Hydraulic attachment tools

A glossary of machinery and methods

Epiroc

Foreword

Welcome to Deconstruction, Recycling & Earthmoving at Epiroc, the company which invented the hydraulic breaker!

We are proud of this innovation. When it was patented in 1963, the hydraulic breaker was the first hydraulically driven tool to be attached to a hydraulic excavator and it brought a completely new dimension to the capabilities of hydraulic excavators. The excavator became a universal tool carrier, which resulted in a much higher level of machine utilization and efficiency, bringing these advantages in turn to our customers.

So it all started with the hydraulic breaker and Epiroc's knowhow in this field is unique. Our innovations in breaker technology over the years speak for themselves: Combined Gas/Oil technology, the Solid Body concept, breakers without side bolts, AutoControl, and so on. But it hasn't stopped there…since then many other hydraulically driven tools have been added to the well-known Epiroc product family we call Hydraulic Attachment Tools. Each tool enables our customers to meet different challenges on the jobsite, in the mine, or in the quarry; tasks which require robust, powerful tools and which could not be handled with an excavator alone.

Thus, the attachment tools determine the versatility of the customer's tool carrier.

Today hydraulic attachment tools have become an essential part of mechanized tasks in most applications. These products can be found on every construction and demolition site and in every mine and quarry. They are assembled together with a carrier and adaptation components to form a highly productive working unit.

In this new guide you will find a glossary of machinery and methods used in the field. It covers carriers, attachment tools and adaptation possibilities, as well as related products. It is not limited to the Epiroc portfolio, other brands are also included. In the creation of this guide, many people and companies have kindly given us permission to use their images and content. We warmly thank you all for your cooperation, without it this guide would not have been possible.

Yours sincerely,

Torsten Ahr

Vice President Marketing Hydraulic Attachment Tools

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Carriers

Hydraulic attachment tools need a carrier to provide power for hydraulic functions and to move them into the working position. A carrier must be capable of performing the necessary movements loaded with an attachment in conditions typical for the application and do it cost efficiently. Therefore a carrier should be powerful enough to get maximum productivity out of the attachment, but not so powerful that it causes damage or premature wear to the attachment.

At the beginning of their era hydraulic attachment tools were typically carried by hydraulic excavators, but during recent decades several new carrier types have come into use. Rapid development of technology in the fields of hydraulics and electronics has made it possible to design more versatile carriers to be used with attachments requiring different features.

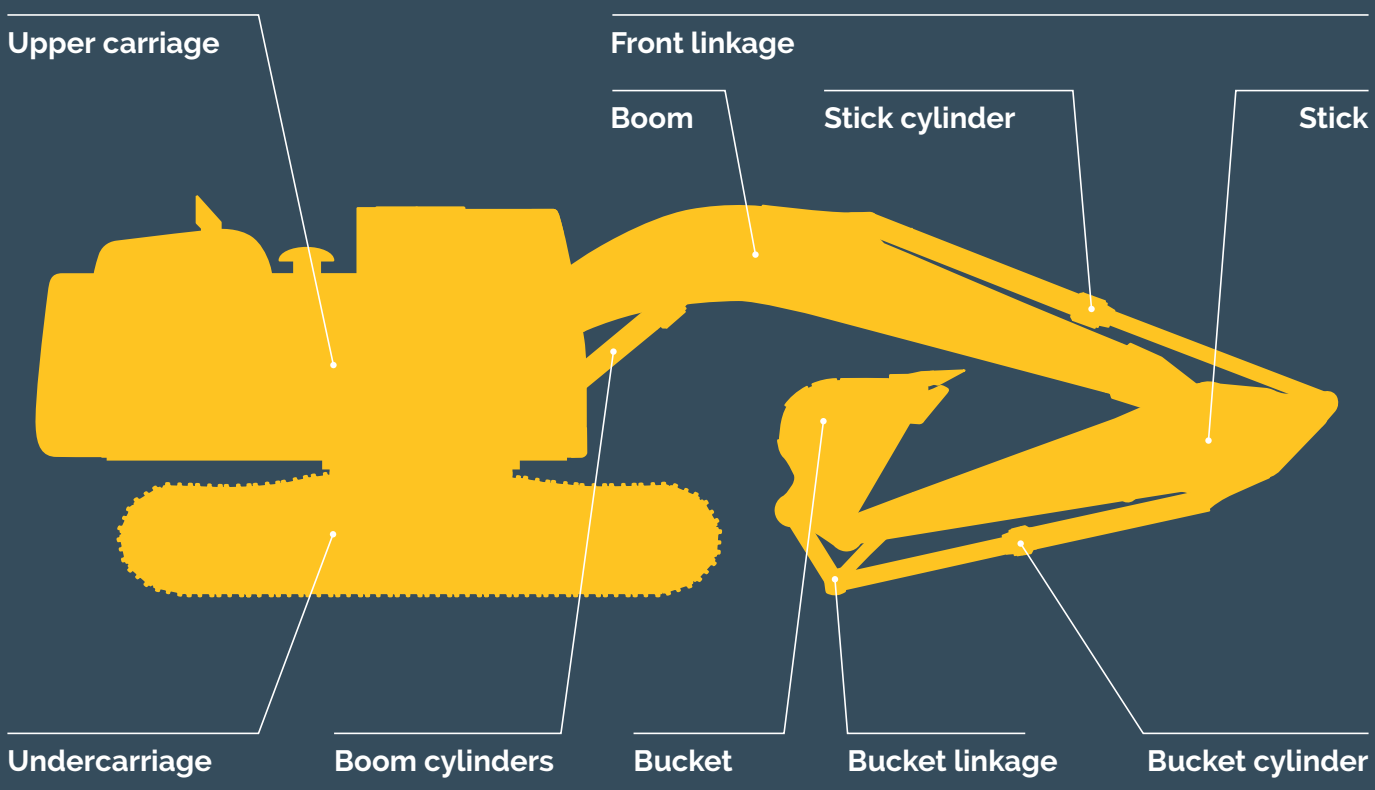
Since hydraulic attachment tools have become standard tools on all jobsites the demand for purpose-built carriers for special applications has increased. Good examples are demolition robots and pedestal boom systems.

On the following pages are presented the most common carrier types and some special machines for certain applications. To choose the right attachment for each application it is important to understand the main features and limitations of the different carrier types and to choose the right size class to match the other machines in the logistics chain.

Crawler excavators

Crawler excavators are the most common carriers for hydraulic attachment tools due to their stability, good lifting force and advanced hydraulic systems. Since crawler excavators are needed for certain tasks on most jobsites they are the obvious choice as carriers. The excavator is on the jobsite anyway and to also use it as a carrier will reduce downtime and save the additional costs of other machines.

The basic structure of an excavator is the same whether it is a small 1 ton mini excavator or an 800 ton giant. Very simplified, an excavator consists of three main components, undercarriage, upper carriage and front linkage. All of them are available in several different versions and with optional accessories that influence attachment selection.



Undercarriage
The frame of an undercarriage is usually a solid X-shaped iron box with track frames bolted onto it. The track gauge may also be adjustable, giving extra stability on a jobsite while the transport dimensions remain reasonable. Tracks are chains with bolt-on track shoes that are selected according to the application. The tracks are driven by hydraulic motors with sprocket wheels and guided from the other end by spring-loaded idler wheels.

Most popular excavator models are available with different track lengths. Extended track width and length gives more stability through extra weight and wider support points. Some excavators are equipped with a dozer blade that can be used as an extra support. Check the maximum load given in the specifications of the excavator.

Rubber tracks (right) are popular on small excavators. Steel tracks are typical for heavier excavators and they can be equipped with rubber pads if they are used mainly on paved surfaces. With minor modifications the same undercarriage can be equipped with either rubber or steel tracks.

Crawler excavators

Upper carriage (superstructure)
The upper carriage or superstructure contains the engine, hydraulic system, cabin and counterweight. The upper carriage may be a short radius version where the back of the frame doesn't swing over the track width. The upper frame rotates on a swing gear driven by hydraulic motors and the hydraulic power needed for the undercarriage goes through a swivel joint inside the swing gear.

The hydraulic systems of today are load sensing which means that hydraulic or electronic sensors measure the needed oil volume and pressure in the system and guide the pumps to produce it. The engine provides the necessary power for variable capacity hydraulic pumps that will supply oil to the hydraulic system on demand.

The operator controls the hydraulic system by means of joysticks and pedals. Pedals are used to control the track valves mechanically and often there are other pedals for auxiliary hydraulic functions to run attachments or accessories mounted on the machine. Joysticks control the valves via electric or hydraulic pre-steering. Electric pre-steering is supported by computer and all functions can be adjusted separately for each operator and even programmed to perform some functions automatically. A hydraulic attachment tool requires hydraulic flow at a certain pressure to work properly and some may need a free return line to avoid excessive back pressure. Check the specifications.

A simple but important part of the upper carriage is the counterweight at the rear. For the bigger excavators there are usually several different counterweights available to balance the machine with different dimensions of front linkage or heavy attachments.

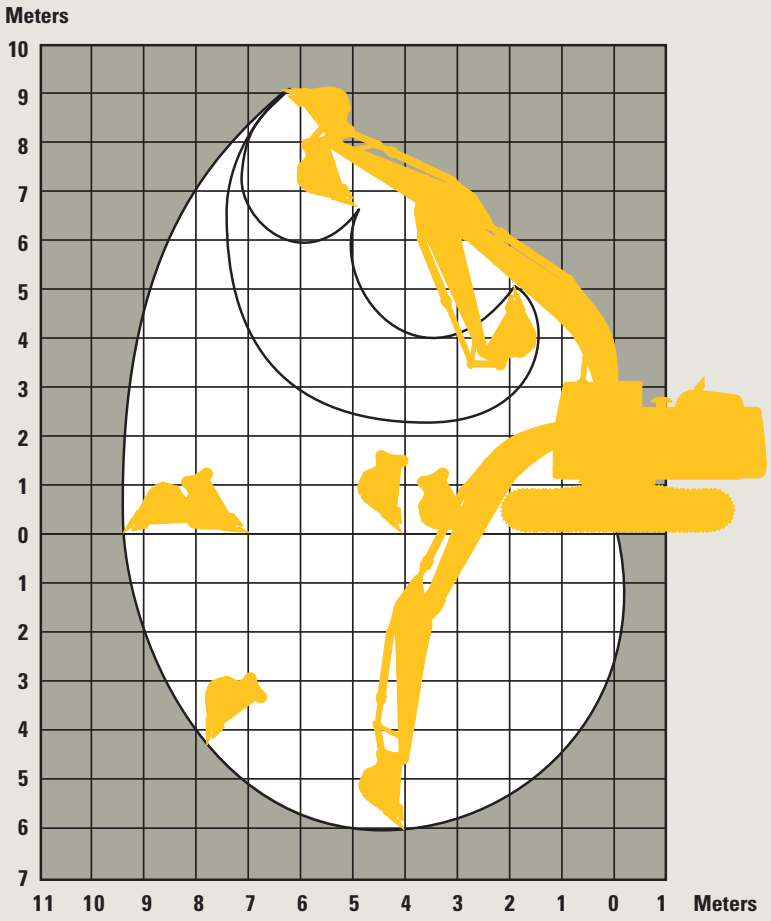
The engine is located directly behind the center point, the hydraulic system is in front of it on the right side of the boom, and the cabin is on the left. The bottom part of the upper carriage is a counterweight that is available in different weights.

Front linkage
The standard front linkage on crawler excavators consists of two sections, boom and stick, which are available in different length combinations. These sections are connected together and to the upper carriage with steel pins and bushings.

The front linkage is lifted and lowered with two boom cylinders and the stick is moved by a stick cylinder mounted above the boom. There is a bucket cylinder on a stick connected to the bucket linkage that will adjust the angle of a bucket or an attachment.

Hydraulic hoses and pipes are mounted on or inside the boom and on the side of the stick. At the end of the pipelines are the couplings for hoses from the attachment. On new excavators there are normally enough pipelines to run all needed attachment functions, but sometimes it is necessary to assemble more pipes or valves to get two functions from one line.

To choose the right attachment we need to know the front linkage dimensions, movement geometry and lifting forces of that combination. Refer to the working range drawings from the spec sheet to see the limitations.



Midi, mini & micro excavators

Midi, mini and micro excavators are crawler excavators on a small scale. The collective name for these carriers in this size range is compact excavators. The nominations vary according to the manufacturer but we can loosely call midi excavators everything between 6 and 13 tons, mini excavators 1 to 6 tons and micro excavators machines below 1,000 kg.

These small machines may have some special features that it is not possible to have on heavier machines while, on the other hand, some features are too expensive to incorporate.

The undercarriage is often equipped with steel reinforced rubber tracks and a dozer blade. On small mini excavators the track gauge can be hydraulically adjustable.

The upper carriage is usually a short radius version and the operator compartment can be a roughly designed cabin or just a canopy. The hydraulic system on the smallest machines is often simple and the oil flow may limit the useful range of attachments, although the latest models can usually provide enough power for all the attachments they can carry.

The front linkage of compact excavators is not exposed to heavy loads but the space on a jobsite may be confined and therefore the front linkage can have more moving parts than on bigger machines. The swing boom (offset), the side shift boom, and the articulated knuckleboom are devices that make it easier to work on wall sides or even around corners. These options increase the weight and change the geometry of a front linkage and you may need to choose a lighter attachment to be able to operate it in the proper way. Make sure you check the model specs, one letter after the number can change everything.

Demolition excavators

High-reach/longfront

While the demand to recycle construction material has increased the majority of high buildings from the last century have reached the end of their lifetimes and need to be demolished. To get the job done safely and to be able to sort different materials for recycling there is a growing market for carriers that can operate hydraulic attachment tools high above the ground.

The first high-reach carriers were modified big crawler excavators equipped with longer front linkage and extra counterweight, but today they are often purpose built at the factory to meet high standards of performance, operator comfort and safety.

The front linkage is the main difference compared to a standard excavator and not only because of length. The most common set-up for this is a long, straight main boom and a relatively short stick connected together by a short intermediate boom to give more range to move the attachment on top of it. On big high-reach carriers the boom may be mounted with a quick coupler and different lengths of boom can be changed at the jobsite according to the application. There are also some telescopic solutions on the market.

The heavy high-reach boom with a heavy attachment mounted at the end requires perfect carrier stability. This is achieved partly by the combined weight of the carrier and counterweight, but also by means of an undercarriage the dimensions of which can be adjusted hydraulically or mechanically. Most new machines have an active computer-aided safety system that limits boom movements when the center of gravity is close to the tipping point.

The upper carriage needs more hydraulic power to compensate for the pressure loss caused by height, and more hydraulic connections for an extended number of functions. The machine and in particular the operator's cabin need extra protection from falling objects. The cabin can be tilted to give the operator a better view of the attachment.

Long and high-reach booms always set special limitations for attachment weight and features. Check the specs of the carrier and consult with the manufacturer or dealer to confirm that the attachment is suitable for the carrier in the specific application.

Wheeled excavators

Wheeled excavators are very popular on small jobsites where relocation is needed several times a day and machine performance is not crucial to overall productivity. In many European countries traffic regulations make trailer transportation for crawler excavators too difficult and expensive and therefore wheeled excavators have become common even on jobsites where crawler machines would be much more suitable. Traffic regulations in these countries have set the standards for wheeled excavators' transport dimensions and structure even in countries where such regulations are not valid.

Although the basic principle looks the same, when it comes to technical details and features wheeled and crawler excavators are totally different machines. Because of their typical applications, wheeled excavators are designed to be versatile tool carriers that can handle all tasks on a small jobsite.

The undercarriage is built on two hydrostatically driven axles and on smaller machines there is the possibility to have four-wheel steering to reduce the turning radius and so-called grab steering to make the machine move sideways. The travel speed of an excavator may be 40 km/h when it is not limited by legislation. Typically there are hydraulic support legs (outriggers) and a dozer blade on the other end to stabilize the machine during operation.

The upper carriage and operator compartment are similar to the crawler excavator but wheeled excavators may need more hydraulic power for the undercarriage. They may also need a more powerful engine and extra cooling capacity.

The front linkage on a wheeled excavator is designed specifically for this type of machine. Because of the wheeled undercarriage the boom is mounted high above the ground and therefore the boom and stick dimensions and cylinder positioning are different. These machines are often used for lifting jobs or as carriers, therefore the front linkage is a compromise between features. A variable angle boom was originally created to reduce the transport length to meet European legislation but because of its other benefits it is common today outside that region.

Wheeled excavators are perfect carriers but when choosing the attachment, you need to pay more attention to the attachment weight recommendations provided by the manufacturer. Check the specs of the carrier.

Material handlers

Material handlers are designed for loading and sorting applications where good lifting force and accurate handling are essential. The hydraulic system is powerful but auxiliary functions are often limited to a minimum. Typically material handlers are used for one specific task around the clock and therefore versatility is not required.

Light material handlers are basically modified wheeled excavators equipped with suitable front linkage and wider outriggers to give more stability with heavy loads. Heavy material handlers are purpose-built special machines with wheeled or crawler undercarriages. The operator's cabin may be mounted higher or it may be hydraulically adjustable horizontally and vertically to give a better view of the suspended load. For some special applications the undercarriage may be 10 m high and trains can run between the tracks.

Material handlers are common carriers for all kind of grapples, clam shell buckets, lifting hooks and pallet forks. For scrapyard applications they may be equipped with steel shears or a Hydraulic Magnet. When choosing the attachment please confirm the maximum weight and available hydraulic connections.

Backhoe loaders

A backhoe loader is a combination of a small wheel loader and an excavator on wheels. Originally they were modified agricultural tractors equipped with a front shovel and a backhoe, but today they are purpose-built special machines.

The main body of the machine is a four-wheel drive tractor where the front wheels are smaller and steerable. On bigger machines wheels may be of equal size with four-wheel steering or with an articulated frame. The powertrain consists of a diesel engine and torque converter with a gearbox or a powershift transmission.

The hydraulic system is often very simple with a gear pump and manually operated valves. The oil flow for auxiliary hydraulics is quite modest and the valve system makes the operator's job a challenge when accurate movements are required. For demanding markets and applications there are well-equipped models available with load sensing hydraulics and electronic pre-steering for accurate and ergonomic control.

A front shovel or a loader is usually equipped with a bucket or pallet forks but it may also be used as a carrier for attachments such as asphalt cutters, brushes, snow blowers, grapples and many more. Auxiliary hydraulic connections are often shared with a backhoe by means of a distribution valve. When the backhoe is in use the loader is used as an extra support for the machine.

The backhoe is designed for light digging applications and for compact transport dimensions. There are two main types of backhoe that are popular in different markets and in some countries both of them are popular for different applications.

One common type is the sideshift backhoe with vertical stabilizer legs. The main feature is that the backhoe can be moved sideways for a better view of the tool and the backhoe boom can be folded close to the main frame for easy transportation.

Another backhoe type is centermount or center pivot where the boom is mounted in the middle and during transportation it hangs behind the machine. Stabilizer legs or thumbs are hydraulically adjustable and provide a wide support area and good stability for the machine. The benefit of this type is its simple design that enables greater lifting and digging forces together with a durable structure.

To increase digging depth and reach, backhoes are often equipped with a telescopic stick extension. This so-called knuckleboom is an articulated boom that makes it possible to dig on wall sides or behind obstacles.

When choosing an attachment for a backhoe loader the first thing to define is the size class of the attachment. Compared to excavators with similar digging and lifting forces, backhoe loaders are heavy machines and we cannot use the overall weight as a reference in selection charts. We need to follow the manufacturer's recommendations for maximum attachment weight.

The hydraulic capacity is normally big enough but connections for auxiliary hydraulics may be missing completely, or there are not enough of them.

Pedestal boom/rockbreaker systems

Pedestal boom systems are common carriers for rock breakers but they can also be used with grapples, shears or magnets for loading or sorting applications.

Small and simple booms are often used on a mobile crusher together with a small hydraulic breaker to break oversized rock boulders or concrete pieces in a feed hopper. Due to the short working range these booms have just one or two boom sections, which is enough to guide the breaker to hit the boulder that is often stuck in the same place. The hydraulic power needed can be taken from the hydraulic system of a crusher and the operator uses the same remote controller to operate the boom system and the crusher.

Big stationary gyratory crushers are common in mining and some quarrying applications. Pedestal booms need to have a wider working range to allow the breaker to reach all parts of the feeding inlet. The inlet diameter can be several meters wide and a few meters deep. If the crusher is located underground the height may be limited as well.

To avoid damaging the crusher or breaker it is important to be able to use the breaker at the correct angle and control it accurately. Booms for these applications have two or three sections and they have their own hydraulic unit to provide the necessary power. The boom and the breaker are operated by remote control. This is either from the operator compartment, which can be located with a direct view of the crusher or sometimes from the control room some distance away from the crusher.

Pedestal booms are also often used for loading and sorting applications, e.g., feeding metal scrap to a cutter, where the process can take place from one location. These booms are easy to mount in places where the operator cannot work and, if necessary, they can be controlled from the other side of the world.

Demolition robots

In simple terms, demolition robots are unmanned mini excavators but they also have special features that make them unbeatable carriers for some applications. When an operator compartment is not needed, it is possible to build the machine much lower and locate components freely on the upper carriage. All parts of these machines contribute to the performance and no dead weight is needed. This gives the best power/weight ratio compared to any other carrier type. As an example the Epiroc SB152 breaker is recommended for excavators from 1.9–4.5 tons, but an ideal demolition robot for this attachment weighs only 1–6 tons.

The undercarriage is similar to a mini excavator but it is also equipped with outriggers to give more stability on the uneven surfaces that are common in demolition applications. Although rubber tracks are standard on small robots, bigger units are often equipped with steel tracks for higher reliability and to achieve greater stability by lowering the center of gravity.

Most demolition robots are powered by electricity but gas and diesel engines are also available. Robots are often used for indoor applications where an electric motor has some important advantages. It is easy to start, silent, exhaust free, powerful, and it doesn't need a fuel tank or batteries that may cause problems if the machine rolls over on a jobsite. The electricity is often produced by a portable generator and power is transported by long cables.

The hydraulic system is controlled by electric pre-steering guided by the operator with a wireless remote controller. Thus the machine can be operated without operator exposure to noise and dust, or risk of injury from falling structures. The remote controller makes it possible to work on applications that are too dangerous for an operator, such as nuclear plant demolition, some tunneling jobs and demolition or deconstruction of high structures.

The front linkage consists of a 3-section boom that gives a wider operating range and enables the machine to work under low ceilings or other obstacles. The robot can work where the operator must kneel down. The boom is mounted very low on the central point of the swing gear which gives good lifting force with a light counterweight.

When choosing an attachment for a demolition robot it is important to follow the recommendations of the manufacturer. The advanced hydraulic systems of these little giants pose no limitations but the weight of an attachment or useful working range of a boom may set limits in some cases.

Pontoon/on-barge excavators

For some special applications it is necessary to use the attachment underwater or on the water. For these demanding tasks there are several custom-made solutions available and a few purpose-built amphibious carriers that have opened up a whole new market for hydraulic attachment tools.

For occasional jobs it is common to use a standard excavator as a carrier and drive it onto a barge or mount pontoons under it to allow it to float. The problem here is anchoring and stabilizing the vessel to be able to work on it with a heavy machine. For this reason there are special pontoons and barges available with long stabilizer legs that can reach down to the bed of the river, lake or sea allowing the excavator to work normally. This kind of solution is common for light dredging and bridge renovation applications, for example.

Some contractors specialize in light dredging operations and there are special machines available for them. One option is to replace the track frames of an excavator with pontoons and the tracks roll over them. This solution makes the machine amphibious. It will float thanks to the pontoons and it can travel short distances on the ground with tracks. This makes it an ideal carrier for soft marshlands and swamps where a boat cannot be used and an excavator will sink. Another special machine is a light barge or a heavy boat equipped with a front linkage mounted on deck. These watermasters are commonly used for light suction dredging and pole driving jobs.

Heavy and deep dredging applications require long reach booms and greater digging force from the excavator. These jobs are often major seaway or harbor maintenance contracts which can take years to complete. Therefore purpose-built on-barge excavators are a competitive solution. One version of this is to remove the track frames and tracks from the crawler excavator's undercarriage and bolt it onto a barge, so that the barge and the excavator become one solid unit. The barge is often supported from the seabed by stabilizer legs and the excavator can thus utilize its maximum force.

Scalers/scaler rigs

Several different carriers can be used for scaling if they are small enough to work in a tunnel and if they are equipped to protect the operator and the carrier against debris flying from the working tool and rocks falling from the roof. However, the working range of the front linkage must be suitable for working upwards. Scaling machines are often equipped with a compressor and a water spraying system to protect the breaker and the carrier from flying debris and dust.

Scaler rigs are special machines for tunneling applications in underground mining and in road or railway tunnels. They are articulated four-wheel drive machines equipped with a front linkage that is optimized for working upwards. Heavy scaler rigs from Epiroc, for example, use the upper carriage of a Brokk demolition robot mounted in front of the carrier frame.

The main body is low and narrow to allow travel through confined tunnels and the operator cabin can be lifted or tilted to give a better view of the working tool. The frame and the operator cabin are protected against heavy loads from falling boulders. Scaler rigs may be powered by a diesel engine or with electricity transported via cable from the big reel mounted on the machine.

Choosing an attachment for a scaler rig or other carrier may be a challenge. The machine may weigh 5 times more than an excavator suitable for the same breaker, so follow the recommendations of the manufacturer. In underground construction jobsites the scaled roof can be 20 m high or a tunnel may offer only 3 m free space in which to operate. Study the application carefully and consult the carrier manufacturer.

Skid steer loaders

Skid steer loaders are versatile machines that are also used as carriers for various hydraulic attachment tools. As the name suggests, these machines are steered by turning the wheels on one side with the wheels on the other side either locked in position or turning in the opposite direction. Thus, when the machine is in motion, some wheels are always skidding, sideways or forwards and backwards.

The loader booms are located on both sides of the operator cabin and mounted on the back end of machine. This design gives high lifting force compared to the machine weight and makes it easy to move the center of gravity rapidly. Some talented operators can utilize these features to run the machine on two wheels and jump over obstacles.

The combined features of the steering system and the loader pose an increased risk of damage and premature wear to attachments and working tools. To avoid problems it is recommended to choose the biggest possible attachment that the loader can carry and operate. Mechanical strength is required to withstand strong forces from unfavorable directions.

The hydraulic system is relatively small and, especially on older machines, it sets the limits for hydraulic attachments. Another issue is that the front loader and many of the most common attachments for skid steers use two way hydraulic cylinders and hydraulic motors and the valve system and lines are designed for that. This may cause problems with hydraulic breakers and other attachments where the back pressure of the return line should remain at a low level. It is sometimes necessary to solve this by fitting an extra return line direct to the tank.

With skid steer loaders it is essential to choose the right attachment and proper mounting bracket to avoid damage. With a skid steer loader an operator can break any attachment easily if he is not careful to operate it in the correct way. Study the application and provide proper start-up training for the operator.

Wheel loaders

A wheel loader is an articulated four-wheel drive machine with a loader boom in front. The hydraulic system is very powerful but the number of valves and hydraulic lines is limited to boom and bucket cylinder movements and one or two auxiliary lines.

Heavy wheel loaders and underground loading machines are mostly used for their original purpose with a bucket, but for some applications they are suitable carriers for hydraulic attachments as well. As an example, a multigrab for stone loading or a heavy breaker for boulder breaking in a quarry or mine are useful solutions.

Light loaders below 20 metric tons are often designed to be used as carriers for different tools and attachments. Big manufacturers have integrated tool carrier versions of their most popular models. The boom of these machines is straight and gives a good view of the tool or pallet forks. It also has a few extra auxiliary hydraulic lines and a hydraulic quick coupler as standard.

Wheel loaders are potential carriers for some special applications. Here a hydraulic breaker is mounted on an underground loading machine for boulder breaking.

Mini loaders

A mini loader is a small wheel loader with an articulated frame or four-wheel steering. These machines were originally designed for light loading applications and they have taken market share from skid steer loaders as partners for mini excavators. With the development of hydraulic systems they have also become more popular as carriers for all types of hydraulic attachments. Today, due to their ease of operation and good operator visibility, mini loaders are no longer designed for professional users only, but also for recreational applications.

The hydraulic system set the limits for attachments but with these machines it is important to pay attention to operator safety as well. Light, compact machines tip over easily and the operator compartment is often poorly protected from flying or falling objects.

Telescopic handlers

Telescopic handlers or telehandlers are versatile machines that have great potential as carriers. The structure of a basic telehandler is very simple: four-wheel drive, four-wheel steering, and a straight telescopic long-reach boom. They are powered by a diesel engine with an advanced hydraulic system. There are three main categories of telehandlers and all of them have good features as carriers.

A loader type telehandler is often used in applications where good lifting capacity is needed but wheel loaders have insufficient reach or are too clumsy. Loader telehandlers are very low and narrow machines to allow them to enter confined spaces, and their four-wheel steering makes them very agile. The smallest units are common in agriculture, while heavier versions are used in industry yards and in mining applications. Lifting heights for loader versions vary from 5 to 10 m and lifting capacities from 1 to 23 tons.

Rigid frame construction telehandlers, or compact telehandlers are technically similar to loader versions but, in addition, they have stabilizer legs in front. Thanks to better stability they may reach from 10 to 20 m with maximum lifting capacity from 1 to 5 tons. These machines may be approved for platform work and therefore they are often remote controller ready.

Rotating telehandlers are the highest level of this machine group. The undercarriage is four wheeled with strong support legs on each corner for maximum stability. The upper carriage has an engine, a hydraulic system and a long-reach telescopic boom. The upper carriage is free rotating and hydraulic power for transmission and for the support legs goes through a swivel joint to the undercarriage.

Rotating telehandlers have become the heart of the construction site with their versatility and wide working range. These machines have reach capabilities from 14 to 30 m and lifting capacities up to 5 tons. The most common applications are lifting and platform works and most of them have a radio remote controller as standard.

The rotating telehandler is a versatile machine for various applications. Here it is being used as a carrier for an Epiroc Perfora Girodrill 200 drilling machine in a dimension stone quarry.

Other carriers

When we think out of the box we can find potential carriers for many special applications and some are so common that we don't even notice them. Trucks and utility vehicles, for example, have a hydraulic system and quite often they are already equipped with a crane or loader. Agricultural tractors have powerful hydraulic systems and can move fast on the road and off-road. With the right accessories and suitable modifications these popular vehicles could be carriers for many attachments.

Even if there is no hydraulic system on the carrier itself, it can be used as a carrier if the hydraulics can be produced by another unit. A hydraulic powerpack with its own engine or electric motor can be located almost anywhere and the oil can be transferred to the attachment with long hoses. Another machine, such as an excavator or a wheel loader, can be used as a powerpack with the first machine working as a carrier. The example in the photo below shows an excavator supplying hydraulic power to a pulverizer suspended from a tower crane.

Kaiser produces special wheeled carriers for slopes and rough terrain.

JAMA produces special carriers for scaling and other underground mining applications. The latest new model breaks over-sized stones with an Epiroc HB 3100 DP breaker in Kiruna Mine in Sweden. This carrier is not self-propelled and it will be moved between the job-sites by an underground loading machine.

Adaption

Adaptation of an attachment to a carrier is a crucial part of combination. The basic rule for adaptation is that the attachment is mounted to an adapter without play, to avoid bolts working loose and causing damage during operation. The adaptation should be designed to give the attachment the widest working range without risk of damage to the carrier. It should also be as light as possible, but durable.

Adaptation is performed in countless different ways around the world. Most carrier types require their own kind of adaptation and there are side classes with different dimensions. In some applications one carrier uses one attachment all the time, while another carrier needs to change attachments several times an hour. Requirements can be totally opposite.

In addition to cold facts there are cultural factors that influence the adaptation method chosen. In some markets it is common for each attachment to have its own carrier while others prefer to have one carrier for all necessary attachments. Therefore quick couplers are common in some cases, while others are happy with pin mounted adapter plates or mounting brackets.

When hydraulic excavators became common at jobsites in the late 60's there were numerous local manufacturers and each had their own standard for adaptation. When the first quick couplers were invented by those companies later on, they became standard in markets where those brands had a big market share. Even today, when most of those machine manufacturers have merged and most of the brands are history, these old standards live on.

New manufacturing methods and technical innovations in hydraulics and electronics have brought new opportunities for adaptation. Today the adaptation may be done with a solid steel adapter plate or by a smart adaptation unit that can perform some carrier or attachment actions for the operator automatically.

Whatever the adaptation system there is always one common aspect when we mount the adapter on top of the attachment. The dimensions of the plate should correspond to the measurements of the attachment's mounting surface, and the thickness of the plate should fulfill the minimum requirements necessary to withstand the forces to which it will be exposed. The bolt pitch or bolt hole pattern must be precisely correct so that all bolts fit their holes and can be properly tensioned. To avoid extra stress on bolts both surfaces must be machined flat and polished to remove paint and dust before assembly.

Another important thing to remember with hydraulic attachment adaptation is that these attachments require hydraulic oil at a certain flow and pressure. The need for hydraulic connections may limit the useful adaptation methods and offset some of the benefits gained from quick coupling systems.

When it comes to the attachment, the number one rule of thumb for adaptation is to keep it as simple as possible. The fewer the moving parts and the more simple the hydraulic connections, the less trouble with the attachment. Stick to reliable basic solutions, it is easy to upgrade them later on if necessary.

Epiroc offers a wide range of accessories for adaptation. Read more in the leaflet **Installation Accessories for Hydraulic Attachment Tools.**

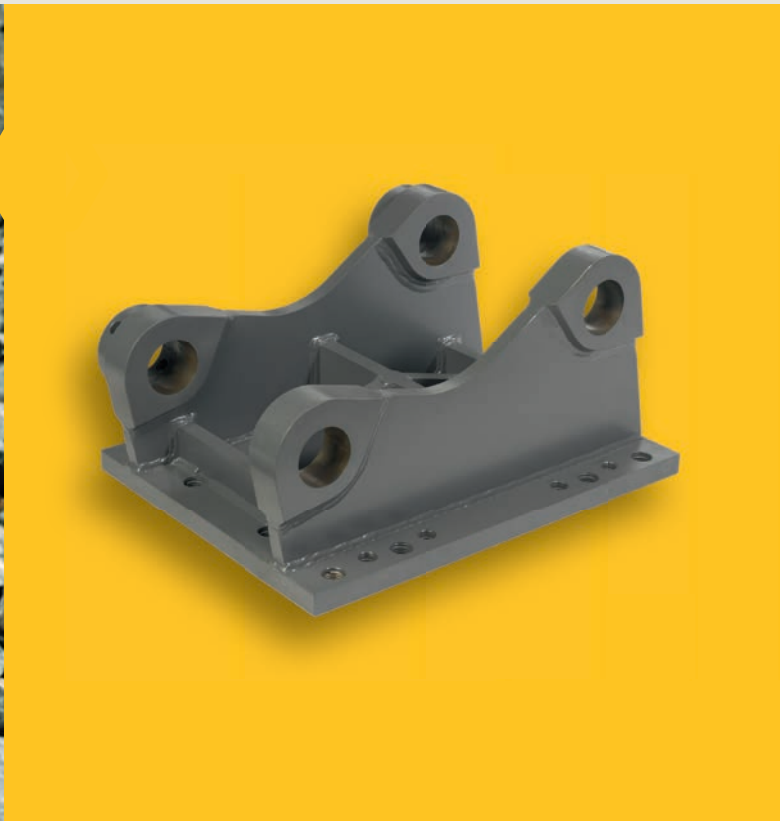
Standard adapter plate

The basic solution for adaptation is a standard adapter plate that is mounted on the attachment with bolts and onto the carrier with pins. This is always recommended when it is not necessary to change the attachment very often. Typical applications of this type are quarries and recycling terminals where machines perform the same job day after day.

This adaptation minimizes the distance between a carrier and an attachment and therefore enables utilization of the maximum force and working range that the carrier can provide. There are no moving parts and the few wear points are easy to repair. It is the lightest and yet the strongest adaptation method with the cheapest possible price.

The problem with the standard adapter is that it is carrier specific. Most of the carriers have different measurements and front linkage geometry so the adapter plate must be custom made for each carrier model. However, the measurements of some excavators, for example, are so close to each other that the adapters may be modified by changing the bushings for different pin dimensions and using shim plates to match the stick width to the measurements of the adapter.

To make sure you get the right adapter plate, confirm the machine model, year model and the serial number from the machine data plate. On excavators this plate is normally located on the right side of the cabin. To be sure, measure the width of the stick and the pin dimensions. Another important factor is the distance between the pins that influences the working range, movement speed and force of an attachment. The easiest way to find out this distance is to measure it from the standard bucket of the machine. If it is not available, measure the length of both parts of the linkage moved by bucket cylinder.



Side mounted bracket

In some market areas it is common to use side mounted brackets to mount the attachments, particularly breakers, on a carrier. Like the standard adapter this is carrier specific but it can be equipped with an adapter to fit the boom dimensions, or a quick coupler.

Quick coupler

A quick coupler is an adaptation system that makes it faster to change attachments on a carrier, and to use the same attachment for different carriers. A quick coupler system consists of two main components, the quick coupler mounted on the carrier boom and the adapter plate mounted on the attachment. As long as these two parts are made to the same standard, it is possible to change attachments without a problem.

The main problem with the quick coupler is the wide variety of different standards. Some coupler systems were originally designed by a certain machine manufacturer or exclusively produced for them by a supplier. Therefore some old standards are still popular in the markets where these machines were popular, but they may be totally unknown outside the market borders. Unfortunately this quite often means that manufacturers and dealers don't have these components in stock and they need to be ordered on a case by case basis.

Another problem with the quick coupler is that, after some time, the interface between components will work loose and the moving parts will wear. A quick coupler is a machine that needs maintenance in order to work safely and to withstand the stresses from the carrier and the attachment.

There are several types of coupler available and in this section we will take a look at the different categories. Although the focus here is on excavator couplers, the main principles are applicable to loaders and other carriers as well.

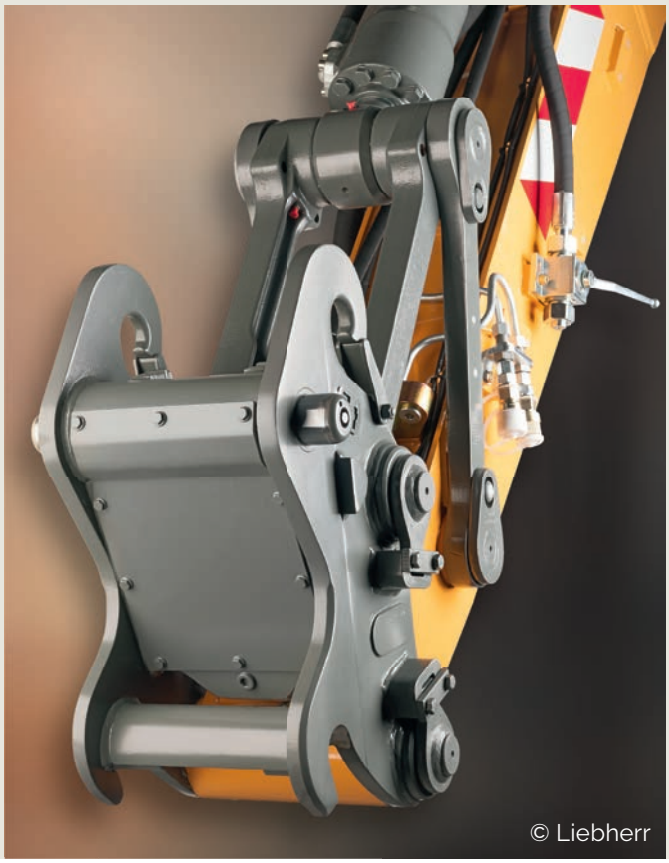
Mechanical
A mechanical quick coupler refers to the system where the adapter plate is locked onto the coupler mechanically with a wedge or bolts, or by tightening the parts together with a screw. In some wedge locking coupler types the wear must be compensated by adding shim plates between the components. In screw tightened models the wear is compensated by tightening the screw.

The mechanical quick coupler is a light and cheap solution and very often it is quick enough. It requires the operator to exit the cabin to lock the connection but on the other hand the operator needs to connect the hoses for the attachment manually anyway. With big machines and heavy attachments the risk of an accident increases when the operator needs to approach the coupler before it is locked properly. Sometimes the operator needs to move the carrier to get the connection locked and that may be too difficult to do alone.

Quick coupler

Hydraulic
The hydraulic quick coupler is an advanced version of a mechanical coupler and basically there is just a hydraulic cylinder to do the locking. The adapter plate for the attachment is exactly the same, therefore the same attachments may be used for carriers with either mechanical or hydraulic couplers, provided the standard is the same. The operator does not need to exit the cabin to lock the coupler but he needs to be sure that the coupler is locked properly before starting to operate the machine. He can check that when connecting hydraulic hoses to the attachment.

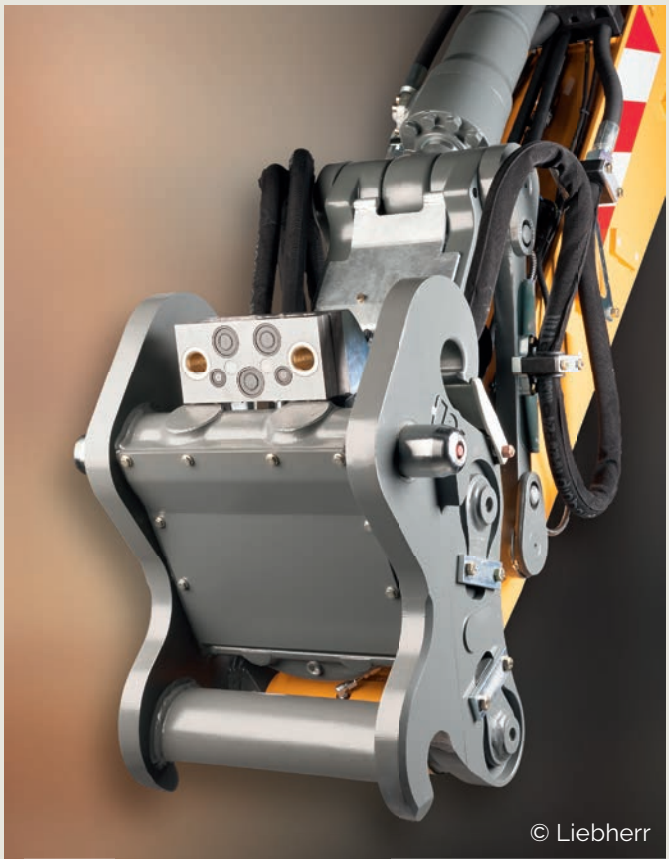
The most important safety issue with hydraulic couplers is to avoid unlocking by accident. Therefore it is recommended that the hydraulic line for the coupler should incorporate an electronic valve controlled by a separate switch so that the unlocking function requires two simultaneous actions by the operator. On new carriers this function is normally built in at the factory.



Fully hydraulic
The fully hydraulic quick coupler is the latest generation of adaptation and makes it possible to connect all attachments without exiting the cabin. The coupler is like a hydraulic quick coupler but in addition there are also quick couplings for hydraulic hoses inside the coupler. On the attachment side all hoses are connected to the adapter plate and when the coupler is attached to an adapter these hose couplings get connected at the same time. When connection is this simple the operator can easily choose the optimal attachment for each task on a jobsite.

A fully hydraulic coupler is naturally very fast and easy to connect, but it also provides some extra benefits during use. When hydraulic hoses are connected to an adapter plate they can be shorter and they don't need to move. Therefore hoses are cheaper and they can be protected from damage, which increases their lifetime. When hoses don't need to move, the connection joints last longer. The same benefits also apply to the carrier, short hoses that are easy to protect. When the operator does not need to think about avoiding damage to hoses all the time he can work more efficiently in confined spaces.

A fully hydraulic quick coupler system is flexible and the number of hydraulic connections may vary according to the attachments. A similar quick coupler system is also available for the booms of high-reach demolition excavators. The operator can change the complete boom system when a different boom length is required on a jobsite. For example, the same machine can be used for high-reach demolition and for pulverizing on the ground.



Tiltable couplers and tiltrotators

Tiltable couplers
Tiltable couplers were originally developed to make it possible to tilt an excavator bucket when leveling surfaces and shaping slopes, but this device is also useful with some other attachments. The structure is very simple, a quick coupler with one extra linkage that makes it possible to tilt the coupler to an angle that may be 90 degrees on both sides depending on the structure.

The basic model is simply tilted by one or two hydraulic cylinders, but the problem is the cylinders may damage walls, or the cylinder and the hoses may be damaged. Another solution is to build a tilting mechanism inside the linkage pin, where a threaded axial piston forces the coupler frame to turn.

Rototilt/tiltrotator
The most advanced adaptation method today is a tiltable and rotating quick coupler, often called rototilt after the trademark of one of the first Swedish manufacturers, or tiltrotator as some others want them to be called. This multi-functional device has become a standard on wheeled excavators and on crawler excavators used for construction applications in the Nordic countries. It makes it possible to use a big excavator for demanding and accurate jobs with less need to move the carrier. With this device and the right attachment an excavator can perform all necessary machine work on a small construction jobsite.

There are two different structures for tilting the coupler. The basic model is simply tilted by one or two hydraulic cylinders, but the problem is the cylinders may damage walls, or the cylinder and the hoses may be damaged. Another solution is to build a tilting mechanism inside the linkage pin, where a threaded axial piston forces the coupler frame to turn.

The rotating system is based on a swing gear and a hydraulic motor that rotates the lower part. Each manufacturer has a slightly different structure but the latest generations have become compact and reliable.

Extension jibs

For some special applications it may be necessary to extend the length of the carrier's front linkage to get more reach and working range. Extension jibs are also used to protect the carrier from harsh conditions on a jobsite, such as high temperatures, corrosive or flammable liquids, etc. These jibs are common on telescopic handlers and wheel loaders, but in some applications they are useful on excavators as well.

Extension jibs are often custom designed but some specialized manufacturers have a wide range of them available from the book. The jib may be mounted on a coupler like other attachments so it is an easy solution for temporary needs.

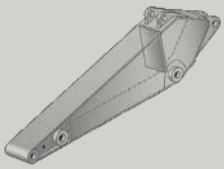
Stick exclusion and shortening

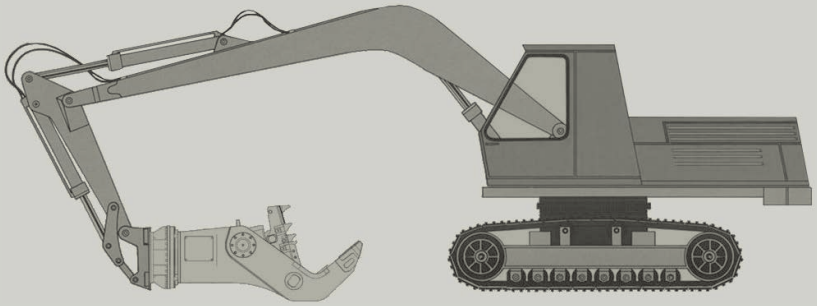
Heavy excavators are very expensive to buy and the operating costs are multiple compared to smaller machines. However, some applications require heavy attachments that require a lot of power from the carrier. If the attachment weight is too much for a smaller excavator but there is enough hydraulic performance, the solution may be stick exclusion or shortening when long reach is not the critical factor.

The trick itself is quite easy to do. Just remove the stick from the boom and make an adapter plate or a quick coupler that fits the measurements of the boom and pins. Another option is to produce a shorter stick or modify the original one to the required dimensions. This solution gives a wider working range and easier positioning of an attachment.

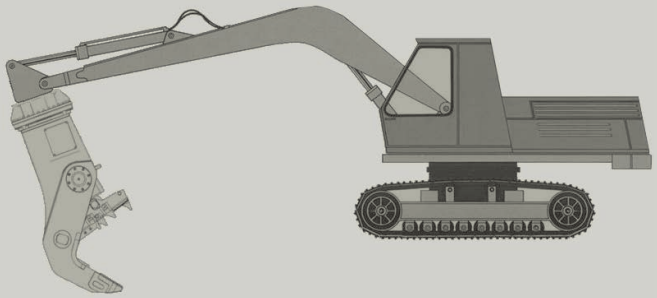
Before starting this kind of modification it is essential to contact the manufacturer's representatives to confirm the functionality of the new set-up and its possible influence on the warranty. Big manufacturers have several stick options for their machines and in an ideal situation the required length is available over the counter.

Stick mounted





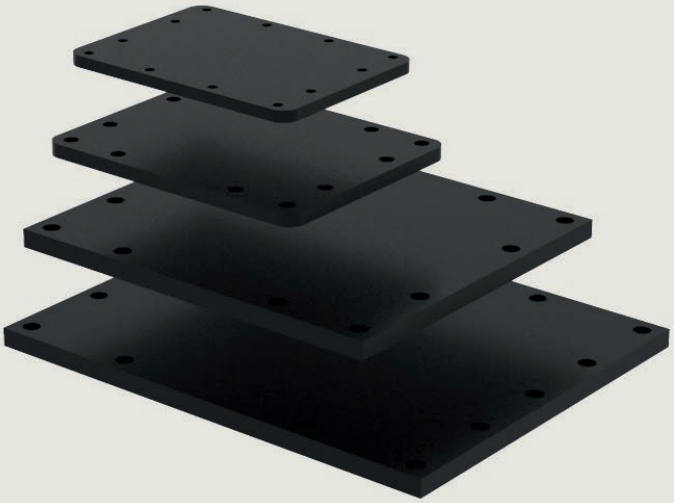
Boom mounted



Base plates

To ensure that the bolt pitch and dimensions of the adapter plate are exactly right, Epiroc offers base plates for each attachment model in its range. All bolt holes are pre-drilled and the plate is cut to precisely match the mounting surface of an adapter. These plates can be used as a base onto which the adapter parts can be welded.

Base plates are available in two versions. The through boring version is meant for adaptation with long bolts and nuts. With some adapter types there is not enough space to mount the bolts and tighten them. Another option is a plate with helicoil inserts in holes where the bolts can be tightened without nuts from below and the adapter can cover the whole plate without a problem.



Bolts and nuts

Bolts and nuts are a small but important part of adaptation where no-one can save much money but may lose a lot. It is essential to follow the instructions of the attachment manufacturer when it comes to the size and strength class of the bolts and nuts. It is strongly recommended to order them together with an attachment and to replace them when there are signs of weakening. Follow the instructions for tightening torques and check the torque on a regular basis.

Hydraulic adaptation

Hydraulic adaptation is the most crucial aspect of getting the attachment functioning properly; most of the problems with attachments are actually carrier problems. On the following pages there is information about the necessary components, but even more important is to know and understand how the hydraulic system works in the specific carrier and adjust it to provide optimal hydraulic flow and pressure for the attachment.

The operating manuals of a carrier and an attachment contain essential information on how the machine is designed to operate. A computer-assisted hydraulic control system on a carrier offers a lot of new opportunities but it can also make it impossible to work with an attachment if we don't know how the system is going to behave. It is strongly recommended to consult the local carrier distributor if we don't have experience of the specific machine already.

The hydraulic system of a carrier must be adjusted as described in the operating manual using recommended components from quality suppliers. It is always essential to verify hydraulic flow and pressure with a pressure gauge and check that the pressure relief valve or oil flow divider is set to the right value.

There are excellent videos available on YouTube which show how to install hydraulic attachments. Please watch the movies from the links on this page and you will learn the main principles that are valid for most attachments.

Epiroc breaker installation and operator instructions video

Epiroc Combi Cutter installation and operator instructions video

Hydraulic flow and pressure must be measured before connecting an attachment to a carrier for the first time.

Hoses
Hoses are one of the most important parts of any hydraulic system. In the worst case scenario, problems with hoses may bring work on a jobsite to a halt for one day or they can destroy the hydraulic system of a carrier. Saving 50 euros may cost 100,000 euros when things go wrong. It is always recommended to use original hoses provided by the manufacturer.

The quality of hydraulic hoses and connections must fulfill the demands of surrounding conditions, oil flow and pressure, oil quality and the demands of adaptation. For carrier safety the rubber quality inside the hose must be able to withstand the mechanical stress of oil flow and pressure together with constant bending when hoses move. Small pieces of rubber will clog the filters and in some systems they may jam the valve block and damage the hydraulic pump. The rubber must be suitable for use with the chemicals used in hydraulic oil over a wide temperature range to avoid foreign chemicals dissolving in the oil. Minor changes in oil consistency may change the characteristics of the oil and cause premature wear and damage to the carrier and the attachment. Some biodegradable oils in particular may have chemicals that can damage the hydraulic system.

Inside the hose there are normally textile and steel weave layers and radial steel wire reinforcement to withstand the pressure inside. This structure is designed to handle a certain constant pressure and the peaks that are possible in that pressure range. The maximum working pressure is printed on a hose and it should never be exceeded.

The outer surface of the hose holds the structure together and protects the hose from external stress and conditions. It should be suitable for the typical conditions of an application and there is a wide selection available for all demands. Hoses can be protected against external wear and damage by steel or plastic springs or a textile outer surface.

The inner diameter of the hose must be big enough to cope with the desired oil flow. Hoses that are too small will increase the flow resistance and pressure inside the hose and eventually increase the oil temperature. These factors will cause attachment malfunctions and leaks in the hydraulic line.

The hose length must fit the setup of connections on the attachment and carrier in any possible movement of the attachment. A hose that is too short will break up and damage the connections, a hose that is too long may be damaged easily and will place extra stress on connections. Check the correct length when the attachment is adapted on a carrier.

Hydraulic adaptation

Couplings
There are basically two kinds of couplings, screw-on and quick couplings, and countless variations on them. The rule of thumb for couplings is – the simple the better. Screw-on connections are cheap and they are easy to seal to maintain the pressure without leakage. Best of all, they won't choke the oil flow.

Quick couplings are easy to connect and disconnect but they have some disadvantages. In most of them the inner diameter is smaller than the pipeline and they choke the oil flow which often causes the attachment to malfunction. Proper sealing in high pressure lines is challenging and after numerous connections they may start to leak.

Before choosing the coupling type it is good to consider if it is really necessary to have quick couplings. If an attachment will be mounted on the same carrier most of the time there is no reason to choose quick couplings. Whatever the connection type it is always important to keep the connections clean and plugged when they are disconnected to prevent dirt and moisture from entering the hydraulic system.

Pipelines
On new carriers there are normally enough pipelines for all attachments, but with the older ones and some special machines it may be necessary to add more. One typical case is the need for a free return line to the tank for attachments that cannot tolerate the backpressure.

Pipelines should be big enough to cope with the desired oil flow and maintain the necessary pressure. Tight corners and connections choke the oil flow and they should be avoided. All materials should be compatible with the hydraulic oil used in the conditions of the application.

In some applications there is a high risk of foreign particles entering the hydraulic system and extra filtration may be needed on the return line. A filter on the return line is a cheap insurance to avoid damage to the carrier and attachment and it will prolong the lifetime of the hydraulic oil.

Some carriers have additional fine filters to remove the smallest particles from the oil and these filters are recommended for all carriers. They will offset their cost by prolonging the lifetime of the oil and the hydraulic system.

Hydraulic adaptation

Valves and control systems
On some carriers there is not enough valve capacity for all the required attachment functions or the valves don't allow the necessary adjustments for oil flow and pressure. Sometimes it is possible to add more valves to the existing valve block or replace the whole valve system with a new one. A complete new system may be worth considering, for example, if it is necessary to change the valve control system from mechanical to electronic.

Electronic pre-steering enables several hydraulic functions to be controlled by one joystick.

Fortunately, in most cases it is possible to use the existing hydraulic line and mount an additional valve on it. This valve can be used for adjustments and control only, or it can also distribute the oil flow to several lines. It is good to locate the distribution valve as close to the attachment as possible to minimize the need for pipelines and connections.

Typically a new valve is needed when an on-off valve is going to be replaced with a proportional valve for more accurate and soft movements of an attachment. Attachments with hydraulic motors quite often need a valve that can control the rotation speed accurately. Street cleaning brushes, bush cutters, grinders and drills are some examples of these.

Remote controllers are sometimes needed for security reasons or to get a better view of the job. Today there are easy solutions available at reasonable prices that enable remote control of all or some of the machine's functions. If the valve system already has electronic pre-steering it is very easy to modify, but for mechanical valves and hydraulic pre-steered valves there are solutions available.

Some frequent machine and attachment functions may be worth automating to allow the operator to focus on something more important.

For example when the wheel loader operator lifts the rotating brush up from the street it stops and starts to rotate again when lowered. Some excavators can keep a hydraulic breaker at the same angle while the operator is lowering the boom to protect the breaker and the working tool.

The computer system of a modern carrier has a lot of useful functions to make operating the machine easier. Some of these functions may influence the attachment choice and it is good to know what possibilities are available.

The radio remote controller releases the operator from the cabin to get a better view of the tool.

Hydraulic attachment tools

The technical development of carriers and hydraulic systems has made it possible to design more sophisticated attachments for these machines. Several functions that were against the laws of physics twenty years ago are now possible to implement by means of a computer aided hydraulic control system. Thanks to new technology, attachments can be much lighter and compact, but even more powerful than before.

While machines have become more capable the demand for new functions and completely new attachment types has grown even faster in the industry. The more common the attachments become, the more ideas and needs come from the field.

Attachment development is driven by rising labor costs and increasingly tough safety regulations everywhere. Many small jobs that were previously done using handheld tools are now mechanized with hydraulic attachment tools.

On the following pages are some typical hydraulic attachments that are currently available. This list can never be up to date or complete, not even today. Many of these attachments are only needed in certain markets, but perhaps seeing them here will generate ideas on how they can be used for totally new applications elsewhere.

Hydraulic breakers

Hydraulic breakers are the oldest hydraulic attachments for carriers. The first serial manufactured hydraulic breaker was the Krupp HM 400 in 1967 and the patent was secured in 1963. Hydraulic breakers are impact devices designed to break any kind of rock or concrete with any hardness or physical property. They have a wide range of applications such as demolition, deconstruction, primary rock excavation, secondary rock breaking, trenching, foundation work, asphalt cutting and many others.

The working principle is as simple as it was thousands of years ago when human beings raised and accelerated a weight to impact on a chisel. The difference within a hydraulic breaker is that the weight, called an impact piston, is raised and accelerated by hydraulic force and guided in a hydraulic cylinder to impact on a chisel called the working tool.

The lifting and acceleration of the impact piston is controlled by a hydraulic valve integrated either in the cylinder or in the cylinder head which is enclosed within the device. This device is called a power cell and in modern breakers it is supported and protected in steel framed boxes which are equipped with internal suspension to reduce vibrations and the noise of the breaker in operation.

Together, the power cell and the breaker box combination is referred to as a rig mounted hydraulic breaker. To install this rig mounted hydraulic breaker on carriers like an excavator, one needs an adapter plate to adapt the breaker to the dimensions of the carrier.

Today our rig mounted hydraulic breakers are available from ~ 50kg to more than 10,000kg of operating weight for any kind of carrier. Over

sixty years of development of the hydraulic breaker has produced advances at different levels, such as self-lubricating systems, sound & vibration damped systems, automatic rock hardness adjusting systems, energy recovery, solid body concept and much more.

Epiroc (Krupp) was not only the inventor of hydraulic breakers but has also always been one of the most innovative hydraulic breaker manufacturers. One of the most innovative developments is the AutoControl feature where the breaker from one impact to the next impact measures the rock hardness and at the same millisecond, self-adjusts the impact energy for the next stroke. Another great innovation is the Solid Body concept where the power cell is integrated into the breaker box in one and the same body.

Epiroc
Hydraulic breakers

Epiroc
Hydraulic breakers
video

Gravity impact hammers

The gravity impact hammer is a breaker that produces extremely high impact energy and a very low impact rate, from 10 blows per minute. Suitable applications for this breaker are hard rock primary breaking and oversize block and boulder breaking in quarries and on construction sites.

The working principle is simple. A steel weight is lifted up by a hydraulic cylinder and dropped down freely on a striker pin. Therefore the attachment is relatively big to allow maximum dropping height for the weight.

Hydraulic Magnets

A Hydraulic Magnet is an attachment where a hydraulic motor powered generator creates a magnetic field below the bottom plate. The magnetic force is used to hold steel particles and with rapid demagnetizing the particles drop immediately. The operator controls the functions by means of the hydraulic system and no other connections are needed.

These magnets are used in demolition and recycling applications for loading the vehicles, feeding the crushers and separating out the steel from other material. They are good for removing the steel from demolition and construction jobsites, tunnels and bridges where steel can harm pedestrians or vehicle tyres.

Epiroc
Hydraulic Magnet

Bucket Crushers

A Bucket Crusher is a small jaw crusher that is mounted on a carrier. In the most common solution the bottom of the bucket is fixed and one moving jaw crushes the material against it. This jaw is moved by an eccentric element that is mounted on an axle rotated by a hydraulic motor. For adaptation it normally requires pressure and return lines and, in addition, one free shock line to the tank.

Bucket Crushers are used to crush the demolition material on a jobsite to be used for backfill for a new building or to be transported to a customer. On construction sites they can crush the stones excavated from the jobsite and the aggregate can be used for construction. In quarries and gravel pits they can crush boulders after prescreening and small amounts of soft stones.

Epiroc
Bucket Crusher

Bucket screeners and crushers

A screener bucket is a trommel screen where hydraulically driven drums rotate inside the bucket and separate oversized material with eccentric discs that allow fines to flow between them. Softer material like peat and wood bark is also crushed during the process. Screener buckets are usually mounted on an excavator or a wheel loader. For adaptation it normally requires pressure and return lines and, in addition, one free shock line to the tank.

Screener buckets are used for screening all kinds of organic and mineral material. They are common in screening waste and landscaping materials, screening padding material for pipelines and backfill for construction. They are also used as crushers for, e.g., gypsum, glass waste and many other soft or fragile materials.

There are also special screener crushers that are technically similar to screener buckets, but they are stronger in construction to withstand greater stress and wear. These crushers may be equipped with specific cutter blades or hammers to be able to crush certain types of material. Screener crushers can be used as mobile crushers in soft stone quarries where they can excavate, crush and load the material in a single operation work-cycle.

Compactors

The hydraulic compactor is an ideal machine for applications where the task is to compact soil on slopes or in confined places where self-moving plates or rollers cannot operate. Good examples are pipeline backfills and road or railway slopes. The hydraulic compactor has very good compaction performance and it makes it possible to add thicker layers on a backfill. When adapted by a quick coupler, the same excavator can easily perform filling and compaction without waiting for a separate machine.

The hydraulic compactor consists of four main components. The bottom plate is made of wear resistant steel and the eccentric element bolted onto it gives it a vibration force. The eccentric element is rotated by a hydraulic motor that requires pressure and return lines from the carrier and sometimes also a shock line to the tank.

This vibrating lower part is mounted on a top frame with rubber pad absorbers. On top of the frame can be a hydraulic rotator or free rotating plate where the adapter plate is mounted, or sometimes it is bolted directly to the frame.

The latest invention is a hydraulic roller compactor that can be mounted on a carrier boom. Inside the rollers is a hydraulically rotating eccentric element that provides vibration for the machine. Another type of compactor is a compactor bucket, where a conventional bucket is equipped with a vibrating element and absorbed from the adapter plate by rubber pads.

Epiroc
Hydraulic compactor

Pulverizers

A pulverizer is a machine that crushes demolished material between one fixed and one moving jaw to reduce the particle size and to separate iron from other material. There are two main categories of pulverizers but definitions vary a lot between manufacturers and similar equipment may be called by different names.

A bulk pulverizer or cruncher is designed to pick up demolished material from the pile and therefore many customers don't need a rotator for it. Without a rotator the machine is lighter for precise movements and shorter to get maximum digging power. The jaws are wide and equipped with teeth to crush the concrete and to hold iron between them to be dropped onto a separate pile. For long iron bars and wires there are short steel cutter blades to cut them.

A demolition pulverizer or crusher is designed to crush the material straight from the wall and to pick up the iron. These attachments are mostly equipped with a hydraulic rotator for easier positioning to a target. It is a particularly good solution for renovations when it is necessary to avoid damage to other structures from collapsing elements or when there's no room to handle the rubble on a jobsite. Pulverized material is also easier to remove from the building with loaders and conveyors. On a small demolition jobsite it can replace a separate cutter and pulverizer by performing both actions with one bite.

Epiroc
Bulk and Demolition
Pulverizers

Combi Cutters/multiprocessors

Combi Cutters/multiprocessors are designed to enable a single host frame and cylinders to accept different, interchangeable jaw variations, each designed for a specific application.

For different applications there are various working jaws available including concrete cutting jaws, pulverizing jaws, steel cutting jaws and others. They are found on demolition jobsites where they are mainly used as primary demolition cutting tools.

For optimum operation, Combi Cutters/multiprocessors have 360° integrated rotation devices. Also, the hydraulic installation on the carrier is more sophisticated in comparison to other hydraulic attachments such as hydraulic breakers. While hydraulic breakers require a single direction hydraulic circuit, Combi Cutters/multiprocessors require a bi-directional circuit for opening and closing, plus an additional installation for rotation functions.

Epiroc
Concrete Cutters

Concrete busters

Concrete busters are dedicated concrete cracking machines for breaking concrete. They are very similar to Combi Cutters/multiprocessors when they are equipped with concrete cutting jaws, but they are stronger in design. Concrete busters are used for very thick concrete wall structures, such as building foundations or for very tough applications, such as long front demolition where the operator has restricted visibility. Some of the bigger Concrete busters do not close their jaws completely which allows them to achieve wider openings. The focus on these machines is to have the widest possible jaws opening (1 to 3m) to bust thick concrete walls.

The carrier installation is the same as for Combi Cutters/multiprocessors.

Epiroc
Ecxavator concrete busters

Steel shears

A purpose-built machine for steel cutting, a steel shear is an efficient tool for demolishing steel structures where large steel plates or steel girders must be cut. Ships and airplanes are examples of typical applications where it is important to avoid generating sparks and flames but good cutting performance is needed. Scrapyards are another important customer group for these attachments.

A typical design for a steel shear is a fixed pair of jaws and a single non-fixed jaw that moves between them, cutting the steel like scissors. For maximum cutting force there is a large hydraulic cylinder which makes the frame very long compared to the jaws. Steel shears are equipped with hydraulic rotation and they need two two-way hydraulic connections.

Epiroc
Steel cutters

Orange peel grapples

Orange peel or onion grapples are common nicknames for multi jaw grapples. Originally developed for scrap handling, with different jaw designs they can handle almost anything. There are countless different designs on the market with 3 to 6 moving jaws, each equipped with its own hydraulic cylinder. On some versions all the jaws are closed mechanically by one hydraulic cylinder. On some designs the grapple can be closed mechanically by the lifting force of the carrier.

Multi Grapples

Demolition and sorting grabs are universal tools for demolition, sorting and loading all kind of materials. The name Multi Grapple is quite a good description for them. The basic structure is quite simple and similar for all brands: a rigid main body with two moving jaws mounted on both ends of the frame. The jaws are powered by one or two hydraulic cylinders and they are connected together with a steel bar so that they move simultaneously. For heavy applications these grapples are always equipped with a powerful hydraulic rotator but for light loading and sorting jobs a tilt rotator can replace it.

The design of the grapple is always a compromise between features needed for different applications. For sorting it is essential to have fast movements and precise control of jaws that penetrate the pile easily, whilst for demolition it is more important to have a powerful and strong tool where weight is a plus.

To make a Multi Grapple even more versatile it can be equipped with various accessories for different jobs. Some of the most typical are steel plates to make it a clam shell bucket, teeth for rock handling, wood cutter blades inside the jaws, etc.

Epiroc
Excavator grapples

Drum Cutters

A Drum Cutter is an attachment where rotating drums equipped with picks, strategically positioned around the outer diameter, are rotated by a hydraulic motor at several hundred revolutions per minute to cut rock, concrete or frozen ground. The picks that perform the cutting job are wear resistant, exchangeable teeth.

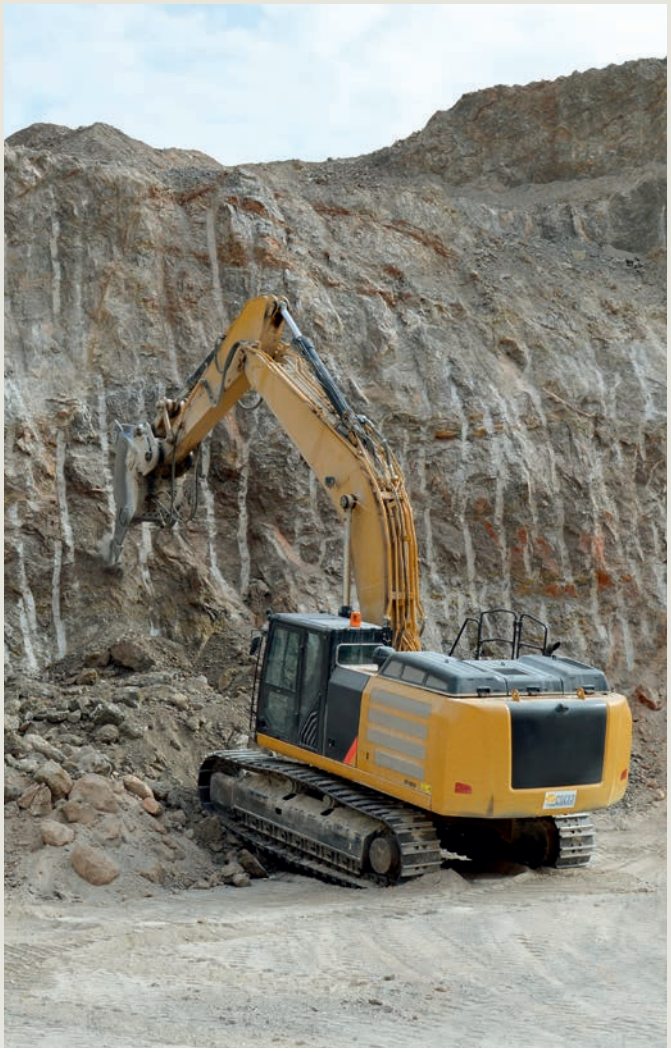
Drum Cutters can be used for rock excavation, demolition, underground scaling, tunnel profiling, trenching and other applications. The excavated material can be used for backfill without separate crushing.

Drum Cutters can also be used underwater without modification at depths of up to 30m.

Epiroc
Drum Cutters

Vibration ripper

A vibration ripper or eccentric ripper is a tool for rock, trenching or frozen ground excavation. The working principle is a combination of active penetration by vibration and ripping out of material utilizing the boom force of the excavator.



Asphalt/concrete saw

The hydraulic asphalt or concrete saw is an attachment where a cutter blade or blades are rotated by a hydraulic motor and a gearbox. Blades are equipped with wear resistant steel or diamond teeth that are harder than the material being cut.

Hydraulic saws are becoming popular in utility and road maintenance applications where they can replace walk-behind saws or mechanical cutter blades on excavators. On demolition jobsites they are versatile tools that can be used to cut walls and floors and on renovation jobs to grind grooves for pipelines and gables, cut openings for doors and windows, etc.

Dust suppression systems

When rocks and construction materials are crushed and handled dust is created that can be a problem, both for the jobsite and the surrounding area. In urban areas the regulations demand that the dust is kept strictly within the construction site or quarry.

The simplest way to stop dust flying around is to spray water on it, but water is always a problem on a jobsite and therefore smart solutions are needed to limit the amount of water to a minimum. It's known that mist can suppress the dust efficiently with a very small amount of water and there are different ways to produce this mist cloud precisely where it's needed. One way is to spray the water to an airflow created by a blower or compressor. This airflow is directed to the source of the dust and it will come down as mud.

Another way is to spray the water with high pressure from small nozzles as close to the material crushing process as possible. High pressure gives a thick mist with very small drops and is effective with small amounts of water.

In some applications, such as rock drilling and certain indoor jobs, a dry vacuum suppression system can be used to suck the dust from the source and collect it in bags or a container.
For indoor demolition and renovation jobs some parts of the building are often protected by sealing them with plastic film and tape to keep the dust in a limited area. These indoor systems are equipped with filtration to keep the air as clean as possible for the workers.

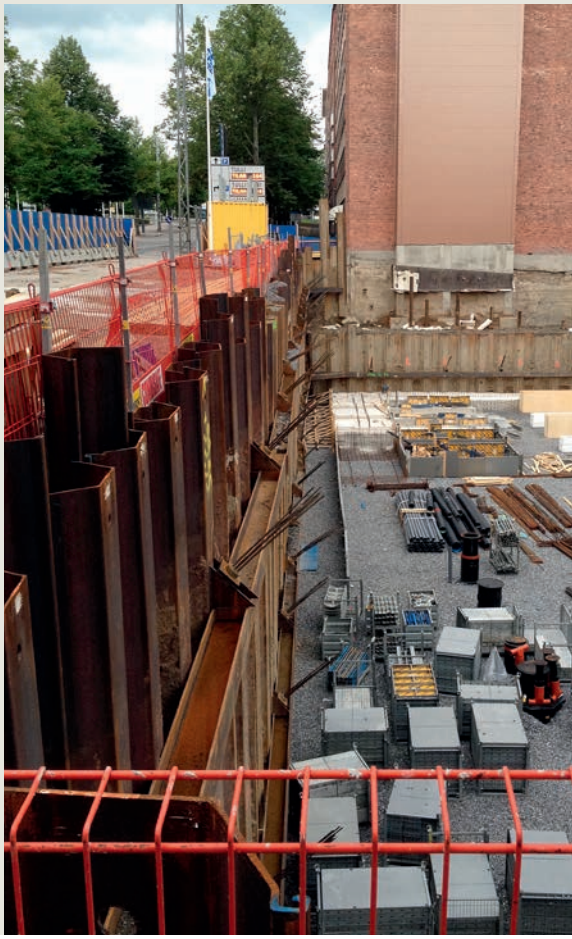
Sheet pilers

Steel sheet piles are used to support the ground around the excavated hole on construction sites. In some countries they are mandatory to protect workers from collapsing earth and mud from the wall. Sheet piles are often driven into the ground first, side by side, supported by each other, and then the earth is dug from one side of the piles. After excavation these piles create a solid steel wall that can hold the earth behind it.

Most sheet pilers are purpose-built machines that grab the pile from the top or side, lift it up and drive it down by vibration and with the help of the weight of the machine and the pile itself.

Technically the machine's main components are a frame and clamp unit to hold the pile and the eccentric element to create vibration for the clamp. There may also be a tilting device to adjust the piles vertically and a rotator to turn the pile in right direction.

On a small jobsite these piles can also be driven down by a hydraulic compactor or eccentric ripper equipped with clamp that can hold the pile during driving and pulling off.



Post drivers

Post drivers can be based on two main working principles, vibration or impact force. Post drivers are special attachments that can be mounted on almost any carrier depending on the application.

Small posts or rods can easily be driven by vibration, which is also a gentle method that avoids breaking or bending the posts. Post drivers based on the vibration principle are equipped with an eccentric element that creates the vibration and a clamp that grabs the post from the top or side. The weight of the unit together with the vibration drives the post into the ground.

Posts can also be driven down by impact force created by a percussion mechanism. Depending on the structure of the machine the impact force is often provided by a hydraulic breaker, or just an impact mechanism, or a small handheld breaker modified to fit the machine.

Pile drivers

Small, short steel piles can easily be driven into the ground by a post driver. However, big, long foundation piles are driven by purpose-built machines. For steel piles the driver can utilize a hydraulic impact mechanism, but for heavy wooden and concrete piles or poles the impact force used is usually gravity.

Pile drivers are often modified heavy crawler excavators equipped with a high tower that holds the pile and guides the gravity weight to hit the pile. The weight is lifted by the hydraulic system and dropped freely.

Post borers

Post borers are simple drilling machines that have a hydraulic motor and a gearbox to reduce the rotation speed. Below the gearbox there is a shank where augers of different sizes are mounted.

Post borers are used to drill holes in the ground for posts or piles. They are also used to drill holes for crop plantation or to obtain earth samples. Equipped with a suitable adapter they can also drive threaded piles or rods.

Epiroc
Post hole borers

Ground stabilizers

Ground stabilizing is a method of making soft and often wet ground solid by mixing in concrete or chemicals. The job can be done by injecting the material into the ground at high pressure or by mixing the chemicals and earth mechanically. There are various ways to do this and there are special hydraulic attachment tools available for this purpose.

One example is the rotating drum mixer, where two rotating mixer drums are mounted on a long main body and powered by a hydraulic motor and a gear transmission. Concrete powder or another stabilizing chemical is sprayed through the body against the rotating drums, resulting in an even mass that will create a solid ground layer following a chemical reaction. Crawler excavators are the most common carriers for these hydraulic attachment tools.

Brushes and sweepers

Hydraulic brushes and sweepers are popular tools in utility and construction applications. Mounted on wheel loaders, tractors and trucks they are popular for road cleaning and mounted on excavators they are handy attachments on demolition and construction jobsites.

Depending on the application and carrier they can either move the dust aside or collect it in a container. They may be equipped with a water sprayer for dust suppression or to make the cleaning easier. In some special applications they may have steel or bronze brushes to grind concrete surfaces.

Felling heads

Felling heads were originally developed for felling timber in logging applications. However, mounted on excavators, they are becoming popular in construction applications for removing trees from the construction site. Another growing market for these attachments is removing trees from roadsides and residential areas. An excavator with a felling head can cut the trees and fell them safely and no difficult clean-up work is required afterwards.

Technically, felling heads are simple, reliable attachments. The hydraulically tiltable main frame is equipped with grapple arms that hold the tree during the cutting and felling process. Cutting is performed mechanically with blades when the arms are closed or with a separate hydraulic blade, a so-called guillotine. Heads for bigger trees are equipped with a chainsaw rotated by a hydraulic motor and pressed against the trunk by a hydraulic cylinder.

Harvester heads

Harvester heads are multipurpose attachments that can cut, fell, delimb and cut the tree to the desired dimensions with the help of a computer. The most popular carrier for a harvester head is a purpose-built forestry machine and then the complete package is called a harvester. Harvester heads are often mounted on crawler excavators and used to clear the construction site of trees. Typical applications are roads or pipelines in remote areas or construction sites where the amount of timber is too small to justify using special machines.

A harvester head is a highly complicated and expensive hydraulic attachment tool requiring a very skilled operator and constant maintenance. The tiltable main frame has a hydraulic chainsaw for gutting, grapple arms to hold the tree, de-limbing arms to gut the twigs from the trunk and feed rollers or tracks to move the trunk through the head. A large number of electric hydraulic valves are located inside the main frame and controlled by a computer system via CAN bus or a bundle of wires.

While the trunk goes through the head there are sensors on the delimbing arms or feed rollers to measure the diameter and a separate wheel to measure the length. Using this information the computer can control all functions in the head and on the most sophisticated versions it can communicate with the server of a forestry company and optimize the cutting to meet orders from the sawmill. It can also report the logging volume interactively and based on that information the server can guide haulage machines and timber trucks to pick up logs from the right location.

Crushers and screens

In quarry and demolition applications it is essential to understand the whole process and to choose the right attachment it is crucial to know the next step in the logistics chain. In most cases the material will be processed with a crusher or screen and quite often both are used.

There are several different types and size classes of these machines and they all have their demands regarding the type of material that can be fed in. Some of them can take bigger boulders and harder stone, while others can accept iron and other foreign particles. The feed material has a strong influence on the productivity and reliability of these machines so it is crucial to know the demands on material quality before the first bite from the wall or the first hit on the stone.

Some of these machines can be platforms, e.g., for pedestal booms and hydraulic breakers, and this also makes their owners an important customer segment for hydraulic attachment tools.

In large quarries and gravel pits there can be a number of different crushers and screens feeding each other and producing more than ten different fractions of aggregates and sand. That makes it even more important to know and respect the demands on material quality from the beginning. Epiroc withdrew from mobile crusher and screen production at the beginning of 2015. The power crushing machines shown are no longer available.

On small jobsites and in special applications hydraulic bucket crushers and screens can do the job.

Stationary crushers

Stationary crushers are standard machines in mines and large quarries where a machine can work for years at one location and the material can be transported to it by conveyors or trucks. Typically the crusher is a large gyratory crusher with an oscillating cone inside a bowl and stones are crushed between the cone and bowl. Quite often there are several crushers in a row to mill the stones to fine sand before separating minerals in a chemical process. Stationary crushers are powered by large electric motors and they need a reliable electricity supply or a powerful generator to keep them running.

To achieve maximum performance a gyratory crusher needs homogenous material with optimum stone dimensions. That material quality is often the result of secondary or primary breaking in a quarry and to meet the demands a breaker and a carrier must have the right features. They must be big enough to be able to break the stones in a quarry and keep up the needed productivity, but at the same time they need to be as small as possible to keep the investment and operating costs at an acceptable level.

Stationary crushers in recycling applications are often big jaw or impact crushers depending on the material and the stage of the process at which they are located. These recycling plants may have several different crushers, screens and trommels for material reduction and sorting.

Mobile crushers

As the name indicates, mobile crushers are relatively easy to move from one jobsite to another and around the quarry or demolition jobsite. In most cases they are equipped with a diesel engine that makes them independent of power sources. Mobile crushers may be mounted on feet or wheels, but most new units are mounted on a crawler undercarriage that gives them good maneuverability on rough terrain and makes them stable to operate without extra support.

Mobile crushers can be roughly divided into three main categories by the crushing principle. Jaw, impact and cone crushers have their own unique features that are important to understand. From the outside these different crusher types look similar and many of the main components are exactly the same.

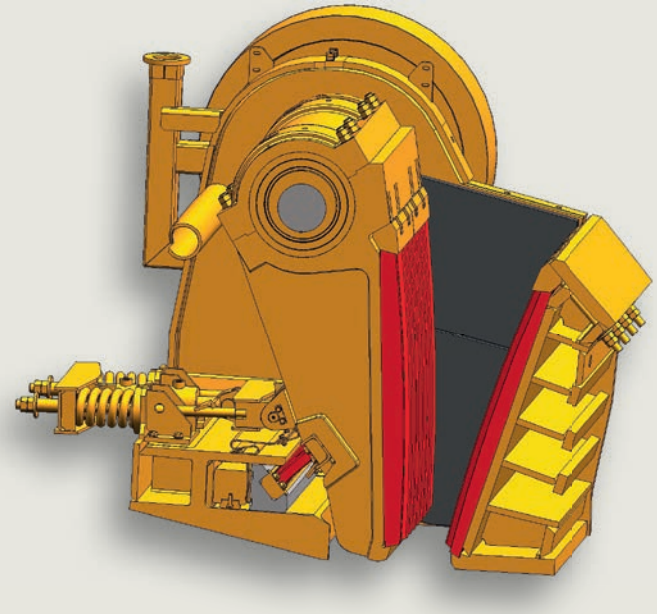
The working principle of the feed hopper is based on vibration created by an eccentric element in the machine. There is a pre-screener in it to improve crushing performance by preventing fine material from entering the crusher. An apron feeder is often used on cone crushers where maintaining the correct feeding amount is crucial to product quality.

A main conveyor removes the material below the crusher box and transports it forward to a pile or straight on to the next step in a process.

On all crusher types the moving parts are driven mechanically by the flywheel that is rotated by direct belt transmission or a hydraulic motor.

Mobile crushers

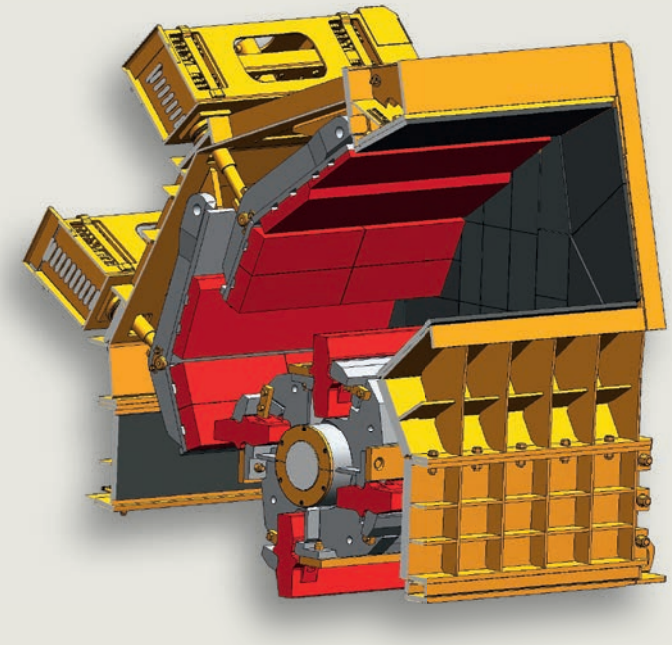
Jaw crusher
The most common and versatile crusher type is a jaw crusher. The material is dropped into a breaker box, where a moving jaw crushes the stones against a fixed jaw and the aggregate drops down onto a conveyor to be piled.



Thanks to its working principle the jaw crusher can handle hard rocks and uneven stone sizes, including big boulders. Therefore it is not sensitive to the feed material and that makes it popular at hard rock quarries and for use as a primary crusher when it is necessary to produce fine fragments with several crushers in a row.

In demolition applications it can handle rubble in the form of large pieces of concrete containing iron and other foreign inclusions. This makes it possible to use efficient demolition methods since the material can then be crushed by light pulverizing and the metal separated out. Most crushers can be equipped with a metal separator on the conveyor belt and the crushed material is ready to use for backfill.

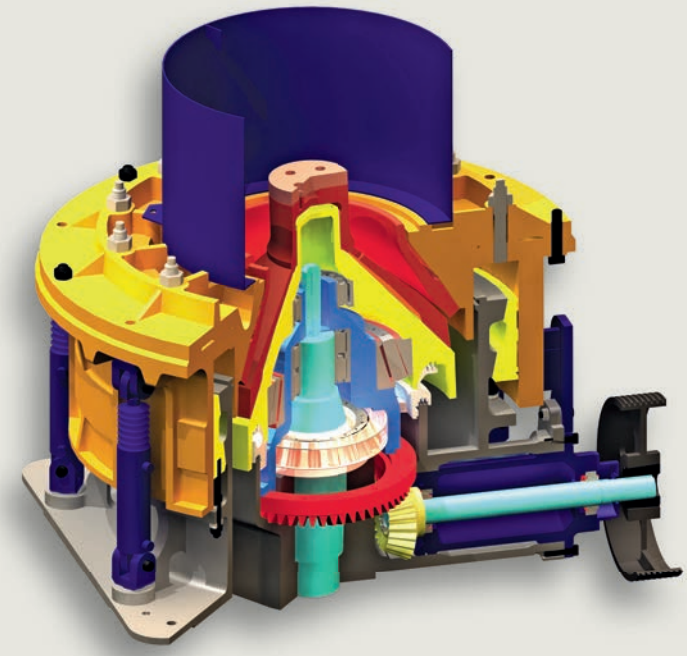
Impact crusher
The crushing principle of an impact crusher or hammer crusher is that stones are fed into the crusher box and a rotating drum equipped with hammer bars throws the stones against swing beams mounted on the breaker box as an anvil. In the crusher box crushing takes place in three stages. The first is when the hammer hits the stones, the second is when the stones hit the swing beam, and the third is when the stones hit each other. The fragment size can be adjusted by changing the distance of the swing beam from the hammers.



An impact crusher is mostly used as a secondary crusher after a jaw crusher, but in soft rock applications it can also be used as a primary crusher with high performance. In demolition applications it requires careful pulverizing and metal separation to avoid sticking problems and damage. For clean masonry rubble, asphalt and soft concrete it is a perfect machine. With hard and abrasive material the wear of consumables is very fast and often that sets the limit for economically acceptable applications.

Mobile crushers

Cone crusher
The crushing principle of a cone crusher is based on an oscillating cone inside the bowl where stones are crushed between them when the parts move. The oscillating movement is generated by a rotating vertical axle with an eccentric element on it that forces the cone to move. On the cone there is a replaceable mantle and the bowl liners can also be changed. They can be produced in different materials and shapes to meet the demands of the material to be crushed and the fragment size. The fragment size can be adjusted by lifting the bowl when the gap between the cone and bowl increases.



Mobile cone crushers are mainly used as a secondary crusher after a jaw or impact crusher, but they can be used as primary crushers for finer feed grades, such as river bed material or similar. A cone crusher is extremely sensitive to the cleanliness of the feed material and therefore not suitable for demolition, deconstruction and recycling applications.

Screens

Screens are used to separate different sized fragments from the material. There are countless different screen types for various materials but here we will focus on vibrating deck screens that are common in quarry and demolition applications.

The working principle of a vibrating screener is based on decks through which certain sized fragments cannot pass but end up on a conveyor to be transported away. Particles which pass through the deck drop onto another deck where they are screened again and if they are too big they will drop onto another conveyor to be taken away, and so on. Typically there are options from one to three decks, depending on how many fragment sizes are to be separated – three decks means four different fragment sizes. The package of screening decks is vibrated by a hydraulic motor.

A screening deck can consist of steel fingers, piano wires, steel or rubber mesh, or several other options, but in all cases the opening size gets smaller on the lower decks. The material must be chosen according to material quality, moisture, outside temperature and all the other factors that may influence the screening result.

There are special heavy duty screeners for prescreening that can handle heavy boulders in quarries and foreign particles in demolition rubble. The idea is to sort out fine material before crushing to improve crusher performance. These machines are equipped with a strong apron feeder and the deck angle is designed to enable easy material flow on it. These scalper machines are often located so as to feed the jaw crusher directly.

At quarries and gravel pits the most common screen types are two or three deck screens and there are often several in a row. These screens can produce very precisely sized fragments, e.g., for the cement or asphalt industry.

Application guide

Applications are a complicated combination of natural and cultural factors all of which influence each other. Material characteristics and climate conditions may vary considerably at various times of the year, even on the same jobsite. From country to country there are different ways of doing the same job – one contractor may believe in one method while another prefers a different approach. When the equipment selected is influenced by people's choices and other factors, it may be that the most obvious attachment for the job is totally unsuitable to work as a part of the chain.

All carriers and hydraulic attachment tools are developed to accomplish tasks in certain applications. Although some of them are versatile enough to handle different jobs and conditions, most of them are really efficient in only a limited number of applications. To get the highest productivity from the machinery and the best return on the investment, it is important to know the different applications and understand their influence on the whole production cycle.

Described on the following pages are some applications that are typical for the mining and construction industries and for demolition and recycling. The list is far from complete and the definitions are very rough with countless variations in a real life.

Quarrying and mining

Quarrying and mining is one of the most important industry segments for hydraulic attachment tools. Hydraulic breakers are common wherever rocks are excavated or their size is reduced for further processing, but today many other attachments are used in these applications. Hydraulic drills, cutters, eccentric rippers and many more are also often used by these customers.

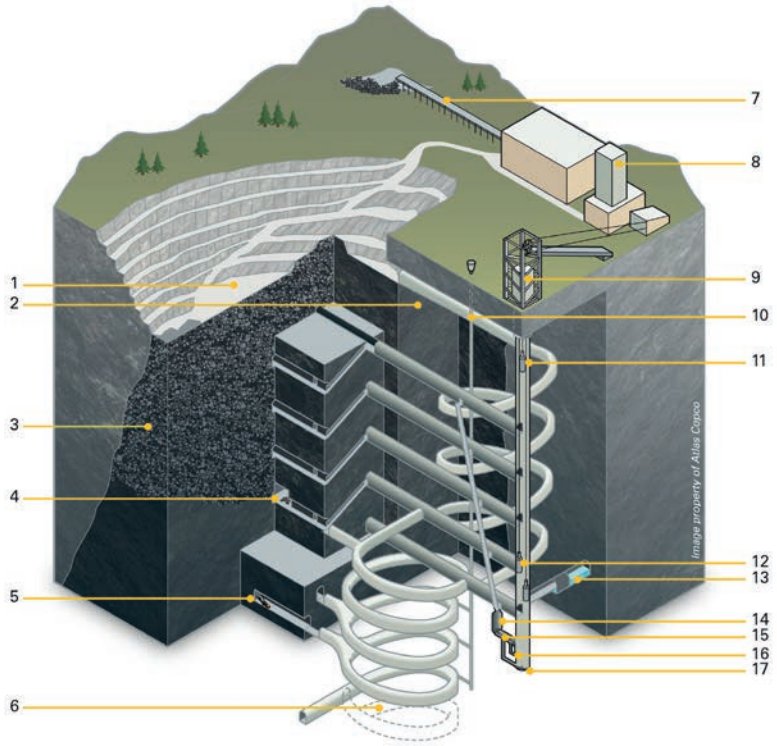
Different mining methods set different standards for hydraulic attachment tools and it is important to understand the basics of the most common ones. There can be a number of reasons why a certain method has been chosen and that is also significant information when we approach these applications from an attachment point of view. It is not always possible to use the most efficient method and we need to compromise between productivity and environmental requirements. Actually that fact has created a totally new market for hydraulic attachment tools.

Drill and blast methods

Drilling and blasting has been a very popular rock excavation method ever since dynamite was invented and it is still the most cost efficient way to take stones from rock. There are countless variations on how to do it and it is approached totally differently depending on whether we do it underground or in an open pit quarry.

The drill and blast method is very common in underground mining. Stones are excavated by drilling holes in the rock in underground tunnels and exploding the rock between the holes. In modern mines the holes are drilled by automated machines that can drill several holes at the same time. Explosives are loaded into the holes with another machine, and everything happens safely and easily.

After the explosion some of the stones are still too big for transportation and their size must be reduced by hydraulic breaker in the tunnel. Excavated stones will be crushed before processing and oversized stones may need to be broken with a breaker on a feed hopper being fed to the crusher. After the explosion there are loose stones on the tunnel walls and roof that need to be knocked off with a hydraulic breaker (scaling) before drilling new holes at the tunnel head.



1 Open pit (mined out)
2 Decline
3 Mined out and backfilled or caving masses (SLC, BC)
4 Exploration Drilling
5 Producing stopes development of stopes
6 Future reserves
7 Tailings
8 Production plant
9 Headframe
10 Ventilation shaft
11 Skip
12 Cage
13 Water basin. Pump station
14 Ore bin
15 Conveyor belt
16 Measuring pocket
17 Sump

Drill and blast methods

Drilling and blasting is also common in open pit mines where ore stones are relatively near the surface and open pit quarries where stones are excavated to be used as aggregates for construction. In both cases the excavation process is more or less the same and so is the suitable machinery.

The structure of an open pit quarry is a pit where walls are formed as embankment, so-called benches. The walls of these benches are typically 10–20m high and there is a flat surface that is used for loading and transporting of excavated rock. Slices of the benches are exploded which collapse and the resulting rock pile is transported away.

Drilling is performed by special machines (drill rigs) that drill up to 20m deep vertical holes close to edge of the bench. These holes are drilled to a precise pattern and angle to optimize the excavation result and homogeneity of the resulting rock pile. Explosives are loaded into the holes and detonated electronically in a certain sequence to achieve ideal stone size and safety during the explosion.

After the explosion some of the stones are still too big for transportation and their size must be reduced by hydraulic breaker on a bench. Excavated stones will be crushed before processing and oversized stones need to be broken with a breaker on a feed hopper before feeding to a crusher. When loose rocks are excavated the surface of the bench will be uneven and it needs to be smoothed by knocking off the overburden rocks with a breaker.

Blast free methods

Blast free mining or quarrying is a cost efficient rock excavation method in areas where the rock is soft or brittle and easy to excavate without drilling and blasting. Blast free processes are simple and all machines can work without blasting breaks or waiting time for the previous stage of the operation. This makes them cost efficient even when overall production in tons may be much higher with drilling and blasting.

Increasingly often it is necessary to choose blast free methods due to demands and pressure by residents in the area or for environmental reasons. Old quarries and mines are often located in residential or industrial areas and if they want to expand and continue operation they need to give up blasting.

Selective mining can be one reason to use blast free methods. Sometimes different stone qualities vary in the rock so much that they can't be mixed in a final process and they are difficult to excavate separately by drilling and blasting. With blast free methods it is easier to keep stone quality homogenous and save money in milling process.

Blast free methods

Primary breaking
Primary breaking is a method where a breaker is used to excavate the stones straight from the rock. In very special conditions it can also be used in underground mining but typically it is a method for open pit quarries.

In open pit quarries the workcycle starts from the foot of the bench wall and the breaker operates upwards until it reaches the edge of the bench. This way the rock is easier to break and the breaker doesn't have to work inside the stone pile and dust. In the next stage the breaker excavator moves to the next position and starts over again. After the breaking another machine loads the stones on a truck that takes them to the crusher. Now the bench floor is ready for another round.

In primary breaking the bench height must match the carrier reach so that it can safely operate the breaker at the correct angle and still be able to excavate enough stones per bench meter to keep the haulage process efficient. A bench height of about 5–7m is normal in primary breaking.

The main benefits of this method are that blasting and related problems are avoided, it offers non-stop operation with simple and fewer machines needed, it is environmentally acceptable, and it makes selective mining possible. The primary breaker produces the required stone dimensions without secondary breaking or problems during the crushing. Most of the machines are suitable for construction and demolition applications which improves resale value and makes it possible to adapt the machine fleet for high and low season operation.

Excavating
Some rock qualities are so fragile or soft you can excavate them with a strong excavator bucket with teeth. This is naturally one of the most cost efficient methods of rock excavation whenever possible.

Cutting
Cutting is a suitable method for very brittle or soft stone qualities that are easy to break. Drum Cutters and surface mining machines are used to excavate stones in both underground and open pit mines.

Ripping
Ripping is a method for stone qualities that are brittle or soft or when the rock structure consists of thin layers with discontinuous spacing. A mechanical ripper can be pulled by a bulldozer or an excavator and is a very cheap solution in the appropriate circumstances.

Scraping
Scraping can be used in open pit mines where the stone is very soft and formed by thin layers, e.g., shale oil stone mines. A huge scraping wagon that scrapes a thin layer from the ground into its container can be pulled by a bulldozer and tipped straight into a crusher. Scraping machines sometimes work together with rippers.

Secondary breaking

Secondary breaking is stone size reduction in underground mining, or in open pit quarrying for stones that are excavated from the rock. Stone size needs to be optimized to the feeding size of the crusher or sometimes the stones can be used for backfill or landscaping directly after breaking. Secondary breaking is often required as a part of the process in drill and blast rock excavation, but in some cases it may also be needed with blast free methods.

Depending on boulder size and the compressive strength of the rock secondary breaking can be performed by different sized hydraulic breakers. Carriers are almost always crawler excavators, but in underground mines there are some purpose-built machines for this application. Gravity impact hammers and secondary blasting are seldom used methods in special applications.

Crusher feeding and oversize breaking
In mines and big quarries the crushers and conveyors are big and feeding is done by tipping the load from the truck straight into the feed hopper, or the machines are fed by a heavy wheel loader. In small quarries mobile crushers are common and they are normally fed with a bucket, but for some material a grapple or clamshell bucket may be a more suitable tool.

When feeding the crusher, oversized stones occur despite secondary breaking and they get stuck in the crusher. In big mines with huge gyratory crushers, it may be easier to break oversized boulders in a feed hopper. There are two ways to handle oversized stones – either break them in a feed hopper or remove them and break them afterwards when a pile has accumulated.

A pedestal boom equipped with a hydraulic breaker is a good solution for oversized breaking in a feed hopper and they can be mounted on both mobile and stationary crushers. When oversized stones occur occasionally they can be broken with an excavator or other carrier in a feed hopper on demand or they can be moved aside to be broken with an excavator and breaker separately.

Tunneling

Tunneling is a special application that can be very similar to underground mining and a big part of underground mining is actually tunneling. The same drilling and blasting methods are used and scaling is common to both of them. When rock is easy to break the tunneling can be performed by primary breaking, so-called tunnel heading.

The bigger and longer the tunnels become, the more specialized working methods and machinery are needed. In long railway and highway tunnels such as the Channel Tunnel between France and Great Britain, huge special drills that can drill a tunnel in one stage and produce aggregates at the same time are a good solution. Also some smaller special tunnels may require a tunneling machine that is purpose-built for that one project.

After the tunnel is drilled or excavated the walls and roof need to be supported to prevent loose rock and stones from falling down. When the rock is solid enough the easiest approach is to bolt a steel net onto the surface and spray concrete on it. If the rock is weak or when the tunnel is built in soil, concrete or steel elements can be used to support the walls and roof. Sometimes there is a lot of water seeping into the tunnel and then it is necessary to build a drainage system between the support layer and the rock.

The finishing phase of the tunnel is similar to an ordinary construction project, although some special machines may be required due to limited space, moisture or other factors. Whatever the final purpose of the tunnel, there is a constant demand for construction tools during its construction and maintenance.

Scaling

Scaling is the task of scratching or knocking down loose rocks from the tunnel wall and roof. This job was previously done manually with a steel bar but, since it is heavy and dangerous work, nowadays it is mechanized with hydraulic breakers.

The hammer is often mounted on a special scaling machine that can reach the whole tunnel and is equipped with water spraying and a compressed air supply to avoid stones and dust entering the breaker. The operator moves the breaker around the tunnel surface and knocks off all loose and uneven rocks from the surface.

Epiroc breaker tunnel video

Heading

In some applications tunnel heading can be performed with a hydraulic breaker or a machine that grinds the surface, such as a Drum Cutter or special milling machine. Typical carriers for this application are special tunnel excavators equipped with front linkage suitable for working in low roofed tunnels. There are also special carriers available for this application.

When rock is hard or difficult to excavate with a breaker, the work can be assisted by means of pre-drilled holes. Pre-drilling makes it easier to keep the tunnel heading in the right direction and minimizes the amount of excavated stones.

To achieve maximum productivity from the breaker excavated material must be continuously transported away.

Demolition, deconstruction & recycling

Demolition, deconstruction and recycling is one of the few businesses that will expand in all markets throughout the world in future. An increasing number of buildings, bridges and other structures are reaching the end of their lifetimes while, at the same time, there is a general shortage of virgin construction materials. Vehicles and vessels get old, computers and other electronic devices need to be replaced with new ones, but precious metals needed for manufacturing are difficult to obtain and prices are constantly rising. These factors, together with the lack of space for dump yards and increasing environmental awareness, have led to a growing demand for recycling and sorting of waste material after use.

In Western Europe recycling has been a natural part of daily life for some time and in many countries it has been made mandatory by legislation or just by making it a way to save money.

To support this positive trend and to bring member countries up to the same level, the EU has issued a directive that forces the national governments to change their legislation to meet high recycling targets. For example, for construction and demolition waste, the target is to reuse 70% of material before 2020.

Naturally, there are different levels of recycling in different parts of the world but even where it is not driven by environmental pressure, recycling will increase due to the rising value of the raw materials contained in the waste. Also, even in areas where recycling is not common practice, old buildings still need to be demolished to make space for new modern cities and infrastructure. New demolition methods and machinery are cost efficient compared to many older methods and the market for them already exists around the globe.

Demolition

Wooden houses and structures
Wooden houses and structures such as wooden bridges, etc., are common in areas where there are big forests and wood is easily available. Depending on the structure and age of the wood it can be deconstructed on the jobsite, separating different materials during the work, or in a terminal later on. Some buildings, such as log houses, can be dismantled and rebuilt in other locations, for example if they have cultural value and the logs are in good shape.

Multi Grapples are common tools for demolition and for sorting the material afterwards. Foundations and concrete structures may need a hydraulic breaker or cutter. Steel reinforcements are removed from the rubble with a pulverizer. Steel and glass will be reused and burnable material will be crushed and used for energy production. Most of the materials in wooden buildings are recyclable and only a very small amount will be discarded.

Brick and other masonry buildings
Brick and masonry buildings are common in areas where wood is difficult to obtain or is not popular for cultural reasons and where, on the other hand, clay and sand have been readily available. These buildings can be deconstructed on the jobsite, separating different materials during the work, or they can be reduced to individual material fractions in a terminal later on.

Multi Grapples are common tools for demolition and for sorting the material afterwards. Walls can often be demolished with a Multi Grapple or excavator bucket, but foundations and concrete structures may need a hydraulic breaker or cutter. Steel reinforcements are removed from the rubble with a pulverizer. In some areas box shaped cutters have become popular for these applications. They cut pieces that can be fed directly to a crusher that separates the iron without pulverizing.

Steel and glass will be reused and burnable material will be crushed and used for energy production. Demolition rubble will be crushed on the jobsite or in a terminal to be used for backfill or landscaping.

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Concrete buildings and structures
Concrete has become the most important construction material during recent decades and therefore a growing number of concrete buildings are coming to the end of their lives and will be demolished. Concrete is a very versatile construction material that has been used for various kinds of structures, which have big differences between them in terms of the demolition and recycling process.

Apartment and office buildings
There are countless different ways to build an apartment or office building from concrete and they are also different demolition-wise. Low buildings are often made of precast concrete and they can be deconstructed easily by picking up the elements with a grapple or cutting them into smaller pieces with a hydraulic cutter. Foundations and some structures, such as garages, will be demolished with a hydraulic breaker or a powerful hydraulic cutter.

Higher buildings have a steel frame supporting concrete walls and floors that are often pre-cast. Concrete sections can be demolished with a high-reach demolition machine and cutter from the ground or by using a small excavator or demolition robot with a breaker and cutter down from the top floor. The steel frame can be demolished with a high-reach machine and steel shears from the ground, or manually from the top down after the concrete is removed.

Demolition rubble will be pulverized to separate steel from the concrete. This can be done by a demolition pulverizer during the demolition process, by a bulk pulverizer on the jobsite or at a recycling terminal. Finally the concrete will be crushed to be used for backfill or as construction material.

Demolition

Industrial buildings

Industrial buildings have often been built in several stages and one building may consist of construction materials from many different eras. For example, a small factory, originally brick-built, often has an extension in concrete and a later one in steel. Old concrete sections can be very easy to break while new ones are hard and heavily reinforced. These different construction materials and styles need several different machines and hydraulic attachment tools for demolition.

Another even bigger challenge in industrial areas are special structures that were previously needed for production and logistics. To be demolished safely and cost efficiently, high silos and chimneys need specialized demolition teams and special machinery. Steel tanks, large cranes, conveyors, railways and heavy steel frames in a building require special machinery and manual work.

Bridges and viaducts

Bridges and viaducts are challenging demolition projects. They are often demolished to make space for bigger ones to replace them and traffic cannot be interrupted for long periods. Typically the time-frame for such a job is very short and contractors need to build temporary roads and bridges to keep traffic moving. Even on relatively small projects only the biggest companies can do the job, or special contractors need to collaborate in order to finish all aspects of the job on time. Construction materials on these structures can range from wood to steel and heavily reinforced concrete.

Another challenge with bridges is the waterway below them. To perform the work it is necessary to have pontoons and ships, special cranes and temporary bridges for demolition machines. Ship traffic on a river or channel can be heavy and a section of the waterway needs to be kept open at all times. For environmental reasons, the water cannot be contaminated and very expensive arrangements may be required to avoid that.

Railways
Railway demolition requires special machinery and a lot of knowledge from the contractor. Track rails need special cutters and there are special railway cars that can cut the bars and remove part of the track with sleepers to be transported to the terminal by train. On small jobs tracks can be removed with excavators and grapples and cut with handheld tools or a special rail cutter. Sleepers are transported to terminals to be recycled and aggregates can be collected to be used as backfill elsewhere.

Roads
When roads are replaced with shortcuts or relocated to make way for buildings they need to be demolished. Asphalt can be ground away with a milling machine or collected with an excavator to be crushed at a terminal. Aggregates and other backfill material will be collected and transported away to be used elsewhere. Concrete paving can be removed by cutting it into pieces for transportation to a terminal. Or it can be crushed with a breaker on the jobsite, then a pulverizer can be used to separate the steel and crush the rubble.

Renovation

Surface renovation
Surface renovation can be a light face-lift job where new paint and surface materials can be applied without removing much of the old surface, and that can be done with light hand-held tools. At the other end of the spectrum, the job can be a huge public building like a swimming baths where thousands of square meters of tiles need to be removed and the entire plumbing and electrical network must be replaced. These are typical jobs for hydraulic attachment tools and small carriers such as skid steer loaders and mini excavators.

Light job, such as paint or masonry removal can be done by sand or soda blasting with a compressor and handheld tools. Hydraulic steel and bronze brushes or light grinding machines are also needed for the job.

Dust suppressor systems are mandatory for these jobs and because water cannot be used, there are dust collectors, filtration systems and special film and tape that can be used to seal parts of the building.

Structural changes
On renovation jobs it is necessary to make structural changes at the same time as surface repairs. Old buildings don't meet all requirements of the modern world and such projects normally involve wall removal, new windows and doors, elevators and escalators, plumbing and electrical networks, new ventilation and air conditioning, etc. Sometimes the foundation has also collapsed and it needs to be repaired and the ground under the building may need to be supported or stabilized.

These jobs are ideal for small carriers like demolition robots, mini loaders and mini excavators with hydraulic attachment tools. The most common hydraulic attachments are hydraulic breakers and small cutters. Demolition robots have become popular because of their superior performance with low operating weight and, thanks to remote control, they are light and safe to use for the operator.

For rubble removal it is common to use small loaders and dumpers, both ride-on and walk-behind versions. Belt conveyors are handy to transport the material horizontally to be dropped down through a tube. The rubble can be crushed on the jobsite or it can be transported to a terminal for recycling.

Recycling

Recycling is part of our everyday lives even if we are perhaps not so aware of it any more. Here we focus on recycling of construction and demolition materials and other recycling processes where hydraulic attachment tools are common.

On a jobsite
On a construction jobsite the recycling process is simple. Packing material and waste fractions of construction materials are separated immediately and transported to a recycling terminal where they are processed for reuse, burned to produce energy, or discarded.

On a demolition jobsite the process is more complicated. Depending on the demolition method some of the materials can be separated out and collected in their own containers during the actual deconstruction process. For example, steel plates from the roof, steel fences, and wooden structures. This keeps the materials clean and makes the next steps of the work easier.

Different construction materials can be separated immediately they are removed from the building: masonry and brick material for crushing separately and reinforced concrete to be pulverized. Steel frames can be cut and loaded into their own container, etc. With good planning and careful, selective deconstruction it is possible to save time and money in the next stages.

Reinforced concrete will be pulverized carefully to extract the steel as cleanly as possible. The steel will be sold to a steel factory to be reused and the concrete will be crushed with a mobile crusher or Bucket Crusher. Crushed concrete can be used on a jobsite as backfill for a new building or it can be transported away for use elsewhere.

If the demolition is performed without separating the various materials this can be done afterwards on a jobsite with a Multi Grapple. The grapple is normally mounted on a crawler excavator and the operator separates the different materials into their own containers. A Hydraulic Magnet can be used to separate the metal from the rubble and for loading.

Recycling

At a terminal

At a recycling terminal it is possible to use more sophisticated methods and machines for separation and naturally this is much easier if rough separation has already been done on the jobsite. Typically the recycling process at a terminal starts with rough separation with a grapple, when most of the wood and steel is removed from the pile. Then the material will be pre-crushed and moved forward with a conveyor. The next separation step is on a conveyor belt when some items can be removed manually before the next crusher.

After the crusher the material goes through the trammel that separates small and heavy parts from the rubble, and light particles can later be blown away by air. Light material continues to crushing and burning and heavier material, sand and concrete, continue to pre-screening and crushing once more. During the process there are several magnets to collect all the metal still remaining in the material.

Steel material goes to the scrapyard where it is cut into smaller pieces or pressed to form bales that fit the crusher. Steel shears, magnets and grapples are typical attachments for these applications.

Cars, ships, trains and planes

Hydraulic attachment tools can be utilized for other recycling applications and some of them offer a very big market for attachments. One of the biggest business areas is recycling of cars, trucks and other vehicles. Before crushing and melting to produce new steel bars and other raw materials they need several pre-processing steps and hydraulic attachment tools are perfect tools for these. During loading and transportation to the scrapyard grapples and magnets are used. At the terminal the size of the scrap is reduced by steel shears and finally it is fed to the crusher with a grapple or magnet.

Another big target group for steel recycling is trains, ships and planes. There are a lot of regulations and restrictions for recycling these due to the large amounts of hazardous materials and the high value of the raw materials they contain. These giants consist of various different materials and that makes the demolition and recycling process difficult. Hydraulic shears are perfect tools for this job as they can cut most of the steel structures and they reduce the risk of fire when there are flammable materials and liquids in a vessel.

General construction and civil engineering

Construction projects are a growing market for hydraulic attachment tools. Thanks to the development of carriers and attachments they can handle many jobs that were previously done by expensive special machines or manually. Today we can say hydraulic attachment tools are present on every jobsite and they have become a very important part of the process.

General construction and civil engineering

Site preparation
Before construction work can begin there are several preparation jobs to do on a jobsite. If there have been buildings previously, the site preparation can be done as a part of the demolition process and most of the infrastructure already exists onsite. Recycled demolition material can be used for backfill and that can save a lot of material and transportation costs.

On new construction sites, trees and bushes are cut and stumps lifted from the ground and transported away from the area. The soft topsoil and humus layer need to be excavated and moved away or piled to be used for landscaping later on. Surface water needs to be led away with sewers or drains and if the groundwater level is close to the surface it needs to be lowered with drains.

When there is solid rock on a site it needs to be excavated by drilling and blasting or by some of the blast free excavation methods. Big stones and boulders must be removed or broken onsite. If it is possible to crush the stones onsite the aggregate can be used for backfill and landscaping.

In soft soil areas the main problem is to prepare the ground to carry the weight of a new building. When the soft soil layer on firm ground or solid rock is thin it is easier to remove it and replace it with aggregates, sand or recycled concrete, whatever is available. In northern latitudes this needs to be done anyway to avoid frost problems.

When the soft layer is thicker and the new building will be heavy the foundations need to be built on piles that meet solid rock. These piles can be made from wood, concrete or steel and they are driven down with heavy pile driving machines or attachments, depending on pile size. Long and large steel piles can be drilled down with special drilling equipment.

When the soft layer is very thick or the expected load on the ground will be light it is possible to firm up the soil by ground stabilizing. In ground stabilizing, special cement and other chemicals are mixed into the ground and together they create a solid surface that can carry the weight of coming structures. These chemicals can be sprayed into the ground or, in very soft soil, they can be mixed mechanically with drum mixers or even with an excavator bucket. Ground stabilizing is a very competitive method in road and railway construction where areas are large and expected loads are light.

Frozen ground
Frozen ground causes problems for site preparation and later on for construction work. Frozen ground is difficult to excavate and it can be impossible without a hydraulic breaker or a ripper. The job is similar to primary breaking on soft stone; the breaker breaks a layer of soil, the excavator cleans the loose soil away and the breaker breaks another layer.

Frost will melt in the summer and freeze again the following winter and together with the weight of the building this will break even the strongest foundations. Frost problems occur if soil is wet when winter comes or if the topsoil is too fine or rich in humus. To avoid frost problems the drainage system must cover the entire construction area and the topsoil needs to be excavated to below maximum frost depth and replaced with aggregates or sand. The rule of thumb says anything finer than 0.2 mm will have capillarity and will freeze in winter.

If the soil is frost sensitive it must be melted and kept warm until the insulation is mounted and ground warmth will keep it from freezing. The ground can be melted by building a tent on the jobsite and lifting the temperature with a mobile heater. On bigger jobsites it is possible to use special surface heaters. The principle is simple, a transfer fluid is heated with a fuel burner and run through the hoses that are spread on the ground and covered with insulating mats. This system can be used instead of a breaker to melt the ground in small areas before excavation.

Backfill
Backfill refers to the material that is used to fill an excavated hole, the gap between structures and the material on the ground to elevate the structure above ground level. The quality demands for backfill material vary depending on its purpose and it is always defined in the working instructions of a structural plan.

Where the weight will be heaviest, e.g., under foundations, the material must carry that weight and withstand the stress of strong compaction during construction. This requires clean and hard aggregates crushed to the right size and shape. Between structures inside the building the material should be dry to avoid moisture problems and easy to compact to carry the floors and structures on it. Sand and aggregates are good materials for this purpose and high quality recycled material can be useful too. Backfills for roads, parking areas and landscaping can be made totally or partly of recycled construction materials.

General construction and civil engineering

Trenching
Pipeline and cable works can be small renovation jobs, short connection lines for new buildings or oil or gas pipelines thousands of kilometers long. The biggest pipelines are built with special large machines whilst smaller scale operations offer plenty of opportunities for hydraulic attachments and carriers, especially when pipes are mounted underground.

The job starts with trenching which means excavating a ditch in the ground. Depending on the soil and available machinery, it can be done simply with an excavator but very often rocks or frozen ground must be broken with a hydraulic breaker. When the ground is frozen or trenches are made in soft rock, a Drum Cutter or a hydraulic ripper may be a good tool for excavation. In hard rock areas drilling and blasting may be mandatory.

When the trench is ready it is often necessary to have a compacted layer of backfill before placing the pipes or cables in the trench. This backfill can be sand or aggregates or it can be screened from excavated material, but it is important that all stones that can damage the pipe are removed. After pipes or cables are laid on the bottom the next backfill will use similar material to the first one. This backfill material can be screened with a screener bucket or processed with a Bucket Crusher straight onto the pipe. A hydraulic compactor is a perfect tool for compaction of the trench bottom and the backfill around the pipe. A Multi Grapple is a good tool for pipe handling.

Road and railway construction
A road and railway construction project may include all possible applications, from tunneling and quarrying to paving of new asphalt. There may be demolition of old roads and bridges and sometimes entire villages will be moved to make way for the road or line. Therefore these projects are always a very important market opportunity for hydraulic attachment tools.

Fencing
Fencing is a much bigger business area for hydraulic attachment tools than most people think, probably because fences are often just a small part of a bigger project and not so visible. Fences are often built on difficult terrain and on all types of ground from soft swamp to hard rock so the construction requires a wide range of tools that can be used in remote areas. Hydraulic attachments are the perfect choice for these projects.

To mount the posts in the ground a post borer and post driver may be needed. In rocky terrain, the holes and anchors must be drilled with a rock drill. Hydraulic breakers are needed to break stones from the line or for post driving. Multi Grapples are good for handling posts and nets.

Special applications

Dredging and underwater demolition
Underwater construction and demolition jobs need special carriers and special accessories for hydraulic attachments when they are used for these applications. Dredging is a typical job where a hydraulic breaker is often needed to be able to excavate the rocks under water. Carriers on these jobs can be standard excavators driven onto a barge or they can be purpose-built dredging vessels with the upper carriage of an excavator mounted on deck.

A Drum Cutter can be another option when rock is softer or when it is necessary to excavate very hard sediment from the bottom.

Underwater demolition may be needed for example during removal or renovation of old dams, bridges or wharfs. Old marine defense lines and wave breakers are sometimes removed from the sea lanes and hydraulic breakers can do the job without blasting.

Steel factories and other high thermal load applications
At steel factories and heating plants for example, there are some applications where hydraulic attachments are the best and often only choice to accomplish the job. Heating ovens and steel melting pots need to be cleaned regularly to remove the extra layers of carbon and steel that accumulate inside them, and the hydraulic breaker is a perfect tool for the job. The temperature in these ovens and melting pots can be several hundred degrees Celsius; plastic parts melt away and rubber starts to burn or disintegrate from the heat. Therefore as many plastic and rubber parts as possible should be replaced with metal or other heat-resistant material.

Military
Some military applications can be handled with hydraulic attachment tools that are used for similar jobs in civil applications, but the closer the tools get to the battlefield, the more special demands are placed on them. Hydraulic attachment tools will face poor oil quality, lack of service and unskilled operators that may damage them at critical moments, therefore these factors must be considered carefully before choosing the attachment.

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