

# Moda 410L/4003

EN 1.4003, ASTM UNS S40977

## General characteristics

Moda 410L/4003 is a weldable ferritic stainless steel with elevated yield strength and resistance to abrasion. Its better corrosion resistance compared to carbon steels enables lower maintenance costs and longer service life.

Outokumpu Moda 410L/4003 is a low-chromium structural ferritic stainless steel. Its corrosion resistance is limited in applications with increased corrosiveness. Moda 410L/4003 can, however, replace carbon steel in many structural applications. When some discoloration in more aggressive environments is not acceptable, Moda 410L/4003 may be painted.

Moda 410L/4003 is available in many product forms and dimensions, often also from stainless steel stockholders.

## Typical applications

- Railroad and road vehicles
- Shipping containers
- Industrial applications
- Mining conveyors

## Products & dimensions

### Cold rolled products, available dimensions (mm)

Surface finish		Coil / Strip		Plate / Sheet	
		Thickness	Width	Thickness	Width
2B	Cold rolled, heat treated, pickled, skin passed	0.40-3.00	30-1550	0.40-3.00	350-1550
2BB	Bright-pickled	0.50-3.00	30-1500	0.50-3.00	600-1500
2C	Cold rolled, heat treated	0.50-3.00	30-1500		
2E	Cold rolled, heat treated, mech. desc. pickled	0.50-3.00	30-1500	0.50-3.00	600-1500
2G	Ground	0.50-3.00	30-1500	0.50-3.00	600-1500
2J	Brushed or dull polished	0.50-3.00	30-1500	0.50-3.00	600-1500
2R	Cold rolled, bright annealed	0.05-3.00	3-1500	0.40-3.00	125-1500

### Continuous hot rolled products, available dimensions (mm)

		Coil / Strip	Plate / Sheet
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Surface finish		Thickness	Width	Thickness	Width
1C	Hot rolled, heat treated, not descaled	1.90-8.00	50-1530		
1D	Hot rolled, heat treated, pickled	2.70-8.00	50-1530	2.70-8.00	50-1530
1E	Hot rolled, heat treated, mech. desc.	1.50-3.00	50-1530	1.50-3.00	400-1530
1G	Ground	1.90-3.00	750-1530	1.90-3.00	750-1350
1U	Black hot rolled	1.90-10.00	50-1530		

## Chemical composition

The chemical composition may vary slightly between different product standards. The required standard will be fully met as specified in the order.

The typical chemical composition for this grade is given in the table below, together with composition limits given for the product according to different standards. The required standard will be fully met as specified on the order.

The chemical composition is given as % by mass.

	C	Mn	Cr	Ni	Mo	N	Other
<b>Typical</b>	<b>0.02</b>		<b>11.5</b>	<b>0.5</b>			
ASME II A SA-240	≤0.030	≤1.50	10.5-12.5	0.30-1.00		≤0.030	
ASTM A240	≤0.030	≤1.50	10.5-12.5	0.30-1.00		≤0.030	
EN 10028-7	≤0.030	≤1.50	10.50-12.50	0.30-1.00		≤0.030	
EN 10088-2	≤0.030	≤1.5	10.5-12.5	0.3-1.0		≤0.030	
EN 10088-3	≤0.030	≤1.5	10.5-12.5	0.3-1.0		≤0.030	
EN 10088-4	≤0.030	≤1.5	10.5-12.5	0.3-1.0		≤0.030	

## Corrosion resistance

Moda 410L/4003 has a significantly increased corrosion resistance compared to mild carbon steel for many indoor and outdoor applications in rural areas where chloride contamination is very low. When discoloration and superficial rusting is acceptable, it can often provide a sufficiently long service life in many structural applications and process environments where atmospheric corrosion conditions are more demanding. Paint or a protective coating may be applied for decorative applications, where rust and discoloration is not acceptable, and for use in areas with more severe corrosive attack. The best material performance is typically achieved with the help of adequate design, correct post-weld treatment, and regular cleaning during use (if applicable).

Moda 410L/4003 exhibits greater resistance to wear than unalloyed structural steels, especially in corrosive environments. Moda 410L/4003 has good corrosion resistance in solutions of many halogen-free organic and inorganic compounds over a wide temperature and concentration range. When in contact with acidic pH value solutions, uniform corrosion is likely to occur even at low temperatures. If sensitized for intergranular corrosion due to welding or an inappropriate heat treatment, corrosion rates in certain environments may be significantly higher. More detailed information on corrosion properties of Moda 410L/4003 can be found in Outokumpu's Corrosion Tables published in the [www.outokumpu.com](http://www.outokumpu.com).

In aqueous solutions containing halogenides, e.g. chlorides or bromides, pitting and crevice corrosion may occur depending on the halogenide concentration, temperature, pH-value, concentration of oxidizing compounds, or crevice geometry, if applicable. Even relatively low halogenide concentrations may lead to corrosion damages on Moda 410L/4003. The presence of corrosion inhibiting or accelerating compounds like e.g. transition metal ions or organic compounds may influence the corrosion behavior of Moda 410L/4003.

For more information on corrosion resistance, please refer refer to the Outokumpu Corrosion Handbook or contact our corrosion experts.

Pitting corrosion resistance		Crevice corrosion resistance
PRE	CPT	CCT
12	<10	<0

Pitting Resistance Equivalent (PRE) is calculated using the following formula:  $PRE = \%Cr + 3.3 \times \%Mo + 16 \times \%N$   
Corrosion Pitting Temperature (CPT) as measured in the Avesta Cell (ASTM G 150), in a 1M NaCl solution (35,000 ppm or mg/l chloride ions).

Critical Crevice Corrosion Temperature (CCT) is obtained by laboratory tests according to ASTM G 48 Method F

For a more detailed description of their corrosion resistance properties in different environments, see the Outokumpu Corrosion Handbook.

## Mechanical properties

The mechanical properties of Moda 410L/4003 make it an attractive choice for applications where high strength and stiffness is desired. The engineering properties are on par with carbon steels. As opposed to many other ferritic steels it retains its toughness, even when welded, at temperatures below the freezing point. Outokumpu uses European Standard EN 10088 when applicable. The permitted design values may vary between product forms. The appropriate values are given in the relevant specification.

Cold rolled coil and sheet	R <sub>p0.2</sub> MPa	R <sub>p1.0</sub> MPa	R <sub>m</sub> MPa	Elongation <sup>1)</sup> %	Impact strength J	Rockwell	HB	HV
<b>Typical (thickness 1 mm)</b>	<b>355</b>	<b>375</b>	<b>525</b>	<b>45</b>				
ASME II A SA-240	≥ 280		≥ 450			≤ 88HRB	≤ 180	
ASTM A240	≥ 280		≥ 450			≤ 88HRB	≤ 180	
EN 10088-2	≥ 280		450 - 650	≥ 20				
EN 10088-4	≥ 280		450 - 650	≥ 20				

Hot rolled coil and sheet	R <sub>p0.2</sub> MPa	R <sub>p1.0</sub> MPa	R <sub>m</sub> MPa	Elongation <sup>1)</sup> %	Impact strength J	Rockwell	HB	HV
<b>Typical (thickness 4 mm)</b>	<b>380</b>	<b>405</b>	<b>510</b>	<b>25</b>			<b>185</b>	
EN 10088-2	280 - 650		450 - 650					
EN 10088-4	280 - 650		450 - 650					

Hot rolled quarto plate	R <sub>p0.2</sub> MPa	R <sub>p1.0</sub> MPa	R <sub>m</sub> MPa	Elongation <sup>1)</sup> %	Impact strength J	Rockwell	HB	HV
<b>Typical (thickness 15 mm)</b>	<b>360</b>	<b>430</b>	<b>570</b>	<b>28</b>				

EN 10028-7	$\geq 280$		450 - 650					
EN 10088-2	$\geq 280$		450 - 650					
EN 10088-4	$\geq 280$		450 - 650					

<sup>1)</sup>Elongation according to EN standard:

A<sub>80</sub> for thickness below 3 mm.

A for thickness = 3 mm.

Elongation according to ASTM standard A<sub>2</sub><sup>\*</sup> or A<sub>50</sub>.

# Physical properties

Data according to 10088

Density	Modulus of elasticity	Thermal exp. at 100 °C	Thermal conductivity	Thermal capacity	Electrical resistance	Magnetizable
kg/dm <sup>3</sup>	GPa	10 <sup>-6</sup> /°C	W/m°C	J/kg°C	μΩm	
7.7	220	10,4	25	430	0.60	Yes

## Fabrication

### Forming

The formability of Moda 410L/4003 is comparable to many high-quality carbon steels. It is well suited for standard cold forming operations like bending, flanging, and drawing, but has limited stretch formability. When performing demanding forming operations, it might be necessary to perform drawing in several steps with intermediate annealing.

### Machining

Moda 410L/4003 is relatively easy to machine. Compared to austenitic grades, it has lower tendency to form edges, which gives a larger machining window. Since the machinability is comparable to that of structural carbon steels, the same recommendations regarding choice of tool, cutting speed, and cutting feed can be used.

### Welding

Moda 410L/4003 has good weldability and can be welded using the common fusion and resistance welding methods. Conventional welding methods like MMA, MIG, MAG, TIG, SAW, LBW, or RSW – except gas welding – are applicable. Austenitic 19 9 L (308L) or 13 Cr filler metals can be used.

The low-chromium product Moda 410L/4003 is essentially a low-carbon lath martensitic in the as-welded condition, which is preferred. The high austenite content restricts the grain coarsening efficiently, while lath martensite prevents sensitization by preventing chromium carbide precipitation. Due to its excellent toughness properties in the as-delivered and as-welded conditions, Moda 410L/4003 is the most suitable product for structural use and is included in Eurocode 3. Shielding gases should be Ar/He based, mixed with a maximum of 2% oxygen to improve the arc stability. Hydrogen and nitrogen additions are forbidden.

More detailed information concerning welding procedures can be obtained from the Outokumpu Welding Handbook, available from our sales offices.

# Standards & approvals

The most commonly used international product standards are given in the table below.

Standard	Designation
ASME SA-240M Code Sect. II. Part A	UNS S40977
ASTM A240/A240M	UNS S40977
EN 10028-7, PED 2014/68/EU	1.4003
EN 10088-2	1.4003
EN 10088-3	1.4003
EN 10088-4	1.4003

## Contacts & Enquiries

Contact your nearest sales office

[www.outokumpu.com/contacts](http://www.outokumpu.com/contacts)

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