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HOT-ROLLED STEEL PLATES, SHEETS AND COILS

Machining

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This brochure compiles information on machining our hot rolled steel products, including the following methods:

- drilling
- thread cutting
- sawing
- milling and turning

Raex wear-resistant steels

Machinability

General instructions for machining:

- The machine must be rigid and stable.
- Clamp the workpiece as rigidly and close to the area to be cut as possible.
- Long tool holders and spindle overhangs must be avoided.
- No harmful vibration may occur during any stage of machining.
- Particular caution must be exercised when starting a cutting operation.
- Grind away any rough edges on a thermally cut plate in the area where the first cut is started.
- Sufficient feed and depth of cut must be used.
- Provide a generous flow of cutting fluid.
- Lower the cutting speed in dry cutting.
- When machining wear-resistant steels on a regular basis, hard metal tools should be selected using the manufacturers' data sheets.

Drilling

Recommended drilling parameters for non-alloyed highspeed steel (HSS) drills and cobalt-alloyed HSS drills are presented in tables 1, 2 and 3. Additionally, recommended drilling parameters for the steel grade Raex 500 using solid cemented carbide drills are included in table 3. Raex 400 and Raex 450 can be drilled with HSS drills. For drilling of Raex 500 hard metal drills are recommended. General instructions for drilling of wearresistant steels are:

- The drilling machine has to be rigid and stable in order to minimize vibrations.
- Clamb the workpiece securely and close to the area to be machined.
- Short-hole drills are recommended.
- The service life of the drilling tool can be prolonged by decreasing the feed.
- Provide an abundant supply of cutting fluid.

Table 1.
Raex 400. Recommended drilling parameters

	Drill diameter mm	Feed rate mm/rev	Feed rate mm/minute	Cutting speed m/minute	Speed of rotation rpm
Uncoated HSS drill	5	0.10	60 – 80	9 – 12	600 – 800
	15	0.20	40 – 50	9 – 12	200 – 250
	25	0.25	30 – 40	9 – 12	110 – 150
Uncoated HSS-Co drill	5	0.10	70 – 100	12 – 15	800 – 950
	15	0.20	50 – 70	12 – 15	250 – 320
	25	0.20	25 – 30	9 – 12	110 – 150

Table 2.
Raex 450. Recommended drilling parameters

	Drill diameter mm	Feed rate mm/rev	Feed rate mm/minute	Cutting speed m/minute	Speed of rotation rpm
Uncoated HSS drill	5	0.08	40 – 50	8 – 10	500 – 650
	15	0.20	35 – 45	8 – 10	170 – 210
	25	0.25	25 – 35	8 – 10	100 – 130
Uncoated HSS-Co drill	5	0.10	60 – 75	8 – 10	600 – 750
	15	0.20	35 – 45	8 – 10	170 – 210
	25	0.20	15 – 20	6 – 8	75 – 100

Table 3.
Raex 500. Recommended drilling parameters

	Drill diameter mm	Feed rate mm/rev	Feed rate mm/minute	Cutting speed m/minute	Speed of rotation rpm
Uncoated HSS drill	5	0.10	25	4	250
	15	0.15	15	4	85
	25	0.15	8	4	50
Uncoated HSS-Co drill	5	0.10	25 – 35	4 – 6	250 – 380
	15	0.15	15 – 20	4 – 6	80 – 130
Solid cemented carbide drill	16	0.15	120	40	800

Machine tapping

For thread cutting, micro-alloyed HSS-E or cobalt-alloyed HSS-Co taps with four cutting edges are recommended. The best result is obtained by using cutting oil or paste. When the strength of the joint is not critical, thread holes approximately 3 - 5% larger than the standard values are recommended. A larger hole diameter will significantly increase tool life. During the threading pass, unobstructed chip removal must be secured without reversing the tool or alternating the direction of rotation. Shallow holes should be threaded using appropriate taps, Table 4.

Table 4.
Raex. Machine tapping, HSS-E tap

	Cutting speed m/min	Tap size					
		M10 Spindle speed rpm	M16 Spindle speed rpm	M20 Spindle speed rpm	M24 Spindle speed rpm	M30 Spindle speed rpm	M42 Spindle speed rpm
Raex 400	3.6	115	80	63	53	42	30
Raex 500	1.6	50	40	32	25	21	15

Sawing

When selecting the sawing machine and blade, the high hardness and strength of the steels should be taken into account. A generous flow of cutting fluid should be provided. In band sawing, the best results are achieved with an asymmetric tooth pitch, Table 5.

Table 5.
Raex. Cutting data for sawing

	Cutting speed m/min Cutting length mm		
	100	200	300
Raex 400	60	50	40
Raex 500	40	35	30

General instruction for band sawing:

- The blade must be supported and tensioned adequately.
- The burr and hardened layer caused by flame cutting should be ground away from the area where sawing is started.
- Long chip removal distances should be avoided, for example by clamping the workpiece rigidly in a slanting position.
- If the cutting length cannot be reduced, a blade with a coarser tooth pitch can be used.
- The tooth pressures should be reasonably high.
- Blade noise can eliminated by adjusting the cutting speed.
- Sawing should always be started using manual feed, and the feed should be adjusted to bring the blade into sufficiently stable contact.
- The hardness and strength of the workpiece should be taken into account when adjusting the feed.
- A generous flow of cutting fluid ensures that the blade remains wet throughout the run.
- Tooth damage is in part caused during the exit phase, when the blade wedges, jams, bites and jitters.

Milling and turning

The most common milling operation in the abrasion resistant steels is roughing. The milling machine must be rigid and of heavy construction. It is necessary to use coated hard metal tools. In terms of cutting data, turning is in principle similar to milling, Table 6.

Table 6.
Raex. Cutting data for rough milling

Wet rough milling	Indexable insert P40		
	Cutting speed m/min	Feed mm/tooth	Depth of cut mm
Raex 400	75 – 90	0.1 – 0.2	2 – 5
Raex 500	60 – 75	0.1 – 0.15	1 – 4

Optimal conditions allow using up to 50% higher cutting data.
For dry milling, 20 – 30% lower values are recommended.

General instructions for milling:

- A generous flow of cutting fluid should be provided.
- Start milling operations carefully.
- The burr and hardened layer caused by flame cutting should be ground away from the area where the milling is started.
- When rough milling, the first cut should be thick enough to keep the cutting edge from dragging on the scaly, hardened surface of the workpiece.

Ramor 500 protection steel

Drilling

Hard metal drills like solid cemented carbide drills and hard metal bits are recommended. HSS drills can only be used for drilling of separate holes with low-efficiency parameters. Recommended drilling parameters for cobalt-alloyed HSS drills, hard metal bit and solid cemented carbide drill are presented in table 7.

Table 7.
Ramor 500. Recommended drilling parameters for HSS-Co drills, hard metal bit and solid cemented carbide drill

	Drill diameter mm	Feed rate mm/rev	Feed rate mm/minute	Cutting speed m/minute	Speed of rotation rpm
Uncoated HSS-Co drill	5	0.10	20	3	200
	15	0.15	12	4	85
	25	0.20	8	3	40
Hard metal bit	16	0.15	120	40	800
Solid cemented carbide drill	8.7	0.10	150	40	1500

General instructions:

- The drilling machine has to be rigid and stable
- Clamb the workpiece securely and close to the area to be machined
- Solid cemented carbide drills and hard metal bits have to be used
- Short-hole drills are recommended
- Provide an abundant supply of cutting fluid.

Optim 700 MC Plus

Drilling

High strength formable Optim 700 MC Plus steel grade can excellently be drilled using ordinary uncoated HSS drills or uncoated HSS-Co drills. Recommended drilling parameters are shown in table 8.

Table 8.
Optim 700 MC Plus. Recommended drilling parameters for HSS drills

	Drill diameter mm	Feed rate mm/rev	Feed rate mm/minute	Cutting speed m/minute	Speed of rotation rpm
Uncoated HSS drill	5	0.12 – 0.16	190 – 250	25	1600
	15	0.25 – 0.30	130 – 160	25	530
	25	0.30 – 0.40	100 – 130	25	320
Uncoated HSS-Co drill	5	0.12 – 0.16	190 – 250	25	1600
	15	0.22 – 0.28	120 – 150	25	530
	25	0.25 – 0.30	80 – 100	25	320

- **Optim 700 QL**

Drilling

Optim 700 QL quenched and tempered steel can well be drilled using ordinary uncoated HSS drills. Recommended drilling parameters for HSS drills and HSS-Co drills are presented in table 9.

Table 9.
Optim 700 QL. Recommended drilling parameters. Uncoated HSS drill and uncoated HSS-Co drill

Drill diameter mm	Feed rate mm/rev	Feed rate mm/minute	Cutting speed m/minute	Speed of rotation rpm
5	0.12	170	22	1400
15	0.25 – 0.30	120 – 140	22	470
25	0.30 – 0.40	85 – 110	22	280

Ruukki Laser 355 MC and Multisteel

Drilling

When drilled, these steel grades are long chipping. The chip removal has a significant impact on the tool life. To secure efficient chip removal, the chip grooves should be spacious and smooth. The drilling test parameters are shown in Table 10.

Table 10.
Ruukki Laser 355 MC and Multisteel. Drilling tests

Thickness	Drill	Hole Ø mm	Cutting speed m/min	Feed mm/r	Number of holes	Indexed cost
Ruukki Laser 355 MC 10 mm	Standard drill	8.5	20	0.25	1000	100
	Titex Plus A1211	8.5	30	0.15	750	120
	Titex Plus A3265 TFL	9.3	100	0.35	16200	17
	Titex Plus A1211 TiN	15	40	0.35	1615	60
	Titex Plus A1149 TFL	15	60	0.45	4011	33
Ruukki Laser 355 MC 20 mm	Standard drill	8.5	20	0.35	3807	100
	Titex Plus A1211	8.5	20	0.30	4226	115
	Titex Plus A1211	15	30	0.38	524	109
	Titex Plus A1211 TiN	15	50	0.38	1344	61
	Titex Plus A1149 TFL	15	60	0.45	1427	55
Multisteel 10 mm	Standard drill	8.5	30	0.20	4556	100
	Titex Plus A1211 TiN	8.5	30	0.25	8900	81
	Titex Plus A1249 TiN	8.5	30	0.35	7116	9
	Titex Plus A1249 TFL	8.5	30	0.35	9100	62
	Titex Plus A1249 TFL Dry drilling	8.5	30	0.35	7415	63
	Titex Plus A1149 TFL	15	40	0.35	7122	84
Multisteel 20 mm	Standard drill	8.5	30	0.22	1407	100
	Titex Plus A1211 TiN	8.5	30	0.25	3382	88
	Titex Plus A1211 TiN	15	30	0.35	3053	116

Notes to the drilling test:
- The reference drill is a commonly available standard drill.
- Titex Plus A1211, Titex Plus A1211 TiN: a standard drill and a TiN-coated drill.
- Titex Plus A1149 TFL, Titex Plus A1249 TFL: multi-layer coated drills.
- Titex Plus A3265 TFL: a multi-layer coated solid cemented carbide drill.
- Parameters: cutting speed 15 – 120 m/min and feed 0.10 – 0.45 mm/r.
- Chips were not broken by peck drilling.
- The tool life was estimated using the 0.3-mm wear criterion.
- Dry drilling and minimum mist lubrication was used.
- The cost index is calculated for 100 standard drills. The costs shown in the table are estimations intended for comparison of the results when applying the drill/steel combination with different cutting data.

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