technical data

RAEX™

Wear Resistant Steel

RAEX™ is a high strength and wear resistant steel with favourable hardness and impact toughness.

With RAEX you can extend the lifespan of machinery, decrease wear in structural components and save costs. It also enables innovative design and lightweight products improving energy efficiency.

Applications

Buckets and containers, cutting edges for earth moving machines, wearing parts for mining machines, wearing parts for concrete mixing plants and wood processing machines, platform structures, feeders and funnels.

Tolerances

Tolerances on dimensions and shapes:

Heavy Plates:

- Thickness EN 10029 Class A.
- Width and length EN 10029.
- Flatness EN 10029, Class N normal tolerances on flatness, steel type H.

Cut Lengths:

- Thickness, width, and length EN 10051.
- Flatness EN 10029 Class N, steel type H.

Tolerances on thickness according to the EN 10051:2010 category A.

Delivery Condition: The delivery condition of RAEX steel is hardened.

Hardness Values

Steel Grade	Thickness mm	Hardness (HBW)
RAEX 400	2.5 – 6.4	360 - 440
RAEX 400	6 – 30	360 - 440
RAEX 400	30.01 – 40	360 - 480
RAEX 500	4.0 – 5.0	450 - 540
RAEX 500	6 – 40	450 - 540

Materials Testing:

Hardness is measured in Brinell units (HBW) in compliance with EN ISO 6506-1 on a milled surface 0.3-2mm below plate surface. The measurement depth is determined on the basis of product form and plate thickness.

Unit 89 Marston Moor Business Park,
Rudgate, Tockwith, York YO26 7QF
Tel: 01423 359111
Fax: 01423 359222
www.ajmarshall.com
sales@ajmarshall.com

Typical Mechanical Properties

Steel Grade	Yield strength $R_{p0,2}$ MPa	Tensile Strength R_m MPa	Elongation A_5 %	Impact Strength, Charpy V 20 J
RAEX 400	1000	1250	10	-40 C
RAEX 500	1250	1600	8	-30 C

Chemical Composition Content %, maximum (cast analysis)

Steel Grade	C	Si	Mn	P	S	Cr	Ni	Mo	B
RAEX 400	0.25	0.80	1.70	0.025	0.015	1.50	1.00	0.50	0.005
RAEX 500	0.30	0.80	1.70	0.025	0.015	1.00	1.00	0.50	0.005

In addition, aluminium (Al), niobium (Nb), vanadium (V) and/or titanium (Ti) can be used as micro-alloy material.

Typical Carbon Equivalent Values (CEV)

CEV = C + Mn/6 + (Cr + Mo + V)/5 + (Ni + Cu)/15

Steel Grade	Thickness mm	CEV
RAEX 400	2.5 – 4	0.48
RAEX 400	4.01 – 6.4	0.53
RAEX 400	6 – 20	0.42
RAEX 400	20.01 – 30	0.50
RAEX 400	30.01 – 40	0.56
RAEX 500	4 – 5	0.54
RAEX 500	6 – 40	0.57

Processing

Welding & Thermal Cutting

The weldability of RAEX steels has been developed to the top class among wear resistant steels on the market. Practical welding instructions for the RAEX 400 and RAEX 500 grades are presented on the separate technical brochure. Moreover, the brochure specifies the special features regarding thermal cutting of RAEX steels.

Cold Forming

RAEX 400 steels can be cold formed up to the thickness of 20mm. Forming temperature must be a minimum of +20°C and a maximum of +200°C.

Steel Grade	Thickness (mm)	Free Bending < 90° Plunger radius or curvature/ Plate Thickness R/t Bend Line Position vs. Rolling Direction		Gap Width / Plate Thickness W/t		Bending to 90° W/t V Channel
		Transverse	Longitudinal	Transverse	Longitudinal	
RAEX 400	2.5 - 6	3	3	9	9	≈15
RAEX 400	6.01 - 20	3	4	9	11	≈15
RAEX 500	5.0 - 20	≈10	≈12	23	27	

It is recommended to consult Ruukki Technical Customer Service when bending RAEX 500 steel or plates thicker than 20mm.

Due to high hardness of RAEX steels, the bending force needed, springback and bending radius are higher than those of traditional structural steels. It is recommended to consult Ruukki's Technical Customer Service prior to cold forming of over 20mm thick plates or RAEX 500 steel. Preheating is always required in the bending of over 20mm thick plates. The recommended forming temperature is 150°C-200°C. Preheating improves the deformation properties of the plate and guarantees successful bending.

High quality technology and tools that are in good condition should be used for forming. Wear and tear of tools, surface defects on plates and burrs in cut edges will impair forming quality. It is recommended to use the widest possible bending radius. The plate is bent in a single pass to the ultimate curvature to avoid springback during the work. Lubrication of bending surfaces reduces friction.

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A basic requirement for successful flanging and bending is that, prior to commencing work, a plate that has been stored in a cold atmosphere is allowed to warm up thoroughly to room temperature (+20°C). Particular care must be taken when forming all hardened plates and sheets.

Heat-Treatment

Hardened steels are not intended to be heat treated. Tempering in the maximum temperature of 200°C is the only heat treatment which will maintain the abrasion resistant properties of the plate at a good level. Heat treatment in higher temperatures decreases the strength, hardness and abrasion resistance properties of steels.

Drilling

RAEX 400 can be drilled with HSS drills. For drilling of RAEX 500, hard metal drills are recommended. General instructions for drilling of wear resistant steels are:

- The drilling machine has to be rigid and stable in order to minimise vibrations.
- Clamp the work piece securely and close to the area to be machined.
- Short-hole drills (DIN 1897) are recommended.
- The service life of the drilling tool can be prolonged by decreasing the feed.
- Provide an abundant supply of cutting fluid.

Mechanical Cutting

Hardened steels can be cut mechanically. This is, however, challenging because the plate is almost as hard as the cutting blade. High shear force is needed due to the high tensile strength of the steel. High surface pressures during cutting are directed at the blade, which increases wear. The most recommended cutting tool is a straight cutting tool.

The most important cutting parameters are blade clearance and blade angle. The hardness of the blade is of great importance. RAEX 400 steels can be cut with heavy duty cutting machines, but the hardness of the cutting blade must exceed 53 HRC. The mechanical cutting of RAEX 500 steel can be recommended only with certain reservations, and then only at thicknesses of less than 10mm and blade hardness over 57 HRC.

Mechanical Cutting of RAEX 400 Steels, guideline values

Plate Thickness mm t	Blade Clearance mm U	Angle of Tilt a°	Angle of Skew λ°	Shearing Force a x 10^3 N
6	0.60 - 0.72	3 - 4	0 - 3	150 - 200
8	0.80 - 1.28	3 - 5	0 - 5	250 - 350
10	1.00 - 1.80	4 - 6	0 - 5	300 - 450
12	1.20 - 2.16	4 - 6	0 - 5	400 - 600

Occupational Safety

Special care must be taken in all stages of handling hardened steels. Flanging is challenging due to the high strength and high flexural stresses of the plate. If the bending radius, for example, is too small and a crack is created in the bending point, the plate may fly from the bending tool in the direction of the bend.

Those bending the plate must take appropriate precautions to protect themselves and no unauthorised persons must be allowed in the area. The safest location is usually by the bending machine. The handling instructions of the steel supplier and safety instructions of the workshop must be adhered to in detail. New employees must receive appropriate training before they are allowed to process hardened steels.

Inspection Document

An inspection certificate 3.1 in compliance with EN 10204 is granted to RAEX steels. The inspection document states the chemical composition of steel based on cast analysis and hardness in delivery condition.

A.J. Marshall
Abrasion Resistant, High Strength, COR-TEN ® & Manganese Steel Plates

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