technical data

RAEX®
Wear-Resistant Steel

RAEX® is a high strength and wear-resistant steel with favourable hardness and impact toughness. The plate thicknesses range from 2mm up to 80mm providing a solution to all wear needs. With RAEX® wear plate you can extend the lifespan of machinery, decrease wear in structural components and save costs. RAEX® steel grades also enable innovative design and lightweight products improving energy efficiency and lowering fuel costs. RAEX® is utilised in various applications of mechanical engineering by, for example, the automotive, heavy lifting and transportation, and mining industries.

Applications
Buckets and containers, cutting edges for earth moving machines, wear parts for mining machines; wear parts for concrete mixing plants and wood processing machines, platform structures, feeders and funnels, tipper bodies.

Tolerances
Cut Lengths:
- Thickness EN 10051:2010 category A
- Width and length EN 10051.
- Flatness EN 10029 Class N normal tolerances on flatness, steel type H.

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

Surface Quality
Cut lengths are delivered in as-rolled condition.
Heavy plates can be delivered as-rolled or in shop-primed condition.
Surface quality: EN 10163-2 Class B3.

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

Hardness Values

Steel Grade	Thickness mm	Hardness (HBW)
RAEX® 400	2 - 8	360 - 440
RAEX® 400	6 - 80	360 - 440
RAEX® 500	3 - 6.5	470 - 540
RAEX® 500	6 - 80	450 - 540

Materials Testing:
Hardness is measured in Brinell units (HBW) in compliance with EN ISO 6506-1 on a milled surface 0.3-3mm 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 %	Impact Strength, Charpy V 30 J
RAEX® 400	1000	1250	10	-40°C
RAEX® 500	1250	1600	8	-40°C

Chemical Composition Content %, maximum (cast analysis). The steel is grain refined.

Steel Grade	C	Si	Mn	P	S	Cr	Ni	Mo	B
RAEX® 400	0.23	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	1.50	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 CET = C +Mn/10 + Mo/10 + Cr/20 + Cu/20 + Ni/40

Steel Grade	Thickness mm	CEV [1)]	CET [2)]
RAEX® 400	2 - 4	0.48	0.29
RAEX® 400	4.01 - 8	0.53	0.31
RAEX® 400	6 - 20	0.42	0.28
RAEX® 400	20.01 - 30	0.50	0.32
RAEX® 400	30.01 - 40	0.56	0.34
RAEX® 400	40.01 - 80	0.57	0.35
RAEX® 500	3 - 6.5	0.54	0.40
RAEX® 500	6 - 40	0.57	0.40
RAEX® 500	40.01 - 80	0.66	0.40

[1)] The CEV value is being announced in the inspection certificate. [2)] The CET values are tabulated for information only.

Processing Instructions

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® steels can be cold formed up to the thickness of 20mm, see the table below. Forming temperature must be a minimum of +20°C and a maximum of +200°C.

Standard values for free bending and flanging. Thickness ≤ 20mm.

Steel Grade	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° V Channel W/t
	Transverse	Longitudinal	Transverse	Longitudinal	
RAEX® 400	3	4	9	11	≈15
RAEX® 500	5	6	13	15	≈15

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

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

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

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 resistance 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 speed.
- 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

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