

# Moda 409/4512

EN 1.4512, ASTM TYPE 409 / UNS S40900

## General characteristics

Moda 409/4512 is a weldable ferritic stainless steel with good oxidation resistance in dry air. This product is also available as low-carbon Moda 409L. Its corrosion resistance is limited in applications with increased corrosiveness. Because of its titanium alloying, Moda 409/4512 can be welded in all dimensions without becoming susceptible to intergranular corrosion. It is possible to use Moda 409/4512 in high-temperature applications, for instance in automotive exhaust systems, where it is often used to replace aluminium-coated carbon steel.

## Typical applications

- Automotive applications
- Industrial exhaust systems

## 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	0.30-3.58	12-1550	0.30-3.58	18-1550
2BB	Bright-pickled	0.30-3.50	30-1530	0.30-3.50	600-1530
2C	Cold rolled, heat treated	0.80-4.00	30-1500		
2D	Cold rolled, heat treated, pickled	0.40-5.00	30-1530	0.40-5.00	600-1530
2E	Cold rolled, heat treated, mech. desc. pickled	0.33-5.00	12-1530	0.33-5.00	18-1530
2G	Ground	0.40-3.00	30-1500	0.40-3.00	600-1500
2J	Brushed or dull polished	0.40-3.00	30-1500	0.40-3.00	600-1500
2R	Cold rolled, bright annealed	0.05-3.00	3-1325	0.30-3.00	350-1325
2S	Surface coated	0.40-3.00	50-1500		

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

Surface finish		Coil / Strip		Plate / Sheet	
		Thickness	Width	Thickness	Width
1C	Hot rolled, heat treated, not descaled	2.00-8.00	50-1530		
1D	Hot rolled, heat treated, pickled	3.00-6.36	30-1530	3.00-6.36	350-1524
1E	Hot rolled, heat treated, mech. desc.	4.50-5.00	50-1550		
1G	Ground	2.00-3.00	750-1530	1.50-3.00	750-1530
1U	Black hot rolled	2.00-8.00	50-1530		

## Chemical composition

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>0.2</b>			<b>Ti</b>
ASME II A SA-240	≤0.030	≤1.00	10.5-11.7	≤0.50		≤0.030	
ASTM A240							
EN 10088-2	≤0.030	≤1.0	10.5-12.5				
EN 10088-4	≤0.030	≤1.0	10.5-12.5				
IS 6911	≤0.030	≤1.00	10.5-11.7	≤0.50	≤0.30	≤0.030	

## Corrosion resistance

Moda 409/4512 has a significantly increased corrosion resistance compared to mild carbon steel in 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 reached usually with the help of adequate design, correct post-weld treatment, and regular cleaning during use (if applicable).

Moda 409/4512 exhibits greater resistance to wear than unalloyed structural steels, especially in corrosive environments.

Due to its titanium content, the risk of sensitization to intergranular corrosion is strongly reduced when compared to non-stabilized ferritic grades. Moda 409/4512 can be used in the temperature range in which chromium carbides would precipitate in non-stabilized ferritic grades. Its maximum service temperature in dry air is 600 °C. The presence of other corrosive compounds in the hot environment, like water or sulfur compounds, may reduce the maximum service temperature significantly.

Outokumpu Moda 409/4512 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 already occur at low temperatures. More detailed information on the corrosion properties of Moda 409/4512 can be found in the Outokumpu Corrosion Tables published in the Outokumpu Corrosion Handbook and on [Stainless Steel Finder](#).

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. The presence of corrosion-inhibiting or accelerating compounds like transition metal ions or organic compounds may influence the corrosion behavior of Moda 409/4512.

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

## Mechanical properties

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>255</b>	<b>275</b>	<b>425</b>					
ASME II A SA-240	≥ 170		≥ 380				≤ 179	
ASTM A240	≥ 170		≥ 380			≤ 88HRB	≤ 179	
EN 10088-2	≥ 220		380 - 560	≥ 25				
EN 10088-4	≥ 220		380 - 560	≥ 25				
IS 6911	≥ 170		≥ 380			≤ 88HRB	≤ 179	

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>350</b>	<b>365</b>	<b>445</b>	<b>35</b>				
EN 10088-2	≥ 220		380 - 560	≥ 25				
EN 10088-4	≥ 220		380 - 560	≥ 25				
IS 6911	≥ 170		≥ 380			≤ 88HRB	≤ 179	

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
IS 6911	≥ 170		≥ 380			≤ 88HRB	≤ 179	

<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> or A<sub>50</sub>.

## Physical properties

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	10,5	25	460	0.60	Yes

# Fabrication

## Forming

The formability of Moda 409/4512 is comparable to many high quality carbon steels. It is well suited for standard cold forming operations like bending, flanging, and drawing. This stabilized product is particularly suitable for deep drawing.

## Machining

Moda 409/4512 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 low-alloyed carbon steels, the same recommendations regarding choice of tool, cutting speed, and cutting feed apply.

## Welding

Moda 409/4512 has good weldability and can be welded with 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 ferritic 12 L Nb (409LNb) or 18 L Nb (430LNb) filler metals can be used.

Low interstitial levels and added stabilizer have made enormous improvements to the welding characteristics of ferritic grades. Heat input should be minimized to reduce the grain growth in the heat affected zone (HAZ). Titanium stabilization of Moda 409/4512 improves autogenously welded joints by refining the grain structure in the weld metal. Stabilization prevents chromium carbide precipitation, which could otherwise lead to sensitization embrittlement. Consequently, the stabilized grades are practically immune to intergranular corrosion in the as-welded condition.

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

Standard	Designation
ASME SA-240M Code Sect. II. Part A	TYPE 409 / UNS S40900
ASTM A240/A240M	TYPE 409 / UNS S40900
EN 10088-2	1.4512
EN 10088-4	1.4512
IS 6911, AMENDMENT NO. 2	ISS 409

## Contacts & Enquiries

Contact your nearest sales office

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

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