outokumpu
high performance stainless steel

Temper rolled stainless steels

Outokumpu Forta range datasheet

Forta
Duplex
& other
high strength

General characteristics

Forta is associated with strength. This range covers the strongest stainless steels in Outokumpu's portfolio. It also brings together three product groups:

- **Forta Duplex** products for high strength, high to very high corrosion resistance, and enhanced resistance to stress corrosion cracking
- **Forta H-Series** austenitic products for high strength and high ductility
- **Forta Temper rolled** products for high strength and high hardness

This datasheet focuses on the Forta Temper rolled products presenting charts and diagrams showing how their strength fits in with other stainless steel grades. Examples of where the products are typically used are given throughout the datasheet. The Forta range contains high strength stainless steels, with a yield strength of minimum 350 MPa, that enable thinner structures and weight reduction. Table 1 shows the grades, their properties and chemical composition.

Grades

Table 1

Forta

Temper rolled
(proof strength $R_{p0.2}$ > 350 MPa), PRE 15 to 25.

Outokumpu Pro family

Steel designations				Performance			Typical chemical composition, % by mass					
		ASTM			$R_{p0.2}$							
Outokumpu name	EN	Type	UNS	PRE	MPa	Grade family	C	Cr	Ni	Mo	N	Others
Forta 4589	1.4589	–	S42035	15	420	F	0.05	14.0	1.7	0.3	–	Ti
Forta 430/4016	1.4016	430	S43000	16	350 – 700	F	0.05	16.2	–	–	–	–
Forta 301LN/4318	1.4318	301LN	S30153	20	350 – 700 *)	A	0.02	17.7	6.5	–	0.14	–
Forta 301/4310	1.4310	301	S30100	17	500 – 2000	A	0.10	17.0	7.0	–	–	–
Forta 304/4301	1.4301	304	S30400	18	350 – 1300	A	0.04	18.1	8.1	–	–	–
Forta 304L/4307	1.4307	304L	S30403	18	350 – 1300	A	0.02	18.1	8.1	–	–	–
Forta 316/4401	1.4401	316	S31600	24	350 – 700	A	0.04	17.2	10.1	2.1	–	–
Forta 316L/4404	1.4404	316L	S31603	24	350 – 700	A	0.02	17.2	10.1	2.1	–	–
Forta 316plus	1.4420	–	S31655	25	350 – 900 *)	A	0.02	20.3	8.6	0.7	0.19	–
Forta 316Ti/4571	1.4571	316Ti	S31635	24	350 – 700	A	0.04	16.8	10.9	2.1	–	Ti

Grade family: A = austenitic, F = ferritic. *) Fulfills $R_{p0.2}$ minimum 350 MPa in 2B condition.

Outokumpu Forta Temper rolled products

Temper rolling means a controlled additional cold rolling process. This is applied in the mill to traditional stainless steel products like Moda 430/4016, Moda 4589, Core 301/4310, Core 301LN/4318, Core 304/4301, Core 304L/4307, Supra 316/4401, Supra 316L/4404, Supra 316plus, and Supra 316Ti/4571.

Temper rolling creates a strong, lightweight and formable construction material with a hard surface that is ideal for a multitude of applications. Temper rolling increases the strength and surface hardness, making the material suitable for lightweight engineering and constructions. The strength classification includes yield strength classes from CP350 up to CP1100 MPa and tensile strength classes from C700 up to C1900 MPa.

It is a versatile group of stainless steel grades. For example, one steel grade can be used in various strength classes in different places of one application, for instance in the frame of a train carriage.

Characteristic Properties

- High strength
- Suitable for lightweight constructions
- Excellent anti-abrasion properties
- Attractive, easy-to-clean, hygienic surface
- No surface treatment necessary
- Easy to weld
- Good formability and high elongation
- Suitable for mildly to highly corrosive environments

The temper rolled products with typical applications and the product forms Outokumpu supplies

Table 2

Outokumpu designation	Typical applications	Product forms
Forta 4589 (EN 1.4589/UNS S42035) Forta 4589 is a 14 % chromium product with a small amount of niobium for elevated strength, making it suitable for structural parts exposed to loads that demand higher yield points.	• Conveyor chains • Railroad cars	• Cold rolled coil and sheet
Forta 430/4016 (EN 1.4016/UNS S43000) A classic 16% chromium ferritic stainless steel used in mildly corrosive environments.	• Automotive components • Structural applications • Tanks	• Cold rolled coil, sheet and precision strip
Forta 301LN/4318 (EN 1.4318/UNS S30153) A low-carbon, nitrogen alloyed alternative to Forta 301/4310.	• Vehicle chassis • Profiles	• Cold rolled coil and sheet
Forta 301/4310 (EN 1.4310/UNS S30100) A lower chromium and nickel alternative to Forta 304/4301 with high work hardening capacity.	• Automotive components • Cable connectors • Springs • Window frames • Commercial appliances	• Cold rolled coil, sheet and precision strip
Forta 304/4301 (EN 1.4301/UNS S30400) Forta 304/4301 is a classic 18% chromium, 8% nickel austenitic stainless steel. It's an all-purpose product with good corrosion resistance and is suitable for a wide variety of applications.	• Beer kegs • Cutlery • Automotive components • Tanks and vessels • Furniture • Structural applications	• Cold rolled coil, sheet and precision strip
Forta 304L/4307 (EN 1.4307/UNS S30403) Forta 304L/4307 is a low-carbon alternative to Forta 304/4301 and is suitable for a wide variety of applications.	• Beer kegs • Cutlery • Automotive components • Tanks and vessels • Furniture • Structural applications	• Cold rolled coil and sheet
Forta 316/4401 (EN 1.4401/UNS S31600) A normal-carbon alternative to Forta 316L/4404.	• Automotive components • Tanks and vessels	• Cold rolled coil and sheet

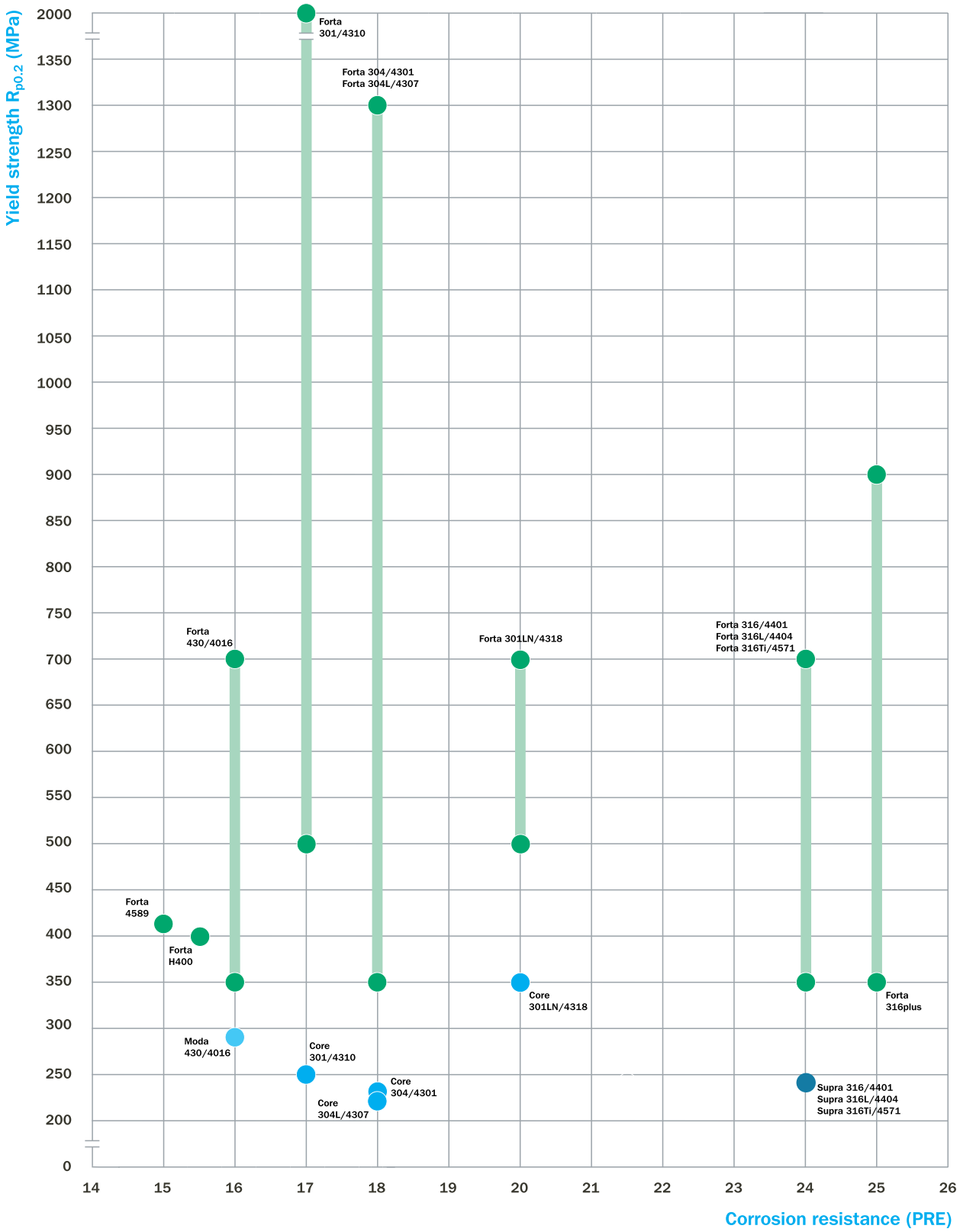
Table 2, continued

Outokumpu name	Typical applications	Product forms
Forta 316L/4404 (EN 1.4404/UNS S31603) Forta 316L/4404 is a low-carbon alternative to Forta 316/4401 and is used in various aggressive environments.	• Automotive components • Tanks and vessels	• Cold rolled coil, sheet and precision strip
Forta 316plus (EN 1.4420/UNS S31655) Forta 316plus is a cost-efficient alternative to traditional molybdenum austenitics like Forta 316L/4404.	• Automotive components • Tanks and vessels • Structual applications	• Cold rolled coil and sheet
Forta 316Ti/4571 (EN 1.4571/UNS S31635) A titanium-stabilized alternative to Forta 316L/4404.	• Heating technology • Profiles • Railway tanks	• Cold rolled coil, sheet and precision strip

Products and dimensions

Forta Temper Rolled products are available as coil, sheet and precision strip. To find the minimum and maximum thickness and width by surface finish for a specific product in the Forta range, please visit **outokumpu.com**

Performance



- Moda – Stainless steels for mildly corrosive environments (PRE ≤17)
- Core – Stainless steels for corrosive environments (PRE 17–22)
- Supra – Stainless steels for highly corrosive environments (PRE 22–26)
- Forta – Temper rolled stainless steels (PRE 15–25)

PRE = %Cr + 3.3 x %Mo + 16 x %N.
Values for $R_{p0.2}$ yield strength EN 10088-2 min. values for cold rolled strip.
Chemical compositions and PRE calculations are based on Outokumpu typical values.

Please see values for other product forms at **steelfinder.outokumpu.com**

Fig. 1. Yield strength vs. corrosion resistance.

Mechanical properties

According to EN 10088-2 intermediate tensile strength values may be agreed. Alternatively, the steels may be specified in terms of minimum yield strength or hardness, but only one parameter can be specified in the order. Tables 5-8 show mechanical properties of temper rolled products in the as-delivered condition. Any kind of heat treatment or exposure to high temperatures including welding may have an impact on the mechanical properties of the fabricated component.

Strength classification according to EN 10088-2

Table 3

Metric

Outokumpu name	EN	ASTM		Tensile strength level EN Tensile strength R_m [MPa]							
		Type	UNS	+C700 [700–850 MPa]	+C850 [850–1000 MPa]	+C1000 [1000–1150 MPa]	+C1150 [1150–1300 MPa]	+C1300 [1300–1500 MPa]	+C1500 [1500–1700 MPa]	+C1700 [1700–1900 MPa]	+C1900 [1900–2200 MPa]
Forta 4589	1.4589	–	S42035		X	X					
Forta 430/4016	1.4016	430	S43000	X	X	X					
Forta 301LN/4318	1.4318	301LN	S30153	X [1)]	X	X					
Forta 301/4310	1.4310	301	S30100		X	X	X	X	X [2)]	X [2)]	X [2)]
Forta 304/4301	1.4301	304	S30400	X	X	X	X	X			
Forta 304L/4307	1.4307	304L	S30403	X	X	X	X				
Forta 316/4401	1.4401	316	S31600	X	X						
Forta 316L/4404	1.4404	316L	S31603	X	X	X					
Forta 316Ti/4571	1.4571	316Ti	S31635	X	X						
Forta 316plus	1.4420	–	S31655	X	X	X					

[1)] Fulfills requirement in 2B condition. [2)] According to EN 10151. Forta 4589 is sold with a combination of strength and elongation agreed with the customer on a case by case basis.

Strength classification according to EN 10088-2

Table 4

Metric

Outokumpu name	EN	ASTM		Yield strength level EN Tensile strength $R_{p0.2}$ [MPa]				
		Type	UNS	+CP350 [350–500 MPa]	+CP500 [500–700 MPa]	+CP700 [700–900 MPa]	+CP900 [900–1100 MPa]	+CP1100 [1150–1300 MPa]
Forta 430/4016	1.4016	430	S43000	X	X	X		
Forta 301LN/4318	1.4318	301LN	S30153	X [*)]	X	X		
Forta 301/4310	1.4310	301	S30100		X	X	X	X
Forta 304/4301	1.4301	304	S30400	X	X	X	X	X
Forta 304L/4307	1.4307	304L	S30403	X	X	X	X	X
Forta 316/4401	1.4401	316	S31600	X	X	X		
Forta 316L/4404	1.4404	316L	S31603	X	X	X		
Forta 316Ti/4571	1.4571	316Ti	S31635	X	X	X		
Forta 316plus	1.4420	–	S31655	X [*)]	X	X	X	

[*)] Fulfills requirements in 2B condition.

Forta 4589 is sold with a combination of strength and elongation agreed with the customer on a case by case basis.

Strength classification according to ASTM A666.

Table 5

Imperial								
Outokumpu name	EN	ASTM		ASTM A666	Tensile strength, min		Yield strength, min	
		Type	UNS		ksi	MPa	ksi	MPa
Forta 301LN/4318	1.4318	301LN	S30153	1/16 hard *)	100	690	50	345
				1/8 hard	110	760	60	415
				1/4 hard	120	830	75	520
				1/2 hard	135	930	100	690
Forta 301/4310	1.4310	301	S30100	1/8 hard	100	690	55	380
				1/4 hard	125	860	75	520
				1/2 hard	150	1035	110	760
				3/4 hard	175	1210	135	930
				Full Hard	185	1275	140	965
				Super Full Hard	270	1860	260	1790
Forta 304/4301	1.4301	304	S30400	1/8 hard	100	690	55	380
				1/4 hard	125	860	75	520
				1/2 hard	150	1035	110	760
Forta 304L/4307	1.4307	304L	S30403	1/8 hard	100	690	55	380
				1/4 hard	125	860	75	520
				1/2 hard	150	1035	110	760
Forta 316/4401	1.4401	316	S31600	1/8 hard	100	690	55	380
				1/4 hard	125	860	75	520
				1/2 hard	150	1035	110	760
Forta 316L/4404	1.4404	316L	S31603	1/8 hard	100	690	55	380
				1/4 hard	125	860	75	520
				1/2 hard	150	1035	110	760

*) Fulfills requirements in 2B condition.

Forta 4589 is sold with a combination of strength and elongation agreed with the customer on a case by case basis.

Additional grades and taylor-made strength levels available upon agreement. For more information, please see **steelfinder.outokumpu.com**

Corrosion resistance

Temper rolled stainless steel are mainly selected for their mechanical properties. However, they generally exhibit a corrosion resistance that is on a par with their annealed counter part.

For more information, see the Outokumpu Corrosion Handbook, available from our sales offices.

Physical properties

The physical properties of Forta Temper Rolled family are basically the same, except the magnetism, as their annealed counter part. Temper rolled should not be used in applications where strictly non magnetic properties are required.

Fabrication

Forming and machining

Compared with many competing materials of similar strength, temper rolled stainless steel sheet and coil has very good formability. Even at full hard strength it remains bendable though larger bending radius are necessary. Increased material strength results in larger springback, which can be compensated by overbending. The required force for forming will also increase compared to the sheet material in the annealed condition.

Austenitic temper rolled products can be easily formed and fabricated using the full range of cold forming operations. They can be used in press forming, drawing, and bending. Work hardening is accentuated by the partial transformation of the austenite phase of the material to hard martensite. Any cold forming operations will increase the strength and hardness of the material, and may leave it slightly magnetic.

Because of their high ductility and strong work hardening, it is recommended to use sharp tools, effective cooling, and an adequate feed tool when machining temper rolled grades.

Welding

Temper rolled sheet and coil can be welded in the same way as equivalent annealed material. However, since strength of Forta temper rolled products can be reduced in the weld area, the location of welds must be carefully considered at the design stage.

Austenitic temper rolled stainless steels in general have excellent weldability. They are readily weldable using all conventional welding methods, including MMA, MIG, MAG, TIG, SAW, LBW and RSW, but excluding gas welding. Austenitic stainless steels have about 50% higher thermal expansion and lower heat conductivity compared to carbon steels. This means that larger deformation and higher shrinkage stresses may result from welding. Cleaning the weld seam is very important for maintaining corrosion resistance. Pickling is also recommended. Because of the austenitic structure, the welded joints are hard down to low temperatures, even in the as-welded condition.

For more information, see the Outokumpu Welding Handbook, available from our sales offices.

outokumpu.com/contacts

Contacts and enquiries

Contact us

Our experts are ready to help you choose the best stainless steel product for your next project.

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Working towards a world that lasts forever

We work with our customers and partners to create long lasting solutions for the tools of modern life and the world's most critical problems: clean energy, clean water, and efficient infrastructure. Because we believe in a world that lasts forever.

outokumpu classic			outokumpu pro					
Moda	Core	Supra	Forta	Ultra	Dura	Therma	Prodec	Deco
Mildly corrosive environments	Corrosive environments	Highly corrosive environments	Duplex & other high strength	Extremely corrosive environments	High hardness	High service temperatures	Improved machinability	Special surfaces

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