 66 mm coupling, Cold weather kit, Extra parts book, Hyd. pressure test kit, Pre skimmer, Single grouser shoe pads, Vaposol (less tank), Vaposol tank (asme).

Main specifications

Recommended hole range		
T38, T45	64-102 mm	2½"-4"
Hole depth,	25 m	82'
Hydraulic rock drills		
Montabert/HC109		
Impact power, max.	18 kW	24 hp
Compressor		
Working pressure, max.	10 bar	140 psi
FAD	128 l/s	270 cfm
Engine		
Cummins/QSB 6.7		
Rating at 2,200 rpm	165 kW	220 hp
Boom variant		
Type	Extendable	
Fuel tank		
Capacity	400 l	~106 US gal.
Feed		
Feed length, total	8,341 mm	27'
Travel length	4,250 mm	14'
Feed extension	1,500 mm	4'11"
Feed rate, max.	0.6 m/s	115 ft/min
Feed force, max.	19.6 kN	4,400 lbf
Pull force, max.	19.6 kN	4,400 lbf
Tramming		
Tramming speed, max.	3.2 km/h	2 mph
Traction force, max	89.6 kN	20,000 lbf
Hill climbing ability	30° (In CE 20°)	
Track oscillation	± 9°	
Ground clearance	420 mm	16½"
Transport dimensions		
Weight, excl. o.e	14 tonnes	30,860 lb
Width	2.47 m	8'2"
Length	9.70 m	31'10"
Height	3.10 m	10'2"

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ECM 590-series



The ECM 590-series consists of rugged, compact drills with simple, direct hydraulic controls. They are ideal for development work in rough terrain on remote sites where mobility and reliability are key features. They are available in three versions: a basic version (590RR) with a manual rod rack for hole depths down to 18.4 m, a long mast version (592) that will accept 2 x 12' (3.6 m) rods in the feed for 22 ft single pass drilling, and third version (590RC) equipped with a mechanized rod handling system for drilling depth to 22 m. All three versions are well equipped with telescopic boom extension, wet and dry dust suppression and an anti-jam drilling system.

Standard equipment ECM 590RR/590RC/592

Automatic throttle, Fully load sense hydraulic system, On off anti-jamming, Preseparator, Dust collector, Retractable dust hood, Boom extension, Feed extension, Hydraulic centralizer, Heavy duty tracks with full length rock guard, Drill and tram console vandal covers, Back up alarm, Pressurized water tank, Variable speed cooling fan (3 step), Toe hole drilling forward (only RR and RC).

Standard equipment only ECM 590RC

Mechanized rod handling system.

Standard equipment only ECM 592

Long feed for 22ft single pass drilling, Manual rod rack.

Selection of optional equipment

ECM 590RR/590RC/ECM 592

Work lights, Hydraulic test kit, Reverse percussion, Winch, Drill steel conversion kits.

Main specifications

Recommended hole range ECM 590RR

T38, T45	64-102 mm	2½"-4"
Hole depth,	18.4 m	60'

Recommended hole range ECM 590RC

T38, T45, T51	64-115 mm	2½"-4½"
Hole depth,	22 m	72'

Recommended hole range ECM 592

T38, T45	64-102 mm	2½"-4"
Hole depth	21.5 m	70'

Hydraulic rock drill

Yamamoto YH80

Impact power, max.	164 kW	220 hp
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Compressor

Working pressure, max.	9.7 bar	140 psi
FAD	118 l/s	250 cfm

Engine

Cummins QSB 6.7

Rating at 2350 rpm	164 kW	220 hp
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Boom variant

Type	extension	
Boom ext. 590RC - 592	762 mm	30"
Boom ext. 590RR	1219 mm	48"

Fuel tank ECM 590RR/590RC/592

Capacity	378 l	100 US gal.
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Feed ECM 590RR/590RC

Feed length, total	7,366 mm	24.2'
Travel length	4,674 mm	15'4"
Feed extension	1,219 mm	4'
Feed rate, max.	0.71 m/s	139 ft/min
Feed force, max.	23 kN	5,200 lbf
Pull force, max.	23 kN	5,200 lbf

Feed ECM 592

Feed length, total	9,500 mm	31.2'
Travel length	6,807 mm	22'4"
Feed extension	1,219 mm	4'
Feed rate, max.	0.71 m/s	139 ft/min
Feed force, max.	23 kN	5,200 lbf
Pull force, max.	23 kN	5,200 lbf

Tramming

Tramming speed, max.	3.3 km/h	2.0 mph
Traction force, max.	81.73 kN	18,373 lbf
Hill climbing ability	30°	
Track oscillation	± 10°	
Ground clearance	457 mm	18"

Transport dimensions

Width	2.62 m	8'7"
Height	2.92 m	9'7"
Length RC-RR	8.94 m	29'4"
Length 592	10.6 m	34'10"

Weight RC	11.1 tonnes	24,500 lb
Weight RR	10.7 tonnes	23,500 lb
Weight 592	10.9 tonnes	24,000 lb

Visit www.surfacedrilling.com for more information

ECM 660



This high performing crawler drill is equipped with a 21 kW reverse percussion hydraulic drifter (HC158) and auto drilling system that offers the combination of high penetration rate, straight holes and long life for consumables. The extendable boom provides for easy and precise hole positioning, and the air conditioned cab for operator's comfort. The ECM can be used for the hole range 76-115 mm with T45 or T51 rod in both quarry and construction applications.

Standard equipment

50 hour element kit, 90 deg. Indexed drill guide, ARCT51 X 12' X 6 for 72 mm coupling, Auto drilling system (Montabert), Auto rod thread greaser, Back mirror, Back up alarm, Drifter hour meter, Dust collector with vertical sliding hood, Engine auto throttle, Full length track guard, HC158 reverse percussion hydraulic drifter, JIC hose fittings, Low level indicator for fuel & hyd. oil, One lever ARC control, Safety shutdown device on drill guide, Standard tool set, Three sets manuals and parts books, Triple grouser shoe pads, Two lever drilling controls, Two speed traction motor, Warning horn, Working lights (F:3/R:1), Limited ambient temperature: 52° C.

Selection of optional equipment

Accumulator charge kit, Angle indicator 2-d Lim, Angle indicator 3-d lim, Anti freezing system, Arc lockout system, Arc T45 X 12' X 6 for 63 mm coupling, Arc T45 X 12' X 6 For 66 mm coupling, Cold weather kit, Extra parts book, Hyd. pressure test kit, Pre skimmer, Single grouser shoe pads, T51 / 77 mm centralizer, Vaposol (less tank), Vaposol tank (asme).

Main specifications

Recommended hole range		
T45, T51	76-115 mm	3"-4½"
Hole depth,	25 m	82'
Hydraulic rock drills		
Montabert/HC158		
Impact power, max.	21 kW	28 hp
Compressor		
Working pressure, max.	10 bar	140 psi
FAD	167 l/s	350 cfm
Engine		
Cummins/QSC 8.3		
Rating at 2,200 rpm	194 kW	260 hp
Boom variant		
Type	Extendable	
Fuel tank		
Capacity	400 l	~106 US gal.
Feed		
Feed length, total	7,660 mm	25'
Travel length	4,250 mm	14'
Feed extension	1,500 mm	4'11"
Feed rate, max.	0.7 m/s	132 ft/min
Feed force, max.	19.6 kN	4,400 lbf
Pull force max.	19.6 kN	4,400 lbf
Tramming		
Tramming speed, max.	3.4 km/h	2.1 mph
Traction force, max.	89.6 kN	20,000 lbf
Hill climbing ability	30° (In CE 20°)	
Track oscillation	± 9°	
Ground clearance	420 mm	16'5"
Transport dimensions		
Weight, excl. o.e	13 tonnes	28,660 lb
Width	2.47 m	8'2"
Length	9.98 m	32'9"
Height	2.87 m	9'5"

Visit www surfacedrilling.com for more information

ECM 720



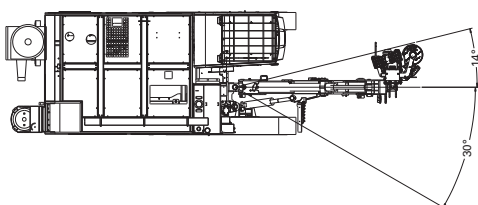
ECM 720 provides a perfect balance of high productivity and cost efficiency. The combination of powerful HC 200A rock drill and the Strata Sense drilling control system allows you to drill through various rock conditions with high penetration rate and yet drilling straight holes. The extension boom helps quick and accurate collaring. Like the rest of the 700 series, simplicity of the 720 makes it easy to operate and easy to maintain.

Standard equipment

Mechanized rod handling, Engine automatic throttle, Load sense progressive anti jamming system (Strata Sense), Central hydraulic system test ports, Variable speed cooling fan control, Tier III emission compliance, 2D electronic angle indicator, Boom extension, Feed extension, Dual pinning for L/R horizontal drilling, Water mist system preplumbed for tank, Preseparator, Dust collector, Retractable dust hood, Hydraulic centralizer, Thread greasing device, FOPS and ROPS operator safety cab, Cab air-conditioning, Working lights, Back up alarm, Heavy duty tracks with full length rock guards, Track oscillation.

Selection of optional equipment

3D angle indicator, 3D angle indicator with speed and depth, Central lubrication system, 14' rod changer group, High capacity dust collector, Hydraulic system test kit, Conversion kit T51/T60, Pressurized water mist tank 80 gal, Pressurized water mist tank 120 gal instead of DCT, Gas charging kit, Diesel fired engine preheater, Arctic package.



All dimensions in mm

Main specifications

Recommended hole range

Hole range	102 - 140 mm	4" - 5½"
Hole depth	29.5 m	97'

Hydraulic rock drill

HC200A		
Impact power, max.	26 kW	35 hp

Compressor

Working pressure, max	10.3 bar	150 psi
FAD	226 l/s	480 cfm

Engine

CAT C11		
Rating at 1800 rpm	287 kW	385 hp

Boom variant

Type	Telescopic	
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Fuel tank

Capacity	587 l	~155 US gal.
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Feed

Feed length, total	8,788 mm	28'10"
Travel length	5,82 mm	17'
Feed extension	1,524 mm	5'
Feed rate, max.	0.96 m/s	190 ft/min
Feed force, max.	33.8 kN	7,600 lbf
Pull force, max.	33.8 kN	7,600 lbf

Tramming

Tramming speed, max.	3.2 km/h	2.0 mph
Traction force	125.4 kN	28,192 lbf
Hill climbing ability	30°	
Track oscillation	± 10°	
Ground clearance	432 mm	17"

Transport dimensions

Weight, excl. o.e	20.5 tonnes	45,300 lb
Width	2.57 m	8'5"

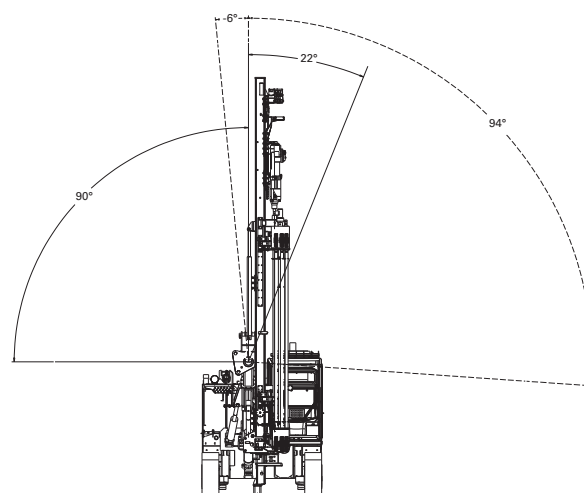
Reaching shortest length

Length	10.72 m	35'2"
Height	3.94 m	12'11"

Reaching lowest height

Length	12.17m	39'11"
Height	3.33 m	10'11"

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Pneumatic rock drills

BBC 120F Tophammer rock drill for hole diameter range 48–76 mm

Robust heavy duty rock drill featuring a large piston and rifle bar reversible rotation with disengagement, making

it ideal for such applications as production drilling in open pit mines and limestone quarries.

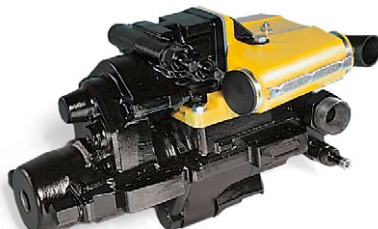


Technical data	BBC 120F
Weight	69 kg
Length	780 mm
Piston diameter	120 mm
Stroke	65 mm
Impact power	7.2 kW
Impact rate	35 Hz
Rotation speed range	0-210 rpm
Air consumption – excluding flushing	175 l/s
Drill steel	R32, R38, T38

COP 131EB Tophammer rock drill for hole diameter range 48–89 mm

A separate rotation, all-round bench driller with a high penetration rate. Effective silencing is a standard feature on this machine (yellow part on this picture). Suitable for use in road embankment and construction work, produc-

tion drilling in quarries and many other types of bench drilling applications. An efficient and reliable rock drill with minimum service requirements.



Technical data	COP 131EB
Weight	179 kg
Length	700 mm
Piston diameter	130 mm
Stroke	65 mm
Impact power	11.1 kW
Impact rate	39 Hz
Rotation speed range	0-300 rpm
Air consumption – excluding flushing	258 l/s
Drill steel	R32, T38

VL 140 Tophammer rock drill for hole diameter 64–102 mm

A separate gear type rotation valve less rock drill, which is suitable for most applications within surface blast hole drilling operations. The large diameter piston

– 140 mm offers highest penetration rate in hard rock formations. Add to this a reliable rock drill, which is easy to maintain and service.



Technical data	VL 140
Weight	191 kg
Piston diameter	140 mm
Stroke	92 mm
Impact power	9.3 kW
Impact rate	35 Hz
Rotation speed range	0-150 rpm
Air consumption – excluding flushing	354 l/s
Drill steel	T38, T45

Hydraulic rock drills



Nitromak, Turkish drill and blast contractor, location is Aslan Cement Quarry, Gebze-Kocaeli.

COP 2560 Tophammer rock drill for hole diameter range 89-127 mm

The COP 2560 is one of the most powerful rock drills on the market, with bigger adapter, increased bearing surface, larger driver and an impact piston with a greater diameter at the striking end than the earlier COP 2550. These changes give better impact tolerance for really heavy production work.

A great advantage is that COP 2560 can work with both T51 drill steel and with the considerably more rigid ThunderRod T60 for hole diameters of 102 mm and above. The reduced hole deviation using T60 drill steel allows larger burdens and saves on drilling time.



Technical data	COP 2560	COP 2560EX
Weight	187 kg	249 kg
Length	1,138 mm	1,336 mm
Impact power, max	25 kW	25 kW
Impact rate	44 Hz	44 Hz
Hydraulic pressure, max	230 bar	230 bar
Rotation speed range, max	0-110 rpm	0-110 rpm
Rotation pressure, max	200 bar	200 bar
Rotation motor type	-10	-10
Rotation motor torque, max	1,810 Nm	1,810 Nm
Flushing air pressure	12 bar	12 bar
Lubricating air consump. at 2 bar	5 l/s	5 l/s
Shank adapter	T51,T60	T51,T60

COP 1020-series Tophammer rock drills for hole diameter range 23-45 mm

The COP 1020-series of light rock drills is designed for bench drilling and rock bolting. Stepless variable rotation speed and high torque capacity offer fast drilling rates combined with low drill steel consumption. Versions for integral steels and drill rods are available. COP 1022 is high frequency for extra fast drilling. COP 1028 has a pressurized fronthead to lubricate the shank adapter



and prevent dirt and water from entering the rock drill. External sealed of water flushing for pressures up to 13 bar ensures efficient removal of cuttings and better bit life. A nitrogen charged accumulator levels out pressure peaks in the hydraulic systems, reducing vibration and wear on hydraulic components.

Technical data	COP 1022HF	COP 1028
Weight	55 kg	51 kg
Length	709 mm	755 mm
Impact power, max	5 kW	5.5 kW
Impact rate	73 Hz	53 Hz
Hydraulic pressure, max	190 bar	185 bar
Shank adapter	H22, H25	R28, R32

COP 1240 Tophammer rock drill for hole diameter range 45-89 mm

The COP 1240 is a robust and extremely reliable rock drill designed specifically for cost-efficient surface drilling. Based on the same winning design that made its predecessor the COP 1238 one of the most dependable and efficient rock drills, the COP 1240 has been further refined. It has three different stroke settings and can be rapidly and easily adjusted to exploit the available power



in the best possible way, whether in hard or soft rock conditions. A single-stage damping system contributes to its high operational reliability, making the machine the ultimate example of trouble-free productivity. Commonality of COP 1240 components with family members COP 1640 and COP 1840 assures simplified spare parts management

Technical data	COP 1240
Weight	185 kg
Length	1,048 mm
Impact power, max	12 kW
Impact rate	52 Hz
Hydraulic pressure, max	220 bar
Rotation speed range, max	0-210 rpm
Rotation motor type	-07/-09
Rotation motor torque, max	980 Nm
Flushing air pressure	12 bar
Shank adapter	R32, T38, T45

COP 1640 Tophammer rock drill for hole diameter range 45-89 mm

The COP 1640 is meant for seriously challenging drilling, for which it features the same large, robust driver and gearing as the COP 1840. This helps extend wear-part service life and keeps operating costs to a minimum. The COP 1640 has three different stroke settings for excellent efficiency, allowing adjustment according to rock hardness to ensure optimum penetration rate.



Dual damping system ensures that the drill is in contact with the rock throughout the impact cycle, for efficient cuttings removal and continuous retensioning of the drillstring joints. Commonality of COP 1640 components with family members COP 1240 and COP 1840 assures simplified spare parts management.

Technical data	COP 1640
Weight	193 kg
Length	1,048 mm
Impact power, max	16 kW
Impact rate	60 Hz
Hydraulic pressure, max	200 bar
Rotation speed range, max	0-210 rpm
Rotation motor type	-07/-09
Rotation motor torque, max	980 Nm
Flushing air pressure	12 bar
Shank adapter	R32, T38, T45

COP 1840HE Tophammer rock drill for hole diameter range 76 – 115 mm

COP 1840HE is specially suitable for heavy duty drilling, e.g. when using TDS-type guide tubes to obtain straighter holes. Adjustable stroke length makes it possible to adjust impact rate and energy to actual rock conditions and hole size. Powerful, stepless variable and reversible rotation motor gives high torque and excellent speed control. The efficient reflex damping system of the

COP 1800 series is called “dual damping” due to its high efficiency and double acting function. As the feed and the boom are not subjected to unnecessary strain, the entire drill string will give you longer service life. The automatic tightening system of the drill string results in straighter holes and optimum penetration. COP 1840HE can also be supplied with built-in hydraulic extractor.



Technical data	COP 1840HE	COP 1840HEX
Weight	184 kg	244 kg
Length	1,138 mm	1,336 mm
Impact power, max	19 kW	19 kW
Impact rate	42-50 Hz	42-50 Hz
Hydraulic pressure, max	230 bar	230 bar
Rotation speed range, max	0-130 rpm	0-130 rpm
Rotation pressure, max	200 bar	200 bar
Rotation motor type	-07/-09/-10	-07/-09/-10
Drill steel torque, max	1,180 Nm	1,180 Nm
Flushing air pressure	10 bar	10 bar
Lubricating air consump. at 2 bar	6 l/s	6 l/s
Shank adapter	T38, T45, T51	

COP 4050ME Tophammer rock drill for hole diameter range 89 – 127 mm

For use with drill steel, drill steel/guide tube or COPROD drill string, the new generation COP 4050 is the most powerful rock drill in the Atlas Copco range, delivering up to 40 kW of percussive power while maintaining good drill string economy using Speedrod T51 extension rods. The COP 4050ME is specially designed with two powerful hydraulic rotation motors and a large impact piston for continuous, heavy duty bench drilling. Impact and power levels are easily adjustable to prevailing rock conditions for achieving good hole quality, long drill steel life, and an overall high productivity.

The COP 4050MEX is equipped with a hydraulic extractor that automatically comes into operation when the feed is reversed. The power applied is about 20% of the rated percussion power of the drill, which makes it almost impossible to lose a drill string in the hole. COP4050ME/MEX rock drills are provided with two stroke-length pistons for frequency adjustment. This, together with selectable power take-out and rotation speed makes it extremely easy to adjust the operation of the drill for optimal production.

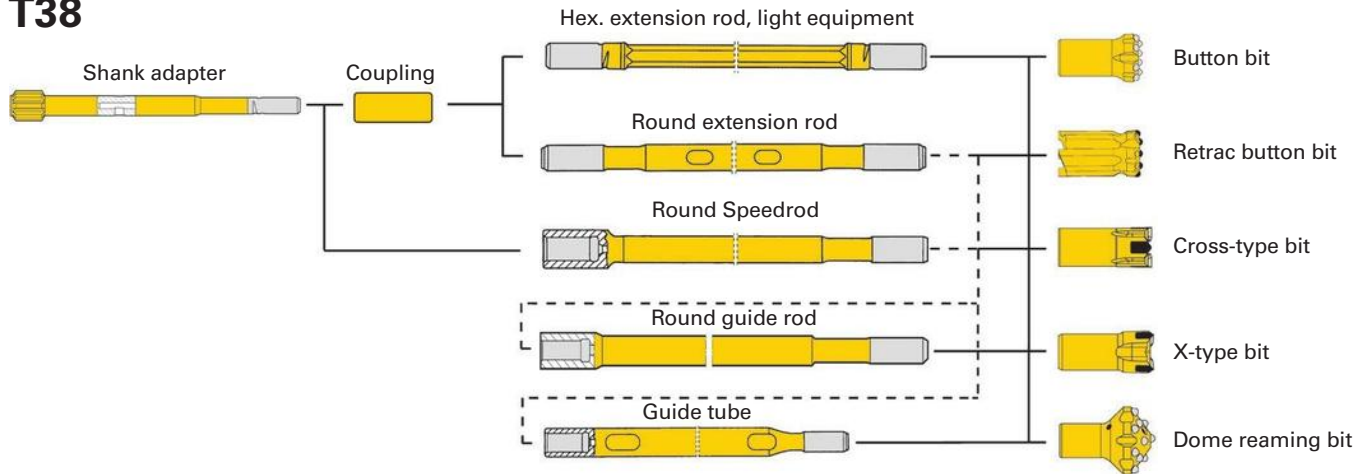


Technical data	COP 4050ME	COP 4050MEX
Weight	390 kg	420 kg
Length	1,293 mm	1,546 mm
Impact power, max	40 kW	40 kW
Impact rate	42-60 Hz	42-60 Hz
Hydraulic pressure, max	230 bar	230 bar
Rotation speed range, max	0-110 rpm	0-110 rpm
Rotation pressure, max	200 bar	200 bar
Rotation motor type	2x -09	2x -09
Drill steel torque, max	3,500 Nm	3,500 Nm
Flushing air pressure	8 bar	8 bar
Lubricating air	4 bar	4 bar
Shank adapter	T51	

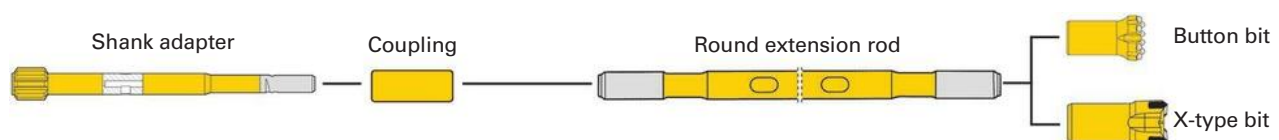
Bench and production drilling

R/T38 (1½")

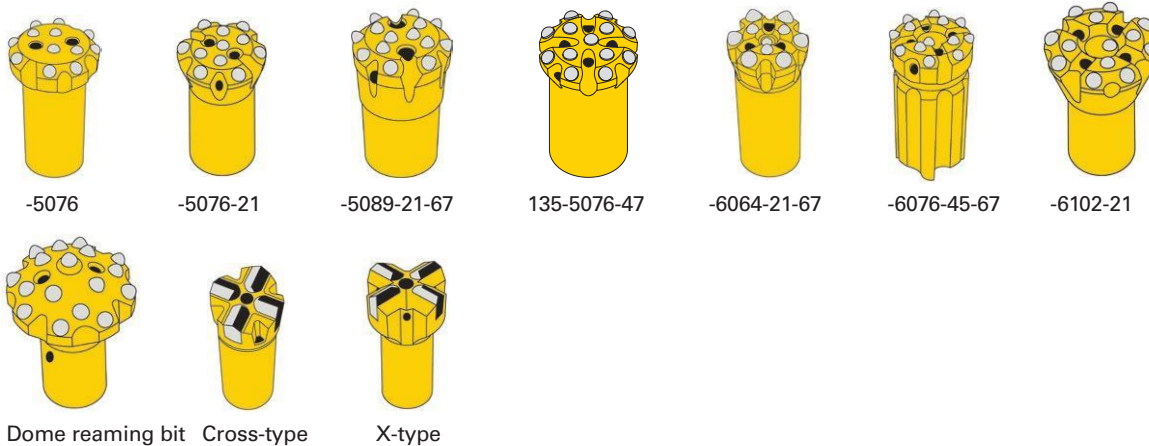
T38



R38



Drill bit design



Drill bit

Diameter		Product No.	Product code		No. of buttons	Buttons × button diameter (mm)		Gauge buttons angle°	Flushing hole		Weight approx. kg
mm	inch		R38 thread	T38 thread		Gauge	Centre		Side	Centre	
BUTTON BIT - Spherical buttons											
64	2½	90510304	104-5064,49-20		12	8×10	4×10	40°	–	2	1,6
64	2½	90510305		135-5064,49-20	12	8×10	4×10	40°	–	2	1,6
64	2½	90510309		135-5064-45,49-20	12	8×10	4×10	40°	–	2	1,9
64	2½	90510316		135-5064-20,49-20	9	6×12,7	3×11	35°	1	1	1,9
64	2½	90513748		135-5064-21,49-20	10	6×11	4×10	35°	1	2	1,6
64	2½	90510307		135-6064,49-20	10	6×11	3×10, 1×10	35°	–	3	1,7
64	2½	90510311		135-6064-45,49-20	10	6×11	3×10, 1×10	35°	–	3	2,3
64	2½	90510347		135-6064-21,49-20	10	6×12,7	3×10, 1×8	25°	–	3	1,7

Cont. next page

Bench and production drilling

R/T38 (1½")

Diameter		Product No.	Product code		No. of buttons	Buttons × button diameter (mm)		Gauge buttons angle°	Flushing hole		Weight approx. kg
mm	inch		R38 thread	T38 thread		Gauge	Centre		Side	Centre	
BUTTON BIT - Spherical buttons											
70	2¾	90510349		135-5070,49-20	12	8×11	4×11	40°	–	2	2,0
70	2¾	90510350		135-5070-20,49-20	11	6×12,7	5×11	35°	2	1	2,3
70	2¾	90510352		135-6070,49-20	10	6×11	3×11, 1×9	35°	–	3	1,9
70	2¾	90510707		135-6070-21,49-20	10	6×12,7	3×10, 1×10	35°	–	3	1,7
70	2¾	90514157		135-6070-21-45,49-20	10	6×12,7	3×10, 1×10	35°	–	3	2,3
76	3	90510318	104-5076,49-20		12	8×11	4×11	40°	–	2	2,6
76	3	90510319		135-5076,49-20	12	8×11	4×11	40°	–	2	2,2
76	3	90510366		135-5076-45,49-20	12	8×11	4×11	40°	–	2	3,1
76	3	90510321		135-5076-20,49-20	11	6×12,7	5×11	35°	2	1	2,5
76	3	90513749		135-5076-21,49-20	13	8×12,7	5×11	35°	1	2	2,3
76	3	90515235		135-5076-47,49-20	13	8×11	5×11	35°	1	4	2,2
76	3	90510330		135-6076,49-20	10	6×12,7	3×11, 1×11	35°	1	3	2,6
76	3	90510369		135-6076-45,49-20	13	8×11	4×11, 1×11	35°	1	4	3,5
76	3	90513806		135-6076-21,49-20	13	8×12,7	4×11, 1×11	35°	–	4	2,4
76	3	90510810		135-6076-21-45,49-20	13	8×12,7	4×11, 1×11	35°	–	4	3,3
89	3½	90510323	104-5089,49-20		12	8×12,7	4×12,7	40°	–	2	3,3
89	3½	90510324		135-5089,49-20	12	8×12,7	4×12,7	40°	–	2	3,2
89	3½	90510367		135-5089-45,49-20	12	8×12,7	4×12,7	40°	–	2	5,2
89	3½	90515273		135-5089-47,49-20	16	10×11	6×11	35°	1	4	3,4
89	3½	90510332		135-6089,49-20	11	6×12,7	3×11, 2×11	35°	1	3	3,0
89	3½	90513808		135-6089-21,49-20	13	8×12,7	4×11, 1×11	35°	–	4	3,0
89	3½	90515287		135-6089-21-45,49-20	13	8×12,7	4×11, 1×11	35°	–	4	4,6
102	4	90510329		135-5102,49-20	12	8×14,5	4×14,5	40°	–	2	4,0
102	4	90515369		135-5102-47,49-20	14	8×14,5	6×12,7	35°	1	4	4,3
102	4	90513810		135-6102-21,49-20	13	8×14,5	4×12,7, 1×12,7	35°	–	4	3,9
127	5	90513776		135-5127-42-24,49-20*	19	18×12,7	1×12,7	35°	1	3	5,2
BUTTON BIT - Ballistic buttons											
64	2½	90510413		135-5064-67,49-20	12	8×10	4×10	40°	–	2	1,6
64	2½	90510365		135-5064-45-67,49-20	12	8×10	4×10	40°	–	2	1,9
64	2½	90510306		135-6064-67,49-20	10	6×11	3×10, 1×10	35°	–	3	1,6
64	2½	90510368		135-6064-45-67,49-20	10	6×11	3×10, 1×10	35°	–	3	2,3
64	2½	90510524		135-6064-21-67,49-20	10	6×12,7	3×10, 1×8	25°	–	3	1,8
64	2½	90513805		135-6064-21-45-67,49-20	10	6×12,7	3×10, 1×8	25°	–	3	2,2
64	2½	90514631		135-6064-48-45-67,49-20	13	8×10	4×10, 1×7	35°	–	4	2,0
70	2¾	90510351		135-6070-67,49-20	10	6×11	3×11, 1×9	35°	–	3	1,9
70	2¾	90510384		135-6070-45-67,49-20	10	6×11	3×11, 1×9	35°	–	3	2,4
76	3	90513760		135-5076-21-67,49-20	13	8×12,7	5×11	35°	1	2	2,3
76	3	90510312		135-5076-45-67,49-20	12	8×11	4×11	40°	–	2	3,1
76	3	90510331		135-6076-67,49-20	10	6×12,7	3×11, 1×11	35°	1	3	2,5
76	3	90510370		135-6076-45-67,49-20	13	8×11	4×11, 1×11	35°	1	4	3,5
76	3	90513807		135-6076-21-67,49-20	13	8×12,7	4×11, 1×11	35°	–	4	2,4
76	3	90510811		135-6076-21-45-67,49-20	13	8×12,7	4×11, 1×11	35°	–	4	3,3
89	3½	90513763		135-5089-21-67,49-20	14	8×12,7	6×12,7	35°	1	2	3,1

* For reaming, reversed flushing.

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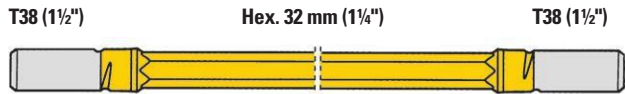
Bench and production drilling

R/T38 (1½")

Diameter		Product No.	Product code		No. of buttons	Buttons × button diameter (mm)		Gauge buttons angle°	Flushing hole		Weight approx. kg
mm	inch		R38 thread	T38 thread		Gauge	Centre		Side	Centre	
BUTTON BIT - Ballistic buttons											
89	3½	90510355		135-6089-67,49-20	11	6×12,7	3×11, 2×11	35°	1	3	3,1
89	3½	90510654		135-6089-45-67,49-20	14	8×11	4×11, 2×9	35°	1	4	5,0
89	3½	90513809		135-6089-21-67,49-20	13	8×12,7	4×11, 1×11	35°	–	4	3,0
102	4	90513762		135-6102-21-67,49-20	13	8×14,5	4×12,7, 1×12,7	35°	–	4	3,9
127	5	90513775		135-5127-42-24-67,49-20*	19	18×12,7	1×12,7	35°	1	3	5,2
X-TYPE BIT											
64	2½	90002256		135-8064,08-16	14,0	25,0			4	1	1,9
76	3	90001716	104-8076,08-16		14,0	26,0			4	1	2,5
76	3	90002260		135-8076,08-16	14,0	26,0			4	1	2,5

* For reaming, reversed flushing.

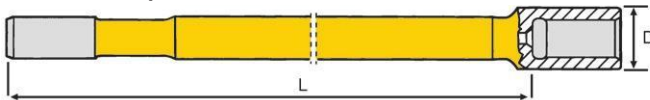
Extension rod



Light equipment, fully carburized. Rod section 35,8 mm.

Length		Product No.	Product code		Weight approx. kg
mm	foot/inch		R38 thread	T38 thread	
3050	10'	90001962		235-0531-C,02	18,7
4000	13'1½"	90510050		235-0540-C,02	23,6

T38 (1½") round Speedrod



Fully carburized. D = 57 mm.

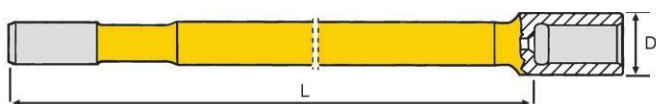
Length (L)		Product No.	Product code		Weight approx. kg
mm	foot/inch		R38 thread	T38 thread	
600	1'11⅝"	90510857		235-4706-MF-C,02	6,0
915	3'	90510718		235-4709-MF-C,02	8,3
1220	4'	90510719		235-4712-MF-C,02	10,9
1525	5'	90510720		235-4715-MF-C,02	13,3
1830	6'	90510721		235-4718-MF-C,02	15,8

Both surface hardened and fully carburized, see next page.

Bench and production drilling

R/T38 (1½")

T38 (1½") round Speedrod



Fully carburized (C) and Surface hardened (SH). D = 57 mm.

Length (L)		Product No.	Product code		Weight approx. kg
mm	foot		R38 thread	T38 thread	
Both surface hardened and fully carburized					
3050	10	90515312		235-4731-MF,29	26,3
3660	12	90515315		235-4737-MF,29	31,5
4270	14	90515570		235-4743-MF,29	36,9
4880	16	90515571		235-4749-MF,29	41,9

R/T38 (1½") round rod



Fully carburized (C) / Surface hardened (SH).

Length		Product No.	Product code		Weight approx. kg
mm	foot/inch		R38 thread	T38 thread	
Fully carburized					
280	11"	90504090	204-2702-C,02		2,0
610	2'	90502448		235-2706-C,02	5,0
1220	4'	90500622		235-2712-C,02	10,0
Surface hardened					
1830	6'	90590109	204-2718-SH,03		14,9
3050	10'	90515405	204-4731-SH,03		24,3
3050	10'	90515289		235-4731-SH,03	24,8
3660	12'	90515288		235-4737-SH,03	29,0
4270	14'	90515291		235-4743-SH,03	34,7

T38 (1½") round rod with double thread



Surface hardened.

Length		Product No.	Product code		Weight approx. kg
mm	foot		R38 thread	T38 thread	
3050	10	90515292		235-4731-95-SH,03	27,0
3660	12	90515290		235-4737-95-SH,03	30,0

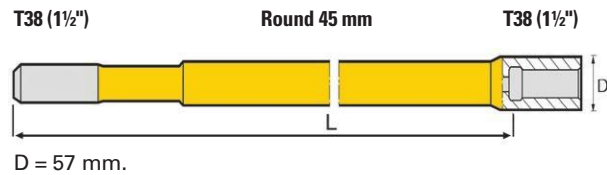
Bench and production drilling

R/T38 (1½")

Drifter rod

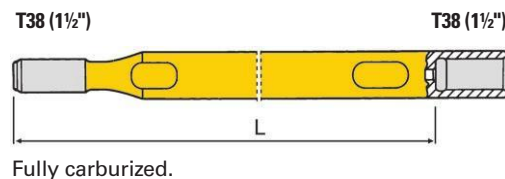
For one rod drilling drifter rods can be used.

Guide rod



Length (L)		Product No.	Product code	Weight approx. kg
mm	foot			
3660	12	90515575	235-4937-MF29	44,8

Guide tube



Hole diameter		Tube diameter		Length (L)		Product No.	Product code	Weight approx. kg
mm	inch	mm	inch	mm	foot			
64	2½	56	2⅛	1220	4	94502648	235-7012,10	12,6
64	2½	56	2⅛	1525	5	94000051	235-7015,10	14,0
64	2½	56	2⅛	1830	6	94000052	235-7018,10	17,4
64	2½	56	2⅛	3050	10	94000053	235-7031,10	28,3
64	2½	56	2⅛	3660	12	94000054	235-7037,10	32,8
76	3	64	2½	3660	12	94502622	235-6937,10	51,0

Coupling

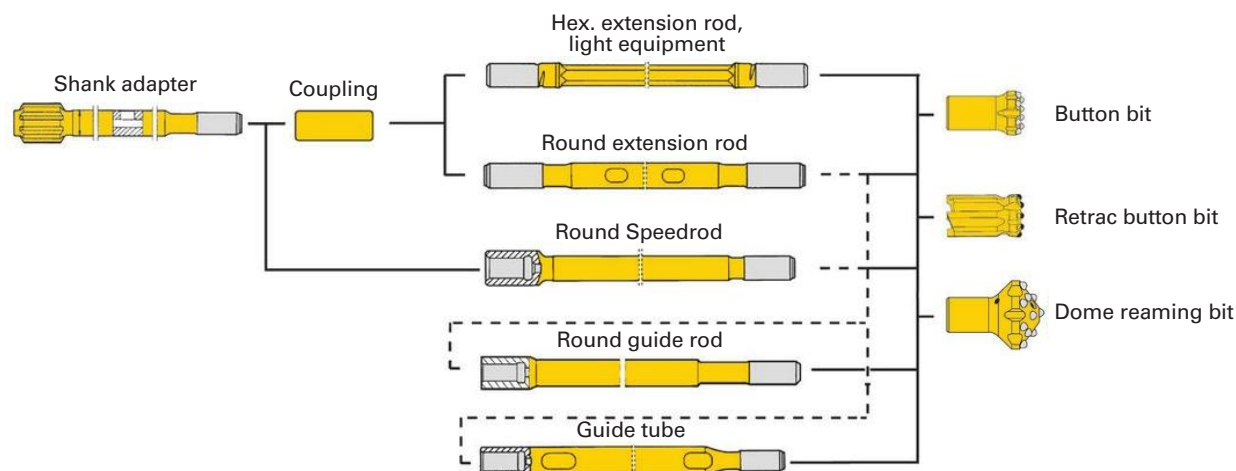


Full bridge -57.

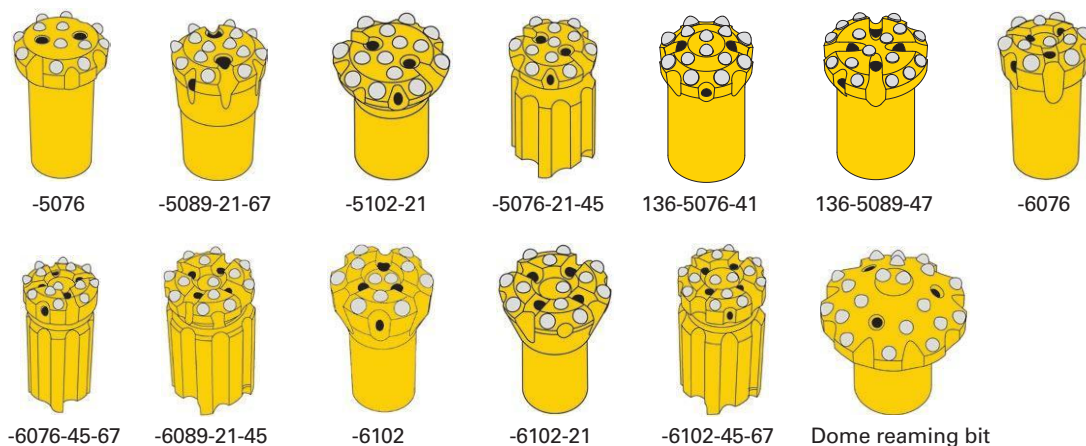
Thread diameter		Diameter		Length		Product No.	Product code		Weight approx. kg
mm	inch	mm	inch	mm	inch		Rope thread	T thread	
38	1½	52	2⅛	190	7½	90515736		335-0052,10	1,8
38	1½	55	2⅝	170	6¾	90515733	304-0055,10		1,7
38	1½	55	2⅝	170	6¾	90515737		335-0055,10	1,7
38	1½	55	2⅝	180	7⅛	90515734	304-0055-57,10		1,9
38	1½	55	2⅝	180	7⅛	90515738		335-0055-57,10	1,9

Bench and production drilling

T45 (1³/₄"



Drill bit design



Drill bit

Diameter		Product No.	Product code	No. of buttons	Buttons × button diameter (mm)		Gauge buttons angle°	Flushing hole		Weight approx. kg
mm	inch				Gauge	Centre		Side	Centre	
BUTTON BIT - Spherical buttons										
70	2¾	90510478	136-6070,49-20	10	6×11	3×11, 1×9	35°	–	3	2,0
70	2¾	90510479	136-6070-45,49-20	10	6×11	3×11, 1×9	35°	–	3	2,1
76	3	90510320	136-5076,49-20	12	8×11	4×11	40°	–	2	2,2
76	3	90510371	136-5076-45,49-20	12	8×11	4×11	40°	–	2	2,8
76	3	90510322	136-5076-20,49-20	11	6×12,7	5×11	35°	2	1	2,6
76	3	90514051	136-5076-21,49-20	13	8×12,7	5×11	35°	1	2	2,4
76	3	90513761	136-5076-21-45,49-20	13	8×12,7	5×11	35°	1	2	2,7
76	3	90515248	136-5076-41,49-20	14	8×12,7	4×11, 2×11	35°	2	2	2,5
76	3	90510333	136-6076,49-20	10	6×12,7	3×11, 1×11	35°	1	2	2,6
76	3	90510313	136-6076-45,49-20	13	8×11	4×11, 1×11	35°	1	4	3,2
76	3	90513750	136-6076-21,49-20	13	8×12,7	4×11, 1×11	35°	–	4	2,4
76	3	90510808	136-6076-21-45,49-20	13	8×12,7	4×11, 1×11	35°	–	4	3,0

Cont. next page

Bench and production drilling

T45 (1 3/4")

Diameter		Product No.	Product code	No. of buttons	Buttons × button diameter (mm)		Gauge buttons angle°	Flushing hole		Weight approx. kg
mm	inch				Gauge	Centre		Side	Centre	
BUTTON BIT - Spherical buttons										
89	3½	90510325	136-5089,49-20	12	8×12,7	4×12,7	40°	–	2	3,3
89	3½	90510418	136-5089-20,49-20	14	8×12,7	6×11	35°	1	1	3,8
89	3½	90510372	136-5089-45,49-20	12	8×12,7	4×12,7	40°	–	2	5,0
89	3½	90515268	136-5089-47,49-20	16	10×11	6×11	35°	1	4	3,0
89	3½	90513751	136-5089-21-45,49-20	14	8×12,7	6×12,7	35°	1	2	4,7
89	3½	90510335	136-6089,49-20	11	6×12,7	3×11, 2×11	35°	1	3	3,5
89	3½	90510374	136-6089-45,49-20	14	8×11	4×11, 2×9	35°	1	4	4,7
89	3½	90513752	136-6089-21,49-20	13	8×12,7	4×11, 1×11	35°	–	4	3,0
89	3½	90510692	136-6089-21-45,49-20	13	8×12,7	4×11, 1×11	35°	–	4	4,2
102	4	90510326	136-5102,49-20	12	8×14,5	4×14,5	40°	–	2	4,4
102	4	90510888	136-5102-21,49-20	14	8×15,8	6×12,7	35°	1	2	3,7
102	4	90510373	136-5102-45,49-20	12	8×14,5	4×14,5	40°	–	2	6,7
102	4	90515364	136-5102-47,49-20	14	8×14,5	6×12,7	35°	1	4	4,1
102	4	90510337	136-6102,49-20	11	6×14,5	3×12,7, 2×12,7	35°	1	3	3,9
102	4	90510392	136-6102-45,49-20	14	8×12,7	4×12,7, 2×12,7	35°	1	4	7,8
102	4	90513811	136-6102-21,49-20	13	8×14,5	4×12,7, 1×12,7	35°	–	4	5,3
102	4	90515366	136-6102-21-45,49-20	13	8×14,5	4×12,7, 1×12,7	35°	–	4	6,4
115	4½	90510409	136-5115,49-20	18	10×12,7	8×12,7	35°	–	2	5,4
115	4½	90515269	136-5115-47,49-20	14	8×14,5	6×14,5	35°	1	4	5,8
115	4½	90510399	136-6115,49-20	14	8×14,5	4×12,7, 2×12,7	35°	1	4	5,0
115	4½	90514660	136-6115-45,49-20	14	8×14,5	4×12,7, 2×12,7	35°	1	4	9,0
127	5	90515253	136-5127-47,49-20	14	8×15,8	6×15,8	35°	–	4	6,6
127	5	90513778	136-5127-42-24,49-20*	19	18×12,7	1×12,7	35°	1	3	5,3
152	6	90513818	136-5152-42-24,49-20*	20	18×14,5	2×14,5	35°	1	3	9,9
BUTTON BIT - Ballistic buttons										
70	2¾	90510385	136-6070-45-67,49-20	10	6×11	3×11, 1×9	35°	–	3	2,1
76	3	90514027	136-5076-21-67,49-20	13	8×12,7	5×11	35°	1	2	2,3
76	3	90510386	136-5076-45-67,49-20	12	8×11	4×11	40°	–	2	2,8
76	3	90510334	136-6076-67,49-20	10	6×12,7	3×11, 1×11	35°	1	2	2,6
76	3	90510314	136-6076-45-67,49-20	13	8×11	4×11, 1×11	35°	1	4	3,1
76	3	90510809	136-6076-21-45-67,49-20	13	8×12,7	4×11, 1×11	35°	–	4	3,0
89	3½	90510390	136-5089-45-67,49-20	12	8×12,7	4×12,7	40°	–	2	5,0
89	3½	90510780	136-5089-21-67,49-20	14	8×12,7	6×12,7	35°	1	2	3,3
89	3½	90514073	136-5089-21-45-67,49-20	14	8×12,7	6×12,7	35°	1	2	4,7
89	3½	90510336	136-6089-67,49-20	11	6×12,7	3×11, 2×11	35°	1	3	3,4
89	3½	90510375	136-6089-45-67,49-20	14	8×11	4×11, 2×9	35°	1	4	4,8
89	3½	90515523	136-6089-21-67,49-20	13	8×12,7	4×11, 1×11	35°	–	4	3,1
89	3½	90510772	136-6089-21-45-67,49-20	13	8×12,7	4×11, 1×11	35°	–	4	4,8
102	4	90510889	136-5102-21-67,49-20	14	8×15,8	6×12,7	35°	1	2	3,7
102	4	90515367	136-6102-21-67,49-20	13	8×14,5	4×12,7, 1×12,7	35°	–	4	4,9
102	4	90510376	136-6102-45-67,49-20	14	8×12,7	4×12,7, 2×12,7	35°	1	4	7,8
115	4½	90515263	136-6115-67,49-20	14	8×14,5	4×12,7, 2×12,7	35°	1	4	4,7
115	4½	90515256	136-6115-45-67,49-20	14	8×14,5	6×12,7	35°	1	4	8,1
152	6	90510782	136-5152-42-24-67,49-20*	20	18×14,5	2×14,5	35°	3	3	9,5

* For reaming, reversed flushing.

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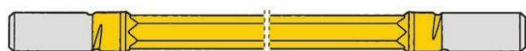
Bench and production drilling

T45 (1 3/4")

Diameter		Product No.	Product code	No. of buttons	Buttons × button diameter (mm)		Gauge buttons angle°	Flushing hole		Weight approx. kg
mm	inch				Gauge	Centre		Side	Centre	
BUTTON BIT - Full-ballistic buttons (Soft rock bit)										
89	3½	90514993	136-5089-47-45-66,49-20	16	10×11	6×11	35°	1	4	4,9
X-TYPE BIT				Insert						
				Width (mm)		Height (mm)				
76	3	90514366	136-8076,02-17	14,0		26,0		4	1	2,5

Extension rod

T45 (1 3/4") Hex. 38 mm (1 1/2") T45 (1 3/4")



Light equipment, fully carburized. Rod section 42,6 mm.



Length		Product No.	Product code		Weight approx. kg
mm	foot		Fully carburized	Surface hardened	
3050	10	90002188	236-0731-C,02		25,6
3660	12	90002163	236-0737-C,02		30,8

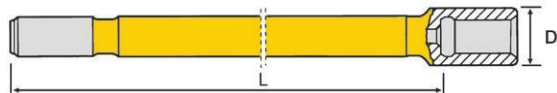
T45 (1 3/4") round rod



Surface hardened.

Length		Product No.	Product code		Weight approx. kg
mm	foot/inch		Fully carburized	Surface hardened	
3050	10'	90515296		236-4931-SH,03	34,5
3660	12'	90515294		236-4937-SH,03	41,4
4270	14'	90515295		236-4943-SH,03	48,3
4800	15'9"	90515408		236-4948-SH,03	54,3
6095	20'	90515297		236-4961-SH,03	69,0

T45 (1 3/4") round Speedrod



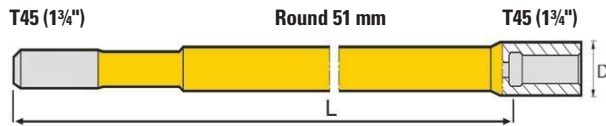
Fully carburized. D = 65 mm.

Length (L)		Product No.	Product code		Weight approx. kg
mm	foot		Fully carburized	Surface hardened	
1525	5	90510730	236-4915-MF-C,02		18,2
1830	6	90510731	236-4918-MF-C,02		21,5
Both surface hardened and fully carburized					
3050	10	90515567	236-4931-MF,29		37,6
3660	12	90515313	236-4937-MF,29		43,5
4270	14	90515316	236-4943-MF,29		51,5

Bench and production drilling

T45 (1 3/4")

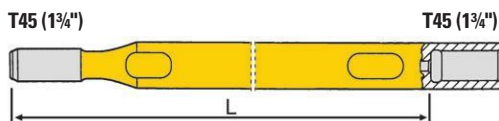
Guide rod



Fully carburized. D = 65 mm.

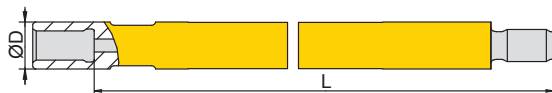
Length (L)		Product No.	Product code	Weight approx. kg
mm	foot			
3660	12	90513771	236-5137-MF-C,02	55,0
4270	14	90514785	236-5143-MF-C,02	63,5

Guide tube



Fully carburized.

Hole diameter		Tube diameter		Length (L)		Product No.	Product code	Weight approx. kg
mm	inch	mm	inch	mm	foot			
76	3	64	2 1/2	1220	4	94502687	236-6912,10	20,0
76	3	64	2 1/2	1525	5	94000047	236-6915,10	21,6
76	3	64	2 1/2	1830	6	94000046	236-6918,10	25,4
76	3	64	2 1/2	3660	12	94000050	236-6937,10	49,0
89	3 1/2	76	3	1830	6	94502656	236-6618,10	40,0
89	3 1/2	76	3	3660	12	94502627	236-6637,10	77,8



Fully carburized. Without undercut (shoulder).

Hole diameter		Tube diameter		Length (L)		Product No.	Product code	Weight approx. kg
mm	inch	mm	inch	mm	foot/inch			
76	3	64	2 1/2	1830	6'	94502714	236-6918-87,10	27,0

Coupling

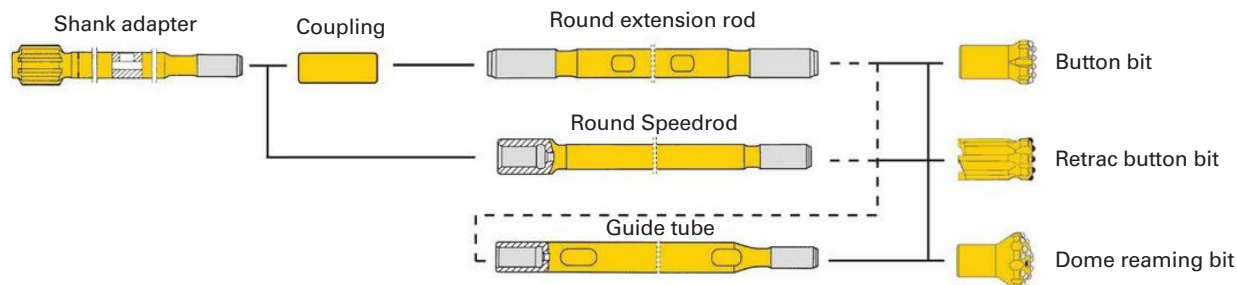


Full bridge -57.

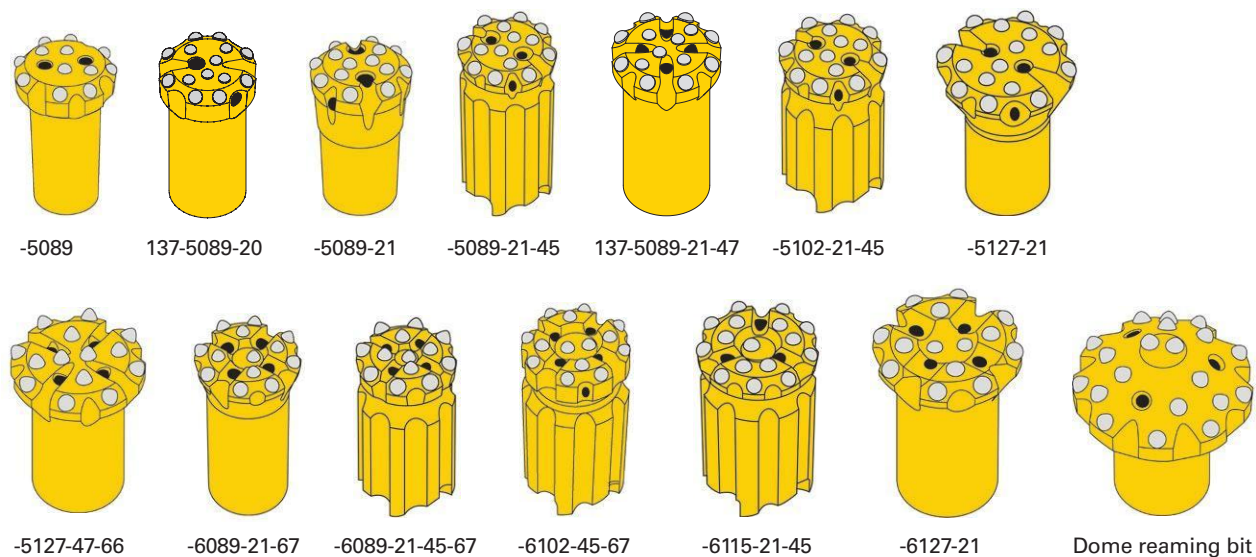
Thread diameter		Diameter		Length		Product No.	Product code T thread	Weight approx. kg
mm	inch	mm	inch	mm	inch			
45	1 3/4	63	2 15/32	210	8 1/4	90515739	336-0063,10	2,7
45	1 3/4	63	2 15/32	210	8 1/4	90515740	336-0063-57,10	2,7
45	1 3/4	66	2 5/8	210	8 1/4	90515741	336-0066,10	3,2
45	1 3/4	66	2 5/8	210	8 1/4	90515742	336-0066-57,10	3,2

Bench and production drilling

T51 (2")



Drill bit design



Drill bit

Diameter		Product No.	Product code	No. of buttons	Buttons × button diameter (mm)		Gauge buttons angle°	Flushing hole		Weight approx. kg
mm	inch				Gauge	Centre		Side	Centre	
BUTTON BIT - Spherical buttons										
89	3½	90510338	137-5089,49-20	12	8×12,7	4×12,7	40°	–	2	3,5
89	3½	90510377	137-5089-45,49-20	12	8×12,7	4×12,7	40°	–	2	4,8
89	3½	90510357	137-5089-20,49-20	14	8×12,7	6×11	35°	1	1	4,0
89	3½	90510527	137-5089-21,49-20	14	8×12,7	6×12,7	35°	1	2	3,7
89	3½	90513764	137-5089-21-45,49-20	14	8×12,7	6×12,7	35°	1	2	5,3
89	3½	90515252	137-5089-21-47,49-20	14	8×12,7	6×11	35°	–	4	3,6
89	3½	90515251	137-5089-47,49-20	16	10×11	6×11	35°	–	4	3,8
89	3½	90510341	137-6089,49-20	11	6×12,7	3×11, 2×11	35°	1	3	3,6
89	3½	90510391	137-6089-45,49-20	14	8×11	4×11, 2×9	35°	1	4	4,7
89	3½	90513813	137-6089-21,49-20	13	8×12,7	4×11, 1×11	35°	–	4	3,5
89	3½	90510773	137-6089-21-45,49-20	13	8×12,7	4×11, 1×11	35°	–	4	4,9
102	4	90510339	137-5102,49-20	12	8×14,5	4×14,5	40°	–	2	4,8
102	4	90510378	137-5102-45,49-20	12	8×14,5	4×14,5	40°	–	2	7,1

Cont. next page

Bench and production drilling

T51 (2")

Diameter		Product No.	Product code	No. of buttons	Buttons × button diameter (mm)		Gauge buttons angle°	Flushing hole		Weight approx. kg
mm	inch				Gauge	Centre		Side	Centre	
BUTTON BIT - Spherical buttons										
102	4	90510807	137-5102-21,49-20	14	8×15,8	6×12,7	35°	1	2	5,1
102	4	90510855	137-5102-21-45,49-20	14	8×15,8	6×12,7	35°	1	2	6,9
102	4	90515365	137-5102-47,49-20	14	8×14,5	6×12,7	35°	1	4	5,1
102	4	90510343	137-6102,49-20	11	6×14,5	3×12,7, 2×12,7	35°	1	3	5,1
102	4	90510415	137-6102-45,49-20	14	8×12,7	4×12,7, 2×12,7	35°	1	4	7,2
102	4	90510824	137-6102-21,49-20	13	8×14,5	4×12,7, 1×12,7	35°	–	4	5,3
102	4	90510825	137-6102-21-45,49-20	13	8×14,5	4×12,7, 1×12,7	35°	–	4	7,2
115	4½	90510340	137-5115-20,49-20	17	9×14,5	8×12,7	35°	2	1	6,7
115	4½	90510791	137-5115-20-45,49-20	17	9×14,5	8×12,7	35°	2	1	7,0
115	4½	90510818	137-5115-21,49-20	14	8×15,8	6×14,5	35°	1	2	6,1
115	4½	90515250	137-5115-47,49-20	14	8×14,8	6×14,5	35°	1	4	5,8
115	4½	90510344	137-6115,49-20	14	8×14,5	4×12,7, 2×12,7	35°	1	4	5,8
115	4½	90510655	137-6115-45,49-20	14	8×14,5	4×12,7, 2×12,7	35°	1	4	9,5
115	4½	90510874	137-6115-21,49-20	14	8×15,8	4×14,5, 2×14,5	35°	–	4	6,0
115	4½	90510826	137-6115-21-45,49-20	16	9×14,5	6×14,5, 1×14,5	35°	–	3	9,7
127	5	90510360	137-5127,49-20	22	12×12,7	10×12,7	35°	–	2	6,8
127	5	90510361	137-5127-20,49-20	20	10×14,5	10×12,7	35°	–	2	6,8
127	5	90510790	137-5127-20-45,49-20	20	10×14,5	10×12,7	35°	–	2	11,9
127	5	90513747	137-5127-21,49-20	16	8×15,8	8×14,5	35°	1	2	6,8
127	5	90515249	137-5127-47,49-20	14	8×15,8	6×15,8	35°	–	4	8,0
127	5	90510406	137-6127,49-20	16	8×14,5	4×14,5, 4×11	35°	1	4	6,8
127	5	90510656	137-6127-45,49-20	16	8×14,5	4×14,5, 4×11	35°	1	4	11,2
127	5	90513815	137-6127-21,49-20	14	8×15,8	4×15,8, 2×12,7	35°	–	4	7,7
127	5	90513757	137-6127-21-45,49-20	14	8×15,8	4×15,8, 2×12,7	35°	–	4	11,0
140	5½	90515254	137-5140-47,49-20	14	8×15,8	6×15,8	35°	–	4	9,4
152	6	90514185	137-5152-42-24,39-20*	20	18×14,5	2×14,5	35°	1	3	10,0
BUTTON BIT - Ballistic buttons										
89	3½	90514003	137-5089-21-67,49-20	14	8×12,7	6×12,7	35°	1	2	3,7
89	3½	90514002	137-5089-21-45-67,49-20	14	8×12,7	6×12,7	35°	1	2	5,3
89	3½	90514329	137-5089-45-67,49-20	12	8×12,7	4×12,7	40°	–	2	5,0
89	3½	90513814	137-6089-21-67,49-20	13	8×12,7	4×11, 1×11	35°	–	4	3,6
89	3½	90510696	137-6089-21-45-67,49-20	13	8×12,7	4×11, 1×11	35°	–	4	4,9
89	3½	90510380	137-6089-45-67,49-20	14	8×11	4×11, 2×9	35°	1	4	4,7
102	4	90514476	137-5102-45-67,49-20	12	8×14,5	4×14,5	40°	–	2	7,0
102	4	90510841	137-5102-21-45-67,49-20	14	8×15,8	6×12,7	35°	1	2	7,0
102	4	90510346	137-6102-67,49-20	11	6×14,5	3×12,7, 2×12,7	35°	1	3	5,2
102	4	90510379	137-6102-45-67,49-20	14	8×12,7	4×12,7, 2×12,7	35°	1	4	7,2
102	4	90513756	137-6102-21-67,49-20	13	8×14,5	4×12,7, 1×12,7	35°	–	4	5,2
102	4	90515368	137-6102-21-45-67,49-20	13	8×14,5	4×12,7, 1×12,7	35°	–	4	7,2
115	4½	90510819	137-5115-21-67,49-20	14	8×15,8	6×12,7	35°	1	2	6,1
115	4½	90510407	137-6115-67,49-20	14	8×14,5	4×12,7, 2×12,7	35°	1	4	5,8
BUTTON BIT - Full-ballistic buttons (Soft rock bit)										
102	4	90514538	137-5102-47-66,49-20	14	8×14,5	6×12,7	35°	1	4	5,0
127	5	90514361	137-5127-47-66,49-20	14	8×15,8	6×15,8	35°	–	4	8,0

* For reaming, reversed flushing.

Bench and production drilling

T51 (2")

Extension rod

T51 (2") round rod



Surface hardened.

Length		Product No.	Product code		Weight approx. kg
mm	foot		Fully carburized	Surface hardened	
3660	12	90515299		237-5137-SH,03	51,1
4270	14	90515300		237-5143-SH,03	59,5
6095	20	90515301		237-5161-SH,03	85,1

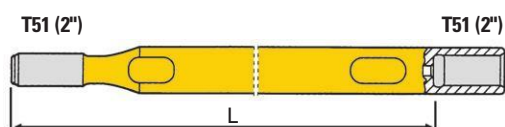
T51 (2") round Speedrod



Fully carburized. D = 72 mm.

Length (L)		Product No.	Product code		Weight approx. kg
mm	foot		Fully carburized	Surface hardened	
1525	5	90510737	237-5115-MF-C,02		25,0
1830	6	90510738	237-5118-MF-C,02		26,8
Both surface hardened and fully carburized					
3660	12	90515311	237-5137-MF,29		55,4
4270	14	90515314	237-5143-MF,29		64,0
6095	20	90515557	237-5161-MF,29		89,5

Guide tube



Fully carburized.

Hole diameter		Tube diameter		Length (L)		Product No.	Product code	Weight approx. kg
mm	inch	mm	inch	mm	foot			
89	3 1/2	76	3	1830	6	94502624	237-6618,10	40,0
89	3 1/2	76	3	3660	12	94502641	237-6637,10	79,1
102	4	87	3 3/16	3660	12	94502707	237-6837,10	80,0

Coupling

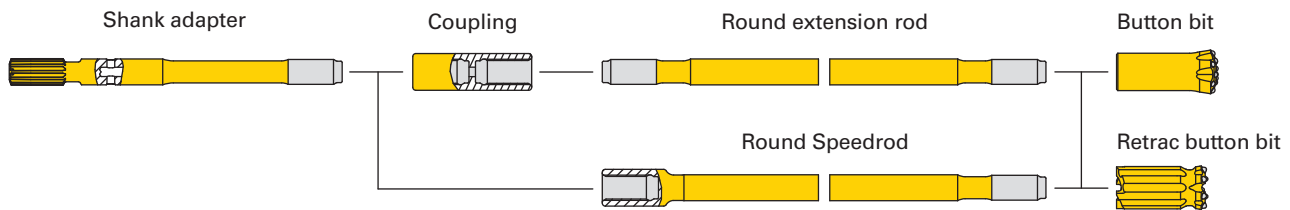


Full bridge -57.

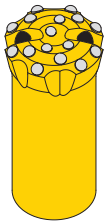
Thread diameter		Diameter		Length		Product No.	Product code T thread	Weight approx. kg
mm	inch	mm	inch	mm	inch			
51	2	72	2 7/32	235	9 1/4	90515743	337-0072,10	4,0
51	2	72	2 7/32	255	10	90515744	337-0072-57,10	4,0
51	2	77	3 1/32	235	9 1/4	90515745	337-0077,10	4,3

Bench and production drilling

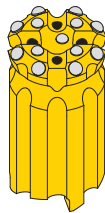
T60 (2³/₈"



Drill bit design



157-6102-41



157-6102-45

Drill bit

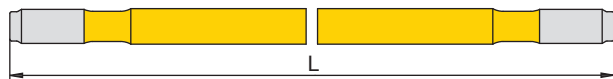
Diameter		Product No.	Product code	No. of buttons	Buttons × button diameter (mm)		Gauge buttons angle°	Flushing hole		Weight approx. kg
mm	inch				Gauge	Centre		Side	Centre	
BUTTON BIT - Spherical buttons										
102	4	90515472	157-6102-41,49-20	16	8×12,7	4×14,7, 4×11	35°	–	2	8,1
102	4	90516351	157-6102-45,49-20	13	8×14,5	4×12,7, 1×12,7	35°	–	4	7,4
115	4½	90515470	157-6115-41,49-20	16	8×14,5	4×14,5, 4×12,7	35°	–	2	9,0
115	4½	90516063	157-6115-45,49-20	16	8×14,5	4×14,5, 4×11,0	35°	1	4	11,9
127	5	90515431	157-6127-41,49-20	16	8×15,8	4×15,8, 4×14,5	35°	–	2	10,1
127	5	90516353	157-6127-45,49-20	16	8×14,5	4×14,5, 4×11,0	35°	1	4	11,9
140	5½	90515450	157-6140-41,49-20	16	8×15,8	5×15,8, 3×15,8	35°	–	2	11,6
140	5½	90516354	157-6140-45,49-20	16	8×14,5	4×14,5, 4×12,7	35°	1	4	16,0
152	6	90515473	157-6152-41,49-20	16	8×18,0	7×15,8, 3×15,8	35°	–	2	13,5
152	6	90516352	157-6152-45,49-20	16	8×16,0	4×16,0, 4×14,5	35°	–	4	19,0
BUTTON BIT - Ballistic buttons										
102	4	90515478	157-6102-45-67,49-20	13	8×14,5	4×12,7, 1×12,7	35°	–	4	7,4
115	4½	90515477	157-6115-45-67,49-20	16	8×14,5	4×12,7, 4×11	35°	1	4	11,9
127	5	90515449	157-6127-45-67,49-20	16	8×14,5	4×14,5, 4×11	35°	1	4	11,9
140	5½	90515475	157-6140-45-67,49-20	16	8×14,5	4×14,5, 4×12,7	35°	1	4	16,0
152	6	90515480	157-6152-45-67,49-20	16	8×15,8	4×15,8, 4×14,5	35°	–	4	19,0

Bench and production drilling

T60 (2 $\frac{3}{8}$ ")

Extension rod

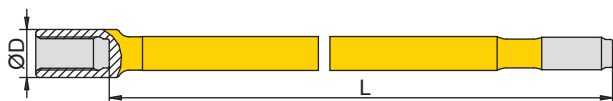
T60 (2 $\frac{3}{8}$ ") round rod



Fully carburized.

Length (L)		Product No.	Product code	Weight approx. kg
mm	foot/inch			
3630	11'10 $\frac{7}{8}$ "	90516270	257-6037-C,02	67,7
4240	13'10 $\frac{7}{8}$ "	90516271	257-6043-C,02	79,2

T60 (2 $\frac{3}{8}$ ") round Speedrod



Fully carburized. D = 85 mm.

Length (L)		Product No.	Product code	Weight approx. kg
mm	foot/inch			
3630	11'10 $\frac{7}{8}$ "	90515453	257-6037-MF-C,02	72,0
4240	13'10 $\frac{7}{8}$ "	90515454	257-6043-MF-C,02	83,5
5470	17'11 $\frac{3}{8}$ "	90515455	257-6055-MF-C,02	108,5
6065	19'10 $\frac{3}{4}$ "	90515456	257-6061-MF-C,02	120,0

Coupling



Full bridge -57.

Thread diameter		Diameter		Length		Product No.	Product code T thread	Weight approx. kg
mm	inch	mm	inch	mm	inch			
60	2 $\frac{3}{8}$	85	3 $\frac{1}{32}$	315	1 $\frac{3}{8}$ "	90516269	357-0085-57,10	7,9

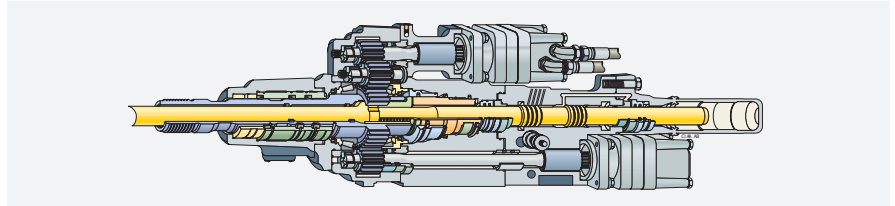
COPROD® system

Straight and fast drilling in demanding rock used to be a production planner's dream. However, with the advent of COPROD, the patented tophammer drilling system developed by Atlas Copco, the dream has been translated into reality. COPROD provides a drill string that combines the hole straightness of down-the-hole drilling with the speed of the tophammer system. The COPROD section is a combination of impact rods and drill pipes: the impact rods transmit energy and feed force only, while the drill tubes transmit rotational torque and flushing.

COPROD section

The COPROD sections are joined together via the drill tubes. Since the drill tubes transmit rotation force only, stress to the threads is minimal, and their service life is very long. The normal effects of the transmission of impact energy through the threads are eliminated, resulting in high impact power with minimal wear. Since the COPROD section is smooth and flush along the entire length of the drillstring, it is almost impossible for jamming to occur.

The ROC L740CR is suitable for large-scale work sites and quarries with high demand on productivity.



COP 2550CR series rock drills are designed for the 90 -127 mm hole range.

Inside each COPROD section is a floating impact rod. These have no threads, which means that the impact shockwaves from the rock drill are transmitted directly down to the drill bit, with no energy losses. Each impact rod is furnished with stop lugs to hold it in place inside the COPROD section. The rock drill is mounted on the feed beam of the rig, and impact energy is imparted from above.

COPROD head

The COPROD head delivers flushing air to the centre of the bit. It also transmits rotation to the bit. Inside each COPROD head is a two-piece stop ring that locks the bit into position. To change bit just open the thread between the bit chuck and the bit tube. The stop ring then opens automatically and the bit falls down. It's therefore easy and timesaving to change bits.

Straight holes

The benefits of straight holes include: a more widely spaced drilling pattern with

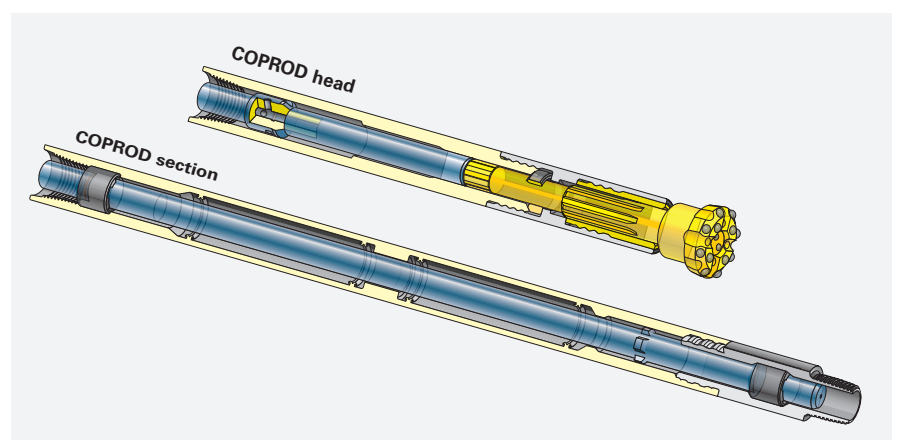
fewer holes, saving time and money; trouble-free charging with dramatically reduced explosives consumption; more evenly distributed charges, reducing ground vibration, blasting noise, and risk of flyrock; more regular fragmentation, avoiding the costly secondary blasting needed to pop oversize boulders; smoother bench floors, requiring less extra work; and fewer stuck drill rods, decreasing the time required to remove rods from the hole.

All these benefits are provided by the COPROD system.

Production economy

For total production economy, the speed and precision of drilling, combined with the long service life of its components, makes the COPROD system an unbeatable combination. Practical experience with COPROD drilling has confirmed the theoretical benefits. The method gives good overall economy, particularly in large-scale production drilling, and when drilling in fissured or otherwise demanding rock conditions.

The COPROD drill string provides long service life and high penetration rate.



ROC F9CR



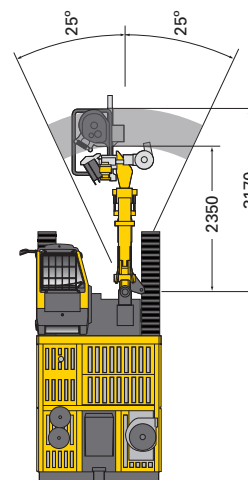
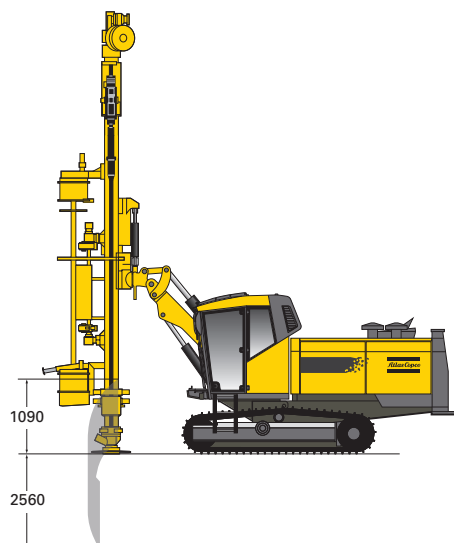
The ROC F9CR crawler drill rig is very powerful in its class, with true 127 mm topammer capability, and is available with single boom for quarrying. Features the 25 kW COP 2550 rock drill with COPROD drill steel for fast penetration and perfect flushing, powered by a fuel-efficient diesel engine.

Standard equipment

Air conditioner, Reduced impact pressure mechanism, Anti-jamming system, Automatic feed-force control, Fuel saving device, Two-speed traction motors, Dust collector and pre-separator, Double hydraulic drillpipe support, Rod-handling system, Feed extension, Heavy-duty tracks, Operator's cabin, ECM, ROPS and FOPS approved, Air-flow control switch, Water mist system excl. tank, Toe-hole drilling kit, Inclination/depth instrument.

Optional equipment

Hydraulic winch, Hydraulic support leg, Electric refuelling pump, Central lubrication system.



All dimensions in mm

Main specifications

Recommended hole range

CR76, CR89	90-127 mm	3½"-5"
Hole depth	29 m	96'

Hydraulic rock drill

COP 2550CR		
Impact power, max.	25 kW	33.5 HP

Atlas Copco screw compressor

Working pressure	12 bar	175 psi
FAD	210 l/s	450 cfm

Engine

Caterpillar Diesel Stage 3/Tier III	CAT C9	
Rating at 2000 rpm	224 kW	304 HP

Boom variants

Single boom

Fuel tank

Capacity	400 l	106 US gal.
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Feed

Feed length, total	8,100 mm	26'7"
Travel length	4,770 mm	15'8"
Feed extension	1,300 mm	4'3"
Feed rate, max.	0.92 m/s	180 ft/min
Feed force, max.	20 kN	4,500 lbf

Tramming

Tramming speed, max.	3.6 km/h	2.2 mph
Traction force	112 kN	25,200 lbf
Hill climbing ability	20° without winch	
Track oscillation	± 10°	
Ground clearance	405 mm	16"

Transport dimensions

Weight, excl. options	17,300 kg	38,100 lb
Width	2,490 mm	8'2"
Length	12,300 mm	40'4"
Height	3,200 mm	10'6"

Visit www.surfacedrilling.com for more information

ROC L7CR



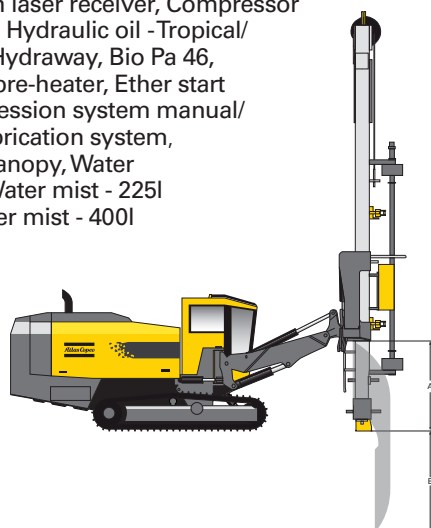
The ROC L7CR drill rig offers an economic alternative with an extraordinary performance in its hole range. Large scale work sites, and quarries with high demand on productivity, are in focus. The standard drill rig is designed to operate within the most demanding production environment. We also provide the short feed version for contract drilling.

Standard equipment

RHS 140 Rod magazine, Engine monitoring, Hole inclination and drill depth instrument, Dust collector and pre-separator, Automatic cleaning system, 12 hours fuel capacity, Fuel tank in steel, Hydraulic oil - Mineral, Manual hydraulic oil filling system, Stepless flushing regulation in cabin, Triple track chain grouser pads, Electrical outlet 12VDC, Feed lightening.

Optional equipment

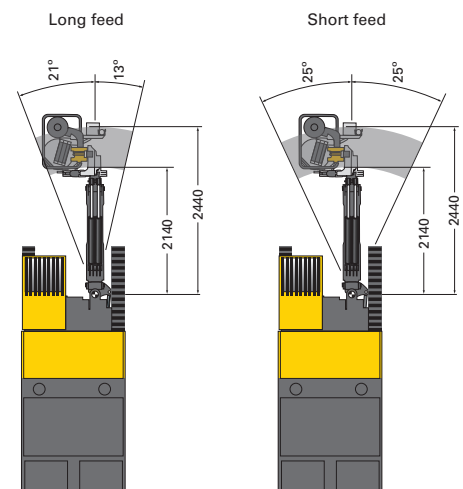
Gas charging equipment, Extractor, Service winch on feed, Rock drill stroke length selection in cabin, Diesel driven cabin heater, Cab windows tinted, Cab windows laminated, Wind shield dryer for right window, Sun shade kit for cab, Electrical heated operators seat, Reversing camera, Radio/CD, Canopy lighting, Safety rails on canopy, Beacon, ProCOM, Engine monitoring, Hole inclination and drill depth instrument with laser receiver, Compressor regulation heating kit, Hydraulic oil - Tropical/Arctic/Bio oil, Statoil Hydraway, Bio Pa 46, Diesel driven engine pre-heater, Ether start for engine, Fire suppression system manual/automatic, Central lubrication system, Service lamp inside canopy, Water mist - pre-plumbed, Water mist - 225l pressurised tank, Water mist - 400l non pressurised tank.



Main specifications

Recommended hole range		
CR89, CR102, CR127, CR140	105-180 mm	4"- 7"
Hole depth, max.	36 m	120'
Hydraulic rock drill		
COP 4050CR		
Impact power, max.	40 kW	54 HP
Atlas Copco screw compressor		
Working pressure	12 bar	171 psi
FAD	254 l/s	540 cfm
Engine		
Caterpillar Diesel stage 3/Tier III	CAT C13	
Rating at 2000 rpm	328 kW	417 HP
Boom variants		
single boom		
Fuel tank		
Capacity	760 l	201 US gal.
Feed		
Feed length, total	12,200 mm	40'
Travel length	7,500 mm	25'
Feed extension	1,150 mm	59"
Feed rate, max.	0.9 m/s	177 ft/min
Feed force, max.	40 kN	8,992 lbf
Tramming		
Tramming speed, max.	1.7/3.5 km/h	1.2/2.2 mph
Traction force	124/49 kN	27,876/11,016 lbf
Hill climbing ability	20°	
Track oscillation	+ 10°/-10°	
Ground clearance	405 mm	16"
Transport dimensions		
Weight, excl. options	24,600 kg	54,230 lb
Width	2,500 mm	8'2"
Length	12,200 mm	40'
Height	3,500 mm	11'6"

Visit www.surfacedrilling.com for more information



All dimensions in mm

Hydraulic rock drills

COP 2550CR

Tophammer rock drill for hole diameter range 90–127 mm

The COP 2550CR together with respective COPROD® drillstrings provide a fast and reliable means of working in demanding rock formations. The rock drill is equipped with two hydraulic rotation motors with a torque output well suited to their respective hole diameter ranges. High torque reduces the risk of jamming and gives smooth rotary action that eases stress to the equipment.



Success of the original COPROD system has stimulated the development of rock drills and additional drill strings. COP 2550CR is used in the hole range 90-127 mm in combination with COPROD 76 or COPROD 89 drill strings. COPROD 76 is used in the hole range 90-105 mm and COPROD 89 is used for hole range 105-127 mm.

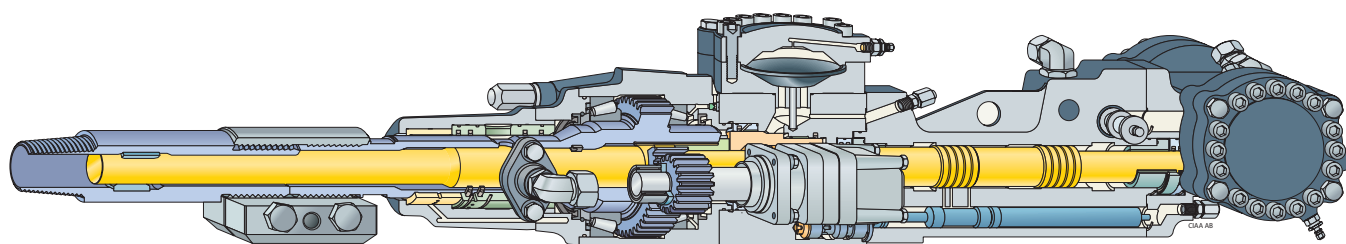
Technical data	COP 2550CR
Weight, (incl. adapter)	242 kg
Length, (with adapter)	1 661 mm
Impact power, max.	25 kW
Impact rate	44-55 Hz
Hydraulic pressure, max.	230 bar
Rotation speed range, max.	0-100 rpm
Rotation pressure, max.	200 bar
Rotation motor size (OMS 315)	2x -10
Drill steel torque, max.	4 000 Nm
Flushing air pressure	12 bar
Lubricating air	6 bar
Tube adapter, male	COPROD 76, COPROD 89

COP 4050CR

Tophammer rock drill for hole diameter range 105–180 mm

COP 4050ME-CR and COP 4050HE-CR together with their respective COPROD® drill strings provide a fast and reliable means of working in demanding rock formations. These rock drills are equipped with two hydraulic rotation motors with a torque output well suited to their respective hole diameter ranges. High torque reduces the risk of jamming and gives smooth rotary action that eases stress to the equipment. Success of the original COPROD system has stimulated the development of rock drills and additional drill strings. COP 4050ME-CR is used in the hole range 105-140 mm in combination with COPROD 89 or COPROD 102 drill strings. In the hole range 115-180 mm COP 4050HE-CR is used together with COPROD 102, 127 or COPROD 140 drill strings.

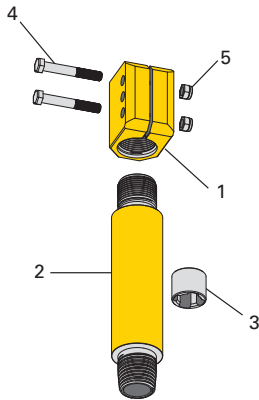
Technical data	COP 4050ME-CR	COP 4050HE-CR
Weight, (incl. adapter)	435 kg	435 kg
Length, (without adapter)	1 780 mm	1 780 mm
Impact power, max.	40 kW	40 kW
Impact rate	40-60 Hz	40-60 Hz
Hydraulic pressure, max.	230 bar	230 bar
Rotation speed range	0-95 rpm	0-95 rpm
Rotation pressure, max.	200 bar	200 bar
Rotation motor size (OMS 315)	2x -10	2x -10
Drill steel torque, max.	4 200 Nm	4 200 Nm
Flushing air pressure, max.	8 bar	8 bar
Lubricating air	4 bar	4 bar
Tube adapter, male	COPROD 89, COPROD 102, COPROD 127, COPROD 140	



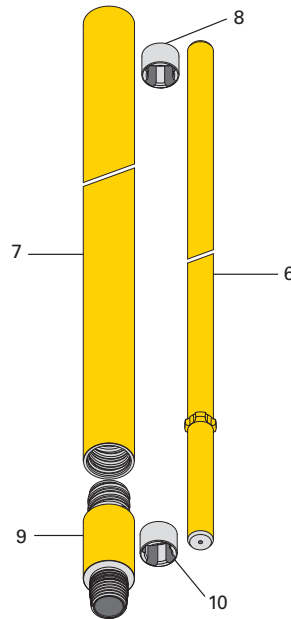
COPROD

COPROD 76 and 89 for COP 1838CR, 1850CR, 2150CR, 2550CR

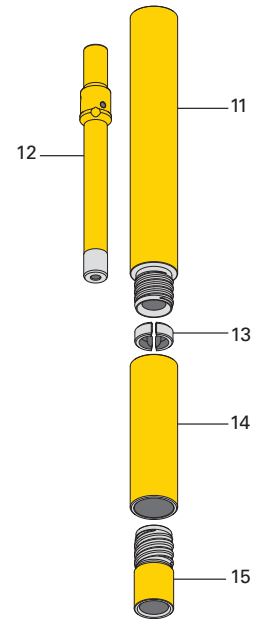
COPROD tube driver



COPROD section



COPROD head



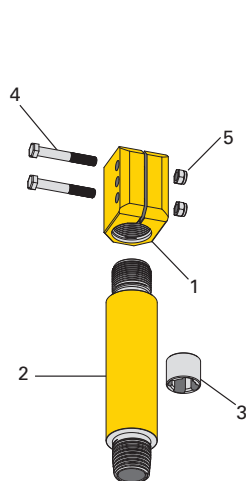
Part description	COP 1838CR, 1850CR, 2150CR, 2550CR					
	COPROD 76			COPROD 89		
	Product No.	Product code	Weight*	Product No.	Product code	Weight*
COPROD tube driver						
1 Coupling	94800299	7970-8928-80	6,3	94800299	7970-8928-80	6,3
1 Coupling, for TED	94800300	7970-8929-80	13,7	94800300	7970-8929-80	13,7
2 Tube adapter, for TED, L = 350 mm (1'1¾")	94800279	7970-7637-80	9,2	94800277	7970-8937-80	12,5
2 Tube adapter, L = 350 mm (1'1¾")	94800220	7970-7635-80	7,3	94800239	7970-8946-80	11,1
2 Tube adapter, L = 807 mm (2'7¾")	94800222	7970-7633-80	17,3	94800240	7970-8943-80	27,1
3 Rod guide	94800215	7970-8912-00	0,1	94800215	7970-8912-00	0,1
4 Bolt (2 pcs) M16 × 110 (M16 × 150 for TED)**	—	—	—	—	—	—
5 Nut (2 pcs) M16**	—	—	—	—	—	—
COPROD section 3,66 m (12')	94800313	7970-7690-80	100	94800326	7970-8990-80	118
6 Rod 3660 mm (12')	94800314	7970-7691-00	44	94800327	7970-8991-00	46
7 Tube 3660 mm (12')	94800315	7970-7692-80	52	94800328	7970-8992-80	66
8 Rod guide	94800215	7970-8912-00	0,1	94800121	7970-8902-00	0,1
9 End piece	94800316	7970-7693-80	4,1	94800329	7970-8993-80	6,1
10 Rod guide	94800215	7970-8912-00	0,1	94800121	7970-8902-00	0,1
COPROD head	94800317	7970-7682-80	22	94800310	7970-8982-80	32
11 Bit tube	94800318	7970-7681-00	12,3	94800311	7970-8981-00	18,2
12 Bit rod	94800365	7970-7685-00	4,4	94800366	7970-8985-00	5,6
13 Stop ring	94800235	7970-7604-00	0,2	94800128	7970-8904-00	0,4
14 Bit chuck	94800320	7970-7683-00	3,8	94800298	7970-8983-00	5,8
15 Bit driver	94800227	7970-7674-00	1,8	94800272	7970-8984-00	2,8

* Weight approx. kg ** Included in coupling

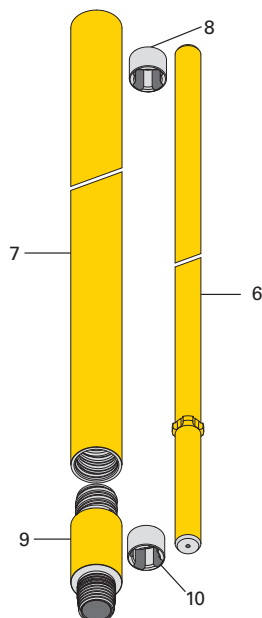
COPROD

COPROD 89 and 102 for COP 4050CR

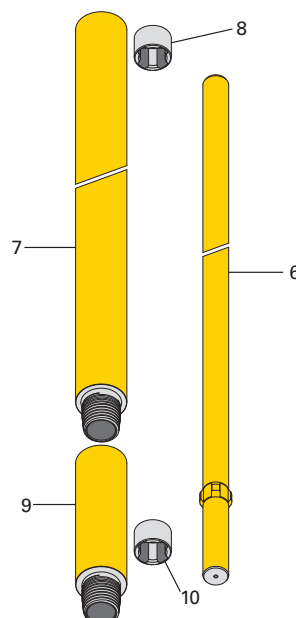
COPROD tube driver



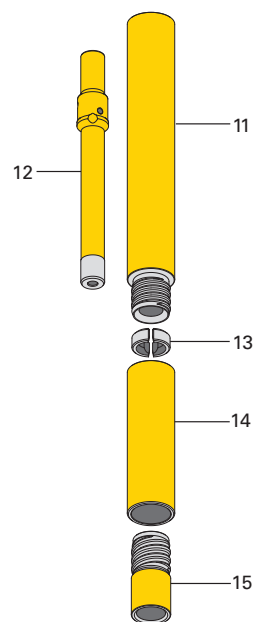
COPROD section for COPROD 89



COPROD section for COPROD 102



COPROD head

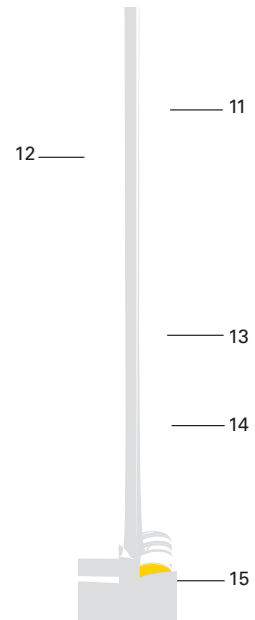


Part description	COP 4050CR					
	COPROD 89			COPROD 102		
	Product No.	Product code	Weight*	Product No.	Product code	Weight*
COPROD tube driver						
1 Coupling	94800284	7970-0232-80	18,3	94800284	7970-0232-80	18,3
2 Tube adapter, L = 253 mm (10")	94800241	7970-8935-80	7,8	94800243	7970-0235-80	9,5
2 Tube adapter, L = 714 mm (2'4 1/8")	94800242	7970-8933-80	21,6	94800244	7970-0233-80	30,4
3 Rod guide	94800121	7970-8902-00	0,1	94800087	7970-0202-00	0,1
4 Bolt (2 pcs) M24 x 160**	—	—	—	—	—	—
5 Nut (2 pcs) M24**	—	—	—	—	—	—
COPROD section 3,66 m (12')						
6 Rod 3660 mm (12')	94800327	7970-8991-00	46	94800303	7970-0241-00	56
7 Tube 3660 mm (12')	94800328	7970-8992-80	66	94800304	7970-0242-80	60
8 Rod guide	94800121	7970-8902-00	0,1	94800087	7970-0202-00	0,1
9 End piece	94800329	7970-8993-80	6,1	94800086	7970-0253-80	11,7
10 Rod guide	94800121	7970-8902-00	0,1	94800087	7970-0202-00	0,1
COPROD section 6,1 m (20')						
6 Rod 6100 mm (20')	94800387	7970-8956-00	76	94800084	7970-0251-00	94
7 Tube 6100 mm (20')	94800388	7970-8957-80	108	94800085	7970-0252-80	93
8 Rod guide	94800121	7970-8902-00	0,1	94800087	7970-0202-00	0,1
9 End piece	94800329	7970-8993-80	6,1	94800086	7970-0253-80	11,7
10 Rod guide	94800121	7970-8902-00	0,1	94800087	7970-0202-00	0,1
COPROD head						
11 Bit tube	94800310	7970-8982-80	32	94800324	7970-0282-80	47
12 Bit rod	94800311	7970-8981-00	18,2	94800323	7970-0281-00	26,1
13 Stop ring	94800366	7970-8985-00	5,6	94800367	7970-0285-00	10,4
14 Bit chuck	94800128	7970-8904-00	0,4	94800096	7970-0204-00	0,5
15 Bit driver	94800298	7970-8983-00	5,8	94800325	7970-0273-00	7,5
	94800272	7970-8984-00	2,8	94800082	7970-0274-00	2,9

* Weight approx. kg ** Included in coupling.

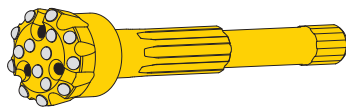
COPROD

COPROD 127 and 140 for COP 4050CR

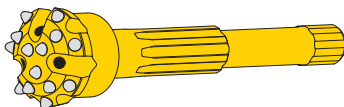


COPROD

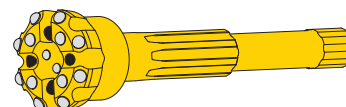
Drill bits



Flat front



Convex front

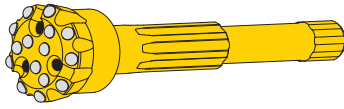


Drop center

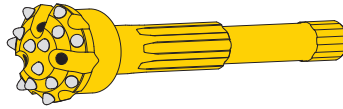
Drill bit	Diameter		Product No.	Product code	Buttons × button diameter (mm)			Gauge buttons angle°		Flushing holes	Weight approx. kg
	mm	inch			Gauge outer	Gauge inner	Centre	Outer	Inner	No. × size mm	
COPROD 76 for	Flat front, HD, spherical buttons										
COP 1838CR	90	3 ⁹ / ₁₆	94800332	7976-1090-40,10-20	9×11	–	7×11	35°	–	3×8	5,8
COP 1850CR	95	3 ³ / ₄	94800333	7976-1095-40,10-20	9×12,7	–	7×11	35°	–	3×8	6,0
COP 2150CR	102	4	94800422	7976-1102-40,10-20	9×12,7	–	7×12,7	35°	–	3×10	6,3
COP 2550CR	105	4 ¹ / ₈	94800334	7976-1105-40,10-20	9×12,7	–	7×12,7	35°	–	3×10	6,4
	Convex front, full-ballistic buttons										
	90	3 ⁹ / ₁₆	94800335	7976-2090-66,10-20	7×12,7	4×12,7	2×12,7	40°	20°	2×10	5,6
	95	3 ³ / ₄	94800336	7976-2095-66,10-20	7×12,7	3×12,7	2×12,7	45°	30°	3×8	5,6
	105	4 ¹ / ₈	94800337	7976-2105-66,10-20	9×12,7	3×12,7	4×12,7	45°	30°	3×10	6,2
	Drop center, spherical buttons										
	90	3 ⁹ / ₁₆	94800338	7976-3090-40,10-20	8×11	4×11	2×11	35°	–	4×8	5,7
	95	3 ³ / ₄	94800339	7976-3095-40,10-20	8×12,7	4×11	2×11	35°	–	4×8	5,8
	105	4 ¹ / ₈	94800340	7976-3105-40,10-20	8×12,7	4×12,7	2×11	35°	–	4×10	6,2
COPROD 89 for	Flat front, HD, spherical buttons										
COP 1838CR	105	4 ¹ / ₈	94800341	7989-1105-40,10-20	9×12,7	–	7×12,7	35°	–	3×13	9,1
COP 1850CR	110	4 ⁵ / ₁₆	94800342	7989-1110-40,10-20	9×14,5	–	6×14,5	35°	–	3×13	9,5
COP 2150CR	115	4 ¹ / ₂	94800343	7989-1115-40,10-20	9×14,5	–	6×14,5	35°	–	3×13	9,7
COP 2550CR	127	5	94800344	7989-1127-40,10-20	9×14,5	–	7×14,5	35°	–	3×13	10,6
COP 4050CR	Convex front, full-ballistic buttons										
	105	4 ¹ / ₈	94800345	7989-2105-66,10-20	9×12,7	3×12,7	4×12,7	45°	30°	3×13	8,8
	110	4 ⁵ / ₁₆	94800346	7989-2110-66,10-20	9×12,7	6×12,7	4×12,7	45°	30°	3×13	9,2
	115	4 ¹ / ₂	94800347	7989-2115-66,10-20	7×14,5	4×14,5	3×14,5	45°	30°	3×13	9,2
	127	5	94800348	7989-2127-66,10-20	9×14,5	6×14,5	4×14,5	45°	30°	3×13	10,1
	Drop center, spherical buttons										
	105	4 ¹ / ₈	94800349	7989-3105-40,10-20	8×12,7	4×12,7	2×11	35°	–	4×13	8,9
	115	4 ¹ / ₂	94800351	7989-3115-40,10-20	8×14,5	4×14,5	2×11	35°	–	4×13	9,5
	127	5	94800352	7989-3127-40,10-20	8×14,5	4×14,5	4×11	35°	–	4×13	10,3

COPROD

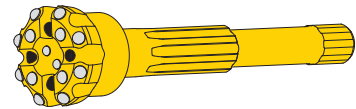
Drill bits



Flat front



Convex front



Drop center

Drill bit	Diameter		Product No.	Product code	Buttons × button diameter (mm)			Gauge buttons angle°		Flushing holes	Weight approx. kg
	mm	inch			Gauge outer	Gauge inner	Centre	Outer	Inner	No. × size mm	
COPROD 102 for COP 4050CR	Flat front, HD, spherical buttons										
	115	4½	94800353	7902-1115-40,10-20	9×14,5	–	6×14,5	35°	–	3×13	12,6
	127	5	94800354	7902-1127-40,10-20	9×14,5	–	7×14,5	35°	–	3×13	13,2
	140	5½	94800355	7902-1140-40,10-20	9×16	–	9×16	35°	–	3×13	14,5
	Convex front, full-ballistic buttons										
	115	4½	94800356	7902-2115-66,10-20	7×14,5	4×14,5	3×14,5	45°	30°	3×13	12,2
	127	5	94800357	7902-2127-66,10-20	9×14,5	6×14,5	4×14,5	45°	30°	3×13	12,8
	140	5½	94800358	7902-2140-66,10-20	9×14,5	6×14,5	5×14,5	45°	30°	3×13	13,8
	Drop center, spherical buttons										
	115	4½	94800359	7902-3115-40,10-20	8×14,5	4×14,5	2×11	35°	–	4×13	12,4
	127	5	94800360	7902-3127-40,10-20	8×14,5	4×14,5	4×11	35°	–	4×13	13,0
	140	5½	94800361	7902-3140-40,10-20	9×16	6×16	4×12,7	35°	–	3×13	14,5
COPROD 127 for COP 4050CR	Flat front, HD, spherical buttons										
	140	5½	94800383	7927-1140-40,10-20	9×16	–	9×16	35°	–	3×15	22,2
	152	6	94800417	7927-1152-40,10-20	9×16	–	9×16	35°	–	3×16	22,9
	165	6½	94800384	7927-1165-40,10-20	10×16	–	10×16	35°	–	3×15	23,9
	Convex front, full-ballistic buttons										
	152	6	94800418	7927-2152-66,10-20	9×16	6×16	4×16	45°	30°	3×16	22,3
	165	6½	94800385	7927-2165-66,10-20	9×16	6×16	6×16	45°	30°	3×15	23,1
	Drop center, spherical buttons										
	165	6½	94800378	7927-3165-40,10-20	10×16	6×16	5×16	35°	–	2×18	23,8
	Drop center, full-ballistic buttons										
	140	5½	94800368	7927-3140-66,10-20	9×16	6×16	4×12,7	35°	–	3×16	20,2

BVB 25



A robust rubber tyre three wheeled wagon drill. Fitted with the powerful rotation motor BBR 4, it covers the hole range 90-130 mm (3½"-5⅝") with 3" and 4" down-the-hole hammers. BVB 25 features a hydraulic hand pump for boom lift, mechanical jacks, a pneumatic powered steering wheel with tow bar for tramming. With an optional conversion kit it's easy to convert the unit for tophammer drilling with Atlas Copco's tophammer BBC 120F, for drilling of 48-76 mm (1⅞"-3") blast holes.

Optional equipment

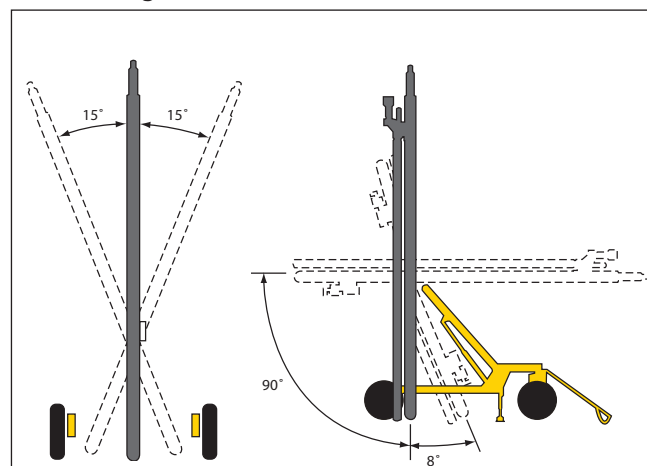
- Water mist flushing
- Hole incl. instrument
- TH conversion kit

Technical data

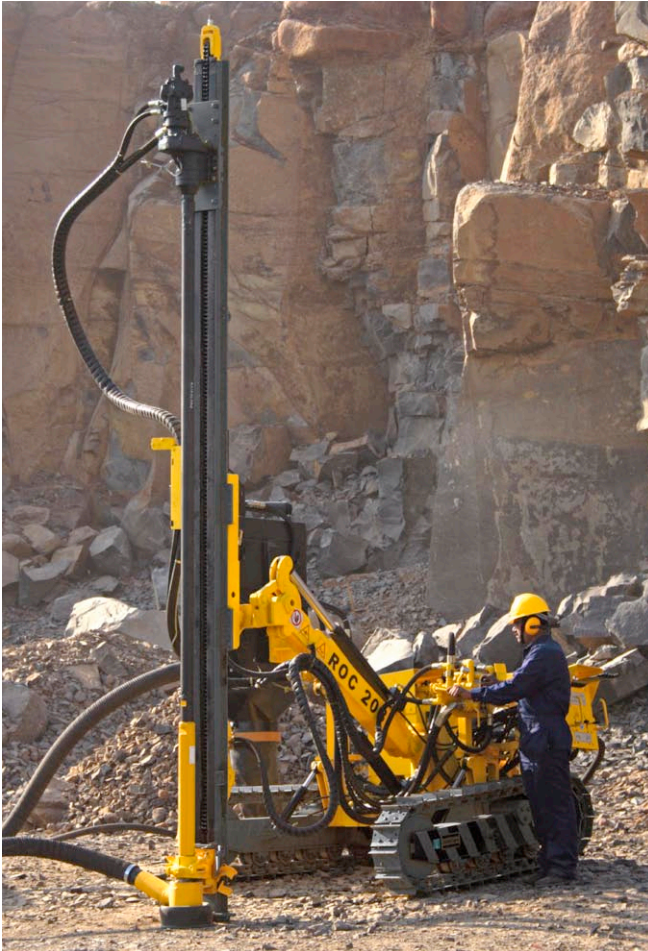
Hole range	90 -130 mm	3½" - 5⅝"
Preferred DTH hammer size	3", 4"	
Hammer system pressure, max	12 bar	175 psi
Drill pipe diameter	70-76 mm	3⅜"-3"
Drill pipe length	3 m	9'10"
Rotary head	BBR 4	
Rpm	0-70	
Torque, max at 6 bar/100 psi	900 Nm	662 lbf.ft
Feed and boom		
Feed type	Chain drive	
Feed length, total	5,430 mm	17' 9"
Travel length	4,009 mm	13' 2"
Feed force	8 kN	1,800 lbf
Boom type	Single section	
Drill control panel	Side mounted	
Carrier		
Traction type	Pneumatic wheel drive	
Tramming speed, max	2 km/h	1.3 mph
Traction force, max	7.8 kN	1,750 lbf
Hill climbing ability ¹⁾	20 degrees	
Ground clearance	310 mm	10'
¹⁾ Max allowable according to CE directives		
Transport dimensions		
Weight, excl options	1,440 kg	3,168 lb
Length	5,430 mm	17' 9"
Width	2,100 mm	7'
Height	1,600 mm	5' 3"

Visit www.surfacedrilling.com for more information

Reach (degr.)



ROC 203



The down-the-hole version of ROC 203 is a powerful drill in relation to weight and price. Designed for drilling with 3" and 4" down-the-hole hammers it offers a wide selection of hole sizes, from 90 to 130 mm. For increased performance the unit allows a hammer operating pressure up to 12 bar. With an optional conversion kit it's easy to convert for drilling of 48-76 mm blast holes with Atlas Copco's top hammer BBC 120F.

Optional equipment

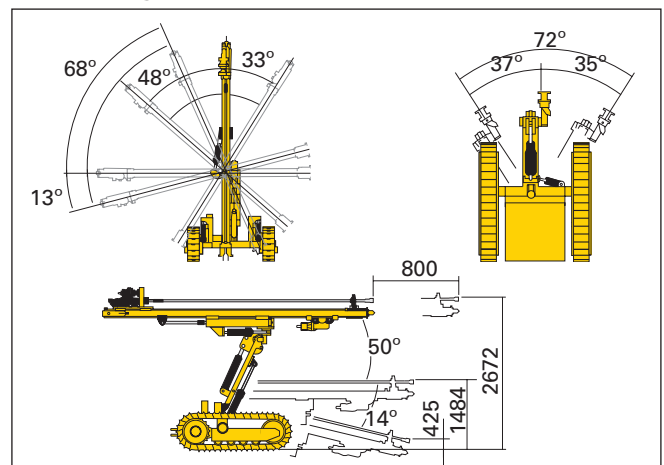
- Dry dust collector
- Water mist flushing
- Hole incl. instrument
- TH conversion kit
- CE-approval kit

Technical data

Hole range	90 - 130 mm	3½" - 5½"
Preferred DTH hammer size	3", 4"	
Hammer system pressure, max	12 bar	175 psi
Drill pipe diameter	70-76 mm	3⅜"-3"
Drill pipe length	3 m	9'10"
Rotary head	BBR 4	
Rpm	0-70	
Torque, max at 6 bar/100 psi	900 Nm	662 lbf.ft
Feed and boom		
Feed type	Chain drive	
Feed length, total	5,430 mm	17' 9"
Travel length	4,009 mm	13' 2"
Feed force	8 kN	1,800 lbf
Boom type	Single section	
Drill control panel	Side mounted	
Carrier		
Traction type	Hydraulic crawler drive	
Tramming speed, max	2.5 km/h	1.6 mph
Traction force, max	18.8 kN	4,225 lbf
Hill climbing ability ¹⁾	20 degrees	
Track oscillation	± 12 degrees	
Ground clearance	295 mm	11⅝"
¹⁾ Max allowable according to CE directives		
Transport dimensions		
Weight, excl options	2,600 kg	5,720 lb
Length	5,500 mm	18'
Width	1,950 mm	6'5"
Height	1,600 mm	5' 3"

Visit www.surfacedrilling.com for more information

Reach (degr.)



ROC 460



ROC 460 is modern, high capacity DTH crawler drill for blast hole drilling. It's total hole diameter range 90 - 152 mm (3 1/2" - 6") is covered with 3", 4" and 5" DTH hammers, which ensures an optimum utilisation for blast hole drilling in quarrying and surface mining applications. It's extensive range of optional equipment, such as dust collectors, rod rack, pipe break out accessories simplifies operation and improves the environmental conditions. It's also like ROC 460HF, CE approved when fitted with dust collectors and the optional CE components.

Optional equipment

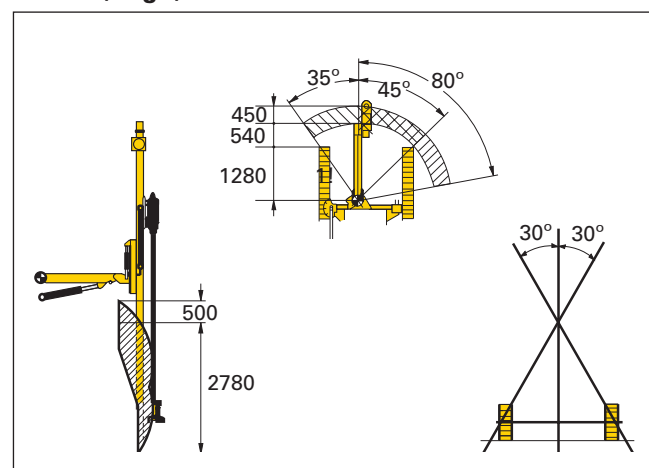
- Dry dust collector
- Water mist flushing
- Hole incl. instrument
- Hyd support leg
- Track mounted rod rack
- Pipe break out accessories
- Swing arm drill control panel
- Work light set
- CE-approval kit

Technical data

Hole range	90-152 mm	3 1/2" - 6"
Preferred DTH hammer size	3", 4", 5"	
Hammer system pressure, max.	20 bar	290 psi
Drill pipe diameter	76-89 mm	3"-3 1/2"
Drill pipe length	3 m	9'10"
Rotary head	DHR 45A	
Rpm	0-70	
Torque, max at 6 bar/100 psi	1,280 Nm	940 lbf.ft
Feed and boom		
Feed type	Chain drive	
Feed length, total	6,350 mm	20' 9"
Travel length	4,350 mm	14' 3"
Feed force	17 kN	3,820 lbf
Boom type	Single section	
Drill control panel	Feed mounted	
Carrier		
Traction type	Hydraulic crawler drive	
Tramming speed, max.	2.5 km/h	1.6 mph
Traction force, max.	45 kN	10,100 lbf
Hill climbing ability ¹⁾	20 degrees	
Track oscillation	± 12 degrees	
Ground clearance	350 mm	13 3/4"
¹⁾ Max allowable according to CE directives		
Transport dimensions		
Weight, excl options	5,000 kg	11,025 lb
Length	6,350 mm	20' 9"
Width	2,300 mm	7' 6"
Height	1,500 mm	4' 11"

Visit www.surfacedrilling.com for more information

Reach (degr.)



ROC 460HF



Power and performance! These are the words that immediately spring to mind when describing the ROC 460HF, a top-of-the range DTH pneumatic crawler drill for deep hole drilling. Capable of driving 4", 5" and 6" DTH hammers, this rig will give you straight drill holes up to 178 mm (7"), with depths up to 200 m (650 ft). The ROC 460HF is a first-rate drill rig for heavy-duty ground engineering, for anchoring, piling and grouting and for high bench blast hole production drilling. But you also find it ideal for water well drilling and drilling of wells for thermo heating, where an all pneumatic drill is asked for.

Optional equipment

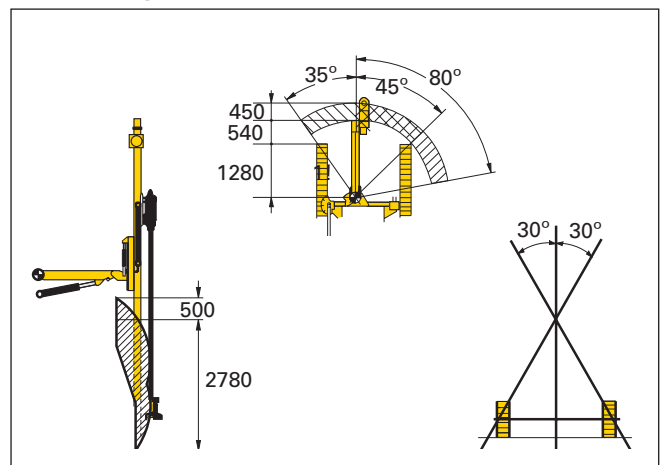
- Dry dust collector
- Water mist flushing
- Hole incl. instrument
- Hyd support leg
- Track mounted rod rack
- Pipe break out accessories
- Swing arm drill control panel
- Work light set
- CE-approval kit

Technical data

Hole range	105-178 mm	4 1/8" -7"
Preferred DTH hammer size	4", 5", 6"	
Hammer system pressure, max.	20 bar	290 psi
Drill pipe diameter	76-115 mm	3"-4 1/2"
Drill pipe length	3 m	9'10"
Rotary head	DHR 56A	
Rpm	0-60	
Torque, max at 6 bar/100 psi	2,800 Nm	2,090 lbf.ft
Feed and boom		
Feed type	Chain drive	
Feed length, total	5,630 mm	18' 6"
Travel length	3,730 mm	12' 6"
Feed force	34.5 kN	7,750 lbf
Boom type	Single section	
Drill control panel	Feed mounted	
Carrier		
Traction type	Hydraulic crawler drive	
Tramming speed, max.	2.5 km/h	1.6 mph
Traction force, max.	45 kN	10,100 lbf
Hill climbing ability ¹⁾	20 degrees	
Track oscillation	± 12 degrees	
Ground clearance	350 mm	13 3/4"
¹⁾ Max allowable according to CE directives		
Transport dimensions		
Weight, excl options	6,000 kg	13,200 lb
Length	5,630 mm	18' 6"
Width	2,300 mm	7' 6"
Height	1,500 mm	4' 11"

Visit www.surfacedrilling.com for more information

Reach (degr.)



CM 348



Model CM 348 can drill 90–140 mm (3½"–5½") blast holes with 3", 4" and 5" down-the-hole hammers. It's widely used in quarry and mining operations where an all pneumatic alternative is preferred. It features powerful air driven propel motors, a boom and feed system for drilling in most required directions. The feed, boom and controls are held on a rugged main frame, which is mounted on a heavy duty track assembly with built in transmission brakes.

Optional equipment

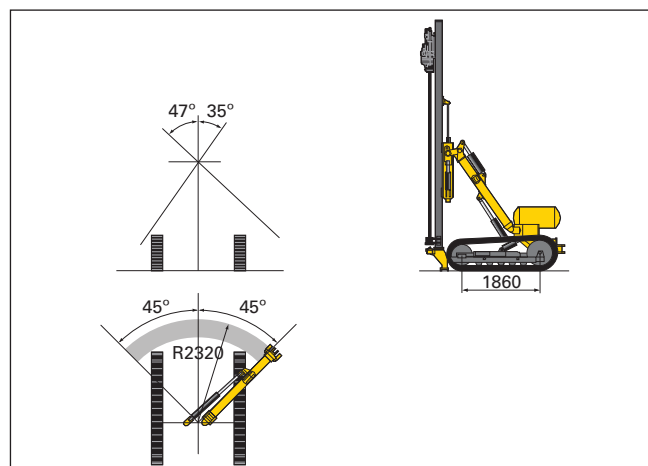
- Water mist flushing

Technical data

Hole range	90-140 mm	3½"-5½"
Preferred DTH hammer size	3", 4", 5"	
Hammer system pressure, max.	17 bar	250 psi
Drill pipe diameter	76-89 mm	3"-3½"
Drill pipe length	3 m	9'10"
Rotary head	ARH	
Rpm	0-72	
Torque, max at 6 bar/100 psi	1,342 Nm	990 lbf.ft
Feed and boom		
Feed type	Chain drive	
Feed length, total	5,732 mm	18' 9"
Travel length	3,733 mm	12' 3"
Feed force	13.3 kN	3,000 lbf
Boom type	Single section	
Drill control panel	Side alt. feed mounted	
Carrier		
Traction type	Pneumatic crawler drive	
Tramming speed, max.	3.2 km/h	2 mph
Traction force, max.	30 kN	6,680 lbf
Hill climbing ability ¹⁾	20 degrees	
Track oscillation	± 10 degrees	
Ground clearance	254 mm	10"
¹⁾ Max allowable according to CE directives		
Transport dimensions		
Weight, excl options	4,550 kg	10,010 lb
Length	5,732 mm	18' 9"
Width	2,260 mm	7' 4"
Height	3,275 mm	10' 9"

Visit www.surfacedrilling.com for more information

Reach (degr.)



CM 351



Model CM 351, a heavy duty pneumatic crawler drill, designed to drill 105–140 mm (3¹/₈"–5¹/₂") blast holes with 4" and 5" down-the-hole hammers up to an operating pressure of 24 bar (348 psi). It is widely used in quarry and mining operations where an all pneumatic alternative with highest possible performance is preferred. It features powerful air driven propel motors, a boom and feed system for drilling in most required directions. The feed, boom and controls are held on a rugged main frame, which is mounted on a heavy duty track assembly with built in transmission brakes.

Optional equipment

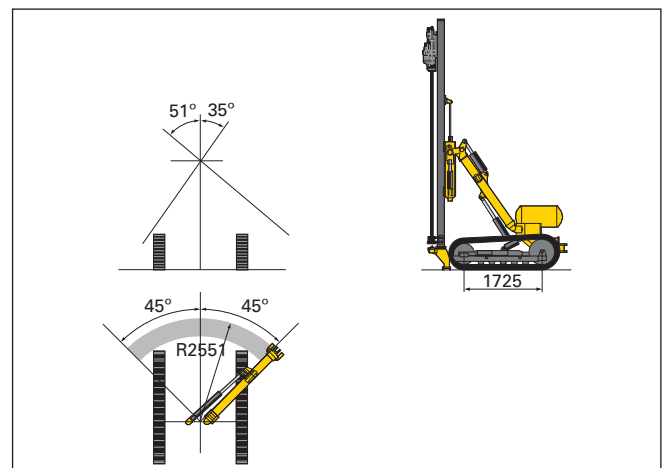
- Water mist flushing

Technical data

Hole range	105-140 mm	3 ¹ / ₈ "-5 ¹ / ₂ "
Preferred DTH hammer size	4", 5"	
Hammer system pressure, max.	24 bar	348 psi
Drill pipe diameter	76-89 mm	3"-3 ¹ / ₂ "
Drill pipe length	3 m	9'10"
Rotary head	ARH	
Rpm	0-72	
Torque, max at 6 bar/100 psi	1,080 Nm	800 lbf.ft
Feed and boom		
Feed type	Chain	
Feed length, total	5,125 mm	16' 9"
Travel length	4,000 mm	13' 1"
Feed force	12 kN	2,700 lbf
Boom type	Single section	
Drill control panel	Side mounted	
Carrier		
Traction type	Pneumatic crawler drive	
Tramming speed, max.	3.0 km/h	1.9 mph
Traction force, max.	50 kN	11,240 lbf
Hill climbing ability ¹⁾	20 degrees	
Track oscillation	± 10 degrees	
Ground clearance	254 mm	10"
¹⁾ Max allowable according to CE directives		
Transport dimensions		
Weight, excl options	5,300 kg	11,985 lb
Length	6,900 mm	22' 8"
Width	2,260 mm	7' 5"
Height	1,800 mm	5' 8"

Visit www.surfacedrilling.com for more information

Reach (degr.)



ROC F6



ROC F6 years ago set the standards for a modern crawler in the quarry market. Still it's a widely appreciated down-the-hole crawler drill thanks to its functionality, safety and ergonomic solutions. A modern operator's cab environment together with an efficient tube handling and tube breakout system make this drill an efficient and economical choice for drilling of 85-130 mm blast holes to a maximum depth of 36m.

Standard equipment

Tube handling system capacity of 8 tubes, with permutation, Fuel saving device, Two-speed traction motors, Dust collector and pre-separator, Feed extension, Operator's cab, ROPS and FOPS approved, Air conditioning, Reduced air pressure for collaring, Break-out table, Retractable suction hood, Heavy duty tracks, Track chains with single grouser pads, Electronic hole inclination and depth control instrument, Toe-hole drilling kit.

Optional equipment

Central lubrication system, Engine pre-heater, Track chains with triple grouser pads, Water mist systems, Cab windows tinted, Hydraulic support leg, Heavy duty air intake filters for engine and compressor, Diesel-driven engine pre-heater, Heating system for cabin, Electric operated fuel filling pump, Cab windows laminated, Sun shades for cab windows, Electric heated operator's seat.

Technical data

Recommended hole range

COP 32	90 -100 mm	3½" - 4"
COP 34/34Q	92 -105 mm	3⅝" - 4⅛"
COP 44/44Q	110 -130 mm	4⅝" - 5⅛"
Drill tube diam.	76/89 mm	3"/3½"
Drill tube length	4 m	13'1½"
Hole depth, max.	36 m	118 ft

Compressor

Atlas Copco	screw compressor	
Working pressure	14 bar	200 psi
FAD	213 l/s	458 cfm

Engine

Caterpillar Diesel	CAT C7Tier III Compliant	
Rating at 2,000 rpm	186 kW	253 HP

Fuel tank

Total Capacity	380 l	100 US gal.
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Feed

Feed length, total	7,550 mm	25'
Travel length	4,600 mm	15'1"
Feed extension	1,300 mm	4'3"
Feed rate, max.	0.92 m/s	180 ft/min
Feed force, max.	16 kN	3,597 lbf

Tramming

Tramming speed, max.	3.5 km/h	2.2 mph
Traction force	166 kN	37,310 lbf
Hill climbing ability	20°	
Track oscillation	± 10°	
Ground clearance	405 mm	16"

Hydraulic rotation unit

DHR 45H

Max speed (rpm) ¹	77	
Max torque (Nm) ²	1,600	1,180 lbf/ft
Max flow (l/min)	72	153 cfm

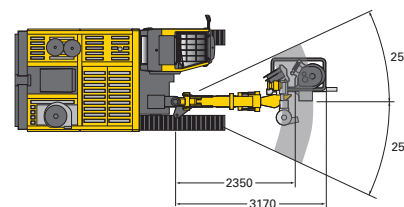
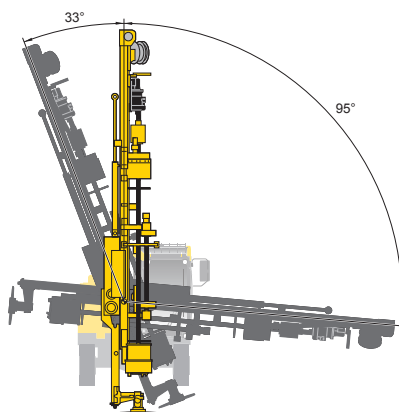
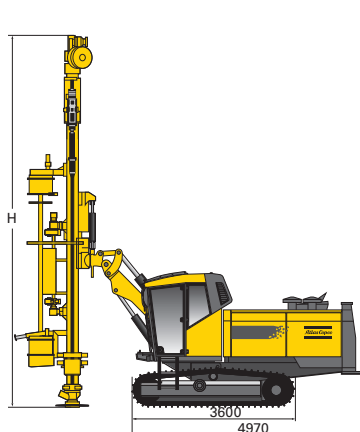
¹ Not in combination with max torque

² at max pressure at 125 bar (1812 psi)

Transport dimensions

Weight, excl. options	15,700 kg	34,600 lbs
Width	2,420 mm	8'
Length	11,300 mm	37'1"
Height	3,100 mm	10'2"

Visit www.surfacedrilling.com for more information



CM 765



The CM 765 offers excellent performance and low operating costs when drilling with 4" DTH hammers. The advanced feeding system optimizes the performance of the rock drill and contributes to high penetration rate. Straightforward and ergonomic design makes the machine maintenance friendly.

Standard equipment

Mechanized pipe handling, Automatic throttle, Max engine rpm control, Central hydraulic system test ports, Three speed cooling fan control, Tier III emission compliance, 2D electronic angle indicator, Feed extension, Dual pinning for L/R horizontal drilling, Water mist system preplumbed for tank, Preseparator, Dust collector, Retractable dust hood, Thread greasing device, FOPS and ROPS operator safety cab, Cab air-conditioning, Work lights, Back up alarm, Heavy duty tracks with full length rock guards, Track oscillation, Variable air volume control for collaring, DTH hammer lubricator device (pneumatic), Spindle locking plate and adapter wrench.

Optional equipment

3D angle indicator, 3D angle indicator with depth and speed, Central lubrication system, Feed mounted service winch, DTH hammer lubricator device (electric), Non-pressurized water mist tank 80 gal, Non-pressurized water mist tank 120 gal instead of DCT (not in combination with 80 gal tank), Diesel driven engine preheater 45,000 btu, Hydraulic system pressure test kit, High capacity dust collector. Arctic package includes diesel fired engine preheater 100,000 btu, arctic hosing, arctic fluids, hydraulic and fuel tank heaters, compressor air regulator heater, water mist tank heater, compressed air tank relief valve.

Technical data

Recommended hole range

Recommended	92 -152 mm	3 9/16" - 6"
DTH hammer	102 -127 mm	4" - 5"
Drill tube diam.	76/89/102 mm	3"/3 1/2"/4"
Drill tube length	5 m	16" 4'
Hole depth, max.	39.4 m	129 ft

Compressor

Type	2-stage Rotary Screw	
Working pressure	24 bar	350 psi
FAD	298 l/s	635 cfm

Engine

Caterpillar diesel	CAT C11 Tier III Compliant	
Rating at 1,800 rpm	287 kW	385 HP

Fuel tank

Total capacity	568 l	150 US gal.
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Feed

Feed length, total	9,500 mm	374"
Travel length	5,600 mm	220.5"
Feed extension	1,150 mm	45.3"
Feed rate, max.	0.88 m/s	174 ft/min
Feed force, max.	22.6 kN	5,075 lbf

Tramming

Tramming speed, max.	3.2 km/h	2 mph
Traction force	125.4 kN	28,192 lbf
Hill climbing ability	30°	
Track oscillation	± 10°	
Ground clearance	432 mm	17"

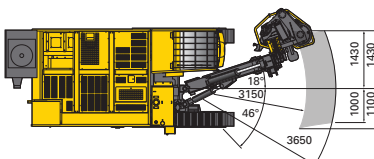
Hydraulic rotation unit

Max speed	0 - 120 rpm	
Torque max, drilling	2,820 Nm	2,080 ft.lbf
Max torque	4,067 Nm	3,000 ft.lbf

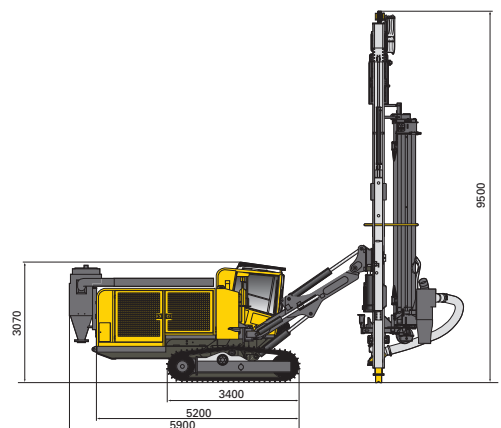
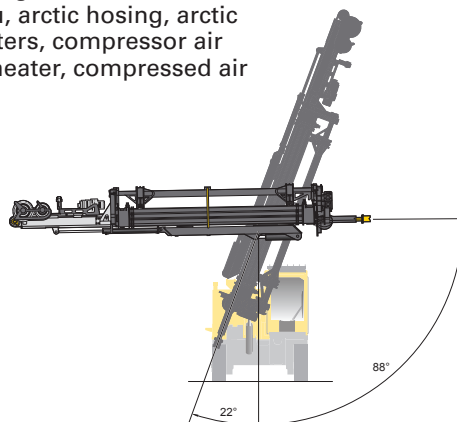
Transport dimensions

Weight, excl. options	22,700 kg	50,000 lbs
Width	2,500 mm	98' 4"
Height	3,330 mm	131"
Length	12,100 mm	477"

Visit www.surfacedrilling.com for more information



All dimensions in mm



ROC L6²⁵ and ROC L6³⁰



ROC L6²⁵ and L6³⁰ is a high-capacity down-the-hole crawler for quarry drilling in soft, medium and hard rock, with a power unit that delivers compressed air at a full 25 bar. With the powerful CAT C11 diesel engine the ROC L6²⁵ and L6³⁰ not only provides power but economy.

Standard equipment

Air conditioning/heater, Tube handling system (capacity of 8 tubes), Reduced air pressure for collaring, Fuel saving device, Automatic fan speed regulation, Two-speed traction motors, Dust collector and pre-separator, Feed extension, Heavy-duty tracks, Operator's cabin (ROPS and FOPS approved), Engine monitoring and hole depth/inclination system with color display, Breakout table, Retractable suction hood, Track chains with triple grouser pads, Hydraulic support leg.

Optional equipment

Central lubrication system, Electric refuelling pump, Water mist systems, Hydraulic support leg, Cold weather kits including engine heater, Heating system for cabin, Cab windows laminated, cab window tinted, Radio/CD or DVD player, Reverse camera with monitor for DVD player, Sun shades for cab windows, Electric heated operator's Seat.

Technical data

Recommended hole range

TD 35, COP 44, COP 54	95-152 mm	3 ⁵ / ₈ " - 6"
Hole depth	45 m	148'

Compressor

Atlas Copco XRX 10, two stage screw type compressor

ROC L6²⁵

Working pressure, max.	25 bar	363 psi
FAD	295 l/s	625 cfm

ROC L6³⁰

Working pressure, max.	30 bar	435 psi
FAD	354 l/s	729 cfm

Engine

ROC L6²⁵

Caterpillar turbo charged, diesel engine, CAT C11, Tier III/Stage 3		
Rating at 1,800 rpm	287 kW	385 hp

ROC L6³⁰

Caterpillar turbo charged, diesel engine, CAT C13, Tier III/Stage 3		
Rating at 1,800 rpm	328 kW	440 hp

Fuel tank

Capacity	760 l	201 US gal.
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Feed

Feed length, total	11,560 mm	38'
Travel length	5,400 mm	17'7"
Feed extension	1,900 mm	6'3"
Feed rate, max.	0.9 m/s	177 ft/min
Feed force, max.	40 kN	8,992 lbf

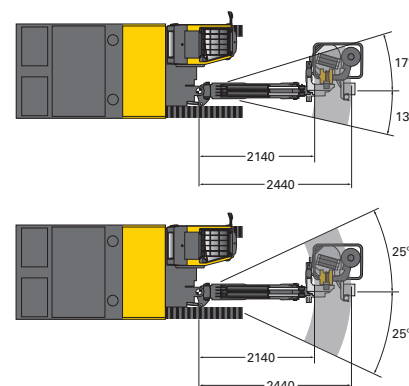
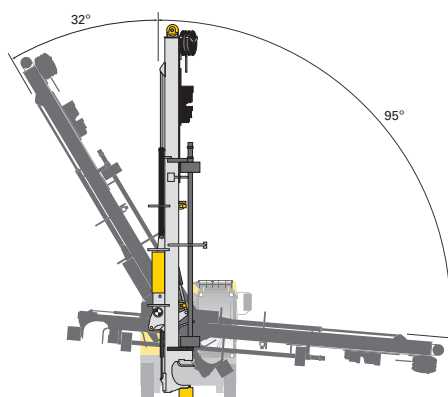
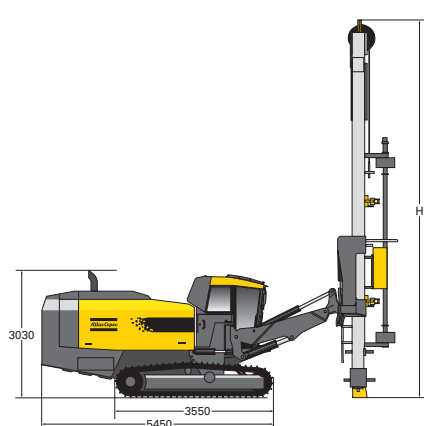
Tramming

Tramming speed, max.	3.5 km/h	2.2 mph
Traction force	166 kN	37,310 lbf
Track oscillation	+10°	
Ground clearance	405 mm	16"

Transport dimensions

Weight excl. options	21,700 kg	47,900 lb
Length	10,700 mm	35'1"
Height	3,200 mm	10'6"

Visit www.surfacedrilling.com for more information



All dimensions in mm

CM 785



The CM 785 is a high capacity down-the-hole crawler for drilling with 4" to 6" hammers in aggregate and limestone quarries or mining operations. The simple direct-drive rotary head delivers plenty of torque, a benefit when drilling in poor ground conditions. The advanced feeding system optimizes the performance of the rock drill and contributes to high penetration rate. Straight-forward and ergonomic design makes the machine maintenance friendly.

Standard equipment

Mechanized pipe handling, Automatic throttle, Max engine rpm control, Central hydraulic system test ports, Three speed cooling fan control, Tier III emission compliance, 2D electronic angle indicator, Feed extension, Dual pinning for L/R horizontal drilling, Water mist system preplumbed for tank, Preseparator, Dust collector, Retractable dust hood, Thread greasing device, FOPS and ROPS operator safety cab, Cab air-conditioning, Work lights, Back up alarm, Heavy duty tracks with full length rock guards, Track oscillation, Variable air volume control for collaring, DTH hammer lubricator device (pneumatic), Spindle locking plate and adapter wrench.

Optional Equipment

3D angle indicator, 3D angle indicator with depth and speed, Central lubrication system, Feed mounted service winch, DTH hammer lubricator device (electric), Non-pressurized water mist tank 80 gal, Non-pressurized water mist tank 120 gal instead of DCT (not in combination with 80 gal tank), Diesel driven engine preheater 45,000 btu, Hydraulic system pressure test kit, High capacity dust collector. Arctic package includes diesel fired engine preheater 100,000 btu, arctic hosing, arctic fluids, hydraulic and fuel tank heaters, compressor air regulator heater, water mist tank heater, compressed air tank relief valve.

Technical data

Recommended hole range

Recommended	110 - 165 mm	4 ⁵ / ₁₆ " - 6 ¹ / ₂ "
DTH hammer	102 - 127 mm	4" - 5"
Drill tube diam.	89-102 mm	3 ¹ / ₂ " - 4"
Drill tube length	5 m	16' 4"
Hole depth, max.	39.4 m	129 ft

Compressor

Type	2-stage Rotary Screw	
Working pressure	24 bar	350 psi
FAD	405 l/s	862 cfm

Engine

Caterpillar Diesel	CAT C13Tier III Compliant	
Rating at 1,800 rpm	328 kW	440 HP

Fuel tank

Total capacity	568 l	150 US gal.
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Feed

Feed length, total	9,500 mm	374"
Travel length	5,600 mm	220 1/2"
Feed extension	1,150 mm	45.3"
Feed rate, max.	0.88 m/s	174 ft/min
Feed force, max.	22.6 kN	5.075 lbf

Tramming

Tramming speed, max.	3.2 km/h	2 mph
Traction force	125.4 kN	28,192 lbf
Hill climbing ability	30°	
Track oscillation	± 10°	
Ground clearance	432 mm	17"

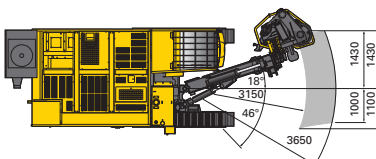
Hydraulic rotation unit

Max speed	0 - 80 rpm	
Torque max, drilling	4,236 Nm	3,125 ft.lbf
Max torque	6,100 Nm	4,500 ft.lbf

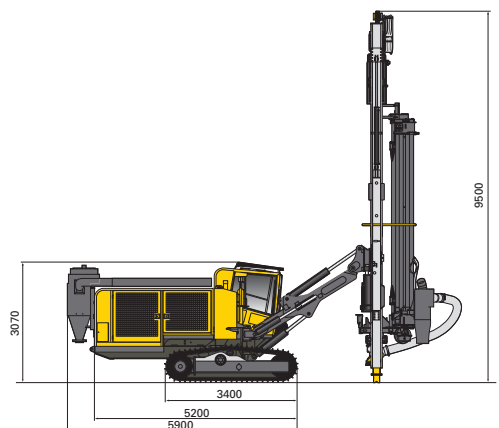
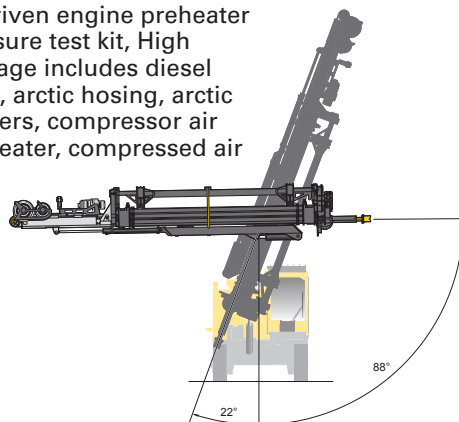
Transport dimensions

Weight, excl. options	22,700 kg	50,000 lbs
Width	2,500 mm	98'4"
Height	3,330 mm	131"
Length	12,100 mm	477"

Visit www.surfacedrilling.com for more information



All dimensions in mm



ROC L8²⁵ and ROC L8³⁰



This new version of the proven ROC L series of down-the-hole crawler drills offers extended performance through increased operating pressure and a new genius cylinder feed system. Like the well proven ROC L8²⁵ and L8³⁰ it's well suited for large-scale production work, pre-split operations, RC in-pit grade control in surface mining operations and large scale quarry operations.

Standard equipment

Air conditioning/heater, Tube handling system (capacity of 8 tubes), Reduced air pressure for collaring, Fuel saving device, Automatic fan speed regulation, Two-speed traction motors, Dust collector and pre-separator, Feed extension, Heavy-duty tracks, Operator's cabin (ROPS and FOPS approved), Engine monitoring and hole depth/inclination system with color display, Breakout table, Retractable suction hood, Track chains with triple grouser pads, Hydraulic support leg.

Optional equipment

Central lubrication system, Electric refuelling pump, Water mist systems, Hydraulic support leg, Cold weather kits including engine heater, Heating system for cabin, Cab windows laminated, cab window tinted, Radio/CD or DVD player, Reverse camera with monitor for DVD player, Sun shades for cab windows, Electric heated operator's seat, Reverse circulation for in-pit grade control.

Technical data

Recommended hole range ROC L8²⁵

COP 44, COP 54, COP 64 110-178 mm 4⁵/₁₆"-7"

Recommended hole range ROC L8³⁰

COP 44, COP 54, COP 64 110-203 mm 4⁵/₁₆"-8"

Hole depth 25-54 m 82'-178'

Compressor

Atlas Copco XRX 10, two stage screw type compressor

ROC L8²⁵

Working pressure, max. 25 bar 363 psi
FAD 405 l/s 858 cfm

ROC L8³⁰

Working pressure, max. 30 bar 435 psi
FAD 470 l/s 995 cfm

Engine

ROC L8²⁵

Caterpillar turbo charged, diesel engine, CAT C13, Tier III/Stage 3
Rating at 1,800 rpm 328 kW 440 hp

ROC L8³⁰

Caterpillar turbo charged, diesel engine, CAT C15, Tier III/Stage 3
Rating at 1,800 rpm 402 kW 539 hp

Fuel tank

Capacity 760 l/ 201 US gal/
1,050 l 277 US gal

Feed

Long feed (LF)
Feed length, total 11,560 mm 38'
Travel length 7,540 mm 25'
Feed extension 1,150 mm 3'9"
Feed length, total 9,266 mm 30'4"
Travel length 5,400 mm 17'7"
Feed extension 1,900 mm 6'3"
Feed rate, max. 0.9 m/s 177 ft/min
Feed force, max. 40 kN 8,992 lbf

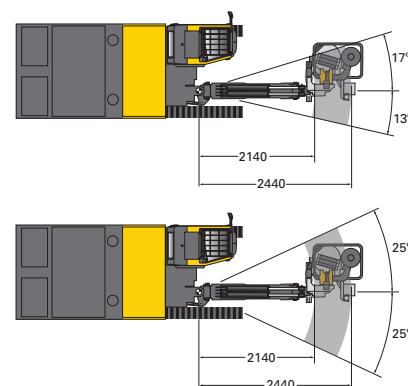
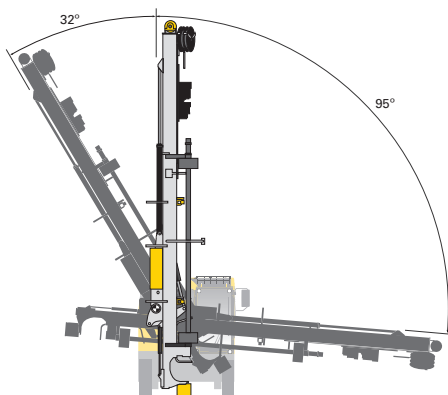
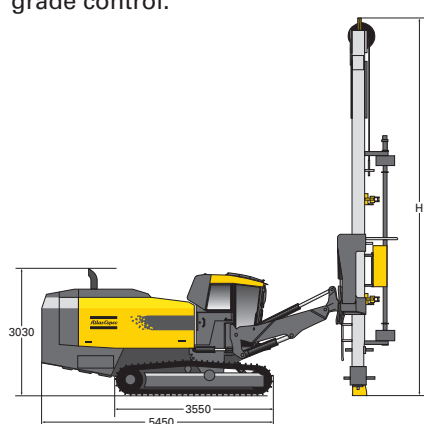
Tramming

Tramming speed, max. 3.5 km/h 2.2 mph
Traction force 166 kN 37,310 lbf
Track oscillation +10°
Ground clearance 405 mm 16"

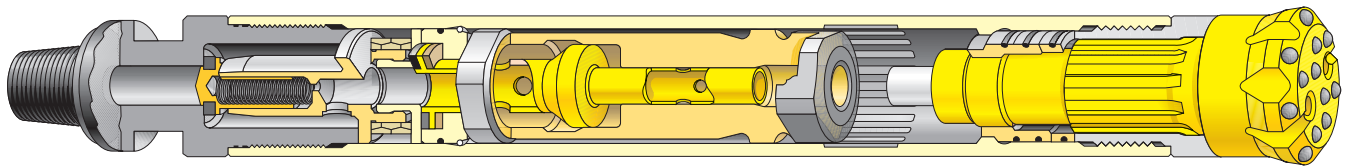
Transport dimensions

Weight excl. options (LF) 22,600 kg 49,800 lb
Weight excl. options (SF) 22,200 kg 49,950 lb
Width 2,500 mm 8'2¹/₂"
Length (LF) 11,700 mm 38'5"
Length (SF) 10,700 mm 35'1"
Height (LF) 3,500 mm 11'6"
Height (SF) 3,350 mm 11'

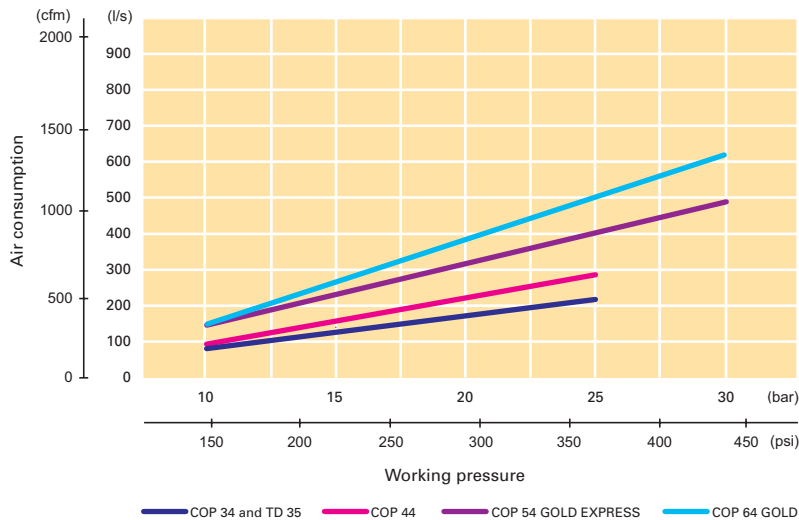
Visit www.surfacedrilling.com for more information



All dimensions in mm



Air consumption/Working pressure



Secoroc DTH hammer

Type	Std	HD	Slim*
COP 34	■		
TD 35	■		
COP 44	■		
COP 54 GE	■	■	■
COP 64 G	■	■	■

* Reduced hammer OD

Technical data

Hammer	COP 34		TD 35		COP 44		COP 54 Gold Express		COP 64 Gold	
Length excl. thread	954 mm	37.55 in	799 mm	31 1/8 in	958 mm	37.72 in	1119 mm	44.1 in	1163 mm	45.78 in
External diameter	83.5 mm	3.28 in	79 mm	3 1/8 in	98 mm	3.86 in	120 mm	4.72 in	142 mm	5.59 in
External diameter HD							126 mm	4.96 in	146 mm	5.75 in
Hammer weight	27 kg	60 lbs	30 kg	66 lbs	38 kg	84 lbs	66 kg	145 lbs	96 kg	212 lbs
Hammer weight HD							76 kg	167 lbs	109 kg	241 lbs
Piston diameter	68 mm	2.67 in	64 mm	2 1/2 in	78 mm	3.07 in	100 mm	3.93 in	120 mm	4.72 in
Piston weight	4.8 kg	10.7 lbs	5.5 kg	12 lbs	7.1 kg	16 lbs	15 kg	33 lbs	20.5 kg	45 lbs
Recommended bit size	92-105 mm	3 5/8-4 1/8 in	92-105 mm	3 5/8-4 7/8 in	110-125 mm	4 3/16-5 in	134-152 mm	5.3-6 in	156-178 mm	6 1/8-7 in
Rec. bit size HD							140-152 mm	5.5-6 in	165-178	6 1/2-7 in
Rec. bit size Slim							130-152 mm	5.1-6.0 in	152-178 mm	6-7 in
Bit shank	COP 34		DHD 3.5		IR DHD340		IR QL 50		IR QL 60	
Top sub thread	2 3/8" API Reg		2 3/8" API Reg		2 3/8" API Reg		3 1/2" API Reg		3 1/2" API Reg	
Optional thread connection							2 7/8" API Reg		3 1/2" API IF	
Wrench flat										
2 3/8" API Reg	65 mm	2.6 in	65 mm	2.6 in	65 mm	2.6 in				
2 7/8" API Reg							65 mm	2.6 in		
3 1/2" API Reg							95 mm	3.7 in	102 mm	4.0 in
3 1/2" API Reg (HD)							102 mm	4.0 in	102 mm	4.0 in
Feed force	3-12 kN	700-2500 lbs	3-12 kN	700-2500 lbs	5-15 kN	1100-3300 lbs	6-19 kN	1300-4100 lbs	7-20 kN	1600-4400 lbs
Feed force, normal	6 kN	1300 lbs	6 kN	1300 lbs	10 kN	2200 lbs	14 kN	2600 lbs	14 kN	3100 lbs
Working pressure	6-25 bar	87-360 psi	6-30 bar	87-430 psi	6-25 bar	87-360 psi	12-30 bar	174-430 psi	12-30 bar	174-430 psi
Rotation speed	30-90 r/min				25-80 r/min		20-70 r/min		25-60 r/min	

Standard design – Ideal for water well drilling, blast hole drilling and civil engineering projects.

HD design – Designed for abrasive and demanding applications. The HD hammer features a larger overall diameter, in turn allowing for thicker walls and, ultimately, a longer service life. It's also equipped with reversing back-out buttons, protecting the top sub from wear.

Slim design – The Slim version is designed for non to medium-abrasive formations, using a smaller bit diameter than recommended for the standard hammer OD. The Slim design allows an oversized hammer to drill the hole, thereby optimizing performance.

ROC F6



Rotary head DHR variant	Adapter Thread x length	Drill pipe L = 4,000 mm	Crossover sub	Hammer Type	Hole range Bit Ø
DHR 45H-1	API 2 3/8" x 2 3/8" Reg, pin x box	OD 76 mm OD 76 mm OD 76 and 89 mm	Not needed	TD 35 COP 34 COP 44	90-100 mm 92-105 mm 110-130 mm

ROC L6²⁵ ROC L6³⁰



Rotary head DHR variant	Adapter Thread x length	Drill pipe L = 5,000 mm	Crossover sub	Hammer Type	Hole range Bit Ø
DHR 6 H45-1 DHR 6 H45-2	API 2 3/8" x 2 3/8" Reg, pin x box L = 220 mm (DHR 6 H45-1) L = 580 mm (DHR 6 H45-2)	OD 76 mm OD 76 mm OD 76 and 89 mm	Not needed	TD 35 COP 34 COP 44	90-100 mm 92-105 mm 110-130 mm
DHR 6 H56-1 DHR 6 H56-2	API 2 3/8" x 2 7/8" Reg, pin x box L = 220 mm (DHR 6 H56-1) L = 580 mm (DHR 6 H56-2)	OD 102 mm	Not needed	COP 54 Gold COP 54 QM Gold	134-152 mm 140-152 mm

ROC L8²⁵ ROC L8³⁰



Rotary head DHR variant	Adapter Thread x length	Drill pipe L = 5,000 mm, sf* L = 6,000 mm, lf**	Crossover sub	Hammer Type	Hole range Bit Ø
DHR 6 H45-1 DHR 6 H45-2	API 2 3/8" x 2 3/8" Reg, pin x box L = 220 mm (DHR 6 H45-1) L = 580 mm (DHR 6 H45-2)	OD 89 mm	Not needed	COP 44	110-130 mm
DHR 6 H56-1 DHR 6 H56-2	API 2 3/8" x 2 7/8" Reg, pin x box L = 220 mm (DHR 6 H56-1) L = 580 mm (DHR 6 H56-2)	OD 102 mm	Not needed	COP 54 Gold COP 54 QM Gold	134-152 mm 140-152 mm
DHR 6 H56-3 DHR 6 H56-6	API 3 1/2" x 2 7/8" Reg, pin x box L = 220 mm (DHR 6 H56-3) L = 580 mm (DHR 6 H56-6)	OD 102 mm	Not needed	COP 54 Gold COP 54 QM Gold	134-152 mm 140-152 mm
DHR 6 H56-3 DHR 6 H56-6	API 3 1/2" x 3 1/2" Reg, pin x box L = 220 mm (DHR 6 H56-3) L = 580 mm (DHR 6 H56-6)	OD 114 mm	Not needed	COP 64 Gold COP 64 QM Gold	156-178 mm 165-178 mm
DHR 6 H68-3 DHR 6 H68-6	API 3 1/2" x 3 1/2" Reg, pin x box L = 220 mm (DHR 6 H68-3) L = 580 mm (DHR 6 H68-6)	OD 114 mm OD 127 mm	Not needed	COP 64 Gold COP 64 QM Gold	156-178 mm 165-178 mm

ROC L8³⁰

DHR 6 H78-3 DHR 6 H78-6	API 3 1/2" x 3 1/2" Reg, pin x box L = 220 mm (DHR 6 H78-3) L = 580 mm (DHR 6 H78-6)	OD 114 mm OD 127 mm	Not needed	COP 64 Gold COP 64 QM Gold	156-203 mm 165-203 mm
DHR 6 H78-3 DHR 6 H78-6	API 3 1/2" x 4 1/2" Reg, pin x box L = 220 mm (DHR 6 H78-3) L = 580 mm (DHR 6 H78-6)	OD 140 mm	API 4 1/2" x 3 1/2" Reg, pin x box	COP 64 Gold COP 64 QM Gold	156-203 mm 165-203 mm

* short feed ** long feed

Rotary head variants -1 and -3 are fitted with a floating spindle sub

Rotary head variants -2 and -6 are fitted with a fixed spindle sub

Specified adapters are required to fit drill string to pipe handling system

ROC L8²⁵ and ROC L8³⁰ are available with a short feed or a long feed

For Further info on pipe and adapter designs, bit designs and sizes see our Secoroc Tools Catalogues

Rotation units for DTH drilling

DHR series

Hole diameter range 70-254 mm,
drilling torque up to 6,400 Nm

The Atlas Copco DHR series of rotation units includes a total of 7 airpowered and 15 hydraulically-powered standard motors designed for longer life, superior wear resistance, and enhanced output. All are equipped with both fixed and moving adapters for all common types and dimensions of thread.

Air-powered versions in the DHR series have powerful vane motors, to ensure top-quality operating reliability and wear resistance. The torque, delivered at a working pressure of 6 bar, is sufficient for maximum drill capacity, and can be easily increased to 8 bar for greater torque without any risk of overloading. Both rotation speed and direction can easily be changed. The vane motor is integrated with a long-life, well-tested planetary gear.

The hydraulically-operated DHR versions are equipped with reliable, longlife motors of a type for which planetary gear is unnecessary. Normal working torque is obtained even at a very modest hydraulic pressure. The potential working pressure, however, is much greater, offering a good margin for more demanding work situations. Engine speed and rotation direction are easy to set on all motors, and the superior design gives both quiet operation and minimal maintenance. There are two well-proven sizes of reduction gear with various gear combinations to suit all DHR series motor versions. They are extremely strong, and designed for simple and easy mounting. The DHR 48RC version is intended for reverse circulation drilling on ROC L8. It is designed to fit the drill string components as simple hose connection and underneath air swivel from Metzke Engineering, Australia.



DHR 45A



DHR 6H

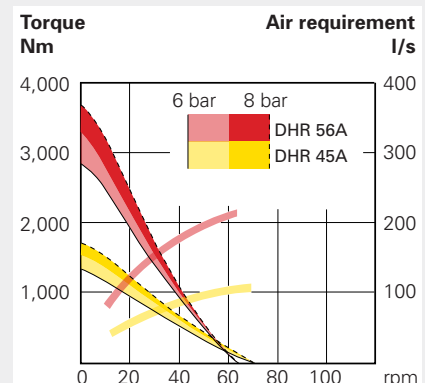


DHR 48RC

Technical data, air powered

Type	DHR 45A	DHR 56A
Length ¹ (mm)	870/1,026	951/1,120
Width cradle (mm)	255	270
Height (mm)	333	365
Height from base to centre of spindle (mm)	126	138
Weight ¹ (kg)	126/144	235/275
Air connection DTH hammer (in)	2	2
Drive motors	1	2
Air connection motor (in)	3/4	3/4

¹with fixed adapter/floating adapter





Technical data, hydraulic adapter type/thread											
Rotation Unit	Prod. no	Adapter type	Adapter thread API Reg Female	DTH Hammer	Weight (kg)	Length (mm)	Torque max (Nm)	Hyd, motor displ. (cm ³)	Pressure drop max (bar)	Speed max (rpm)	Flow max (l/min)
DHR 45 H-1	4350 2581 41	Floating	2 3/8"	3",4",5"	124	842	2,200	250	175	80	75
DHR 45 H-2	4350 2581 42	Fixed	2 3/8"	3",4",5"	111	685	2,200	250	175	80	75
DHR 6 H45-1	4350 2681 01	Floating	2 3/8"	3",4"	243	845	3,000	125	210	136	150
DHR 6 H45-2	4350 2681 02	Fixed			180	530					
DHR 6 H56-1	4350 2682 01	Floating	2 3/8"	5"	243	850	3,900	160	210	107	150
DHR 6 H56-2	4350 2682 02	Fixed			180	535					
DHR 6 H56-3	4350 2682 03	Floating	3 1/2"	5",6"	241	850					
DHR 6 H56-6	4350 2682 06	Fixed			178	535					
DHR 6 H68-1	4350 2683 01	Floating	2 3/8"	4",5"	243	865	5,100	250	175	68	150
DHR 6 H68-2	4350 2683 02	Fixed			180	550					
DHR 6 H68-3	4350 2683 03	Floating	3 1/2"	6"	241	865					
DHR 6 H68-6	4350 2683 06	Fixed			178	550					
DHR 6 H78-3	4350 2684 03	Floating	3 1/2"	6"	241	880	6,400	315	175	54	150
DHR 6 H78-6	4350 2684 06	Fixed			178	560					
DHR 48RC	4350 2570 89	Fixed	4" Metzke RC-hammer		178	696	5,100	250	175	68	150

Pneumatic handheld rock drills



Atlas Copco's range of powerful, handheld, pneumatic drills provides total reliability and performance. The advanced drills are designed for low maintenance cost and with operator's safety and comfort in focus. Atlas Copco's range of pneumatic drills is the preferred choice for utility companies, general contractors, quarries, and the dimension stone industry the world over. Atlas Copco offers drills equipped with silencers and vibration dampened handles, for better operator comfort and safety - and increased productivity. The drills combine lightweight, compact design with powerful output energy for easy-handling and optimum efficiency.

RH rock drills

RH drills are designed for bench drilling, secondary drilling, and drilling for smooth blasting. Because of its light weight, the RH 571 is most suited for smaller jobs. The slightly heavier and more powerful RH 658 can handle greater hole depths. The RH 572E combines light weight with extra comfort for the operator, thanks to the vibration dampened handles and the efficient silencer. All models are equipped with T-handles for a solid, comfortable grip.

- High power to weight ratio
- Adjustable flushing air valve for simple and rapid flushing
- Reliable design for minimum downtime and easy maintenance

BBD rock drills

Equipped with either a T- or a D-handle, the Atlas Copco BBD rock drills are suited for a number of different tasks. Equipped with the D-handle it is ideal for horizontal rock drilling, plug hole drilling and concrete drilling. The T-handle models are best suited for vertical work such as concrete drilling, plug hole drilling, smooth blast drilling and seam drilling. All BBD models are equipped with kick-latch type drillsteel retainers for quick and easy steel changing.

- Light weight for a wide variety of uses
- Available with both T- and D-handle
- Designed for quick and easy maintenance

Main specifications

Model	Air consumption at 6 bar l/s	Impact frequency bpm	Rotation speed rpm	Length mm	Weight kg	Drill steel (hex) mm
RH rock drills						
RH 572E	37	2040	170	583	22.8	22x108
RH 571-5L	39	2100	190	510	17.8	22x108
RH 571-5LS	39	1980	190	510	18.9	22x108
RH 658L	58	2040	215	565	24.0	22x108
RH 658LS	58	2040	215	565	25.0	22x108
BBD rock drills						
BBD 15E	22	2520	220	575	15.5	19x108/ 22x108
BBD 15ET	22	2520	220	575	15.6	19x108/ 22x108

Rock drills for the dimension stone industry



These light pneumatic rock drills have been designed especially for use in the dimension stone industry, drilling holes of 27 – 41 mm. The BBC/BBD drills are well-proven and come equipped with an H22 chuck and air flushing as standard (water flushing is available as option). The machines can be equipped with cable or chain feeds, subject to the conditions overleaf. Thanks to stringent quality control of materials and the manufacturing process you will get consistently high performance, reliability and long service life.

BBD 94-DSI

- High performance rock drill for soft to hard rock
- Short stroke and high impact rate makes it ideal for soft rock
- Large piston diameter for high efficiency, even at low air pressure
- Ratchet wheel rotation mechanism

BBC 34-DSI

- High efficiency in medium to hard rock
- Long stroke, high impact energy
- Large piston diameter makes it very efficient, even at low air pressure
- Powerful rifle bar rotation mechanism



Main specifications

Model	Air consumption at 6 bar l/s	Piston bore mm	Stroke length mm	Impact rate at 6 bar Hz	Length mm	Weight kg	Drill steel	Hole range mm
BBD 94-DSI	97	90	45	55	670	26	H 22	27-41
BBC 34-DSI	88	80	70	38	775	31	H 22	27-41

The right tools to get you back on the cutting edge



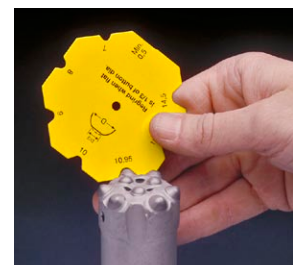
Every regrinding operation requires its own special tool. The wrong one can easily damage your bits. With Secoroc Grind Matic grinding equipment – complemented by a global service organization – you needn't worry. Your bits will soon be as good as new.

A machine for every occasion

Grinding machine	Button bits	DTH/COPROD bits	Reaming bits	Cross-type bits	Integrals
<i>Grind Matic BQ2</i>	■		■		
<i>Grind Matic Jazz</i>	■	■	■		
<i>Grind Matic Manual B</i>	■		■		
<i>Grind Matic HG</i>	■	■	■		
<i>Grind Matic BQ2-DTH</i>	□	■			
<i>Grind Matic Manual B-DTH*</i>	□	■			
<i>Grind Matic X</i>				■	
<i>Grind Matic Swing</i>					■
<i>Grind Matic Senior</i>					■

■ Recommended □ Can be used

* Can be used for ODEX pilot bits and reaming bits.



A useful tip: use a Secoroc grinding template, and you'll see when it's time for a regrind.

Grinding



Grind Matic BQ2

Semi-automatic grinding machine for button bits

Grinding capacity

Maximum height of drill bit	200 mm (7 $\frac{7}{8}$ ")
Maximum diameter of drill bit	127 mm (5")
Maximum bit skirt diameter	120 mm (4.75")
Minimum distance between buttons	3,5 mm ($\frac{9}{64}$ ")

Technical data

Air pressure, max.	7 bar (101.5 psi)
Air pressure, min.	4 bar (58 psi)
Air consumption	40 l/min
Capacity of cooling-fluid tank	22 l
Output, spindle motor	1,00 kW
Output, driving plate motor	0,15 kW
Output, coolant pump motor	0,10 kW
Speed, spindle	14900 r/min
Speed, table (50 Hz)	46 r/min
Speed, table (60 Hz)	55 r/min
Voltage working lighting	12 V
Weight, excluding packaging	222 kg (490 lb)
Transport dimension	L 173 x W 103 x H 116 mm (6 $\frac{3}{4}$ " x 4" x 4 $\frac{5}{16}$ ")

Accessories included in delivery

Allen key, 8 mm (1 piece)
Centring cup
Centring device (1 piece)
Coolant concentrate, 0,5 l
Grinding templates, spherical and ballistic
Grinding wheel, uncoated for centering
Protective goggles
Operator's instructions and spare parts list

Electrical

specifications	Prod. No.	Prod. code
220 V 3-phase 50 Hz	87003801	3800-49
220 V 3-phase 60 Hz	87003805	3800-60
380 V 3-phase 50 Hz	87003800	3800-52
415 V 3-phase 50 Hz	87003802	3800-54
415 V 3-phase 60 Hz	87003804	3800-62
440 V 3-phase 60 Hz	87003806	3800-63

NOTE:

Grind Matic BQ2 must be completed with grinding wheels, centring cups, bitholders (indicate button size and thread dimension) and indexing templates.



Grind Matic BQ2-DTH

Semi-automatic grinding machine for DTH- and COPROD bits

Grinding capacity

Maximum height of drill bit	650 mm (2'1 $\frac{1}{2}$ ")
Maximum diameter of drill bit	178 mm (7")
Minimum distance between buttons	3,5 mm ($\frac{9}{64}$ ")

Technical data

Air pressure, max.	7 bar (101.5 psi)
Air pressure, min.	4 bar (58 psi)
Air consumption	40 l/min
Capacity of cooling-fluid tank	22 l
Output, spindle motor	3,00 kW
Output, table drive motor	0,15 kW
Output, coolant pump motor	0,10 kW
Speed, spindle	14900 r/min
Speed, table (50 Hz)	22 r/min
Speed, table (60 Hz)	26 r/min
Voltage working lighting	12 V
Weight, excluding packaging	345 kg (760 lb)
Transport dimension	L 120 x W 120 x H 170 mm (4 $\frac{3}{4}$ " x 4 $\frac{3}{4}$ " x 6 $\frac{3}{4}$ ")

Accessories included in delivery

Coolant concentrate, 0,5 l
Grinding templates, spherical and ballistic
Puller
Protective goggles
Operator's instructions and spare parts list

Electrical

specifications	Prod. No.	Prod. code
220 V 3-phase 50 Hz	87003901	3900-49
220 V 3-phase 60 Hz	87003904	3900-60
380 V 3-phase 50 Hz	87003900	3900-52
415 V 3-phase 50 Hz	87003902	3900-54
415 V 3-phase 60 Hz	87003905	3900-62
440 V 3-phase 60 Hz	87003906	3900-63

NOTE:

Grind Matic BQ2-DTH must be completed with grinding wheels, centring cups and bitholders (indicate button size, bit diameter and type of hammer).

Optional accessories

	Prod. No.	Prod. code
- Auxiliary set for grinding threaded bits (excl. bitholder and templates)	87003939	9500-3939



Grind Matic Jazz

Rig-mounted, semi-automatic grinding machine for tapered, threaded, DTH- and COPROD bits

Grinding capacity

Maximum distance between bit holder and grinding wheel	250 mm (9 $\frac{7}{8}$ ")
Maximum diameter of drill bit	254 mm (10")
Minimum diameter of drill bit	35 mm (1 $\frac{3}{8}$ ")
Minimum distance between buttons	3,5 mm ($\frac{9}{64}$ ")

Technical data

Air pressure, max.	7 bar (101.5 psi)
Air pressure, min.	6 bar (87 psi)
Air consumption	25 l/s
Coolant container	3 l
Output, spindle motor	1,00 kW
Speed, spindle	15000 r/min
Voltage	24 V
Weight, excluding packaging	90 kg (198 lb)
Transport dimension	L 800 x W 500 x H 700 mm (2'7 $\frac{1}{2}$ " x 1'7 $\frac{1}{8}$ " x 2'3 $\frac{1}{2}$ ")

Accessories included in delivery

Box wrench, 11 mm
Box wrench, 16 mm
Grinding gauge
Protective goggles
Operator's instructions and spare parts list

NOTE:

Grind Matic Jazz must be completed with grinding wheels, centring cups, bitholders and indexing templates.

Optional accessories	Prod. No.	Prod. code
- Anti-freeze kit	87004315	9500-4315
- Main bit holder for DTH/COPROD bits	87004268	9500-4268
- Main bit holder for threaded bits	87004214	9500-4214
- Mounting bracket for Atlas Copco drill rig		
- with cabin	87004388	9500-4388
- without cabin	87004456	9500-4456
- 3-leg stand	87004450	9500-4450
- Centring tool	87004465	9500-4465

Grind Matic Jazz, std	Prod. No.	Prod. code
	87004100	9500-4100

incl. main bit holder for threaded bits

Grind Matic Jazz, DTH	Prod. No.	Prod. code
	87004300	9500-4300

incl. main bit holder for DTH/COPROD bits

Grinding



Grind Matic Manual B

Hand-held portable grinding machine for button bits

Grinding capacity

Maximum diameter of bit skirt	90 mm (3 ⁹ / ₁₆ "
Threaded bits, maximum diameter	127 mm (5")
Retrac, maximum diameter	127 mm (5")*
Tube drilling, maximum diameter	152 mm (6")*

Technical data

Air pressure, max.	7 bar (101.5 psi)
Air consumption	15 l/s
Coolant container	10 l
Idling speed of hand-held grinder	30000 r/min
Speed of bit rotation	0–45 r/min
Weight, excluding packaging	55 kg (121.3 lb)
Weight, including packaging	90 kg (198.4 lb)
Transport dimension	L 1200 x W 800 x H 850 mm (3'11 ¹ / ₄ " x 2'7 ¹ / ₂ " x 2'9 ¹ / ₂ "

* Large clamping device necessary

Accessories included in delivery

Allen key, 4 mm
Centring fingers (4 pcs)
Grinding templates, spherical and ballistic
Hand-held grinder, 30000 r/min
Open end spanner, 14 mm (2 pcs)
Protective goggles
Operator's instructions and spare parts list

NOTE:

Grind Matic Manual B must be completed with grinding wheels and bitholders.

Optional accessories	Prod. No.	Prod. code
- Vibration absorbing sleeve to fit the hand-held grinder	87001931	9500-1931
- Set of 5 centring fingers	87001935	9500-1935

Grind Matic Manual B	Prod. No.	Prod. code
	87001890	9424



Grind Matic Manual B-DTH

Hand-held portable grinding machine for DTH bits

Grinding capacity

Maximum height of drill bit	506 mm (1'7 ⁷ / ₈ "
Maximum diameter of drill bit	203 mm (8")
Maximum diameter of bit shank	170 mm (6 ³ / ₄ "

Technical data

Air pressure, max.	7 bar (101.5 psi)
Air consumption (incl. gauge grinding)	25 l/s
Air consumption (excl. gauge grinding)	23 l/s
Coolant container	10 l
Dimension of grinding belt	50 x 1500 mm (2" x 4'11")
Idling speed of hand-held grinder	18000 r/min
Speed of bit rotation	0–45 r/min
Weight, excluding packaging	110 kg (253 lb)
Weight, including packaging	148 kg (326 lb)
Weight of gauge grinding unit, net	27,5 kg (60.6 lb)
Weight of gauge grinding unit, gross	35 kg (77.2 lb)
Transport dimension	L 1200 x W 800 x H 940 mm (3'11 ¹ / ₄ " x 2'7 ¹ / ₂ " x 3'1")

Accessories included in delivery

Allen key, 5 mm
Allen key, 6 mm
Centring fingers (4 pcs)
Grinding belt (4 pcs)*
Grinding templates, spherical and ballistic
Hand-held grinder (spherical, 18000 r/min)
Open end spanner, 14 mm (2 pcs)
Protective goggles
Operator's instructions and spare parts list

*) When ordering gauge grinding unit, Product No. 87002302 / Product code 9500-2302.

NOTE: Grind Matic Manual B-DTH must be completed with grinding wheels and bitholders.

Optional accessories	Prod. No.	Prod. code
- Gauge grinding unit complete	87002302	9500-2302
- Grinding belt for gauge grinding (set of 10 pcs)	87002399	9500-2399
- Centring fingers (set of 5 pcs), 30000 r/min	87001935	9500-1935
- Clamping device for threaded bits	87002401	9500-2401

Grind Matic Manual B-DTH	Prod. No.	Prod. code
	87002300	9425



Grind Matic HG

Hand-held grinding machine for button bits

Grinding capacity

Button size	7–20 mm (⁹ / ₃₂ "– ²⁵ / ₃₂ "
-------------	--

Technical data

Air pressure, max.	7 bar (101.5 psi)
Air consumption, unloaded	50 l/s
Air consumption, loaded (at 6 bar, 86 psi)	42 l/s
Hose dimension, air	12,5 mm (½")
Hose dimension, water	6,3 mm (¼")
Idling speed	17000 r/min
Water flushing pressure, max.	4,5 bar (65.3 psi)
Weight, excluding hoses	2,8 kg (6.2 lb)

Accessories included in delivery

Adjustable angle connector
Allen key, 2 mm
Allen key, 3 mm
Allen key, 5 mm
Claw coupling (6,3 mm)
Grease gun
Grinding templates, spherical and ballistic
Hose (PVC 03)
Hose (PVC 6; L = 0,1 m)
Hose clamp (7–8,5 mm)
Hose clamp (11–13 mm)
Hose clamp (26–38 mm)
Nipple
Pipe (L = 0,3 m)
Seal kit
Seat
Support ring
Operator's instructions and spare parts list

Optional accessories	Prod. No.	Prod. code
- Lubricator	87002750	9500-2750
- Reconditioning tool for grinding cups	87002810	9500-2810

Grind Matic HG	Prod. No.	Prod. code
	87002435	9542

Grinding



Grind Matic X

Grinding machine for cross-type bits

Grinding capacity
Maximum diameter of cross-type bit 64 mm (2¹¹/₃₂"

Technical data Grind Matic X (380 V, 50 Hz)

Output 1,70 kW
Idling speed, 50 Hz 1400 r/min
Idling speed, 60 Hz 1680 r/min
Output, grinding device 0,37 kW
Automatic grinding action, 50 Hz 117 strokes/min
Automatic grinding action, 60 Hz 140 strokes/min

Grinding wheel, frontal grinding:
Maximum diameter 300 mm (11¹³/₁₆"
Maximum width 68 mm (2¹¹/₁₆"

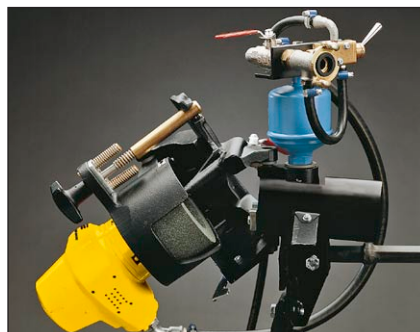
Grinding wheel, gauge grinding:
Diameter 300 mm (11¹³/₁₆"
Width 32 mm (1¹/₄"

Weight, excluding packaging 235 kg (518 lb)
Weight, including packaging 360 kg (794 lb)

Accessories included in delivery

Flange washer
Grinding template, cross-type bit
Mandrel, complete
Protective goggles
Wheel dresser
Wheel dressing template, cross-type bit
Operator's instructions and spare parts list

Electrical specifications	Prod. No.	Prod. code
220 V 3-phase 50 Hz	87002499	9502-49
220 V 3-phase 60 Hz	87002507	2507
380 V 3-phase 50 Hz	87000608	9502-52
380 V 3-phase 60 Hz	87002508	9502-61
415 V 3-phase 50 Hz	87002502	9525
415 V 3-phase 60 Hz	87002509	9502-62
440 V 3-phase 60 Hz	87002510	9502-63



Grind Matic Swing

Grinding machine for integrals

Technical data
Air pressure, max. 7 bar (101.5 psi)
Air consumption (at 6 bar, 86 psi) 25 l/s
Cutting-edge angle 110°
Cutting-edge radius 80 mm (3¹/₂"
Gauge grinding arrangement included
Hose connections:
- Air 12,5 mm (1/2")
- Water 6,3 mm (1/4")
Idling speed 4080 r/min
Power output 1,10 kW

Size of grinding wheel
- D x T x H 125 x 63 x 32 mm (47/8" x 215/32" x 1 1/4")
- DI x TI 80 x 50 mm (3¹/₂" x 2")
Spindle diameter 16 mm (5/8")
Weight incl. grinding wheel and 1,5 m water hose 27,5 kg (61 lb)

Accessories included in delivery

Grinding template
Grinding wheel Grind Master Soft
Pin wrench
Protective goggles
Operator's instructions and spare parts list

Optional accessories	Prod. No.	Prod. code
- Grinding wheel		
Grind Master Hard	87002589	9550
- Grinding wheel		
Grind Master Soft	87002811	9500-2811
- Chuck bushing wear gauge		
H19 (0,75")	90002667	9131
H22 (0,85")	90002668	9132
H25 (1")	90002669	9133

Grind Matic Swing	Prod. No.	Prod. code
	87002482	9544



Grind Matic Senior

Grinding machine for integrals

Technical data
Air pressure, max. 7 bar (101.5 psi)
Cutting-edge angle, adjustable 90–130°
Grinding wheel
- D x T x H 200 x 102 x 32 mm (7⁷/₈" x 4" x 1 1/4")
- DI x TI 150 x 80 mm (5⁷/₈" x 3¹/₂"
- Cutting-edge radius, adjustable 80-130 mm (3¹/₂"–5¹/₈")
Idling speed, electric 50 Hz 2840 r/min
Idling speed, electric 60 Hz 1690 r/min
Output 3-phase 1,50 kW
Rod hex. max. 25 mm (1")
Weight excluding packaging 105 kg (232 lb)
Weight including packaging 120 kg (265 lb)
Transport dimension L 800 x W 600 x H 650 mm (2'7 1/2" x 1'11 1/8" x 2'1 1/8")

Accessories included in delivery

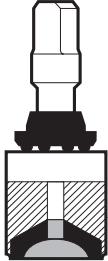
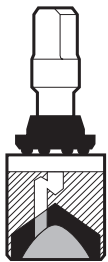
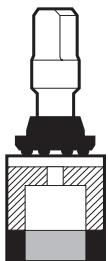
Grease gun
Grinding template
Grinding wheel, Grind Master Hard
Protective goggles
Socket wrench
Wrench
Operator's instructions and spare parts list

Electrical specifications	Prod. No.	Prod. code
220 V 3-phase 50 Hz	87002485	9511-49
220 V 3-phase 60 Hz	87002493	9427
380 V 3-phase 50 Hz	87135402	9511-52
380 V 3-phase 60 Hz	87002494	9428
415 V 3-phase 50 Hz	87002488	9519
415 V 3-phase 60 Hz	87002495	9511-62
440 V 3-phase 60 Hz	87002496	—

Optional accessories	Prod. No.	Prod. code
- Grinding wheels		
Grind Master Hard	87002591	9552
Grind Master Soft	87002813	9500-2813
- Spacer plate for H19 integral	87000519	9500-0519
- Chuck bushing wear gauge		
H19 (0.75")	90002667	9131
H22 (0.85")	90002668	9132
H25 (1")	90002669	9133

Diamond grinding cups for

Grind Matic HG

	Dimension, mm	Product No.	Product code
For spherical button bits 	7,0	87002566	9500-2566
	8,0	87002567	9500-2567
	9,0	87002568	9500-2568
	10,0	87002569	9500-2569
	11,0	87002570	9500-2570
	12,0	87002571	9500-2571
	13,0	87002572	9500-2572
	14,0	87002573	9500-2573
	15,0	87002574	9500-2574
	16,0	87002575	9500-2575
	18,0	87002576	9500-2576
	20,0	87002577	9500-2577
For ballistic button bits 	7,0	87002579	9500-2579
	8,0	87002580	9500-2580
	9,0	87002581	9500-2581
	10,0	87002582	9500-2582
	11,0	87002583	9500-2583
	12,0	87002584	9500-2584
	13,0	87002585	9500-2585
	14,0	87002586	9500-2586
For button bit steel removal 	7-8	87002700	9500-2700
	9-10	87002701	9500-2701
	11-12	87002702	9500-2702
	13-14	87002703	9500-2703
	15-16	87002704	9500-2704
	17-18	87002840	9500-2840
	19-20	87002841	9500-2841

Centring cups for

Grind Matic BQ2/BQ2-DTH

For button size	Product No.	Product code
7,0 mm	87001040	9500-1040
8,0 mm	87000842	9500-0842
9,0 mm	87001047	9500-1047
10,0 mm	87001041	9500-1041
11,0 mm	87000840	9500-0840
12,0 mm	87001042	9500-1042
12,7 mm	87000839	9500-0839
13,0 mm	87001385	9500-1385
14,0 mm	87001043	9500-1043
14,5 mm	87001443	9500-1443
15,0 mm	87001386	9500-1386
16,0 mm	87001387	9500-1387
18,0 mm	87003943	9500-3943
19,0 mm	87003944	9500-3944

Grinding wheels for steel grinding

Boron nitride – button bits

Grind Matic BQ2

Dimension	Product No.	Product code
10-14 mm	87001530	9500-1530
Spacer for 10 mm button	87001631	9500-1631
Spacer for 11 mm button	87001632	9500-1632
Spacer for 12 mm button	87001633	9500-1633
Spacer for 13 mm button	87001634	9500-1634
Spacer for 14 mm button	87001635	9500-1635



Diamond grinding wheels for button bits

Grind Matic BQ2

Grind Matic BQ2-DTH

Grind Matic Jazz

Grind Matic Manual B

Grind Matic Manual B-DTH



Standard diamond-grain wheels

Dimension, mm	Product No.	Product code
Spherical		
7	87001028	9500-1028
8	87001026	9500-1026
9	87001389	9500-1389
10	87001023	9500-1023
11	87003406	9500-3406
12	87001024	9500-1024
13	87001339	9500-1339
14	87001025	9500-1025
15	87001384	9500-1384
16	87001027	9500-1027
18	87003964	9500-3964
19	87003966	9500-3966
Ballistic		
7	87003407	9500-3407
8	87003408	9500-3408
9	87003409	9500-3409
10	87003410	9500-3410
11	87003411	9500-3411
12	87003412	9500-3412
13	87003413	9500-3413
14	87003414	9500-3414
15	87003415	9500-3415
16	87003416	9500-3416
18	87003965	9500-3965
19	87003967	9500-3967

Large diamond-grain wheels

Dimension, mm	Product No.	Product code
Spherical		
9	87003969	9500-3969
10	87003970	9500-3970
11	87003971	9500-3971
12	87003972	9500-3972
13	87003973	9500-3973
Ballistic		
9	87003974	9500-3974
10	87003975	9500-3975
11	87003976	9500-3976
12	87003977	9500-3977

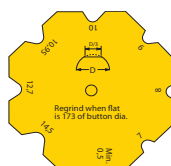
Grind Matic Manual B-DTH

(with the 18 000 rpm grinder)

Dimension, mm	Product No.	Product code
Spherical		
10	87002033	9500-2033
11	87002042	9500-2042
12	87002043	9500-2043
13	87002044	9500-2044
14	87002045	9500-2045
15	87002046	9500-2046
16	87002032	9500-2032
18	87002097	9500-2097
19	87002174	9500-2174

Grinding templates for button bits

	Product No.	Product code
Button bits, spherical	90002944	9104
Button bits, ballistic	90503414	9105
Button bits DTH, spherical	90510753	9129
Button bits DTH, ballistic	90510758	9130



Bitholders for button bits

Grind Matic BQ2, Jazz and BQ

	Product No.	Product code
Threaded bits		
Holder R25	87003475	9500-3475
Holder R28	87003476	9500-3476
Holder SR28	87003960	9500-3960
Holder R32	87003477	9500-3477
Holder SR32	87003962	9500-3962
Holder SR35	87003956	9500-3956
Holder R38, T38	87003478	9500-3478
Holder SR38	87003978	9500-3978
Holder SR38 retrac, guide	87004081	9500-4081
Holder T45	87003479	9500-3479
Holder T51	87003521	9500-3521
Holder T51 retrac	87003688	9500-3688
Tube bits		
Holder ST58	87003522	9500-3522
Holder ST68	87003523	9500-3523
Tapered bits		
Holder 7° taper	87003524	9500-3524
Holder 12° taper	87003525	9500-3525
Reaming bits		
Holder 64, 76 and 89 mm reamer	87003526	9500-3526
Holder 89, 102 and 127 mm reamer	87003527	9500-3527
Guide bits		
Holder SR35 guide bit	87004056	9500-4056
Holder R32 guide bit	87003992	9500-3992
By using the auxiliary set part 87003939 (Product No.) / 9500-3939 (Product code), Grind Matic BQ2-DTH can also use the above bit holders for threaded bits.		

Grind Matic Manual B

(for clamping device compl. 87000772 / 9500-0772 Grind Matic B)

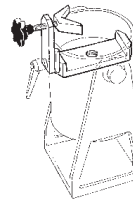
	Product No.	Product code
Threaded bit		
R25	87000792	9500-0792
R28	87000793	9500-0793
R32	87001848	9500-1848
R32	87000794	9500-0794
SR28	87003961	9500-3961
SR35	87003957	9500-3957
R35	87003360	9500-3360
R38/T38	87000795	9500-0795
T45	87000796	9500-0796
T51	87000802	9500-0802
Tapered bit		
with 7° taper	87001044	9500-1044
with 12° taper	87001045	9500-1045
Tube bit		
ST58	87001726	9500-1726
ST68	87001573	9500-1573
Reaming bit		
64, 76, 89 mm ¹⁾	87000798	9500-0798
89, 102, 127 mm ¹⁾	87000799	9500-0799
¹⁾ Centring pin for bitholders 9500-0798 and 9500-0799.	87001070	9500-1070
Clamping device for regrinding retrac bits 64–127 mm and TDS bits 89–152 mm (ST58, ST68) without bitholder (to complete 87000772 / 9500-0772).	87001930	9500-1930

Grind Matic BQ2-DTH and Manual B-DTH

Down-the-hole bits and COPROD bits	Inner diameter bit holder, mm	Product No.	Product code
COP 32	51,2	87002420	9500-2420
COP 34	54,7	87003691	9500-3691
COP 42	65,1	87002391	9500-2391
DHD3.5	55	87004514	9500-4514
DHD340	65,1	87002391	9500-2391
DHD350	84,4	87002390	9500-2390
DHD360	101,7	87002389	9500-2389
DHD380	129,2	87004523	9500-4523
IR QL4	69,0	87004515	9500-4515
IR QL5	88,6	87004033	9500-4033
IR QL6	106,3	87004002	9500-4002
IR QL8	136,5	87004516	9500-4516
TD90	145,9	87004516	9500-4516
Mission 5315	103,5	87004519	9500-4519
ODEX Ø 90	–	87002683	9500-2683
ODEX Ø 115	–	87002684	9500-2684
ODEX Ø 140	–	87002685	9500-2685
ODEX Ø 165	–	87002686	9500-2686
ODEX Ø 190	–	87002687	9500-2687
COPROD 76	48,7	87004414	9500-4414
COPROD 89	54,7	87003155	9500-3155
COPROD 102	65,7	87004415	9500-4415
COPROD 127	82,2	87002396	9500-2396

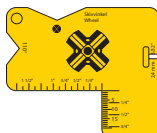
Grind Matic Manual B-DTH only

Threaded bits* T38	–	87002148	9500-2148
Threaded bits* T45	–	87002149	9500-2149
Threaded bits* T51	–	87002147	9500-2147
Threaded bits* ST58	–	87002158	9500-2158
Threaded bits* ST68	–	87002154	9500-2154
*Clamping device for threaded bits	–	87002401	9500-2401

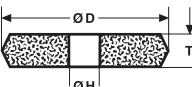
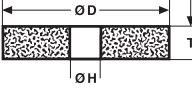


Grinding template for cross-type bits

	Product No.	Product code
Cross-type bits	90002611	9102

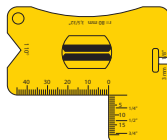


Ceramic grinding wheels for cross-type bits

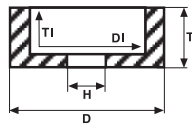
	Bit dimension	Dimension (D x T x H), mm	Product No.	Product code
	29 mm	300 x 19 x 32	87002619	9500-2619
	35 mm	300 x 23 x 32	87002594	9555
	38-41 mm	300 x 26 x 32	87002595	9556
	43 mm	300 x 28 x 32	87002618	9579
	45 mm	300 x 29 x 32	87002597	9558
	48-51 mm	300 x 32 x 32	87002616	9577
	57 mm	300 x 38 x 32	87002600	9561
	76 mm	300 x 52 x 32	87002603	9564
	Gauge grinding wheels			
		200 x 13 x 32	87002613	9574
		200 x 32 x 32	87002615	9576

Grinding template for Integral rods

	Product No.	Product code
Integral rods	90002610	9101



Ceramic grinding wheels for chisel bit

	Grinding machine	Dimension, mm		Product No.	Product code
		D x T x H (mm)	DI x TI (mm)		
	Grind Matic Swing	125 x 63 x 32	80 x 50, hard	87002589	9550
	"	125 x 63 x 32	80 x 50, soft	87002811	9500-2811
	Grind Matic Senior	200 x 102 x 32	150 x 80, hard	87002591	9552
	"	200 x 102 x 32	150 x 80, soft	87002813	9500-2813

Lubrication system



The Quicklub lubrication system is designed to provide a relatively simple and inexpensive method of centralizing and automating the lubrication of machinery bearings.

The system dispenses small measured amounts of lubricant at frequent intervals while the machine is operating. With a fully automated system, the lubricant is supplied by an electric pump through one or more distribution blocks to each point covered by the system. Even those hard to reach are assured of being properly lubricated and purged of contaminants.

Up to 300 lubrication points can be served, depending on the length of the hose.

- Reliably distributed lubricant in predetermined amounts.
- Delivers lubricant to the connected lubrication points in a safe manner.
- With three pump elements mounted, the pump can serve three separate lubrication circuits.
- Each lubrication circuit is equipped with a safety valve that holds the pressure within permissible values.
- If there is a block in a lubrication circuit, lubricant will leak from the safety valve.
- Works through lubrication cycles (interval time, propagation time and load time)
- Pumps grease up to NGLI 2 at temperatures between -25 degrees C and +70 degrees C.
- Can be used down to -40 degrees C if special low temperature grease is used.

Quicklub lubrication pump.

Water mist systems



Optional water injection systems on the drill rigs, combined with reduced flushing air, produce so-called water mist systems – which can be used for dust prevention or hole stabilization. Such systems are especially useful when starting a hole or drilling through top layers of soft rock or overburden. Also, in certain types of rock where dust suppression can be a problem for deep holes, water mist can be used as an alternative to the conventional dust collector.

There are two basic systems available:

- A system where the water tank is pressurized by the rig's air system through a hose with an adjustable nozzle. The quantity of water can be finely tuned using a valve in the system. The system is further controlled by a switch located on the drill control panel.
- A system with a water tank from which the water is pumped into the flushing air line system using similar components as for the pressurized water tank and controlled from the drill control panel.

In order to meet customer demands, all rigs can be equipped with a water mist system – whether they are top hammer or DTH, pneumatic or hydraulic.

*Equipped to operate the water-mist system:
an Atlas Copco ROC F9 crawler drill,
fitted with a pressurized water tank.*



*A crawler drill from the ROC L series
equipped with water tank fitted with
a pneumatic operated pump. The water
tank may be insulated and heated for use
in cold weather conditions.*

Angle and hole depth instrument



Angle instrument with sight

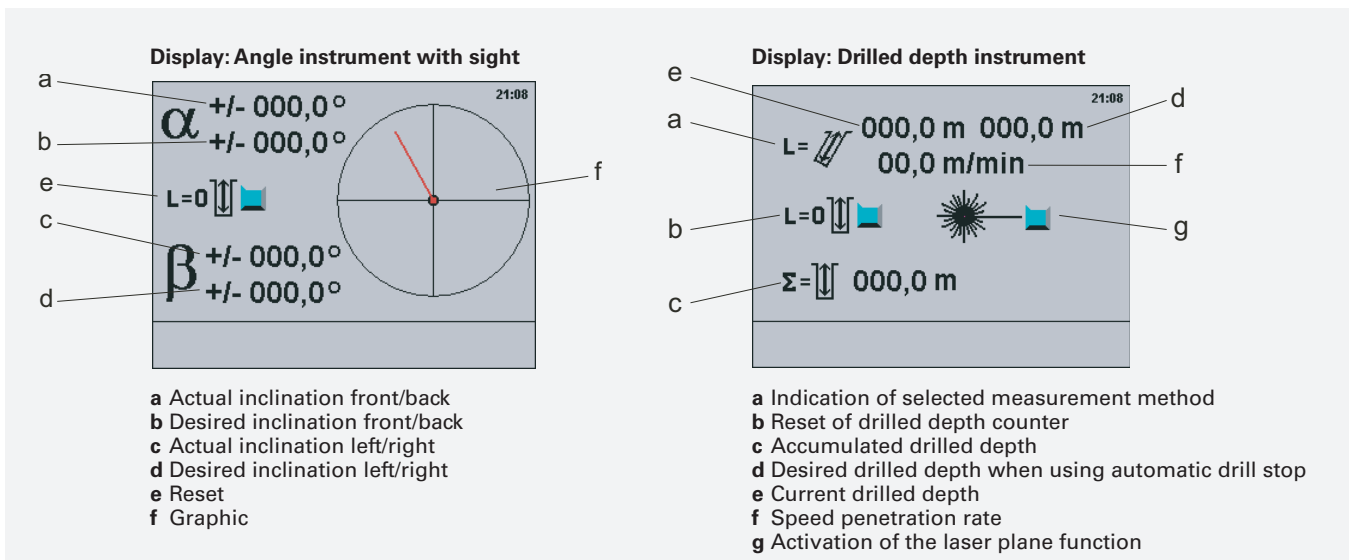
The electronic angle indication system consisting of an angle sensor on the boom and feed, sight and graphic presentation on an LCD display. The sight makes it possible to drill parallel holes by selecting a reference point before the first hole is drilled. This reference point is then maintained throughout the entire round or as long as the direction of movement is the same. By turning the sight back to the same reference point the entire time regardless of how the drill rig travels, the instrument calculates how the feed inclination must be changed to maintain the same direction of movement. The angle sensor on the boom mounting allows the instrument to compensate for the turning of the boom the same way as when the sight is turned.

Drilled depth instrument

In order to maintain control over the drilled depth, drill metres and penetration rate, the system is equipped with a drilled depth sensor.

The drill rig can be equipped with one of the following alternatives:

- Angle and depth measurement instruments with sight.
- Angle, depth and laser plane instruments with sight.

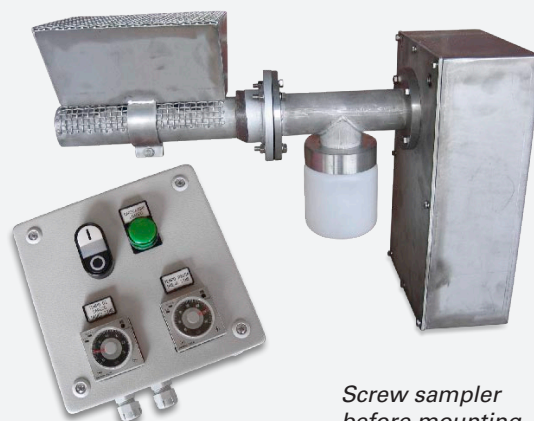


Auto sampling device

A screw type sampler mounted into the pre-cleaner, which automatically takes samples of drill cuttings at intervals and a timing, which are set from a control box mounted inside the cab.

The cuttings are collected in an easy-to-remove bottle. A light on the control panel shows when the sampling is completed.

The bottle with the collected material is removed, emptied or replaced with another bottle before the next sampling takes place.

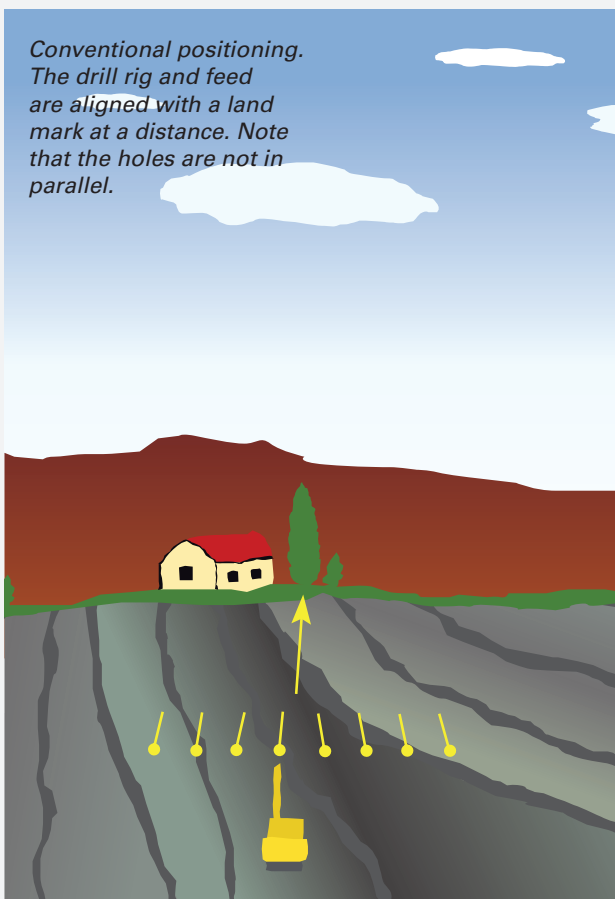


Control box

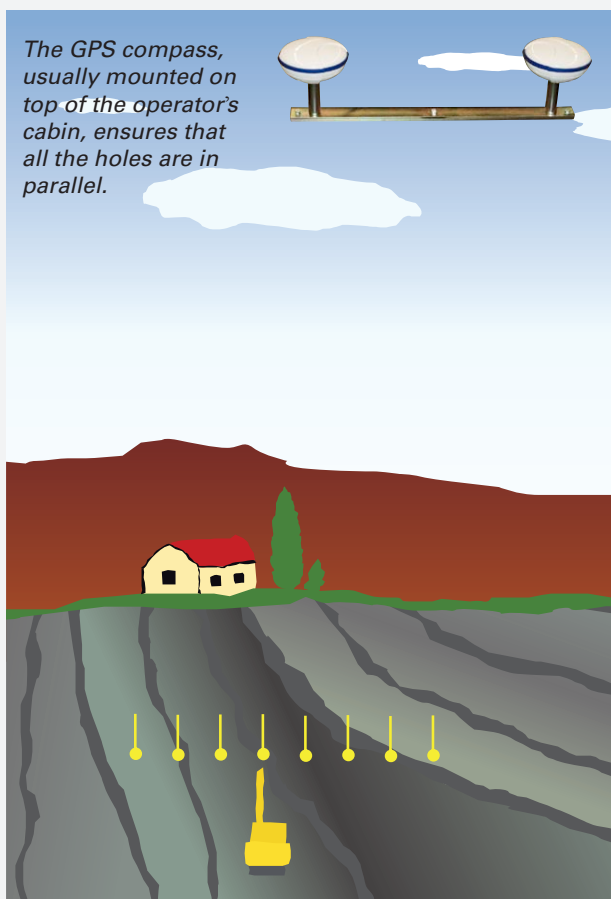
Screw sampler before mounting into the pre-cleaner

GPS compass

Conventional positioning. The drill rig and feed are aligned with a land mark at a distance. Note that the holes are not in parallel.



The GPS compass, usually mounted on top of the operator's cabin, ensures that all the holes are in parallel.



With the GPS compass you will get an even better utilisation of the blast holes, which may have a positive effect on the hole pattern and the fragmentation. Irrespective of fog or other bad weather conditions the holes are inclined in parallel with the blasting direction. The GPS can be combined with hole navigation system (HNS) or replace the mechanical aiming unit on hydraulic drill rigs (TH- and DTH rigs).

Cold weather operation



- To secure trouble-free operation and good operator's working environment, there are valuable options available including cab and diesel engine heating.
- An insulated and heated compressor regulation system prevents it from freezing.
- A well insulated and heated water tank and adjoining lines makes water mist flushing possible.
- Fully utilized these options allow the rigs to operate in Arctic conditions.

Automatic feed positioning

When drilling the bench, the operator has to be sure that, not only is he drilling in the right position, but he is also drilling at the right angle. It is very important that the drill rig feed is set to an exact pre-defined angle, especially for longer holes, where a small error can cause a large deviation at the bottom of the hole. For example, a 2-degree feed angle error produces a 3.6 cm deviation for every metre drilled, resulting in a 72 cm deviation at the bottom of a 20 m depth hole. The longer the hole, the bigger will be the impact on blasting of even a small deviation. The automatic feed positioning function avoids mistakes during setting of the feed angle, and cancels out operator error. The operator simply has to press a button in his cab, and hold it until the feed is set to the correct angle. Automatic feed positioning reduces set-up time and ensures parallel holes, resulting in better blasting and smoother bench bottoms.



Automatic rod adding

Adding rods to the drill string used to be a time-consuming process. First this process was mechanized by the introduction of carousels, clamps and SpeedRods, and now it has been automated.

The automatic rod adding system, AutoRAS, enables the operator to drill a hole automatically to a given depth, allowing him to leave the cab to carry out other duties such as maintenance checks or grinding bits, while keeping the drill rig in sight.

The drilling is supervised by the drill steel break out detection system, which shuts down the drilling operation if a breakage is detected. In particular, this ensures that no damage is caused to the drill rig if a rod breaks above the bottom of the hole.

The result of using AutoRAS is better rig utilization, evidenced by extra holes/shift, and more efficient use of the operator's time by multi-tasking.



Laser plane

Using the laser plane as a reference level, all holes are drilled to the same depth, reducing drilling, blasting and crushing costs by way of better fragmentation, and limiting the need for secondary blasting. A flatter, more uniform bench surface makes loading and transportation easier.

Hole Navigation System



The Atlas Copco satellite-based Hole Navigation System (HNS) for surface drill rigs employs RealTime Kinematic (RTK) GPS for positioning accuracy, to within 10 cm in most situations. With HNS, there is no need to mark out holes, and the accuracy is such that all holes are in parallel, or different holes in each round can be drilled in a predetermined direction, according to the blasting pattern. The result is a controllable product, with better fragmentation and fewer boulders.

Using information on his display, the operator can navigate the rig to the position of each hole, and the computer will provide the information to place and align the feed exactly over the collaring position.

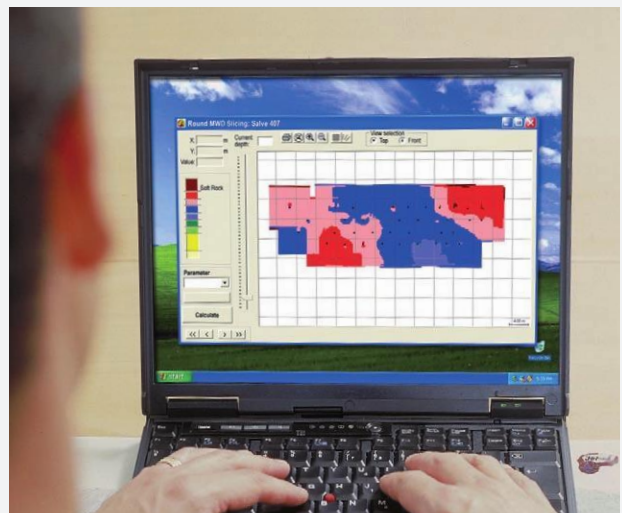
When HNS is used in quarries and mines, the drillplan should be provided by an external tool, such as ROC Manager, and transferred to the rig computer system via a PC card. Using ROC Manager, the operator selects a hole in the drillplan, and information on his display guides him to the correct position to start drilling. The time saved by not having to aim visually to set angles, and by being able to drill more than one hole from a single set-up, results in better rig utilization.

ROC Manager

ROC Manager is a stand-alone PC-based tool for making drill plans, measuring hole deviation, and logging, presenting and reporting drilling data graphically. This information can be presented individually or in combination with other parameters, and used both during drilling operations, and by transferring logged data from the rig.

Advanced MWD analysis is also possible as an option. ROC Manager supports the IREDES format for data exchange on performance, quality and MWD logs, and on drill plans.

A number of graphical tools are available for presentation of data in ROC Manager. These are sometimes customized at site to ensure that local rock conditions such as discontinuities, faults, and boundaries are correctly displayed.



Silenced SmartRig

Noise reduction

In many countries, strict noise restrictions are imposed for drilling in urban areas, and close to habitation or other sensitive buildings. This is exactly the situation for which the Silenced SmartRig ROC D7C was introduced, as the first SmartRig for use especially in areas where noise levels have to be controlled. Silenced SmartRig ROC D9C has now been released to complete the product portfolio. Substantial efforts have been put into redesigning components and soundproofing enclosures, resulting in a 10dB(A) external noise reduction.

Feed enclosure

The most visible difference between the Silenced SmartRig and other computerized drill rigs is its patented feed enclosure, the frame and panels of which are formed from lightweight aluminium. There are four access doors, which are hydraulically operated from the cab. A rubber sliding skirt at its base encloses the drill hole, and this can be hydraulically raised for viewing the collaring sequence. The whole enclosure is designed for quick demounting when not needed.

Lower fuel consumption

The advanced and more efficient hydraulic system on the Silenced SmartRig requires less power. Because its new engine delivers the right amount of power for each phase of the drilling operation in different rock conditions, fuel consumption can be reduced by up to 30%.

SmartRig automation

SmartRig has a PC-based control system that facilitates all kinds of automation in drill rigs. The hardware is designed to operate in every possible weather condition, and the software can be upgraded at site. SmartRig has built-in logging and monitoring functions, together with support for diagnostics and faultfinding. In the cab, the control system replaces hydraulic pipework and gauges with a display unit, considerably increasing the space and reducing the noise for the operator. In addition, the number of hydraulic components on the drill rig has been reduced substantially, and hydraulic efficiency is higher as a result. The need for electrical cables is also diminished.

Increased productivity

SmartRig facilitates increased shift capacity through faster positioning, to which can be added the productivity increase from automatic rod adding and auto feed alignment. Altogether, the Silenced SmartRig is a major step forward for the environment, presenting a flexible choice for quarries and civil engineering work sites.



Overhaul kits



Bring your rock drill back to perfect shape

Regular maintenance gives you peace of mind. Atlas Copco Overhaul kit is ordered by one number and includes all the parts needed for servicing and overhauling your rock drill. The 400 hours Service kit and the Seal kit are included in the Overhaul kit, but can also be ordered separately.

- Saves money, compared to buying individual items
- One kit for servicing and overhauling your hydraulic rock drill
- The overhaul kit is supplied in a practical box for shipping and easy handling at the job site

Order number						
Description	COP 1240/EX	COP 1640/EX	COP 1840/EX	COP 2150/EX	COP 2160/EX	COP 2560/EX
Overhaul kit 800 impact hours	3115 9164 92/ 3115 9164 94*	3115 9168 92/ 3115 9168 94*	3115 9011 66/ 3115 9011 67*	3115 9154 95 3115 9154 96*	3115 9158 92/ 3115 9158 95*	3115 9159 92/ 3115 9159 95*
Service kit 400 impact hours	3115 9164 91/ 3115 9164 93*	3115 9168 91/ 3115 9168 93*	3115 9011 65/ 3115 9011 68*	3115 9154 93/ 3115 9154 94*	3115 9158 91/ 3115 9158 94*	3115 9159 91/ 3115 9159 94*
Seal kit	3115 9164 90	3115 9168 90	3115 9011 64	3115 9154 92	3115 9158 90	3115 9158 90

Extractor unit kits (can only be ordered separately)

Overhaul kit	3115 9153 98	3115 9153 98	3115 9153 98	3115 9154 97	3115 9158 96	3115 9158 96
Seal kit	3115 9153 95	3115 9153 95	3115 9153 95	3115 9154 91	3115 9158 93	3115 9158 93

All 400 hour service kits, seal kits and extractor unit kits are supplied in a standard box.

* EX version, seal kit included, parts for extractor excluded.

Overhaul kit, 800 impact hours

Description

400h service kit
Rotation chuck bushing
Bushings
Driver
Dampening piston
Piston guide front
Piston guide rear
Piston
Front guide
Stop ring



The parts are stored in a solid wooden box for shipping and handling at the job site.

Service kit, 400 impact hours

Description

Seal kit
Diaphragms
Valve
Circlips
Shims
Roller bearings
Needle bearings
Lock ring
Screws
Plug
Side bolts
Nut
Dome nut
Washer
Date plate
Safety labels
Lock washer
Spare part list
Overhaul instructions



Seal kit

Description

O-ring set
Sealing sets
Plug
Gaskets
Grease nipple
Radial lip seal
Seals
Seal washers
Cup seal
O-rings

COP Grease



COP Grease can be ordered either in a tube for use in the field together with a grease gun, or in a can for use in the workshop.

To keep the rock drill in perfect shape, it is necessary to use the right quality of gear box grease. That's why we recommend you to use COP Grease – a grease specially developed for Atlas Copco's hydraulic rock drills. The grease is thoroughly tested to cope with all the trials that the gear box of the rock drill is exposed to, such as damp, vibrations and high temperatures.

COP Grease handles temperatures ranging from 40°C to 150°C and short term up to 220°C. It has excellent mechanical stability, providing high resistance under vibrating conditions. The smooth consistency ensures minimal temperature elevation in the gear. It has excellent load carrying capacity, is very resistant towards water, and has good rust preventing properties.

COP Grease contains additives to prevent wear and corrosion, and to ensure good Extreme Pressure (EP) ability. The additives also improve the oxidation stability, making the grease suitable for use over extended periods of time at high temperatures.

By using COP Grease, you can lower the maintenance cost and increase the life length of your rock drill. You can order COP Grease either in a cartridge for use in the field together with a grease gun, or in a can for use in the workshop.

COP Grease

Items	Content	P/N
Cartridge	0,4 kg	3115 3422 00
Can	18 kg	3115 3423 00

Typical inspections	Methods	Units	
Characteristics			
Thickener	-	-	Lithium-complex 1.5
NLGI	-	-	
Penetration	ASTM D 217		
Worked 60 times		mm/10	305
Dropping point	ASTM D 566	°C	>260
Baseoil viscosity @ 40°C	ASTM D 445	mm²/s	475
Baseoil viscosity @ 100°C	ASTM D 445	mm²/s	50

Tests and approvals

Classified as L-XDDIB1.5 according to ISO 6743-9
 Classified as K1.5N-40 according to DIN 51502
 SKF Emcor VVVO, distilled water
 SKF Lubricity R2F run test A
 SKF Lubricity R2F run test B (150°C)

Handling and Storage

Avoid skin contact. Wash thoroughly with soap and water, after skin contact. Dispose of used grease properly. Safety data sheet available for professional user on request.

COP OIL



Atlas Copco COP OIL for pneumatic and hydraulic rock drills and DTH hammers that unites technology and environment.

Main features

The development of lubricating oil for pneumatic and hydraulic tools has been driven by the high demands on environment and reliability. COP OIL is made of carefully selected components that give the highest technical performance. COP OIL has a broad temperature range that gives you optimum operation in the most variable temperatures. It withstands heavy loads and protects against wear and corrosion. More and more users are recognising the advantages of using environmentally adapted lubricants. In applications where lubricants are contaminating the surroundings, the use of environmentally adapted lubricants will therefore be a strong coming demand. COP OIL is based on renewable raw materials that are readily biodegradable. COP OIL is specially developed for Atlas Copco pneumatic and hydraulic rock drills and down-the-hole hammers.

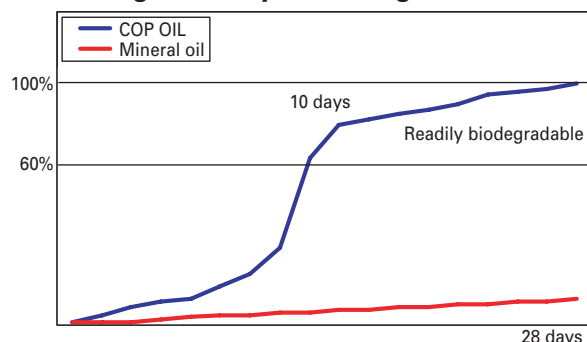
COP OIL

- Excellent lubricating properties.
- Reduces the risk of scoring and abrasion.
- Protects against corrosion and oxidation.
- Insensitive to temperature variations. Works equally well throughout the temperature range - 35°C to + 45°C (-31°F to +113°F).
- Adhesion and larger drop formation contribute to the very good lubricating properties.
- Based on > 90% renewable raw materials.
- Readily biodegradable according to OECD301

Additives in the oil are:

- Approved in accordance with the German authorities "Blue Angel"
- "Approved" in accordance with the Swedish authorities "Ren Smörja"

Biodegradability according to OECD 301



Technical data

COP OIL	
Density, 15°C:	927 kg/m ³
Viscosity at 40°C:	65 cSt
Viscosity at 100°C:	13.4 cSt
Index of viscosity:	215
Flame point	250°C (482°F)
Lowest flow temperature:	- 39°C (-38°F)
Part number	
3115 3125 00	Can 10 litres
3115 3126 00	Can pallet 48 x 10 litres
3115 3127 00	Drum 208 litres

Using Atlas Copco COP OIL ensures that you are doing your best for both the environment and your equipment!

SB-hydraulic breakers (small series)



Features

- noise and vibration damping
- high availability
- individual usage
- high productivity

Applications

- road construction
- smaller trenching and demolition jobs
- building renovation
- in quarries (feed size reduction on crusher)
- landscape gardening and landscaping



SB-hydraulic breakers

		SB 52	SB 102	SB 152	SB 202	SB 300	SB 450	SB 552
Carrier weight class ¹⁾	t	0.7-1.2	1.1-3.0	1.9-4.5	2.5-6.0	4.5-9.0	6.0-12.0	9.0-15.0
Service weight ²⁾	kg	55	83	125	195	312	419	520
Oil flow rate	l/min	12-32	16-35	25-45	35-66	50-80	50-100	65-115
Operating pressure	bar	100-150	100-150	100-150	100-150	100-150	100-150	100-150
Blow frequency	bpm	720-1,800	720-2,280	840-1,920	840-1,800	480-960	390-780	540-1,080
Working tool diameter	mm	40	45	50	65	80	95	100
Useful length of tool	mm	254	335	310	295	470	460	570
Part number		-	-	-	-	8460 0100 01	8460 0100 09	-
Silenced version								
Part number		8460 0300 10	8460 0300 30	8460 0300 40	8460 0300 50	-	-	8460 0300 80

¹⁾ Weights apply to standard carriers only. Any variances must be agreed with Atlas Copco and/or the carrier manufacturer prior to attachment.

²⁾ Breaker and breaker box with standard adapter plus working tool.

MB-hydraulic breakers (medium series)



Features

- noise and vibration damping
- maximum availability
- maximum productivity

Applications

- primary breaking in quarries
- secondary breaking in quarries
- demolition
- tunnelling
- trenching
- foundation work

ContiLube® II as standard



Service contract
as an option



MB-hydraulic breakers

		MB 700	MB 1000	MB 1200	MB 1500	MB 1700
Carrier weight class ¹⁾	t	10-17	12-21	15-26	15-29	19-32
Service weight ²⁾	kg	750	1,000	1,200	1,500	1,700
Oil flow rate	l/min	80-1,120	85-130	100-145	120-155	130-170
Operating pressure	bar	140-170	160-180	160-180	160-180	160-180
Blow frequency	bpm	370-800	350-750	340-680	330-680	320-600
Stroke-length switching		-	Auto Control	Auto Control	Auto Control	Auto Control
Start-up mode		AutoStart	AutoStart	StartSelect	StartSelect	StartSelect
Working tool diameter	mm	100	110	120	135	140
Useful length of tool	mm	550	570	605	630	650
Pt.-Id. No.		3363 0928 95	3363 0887 85	3363 0904 41	3363 0991 01	3363 0904 49
Equipped with DustProtector						
Useful length of tool	mm	510	540	580	605	625
Pt.-Id. No.		3363 0928 97	3363 00887 87	3363 0904 43	3363 0991 39	3363 0904 51

¹⁾ Weights apply to standard carriers only. Any variances must be agreed with Atlas Copco and/or the carrier manufacturer prior to attachment.

²⁾ Breaker and breaker box with standard adapter plus working tool.

HB-hydraulic breakers (heavy series)



Features

- noise and vibration damping
- maximum availability
- maximum productivity

Applications

- primary breaking in quarries
- secondary breaking in quarries
- demolition
- tunnelling
- trenching
- foundation work

ContiLube® II as standard



Service contract
as an option



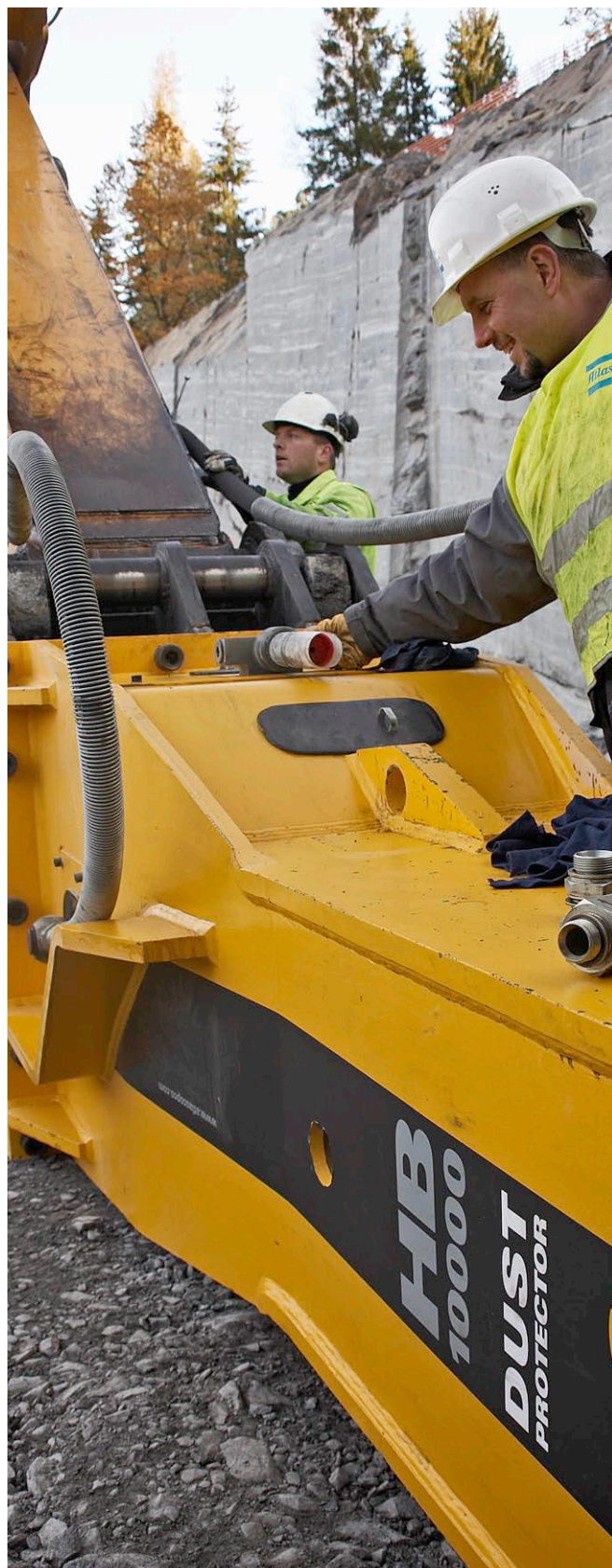
HB-hydraulic breakers

		HB 2200	HB 2500	HB 3000	HB 4200	HB 5800	HB 7000
Carrier weight class ¹⁾	t	26-40	27-46	32-50	42-75	58-100	70-120
Service weight ²⁾	kg	2200	2500	3000	4200	5800	7000
Oil flow rate	l/min	140-180	170-220	210-270	250-320	310-390	360-450
Operating pressure	bar	160-180	160-180	160-180	160-180	160-180	160-180
Impact rate	bpm	280-550	280-550	280-540	270-530	280-460	280-450
Stroke-length switching		Auto Control	Auto Control	Auto Control	Auto Control	Auto Control	Auto Control
Start-up mode		StartSelect	StartSelect	StartSelect	StartSelect	StartSelect	StartSelect
Overload protection device		-	PowerAdapt	-	-	PowerAdapt	PowerAdapt
Working tool diameter	mm	150	155	165	180	200	210
Useful length of tool	mm	650	685	745	820	865	935
Pt.-Id. No.		3363 0904 57	3363 0926 91	3363 0904 65	3363 0901 49	3363 0904 73	3363 0904 81
Equipped with DustProtector							
Useful length of tool	mm	605	640	700	775	810	885
Pt.-Id. No.		3363 0904 59	3363 0938 71	3363 0904 67	3363 0901 81	3363 0904 75	3363 0904 83

¹⁾ Weights apply to standard carriers only. Any variances must be agreed with Atlas Copco and/or the carrier manufacturer prior to attachment.

²⁾ Breaker and breaker box with standard adapter plus working tool.

HB 10000 ProCare



After more than a decade, the HB 7000 is to lose its title of the world's biggest mass-produced hydraulic breaker to a true giant: the HB 10000 ProCare. Weighing in at 10 metric tons and delivering a single blow energy of more than 16,000 j, the HB 10000 ProCare is the new king of the hydraulic breaker world.

And the new dimension doesn't stop there: not only will the HB 10000 ProCare be a 'giant among hydraulic breakers', the pro-active service and availability concept, Atlas Copco ProCare™ will always be part of the product to guarantee dependable production.

Naturally, the breaker has all the features only available on Atlas Copco breakers. The Atlas Copco ProCare™ pro-active service concept will be the key to success for customers using the HB 10000 ProCare, as it guarantees continuous and economic operation and reduces risks to a minimum. Our customers can simply get on with their work and earn money – Atlas Copco will take care of the rest.

Full service contract

The Atlas Copco ProCare™ full-service contract with fixed costs per operating hour.

- Apart from all inspection and maintenance routines we also carry out all repairs on your Atlas Copco hydraulic breaker.
- Depending on individual contractual terms, all wage and material costs for the entire scope of wear and spare parts are included.

Technical specifications

Carrier class ¹⁾	85-140 t
Service weight ²⁾	10,000 kg
Oil flow rate	450-530 l/min
Operating pressure	160-180 bar
Impact frequency	250-380 bpm
Stroke length	Auto Control
Start-up mode	StartSelect
Overload protection	PowerAdapt
Working tool diameter	240 mm

¹⁾ Weights apply to standard carriers only. Any variances must be agreed with Atlas Copco and/or the carrier manufacturer prior to attachment.

²⁾ Breaker and breaker box with standard adapter plus working tool

Tools for every job – more than just a piece of steel

- Made from a special alloy which has been optimized for hydraulic breaker applications.
- The result of a long, complex development process, backed by extensive field experience.
- Adjusted to all surrounded hydraulic breaker components within minor tolerances and hardness levels to guarantee maximum durability of your equipment.
- With its dimensions, material properties and geometries genuine working tools provide a high level of reliability, wear behaviour, performance and productivity.



1. Moil point, conical
(up to a working tool diameter of 100 mm)



2. Moil point, pyramidal
(from a working tool diameter of 100 mm on)



3. Chisel



4. Blunt tool

Overview of tool applications

To use an Atlas Copco hydraulic breaker in the most efficient way, and to lower the risk of tool fractures, choosing the right working tool for an application is crucial.

Material	Use	Specifications	Working tool
Asphalt	Road surfaces, Transport routes	Soft structures	Chisel
Concrete	Thin floors, walls	Reinforced	Chisel
		Non-reinforced	Moil point
	Thin floors, walls	Reinforced	Chisel
		Non-reinforced	Moil point
	Foundations	Reinforced	Chisel
		Non-reinforced	Moil point
	Recycling	-	Blunt tool
Sedimentary rock (sandstone, limestone, greywacke, calcareous sediment)	Trenching foundation work; primary quarry breaking	Heavily fissured	Chisel
		Lightly fissured	Moil point
		Monolithic	Moil point
	Breaking oversizes	-	Blunt tool
Crystalline rock (magma, greenstone, gabbro, granite, etc.)	Trenching, foundation work; primary quarry breaking	Heavily fissured	Chisel
		Lightly fissured	Blunt tool
		Monolithic	Blunt tool
	Breaking oversizes	-	Blunt tool

Working tools for hydraulic breakers

Breaker type	Description	ProductLine	Working length Standard version in mm	Working length Dust version in mm	Total length in mm	Total diameter in mm	Part number
SB 52	Moil point (XProfile)	ClassicLine	254	-	420	40	3363 0982 46
	Moil point	ClassicLine	254	-	420	40	3083 3409 18
	Chisel (XProfile)	ClassicLine	254	-	420	40	3363 0982 47
	Chisel (cross)	ClassicLine	254	-	420	40	3083 3409 19
SB 102	Moil point (XProfile)	ClassicLine	250	-	450	45	3363 0982 48
	Moil point	ClassicLine	250	-	450	45	3083 3409 08
	Chisel (XProfile)	ClassicLine	250	-	450	45	3363 0982 49
	Chisel (cross)	ClassicLine	250	-	450	45	3083 3409 09
SB 152	Moil point (XProfile)	ClassicLine	305	-	510	50	3363 0982 50
	Moil point	ClassicLine	305	-	510	50	3083 3169 00
	Chisel (XProfile)	ClassicLine	305	-	510	50	3363 0982 51
	Chisel (cross)	ClassicLine	305	-	510	50	3083 3170 00
	Blunt tool	ClassicLine	305	-	510	50	3083 3182 00
SB 202	Moil point (XProfile)	ClassicLine	320	-	600	65	3363 0982 52
	Moil point	ClassicLine	320	-	600	65	3083 3162 00
	Chisel (XProfile)	ClassicLine	320	-	600	65	3363 0982 53
	Chisel (cross)	ClassicLine	320	-	600	65	3083 3161 00
	Blunt tool	ClassicLine	320	-	600	65	3083 3411 00
SB 300	Moil point (XProfile)	ClassicLine	475	-	800	80	3363 0982 54
	Moil point	ClassicLine	475	-	800	80	3083 3191 00
	Chisel (XProfile)	ClassicLine	475	-	800	80	3363 0982 55
	Chisel (cross)	ClassicLine	475	-	800	80	3083 3192 00
	Blunt tool	ClassicLine	475	-	800	80	3083 3195 00
SB 450	Moil point (XProfile)	ClassicLine	460	-	840	95	3363 0982 56
	Moil point	ClassicLine	460	-	840	95	3083 3177 00
	Chisel (XProfile)	ClassicLine	460	-	840	95	3363 0982 57
	Chisel (cross)	ClassicLine	460	-	840	95	3083 3178 00
	Blunt tool	ClassicLine	460	-	840	95	3083 3188 00
SB 552	Moil point (XProfile)	ClassicLine	570	-	900	100	3363 0982 58
	Moil point	ClassicLine	570	-	900	100	3083 3409 05
	Chisel (XProfile)	ClassicLine	570	-	900	100	3363 0982 59
	Chisel (cross)	ClassicLine	570	-	900	100	3083 3409 06
	Blunt tool	ClassicLine	570	-	900	100	3083 3409 07
MB 700	Moil point	ClassicLine	560	520	1,000	100	3363 0687 05
	Chisel (cross)	ClassicLine	560	520	1,000	100	3363 0687 07
	Blunt tool	ClassicLine	560	520	1,000	100	3363 0944 48
MB 1000	Moil point	ClassicLine	570	540	1,100	110	3363 0848 77
	Chisel (cross)	ClassicLine	570	540	1,100	110	3363 0848 87
	Blunt tool	ClassicLine	570	540	1,100	110	3363 0901 13
MB 1200	Moil point	ClassicLine	605	580	1,150	120	3363 0827 87
	Chisel (cross)	ClassicLine	605	580	1,150	120	3363 0829 43
	Blunt tool	ClassicLine	605	580	1,150	120	3363 0829 45
MB 1500	Moil point	ClassicLine	630	605	1,175	135	3363 0987 36
	Chisel (cross)	ClassicLine	630	605	1,175	135	3363 0987 34
	Blunt tool	ClassicLine	630	605	1,175	135	3363 1021 25

Working tools for hydraulic breakers

Breaker type	Description	ProductLine	Working length Standard version in mm	Working length Dust version in mm	Total length in mm	Total diameter in mm	Part number
MB 1700	Moil point	ClassicLine	650	625	1,200	140	3363 0822 35
	Chisel (cross)	ClassicLine	650	625	1,200	140	3363 0822 37
	Blunt tool	ClassicLine	650	625	1,200	140	3363 0822 39
HB 2200	Moil point	ClassicLine	650	605	1,300	150	3363 0822 41
	Moil point	SilverLine	650	605	1,300	150	3363 0944 50
	Chisel (cross)	ClassicLine	650	605	1,300	150	3363 0822 43
	Chisel (cross)	SilverLine	650	605	1,300	150	3363 0944 51
	Blunt tool	ClassicLine	650	605	1,300	150	3363 0822 45
	Blunt tool	SilverLine	650	605	1,300	150	3363 0944 52
HB 2500	Moil point	ClassicLine	680	635	1,350	155	3363 0946 14
	Moil point	SilverLine	680	635	1,350	155	3363 0949 19
	Chisel (cross)	ClassicLine	680	635	1,350	155	3363 0946 17
	Chisel (cross)	SilverLine	680	635	1,350	155	3363 0949 18
	Blunt tool	ClassicLine	680	635	1,350	155	3363 0977 43
	Blunt tool	SilverLine	680	635	1,350	155	3363 0977 63
HB 3000	Moil point	ClassicLine	745	700	1,450	165	3363 0822 53
	Moil point	SilverLine	745	700	1,450	165	3363 0918 01
	Chisel (cross)	ClassicLine	745	700	1,450	165	3363 0822 55
	Chisel (cross)	SilverLine	745	700	1,450	165	3363 0918 00
	Blunt tool	ClassicLine	745	700	1,450	165	3363 0822 57
	Blunt tool	SilverLine	745	700	1,450	165	3363 0918 02
HB 4200	Moil point	ClassicLine	820	775	1,600	180	3363 0822 59
	Moil point	SilverLine	820	775	1,600	180	3363 0944 53
	Chisel (cross)	ClassicLine	820	775	1,600	180	3363 0822 61
	Chisel (cross)	SilverLine	820	775	1,600	180	3363 0944 54
	Blunt tool	ClassicLine	820	775	1,600	180	3363 0822 63
	Blunt tool	SilverLine	820	775	1,600	180	3363 0944 55
HB 5800	Moil point	ClassicLine	865	810	1,700	200	3363 0875 27
	Moil point	SilverLine	865	810	1,700	200	3363 0914 20
	Chisel (cross)	ClassicLine	865	810	1,700	200	3363 0875 25
	Chisel (cross)	SilverLine	865	810	1,700	200	3363 0914 21
	Blunt tool	ClassicLine	865	810	1,700	200	3363 0875 28
	Blunt tool	SilverLine	865	810	1,700	200	3363 0914 22
HB 7000	Moil point	ClassicLine	935	885	1,800	210	3363 0822 65
	Moil point	SilverLine	935	885	1,800	210	3363 0914 23
	Chisel (cross)	ClassicLine	935	885	1,800	210	3363 0822 67
	Chisel (cross)	SilverLine	935	885	1,800	210	3363 0914 24
	Blunt tool	ClassicLine	935	885	1,800	210	3363 0822 69
	Blunt tool	SilverLine	935	885	1,800	210	3363 0914 25
HB 10000	Moil point	SilverLine	-	880	1,900	240	3363 0981 07
	Chisel (cross)	SilverLine	-	880	1,900	240	3363 0981 05
	Blunt tool	SilverLine	-	880	1,900	240	3363 0990 51

Lubricants for hydraulic breakers

- Especially developed for equipment used in heavy-duty demolition work.
- Provides maximum service life and availability for your equipment.



Lubricants for hydraulic breakers

Description	Size	Part number
Chisel paste cartridge (for manual greasing)	12 x 400 g	3363 0949 13
Grease gun for 400 g chisel paste cartridge		0909 1071 00
Chisel paste cartridge for ContiLube® II	12 x 500 g	3363 0912 00
Grease gun for 500 g chisel paste cartridge		3363 0345 67
Seal rings for 500 g chisel paste cartridge	Set of 25	3363 0943 93
Chisel paste container	15 kg	3362 2639 00
Chisel paste container	45 kg	3362 2632 75
Filling device for 500 g chisel paste cartridge (for use in combination with 15 kg container)		3363 0946 69
Filling device for 500 g chisel paste cartridge (for use in combination with 45 kg container)		3363 0664 11

VAM water separators

VAM water separators are based on the centrifugal principle. They feature automatic discharge via a float controlled bottom valve, and a coarse strainer for solid particles.

Water separator, fitted with claw couplings

	Description	Hose connection		Air flow		Weight		Ordering No.
		mm	in	l/s	cfm	kg	lb	
	VAM 5A	25	1	120	254	10	22	8092 0110 82

Working pressure 10 bar (145 psi)

BLG and CLG lubricators

BLG and CLG are highly efficient oil lubricators for pneumatic equipment. Their simple, strong design makes the lubricators very resistant to rough handling.

No moving parts contributes to safe and trouble-free operation. The oil supply is easily adjusted even during operation.

Lubricators, fitted with claw couplings

	Description	Hose inner diameter		Air flow		Oil volume		Weight		Ordering No.
		mm	in	l/s	cfm	l	gal	kg	lb	
	CLG 30, for both mineral and synthetic oil	25	1	15-140	32-300	1.3	0.3	3	6.6	8202 5102 39
	BLG 30, for mineral oil	25	1	15-140	32-300	1.3	0.3	3	6.6	8202 5102 05

Max working pressure 20 bar (290 psi)

Breaker and Hammer AIR-OIL, Synthetic bio-degradable lubricant for handheld pneumatic breakers and hammers. Absorbs water and prevents icing.

	Description	Oil volume		Weight		Ordering No.
		l	gal	kg	lb	
	0.25 ltr	0.25	0.05	0.3	0.66	8099 0202 40
	1 ltr	1	0.22	1.1	2.4	8099 0202 36
	5 ltr	5	1.10	5.8	13	8099 0202 02
	20 ltr	20	4.40	22	49	8099 0202 15
	200 ltr drum	208	46.0	220	485	8099 0202 28

Hoses

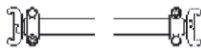
The Atlas Copco rubber hose is ideal for all applications and air lines in use on building and construction sites, in mines, shipyards, etc.

- The Mantex flat hose is a lightweight hose, weighing only 1/3 of a conventional rubber hose.
- The pneumatic hose transports the compressed air safely from the compressor to the drill rig, e.g. during water well boring or other drilling applications.

Round rubber, hose rolls

	Description	Inner diameter		Outer diameter		Max working pressure		Length roll		Weight		Ordering No.
		mm	in	mm	in	bar	psi	m	ft	kg	lb	
	Rubber hose, 30m	10	3/8	17	11/16	16	232	30	98	6.9	15.2	9030 2037 00
	Rubber hose, 30m	12.5	1/2	22	5/8	16	232	30	98	12.3	27.1	9030 2038 00
	Rubber hose, 30m	16	5/8	25	1	16	232	30	98	13.9	30.6	9030 2039 00
	Rubber hose, 30m	20	3/4	30	13/16	16	232	30	98	19.3	42.5	9030 2040 00
	Rubber hose, 20m	20	3/4	30	13/16	16	232	20	65	12.9	28.3	9030 2040 03
	Rubber hose, 30m	25	1	36	15/16	16	232	30	98	24.0	52.9	9030 2041 00
	Rubber hose, 20m	25	1	36	15/16	16	232	20	65	16.0	35.3	9030 2041 03

Round rubber hoses, pre-mounted hoses fitted with couplings and hose clamps

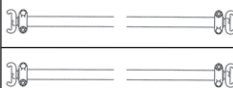
	Description for products	Inner diameter		Outer diameter		Max working pressure		Length roll		Weight		Ordering No.
		mm	in	mm	in	bar	psi	m	ft	kg	lb	
	Universal	12.5	1/2	22	5/8	16	232	15	49	5.9	13	9030 2045 00
	Universal	20	3/4	30	13/16	16	232	15	49	7.6	16.8	9030 2049 00
	Universal	25	1	36	15/16	16	232	15	49	12	26.5	9030 2050 00

Mantex flat hoses, hose rolls

	Description	Inner diameter		Thickness		Max working pressure		Length roll		Weight		Ordering No.
		mm	in	mm	in	bar	psi	m	ft	kg	lb	
	Lightweight hose, 60m	20	3/4	2.3	3/32	20	290	60	195	13	29	9030 2014 00
	Lightweight hose, 100m	20	3/4	2.3	3/32	20	290	100	325	22	48	9030 2014 01
	Lightweight hose, 200m	20	3/4	2.3	3/32	20	290	200	650	44	96	9030 2014 02
	Lightweight hose, 60m	25	1	2.5	3/32	20	290	60	195	16	35	9030 2006 00
	Lightweight hose, 100m	25	1	2.5	3/32	20	290	100	325	26	57	9030 2006 01
	Lightweight hose, 200m	25	1	2.5	3/32	20	290	200	650	52	114	9030 2006 02
	Lightweight hose, 60m	40	1 1/2	2.5	3/32	14	203	60	195	27	60	9030 2007 00
	Lightweight hose, 60m	50	2	2.8	7/64	14	203	60	195	36	79	9030 2008 00
	Lightweight hose, 40m	76	3	3.0	1/8	10	145	40	130	36	79	9030 2009 00

Max working pressure is calculated with safety factor 5. Burst pressure = 5 x Max working pressure

Mantex flat hoses, pre-mounted hoses with fitted couplings and hose clamps

	Description	Inner diameter		Thickness		Max working pressure		Length roll		Weight		Ordering No.
		mm	in	mm	in	bar	psi	m	ft	kg	lb	
	Universal	20	3/4	2.3	3/32	20	290	20	65	4.5	10	9030 2015 00
	Universal	25	1	2.5	3/32	20	290	20	65	6	13	9030 2011 00

Mantex pneumatic hoses

	Description	Inner diameter		Max working pressure		Length roll		Weight		Working temperature		Ordering No.
		mm	in	bar	psi	m	ft	kg	lb	C	F	
	High-pressure hose, 20 m	50	2	30	435	20	65	17	37	fr. -30 to +100	fr. -20 to +210	9030 2078 00
	High-pressure hose, 40 m	50	2	30	435	40	130	32	71	fr. -30 to +100	fr. -20 to +210	9030 2079 00

Claw couplings

You will not find a better claw coupling anywhere with such a low pressure drop. And its strength and life span are unsurpassed. The Atlas Copco couplings are always easy to assemble and dismantle. They are also available with a lock nut to provide effective, reliable sealing even under extreme conditions.

- Hard treatment resistant
- Made of galvanized drop-forged, hardened steel
- All couplings mate, regardless of nipple and thread size

Claw couplings

	Connection	Hose inner diameter		Bore		Weight		Ordering No.
		mm	in	mm	in	kg	lb	
	Hose nipple	6.3	1/4	5.0	3/16	0.11	0.25	9000 0308 00
	Hose nipple	10.0	3/8	8.0	5/16	0.13	0.29	9000 0309 00
	Hose nipple	12.5	1/2	10.5	13/32	0.14	0.31	9000 0310 00
	Hose nipple	16.0	5/8	13.5	17/32	0.14	0.31	9000 0311 00
	Hose nipple	20.0	3/4	17.2	11/16	0.15	0.33	9000 0312 00
	Hose nipple	25.0	1	22.0	7/8	0.17	0.38	9000 0313 00
	Hose nipple with lock nut	10.0	3/8	8.0	5/16	0.29	0.64	9000 0260 00
	Hose nipple with lock nut	12.5	1/2	10.5	13/32	0.29	0.64	9000 0261 00
	Hose nipple with lock nut	16.0	5/8	13.5	17/32	0.29	0.64	9000 0262 00
	Hose nipple with lock nut	20.0	3/4	17.2	11/16	0.32	0.71	9000 0263 00
	Hose nipple with lock nut	25.0	1	22.0	7/8	0.32	0.71	9000 0264 00

Claw couplings

	Connection	Connecting thread	Bore		Weight		Ordering No.
			mm	in	kg	lb	
	External thread	G3/8A	11.3	7/16	0.11	0.25	9000 0300 00
	External thread	G1/2A	14.8	37/64	0.12	0.27	9000 0301 00
	External thread	G3/4A	19.0	3/4	0.13	0.29	9000 0302 00
	External thread	G1A	25.5	1	0.13	0.29	9000 0303 00
	Internal thread	G3/8	15.0	19/32	0.12	0.27	9000 0304 00
	Internal thread	G1/2	18.6	3/4	0.13	0.29	9000 0305 00
	Internal thread	G3/4	24.2	1	0.14	0.31	9000 0306 00
	Internal thread	G1	30.3	13/16	0.15	0.33	9000 0307 00
	Cover				0.18	0.40	9000 0314 00

Packings and lock spring for claw couplings

	Description	Fit to coupling ordering No. 9000....	Comment	Ordering No.
	Packing	0300 00 to 0314 00	Can be replaced by special packing 9000 0000 01	9000 0000 00
	Packing	0260 00 to 0262 00		9000 0015 00
	Packing	0263 00 and 0264 00	Can be replaced by special packing 9000 0319 00	9000 0268 00
	Lock spring	Fits to all 9000 0300 00 to 9000 0314 00 couplings		3176 8640 00

Special packings can be used in max. temp +200°C (390°F) steam and -40°C to +250°C (-40°F to +482°F) air. Excellent for neutral and alkaline liquids (pH above 5)

Hose couplings for rubber hose

Guide, hose couplings for round rubber hoses

Hose diam. inner mm in	Hose jointing nipple	Hose clamp	Hose clamp	Hose nipple	Cup nut Wing	Cup nut Hexagonal	Connecting nipples External thread
							
10 3/8	9000 0215 00	0347 6105 00		9000 0321 00		G5/8 9000 0331 00	
12.5 1/2	9000 0216 00		9000 0194 00	9000 0322 00		G5/8 9000 0331 00	
12.5 1/2				9000 0323 01	9000 0337 00	G3/4 9000 0332 00	
16 5/8	9000 0217 00		9000 0195 00	9000 0324 00	9000 0337 00	G3/4 9000 0332 00	G3/4A - G3/4A 9000 0343 00
20 3/4	9000 0218 00		9000 0196 00	9000 0325 00	9000 0338 00	G7/8 9000 0333 00	G7/8A - G1A 9000 0345 00

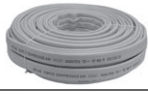
Guide, hose couplings with particularly coarse thread for round rubber hoses

Hose diam. inner mm in	Hose clamp	Hose nipple	Packing ¹⁾	Cup nut Wing	Connecting nipples External thread	Connecting nipples Internal thread
						
12.5 1/2	9000 0194 00	9000 0370 00	9000 0025 00 ²⁾	9000 0154 00	G1/2A 9000 0028 00	G1/2 9000 0033 00
20 3/4	9000 0196 00	9000 0371 00	9000 0371 00 ²⁾	9000 0154 00	G3/4A 9000 0029 00	G3/4 9000 0034 00
25 1	9000 0197 00	9000 0372 00	9000 0371 00 ²⁾	9000 0154 00	G1A 9000 0030 00	G1 9000 0035 00

Guide, Mantex flat hoses

Hose diam. inner mm in	Hose jointing nipple	Hose clamp	Claw coupling	Packing
				
20 3/4	9000 0218 00 ¹⁾	9000 0194 00	9000 0312 00	9000 0000 00 ³⁾
25 1	9000 0219 00 ¹⁾	9000 0196 00	9000 0313 00	9000 0000 00 ³⁾

Guide, Mantex flat hoses

Hose diam. inner mm in	Hose jointing nipple	Hose clamp	Hose nipple	Packing	Cup nut Wing	Connecting nipples External thread	Connecting nipples Internal thread
							
40 1 1/2	9000 0220 00 ²⁾	9000 0381 00	9000 0373 00	9000 0026 00 ³⁾	9000 0159 00	G1 1/2A 9000 0031 00	G1 1/2 9000 0036 00
50 2	9000 0221 00 ²⁾	9000 0198 01	9000 0374 00	9000 0026 00 ³⁾	9000 0159 00	G2A 9000 0332 00	G2 9000 0037 00
76 3	9001 0045 00 ²⁾	9000 0189 00	9001 0025 80	3176 8294 00 ³⁾	3176 8295 00	G2A 3176 8296 00	

1) 2 hose clamps per nipple needed

2) 4 hose clamps per nipple needed

3) All claw couplings and hose nipples supplied with packings

Mobile Service and ROCKHOSE Workshops

For easy and convenient service of drill rigs and hydraulic hoses

When you invest in an Atlas Copco drill rig you receive a quality product. Quality gives reliability, availability and high productivity, which is essential to make profit. But the quality of any machine has to be maintained in order to give continuous high performance and good operating economy. And that can only be achieved through regular preventive maintenance and the use of Genuine Parts from Atlas Copco. A service workshop located on site or close by is the key solution to rapid maintenance and repair routines. This is why Atlas Copco have designed and equipped mobile workshops to serve different servicing requirements.

Convenient service

The latest enhanced versions of the well regarded Atlas Copco Mobile Workshop and Mobile ROCKHOSE Workshop contain all of the equipment needed for maintenance and increased availability of rockdrills and drill rigs. They are housed in 20 ft ISO standard steel containers, internally insulated and fitted with non-slip aluminium floor plating. Each workshop container is equipped with heating and has a complete electric and compressed air line system for immediate connection to external electrical and pneumatic power sources.

Basic Mobile Workshop

The container can be delivered as a Basic Mobile Workshop without any tools or machinery for those who wish to equip the container themselves. In this version it has a workbench, 2.5 m long with vice and lockable

pedestal; shelves; tool-board with tool hooks; 14 m long hose roll-up for air pressure; 17 m long, 230 V electric cable roll-up; writing desk with lockable pedestal; powder fire extinguisher; first aid panel; ventilation system; and heating fan.

Mobile Workshop

The fully equipped version of the Mobile Workshop comes complete with standard tool kit, comprising all hand tools needed for carrying out service and repair work; 30 t hydraulic press, with mandrel set; 500 kg extensible hoist beam with manual tackle; and a small-part cleaning booth, with exhaust. The Mobile Workshop can then be completed with a number of well thought-out options of special tools, instruments and machinery to optimize efficiency. Mobile Workshops are suitable for installation of drill bit grinding equipment, and the Secoroc Grind Matic Manual B air-powered, handheld portable grinding machine can be supplied.

Mobile ROCKHOSE Workshop

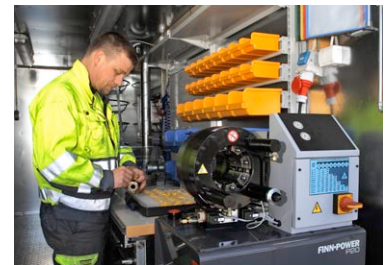
A new approach to hose maintenance is the Mobile ROCKHOSE Workshop with the hose assembly centre, a complete hose mounting workbench, designed to fulfil all your needs for a safe and professional assembly of hydraulic hoses with up to four reinforcement layers. The centre is delivered with a hose reel, cutting machine, peeling machine, marking machine, hose cleaning equipment and hose press. The centre is delivered with all the necessary accessories.



Each container has two main doors at the front that open completely, and on one side they have a window with steel shutter.



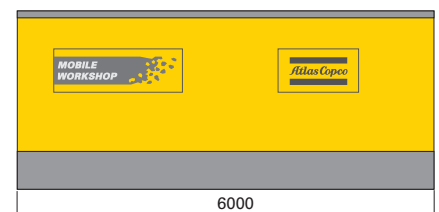
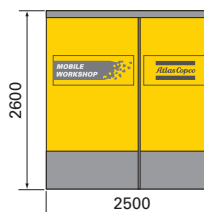
View inside fully equipped Mobile Workshop.



View inside fully equipped Mobile ROCKHOSE Workshop.

General information

The containers have a base socket provided for forklift transportation. The external dimensions of the containers are 6.0 x 2.5 x 2.6 m, and they weigh around 3 t, depending on equipment. The mobile workshops can be delivered for 230V/50 Hz and 380V/50 Hz, or other voltages on request.



Conversion table

This unit → Times → Equals

Length

mm (millimetre)	x 0.001 (10 ⁻³)	= m
cm (centimetre)	x 0.01	= m
dm (decimetre)	x 0.1	= m
km (kilometre)	x 1 000 (10 ³)	= m
in (inch)	x 25.4	= mm
ft (feet)	x 0.305	= m
yd (yard)	x 0.914	= m
mile	x 1609	= m

Power

J/s (joule/second)	x 1	= W
Nm/s (newton metre/second)	x 1	= W
kW (kilowatts)	x 1 000	= W
hk (metric horse power)	x 735.5	= W
hp (horsepower UK, US)	x 745.7	= W
ft.lbf/s	x 1.36	= W
Btu/h	x 0.29	= W

Volume

l (litre)	x 0.001	= m ³
ml (millilitre)	x 0.001	= l
dm ³ (cubic decimetre)	x 1.0	= l
cm ³ (cubic decimetre)	x 1.0	= ml
mm ³ (cubic millimetre)	x 0.001	= ml
in ³ (cubic inch)	x 16.39	= ml
ft ³ (cubic feet)	x 28.316	= l
Imperial gallon	x 4.546	= l
US gallon	x 3.785	= l
Ounce (Imp. fluid oz)	x 28.41	= ml
Ounce (US fluid oz)	x 29.57	= ml
Pint (US liquid)	x 0.4732	= l
Quart (US liquid)	x 0.9463	= l
yd ³ (cubic yard)	x 0.7646	= m ³

Force

kN (kilonewton)	x 1 000	= N
kp (kilopond)	x 9.81	= N
kgf (kilogramme force)	x 9.81	= N
lbf (pound force)	x 4.45	= N

Torque (moment of force)

kpm (kilopondmetre)	x 9.81	= Nm
lbf in (poundforce inch)	x 0.11	= Nm
lbf ft (poundforce foot)	x 1.36	= Nm

Equals ← Divided by ← This unit

This unit → Times → Equals

Mass (commonly but incorrectly called weight)

g (gramme)	x 0.001	= kg
t (tonnes, metric)	x 1 000	= kg
grain	x 0.0648	= g
oz (ounce)	x 28.35	= g
ozt (troy ounce)	x 31.10	= g
lb (pound)	x 0.4536	= kg
ton (long, US)	x 1 016	= kg
ton (UK)	x 1 016	= kg
ton (short)	x 907	= kg

Speed (velocity)

km/h (kilometre/hour)	x 0.2777	= m/s
m/s (metre/sec)	x 3.6	= km/h
mile/h	x 0.45	= m/s
mile/h	x 1.61	= km/h
ft/s (foot/second)	x 18.29	= m/min
ft/min (foot/minute)	x 0.3048	= m/min

Frequency

blow/min	x 0.017	= Hz
kHz (kiloHertz)	x 1 000	= Hz
rev/min	x 0.01667	= r/s
degree/second	x 0.1667	= r/min

Pressure

bar	x 100	= kPa
bar	x 100 000 (10 ⁵)	= Pa
kp/cm ²	x 0.98	= bar
atm (atmosphere)	x 1.01	= bar
psi (pounds/in ²)	x 6.895	= kPa
psi	x 0.06895	= bar

Area

mm ² (square mm)	x 0.000001 (10 ⁻⁶)	= m ²
cm ² (square cm)	x 0.0001 (10 ⁻⁴)	= m ²
in ² (square inches)	x 645	= mm ²
ft ² (square feet)	x 0.0929	= m ²
yd ² (square yard)	x 0.8361	= m ²
Acre	x 4 047	= m ²
Square mile	x 2.590	= km ²
ha (hectare)	x 10 000	= m ²

Equals ← Divided by ← This unit

Handwriting practice area with 20 horizontal dotted lines.

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Consult your Atlas Copco Customer Center for specific information.

Stay on schedule



- Scheduled service
- Inspection protocols
- Extended warranty
- Satellite monitoring

Your insurance to drill as planned

Lowest cost per tonne of rock is the true measure of your drilling investment. But even the best equipment needs regular maintenance. Emergency stops are too expensive!

The best way to ensure productivity is a ROC Care[™] service agreement. It guarantees you qualified scheduled OEM maintenance, insurance against unplanned costs, real-time rig performance data, and service documentation that boosts the value of your equipment.

It's simple and cost-effective for you. With Atlas Copco you get the lowest cost per tonne of rock, and always drill as planned.

Committed to your superior productivity

Signs of success



Smarten up your drilling business with Atlas Copco's SmartRig™.

Profit and growth in quarrying result from many factors, but you can only achieve the lowest cost per tonne of rock by ensuring rig availability and drilling capacity. With the Atlas Copco range of rigs you get productivity, durability and user-friendly control, all backed by service and support that ensures rig availability and low total cost of operation. After all, your productivity is the sign of our success.

Committed to your superior productivity

Find out more at www.atlascopco.com/rock

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