



## Relia®: Quality Wear Resistant Plates

Relia® is a range of high hardness, conventional low-alloyed martensitic steels, which obtain their hardness through intense water quenching during plate manufacturing.

Relia® steel plates offer outstanding resistance to abrasion typically 3 to 6 times higher than 355MPa-class construction steel, although the actual performance may vary depending on the type of wear and operating conditions.

The use of Relia® plates will extend the service life of wear parts and machinery components over standard construction steel, without sacrificing on quick and easy fabrication in the workshop.

Relia® plates are available in 3 nominal hardness levels 400, 450 and 500 HBW and 2 product specification levels to meet a wide range of practical requirements: structural parts.

> The Relia® Standard series offers entry-level products with the main emphasis on surface hardness.

> The Relia® Premium series is carefully optimised to offer superior properties and higher service level for easy and quick fabrication. In addition to high superficial hardness, Relia® Premium plates offer toughness, uniform hardness, enhanced weldability, improved cold formability and narrow plate manufacturing tolerances.

Relia® Premium is the preferred solution for consistent and reliable processing behavior in the workshop combined with optimal in service performance.

### PROPERTIES

#### STANDARDS

Relia® 400, 450, 500 and the Relia® Premium series are proprietary grades developed by Industeel. There exists no engineering standard for plates intended for wear resistant applications.

#### TECHNICAL CHARACTERISTICS

##### Chemical composition

The chemical composition from ladle analysis is detailed in the following table. Individual compositions are adjusted depending on thickness.

The chemical composition of Relia® Premium plates is fully certified for all elements in the mill test certificates and a maximum value is guaranteed for carbon equivalent.

##### Hardness

The technical characteristics table shows the guaranteed Brinell hardness HBW ranges in the as-delivered condition, according to EN ISO 6506-1. Test shall be performed on a ground or milled surface below the decarburized layer typically 0,2 – 2 mm depending on plate thickness.

The Relia® Premium plates offer a narrow range of hardness variation to ensure better consistency from plate to plate. In addition, the Relia® Premium plates are through-hardened to a minimum of 90% of the guaranteed minimum surface hardness.

### Tensile properties

Abrasion resistant steels are not specified or guaranteed by their tensile strength and elongation typically required for structural steels. Typical values for 15 mm plate thickness are provided in Table 2 for reference information only. For further details, please contact us.

### Impact properties

The Relia® Premium series offers an optional guarantee for impact toughness. **Please note that thickness limitation may apply and prior agreement at order confirmation is required.** Table 2 shows the guaranteed Charpy V-notch min impact energy (average of three tests) at -20 °C from longitudinal full-size specimens 10 x 10 mm. Impact testing shall be performed according to ISO EN 148. Location and preparation of test pieces are determined according to ISO 377.



Technical characteristics		Relia® 400		Relia® 400 Premium		Relia® 450		Relia® 450 Premium		Relia® 500		Relia® 500 Premium	
		min	max	min	max	min	max	min	max	min	max	min	max
Chemical composition	C		0.18		0.17		0.20		0.20		0.30		0.28
	Mn		1.90		1.90		1.70		1.70		1.50		1.50
	P		0.02		0.02		0.02		0.02		0.02		0.02
	S		0.005		0.003		0.005		0.003		0.005		0.003
	Si				0.60				0.60				0.55
	Al				0.060				0.060				0.060
	Nb				0.03				0.03				0.03
	V				0.03				0.03				0.03
	Ti				0.05				0.05				0.05
	Cr				1.0				1.0				1.0
	Mo				0.2				0.2				0.5
	Ni				0.8				0.8				0.8
	Cu				0.4				0.4				0.4
	B		0.004		0.004		0.004		0.004		0.003		0.003
	N				0.008				0.008				0.008
Cr + Ni + Mo		1.5				1.6				2.0			
Nb + V + Ti		0.10				0.12				0.12			
CEV <sup>(4)</sup>					0.45 <sup>(3)</sup>				0.52 <sup>(3)</sup>				0.67
Hardness	HBW	360	440	370	430	410	490	420	480	460	540	470	530
	Through-hardening <sup>(2)</sup>			330				380				420	
Tensile test <sup>(1)</sup>	YS 0.5 (MPa)	1100		1100		1200		1200		1400		1400	
	TS (MPa)	1250		1250		1400		1400		1600		1600	
	Total Elong (%)	13		13		10		10		10		10	
CVN - Impact test <sup>(5)</sup>	Temperature (°C)				-20				-20				-20
	Average energy (J)			27				27				27	

Notes: <sup>(1)</sup> Typical values for 15 mm plate thickness (provided for reference information only)

<sup>(2)</sup> The plate is deep hardened to min 90% of the specified range for surface hardness

<sup>(3)</sup> Up to 20 mm; otherwise max 0.56 and 0.62 for 400 and 450 - class respectively

<sup>(4)</sup> CEV = C + Mn/6 + (Cr+Mo+V)/5 + (Cu+Ni)/15

<sup>(5)</sup> After prior agreement; thickness limitation may apply

**DIMENSIONAL PROGRAM**

**Delivery condition: Q (quenched).**

The Relia® range is available as both cut-to-length sheet and heavy plate, offering the widest dimensional range from 4 to 150 mm thickness. The Relia® Standard series is available only from standard plate size typically 6000, 8000 or 12000 mm long and 2000 or 2500 mm width. Tailored dimensions are available from the Relia® Premium series.

	Relia® 400		Relia® 400 Premium		Relia® 450		Relia® 450 Premium		Relia® 500		Relia® 500 Premium	
	min	max	min	max	min	max	min	max	min	max	min	max
Thickness (mm)	4	150	8	50	5	60	8	50	6	60	8	50
Width (mm)	2000	3500	1200	3800	2000	3500	1200	3800	2000	3000	1200	3000
Length (mm)	6000	12000			6000	12000			6000	12000		
Unit weight (t)		15		15		15		15		15		15

For plates outside this dimensional program, please enquire us.

**TOLERANCES**

**Dimensions and shape**

Unless otherwise specified, tolerances on dimensions and shape are determined according to EN 10029. Plates obtained from cut-to-length strips may be delivered with untrimmed edges. The same tolerances on width as trimmed edges will apply. For further information, please contact us.

**Thickness tolerance**

Unless otherwise agreed, tolerances on thickness are determined according to EN 10029 Class A (minus thickness tolerance depending on nominal thickness). If class B, C or D tolerances are required, it shall be indicated at the time of enquiry and order. Tight thickness tolerances closer than those specified by EN 10029 are also available upon enquiry. Plates obtained from cut-to-length strips are delivered with

close thickness tolerances -0,2/0,2 mm. For further information, please contact us.

**Flatness**

Unless otherwise agreed, flatness shall conform to the provisions of EN 10029 Class N - steel type H (products with a specified yield strength > 460 MPa and all grades of quenched and quenched and tempered products). If agreed at the time of enquiry and order, the Relia® Premium series offers an optional extra-close tolerance for flatness corresponding to the special tolerances of EN 10029 Class S - steel type L.

**Surface**

Relia® plates are delivered in accordance to EN 10163-2 Class A, Sub-class 1. The Relia® Premium series will be delivered in the shot-blast condition and if requested, protected with shop primer. For primer type and characteristics, please contact us.

**PLATE PROCESSING**

**FABRICATION GUIDELINES**

**Thermal cutting**

Relia® plates are compatible with all thermal cutting processes such as oxyfuel, plasma, laser, etc. Preheating at 100-150°C is recommended for plates thicker than 40 mm (10 mm for Relia® 500 and Relia® 500 Premium) or in cold environments where the plate temperature is below 10°C. Excess preheating above 200°C may reduce the hardness of Relia®.

**Cold formability**

Thanks to their high cleanliness and uniform properties, the Relia® Premium plates are specifically designed for improved formability and are always recommended over the Standard series plates when subsequent cold forming is considered. Brake press bending of Relia® Premium plates should be carried out using shop practices which include, but are not limited to, using hardened V-dies with

an appropriate radius. It is recommended that adequate lubrication, grinding of thermal cut or sheared plate edges and applying the load in a smooth, steady manner are utilized. Relia® should not be hot formed unless the part is subsequently heat treated by an approved process. For plates up to 20 mm, recommended minimum bending radius and die opening are summarized in the following table. For plate thickness above 20 mm, please consult us.

	Min Internal Bending Radius*	Min die opening*
Relia®400 Premium	3 (4)	10 (12)
Relia®450 Premium	5(6)	12 (14)
Relia®500 Premium	6(8)	14 (18)

\* Values shown in plain are for bending perpendicular to the plate rolling direction; values in bracket are for bending along the longitudinal direction. Those values shall be understood as the min ratio over the plate thickness.

## WELDING

Due to its low carbon content and carbon equivalent, Relia® exhibits very good welding characteristics when the guidelines below are followed.

### Weld preparation

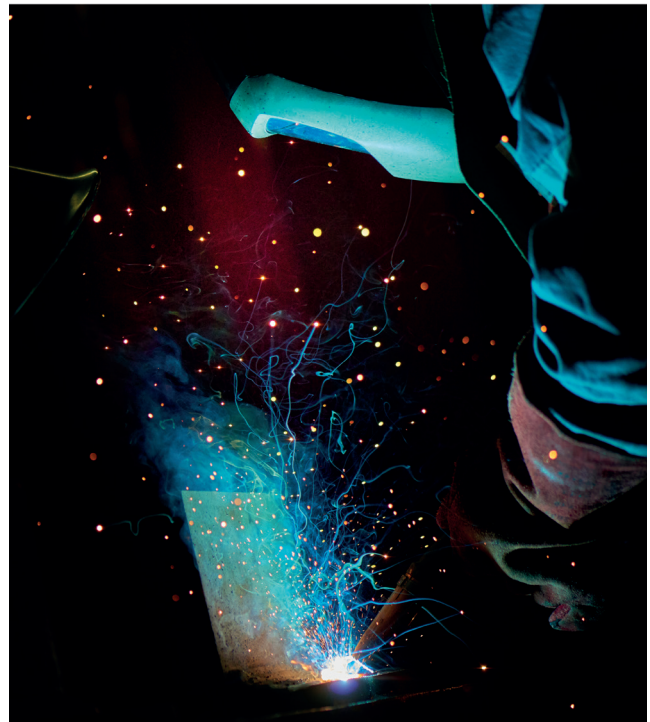
Weld surfaces should be dry, clean and grinded to eliminate rust, scale, grease or paint traces as well as any gas-cutting dross. In all cases, it is recommended that welding is carried out above 5 °C.

### Welding process

All conventional fusion welding methods can be used, such as:

- > SMAW (Shielded Metal Arc Welding)
- > GMAW (Gas Metal Arc Welding)
- > FCAW (Flux Cored Arc Welding)
- > SAW (Submerged Arc Welding)

Heat input should be limited to 10-30 kJ/cm with maximum interpass temperature of 220°C.



### Welding consumables

The manufacturer's recommendations should be strictly followed for the storage, handling and use of welding consumables. For protection of weld against wear, very hard welding products could be used for covering passes. All products in accordance with the following standards are acceptable:

Ferritic filler	Euronorm	AWS
SNAW	EN757 / EN ISO 2560	
	E42 x	A5-5
	E46 x	E70 x
GMAW	EN ISO 14341	
	G42 x	A5-18
	G46 x	ER70Sx
FCAW	EN756 / EN ISO 17632	
	T42 x	A5-20 E71 x
SAW	EN 756	
	S1 x	A5-17 / A5-23
	S3 x	E70 x

Using ferritic filler and welding configuration leading to high combined thicknesses above typically 50 mm (15 mm for Relia® 500 and Relia® 500 Premium), preheating will be required to prevent (delayed) cold cracking. Further information about the suggested preheating temperatures depending on the combined thickness, welding method and heat input is available upon request.

### Stainless filler

	Euronorm	AWS
SNAW	EN1600	A5-4
	E1 8 8 Mn x	E308 x
GMAW	EN ISO 14343	
	G18 8 Mn x	A5-9 ER307 x
FCAW	EN ISO 17633	
	S1 8 8 Mn x	A5-22 E307 x

Stainless welding products self harden after welding and require no preheating or cap passes.

## MACHINING

Machining of Relia® requires the use of coated or uncoated cobalt-alloyed, high speed steel or cemented carbide tips, using a generous supply of cutting fluid or oil-based lubricant.

Relia® is easy to drill, tap and mill respecting the parameters displayed in the following tables.

### Drilling

		Relia®400	Relia®450	Relia®500
High Speed Steel	Cutting speed (m/min)	10-30	5-25	5-15
	Feed (mm/rev)	0.1-0.2	0.1-0.2	0.1-0.2
Carbide Tool	Cutting speed (m/min)	50-90	40-80	40-60
	Feed (mm/rev)	0.1-0.2	0.1-0.2	0.1-0.16

### Tapping

		Relia®400	Relia®450	Relia®500
High Speed Steel	Cutting speed (m/min)	3-6	3-6	3-6
	Feed (mm/rev)	1-3	1-3	1-3

### Milling

		Relia®400	Relia®450	Relia®500
High Speed Steel	Cutting speed (m/min)	30-50	20-40	13-30
	Feed (mm/rev)	0.1-0.2	0.1-0.2	0.1-0.2
Carbide Tool	Cutting speed (m/min)	50-150	40-120	30-100
	Feed (mm/rev)	0.05-0.5	0.05-0.5	0.05-0.5

## YOUR CONTACTS

**David Quidort**  
 Tel. +33 3 85 80 57 29  
 david.quidort@arcelormittal.com

<http://industeel.arcelormittal.com>

**Industeel France**  
 Le Creusot Plant  
 56 rue Clemenceau  
 F-71202 Le Creusot Cedex

*Technical data and information are to the best of our knowledge at the time of printing. However, they may be subject to some slight variations due to our ongoing research programme on steels. Therefore, we suggest that information be verified at time of enquiry or order. Furthermore, in service, real conditions are specific for each application. The data presented here are only for the purpose of description, and considered as guarantees when written formal approval has been delivered by our company. Further information may be obtained from the address opposite.*