

Machining recommendations for Strenx™ and Hardox®

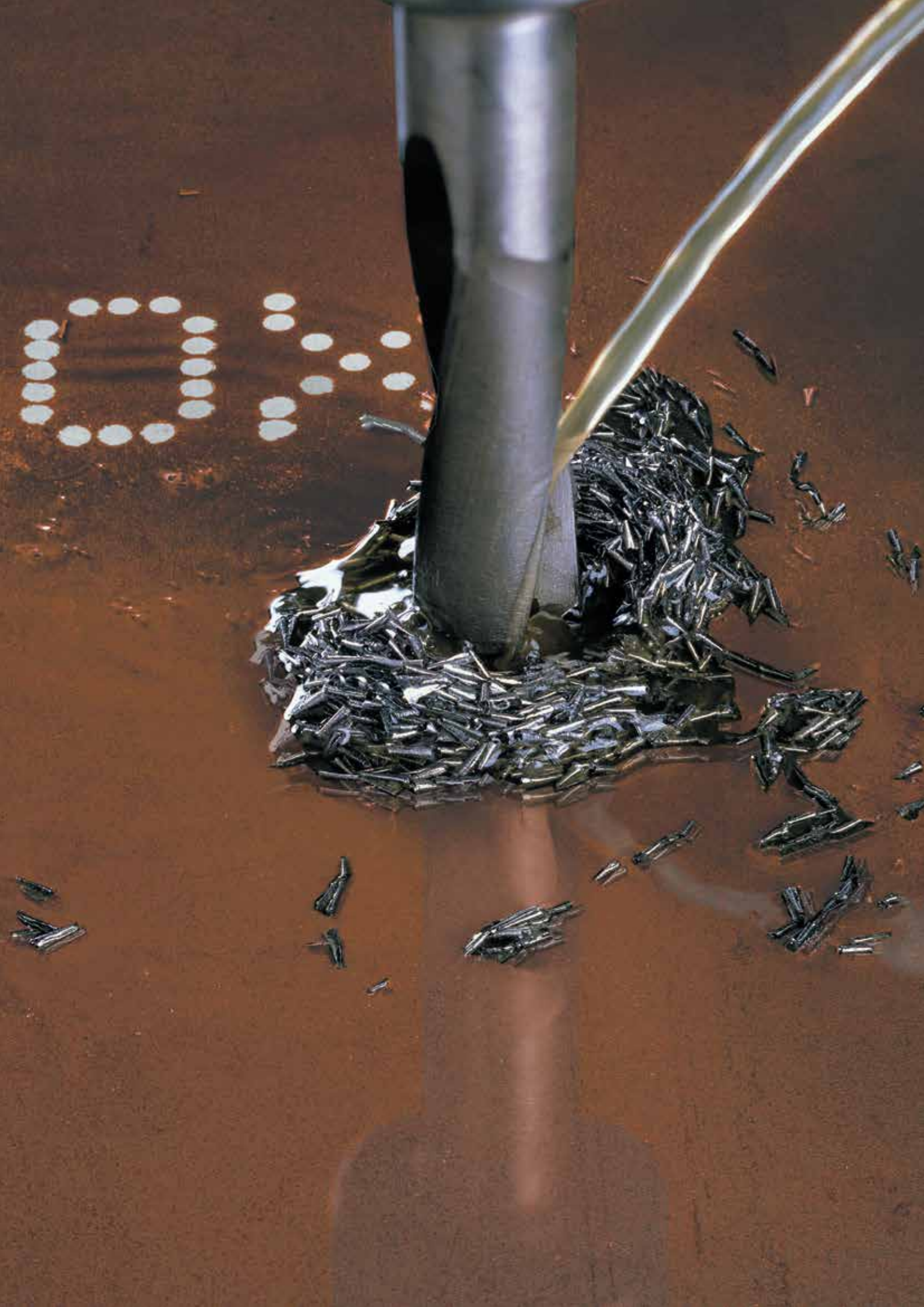


SSAB

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The contents of this brochure represent general suggestions. SSAB accepts no responsibility for their suitability in individual cases. The user is therefore responsible to make the necessary adaptations to the conditions in each individual case.



INTRODUCTION

Strenx performance steel and Hardox wear plate are steel grades that can be machined with high speed steel (HSS) or cemented carbide (CC) tools. This brochure includes our suggestions for cutting data (feeds and speeds) and the selection of tools. Other factors that should be taken into account in machining operations are also discussed. The proposals have been drawn up following our own tests on tools of various makes and in consultation with leading tool manufacturers.

TYPICAL PROPERTIES FOR HARDOX AND STRENX

	Hardness in Brinell (HBW)	Hardness in Rockwell (HRC)	Tensile strength, Rm (N/mm ²)
Strenx 700	~260	~24	~860
Strenx 900	~300	~29	~935
Strenx 960	~320	~32	~990
Strenx 1100	~430	~43	~1340
Strenx 1300	~500	~49	~1580
Hardox HiTuf	~350	~35	~1080
Hardox 400	~400	~40	~1250
Hardox 450	~450	~44	~1400
Hardox 500	~500	~49	~1580
Hardox 550	~550	~52	~1760
Hardox 600	~600	~55	~1940
Hardox Extreme	~675	~62	—

TOOL SUPPLIERS WE RECOMMEND AND HAVE COLLABORATED WITH



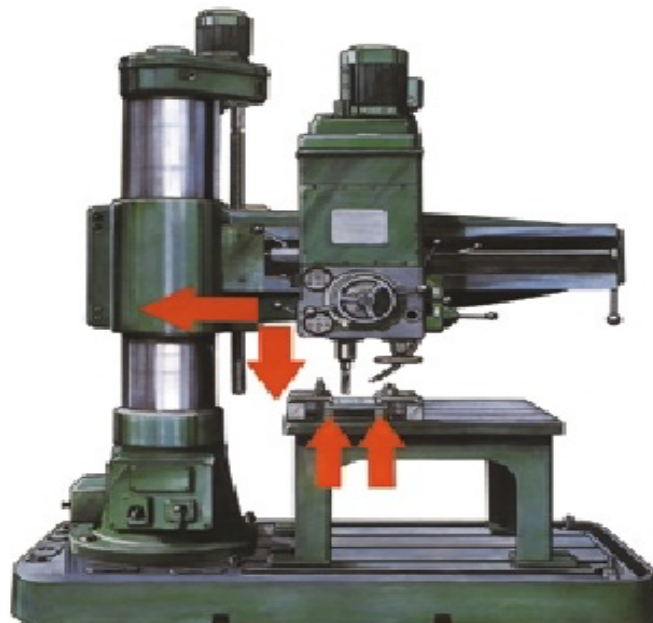
DRILLING RECOMMENDATIONS

HSS-DRILL

Use only HSS drills when you have unstable machine conditions. HSS drills are only suitable up to 500 Brinell. If the machine conditions are good you have several choices of solid cemented carbide drills with exchangeable heads or indexable insert drills.

ADVICE FOR REDUCING VIBRATIONS AND INCREASING THE LIFETIME OF THE DRILL

- Minimize the distance to the column and between the drill tip and the workpiece
- Don't use longer drill than necessary
- Always use metal supports and clamp the workpiece securely
- Solid and firm table
- Always use coolant
- Coolant mix 8-10%
- Just before the drill breaks through, disengage the feed rate for about a second, play/springback can otherwise snap the drill tip, re-engage the feed rate when the play/springback has ceased



	Strenx 700	Strenx 900/960	Strenx 1100	Strenx 1300
Vc (m/min)	~ 18	~ 15	~ 7	~ 5
Drill Ø	Feed rate, fn (mm/rev) and speed (rpm)			
5	0.06/1150	0.06/950	0.05/445	0.04/280
10	0.12/570	0.11/475	0.10/220	0.08/140
15	0.17/380	0.16/320	0.15/150	0.12/95
20	0.24/290	0.23/240	0.20/110	0.16/70
25	0.30/230	0.29/190	0.25/90	0.20/55
30	0.36/190	0.35/160	0.30/75	0.24/45



HSS, HSS-E, HSS-Co
Individual holes can be drilled with an ordinary HSS drill. For rational production, either a microalloyed (HSS-E) drill or a cobalt-alloyed (HSS-Co) drill is recommended.



HSS-Co
Use an HSS-Co drill (8% Co) with a small helix angle and a robust core that can withstand high torques.

	Hardox HiTuf	Hardox 400	Hardox 450	Hardox 500
Vc (m/min)	~ 12	~ 9	~ 7	~ 5
Drill Ø	Feed rate, fn (mm/rev) and speed (rpm)			
5	0.07/760	0.06/570	0.05/445	0.04/280
10	0.10/380	0.11/475	0.10/225	0.08/140
15	0.16/250	0.16/190	0.15/150	0.12/95
20	0.23/190	0.23/140	0.20/110	0.16/70
25	0.29/150	0.29/115	0.25/90	0.20/55
30	0.35/125	0.35/95	0.30/75	0.24/45

FORMULAS AND DEFINITIONS

$$Vc = \pi \times d \times n / 1000$$

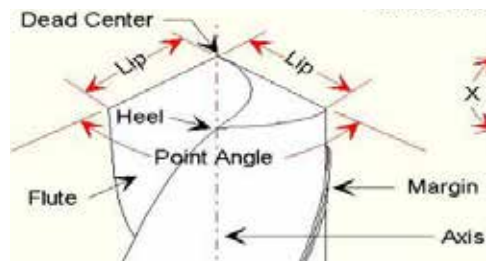
$$vf = n \times fn$$

$$n = Vc \times 1000 / \pi \times d$$

$\pi = 3,14$
Vc=cutting speed (m/min)
n=speed (rpm)
fn=feed rate (mm/rev)
vf=feed rate (mm/min)
d=drill diameter

ADVICE FOR DRILLING IN THIN PLATE BELOW 8 MM

1. Important to have good support under the plate to avoid deflection.
2. Indexable drill is recommended, because it begins cutting at the periphery, and does not build up the high pressure a solid carbide drill would do.
3. With a drill diameter over Ø 10 mm and a point angle of 118-140° it is very important to support the plate that is drilled. If the drill tip breaks through the bottom surface without a supporting plate to guide the tip, it may result in an oval and undersized hole (see picture).
4. Reduce feed rate and increase cutting speed V_c , especially when using an indexable drill.



SOLID CEMENTED CARBIDE DRILL

For stable machine conditions and with internal coolant, this is the only type of drill suitable for drilling Hardox Extreme.



		Strenx 700		Strenx 900/960		Strenx 1100		Strenx 1300	
Vc (m/min)		70-100		60-90		40-60		35-50	
fn (mm/rev)		min-max		min-max		min-max		min-max	
Diam- eter	3.0-5.0	0.03-0.06		0.03-0.06		0.03-0.05		0.03-0.05	
	5.01-10.0	0.06-0.12		0.06-0.12		0.05-0.11		0.05-0.10	
	10.01-15.0	0.12-0.18		0.12-0.18		0.11-0.16		0.10-0.15	
	15.01-20.0	0.18-0.25		0.18-0.24		0.16-0.22		0.15-0.19	
		Hardox HiTuf	Hardox 400	Hardox 450	Hardox 500	Hardox 550	Hardox 600	Hardox Extreme	
Vc (m/min)		60-80	50-70	40-60	35-50	30-40	25-35	18-25	
fn (mm/rev)		min-max	min-max	min-max	min-max	min-max	min-max	min-max	
Diam- eter	3.0-5.0	0.03-0.06	0.03-0.06	0.03-0.05	0.03-0.05	0.03-0.05	0.02-0.04	0.02-0.04	
	5.01-10.0	0.06-0.12	0.06-0.12	0.05-0.11	0.05-0.10	0.05-0.09	0.04-0.08	0.04-0.08	
	10.01-15.0	0.12-0.17	0.12-0.16	0.11-0.15	0.10-0.14	0.09-0.13	0.08-0.13	0.08-0.12	
	15.01-20.0	0.17-0.22	0.16-0.21	0.15-0.20	0.14-0.18	0.13-0.17	0.13-0.16	0.12-0.15	

- Drilling 7x D_c , reduce the feed rate ~20%.
- Drilling with external coolant, reduce the speed and feed rate ~20%.

INDEXABLE INSERT DRILL

For stable machine conditions and with internal coolant.

Important: Use as short drill as possible. The recommendations are for 2XØ.

		Strenx 700	Strenx 900/960	Strenx 1100	Strenx 1300		
Vc (m/min)		100-150	80-140	50-90	40-70		
fn (mm/rev)		min-max	min-max	min-max	min-max		
Diameter	12.0-20.0	0.04-0.10	0.04-0.10	0.04-0.10	0.04-0.10		
	20.01-30.0	0.06-0.12	0.06-0.12	0.06-0.12	0.06-0.12		
	30.01-44.0	0.06-0.14	0.06-0.14	0.06-0.14	0.06-0.14		
	44.01-63.5	0.08-0.16	0.08-0.16	0.08-0.16	0.08-0.16		
		Hardox HiTuf	Hardox 400	Hardox 450	Hardox 500	Hardox 550	Hardox 600
Vc (m/min)		70-130	60-120	50-90	40-70	35-55	30-50
fn (mm/rev)		min-max	min-max	min-max	min-max	min-max	min-max
Diameter	12.0-20.0	0.04-0.10	0.04-0.10	0.04-0.10	0.04-0.08	0.04-0.08	0.04-0.06
	20.01-30.0	0.06-0.12	0.06-0.12	0.06-0.12	0.04-0.10	0.04-0.10	0.04-0.08
	30.01-44.0	0.06-0.14	0.06-0.14	0.06-0.14	0.06-0.12	0.06-0.12	0.06-0.10
	44.01-63.5	0.08-0.16	0.08-0.16	0.08-0.16	0.08-0.14	0.08-0.14	0.06-0.12

- The cutting data for indexable drill has been formulated in co-operation with Sandvik Coromant.
- Not suitable for Hardox Extreme.



DRILLS WITH EXCHANGEABLE DRILL HEADS

For stable machine conditions and with internal coolant.

		Strenx 700	Strenx 900/960	Strenx 1100	Strenx 1300		
Vc (m/min)		70-100	60-90	40-60	35-50		
fn (mm/rev)		min-max	min-max	min-max	min-max		
Diameter	7.5-12.0	0.08-0.13	0.08-0.13	0.07-0.11	0.06-0.10		
	12.01-20.0	0.13-0.22	0.13-0.22	0.11-0.15	0.10-0.14		
	20.01-25.0	0.22-0.28	0.22-0.27	0.15-0.20	0.14-0.18		
	25.01-33.0	0.28-0.37	0.27-0.36	0.20-0.28	0.18-0.24		
		Hardox HiTuf	Hardox 400	Hardox 450	Hardox 500	Hardox 550	Hardox 600
Vc (m/min)		60-80	50-70	40-60	35-50	30-40	25-35
fn (mm/rev)		min-max	min-max	min-max	min-max	min-max	min-max
Diameter	7.5-12.0	0.08-0.13	0.08-0.12	0.07-0.11	0.06-0.10	0.05-0.08	0.04-0.07
	12.01-20.0	0.13-0.22	0.12-0.20	0.11-0.15	0.10-0.14	0.08-0.12	0.07-0.11
	20.01-25.0	0.22-0.27	0.20-0.25	0.15-0.20	0.14-0.18	0.12-0.16	0.11-0.14
	25.01-33.0	0.27-0.36	0.25-0.33	0.20-0.28	0.18-0.24	0.16-0.22	0.14-0.18

- Not suitable for Hardox Extreme.



CUTTING SPEED RECOMMENDATIONS FOR CHAMDRILL/SUMOCHAM IN UNSTABLE MACHINES



With this tool concept and with machine conditions that is not too bad, this can be a good solution for customers that have many holes to make with this type of machines. The drilling operation can be done almost 3 times faster compared to our recommendations for HSS drills.

All recommendations for the cutting data are based on the tests we have performed in our own radial drilling machine.

CHAMDRILL with exchangeable drilling heads (see more info regarding these tools in the end of this brochure).



- If the drill centers badly in the start, the recommendation is that you center the drill manually, otherwise the drill head may break (especially with drill Ø over 15 mm).
- 4 results from our own test.



Hx 450	Ø	Vc	rpm	fn	mm/min	nr of holes	Chamdrill vs HSS
16 mm	8.5	13.3	500	0.11	56	400	2.6 times faster
Hx 450	Ø	Vc	rpm	fn	mm/min	nr of holes	Chamdrill vs HSS
25 mm	14.2	15.8	355	0.17	60	270	2.6 times faster
Hx 500	Ø	Vc	rpm	fn	mm/min	nr of holes	Chamdrill vs HSS
12 mm	14.2	11.1	250	0.11	28	300	2.5 times faster
Hx 500	Ø	Vc	rpm	fn	mm/min	nr of holes	Chamdrill vs HSS
30 mm	25.0	9.8	125	0.17	21	107	1.9 times faster

		Hardox 400	Hardox 450	Hardox 500
Vc (m/min)		12 - 22	10 - 18	8 - 14
fn (mm/rev)		min-max	min-max	min-max
Diameter	7.5-11.5	0.08-0.12	0.08-0.12	0.06-0.12
	12.0-17.5	0.12-0.18	0.12-0.18	0.11-0.16
	18.0-25.9	0.13-0.24	0.11-0.20	0.10-0.18

- Type of tool holder we recommend and used during the test.

COUNTERSINKING AND COUNTERBORING RECOMMENDATIONS

Countersinking/boring is best performed using tools with replaceable inserts from the tool supplier Granlund. Always use a revolving pilot and use coolant. See table below for screw and article number for the tool.

Reduce the cutting data with about 30% for countersinking.

	Strenx 700	Strenx 900/960	Strenx 1100	Strenx 1300
Vc (m/min)	70-100	40-80	20-50	15-45
fn (mm/rev)	0.10-0.20	0.10-0.20	0.10-0.20	0.10-0.20
Diameter	Speed (rpm)			
18.0-26.0	855-1770	490-1415	245-885	185-795
26.0-38.0	590-1225	335-980	170-610	125-550
38.0-47.0	475-840	270-670	135-420	100-380
47.0-60.0	370-680	210-540	105-340	80-305



	Hardox HiTuf	Hardox 400	Hardox 450	Hardox 500	Hardox 550	Hardox 600	Hardox Extreme
Vc (m/min)	30-80	25-70	20-50	15-45	12-40	10-35	5-15*
fn (mm/rev)	0.10-0.20	0.10-0.20	0.10-0.20	0.10-0.20	0.10-0.20	0.10-0.20	0.05-0.15
Diameter	Speed (rpm)						
18.0-26.0	365-1415	305-1240	245-885	185-795	145-710	120-620	60-265
26.0-38.0	250-980	210-855	170-610	125-550	100-490	85-430	40-185
38.0-47.0	200-670	170-585	135-420	100-380	80-335	65-295	35-125
47.0-60.0	160-540	130-475	105-340	80-305	65-270	50-240	25-105



* Counterboring is not suitable for Hardox Extreme.

COUNTERSINKING AND COUNTERBORING TABLE FOR SCREWS



Size	Article number	Ø screw head
M8	0KV9-18.0	16
M10	0KV9- 20.5 / 1KV9- 20.0	20
M12	0KV9- 25.0 / 1KV9- 26.0	24
M14	1KV9- 30.0	27
M16	1KV9- 30.0 / 2KV9- 32.0	30
M20	2KV9- 38.0	36
M24	2KV9- 40.0	39



Size	Article number	Ø screw head
M10	0WHV- 18.0	16
M12	0WHV- 20.0 / 1WHV- 20.0	18
M14	0WHV- 23.0 / 1WHV- 23.0	21
M16	1WHV- 26.0	24
M20	1WHV- 32.0	30
M24	1WHV- 38.0 / 2WHV- 38.0	36
M30	2WHV-47.0	45



WHV



KV9

TAPPING RECOMMENDATIONS

With correct tools and tool holders we recommend tapping up to 500 Brinell with four-flute taps that can withstand the very high torque occurring during tapping in hard materials. If diameter is not critical, the drilled hole can be 3% larger than standard (see table below). This will increase the lifetime of the tap.

	Hardox HiTuf	Hardox 400	Hardox 450	Hardox 500
Vc (m/min)	6-10	4-8	3-5	2.5-3.5
Size	Speed (rpm)			
M5	380-640	255-510	-	-
M6	320-530	210-425	210-320	-
M8	240-400	160-320	160-240	100-140
M10	190-320	125-255	125-190	80-110
M12	160-265	105-210	105-160	65-95
M14	135-225	90-180	90-135	57-80
M16	120-200	80-160	80-120	50-70
M20	95-160	65-125	65-95	40-55
M24	80-135	55-105	50-80	30-45
M27	70-120	45-95	45-70	30-40
M30	65-105	40-85	40-65	25-35
	Strenx 700	Strenx 900/960	Strenx 1100	Strenx 1300
Vc (m/min)	10-12	7-10	3-5	2.5-3.5
Size	Speed (rpm)			
M5	635-765	445-635	-	-
M6	530-640	370-530	210-320	-
M8	400-480	280-400	160-240	100-140
M10	320-380	225-320	125-190	80-110
M12	265-320	185-265	105-160	65-95
M14	225-275	160-225	90-135	57-80
M16	200-240	140-200	80-120	50-70
M20	160-190	110-160	65-95	40-55
M24	130-160	90-135	50-80	30-45
M27	120-140	80-120	45-70	30-40
M30	105-125	75-105	40-65	25-35

- Tapping is not suitable. We recommend thread milling.



Tap for through holes



Tap for blind holes

Emuge Franken is one tool supplier that have the type of tool holders we recommend for tapping, see picture to the left.



Floating chuck for drilling/CNC machines.



Soft synchro chuck for CNC machine.

Size	Pitch	Drill Ø min-max
M4	0.7	3.3-3.4
M5	0.8	4.2-4.3
M6	1	5.0-5.1
M8	1.25	6.8-6.9
M10	1.5	8.5-8.7
M12	1.75	10.25-10.5
M14	2	12-12.3
M16	2	14-14.3
M20	2.5	17.5-18
M24	3	21-21.5
M27	3	24-24.5
M30	3.5	26.5-27.0

THREAD MILLING RECOMMENDATIONS

A CNC machine is necessary for thread milling. The tool supplier can provide programming support for the CNC machines.



	Strenx 700		Strenx 900/960		Strenx 1100		Strenx 1300	
Vc (m/min)	100-130		80-110		50-70		40-60	
fz (mm/tooth)	0.03-0.06		0.03-0.06		0.02-0.05		0.02-0.05	
	Hardox HiTuf	Hardox 400	Hardox 450	Hardox 500	Hardox 550	Hardox 600	Hardox Extreme	
Vc (m/min)	70-100	60-80	50-70	40-60	35-55	30-40	25-35	
fz (mm/tooth)	0.03-0.06	0.02-0.05	0.02-0.05	0.02-0.05	0.02-0.04	0.01-0.03	0.01-0.03	



TAPPING AND THREAD MILLING ADVICE

- Taps for blind holes have shorter lifetime due to the smaller core diameter.
- Before tapping, make sure that the predrilled hole is in good condition (don't use worn out drills).
- Always use coated taps.
- Requires thread milling from Hardox 550 to Hardox Extreme.
- Make the thread milling in 2 passes.
- Make sure that the coolant mix is between 8-10%.
- We recommend climb milling.

MILLING RECOMMENDATIONS

MILLING ADVICE

- Position the cutter off-center (to the left) to achieve a thicker chip at the entry and to avoid thick chip at the exit.
- Avoid cutting through the center line of the cutter, as this could generate vibration.
- Always use down milling (climb milling).
- The recommendation is that the width of the cut (ae) is 25 or 75-80% of the diameter.
- Use rolling into cut method.
- Dry milling is recommended if insert is used.
- If the machine power is low use a coarse pitch cutter.
- Always use wise or good clamping equipment.
- The depth of cut with milling gas-cut edges should be at least 2 mm, to avoid the hard surface layer of the cut edge.



FORMULAS & DEFINITIONS

$$n = \frac{V_c \times 1000}{\pi \times d}$$

$$V_c = \frac{\pi \times d \times n}{1000}$$

$$v_f = f_z \times n \times z_n$$

$$f_z = \frac{v_f}{n \times z_n}$$

$$\pi = 3,14$$

V_c =cutting speed (m/min)

n =speed (rpm)

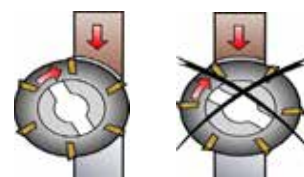
f_z = feed rate per tooth (mm/tooth)

v_f =feed rate (mm/min)

z_n =number of cutting edges

d =tool diameter

a_p =cutting depth (mm)



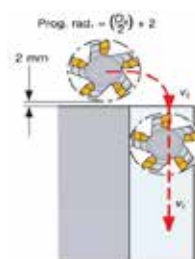
If you enter the workpiece with the rolling into cut method the chip thickness on the exit is always zero, and it will help to give a longer tool life.



Rolling into cut method



Straight into the workpiece



INSERTS GRADES FOR MILLING

P	ISO	ANSI	
	01	C8	↑
	10	C7	
	20	C6	
	30		
	40	C5	
	50		↓
M	10		↑
	20		
	30		
	40		↓
K	01	C4	↑
	10	C3	
	20	C2	
	30	C1	
	40		↓
H	01	C4	↑
	10	C3	
	20	C2	
	30	C1	↓

WORKPIECE MATERIAL

P	ISO P= Steel
M	ISO M = Stainless steel
K	ISO K = Cast iron
H	ISO H = Hardened steel

↑ = Wear resistance

↓ = Toughness

* Example insert grade 1030.

The last 2 numbers in the insert grade indicate the position of the insert in this scale, if the insert has wear or toughness resistance.

INSERT GEOMETRY

The macro geometry affects many parameters in the cutting process. An insert with strong cutting edge can work at higher loads, but it will also generate higher cutting forces, consume more power and generate more heat.



Parameter	L	M	H
Edge strength	Low Medium High		
Cutting forces			
Power consumption			
Max chip thickness			
Heat generated			

- Use inserts grade P30-50 with light cutting geometry and a coarse-pitch cutter if the machine power is low and with unstable machine conditions.

FACE MILLING RECOMMENDATION WITH A 45° SETTING ANGLE

In very stable machine conditions and with rigid set-up the insert grade P10 would be more suitable in all milling operations with inserts, especially in Hardox 600 and Extreme. Then the cutting speed can be increased by approximately 80-100%.

Recommendation for average machine conditions.

	Strenx 700		Strenx 900/960		Strenx 1100		Strenx 1300	
Vc (m/min)	200-250		180-220		110-150		100-140	
Feed rate (fz)	min-max		min-max		min-max		min-max	
Insert grade P30	0.15-0.35		0.15-0.35		0.15-0.35		0.15-0.35	
	Hardox HiTuf	Hardox 400	Hardox 450	Hardox 500	Hardox 550	Hardox 600	Hardox Extreme	
Vc (m/min)	140-180	120-160	110-150	100-140	70-90	50-70	30-50	
Feed rate (fz)	min-max	min-max	min-max	min-max	min-max	min-max	min-max	
Insert grade P30	0.10-0.25	0.10-0.25	0.10-0.25	0.10-0.25	0.10-0.20	0.10-0.20	0.10-0.20	



FACE MILLING RECOMMENDATION WITH ROUND INSERTS

Round inserts have strong cutting edges and are good to use when the surface has holes and cavities etc.

Recommendation for average machine conditions.

	Strenx 700		Strenx 900/960		Strenx 1100		Strenx 1300	
Vc (m/min)	200-250		180-220		110-150		100-140	
Feed rate (fz)	min-max		min-max		min-max		min-max	
Insert grade P30	0.10-0.25		0.10-0.25		0.10-0.25		0.10-0.25	
	Hardox HiTuf	Hardox 400	Hardox 450	Hardox 500	Hardox 550	Hardox 600	Hardox Extreme	
Vc (m/min)	140-180	120-160	110-150	100-140	70-90	50-70	30-50	
Feed rate (fz)	min-max	min-max	min-max	min-max	min-max	min-max	min-max	
Insert grade P30	0.10-0.25	0.10-0.25	0.10-0.25	0.10-0.25	0.10-0.25	0.10-0.20	0.10-0.20	



SHOULDER MILLING RECOMMENDATION WITH A 90° SETTING ANGLE

Recommendation for average machine conditions.



	Strenx 700		Strenx 900/960		Strenx 1100		Strenx 1300
Vc (m/min)	200-250		180-220		110-150		90-130
Feed rate (fz)	min-max		min-max		min-max		min-max
Insert grade P30	0.12-0.25		0.12-0.25		0.12-0.25		0.12-0.25

	Hardox HiTuf	Hardox 400	Hardox 450	Hardox 500	Hardox 550	Hardox 600	Hardox Extreme
Vc (m/min)	140-180	120-160	110-150	100-140	70-90	50-70	30-50
Feed rate (fz)	min-max	min-max	min-max	min-max	min-max	min-max	min-max
Insert grade P30	0.12-0.25	0.12-0.25	0.12-0.25	0.12-0.25	0.10-0.20	0.10-0.20	0.10-0.20

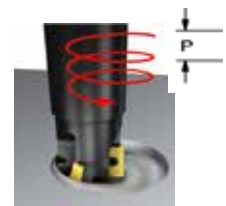
HOLE MAKING WITH HIGH FEED MILLING (CIRCULAR RAMPING)

Circular ramping (also called helical interpolation, spiral interpolation, can be an alternative to drilling). It is a simultaneous movement in a circular path (X and Y) together with an axial feed (Z) with a defined pitch (P). To manage circular ramping a CNC machine is necessary.

Advice

- Use compressed air to remove metal chips.
- Always down-milling/climb milling.
- P = pitch mm/rev.
- Max pitch with insert size 09 is 1,2 mm.
- Max pitch with insert size 14 is 2,0 mm.

Circular ramping



Recommendation for average machine conditions.



Coromill 210

	Strenx 700		Strenx 900/960		Strenx 1100		Strenx 1300
Vc (m/min)	200-250		180-220		110-150		100-140
Feed rate (fz)	min-max		min-max		min-max		min-max
Insert grade P30	0.15-0.35		0.15-0.35		0.15-0.35		0.15-0.35

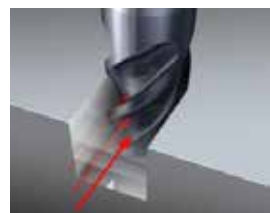
	Hardox HiTuf	Hardox 400	Hardox 450	Hardox 500	Hardox 550	Hardox 600	Hardox Extreme
Vc (m/min)	140-180	120-160	110-150	90-130	70-90	50-70	35-50
Feed rate (fz)	min-max	min-max	min-max	min-max	min-max	min-max	min-max
Insert size 09	0.4-2.0	0.4-2.0	0.4-2.0	0.4-2.0	0.4-2.0	0.4-2.0	0.4-2.0
Insert size 14	0.5-3.0	0.5-3.0	0.5-3.0	0.5-3.0	0.5-3.0	0.5-3.0	0.5-3.0

- The fz and pitch/rev are recommendations for Coromill 210 from Sandvik Coromant.

END MILLING RECOMMENDATION FOR SOLID CEMENTED CARBIDE TOOL

Slot milling recommendation.

		Strenx 700		Strenx 900/960		Strenx 1100		Strenx 1300	
Vc (m/min)		95-120		85-110		70-95		45-70	
Feed rate (fz)		min-max		min-max		min-max		min-max	
Di- ame- ter	3.0-6.0	0.01-0.035		0.01-0.03		0.01-0.03		0.01-0.025	
	8.0-12.0	0.04-0.07		0.04-0.07		0.03-0.06		0.03-0.05	
	14.0-20.0	0.07-0.10		0.07-0.10		0.06-0.08		0.05-0.07	
		Hardox HiTuf	Hardox 400	Hardox 450	Hardox 500	Hardox 550	Hardox 600	Hardox Extreme	
Vc (m/min)		80-105	75-100	70-95	45-70	40-65	30-40	20-30	
Feed rate (fz)		min-max	min-max	min-max	min-max	min-max	min-max	min-max	
Diam- eter	3.0-6.0	0.01-0.03	0.01-0.03	0.01-0.03	0.01-0.025	0.01-0.02	0.005-0.015	0.005-0.01	
	8.0-12.0	0.04-0.07	0.03-0.06	0.03-0.06	0.03-0.05	0.03-0.045	0.02-0.03	0.015-0.025	
	14.0-20.0	0.07-0.10	0.06-0.09	0.06-0.08	0.05-0.07	0.05-0.065	0.03-0.04	0.025-0.035	



Slot milling advice

Ap (depth of cut)
max 0.5x D

SHOULDER MILLING RECOMMENDATION

		Strenx 700		Strenx 900/960		Strenx 1100		Strenx 1300	
Vc (m/min)		210-240		180-210		160-190		120-150	
Feed rate (fz)		min-max		min-max		min-max		min-max	
Diam- eter	3.0-6.0	0.02-0.05		0.02-0.04		0.02-0.04		0.015-0.035	
	8.0-12.0	0.07-0.10		0.06-0.09		0.06-0.09		0.05-0.07	
	14.0-20.0	0.10-0.14		0.10-0.13		0.10-0.12		0.08-0.10	
		Hardox HiTuf	Hardox 400	Hardox 450	Hardox 500	Hardox 550	Hardox 600	Hardox Extreme	
Vc (m/min)		190-220		180-210		160-190		120-150	
Feed rate (fz)		min-max		min-max		min-max		min-max	
Diam- eter	3.0-6.0	0.02-0.05	0.02-0.04	0.02-0.04	0.015-0.35	0.01-0.035	0.01-0.035	0.01-0.03	
	8.0-12.0	0.06-0.10	0.06-0.09	0.06-0.09	0.05-0.07	0.045-0.07	0.04-0.07	0.04-0.06	
	14.0-20.0	0.10-0.13	0.10-0.13	0.10-0.12	0.08-0.10	0.08-0.10	0.08-0.10	0.06-0.08	



Shoulder milling advice

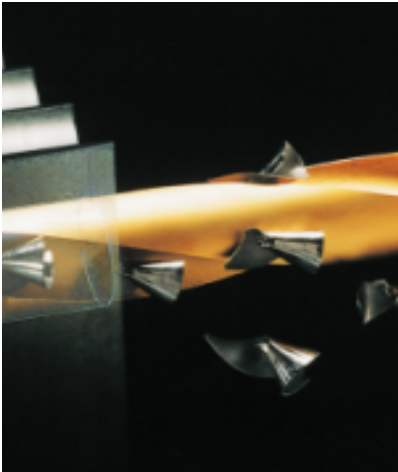
ap (use the whole
cutting length)

ae (radial depth of cut)
max 0.1 x D

- If possible, use only compressed air to remove the chip and use weldon chuck for tool over Ø 10 mm.

TROUBLESHOOTING FOR DRILLING AND MILLING

DRILLING

Short lifetime of cemented carbide tool		●	●	●	●	●				
Short lifetime of HSS tool			●	●		●		●	●	
Vibrations	●			●		●				●
Wear on the cutting edge/margin				●	●			●		
Wear on the chisel edge/drill center				●			●			●
Asymmetrical holes			●	●		●				●
Small chipping on the cutting edges	●		●				●			
Chip build-up in the drill flutes		●		●			●			●
Chipping on the corner of the cutting edges		●		●	●	●				
Holes oversize/undersize				●		●				●
										
Choose a tougher cemented carbide grade.										
Increase the coolant flow rate and clean the coolant holes of the drill.										
Check that the right HSS or cemented carbide grade is used.										
Check the guideline for the cutting data.										
Check the toolholders and the total indicated run-out.										
Improve the set-up of the workpiece /reduce long tool set-up.										
Increase the cutting speed.										
Reduce the cutting speed.										
Increase the feed rate.										
Reduce the feed rate.										



MILLING

Land wear		●			●				●		●
Cratering wear		●					●				●
Plastic deformation		●		●							●
Cutting edge build-up			●		●		●				
Chip jamming				●		●		●			
Small chipping on the cutting edges			●				●		●	●	
Short lifetime on the cutter/inserts		●			●				●		●
Vibrations	●	●			●	●	●	●	●		
Not enough horsepower/torque		●				●	●	●			
											
Position the cutter off-center, see page 15.											
Reduce the cutting speed.											
Increase the cutting speed.											
Reduce the feed rate.											
Increase the feed rate.											
Use a coarse-pitch cutter.											
Use smaller cutter and inserts with positive light cutting geometry, see page 16.											
Reduce the cutting depth.											
Check the set-up of the cutter.											
Use a tougher inserts grade.											
Use a more wear resistant inserts grade.											

TURNING RECOMMENDATIONS

The cutting data recommendations below are applicable for tough cemented carbide grades. These grades are necessary for operations in which impact may occur, such as when turning plate with gas-cut edges.

Inserts grade	P25 / C6	P35 / C6-C7	K20 / C2
Feed rate f_n (mm/rev)	0.1 - 0.4 - 0.8	0.1 - 0.4 - 0.8	0.1 - 0.3
	Cutting speed V_c (m/min)		
Strenx 700	285-195-145	230-150-100	-
Strenx 900/960	130-90-70	105-65-45	-
Strenx 1100	130-90-70	105-65-45	-
Strenx 1300	-	-	100-80
Hardox HiTuf	130-90-70	105-65-45	-
Hardox 400	130-90-70	105-65-45	-
Hardox 450	130-90-70	105-65-45	-
Hardox 500	-	-	100-80

- At higher feed rate, reduce the cutting speed.

FORMULAS AND DEFINITIONS

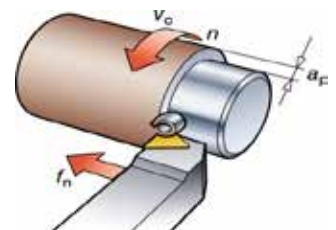
$$V_c = \pi \times d \times n / 1000$$

$$n = V_c \times 1000 / \pi \times d$$

$$v_f = n \times f_n$$

$$\pi = 3,14$$

V_c =cutting speed (m/min)
 n =speed (rpm)
 f_n =feed rate (mm/rev)
 v_f =feed rate (mm/min)
 d =workpiece $\varnothing$
 a_p =cutting depth (mm)



RESULTS FROM OUR OWN TESTS

MACHINES USED DURING THE TESTS

VMC FADAL 4020 HT modell 1997

- Spindle type ISO 40 taper
- Through spindle coolant
- Spindle speed max 10,000 rpm
- Effect spindle motor 16,8 kW
- Torque 303Nm



CSEPEL RF 50 modell 1970

- (Radialdrilling machine)
- Spindle type morse taper 4
- Spindle speed 45-2000
- Effect on the spindle motor 4 kW



* Hardox 500	Tool	drill Ø	Ø	Vc	Thread depth	Total
Tapping/through holes	Manigley 105/4 DUO	21.5	M24	3.4	40 mm	48

* Hardox 500	Tool	Ø	Vc	fn	Drill depth	Total
Drilling/through holes	HSS Co 5% X-Alcr	18	5	0.17	30 mm	33

Hardox 500	Tool	Ø	Vc	fn	drill depth	Total
Drilling/through holes	EF drill	10.4	40	0.1	30 mm	875

Hardox 500	Tool	drill Ø	Ø	Vc	thread depth	Total
Tapping/through holes	Manigley 105/4 DUO	10.4	M12	3	30 mm	161

Hardox 600	Tool	Ø	Vc	fn	drill depth	Total
Drilling/through holes	ChamDrill	18	30	0.1	30 mm	180

Hardox Extreme	Tool	Ø	Vc	fn	drill depth	Total
Drilling/through holes	MPS1 (DP 1021)	12	25	0.1	25 mm	403

* Tests carried out on the drilling machine.

TOOL RECOMMENDATIONS FOR HARDOX AND STRENX

DRILLING IN HARDOX AND STRENX



High speed steel drill alloyed with 8% cobalt (HSS-Co 8%)

Supplier: Alpen-MayKestag, Austria
www.alpenmaykestag.com

Tool name	Article nr	Diameter range
HSS -E Co 8 Taper Shank Drills, WN 103	832xxxx	8.0-40.0



High speed steel drill alloyed with 8% cobalt (HSS-Co 8%)

Supplier: Witec, Germany
www.witec-tools.de

Tool name	Article nr	Diameter range
TYPE WITEC MN	2-135 15 VAP	10.0-40.0



High speed steel drill alloyed with 8% cobalt (HSS-Co 8%)

Supplier: Somta, South Africa
www.somta.co.za

Tool name	Article nr	Diameter range
MTS Armour Piercing drill	261xxx	10.0-50.0



High speed steel drill alloyed with cobalt (DRILL BIT COBALT'S'+X-ALCR DIN1897N HARDOX STUB)

Supplier: Izar, Spain
www.izartool.com

Tool name	Article nr	Diameter range
Ref 1054	32xxx	2.0-12.0

High speed steel drill alloyed with cobalt

(DRILL BIT COBALT“S”+X-ALCR TAPER STUB)

Supplier: Izar, Spain

www.izartool.com

Tool name	Article nr	Diameter range
Ref 1054	xxxxx	14,0-30,0

**High speed steel drill alloyed with 8% cobalt**

(HSCo - 8%)

Supplier: Presto tools, England

www.presto-tools.co.uk

Tool name	Article nr	Diameter range
Armour Piercing drill (APX)	11211 xx.xx	5.0-32.0

**Solid cemented carbide drill**

Supplier: Emuge Franken, Germany

www.emuge.de/english

Tool name	Article nr	Diameter range
EF-Drill-STEEL	TA203344.xxxx	2.8-16.0

**Solid cemented carbide drill**

Supplier: Sandvik Coromant AB, Sweden

www.sandvik.coromant.com

Tool name	Article nr	Diameter range
Cordrill R840 Delta C	R840-xxxx-30-A1A	3.0-20.0

**Solid cemented carbide drill**

Supplier: Granlund Tool AB, Sweden

www.granlund.com

Tool name	Article nr	Diameter range
THUNDER / T80	T80-xx.x	10.0-30.0

**Solid cemented carbide drill**

Supplier: Mitsubishi, Japan

www.mitsubishicarbide.com

Tool name	Article nr	Diameter range
MPS1 (DP 1021)	MPS1-xxxxS	3.0-20.0



Solid cemented carbide drill

For hardness grade 450 Brinell and below, otherwise M-geometri.

Supplier: Seco, Sweden

www.secotools.com



Tool name	Article nr	Diameter range
Seco Feedmax	* SD203A-12,0-36-12R1	2.0-20.0

* Example for Ø 12.

Solid cemented carbide drill

Supplier: WNT, Germany

www.wnt.com



Tool name	Article nr	Diameter range
WTX-UNI	11780	3.0-25.0

Solid cemented carbide drill

Supplier: Hoffmann-Group, Germany

www.hoffmann-group.com



Tool name	Article nr	Diameter range
Garant 122500	122500	1.0-20.0

Drill with exchangeable drill heads

Drillheads grade: IDI SG IC908

Supplier: Iscar, Israel

www.iscar.com



Tool name	Article nr	Diameter range
Chamdrill	DCM xxx-xxx-xxA-3D	7.5-25.9

Drill with exchangeable drill heads

Drillheads grade: ICP IC 908

Supplier: Iscar, Israel

www.iscar.com



Tool name	Article nr	Diameter range
SumoCham	DCN xxx-xxx-xxA-3D	6.0-32.0

Drill with exchangeable drill heads

Drillheads grade: P-geometry (HB 7530)

Supplier: Hoffmann-Group, Germany

www.hoffmann-group.com

Tool name	Article nr	Diameter range
HiPer-Drill	DCN xxx-xxx-xxA-3D	13,0-32,75



Drill with exchangeable drill heads

Drillheads grade: P-geometry (PM 4234)

M-geometry (MM 2234) for Hardox 600

Supplier: Sandvik Coromant AB, Sweden

www.sandvik.coromant.com

Tool name	Article nr	Diameter range
CoroDrill 870	870-xxxx-xxxx	10.0-33.0



Indexable insert drill

Insert grade: Center insert LM 1044

Peripheral insert LM 4044

Supplier: Sandvik Coromant, Sweden

www.sandvik.coromant.com

Tool name	Article nr	Diameter range
CoroDrill 880	880-Dxxxxxx-xx	12.0-63.0



Indexable insert drill

Insert grade: T250D with P1 geometry

Supplier: Seco, Sweden

www.secotools.com

Tool name	Article nr	Diameter range
Perfomax	SD503-xx.x-xxR7	15.0-59.0



Counterboring in Hardox and Strenx

Use counterbore with indexable inserts and the inserts grade shall always end with H

Supplier: Granlund Tool, Sweden

www.granlund.com

Tool name	Article nr	Diameter range
WHV counterbore	XWHV-xx.x	18.0-75.0



Countersinking in Hardox and Strenx

Use countersink with indexable inserts and the inserts grade should always end with H.

Supplier: Granlund Tool, Sweden

www.granlund.com



Tool name	Article nr	Diameter range
KV countersink	xKV9-xx.x	20.5-60.0

Tapping in Hardox and Strenx

Tap for through holes

HSSE-PM tap with TiCN coating

Supplier: Manigley, Switzerland

www.manigley.ch



Tool name	Article nr	Diameter range
105/4 DUO	433xx	M3-M30

Tap for blind holes

HSSE-PM tap with TiCN coating

Supplier: Manigley, Switzerland

www.manigley.ch



Tool name	Article nr	Diameter range
131/3 DUO	433xx	M3-M36

Tap for through holes

HSS-E-PM with CoolTop coating

Supplier: Sandvik Coromant, Sweden

www.sandvik.coromant.com



Tool name	Article nr	Diameter range
CoroTap 200	E324 / E326	M3-M20

Tap for through holes

HSSE-PM with TiAlN coating

Supplier: Hoffmann-Group, Germany

www.hoffmann-group.com



Tool name	Article nr	Diameter range
Garant 132065	132065-Mxx	M3-M16

Tap for through holes

HSSE-PM with TiCN coating

Supplier: BASS, Germany

www.bass-tools.com

Tool name	Article nr	Diameter range
VARIANT 1/2 TIH	1088XX	M2-M16



Thread milling in Hardox and Strenx

Solid carbide thread milling cutter with TiCN coating

Supplier: Emuge Franken, Germany

www.emuge.de/english

Tool name	Article nr	Diameter range
GF-VZ-VHM-R15-IKZ-HB	GFB35106.xxxx	M6-M24



Solid carbide thread milling cutter with TiCN coating

Supplier: Emuge Franken, Germany

www.emuge.de/english

Tool name	Article nr	Diameter range
GSF-VHM 2D IKZ-HB	GF333106.xxxx	M3-M16



End milling in Hardox and Strenx

Solid carbide end milling cutter with Siron-A coating

Supplier: Seco, Sweden

www.secotools.com

Tool name	Article nr	Diameter range
JS 554 Siron-A	JS554xxxx	3.0-25.0



Milling with insert in Hardox and Strenx

Face milling with Coromill 345

Supplier: Sandvik Coromant, Sweden

www.sandvik.coromant.com

Tool name	Article nr	Diameter range
Coromill 345	345-xxxxxx-13x	40-250





Face milling with Coromill 300

(Round inserts)

Supplier: Sandvik Coromant, Sweden

www.sandvik.coromant.com

Tool name	Article nr	Diameter range
Coromill 300	R300-xxxxxx-xxx	10-200

Shoulder/face milling with Coromill 490

Supplier: Sandvik Coromant, Sweden

www.sandvik.coromant.com



Tool name	Article nr	Diameter range
Coromill 490	490-xxxxx-xxx	20-250



Holemaking with high feed milling

Supplier: Sandvik Coromant, Sweden

www.sandvik.coromant.com

Tool name	Article nr	Diameter range
Coromill 210	R210-xxxxx-xxx	25-160

Insert grade in Hardox and Strenx

Use insert grade P1030 for average machine conditions. In very stable machines and with a rigid set-up the insert grade P1010 would be more suitable, especially over 500 Brinell.

Supplier: Sandvik Coromant, Sweden

www.sandvik.coromant.com



Tool name	Article nr/insert grade		Insert geometry
Coromill 210	R210-xxxxxx-Px	1010	M
	R210-xxxxxx-Px	1030	M
Coromill 300	R300-xxxxx-Px	1010	L-M-H
	R300-xxxxx-Px	1030	L-M-H
Coromill 345	345R-1305x-Px	1010	L-M-H
	345R-1305x-Px	1030	L-M-H
Coromill 490	490R-xxxxxx-Px	1010	L-M
	490R-xxxxxx-Px	1030	L-M-H

Portable magnetic drilling machines for Hardox and Strenx

Rotabroach Scorpion

With this type of portable magnetic drilling machine is it possible to drill up to Hardox 500

Supplier: Rotabroach, United Kingdom

www.rotabroach.co.uk

Model nr.	Type of drill	Diameter range
Rotabroach Scorpion (Model CM 500)	TCT cutter for Hardox (core drill)	12-100



The contents of this brochure represent general suggestions. SSAB accepts no responsibility for their suitability in individual cases. The user is therefore responsible to make the necessary adaptations to the conditions in each individual case.

SSAB is a Nordic and US-based steel company. SSAB offers value added products and services developed in close cooperation with its customers to create a stronger, lighter and more sustainable world. SSAB has employees in over 50 countries. SSAB has production facilities in Sweden, Finland and the US. SSAB is listed on the Nasdaq OMX Nordic Exchange in Stockholm and has a secondary listing on the Nasdaq OMX in Helsinki.

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