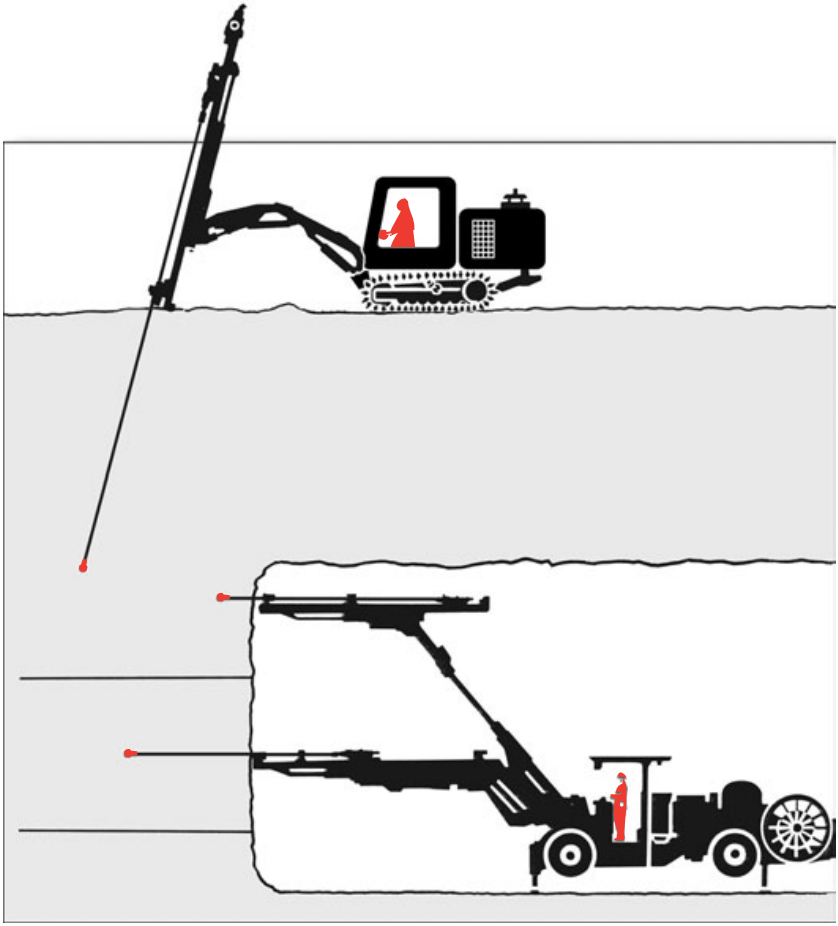
ROBIT® ROCKBIT MANUAL

green steel

Robit®
ROCKTOOLS

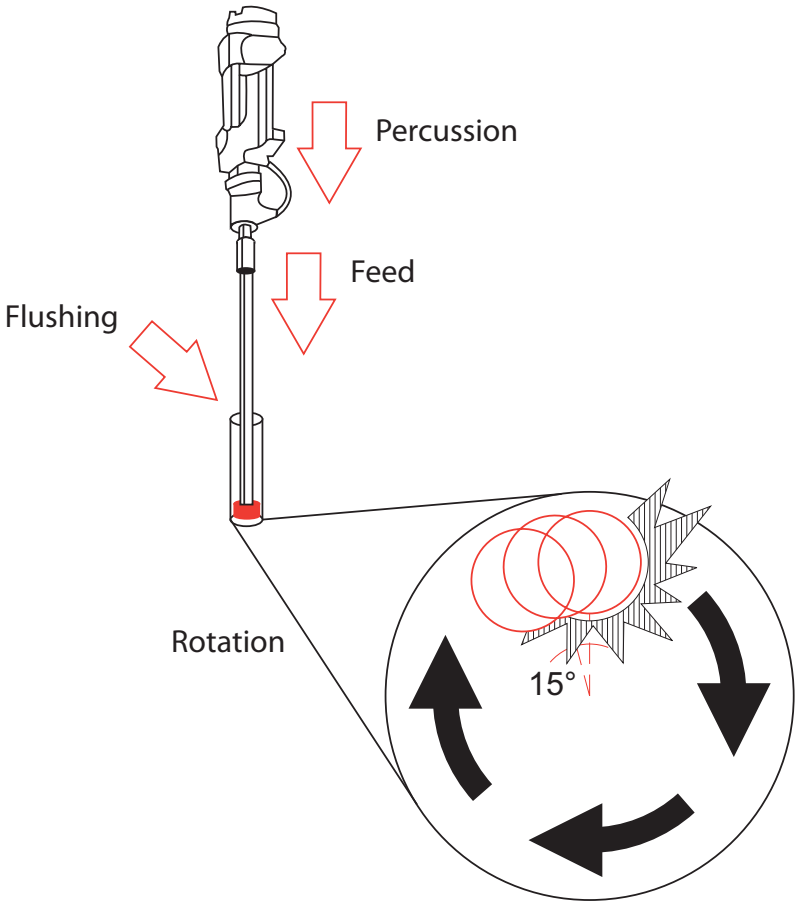
CONTENTS:

1.1 Elements of drilling process



1.2 Percussive drilling

Principles of percussive drilling

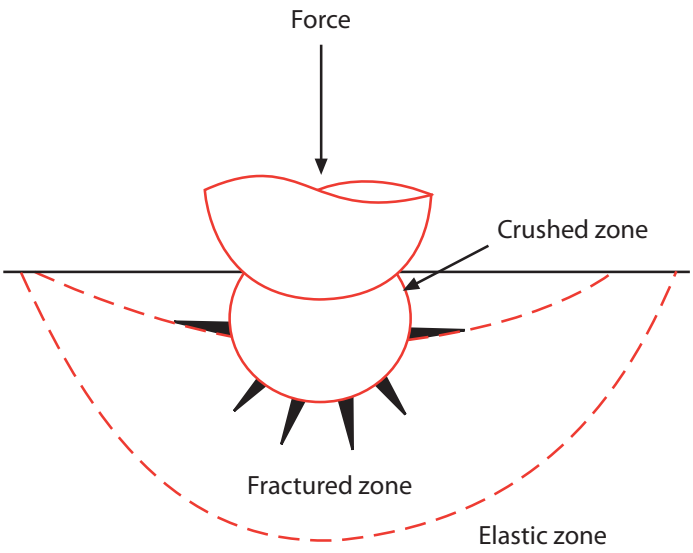


Rule of thumb for calculating the rotation speed

$$\text{Rpm} = \frac{\text{Impacts / minute} * \text{Gauge button Ø (mm)}}{\text{Bit Ø (mm)} * \pi}$$

1.2 Percussive drilling

Principle of rock breaking



1.2.1 Typical problems in percussive drilling

1.2.1.1 Percussion

Too high:
- Button breakages
- Drill steel / Shank breakages

Too low:
- Low penetration rate
- Excessive button wear (due to rotation breaking the rock)

-> percussion measure settings are always compromise between penetration rate and drill steel economy

1.2.1.2 Feed

Too high:
- Problems in flushing
- Rapid button / body wear
- Increased hole deviation
- Problems in uncoupling
- Bending of drill steel and shank -> breakages

Too low:
- Button pop-outs
- Poor penetration rate
- Loose couplings and excessive thread wear
- Poor energy transmission

1.2.1.3 Rotation

Too high:
- Recutting and low penetration rate
- Excessive bit wear (since the rock is forced to break by rotation instead of percussion)
- Uncoupling is difficult

Too low:
- Low penetration rate
- Energy is lost for recutting

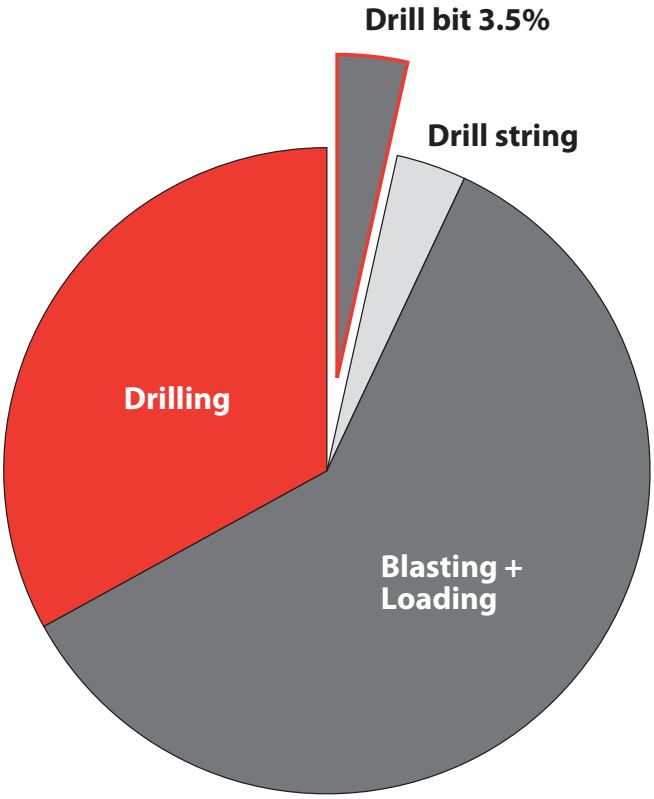
1.2.1.4 Flushing

Too high:
- Unnecessary energy loss at the compressor
- In waterflushing water enters into the drifter if sealing is broken

Too low:
- Low penetration rate (increased recutting)
- Excessive bit wear
- Bit jamming

1.3 Excavation costs vs. bit costs

Drill string itself represents only 7% of the total cost of rock excavation, and the bit cost is around half of the drill string cost. However, the significance of the bit is far higher.



2.1 Basic rock information

2.1.1 Rock hardness

Properties of rock types according to classification based on rock origin

ROCK TYPE		ROCK	SPECIFIC GRAVITY	GRAIN SIZE (mm)	SiO_2 CONTENT (%)	COMPRESSIVE STRENGTH MN/m^2 ($1\ MN/m^2=10\ kg/cm^2$)
IGNEOUS	INTRUSIVE	DIORITE	2.65-2.85	1.5-3	-	170-300
		GABBRO	2.85-3.2	>2	50	260-350
		GRANITE	2.7	0.1-2	70	200-350
	EXTRUSIVE	ANDESITE	2.7	<0.1		300-400
		BASALT	2.8	<0.1	50	250-400
		RHYOLITE	2.7	<0.1		120
		TRACHYTE	2.7	<0.1	-	330
SEDIMENTARY		CONGLOME-RATE	2.6	>2		140
		SANDSTONE	2.5	0.1-1	80-95	160-255
		SHALE	2.7	<1	50-62	70
		DOLOMITE	2.7	1-2	2-10	150
		LIMESTONE	2.6	1-2		120
		LIMEROCK	1.5-2.6	1-2		30-100
METAMORPHIC		GNEISS	2.7	>2		140-300
		MARBLE	2.7	0.1-2		100-200
		QUARTZITE	2.7	0.1-2	98	160-220
		SCHIST	2.7	0.1-1		60-400
		SERPENTINE	2.6			30-150
		SLATE	2.7	<0.1		150

2.1.2 Rock abrasiveness

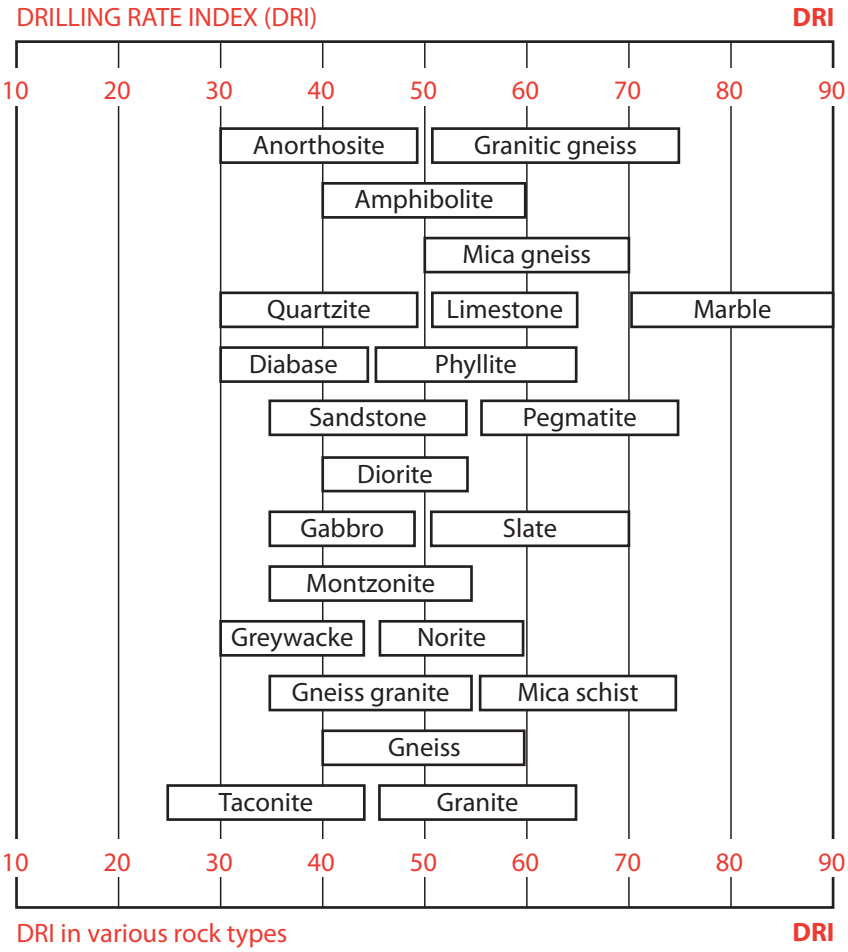
Drillability

Igneous rocks are hardish but massive and relatively easy to drill with percussive methods provided that they are not too badly fissured and not decomposed. They are usually too hard for rotary drilling, at least in underground appilcations. In surface drilling a heavy rotary blast hole rig is used with a high pull-down force, but bit wear can be a big problem.

Limestones vary greatly in hardness, from chalk to carboniferous limestones. Bit wear is not a problem. Hard limestones can be drilled with percussive machines or with heavy rotary drills, while soft limestones are better drilled with rotary drills.

Sandstones are abrasive and therefore not usually drilled by rotary means. With percussive drills they are normally easy to drill.

Drilling rate index



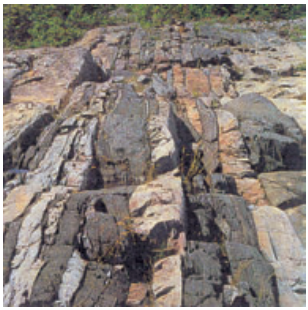
The higher DRI, the better drillability.

1.2.3 Solid vs. broken rock

Solid rock

Limestone is normally easy to drill; penetration is high and the bit wear is low. Sandstone is very often also easy to drill, but bits can wear out rapidly because of the high quartz content.

Broken rock



Strongly layered rock can be difficult to drill; small drilling angle against the layers causes the biggest problems. Correct bit is essential for good drilling results.

Gneiss is often fine grained and has high quartz content, o the bit wear is high and material can be hard to drill.

Limestone is normally easy to drill and causes only a small amount of bit wear. When the rock looks like this, bad fragmentation causes jamming of the rods. Hole deviation can also be a problem. Retrac type of bits are highly recommended.

2.2 Optimal bit selection

2.2.1 Robit® button bits product range in use

Face types:

Flat face

Drop center

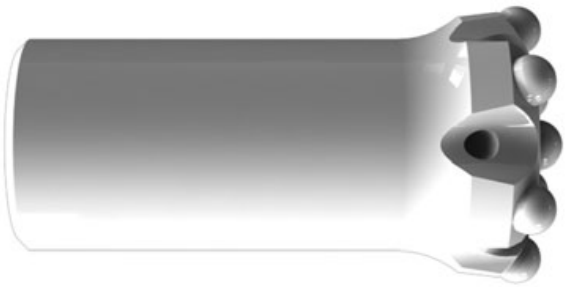
Button types:

SuperDome

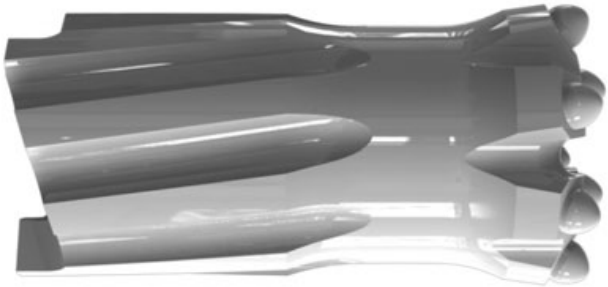
Ballistic/semiballistic

Body types:

Normal body



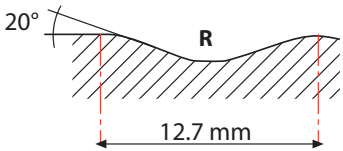
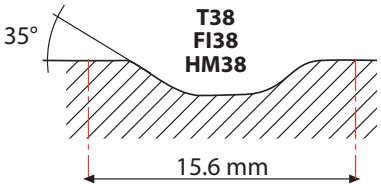
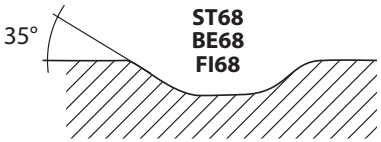
Retrac body



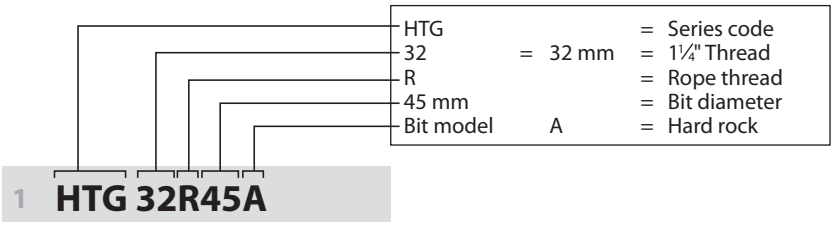
Standard bit diameters:

38 mm	1 1/2	inch	60 mm	2 1/3	inch
41 mm	1 5/8	inch	64 mm	2 1/2	inch
43 mm	1 11/16	inch	70 mm	2 3/4	inch
45 mm	1 3/4	inch	76 mm	3	inch
48 mm	1 7/8	inch	89 mm	3 1/2	inch
51 mm	2	inch	102 mm	4	inch
57 mm	2 1/4	inch	115 mm	4 1/2	inch
			127 mm	5	inch
			152 mm	6	inch

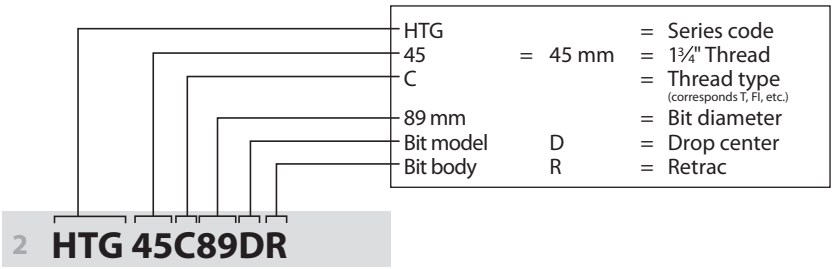
Standardized thread types (examples):

ROBIT THREAD CODE	CORRESPONDING CODES
Rope thread **R**	
Trapez thread **C38**	
Tube thread **CT68**	

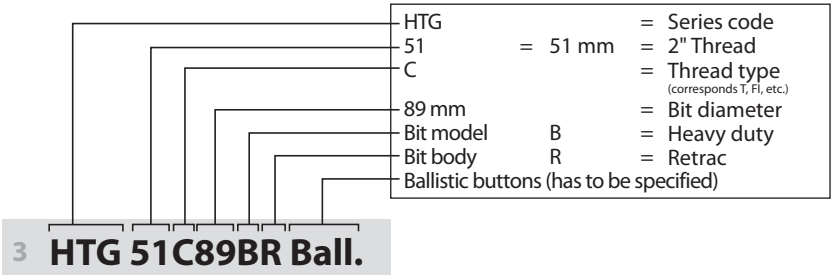
Product code: break down (examples)



1 **HTG 32R45A**

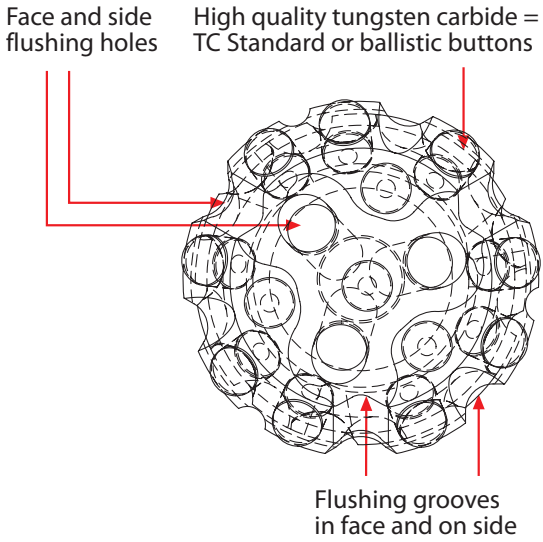


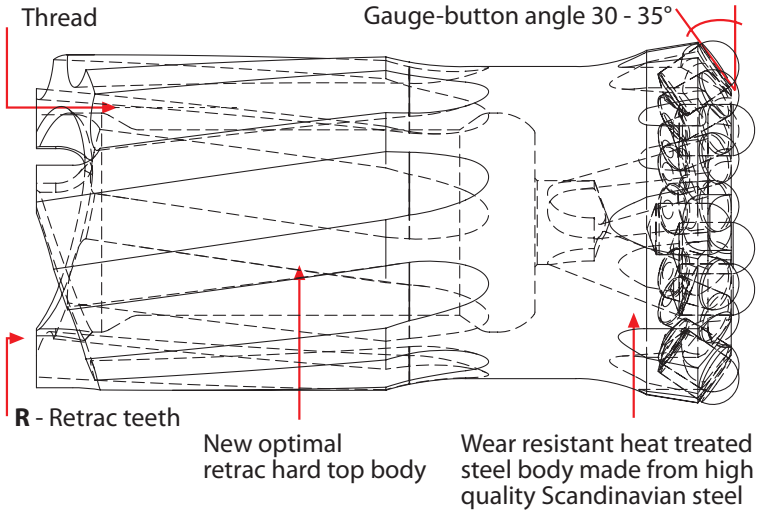
2 **HTG 45C89DR**



3 **HTG 51C89BR Ball.**

Product specifications:





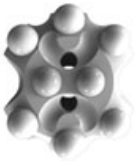
Bit selection

Drifting and tunnelling:

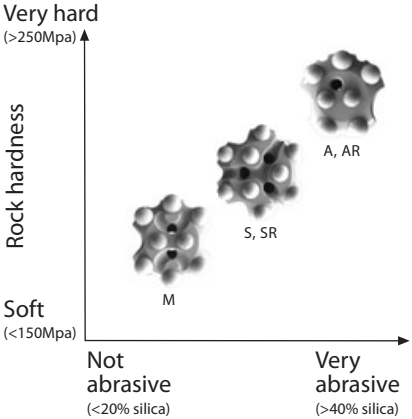
Common bit diameters: 41-51mm

A, AR
Basic model for medium and hard rock drilling

S, SR
Speed drilling model for various conditions



M
Model with maximized flushing properties for soft and medium hard rock



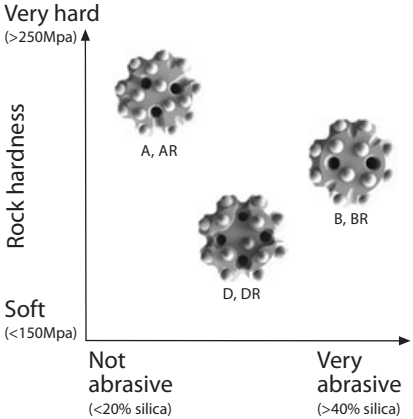
Bench and production drilling:

Common bit diameters: 64-89mm

B, BR
Heavy duty model for abrasive conditions

A, AR
Basic model for medium and hard rock drilling

D, DR
Drop center model with many buttons for soft and medium hard rock



2.2.2 Typical problems in different rocks

Abrasive rock

- Short bit life
- Excessive wear of gauge buttons
- Excessive or uneven wear of bit body

Hard rock

- High percussion and feed force needed
- Short bit life

Soft rock

- Deviation of the holes
- Holes will cave-in
- Insufficient flushing capacity

Broken rock

- Deviation of the holes
- Holes caving in
- Insufficient flushing capacity
- Drill string recovery

Non-homogeneous rock
Hard and soft rock varies within one rod

- Rushing of the feed from hard to soft rock
- Uneven rock contact
- Hole deviation
- Skillful drillers required

2.2.3 Solutions and Robit® recommendations

Abrasive rock

- Bigger gauge buttons
- Robit® bit type B

Hard rock

- Larger quantity of buttons
- SuperDome buttons
- Robit® bit types A & S

Soft rock

- Semiballistic buttons
- Retrac body
- Robit® bit type R

Broken rock

- SuperDome buttons
- Retrac body
- Side flushing recommended
- Robit® bit type R

Non-homogeneous rock

- SuperDome buttons
- Retrac body
- Side flushing recommended
- Robit® bit types R (Retrac)

2.2.4 Bit economics; savings and benefits

Case study

Rock excavation, 1.000.000 m^3 granite

Hole diameter (mm)	**64**	**76**	**89**
Specific drilling (m/m^3)	0,25	0,20	0,15
Total meters drilled (m)	250.000	200.000	150.000
Bit life (average), (m)	800	1.000	1.200
Numbers of bits needed	313	200	125
Bit cost (USD)	140	175	210
Total bit cost (USD)	**43.800**	**35.000**	**26.300**

Drill bit life time

The service life of drill bit is dependent on the following factors:

- Rock abrasiveness
- Type of rock drill used
- Circulation of drill steels
- Handling and maintenance

Diam. mm	Not abrasive (limestone) drm	Intermediate (granite) drm	Very abrasive (quartzite) drm
38	600-800	250-350	100-150
45	800-1000	300-400	150-200
51	1000-1500	500-600	175-250
64	1000-2000	600-800	200-350
76	1500-2000	700-1000	250-350
89	3000-	1000-1200	250-350
102	3000-	1000-1200	250-350
115	3000-	1000-1200	250-350
127	3000-	1000-1200	250-350

(above figures are indicative and vary from site to site)

Case: Drill steel costs – quarry operation

Production rate Rock	1,5 Mtn/year Granite (weight 2,65 tn/m^3)
Production in m^3	1.500.000 tn/2,65 = 566.000 m^3/year Specific drilling with 76 mm diam. Bit: 0,20 drm/m^3
Needed drilling	566.000 X 0,20 drm/m^3 = 113.200 drm/ year
Needed bits (45C76 DR)	113.200 drm/ year/ 1.000 drm/ pc = 113 pcs/year
Needed rods (MF T45/3,6 M)	113.200 drm/ year/ 2.500 drm/ pc = 45 pcs/year
Needed shanks	113.200 drm/ year/ 6.000 drm/ pc = 19 pcs/year

Total costs (€/drm)

Bit	113 pcs x	135 € / 113.200 drm	= 0,13
Rod	45 pcs x	270 € / 113.200 drm	= 0,11
Shanks	19 pcs x	160 € / 113.200 drm	= 0,03
Greasing			= 0,01
Grinding			= 0,02
		Total € / drm	**0,30**

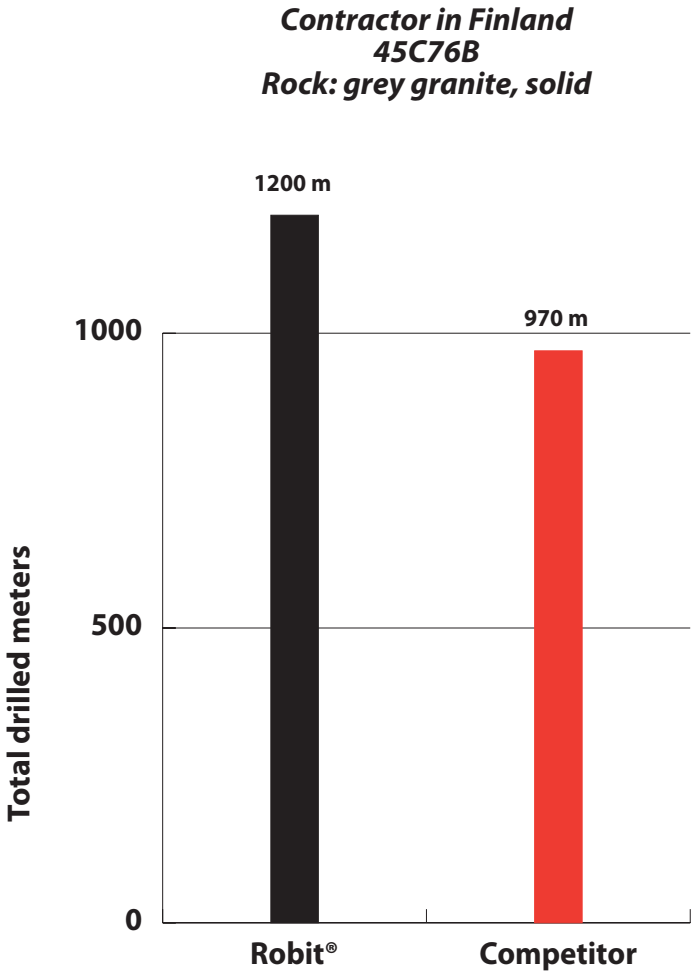
Expected life time of the rock drilling tools in surface drilling

Thread	Component	Material abrasiveness		
		Low (limestone) drm	Medium (granite) drm	High (quartzite) drm
R25	Bit, d=33mm	500-800	200-300	75-100
	Bit, d=38mm	600-800	250-350	100-150
	Shank	1200-1800	1200-1800	1000-1500
	MF rod	800-1200	800-1200	500-600
	Rod	800-1000	800-1000	450-600
	Coupling	800-1000	400-500	400-600
R28	Bit, d=45mm	1000	300-400	150-200
	Shank	1200-1500	800-1200	600-800
	MF rod	1000-1200	800-1200	600-800
	Rod	700-1000	600-800	500-600
	Coupling	700-1000	500-700	400-600
R32	Bit, d=51mm	1000-1500	500-600	175-250 (B)
	Bit, d=64mm	1000-1500	600-750	200-300 (B)
	Shank	1500-2000	1500-1800	1500-1800
	MF rod	1000-1500	1000-1500	800-1200
	Rod	1000-1500	800-1200	800-1200
	Coupling	1000-1500	600-800	400-600
C38	Bit, d=64mm	1200-2000	600-800	200-300
	Bit, d=76mm (R)	1500-2000	700-900	
	Shank	2000-2500	1800-2400	1800-2400
	MF rod	1500-2000	1200-1600	1000-1200
	Rod	1500-2000	800-1000	800-1000
	Coupling	1500-2000	600-800	400-500
C45	Bit, d=76mm (R)	>2000	800-1000	
	Bit, d=89mm	>3000	1000-1200	250-350
	Shank	3000-4000	2500-3000	2500-3000
	MF rod	1500-2000	1200-1600	1000-1500
	Rod	1500-2000	1200-1500	1200-1500
	Coupling	1500-2000	800-1000	600-750
C51	Bit, d=89mm (R)	>4000	1000-2000	250-350 (B)
	Bit, d=102mm (R)	>4000	1000-1200	250-350 (B)
	Bit, d=115mm (R)	>3000	1000-1200	250-350
	Bit, d=127mm (R)	>2000	1000-1200	250-350
	Shank	4000-6000	4000-6000	4000-6000
	MF rod	1500-2000	1500-1800	1400-1600
	Rod	1500-2000	1400-1800	1400-1800
	Coupling	750-1000	700-900	700-900

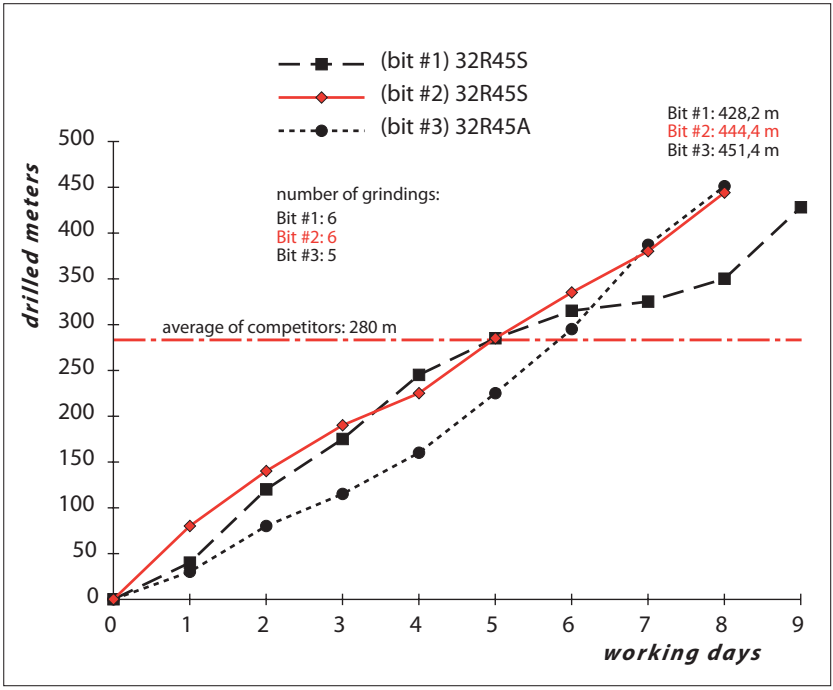
R = retrac button bit, B, C = heavy duty bit

2.3 Robit® references

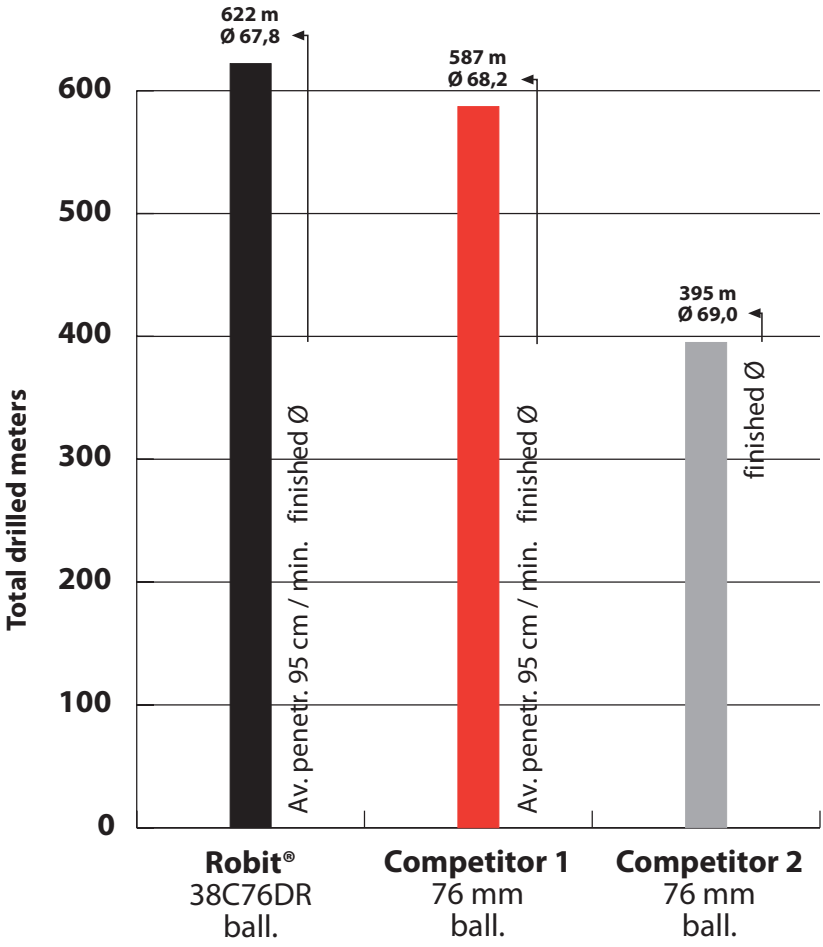
2.3.1 Test results



Test drilling in Chile, Robit® bits



Mine in Sweden
38C76DR ball.



3.1 When bits need service and conditioning

3.1.1 Bits with anti-taper

Drilling problems:	**Result:**
Poor penetration rate	- Decreased efficiency - Bit body or buttons will break prematurely. - Increased thread wear.
Rotation will jamming	- Threads are difficult to uncouple. - Rods' coupling/uncoupling time increasing. - Rods and shanks breaking prematurely.
Hole deviating	- Rods and shanks will bend and break. - Rods' uncoupling time increaseing. - Drifter front is heavily loaded, difficult to charge, block size control difficult.

Conclusion:	Grinding of bits to the right shape

3.1.2 Bits with short, worn out buttons

Drilling problems:
Drilling efficiency decreasing

Result:
- Bit body touching the rock and body flattening
- Flushing is not working well.
- Bit getting hot, gauge buttons loosening and bit starting to wear out.

Conclusion:
Grinding of bit body and buttons

3.1.3 Bits with too long buttons

Drilling problems:
Penetrating only a short time

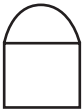
Result:
Button breakages

Conclusion:
Grinding of buttons

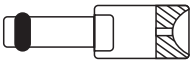
3.2 Grinding cups

Standard button shapes:

Ballistic



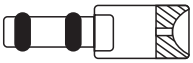
SuperDome



8 mm wing (shoulder) drive with 8 mm diameter shaft and one o-ring.

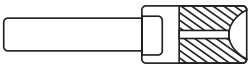
Suitable for:
- Atlas Copco LS machines
- Older CME machines
- Jasco, Dorey and Greenex grinding machines

When using grinding machines with a standard chuck the o-ring should be removed.



8 mm wing (shoulder) drive, with 8 mm diameter shaft and two o-rings for stabilising vibrations and reducing wear when using "Quick-Chuck".

Suitable for:
- Greenex QS22 grinder



9 mm Sandvik wing (shoulder) drive, with 9 mm diameter shaft.

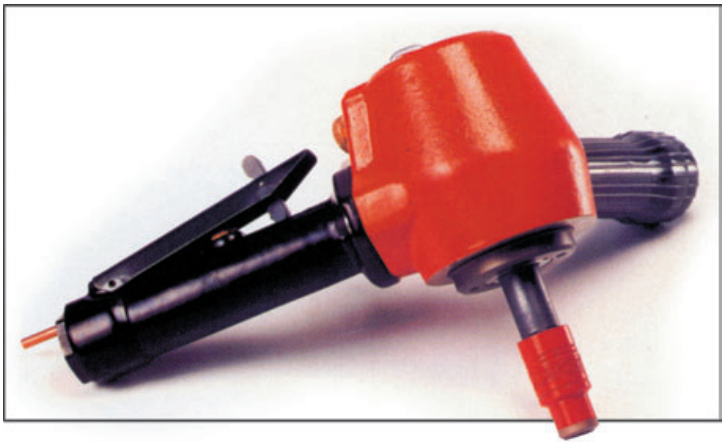
Suitable for:
- All Sandvik grinding machines using grinding cup such as Sanbee Sancone A etc.

Hexaconal drive.

Standard air/water ways on grinding cups

Full water way		Suitable for round inserts and handheld grinding machines and machines which oscillates.
Split water way (SWW) (Standard)		Suitable for all shapes: round, ballistic and conical, even with limited oscillation increases grinding speed and quality.
Split 3 water way		Suitable for ballistic or conical inserts where limited oscillation is available. Increases grinding speed. Available on 14 mm diam. and larger.

3.3 Grinding machines for button bits



Grinding is made with grinding cups specially developed for this purpose. The cups are coated with diamond dust. The principle is to rotate grinding cups with high rpm over the buttons.

During this process water is needed for flushing. Some grinding is done dry but it is very rare.

Grinding machines are divided to three groups:

1. Pneumatic driven
2. Electric driven with air cylinder etc.
3. Hydraulic driven with air cylinder etc.

They can also be divided to:

- handheld machines
- stationary machines

3.3.1 Handheld machines

- Typically pneumatic machines
- Light weight
- Low price
- For small amount of bits to be grinded
- Wet grinding; rarely dry grinding

3.3.2 Stationary machines

- Pneumatic or electro/pneumatic driven
- Rotation driven with electric motor
- Feed/pullback driven with pneumatic motor
- Some models can be installed on drilling rigs
- High capacity
- High quality grinding result
- Some models are computerized and semi-automated
- The most efficient models are with self-centralizing grinding heads
- Only wet grinding

3.4 Why grinding?

3.4.1 Costs and benefits

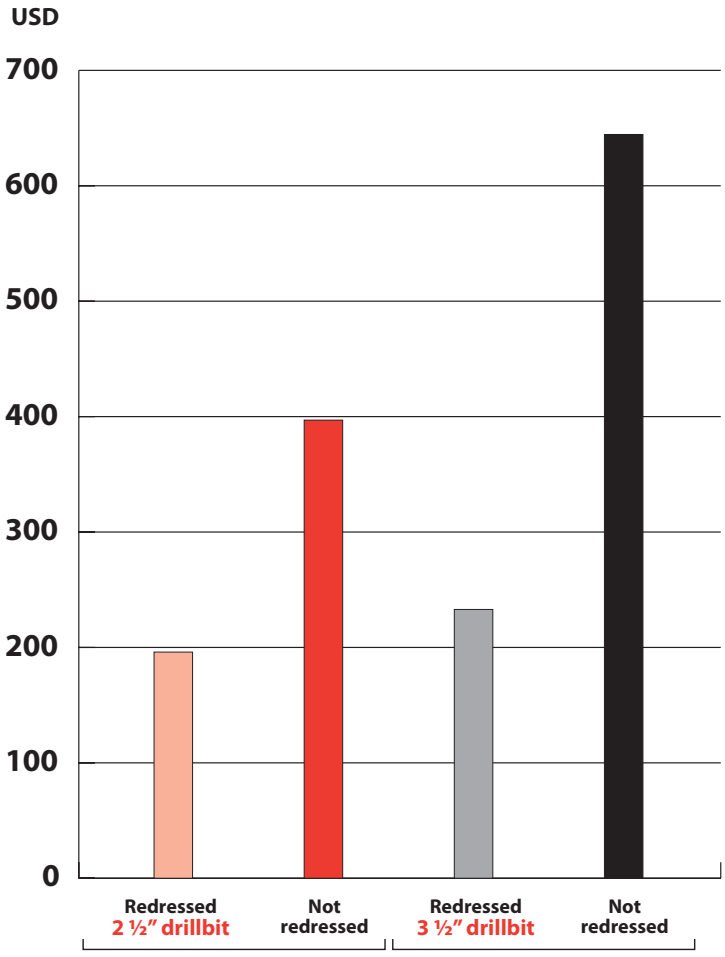
Redressing cost

Bit size	Button size	# of buttons	Cost/ button	Grindings per bitlife	Total redressing cost/bit
2″	8-10 mm	10	$0,25	10	$25,00
2 ½″- 3″	9-11 mm	12	$0,27	14	$45,36
3″- 4 ½″	12-13 mm	13	$0,29	16	$60,32
5″- 6 ½″	14-16 mm	18	$0,31	16	$89,28

Redressing comparison cost (example)

	2 ½″		3 ½″	
	Bitcost redressed	Bitcost not redressed	Bitcost redressed	Bitcost not redressed
Bitcost	$150,00	$150,00	$175,00	$175,00
Redressing	$45,36	$0,00	$60,32	$0,00
Extra bitcost	$0,00	$201,00	$0,00	$425,00
Add drillsteel	$0,00	$45,00	$0,00	$45,00
Total cost	**$195,36**	**$396,00**	**$235,32**	**$645,00**

Cost comparison: Redressing drill bits



Notes:

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