Austral Wright Metals
at the cutting edge

Austral Bronze Crane Copper Limited
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PRODUCT DATA SHEET

Grade 301L

SUS 301L

Stainless Steels

Grade 301L is an austenitic stainless steel widely used in high strength applications such as railway rolling stock. It is available at high strength levels, which may be comparable to quenched and tempered carbon steels. It has corrosion resistance similar to grade 304, the most common stainless steel, which is adequate for atmospheric corrosion service conditions without surface protection.

Grade 304L can be used as an alternative to 301L for applications requiring the LT, DLT or ST tempers. This grade has equivalent properties to 301L, and may be more readily available. Grade 304L is not available in the higher strength tempers.

The 'L' grades of stainless steel have a maximum carbon content of 0.03%. Restricted carbon effectively eliminates sensitisation in welding, which may otherwise occur due to precipitation of carbides after extended time at high temperature during welding. However, using 'L' grade is of little value at section sizes lighter than about 5 mm, as the maximum heat input which can be used in welding light sections does not cause sensitisation.

Chemical Composition (JIS G4305)

	Chromium	Nickel	Carbon	Nitrogen	Silicon	Manganese
Minimum	16.00 %	6.00 %	-	-	-	-
Maximum	18.00 %	8.00 %	0.03 %	0.20 %	1.00 %	2.00 %

Mechanical Properties (JIS G4305, augmented)

Temper	0.2% Proof Stress, Mpa		Tensile Strength, MPa		Elongation, %
	min	max	min	max	min
LT	220	390	520	-	45
DLT	345	485	690	865	40
ST	410	550	760	880	35
MT	550	690	860	1000	25
HT	760	930	950	1140	20

Equivalent Specifications

Country	Specification	Steel	Title
Japan	JIS G4305	SUS 301L	Cold rolled stainless steel plates, sheets and strip
USA	ASTM A666	No equivalent	Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
Europe	EN 10088-2	1.4318 X2CrNiN18-7	Stainless steels Part 2. Technical delivery conditions for sheet/plate and strip for general purposes.
Germany	DIN 5512.3	X2CrNiN18-7	Stainless steel flats for use in rail vehicle construction

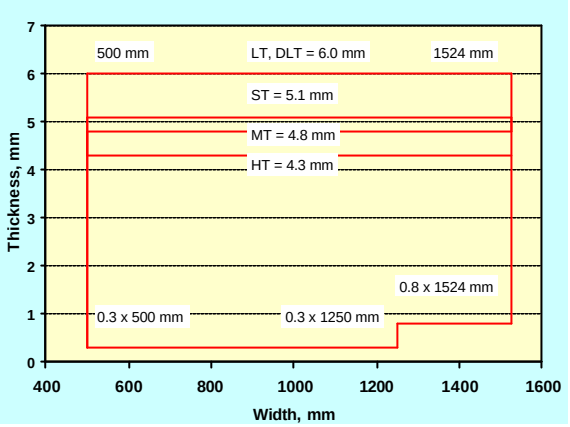
Product Forms Available: Coil, sheet, strip, hollow sections.

Standard Widths: 1219, 1250, 1200, 1524, 1500 mm (in order of preference)

Standard Thickness: This product is made to order, so there are no standards for thickness. However, tempers are made by cold rolling, so the thickness range available is restricted by the cold rolling mill capability. Maximum thickness is 6.0 mm for LT and DLT, 5.1 mm for ST, 4.8 mm for MT, 4.3 mm for HT temper.

At light gauges (<0.8 mm) there may be restrictions on the maximum width available.

Size Availability



Sizes outside this envelope may be available on enquiry.

Thickness Tolerance Product may be ordered either to nominal or to minimum thickness. The thickness tolerance for product ordered to nominal thickness is approximately +/- 5%. The actual tolerances are given in the following table. For product ordered to minimum thickness, the tolerance is approximately - zero + 10%, i.e. twice the tolerance in the following table. Product is also available with a restricted thickness tolerance of approximately half these values, and is designated ET.

	Width			
	Normal Tolerance		Restricted Thickness Tolerance (ET)	
Thickness, mm	Up to 1249 mm	1250 - 1524 mm	Up to 1249 mm	1250 - 1524 mm
0.30 - 0.59	+/- 0.05	+/- 0.08	+/- 0.04	NA
0.60 - 0.79	+/- 0.07	+/- 0.09	+/- 0.05	NA
0.80 - 0.99	+/- 0.09	+/- 0.10	+/- 0.06	+/- 0.07
1.00 - 1.24	+/- 0.10	+/- 0.12	+/- 0.07	+/- 0.08
1.25 - 1.59	+/- 0.12	+/- 0.15	+/- 0.08	+/- 0.10
1.60 - 1.99	+/- 0.15	+/- 0.17	+/- 0.10	+/- 0.11
2.00 - 2.49	+/- 0.17	+/- 0.20	+/- 0.11	+/- 0.12
2.50 - 3.14	+/- 0.22	+/- 0.25	+/- 0.12	+/- 0.13
3.15 - 3.99	+/- 0.25	+/- 0.30	+/- 0.13	+/- 0.15
4.00 - 4.99	+/- 0.35	+/- 0.40	NA	NA
5.00 - 5.99	+/- 0.40	+/- 0.45	NA	NA

Surface Finishes

Finish	Description
2B	Bright, moderately reflective finish resulting from temper rolling and/or skin passing after annealing and acid pickling. Note that the reflectivity increases as the temper increases, and as the thickness decreases. Only material of the same thickness and temper will match. This finish cannot be repaired with hand tools.
No 4	Polished finish produced by grinding with abrasive belts. After fabrication, this finish can be matched with hand tools to remove marks. The appearance of the finish is determined mainly by the abrasive grits used, and is approximately the same for all thicknesses and tempers. The finish is available for 0.7 to 2.0 mm thickness by up to 1524 mm width. This finish requires extra operations and is slightly more expensive than 2B.
Dull Finish	Matt, non-reflective decorative finish produced by finish rolling on rough rolls. Available in LT, DLT and ST tempers only. This finish cannot be repaired by hand tools. It has been used extensively for rail cars, including Tangarra and Millenium cars for State Rail Authority, NSW, Australia
Tempers	When not visible on the completed car, tempered material is generally supplied with the as-rolled finish. This is brighter than 2B finish. Only material of the same thickness and temper will match. This finish cannot be repaired with hand tools. Where the tempered material will be visible, and a matching appearance is required, dull finish should be used.

Metallurgical Description Grade 301L belongs to the most commonly used family of stainless steels, known as 18/8, which have an austenitic structure at room temperature. This group is resistant to atmospheric corrosion, and in atmospheric corrosion conditions in all but severe marine environments its clean appearance can be retained indefinitely with little maintenance. The steels are highly ductile and formable, and have very high toughness. Grade 301L is formulated to allow the generation of high strength levels by temper rolling to partially transform the structure to martensite. The small proportion of martensite is intimately mixed with the austenite matrix, and high strength levels at very high ductility can be achieved.

Grade 301L has been developed from grade 301, by restricting the carbon content to 0.03% or below. This ensures freedom from sensitisation of the heat affected zone of welds, a phenomenon that can result from carbide precipitation at higher carbon contents in welded heavy sections. Sensitisation can result in loss of corrosion resistance at grain boundaries, which in turn may result in stress corrosion cracking in some environments. However all grade 301 stainless steel supplied to the Australian Rail Industry before 1993 was the higher carbon grade 301, not 301L, and there have been no reported problems of sensitisation or stress corrosion cracking in service.

Grade 301L is available in a series of different tempers, of increasing strength. These tempers are achieved by increasing amounts of cold rolling reduction in the stainless steel mill, and the strength will be retained provided the steel is not heated to the annealing temperature, which is in excess of 600^{o}C. Such high temperatures will be encountered in all welding methods. Use of low heat input to minimise the volume of the softened heat affected zone retains much of the base metal strength in the structure, and spot welding is often used. Demonstration of the strength level achieved in a joint welded by spot welding or a fusion technique may be required by some design codes (e.g. ENV 1993-1-4:1996 Eurocode 3: Design of steel structures - Part 1-4: General rules - Supplementary rules for stainless steels).

The strengths achieved in each temper in 301L are slightly below those of grade 301, due to the reduced strengthening effect of the lower carbon level.

Welding

Grade 301L can be welded by spot and seam welding, and by most fusion techniques. Spot welding, gas metal arc (GMAW) and gas tungsten arc welding (GTAW) are in common use for the grade. (The latter two techniques are also known as MIG and TIG). There may be some strength loss of tempered material by annealing during welding, and procedure development may be required to retain full strength. Small welds of low heat input give narrow heat affected zones, which do not impair the strength of the structure.

Practices and procedures for welding of structures and railway equipment in stainless steels are detailed in:

AS/NZS 1554.6:1994 Welding stainless steels for structural purposes (Australian Standard)

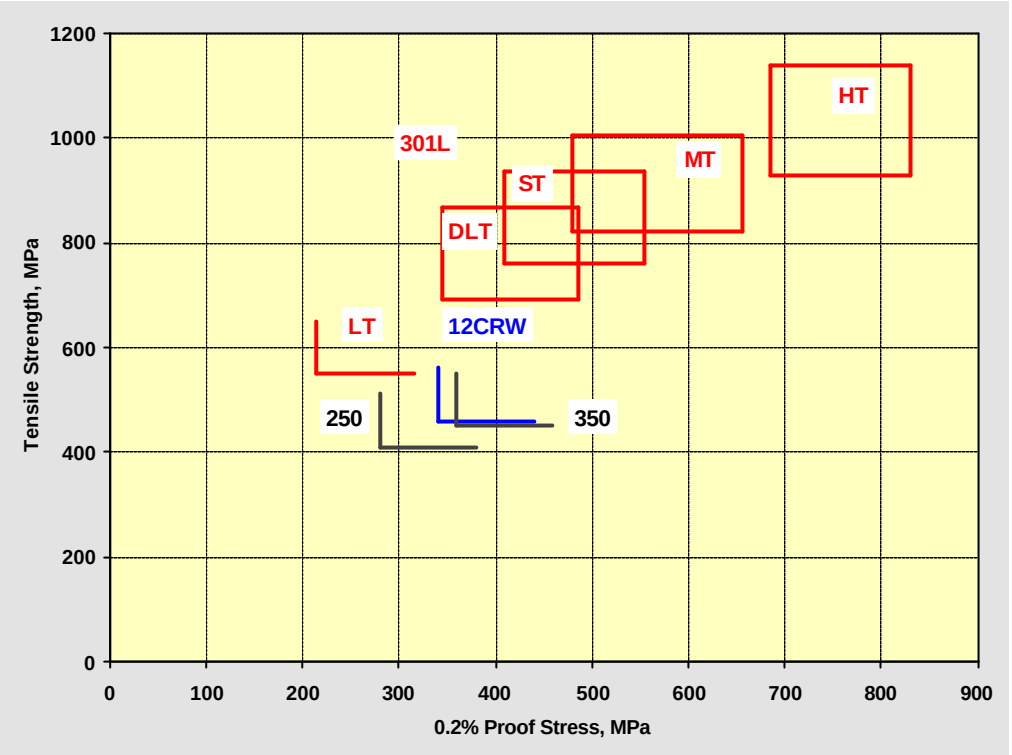
Manual of Standards and Recommended Practices, Mechanical Division, Association of American Railroads (AAR)

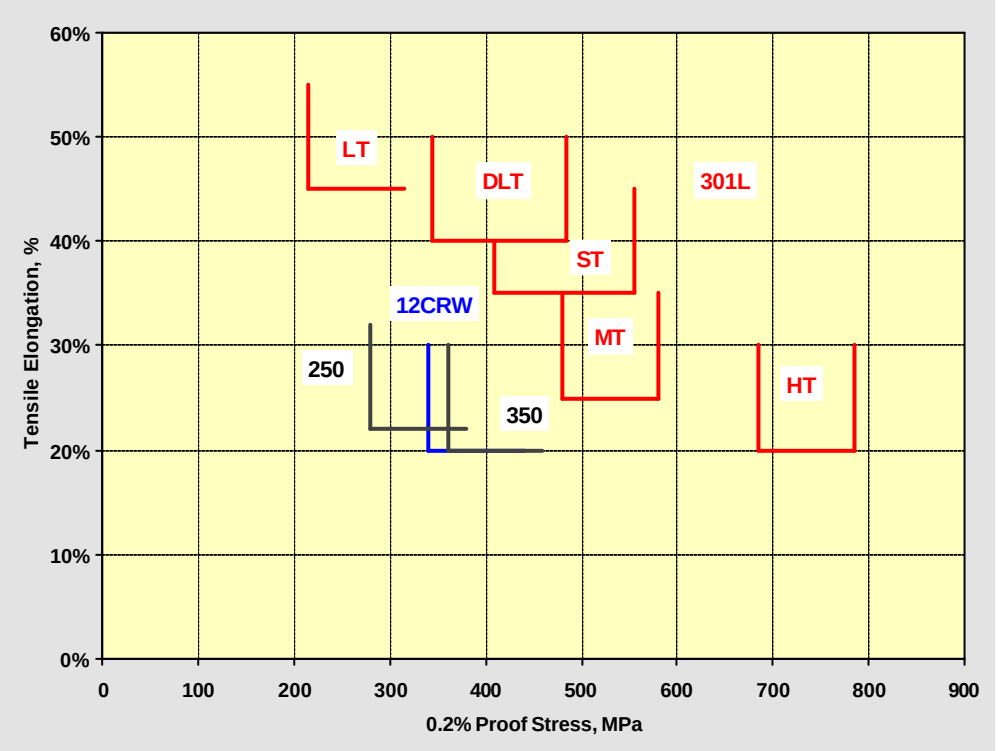
ANSI/AWS D1.1 Structural Welding Code - Steel (American Welding Society)

Physical Properties

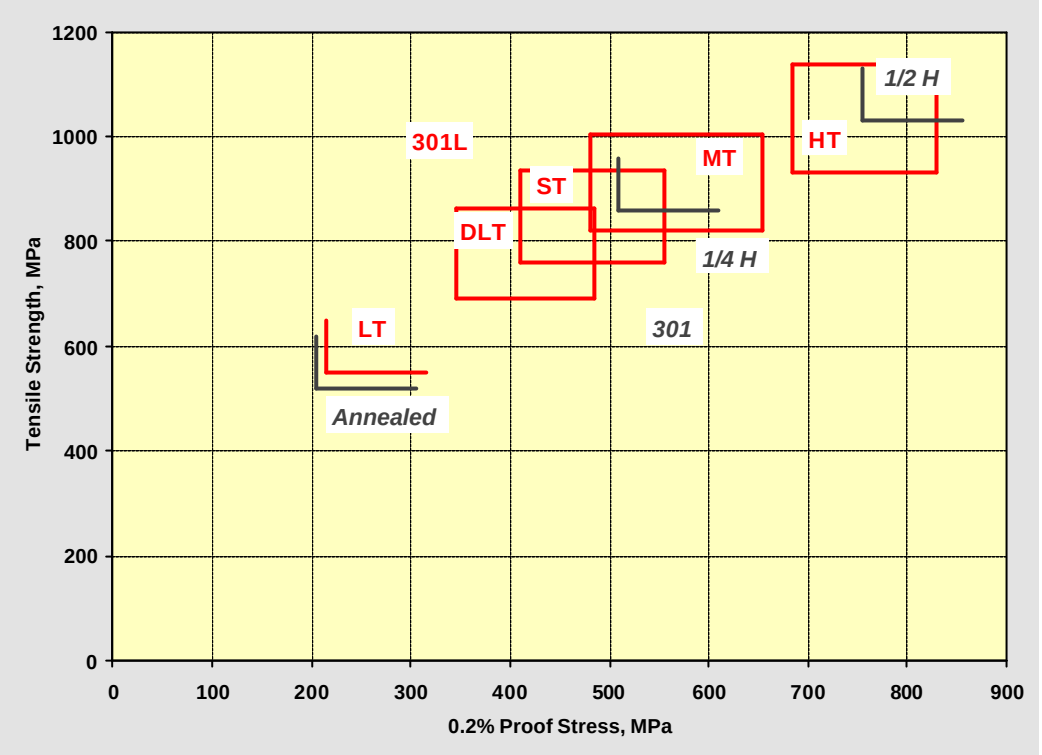
Property	Unit	Value
Density	Kg/m^3	7,900
Melting Range	^oC	1400 - 1450
Specific Heat	$J/kg.\ ^oC$	500
Curie Temperature	^oC	< -196
Relative Magnetic Permeability (annealed)		1.02
Coefficient of Expansion, 20-100^{o}C	$/\ ^oK$	16.0
Coefficient of Expansion, 20-300^{o}C	$/\ ^oK$	17.0
Coefficient of Expansion, 20-500^{o}C	$/\ ^oK$	18.0
Thermal Conductivity, 20^{O}C	$W/m\ .\ ^oK$	15
Electrical Resistivity, 20^{o}C	Micro ohm . m	0.73
Modulus of Elasticity, 20^{o}C	GPa	200
Shear Modulus, 20^{o}C	GPa	76.9
Poisson's Ratio		0.30

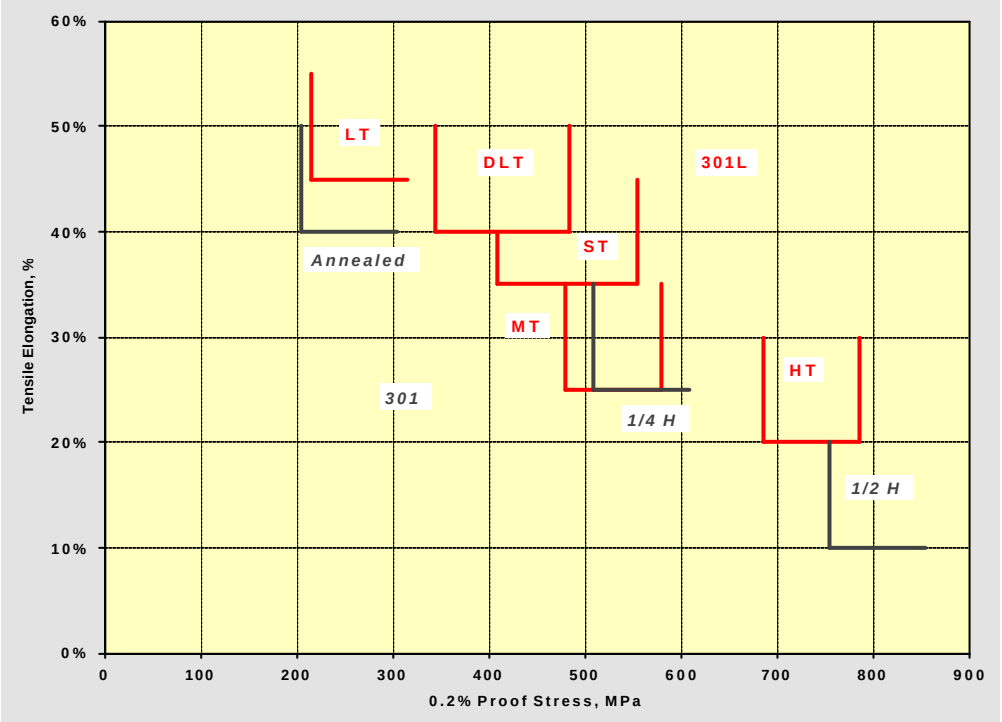
Tensile Properties of 301L compared to carbon steel and 12CRW





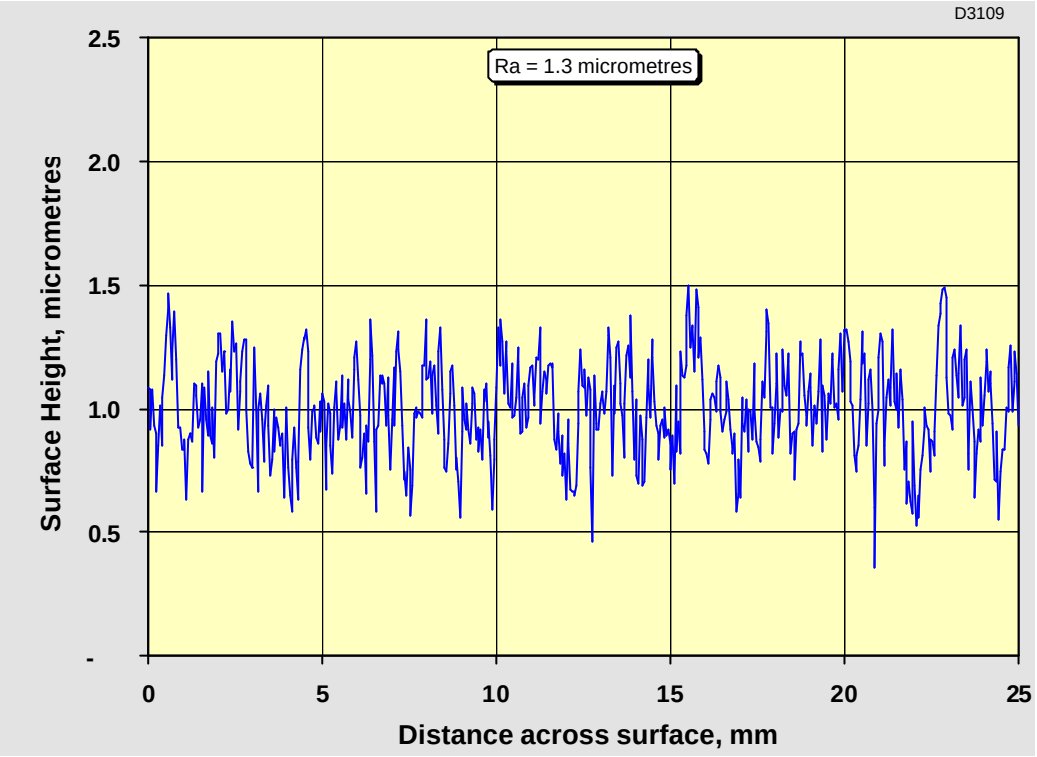
Tensile Properties of 301L compared to grade 301.





Typical Surface Roughness Traces from Dull Finish Material

(a) Longitudinal Direction



(b) Transverse Direction