# THE SECRET LIFE OF QUARRIES

Episode 2: Extraction

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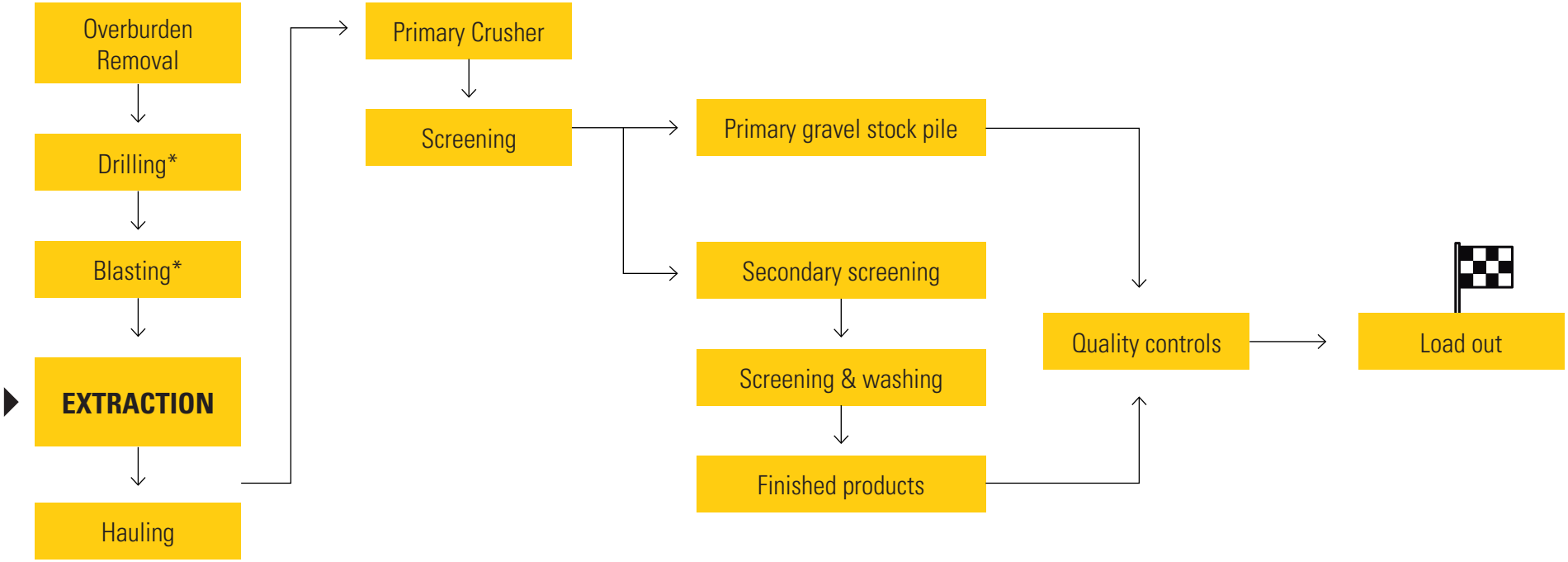
# EXTRACTION IS A KEY PART OF THE QUARRYING PROCESS

After overburden removal, the second stage of the quarrying process is to remove the rock from the ground, a process known as *extraction*.




The newly-exposed stone is first loosened by blasting or ripping, loaded into haulers by excavators or wheel loaders, and finally transported to the crusher.

*Some quarries rip instead of blasting

# BLASTING VS RIPPING

*Blasting* with explosives loosens a large mass of rock at once, breaking it down into different sizes.

*Ripping* is the use of one or more machines to manually break rock into smaller pieces, which can then be removed from the face. This is a much cleaner and quieter means of extraction, but is far slower than blasting.

# BLASTING

Compared to ripping, blasting is a far faster way to create large volumes of broken material for extraction, which is why blasting is the first choice for most quarries.

But blasting has its drawbacks too:

- Blasting can be dangerous, requiring licenced experts for storage, charging and detonating
- Blasting also generates a lot of noise and releases large quantities of dust, both of which can pose problems for the surrounding area
- Using the right amount of explosives requires correct hole spacing, the right drill angle, and in-depth knowledge of the geological consistency and structure of the rock. Without such knowledge blasts are likely to be over- or underpowered, negatively impacting rock size, rock quality and waste ratio

# RIPPING

Ripping takes far longer than blasting and tends to be less cost-effective, but also has several advantages:

- Less noise and dust emissions, allowing rock breaking in sound-sensitive areas
- Safer (no dangerous explosives, lower risk of serious accidents)
- Simpler (no need to seal off nearby roads, no red tape)
- Less vibration and dust emissions
- Improved material quality, less waste
- Same machine can rip and load simply by changing buckets (ideal for smaller quarries)

# MACHINE SELECTION

Machine choice – wheel loader or excavator – may be the single most important decision affecting an extraction operation. Choosing well keeps cost-per-tonne and maintenance to a minimum and allows optimal production rates. Choosing poorly can do the exact opposite, running machines and profits into the ground and multiplying costs. Generally, when mobility and speed matter more than stability and reach, wheel loaders are the ideal choice.

But when post-blast fragmentation is poor, when haul trucks are of different heights, when spaces are tight or elevated, the excavator is a far better option.

| **WHEEL LOADER STRENGTHS**<br>On good underfoot conditions | **EXCAVATOR STRENGTHS**<br>On poor underfoot conditions |
|---|---|
| • Multiple face loading<br>• Load and carry<br>• After blast clean-up/loading area management<br>• Safety at the face | • Reach (vertical and horizontal)<br>• Stability in poor underfoot conditions<br>• Selective Material Loading<br>• Increased Break Out Forces |


**Whether we choose a wheel loader or an excavator, we must still rely on skilled operators using the right techniques.**

Positioning, timing and angles can impact both cost-per-tonne and production, as described on the next page.

# OPERATOR TECHNIQUES | WHEEL LOADER

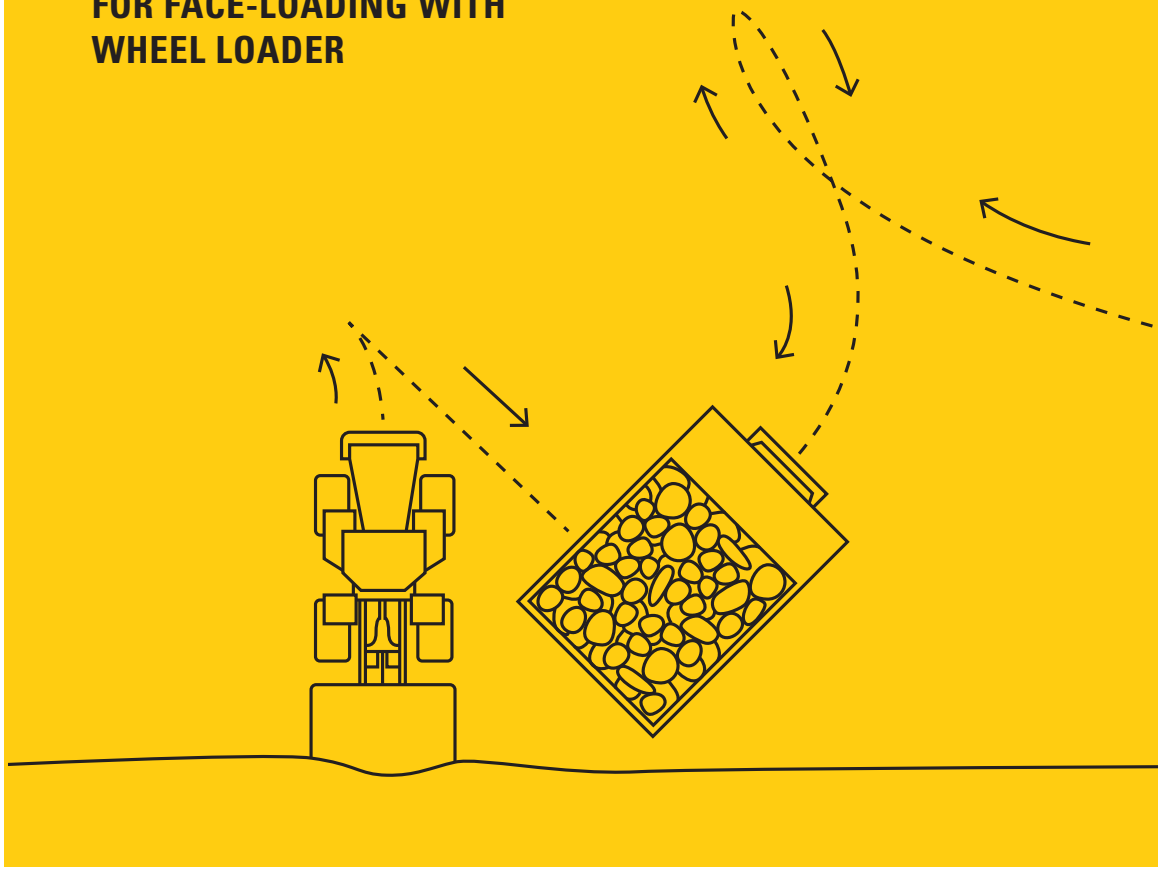
**When used for extraction wheel loaders are primarily face loaders, lifting directly out of the blasted material and into the waiting hauler.**

Efficient production depends on fast cycle times; a single cycle should take less than 30 seconds, with each truck being loaded to completion in 4-5 passes.

Achieving this requires the right operator technique, i.e. how to load the bucket, cycle to the truck and cycle back to the face in one fluid movement.

The goal is to come to rest in a position that will keep the wheel loader's travelling distance to 1.5 wheel rotations or less.

**HAULER OPERATOR TECHNIQUE FOR FACE-LOADING WITH WHEEL LOADER**

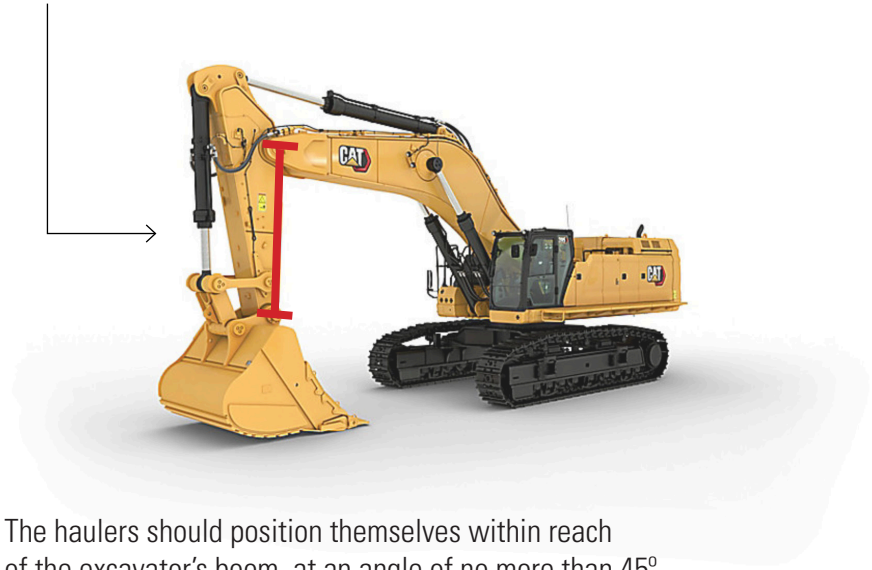


# OPERATOR TECHNIQUES | EXCAVATOR

**The key to using an excavator efficiently is to make the most of its height, reach and 360º turning circle.**

Wherever possible, the excavator should elevated on a purpose-built bench and load haulers from above.

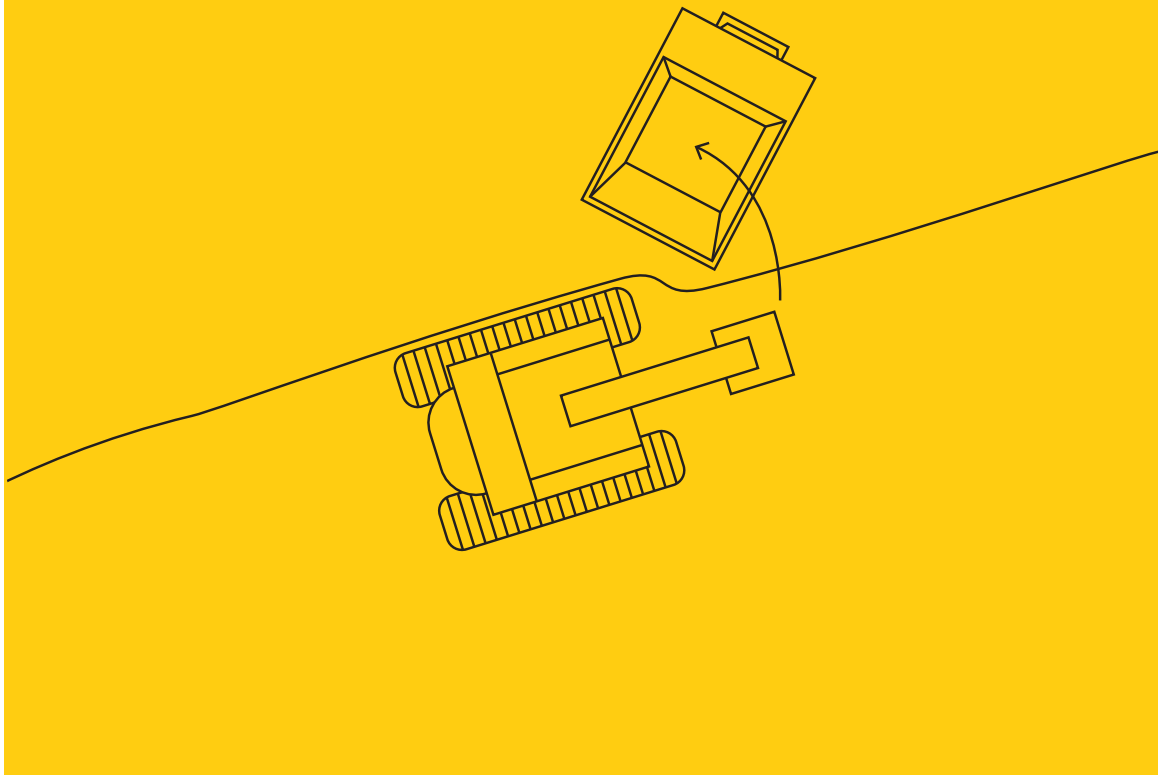
As a rule of thumb, correct bench height should be measured from the boom and stick pivot point, down to the stick and bucket pivot point, with the stick in a vertical position:



The haulers should position themselves within reach of the excavator's boom, at an angle of no more than 45º.

Cycle times should be 20-30 seconds, with each truck being loaded to completion in 4-6 passes.

## HAULER OPERATOR TECHNIQUE FOR LOADING WITH EXCAVATOR



# BUCKET SELECTION | WHEEL LOADER

## CONSIDERATIONS

Loader bucket selection has three key elements:

1. Durability
2. Ease of penetration and filling
3. Maximum payload size

Bucket types for extraction range from General Duty to Rock Heavy Duty Granite, covering low impact material to extreme impact material.

## BUCKET APPLICATION GUIDE

| Rock Material | General Duty | Rock | HA Rock | HD Rock | HD Granite |
|---|---|---|---|---|---|
| Sand and Gravel | ✓ | ✓ | | | ✗ |
| Coal Seam | ✗ | ✓ | | | ✗ |
| Loose Coal | ✓ | | | | ✗ |
| Shot Limestone | ✗ | ✓ | ✓ | | ✗ |
| Crushed Stone (rehandled) | ✓ | ✓ | | | ✗ |
| Shot Granite | ✗ | ✗ | ✗ | | ✓ |
| Iron Ore | ✗ | ✗ | ✗ | ✓ | |
| Gypsum | | ✓ | ✓ | | ✗ |

*HA: Heavy Abrasion; HD: Heavy Duty*

✓ Recommended  Acceptable  ✗ Not recommended

## TYPICAL BUCKETS FOR EXTRACTION

- General Duty
- Rock Standard
- Rock Heavy Duty
- Rock Heavy Duty Granite
- Rock High Abrasion

Picking the right bucket, with the right balance of weighting and resistance, is very important for keeping costs-per-tonne down and production up.

The table above and the graph on the next page show the ideal bucket choice for wheel loaders and excavators respectively.

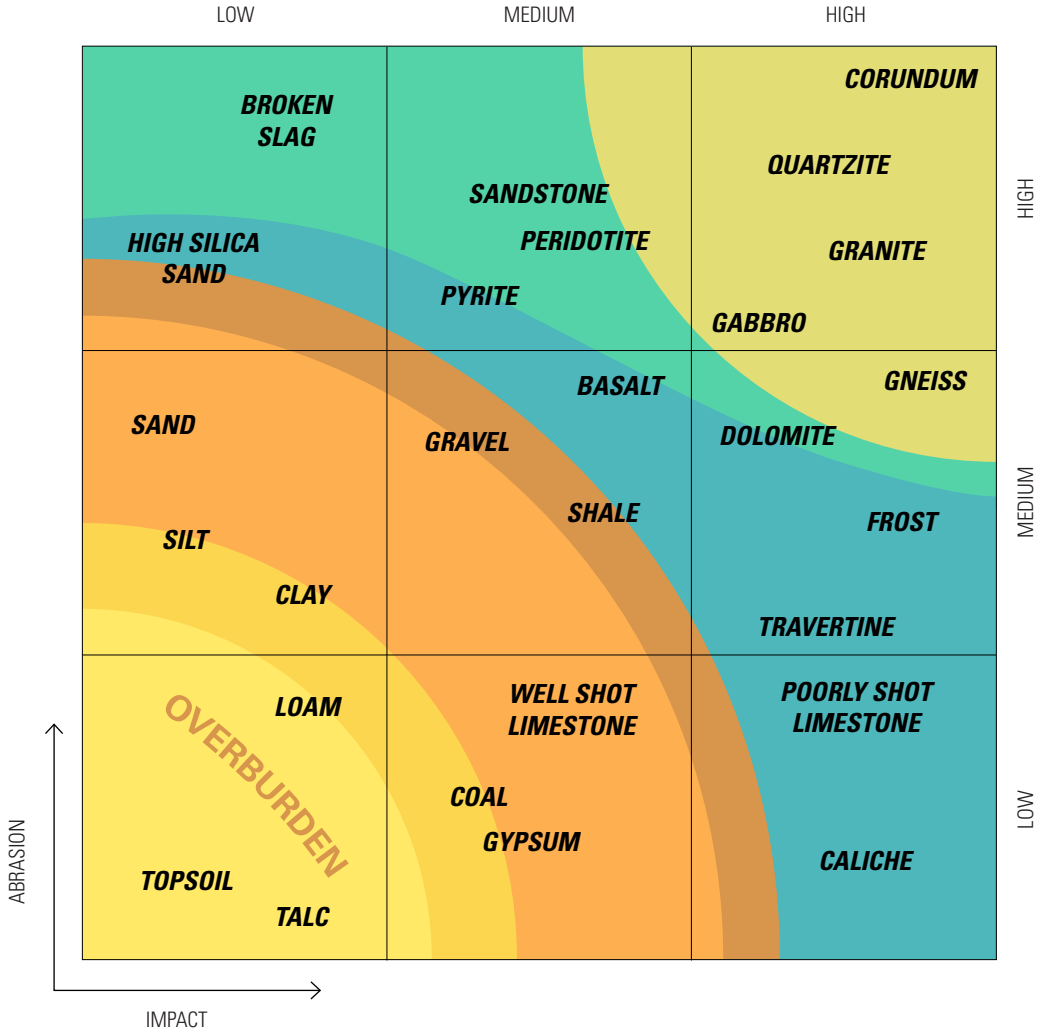
# BUCKET SELECTION | EXCAVATOR

Where material is mostly soft and low impact, General Duty buckets are typically the preferred choice.

But where material becomes more abrasive and higher impact (eg. granite,) Heavy Duty buckets are more suitable.

**Recommended material for bucket durability:**

- General Duty
- Heavy Duty
- Severe Duty
- Extreme Duty



# GROUND ENGAGING TOOLS (GET)

**Choosing the right GET for the machine bucket is just as important as the bucket itself.**

Harder materials need sharper, harder tips to break up and load, while wider, broader ends are needed to gather and scoop up softer, finer materials.

The ideal shape and size of GET will maximise both penetration and pickup, making each bite of the bucket as efficient as possible.

Use latest tip design as recommended by the manufacturer for quick and easy tip replacement.

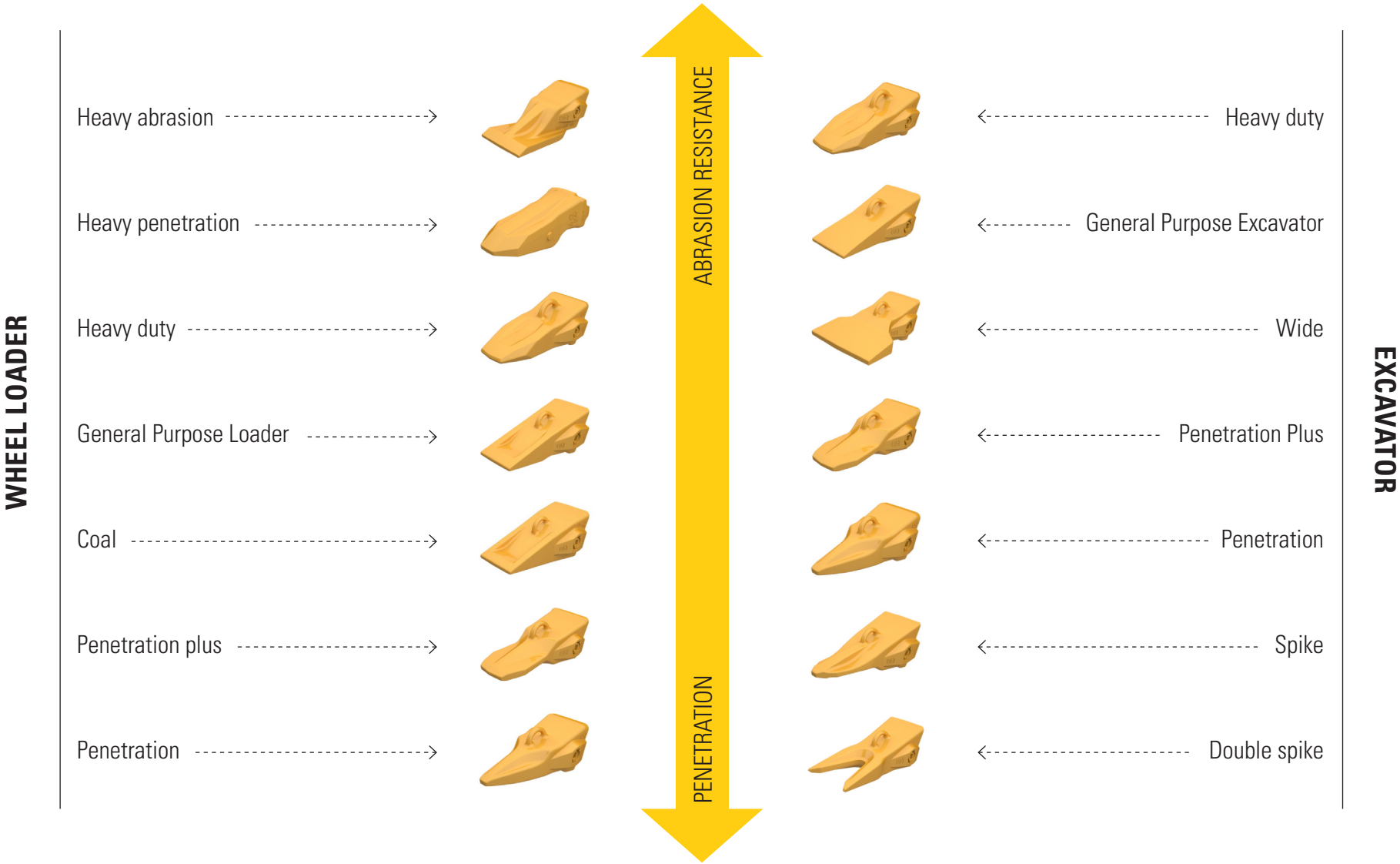
Tip retention is extremely important, as loosing one into the truck could cause problems in the crusher

## GET replacement is all about timing

- Above and beyond their design, there are real advantages to replacing GET at their optimum wear point of 65-70%
- Replacing GET before this stage is potentially wasteful, but delaying replacement– even to 75% wear – can start to seriously affect performance

For these reasons, GET choice and integrity have significant impact on cycle times, fuel usage, cost-per-tonne and production rates.

# GET DESIGNS AND INTENDED MATERIALS



# THE SECRET

The immediate goal of extraction is always to fill haulers as quickly as possible and send them on their way.

But the ultimate goal is to keep the crusher fed.

Perfect production relies on precise hauling and dumping, which in turn requires loaders at the rock face to perfect their approach to extraction.

**Which means the real secret of extraction is to start at the crusher and work backwards.**

To learn more secrets, watch The Secret Life Of Quarries at www.cat.com/SecretLifeOfQuarries, or get in touch with our experts today.

**Thank you**