



# Top Hammer Tooling

JF Nutbroek, Business Development



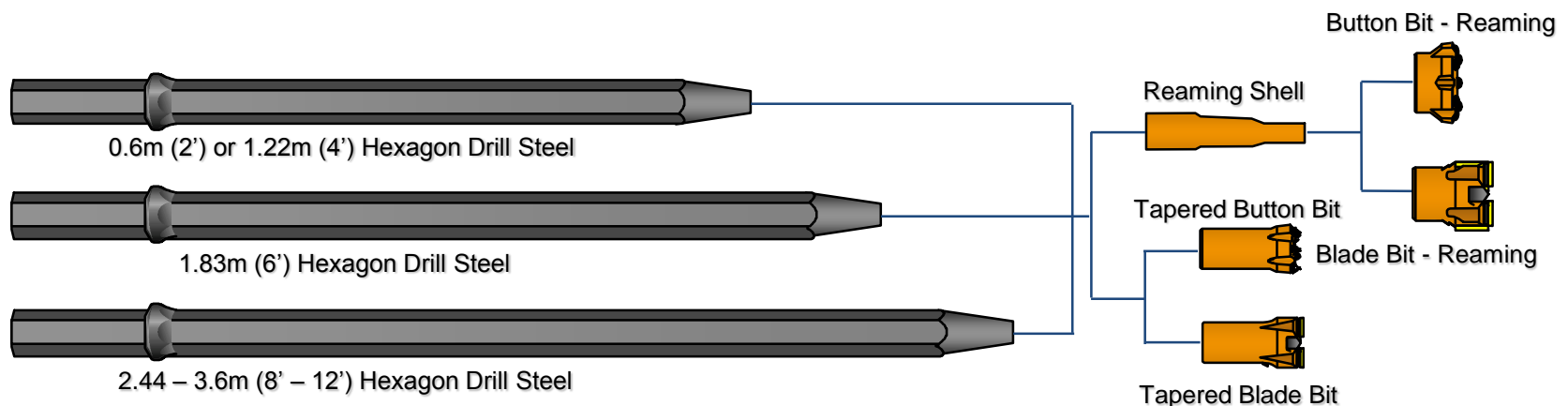
# Top Hammer Tooling



# Handheld Drill String – Tapered Rods



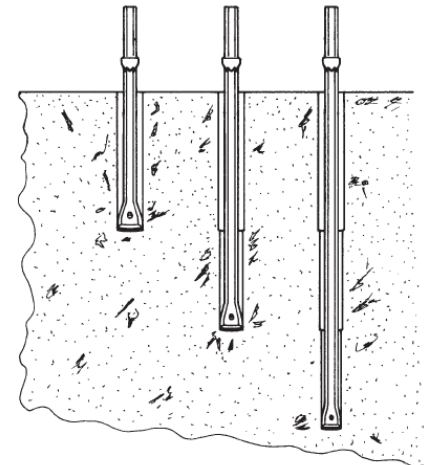
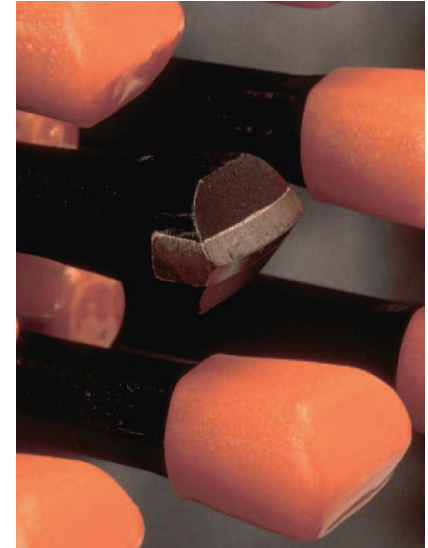
- Light/Medium Pneumatic Drills
- Hexagon rod
- Tapered Angle, push on bit
- Typical Hole Length:  
0,6m – 3,6m (2' to 12')
- Typical Hole Diameter:  
32mm - 45mm (1-1/4" to 1-3/4")



# Handheld Drill String – Integral Rods



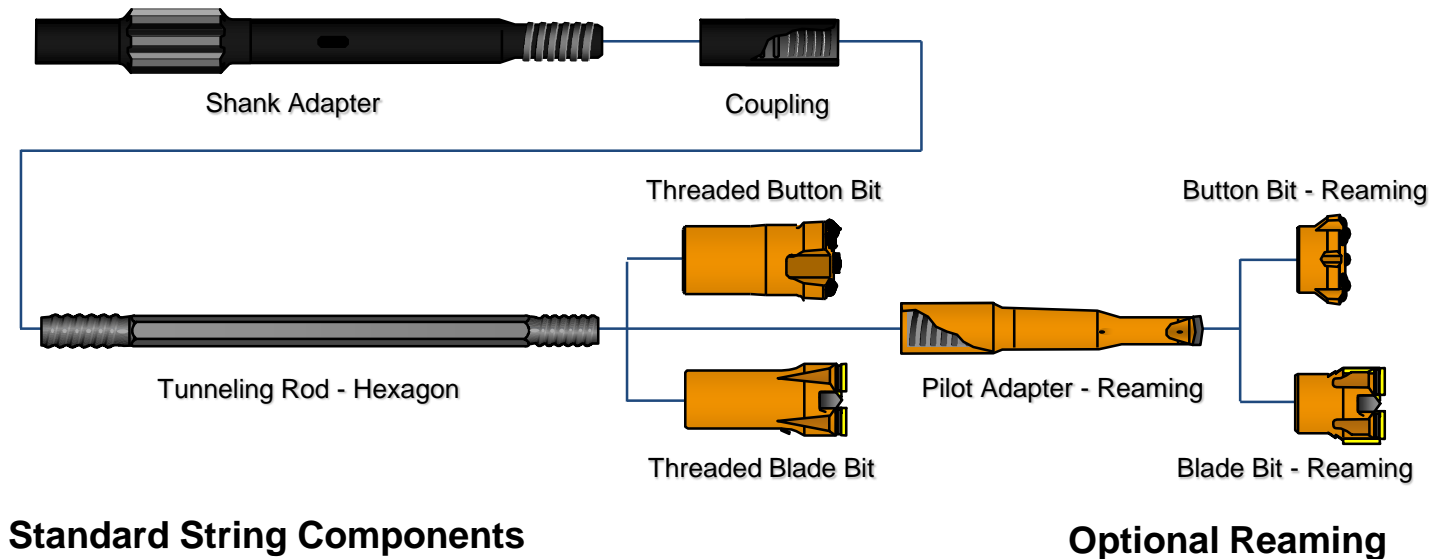
- Light/Medium Pneumatic Drills
- Hexagon Rod
- Each rod has a carbide tip
- Typical Hole Length:  
0,4m – 6,4m (1' to 21')
- Typical Hole Diameter:  
25mm - 40mm (1" to 1.6")
- Less popular v.s. tapered rods
  - it is easier to transport push-on bits to site v.s. entire rods
  - Less economical to replace v.s. push-on bit



# Drifting, Tunneling, Bolting Drill String



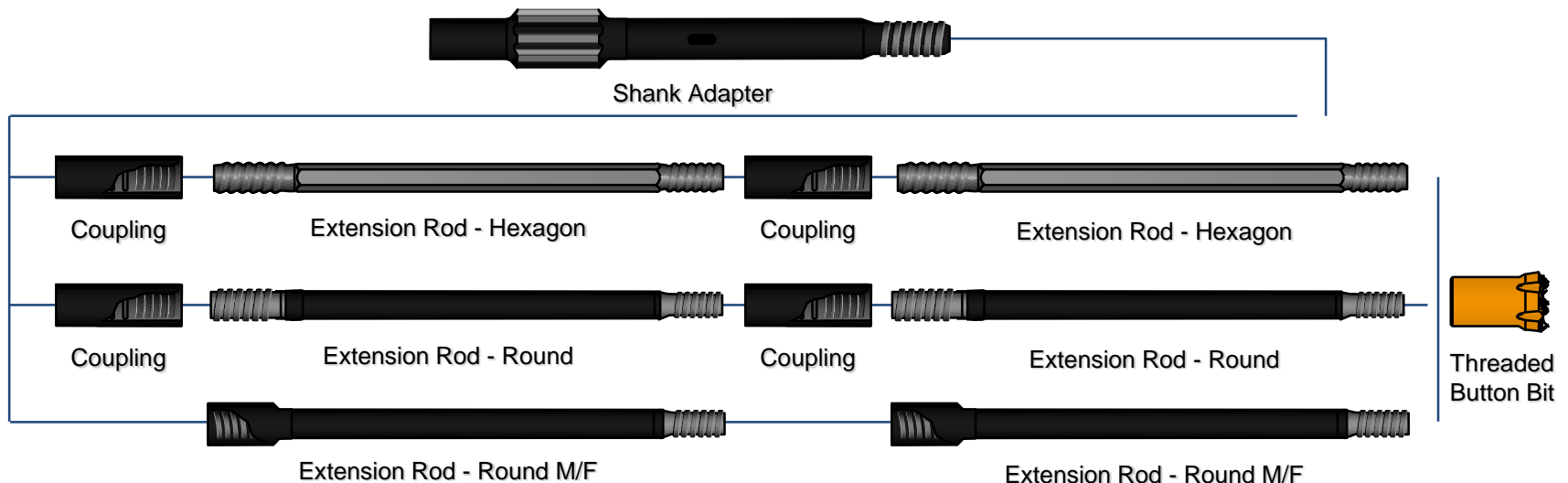
- Light/Medium Pneumatic and Hydraulic Drills
- Mining, Civil Tunnels and Construction
- Typical Hole Diameter: 38mm - 64mm (1-1/2" to 2-1/2")
- Typical Hole Length: 3,1m - 5,5m (10' to 18-1/4")

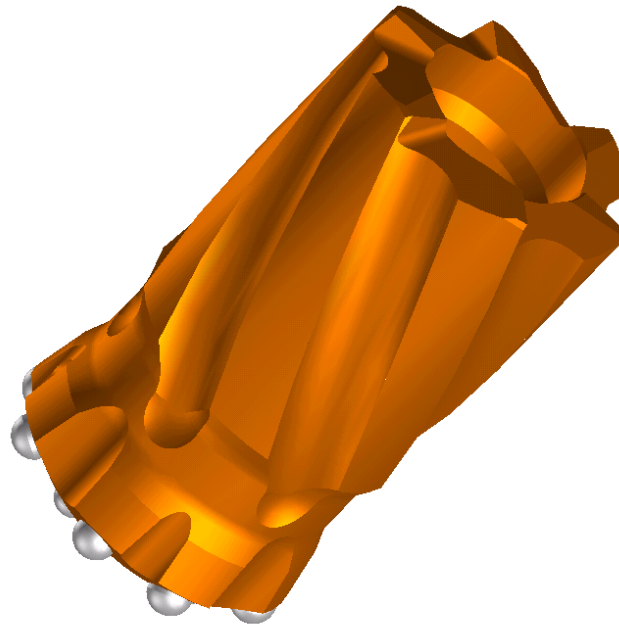


# Production/Extension Drill String

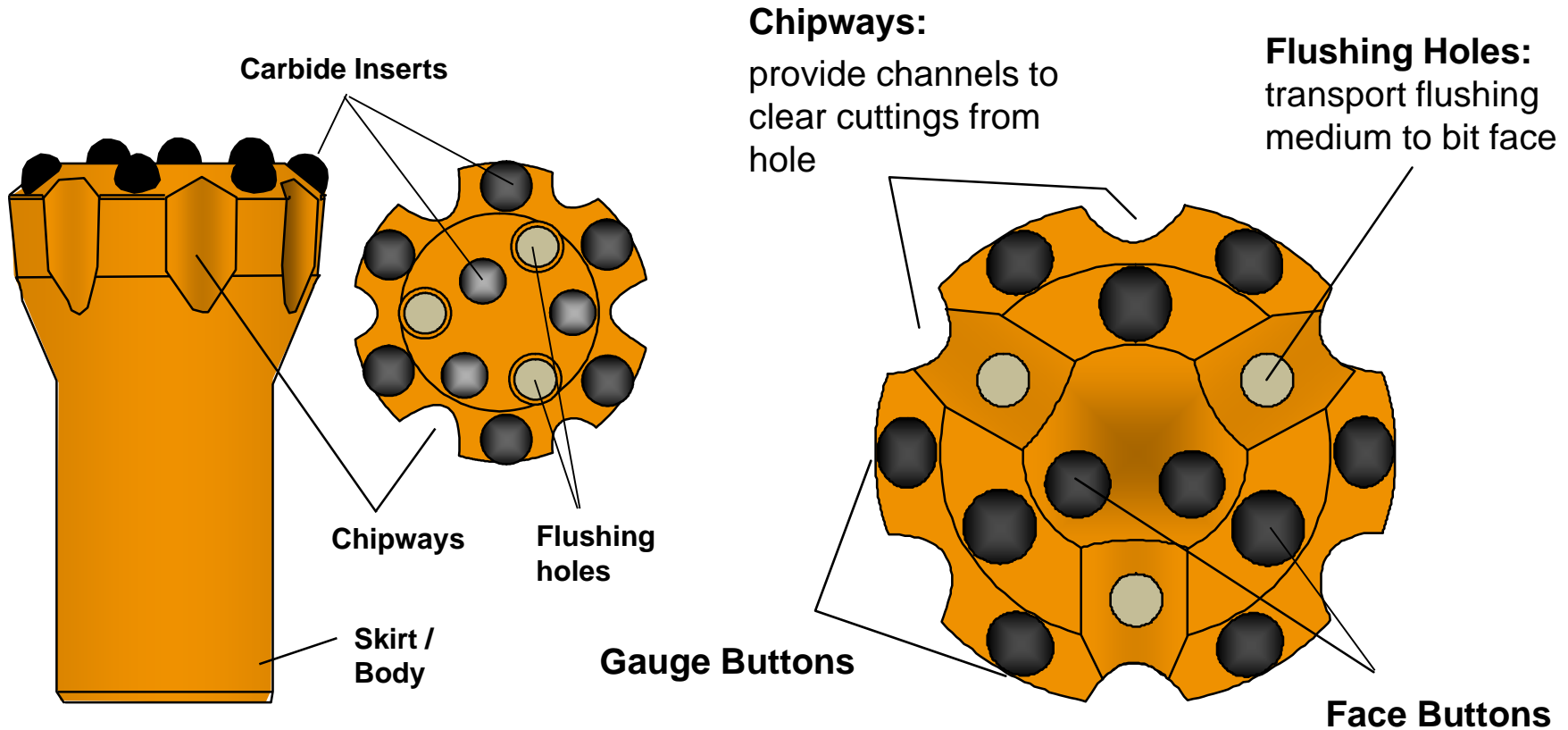


- Medium/Heavy Pneumatic and Hydraulic Drills
- Rubber Tired or Crawler Mounted Drill Rigs
- Benching, Ring Drilling, Fan Drilling
- Typical Hole Diameter: 51mm - 153mm (2" to 6")
- Typical Hole Length: 14m - 28m (45' to 92')





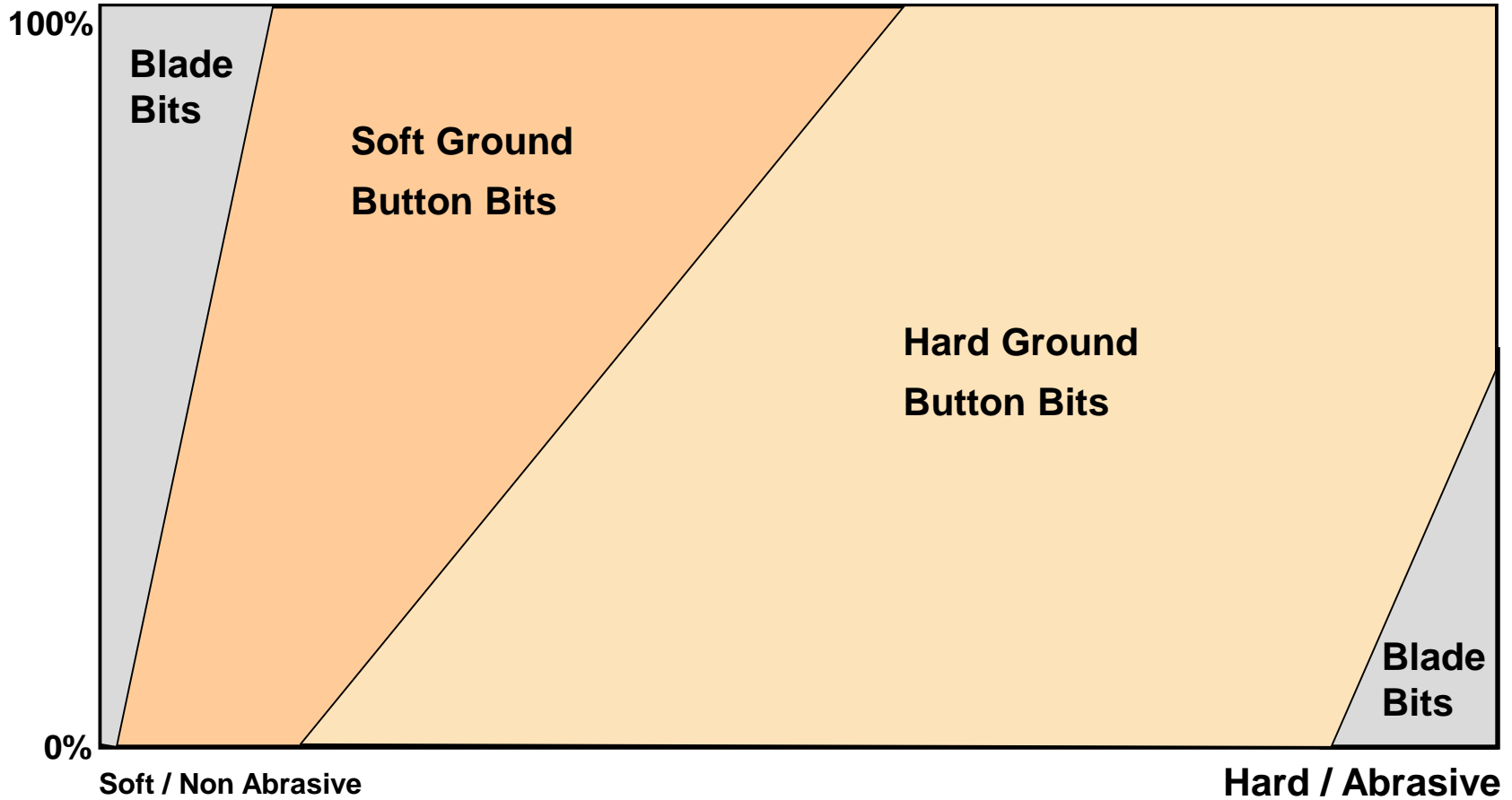
# Button Bit Design Specification



Blade/Cross Bits are available for reduced gauge wear and improved straightness, but with shorter service interval and slower penetration



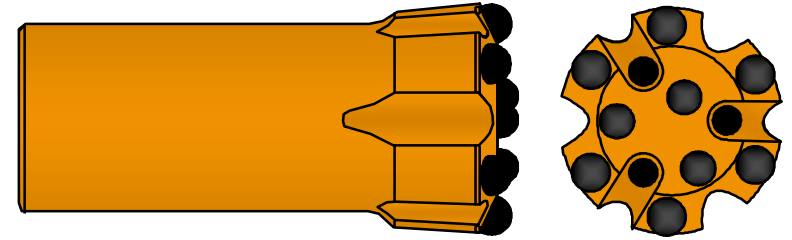
# Button Bit Application Diagram





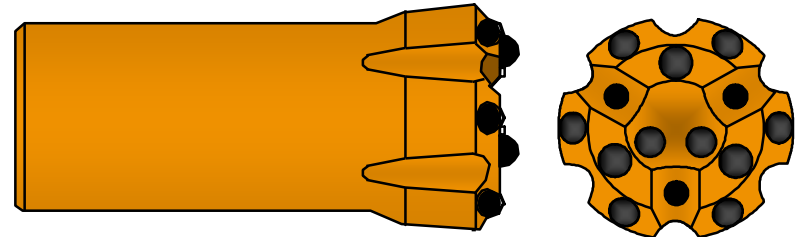
## Button Flat (BF)

- Flat Face
- General purpose bit
- Hard to medium conditions



## Button Recessed (BR)

- “Drop Centre” Face
- Straight hole application
- Broken rock conditions

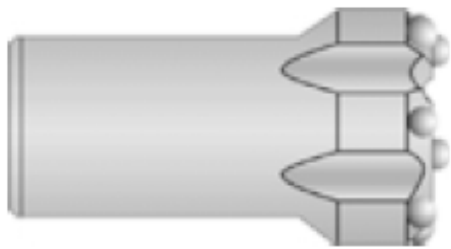


Special Face Designs: BD (Dome) for reaming applications  
BC (Chisel) for abrasive rock; used in tunneling



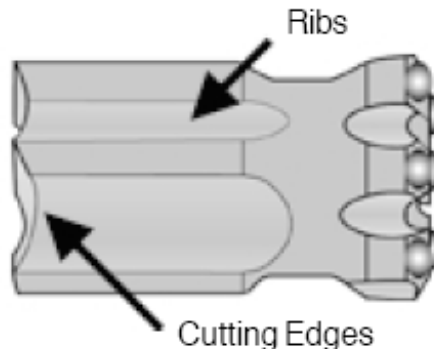
## Conventional

The skirt and bit diameter must allow sufficient clearance to avoid binding in the hole and optimum chip removal



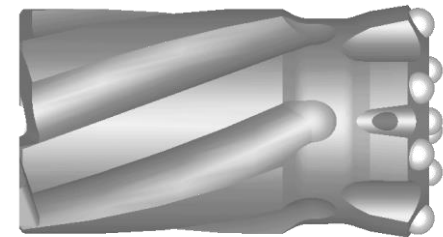
## Retrac

Longer ribbed skirts with hardened rear facing cutting edges for retracting a drill string.



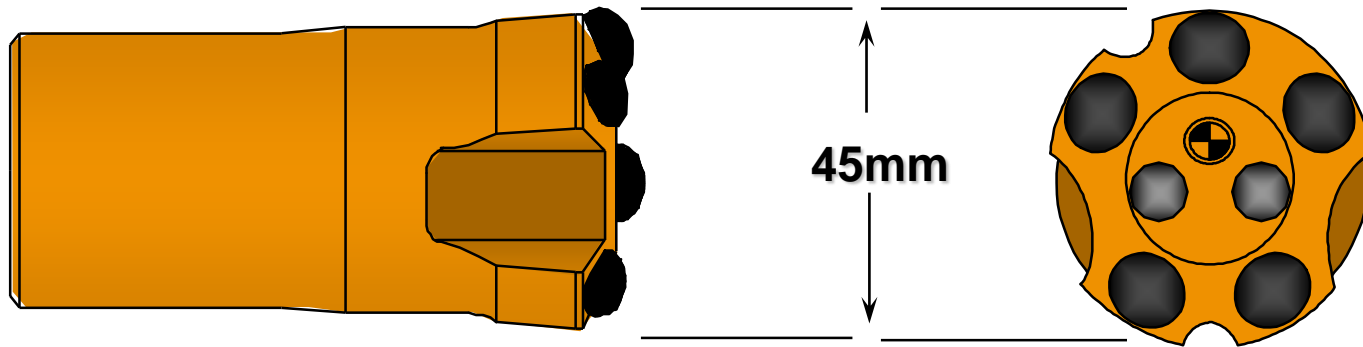
## Straightrac

Constant contact between ribbed skirts and the hole wall. Straighter holes than conventional and retrac bits.





# Bit Description



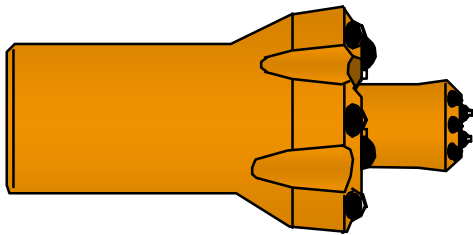
<b>BIT</b>	<b>BTN</b>	<b>THD</b>	<b>045</b>	<b>R32</b>	<b>BF</b>	<b>5</b>	<b>/ 2</b>	<b>H</b>
Product Group	Type	Connection	Drill Hole Diameter	Thread style	Head Design	# Gauge Buttons	# Face Buttons	Button Design
	- Button - Blade	- THD (thread) - PO (push-on)			- BF (flat face) - BR (recessed) - BD (dome) - BC (chisel)			- H (hemi) - P (para) - B (balli) - C (coni)



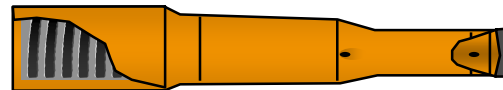
## Reaming Equipment (hole enlargement)

- More economical than single pass large hole drilling
- Hole typically reamed twice it's initial size
- Two styles: one piece and pilot with reamer bit

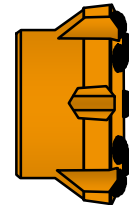
One piece Button Bit Reamers



Pilot Adapter

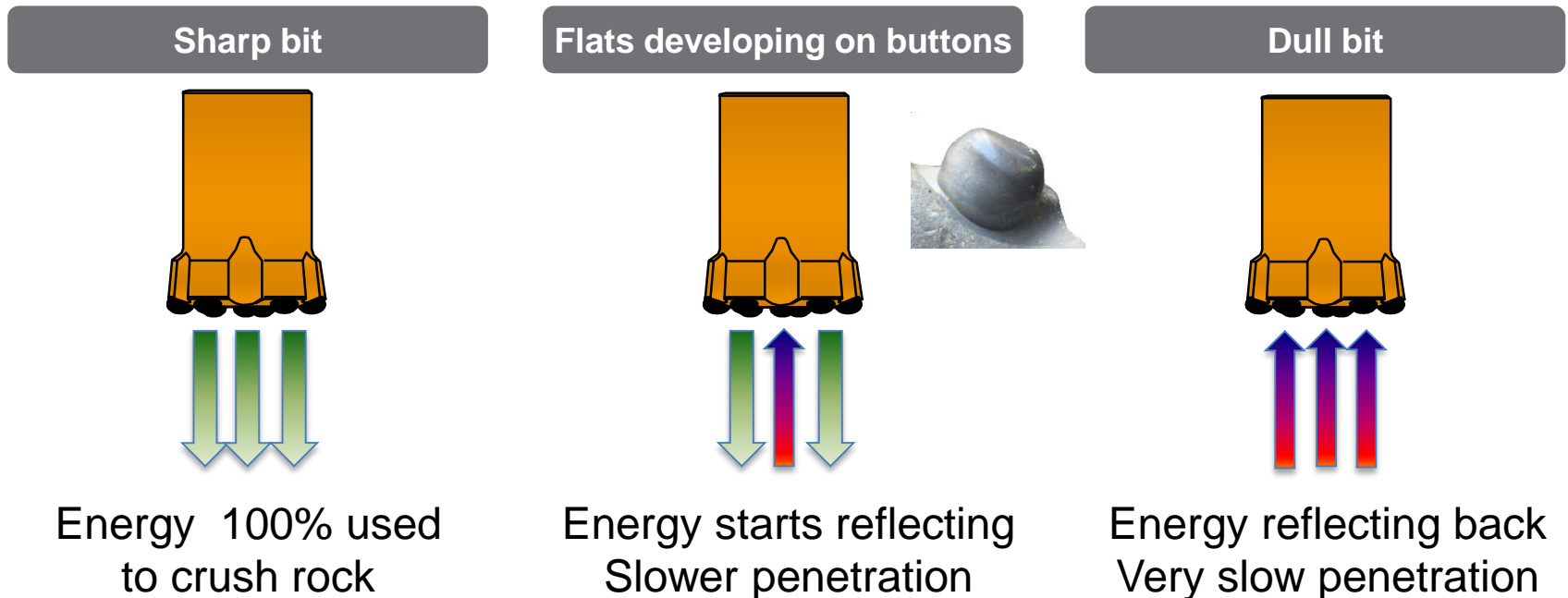


Reamer

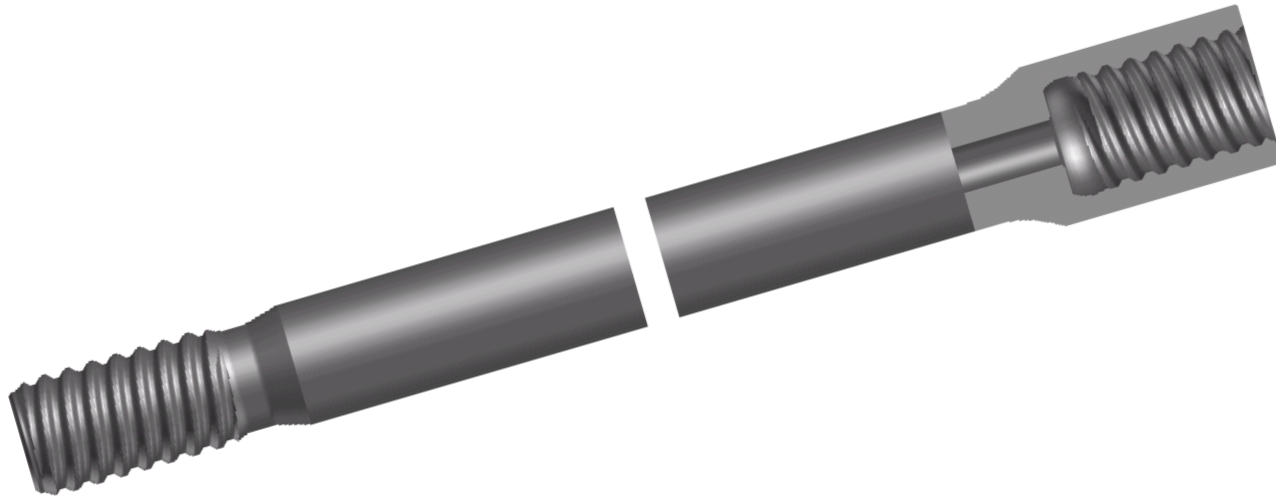




- Larger bits benefit from resharpener to extend service life
  - Resharpen buttons when they wear flat (approx. 30% of diameter)
  - Maintains penetration rate, increases overall tooling / rig life
  - Ensures energy is used to crush rock and not reflected back



# Rods





Tapered Steel



Integral Steel



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Male / Male (M/M)  
Hexagon or Round



Male / Female (M/F)  
Hexagon or Round



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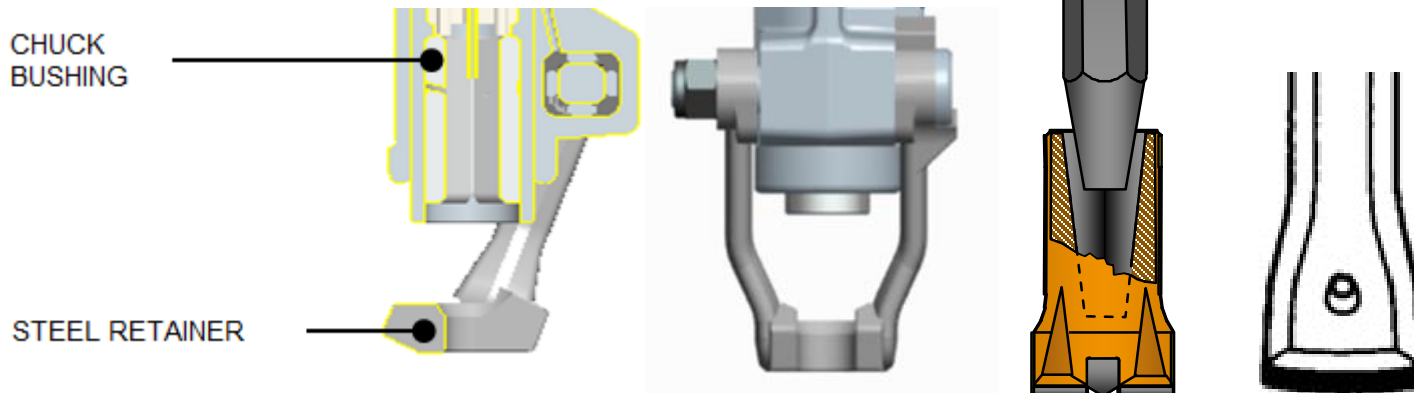
Tube Rods



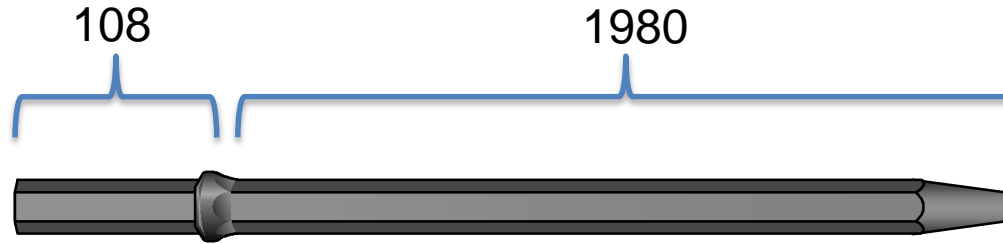
# Handheld Rods



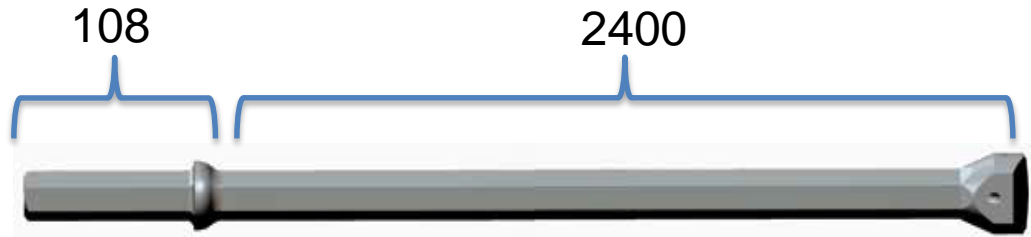
- Hexagonal drill steel in 22mm or 25mm
- Rotation is provided by a hex drive chuck
- Striking distance maintained by forged collar
- Tapered end for push-on bit (PO bit)
  - Different tapered angles: 4.46°, 7°, 11°, 12°
- Carbide Tip for integral drill steel
- Length in 0.6m or 0.8m increments



# Rod Description



<b>ROD</b>	<b>CLR</b>	<b>TPR</b>	<b>1980</b>	<b>22H</b>	<b>108x12*</b>
Product Group	Type - Collar	Type - Taper	Length 1980 mm	Hex size 22mm	Length from collar and angle 108mm and 12°

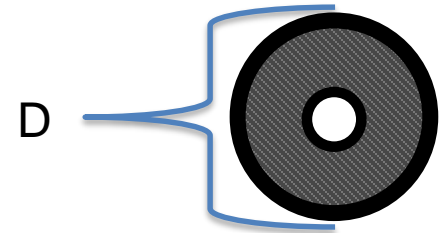
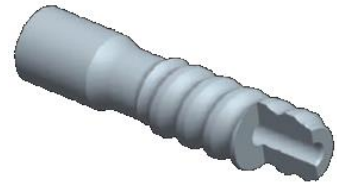


<b>ROD</b>	<b>CHISEL</b>	<b>22X108</b>	<b>2400</b>	<b>X35</b>
Product Group	Type - Chisel	Hex & Collar 22H x 108	Length 2400 mm	Diameter of carbide tip 35mm



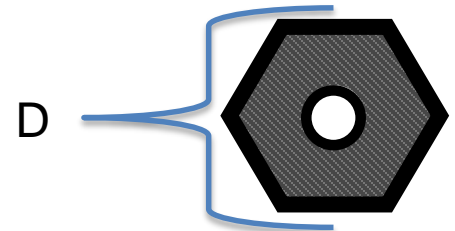
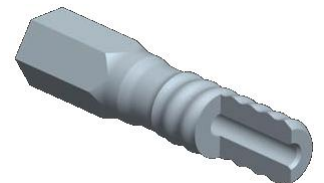
## Round Rods

- Normally used in extension drilling applications
- Lighter than hex rods of same size
- Available in large diameters



## Hexagonal Rods

- Cross sections are more rigid
- Improved flushing (smaller annulus)
- Heavier & transfer energy more efficiently
- Drifting & Tunneling applications



# Male x Male and Male x Female Rods



- Male x Female Rod (M/F) – Extension rod



Easy handling, quicker uncoupling, tighter connections and more rigid thus the potential to drill straighter holes. Reduced energy loss versus M/M extension rods.

- Male x Male Rod (M/M) – Tunneling rod



Since the coupling does not enter the hole, a bit diameter closer to the steel diameter can be used. This enhances flushing and hole accuracy. Shank end can be larger thread.

# Rod Description



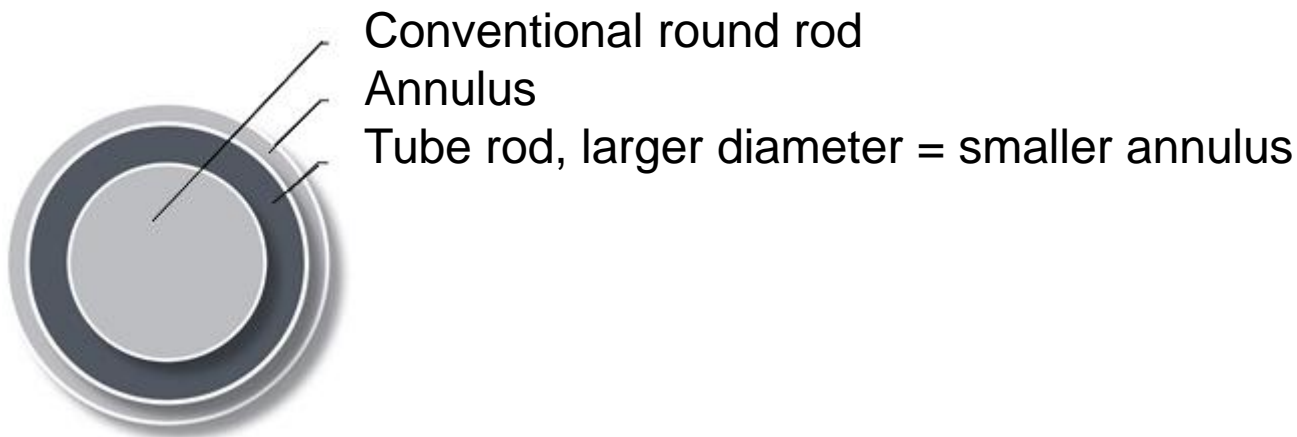
<b>ROD</b>	<b>TUN</b>	<b>M/M</b>	<b>2000</b>	<b>R38</b>	<b>28H</b>	<b>R32</b>
Product	Type	Type thread	Length	Left Thread	Shape and size	Right Thread
Group	- TUN - EXT	- M/M - M/F	2000mm	Style and size	- Hexagon 28mm - Round	Style and size



<b>ROD</b>	<b>EXT</b>	<b>M/F</b>	<b>1830</b>	<b>39R</b>	<b>HM38 WF</b>	<b>C</b>
Product	Type	Type thread	Length	Shape	Thread	With Flats
Group	- TUN	- M/M	1830mm	39mm - Round		Carburized



- Used in underground and surface applications
- Due to enlarged diameter drills straight holes
- Improved hole wall stability
- Excellent flushing characteristics
- Higher penetration rates
- Available in  $\text{Ø}76\text{mm}$  and  $\text{Ø}87\text{mm}$



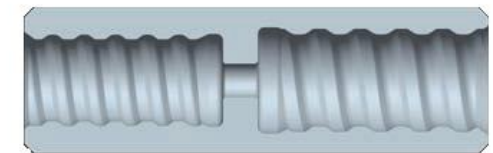
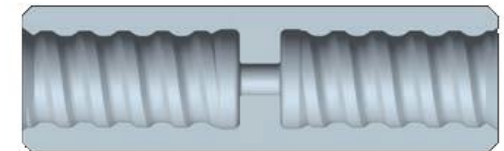
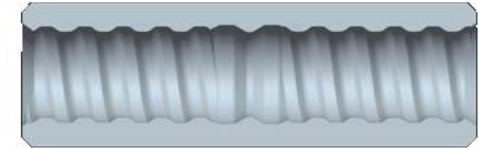
# Rod Description



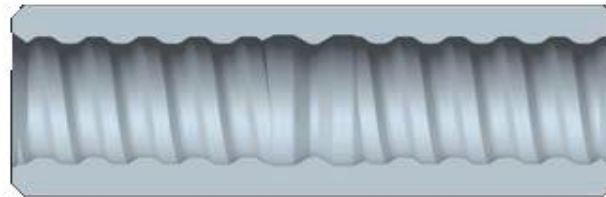
<b>ROD</b>	<b>TUBE</b>	<b>1830</b>	<b>76T</b>	<b>048</b>	<b>BE58</b>	<b>SD</b>
Product	Type	Length	Outer Ø	Inner Ø	Thread	Shoulder Drive
Group	- TUBE	1830mm	76mm	48mm	- BE58 - BE68	



- Semi Bridge
  - A small non-threaded center bridge
  - Rods butt together at the center
  - Better energy transfer
- Full Bridge
  - Eliminates possibility of coupling creep
  - Tighter joints & better uncoupling
- Adapter Coupling
  - Combine dissimilar threads
  - Same characteristics as full bridge coupling



# Coupling Description



## COUPLING

Product  
Group

## R32

Thread Style  
& Size

## S/B

Type  
- S/B Semi Bridge  
- F/B Full Bridge  
- Adapt Adapter

## 045

Outer Ø  
45mm

## 150

Length  
150mm

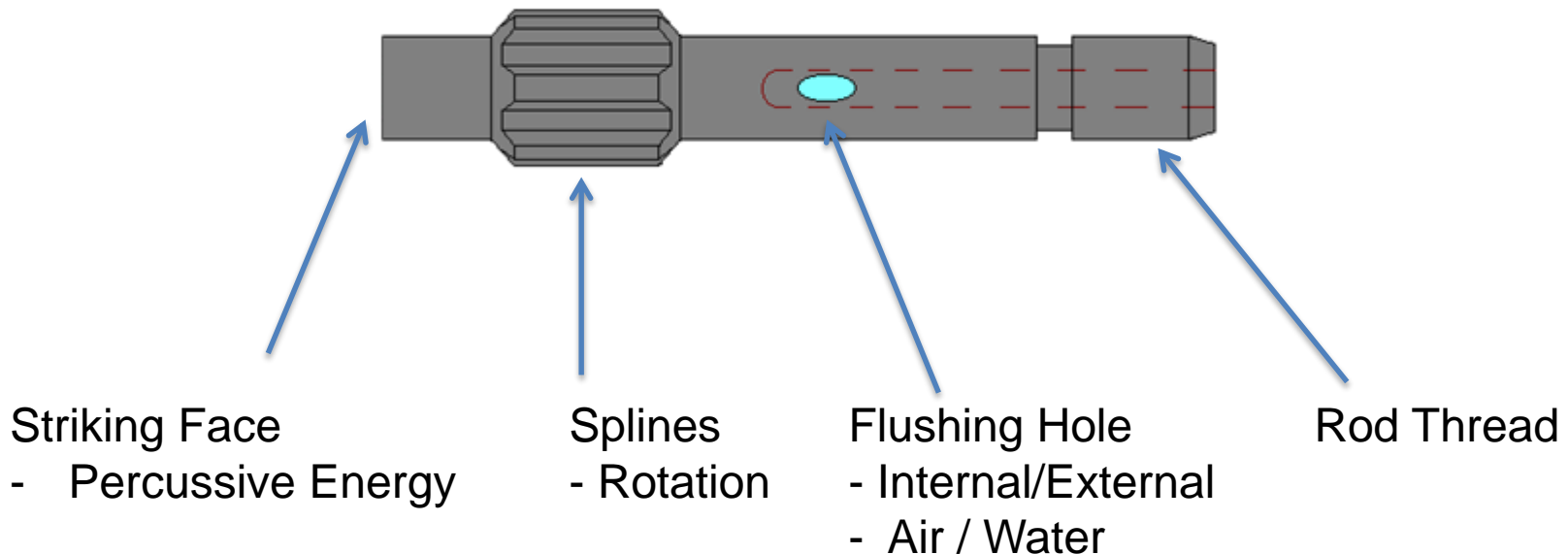
# Shanks



# Shank Adapters



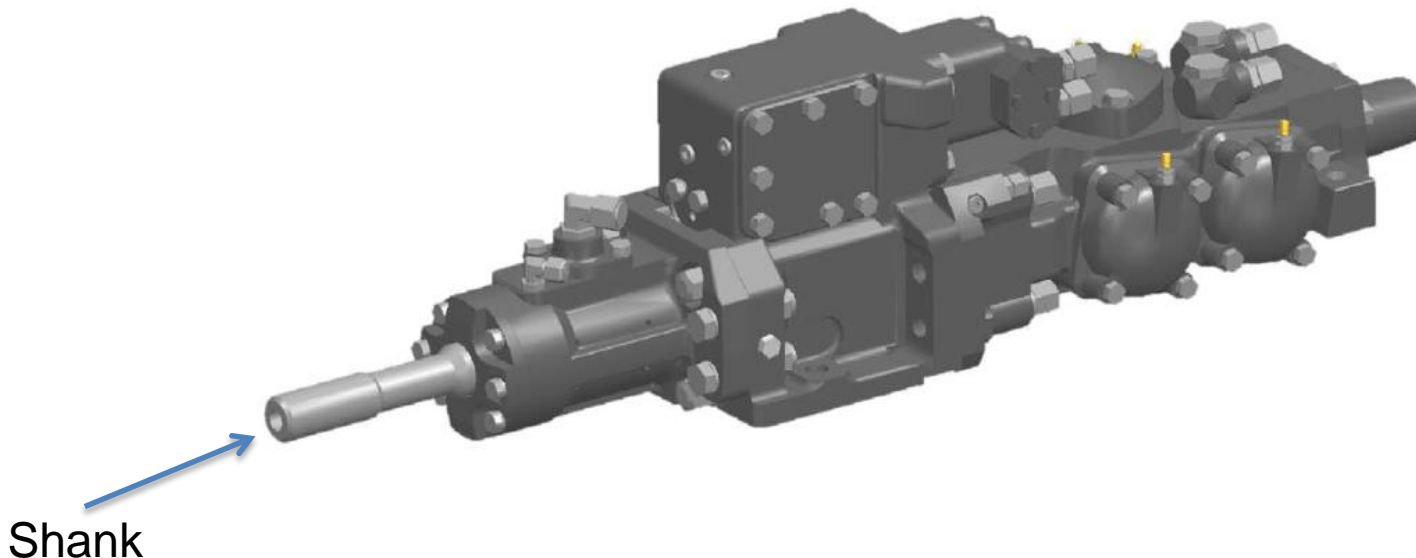
- Connects the rockdrill/drifter to the drill string
- Presents a striking face for the percussive energy
- Presents splines to transfer rotation to the drill string
- Introduces the flushing medium into the drill string



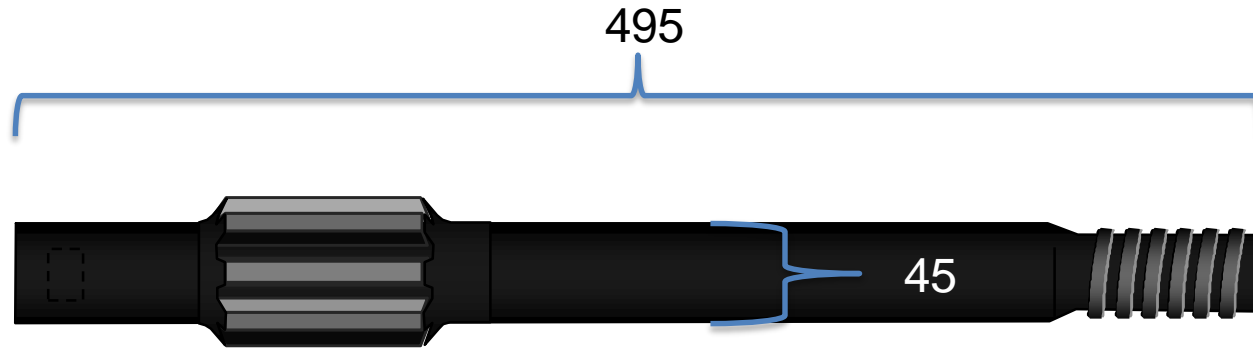
# Shank Adapters



- Rockdrills come from many different manufacturers
  - Atlas Copco, Sandvik, Montabert, Furukawa, GD, IR, etc.
- Key technical parameters to know are
  - Rockdrill type 1840HE, HL1560, HC20, HD709, etc.
  - Thread, diameter & length of the shank



# Shank Description



**SHK**

Product  
Group  
- Shank

**BL HD150**

Rockdrill Make & Type  
- BL  
- COP  
- TAM  
- GD  
- Etc.

**HM38**

Thread  
Style & Size

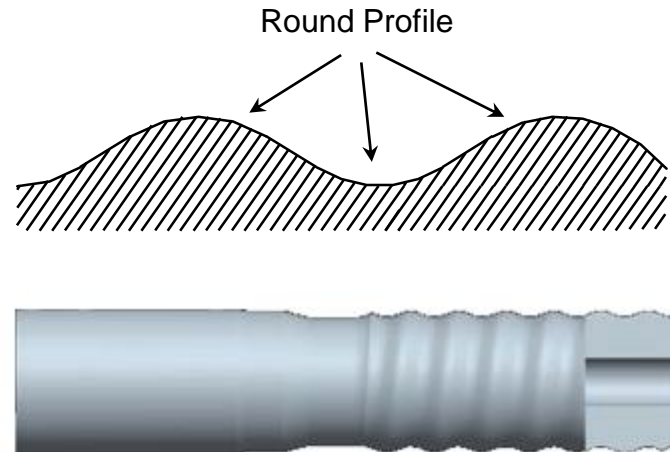
**045 / 495**

Diameter  
45mm  
Length  
495mm



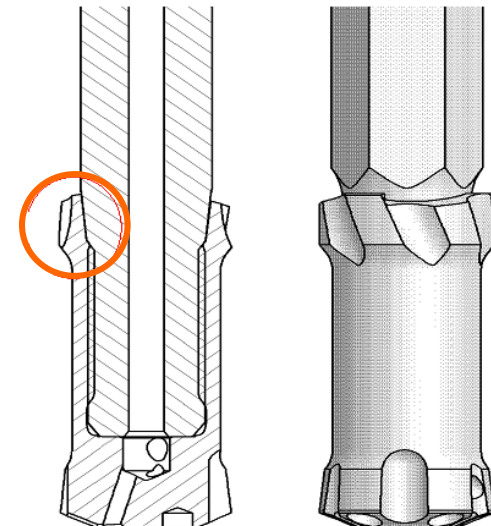
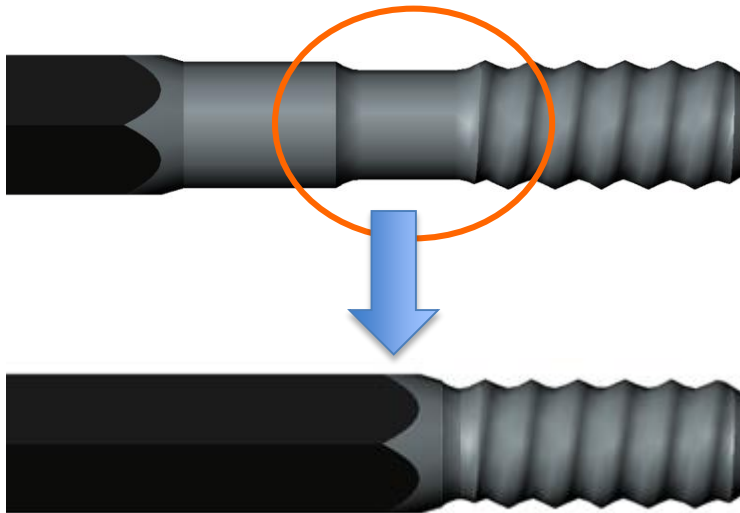


- “Round” overall profile
- High load bearing, good thread wear properties
- Poor uncoupling, use in single pass / short hole
- Poor compatibility with high torque drills
- Designations: R25, R28, R32, R35, R38





- New Boart Longyear design 2012
  - Larger cross-sectional transition area (no goose neck)
  - Increased bit skirt length to match transition area
- Increased rod tip-off resistance and less hole deviation
- Fully compatible with R32



# DM Thread (DriftMaster™)



- New Boart Longyear design 2019
  - Stronger than R32 / RST
  - Easier Coupling / Uncoupling
- Increased rod tip-off resistance and less hole deviation
- **Not** compatible with R32 or any other thread



1. Tapered thread (increased  $\varnothing$  at base)
2. Asymmetrical thread (minimizes stress)
3. Wear resistant & easier make/break

# Thread Compatibility - R

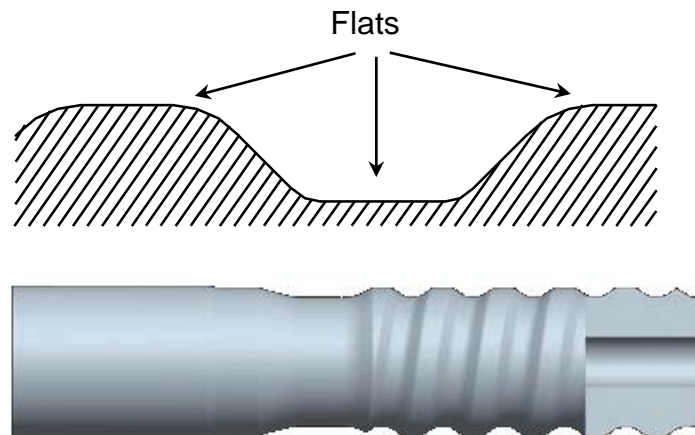


Size	Boart Longyear	Sandvik	Atlas Copco
R25	✓	✓	✓
R28	✓	✓	✓
R32	✓	✓	✓
R35	✓	✓	✓
R38	✓	✓	✓
RST*	✓	✓	✓
DM35	✓	✗	✗

\* RST is fully compatible with R32



- Visibly wider and flat thread profile
- Adequate load bearing, excellent thread wear properties
- Excellent coupling/uncoupling, use in extension drilling
- Good compatibility with high torque drills
- Designations: HM38, HM45, HM51
  - HM is compatible with the T or C thread from other manufacturers



# Thread Compatibility – HM / T / C\*

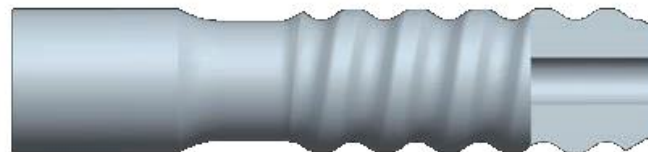
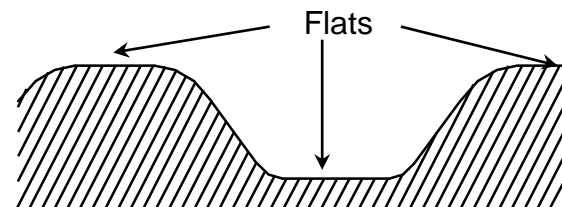


Size	Boart Longyear	Sandvik	Atlas Copco
HM35	×	✓	×
HM38	✓	✓	✓
HM45	✓	✓	✓
HM51	✓	✓	✓

\* T is used by Atlas Copco and Sandvik, C is used by Robit, and HM is used by Boart Longyear, T, C and HM are fully compatible



- Similar profile to HM (T) threads
- Excellent load bearing, excellent thread wear properties
- Excellent coupling/uncoupling, use in extension drilling
- Excellent compatibility with high torque drills
- Designation: EL60, EL68
  - Not compatible with other manufacturers threads





- Specifically developed for straight large diameter drilling
- Better coupling/uncoupling characteristics vs HM51
- Superior performance and high penetration rates
- Available in 60mm and 68mm rod diameter
- Bits from Ø92mm to Ø165mm



# Thread Compatibility – Specialties



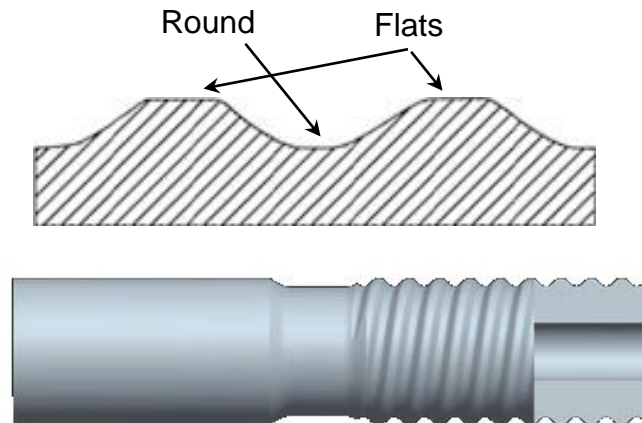
Size	Boart Longyear	Sandvik	Atlas Copco
SR28	×	×	✓
SR32	×	×	✓
SR35	×	×	✓
α250	×	✓	×
α350	×	✓	×
BE58EXT/ Sandvik60*	✓	✓	×
GT60	×	✓	×
T60	×	×	✓
EL60	✓	×	×
EL68	✓	×	×
DM	✓	×	×

\* BE58EXT and Sandvik 60 (ST58) are bottom drive versions of the 58 system. BE58EXT and Sandvik 60 are fully compatible.

# The BE “tube” thread



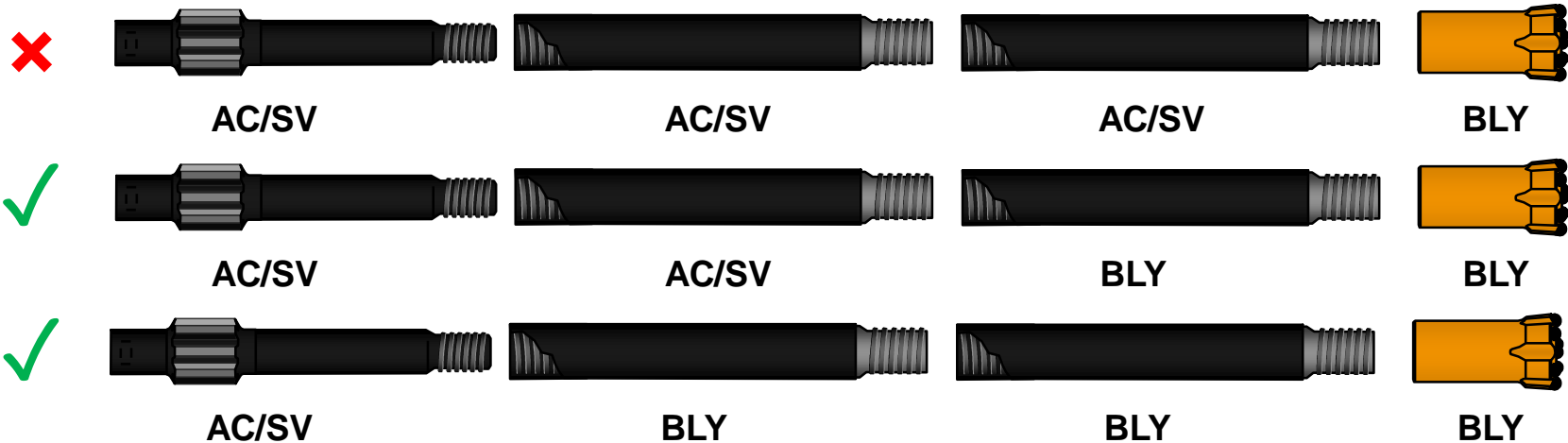
- Shoulder drive tube drilling system
- Good bearing surface due to smaller angle of profile
- Excellent wear properties
- Good coupling/uncoupling characteristics
- Used in extension tube drilling
- Designation: BE58, BE68



# Thread Compatibility – BE/ST\*



Size	Boart Longyear	Sandvik	Atlas Copco
BE58	✓	✓	✓
BE68	✓	✓	✓



- \* The BL tube drilling system is not fully compatible with Sandvik and AC
- The thread design is compatible, but the Boart Longyear thread is shorter
  - AC/SV Shank to BL rod = OK; AC/SV Rod to BL Rod = OK
  - AC/SV Rod to BL bit will not work due to shorter thread in the bit
  - When BL bits are used, the lead rod should be BL also





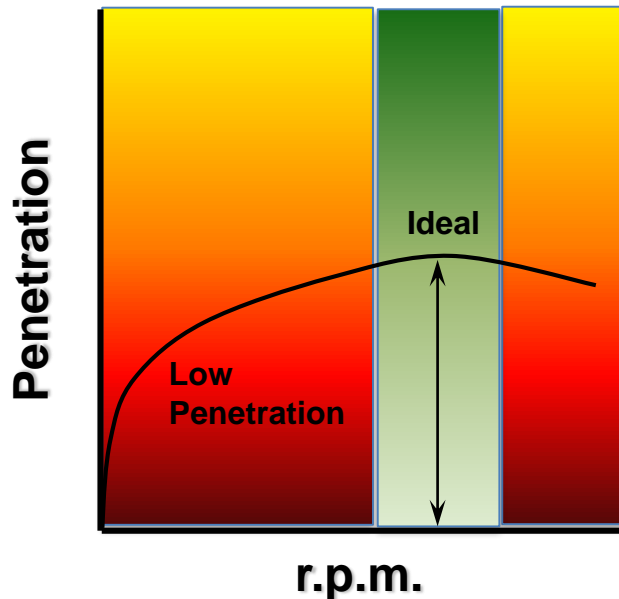
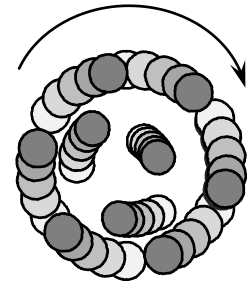
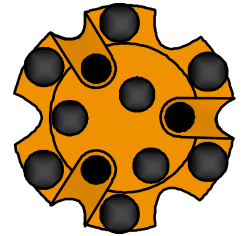
## Key factors in percussive drilling are:

- Rotation speed
  - Feed pressure
  - Percussive energy
  - Flushing
- }] Percussion, feed, rotation and flushing should be continuously adjusted to the varying rock conditions in order to optimize drilling rates and tooling life
- Sharp bits
- }] Running dull bits slows down the drilling rates and escalates drilling costs by: reducing life on all the drill string components, increases equipment maintenance costs and increases unwanted downtime
- Control hole deviation
- }] Hole deviation negatively affects the blast pattern causing higher drilling expense and lower productivity

# Drilling – Rotation Speed



- The button bit needs to turn to re-index the buttons
- RPM needs to be adjusted to rock conditions
- Too high RPM causes wear, re-drilling of cuttings
- Too low RPM causes re-drilling of cuttings



$$\text{Max RPM} = \frac{\text{BPM} \times d}{D \times \pi}$$

RPM = Rotations per minute recommended

BPM = Blows per minute from rockdrill

d = Diameter of gauge button

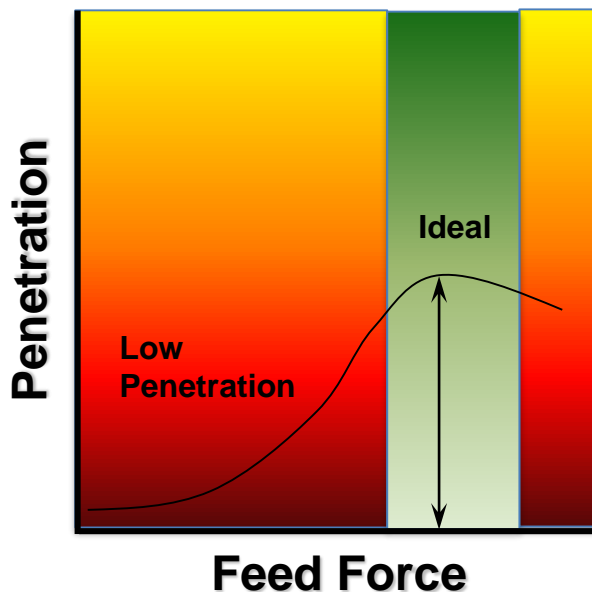
D = Bit diameter

$\pi = 3.14159$

# Drilling – Feed Pressure



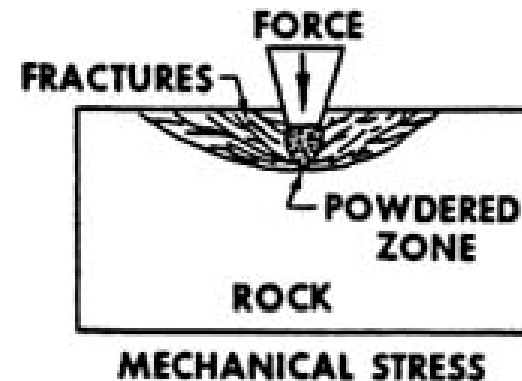
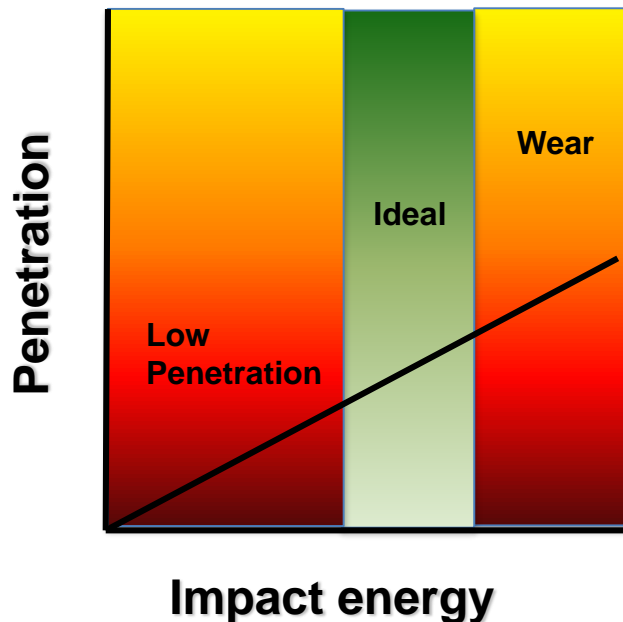
- Keep the buttons on the bit in contact with the rock
- Feed pressure needs to be adjusted to rock conditions
- Too high feed pressure causes wear, deviation, bending
- Too low feed pressure causes wear & buttons to pop out



# Drilling – Percussive energy



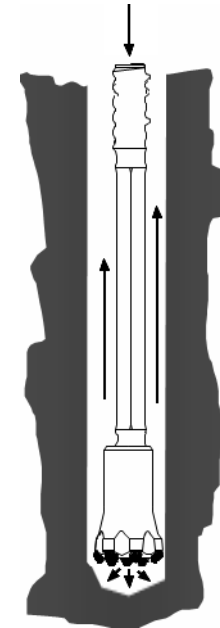
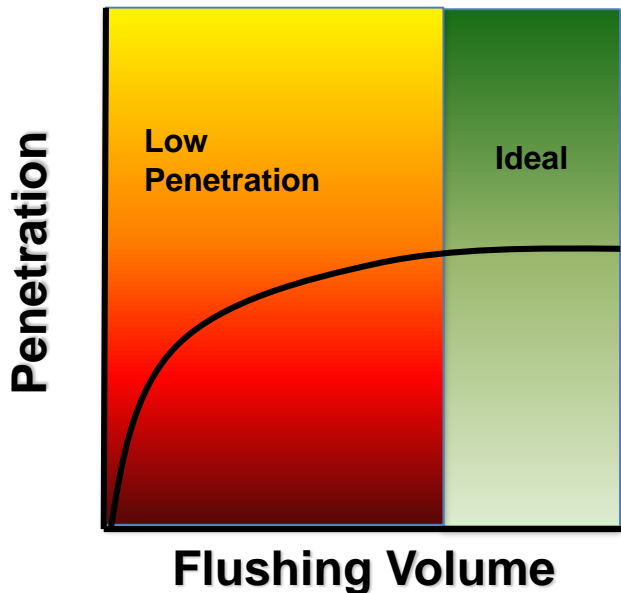
- Insufficient impact energy causes a poor penetration rate
- Too high impact energy causes reflection of energy and excessive wear on the tools
- Impact energy needs to be adjusted to rock conditions



# Drilling – Flushing



- Required to flush cuttings from the hole
- Prevents re-drilling, jamming and cools the operation
- Reduces wear to drill bits, helps penetration
- Flush with air or water
- Too high or powerful flow could lift the bit from bottom





- Overdrilling bits (dull bits)
  - Causes 90% of the button failures
  - Slows down drilling rates
  - Escalates drilling costs
- Ensure sharp bits are continuously used by
  - Enforcing that optimum drilling intervals are followed
  - Implementing a bit sharpening/servicing program



New bit



Minimum wear



Overdrilled





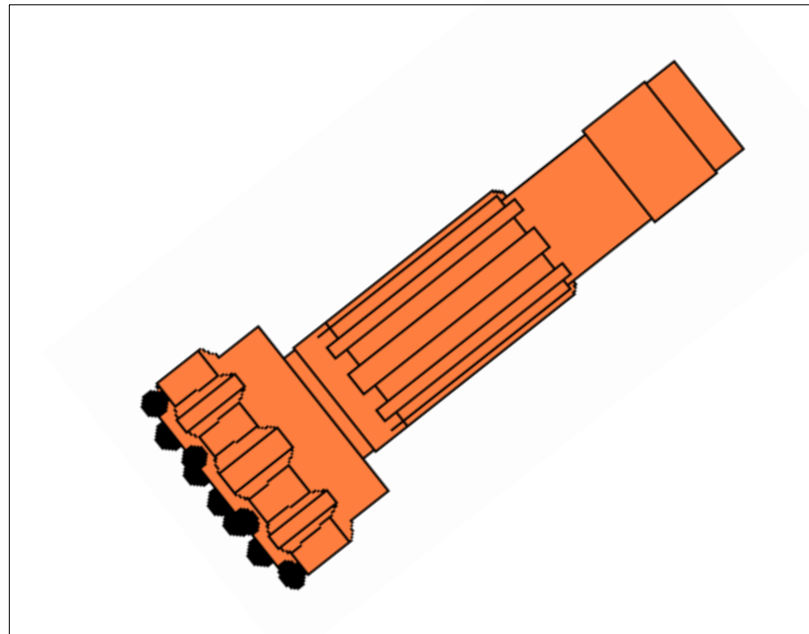
Hole deviation is mostly caused by:

- Incorrect collaring and misalignment (70% of the cases)
- Excessive feed pressure
- Rock conditions (varying hardness, fracture direction)

Control hole deviation by:

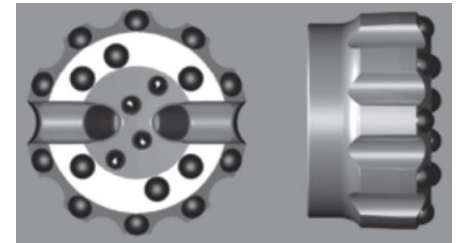
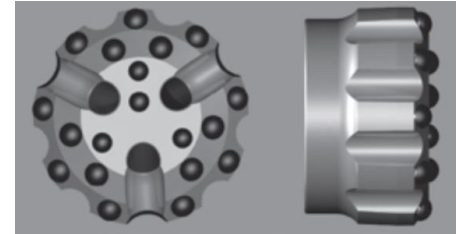
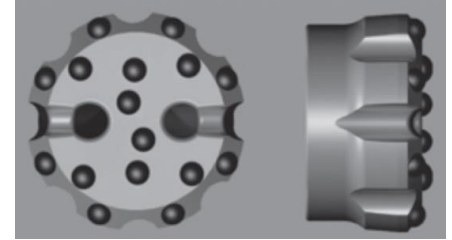
- Pay attention to correct set-up and alignment
- Optimize feed pressure
- Optimize tooling selection (rods, guide tube, tube, bits)
- Keep bits sharp

# DTH (Down The Hole)

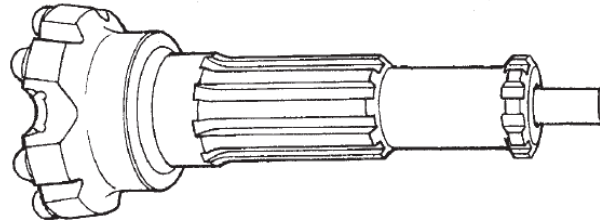




- Flat face design (BF)
  - Standard bit
  - For medium hard rock
- Convex/Dome face design (BD or DH)
  - Double gauge insert row
  - For soft to medium hard & abrasive rock
- Concave/Recessed face design (BR)
  - All purpose bit, straight hole
  - For soft to medium hard rock



# DTH Bit Description



<b>BIT</b>	<b>DTH</b>	<b>165</b>	<b>DHD360</b>	<b>BR</b>	<b>8/4/4</b>	<b>H</b>
Product	Group	Diameter in mm	Shank Design	Face Design	Button Setup	
			- COP	- BR	- 8x Gauge buttons	- Hemi
			- SD	- BF	- 4x 2 <sup>nd</sup> row gauge	- Para
			- IR	- BD/DH	- 4x Center buttons	- Ballistic
			- DHD			
			- QL			
			- BULROC			
			- Etc.			





## 1. Body Wash

- Increase flushing
- Drilling in loose & fractured rock (normal wear)

## 2. Split Skirt

- Bit was loose on rod
- Hammering on bit to break connection

## 3. Steel Crack between button socket base

- Manufacturing problem, return for analysis

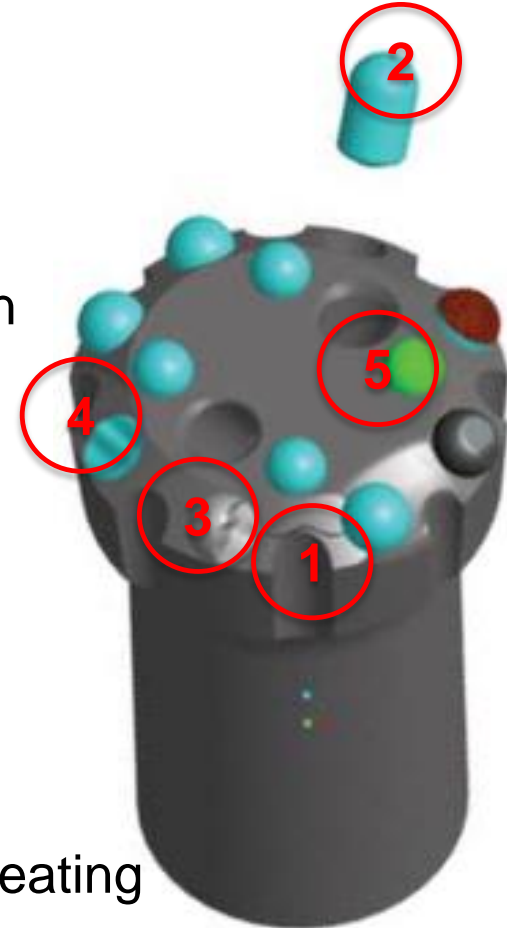
## 4. Wring Off

- High torque on stuck bit
- Hammering to break connection
- Corrosion
- Manufacturing problem, return for analysis



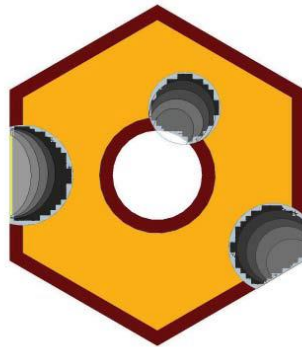


1. Crack between buttons
  - Manufacturing problem, return for analysis
2. Lost button
  - Insufficient or no feed pressure, scaling, erosion
  - Bad interference fit, return for analysis
3. Shattered buttons
  - Lack of resharpening (flats), drilling into metal
  - Drilling in undersized hole
4. Sheared buttons (above or below body)
  - High torque against obstructions in hole
  - Poor collaring, or incorrect resharpening, overheating
5. Split button
  - Lack of resharpening (flats) or bad interference fit (return analysis)





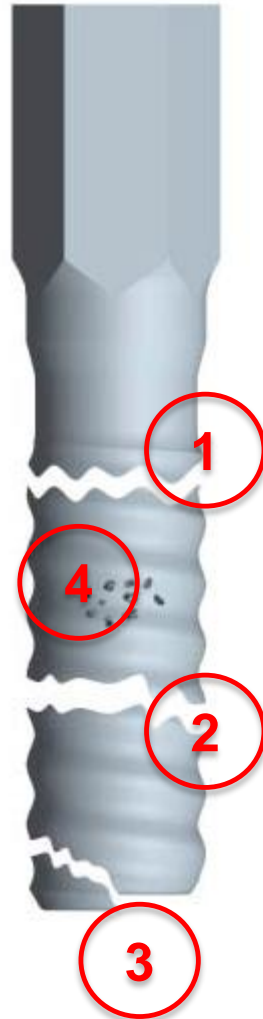
- Rods are subjected to repeated compressive load
  - Under normal conditions threads wear out before the rod steel
  - Under unusual stress, bending or damage, rod could fail early
  - Fatigue failure can be spotted by a “fatigue rose”
  - Fatigue rose can originate from:
    - Outside (damage, hammering, care & handling)
    - Inside (corrosion, care & handling, defect)
    - At the thread end (bending, poor rock condition)



# Trouble Shooting Rods



1. Break near end of thread
  - Bending
  - Worn threads or coupling
  - Drilling in poor rock (jamming, voids, high torque)
2. Break at 1/3 of the thread
  - Worn threads
  - Surface damage (care & handling)
3. Chip off at beginning of thread
  - Rods not properly joined (worn coupling)
  - Hammering to loosen joints
4. Galling of the thread (color blueish)
  - Energy is reflected back in the drill string
  - Resharpen bits



# Trouble Shooting Couplings



1. End is chipped/cracked/flared
  - Drill rod not firmly seated
  - Worn threads (mixing used & new steel)
  - Misalignment of feed or overheating
  - Improper heat treatment (return for analysis)
2. Failure across thread section
  - Misalignment of feed , hole deviation, low
  - High torque, surface damage (care & handling)
3. Pitting or galling
  - Energy is reflected back in the drill string
  - Resharpen bits
4. Split coupling
  - Worn threads or excessive feed pressure



# Trouble Shooting Shanks



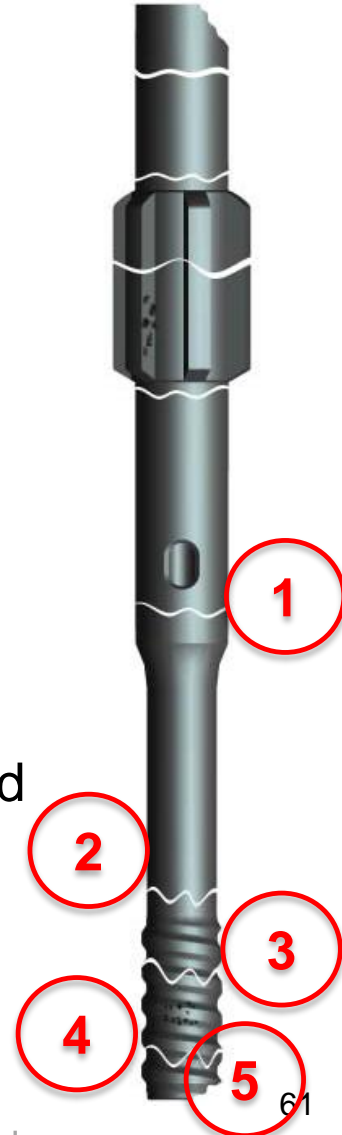
1. Impact marks, chipped, mushroomed
  - Rockdrill: worn bushing or piston
2. Failure 25mm from striking end
  - Rockdrill: worn chuck driver
  - Fatigue failure at water seal recess (return for analysis)
3. Failure at top of splines
  - Rockdrill : worn chuck driver, bushing or lack of lubrication
  - Excessive feed force
4. Failure across splines
  - Rockdrill: worn chuck driver, lack of lubrication
  - Too high torque or inadequate feed force
5. Wear or failure on bottom of spline
  - Excessive rotation while retracting drill string



# Trouble Shooting Shanks



1. Failure at fronthead
  - Rockdrill: worn bushing or lack of lubrication
2. Failure above threads
  - Misalignment of feed, hole deviation
  - Excessive feed force
3. Failure in the main body of threads
  - Worn threads (mixing used and new) or “rattling”
  - Rockdrill: lack of lubrication
4. Failure close to the bottom of the threads
  - Excessive percussive energy, worn threads, broken rod
5. Chipped thread end
  - Worn threads, broken rod, misalignment of feed



# Trouble Shooting Shanks

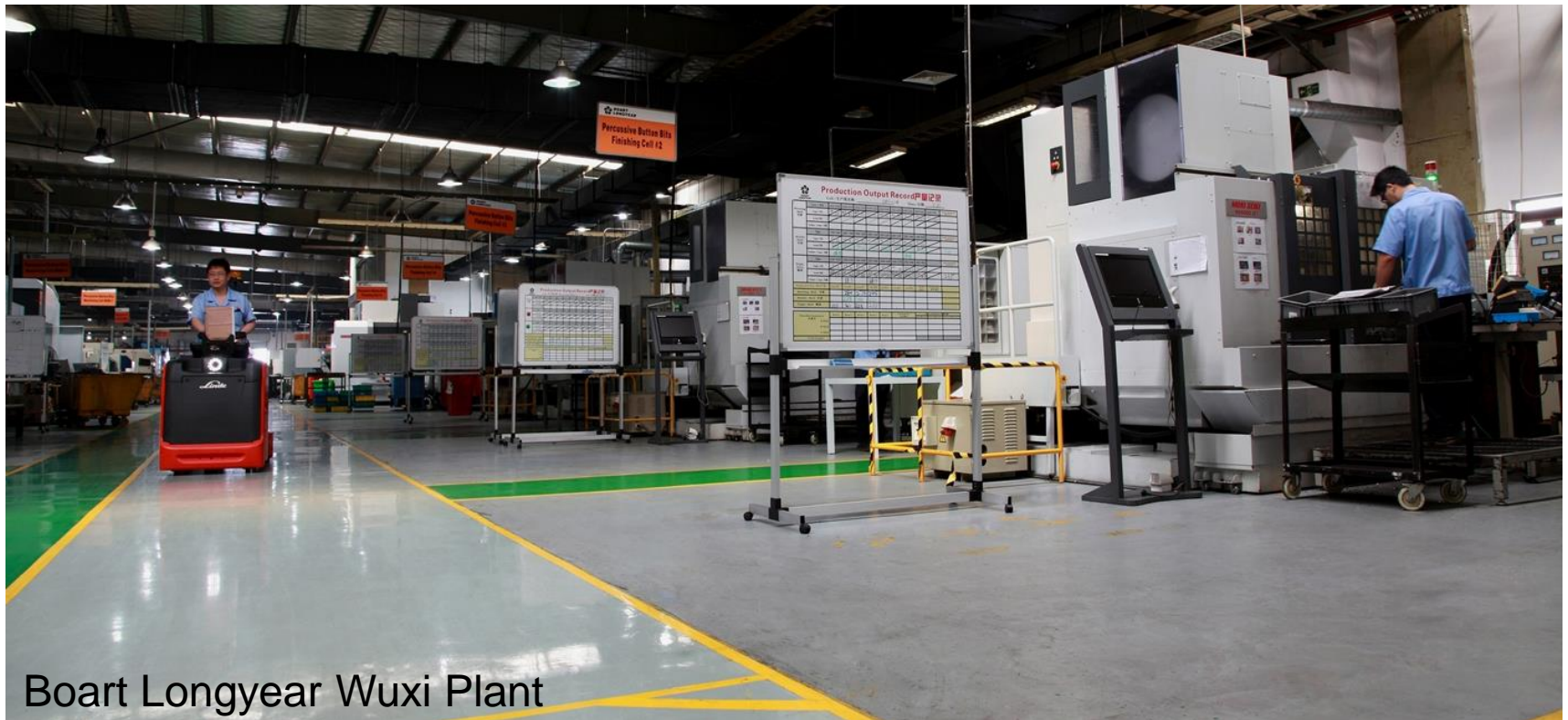


1. Pitting & galling on threads
  - Energy is reflected back in the drill string
  - Resharpen bits
  - Rockdrill: lack of lubrication
2. Pitting & galling on splines
  - Rockdrill: lack of lubrication
  - Excessive rotation in soft or broken rock
3. Excessive wear on top of spline shoulder
  - Excessive feed force
  - Rockdrill: lack of lubrication





Our factories in Mississauga and Wuxi are state of the art manufacturing facilities.

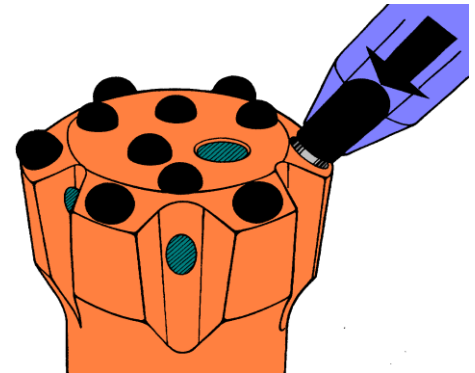


Boart Longyear Wuxi Plant



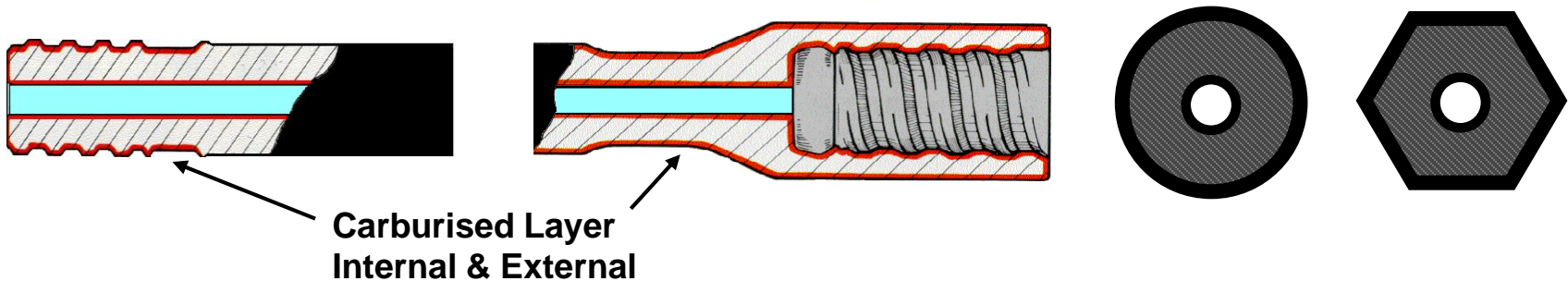
The steel for all our products is specially produced for this application and is imported from world-class steel suppliers.

The Tungsten Carbide (TC) buttons for all our button bits are made in a dedicated specialized plant.





The hardness of hardened steel is dependent on its carbon content. In carburization (C), a carburized layer is produced by heat treatment in an atmosphere with a carbon-rich gas. This increases the fatigue strength of the steel, while also improving the wear resistance and corrosion protection.



An alternative to carburization is high frequency (H/F) induction (I) surface (SURF) hardening. With this method only the thread ends / exterior is hardened. Female ends are carburized before friction welding.



Thank you for your attention

