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## **APPLICATION DATA SHEET**

## **Grade 445M2 For Architectural Applications**

## **Stainless Steels**

Grade **445M2** is a ferritic stainless steel specially formulated to give excellent corrosion resistance to the atmosphere, particularly marine atmospheres.

Grade **445M2** will give corrosion performance superior to the austenitic grade 316, the stainless steel usually used in marine atmospheres. It is suitable for roofing and cladding in areas where the environment is too severe for grade 316.



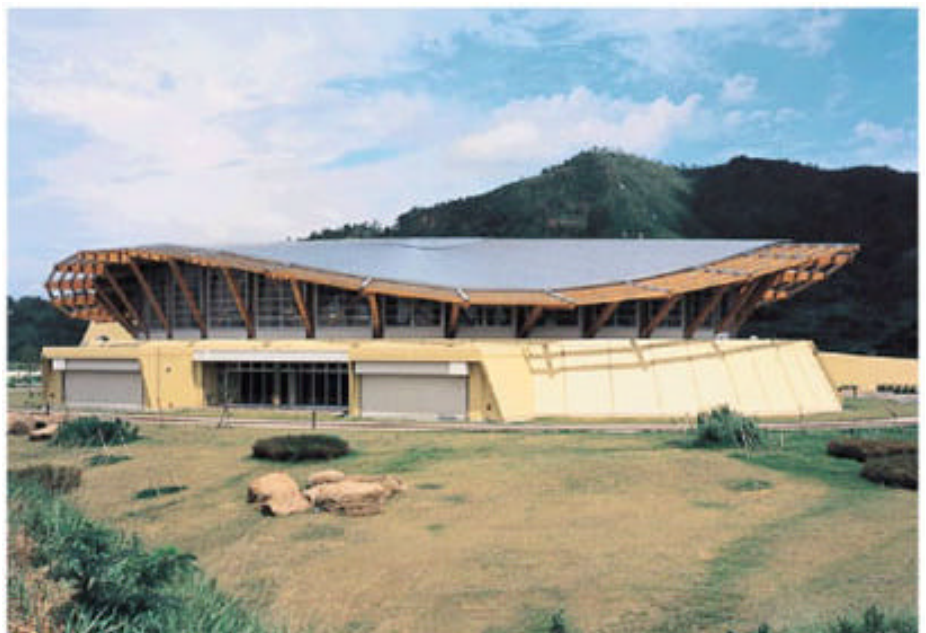
**Seibu Lions Baseball Dome** uses 350 tonnes (22,000 square metres) of 0.8 mm 445M2 with a 2DR finish. The dome is 64.5m high, and the diameter 223m.

Located in Saitama Prefecture, near Tokyo, not in a marine environment.

**Sata Day Hall, Kagoshima Prefecture,** southern Japan, uses 10 tonnes (3,200 square metres) of 0.4 mm 445M2 with a 2DR finish. Located in a sub tropical marine environment.

The hall is multipurpose, used for indoor sports and opera etc.

Winner of the 1996 Nikkei Business Publication Award.





**The Portal Building Development, Fortitude Valley, Brisbane.  
Grade 445M2 with a 2DR finish, roll formed to 'Longspan' profile.**

### **SAA HB39 – 1997 Installation Code for Metal Roofing and Wall Cladding**

Table 2.2.1: Minimum thickness of stainless steel box gutters or valley gutters (with width  $\leq 600\text{mm}$  and continuous support system), or eaves gutters (sole width  $\leq 200\text{ mm}$ , effective cross sectional area  $\leq 10,000\text{ mm}^2$ ) = **0.45 mm**

Minimum thickness of stainless steel eaves gutters (sole width  $\leq 200\text{ mm}$ , effective cross sectional area  $10,000 - 20,000\text{ mm}^2$ ) = **0.55 mm**

Table 2.3.1: Direct contact between cladding material and rainwater goods of stainless steel (300 series) and other metals is acceptable only for other stainless steels and for lead in mildly aggressive atmospheres (because the stainless steel will accelerate the corrosion of the other metal). Grade 445M2 has better corrosion performance than grades 304 and 316, so the warning of SAA HB39 to avoid contact with other metals is reinforced.

Table 2.3.2: Drainage from upper surfaces of other metals to a stainless steel (300 series) surface is acceptable. Grade 445M2 will also be safe to use with drainage from other metals.

There may be a problem with all stainless steels due to drainage from copper and its alloys, but this is unlikely to occur with properly designed systems which do not allow stagnant ponds of water to collect: this is a sound design principle with all stainless steels.

**Fasteners:** stainless steel, or ceramic or organic coated fasteners are recommended.

**PROPERTIES OF STAINLESS STEEL GRADES USED IN ARCHITECTURE****Typical Chemical Composition**

Grade	Group	C	Ni	Cr	Mo	Nb	Ti	Al	PRE*
445M2	Ferritic	0.01	-	22.1	1.20	0.23	0.19	0.09	26
444	Ferritic	0.01	-	18.1	2.2	0.25	-	-	25
304	Austenitic	0.05	8.3	18.2	0.25	-	-	-	19
316	Austenitic	0.04	10.7	17.0	2.1	-	-	-	24

\* - PRE = Pitting Resistance Equivalent = Cr% + (3.3 x Mo%)

**Physical Properties**

Property	Unit	Applicable Range	445M2	444	304	316
Density	Kg/m <sup>3</sup>	20°C	7,750	7,750	7,930	7,980
Modulus of Elasticity in tension	MPa	20°C	1,950	1,960	1,890	1,890
Specific heat	J/kg.°C	20°C	0.46 x 10 <sup>3</sup>	0.46 x 10 <sup>3</sup>	0.50 x 10 <sup>3</sup>	0.50 x 10 <sup>3</sup>
Mean Coefficient of Expansion	/°C	20 - 100°C	10.0 x 10 <sup>-6</sup>	10.4 x 10 <sup>-6</sup>	17.3 x 10 <sup>-6</sup>	16.0 x 10 <sup>-6</sup>
		20 - 300°C	10.5 x 10 <sup>-6</sup>	10.9 x 10 <sup>-6</sup>	18.8 x 10 <sup>-6</sup>	17.5 x 10 <sup>-6</sup>
		20 - 500°C	11.1 x 10 <sup>-6</sup>	11.3 x 10 <sup>-6</sup>	18.3 x 10 <sup>-6</sup>	18.0 x 10 <sup>-6</sup>
Thermal conductivity	W/m.°C	100°C	22.5	22.5	14.0	13.9
		500°C	22.6	22.6	18.4	18.4
Electrical Resistivity	? ? .m	20°C	0.60	0.62	0.72	0.74
Magnetism		20°C	Ferro magnetic	Ferro magnetic	Non magnetic	Non magnetic

**Typical Mechanical Properties**

Property	Unit	445M2			444	304			316	
Finish		2B	2D	2DR	2B	2B	2DR	2B	2DR	
Thickness	mm	1.0	0.8	0.4	1.0	1.0	0.4	1.0	0.4	
Yield Stress (0.2% Proof Stress)	MPa	350	345	385	350	265	260	315	320	
Tensile Strength	MPa	520	510	535	570	655	642	578	600	
Elongation	%	30	29	27	29	60	59	55	53	
Hardness	HV	170	166	178	173	159	164	154	156	

**Formability** (all 2B finish)

		445M2	444	304	316
Thickness	mm	1.0	1.0	0.8	0.8
Work hardening coefficient (n value)		0.18	0.21	0.50	0.50
Plastic deformation (r value)		1.307	1.340	1.033	1.033
Erichsen	mm	10.0	10.2	13.2	12.8
Ring forging ratio (Punched hole)		1.29	1.02	0.51	0.51

As a ferritic stainless steel, many of the properties and behaviour of **445M2** are more like carbon steel than the austenitic grades. Thermal expansion is similar to carbon steel, so the grade is better suited to long roofing spans where thermal cycling is less likely to distort the shape.

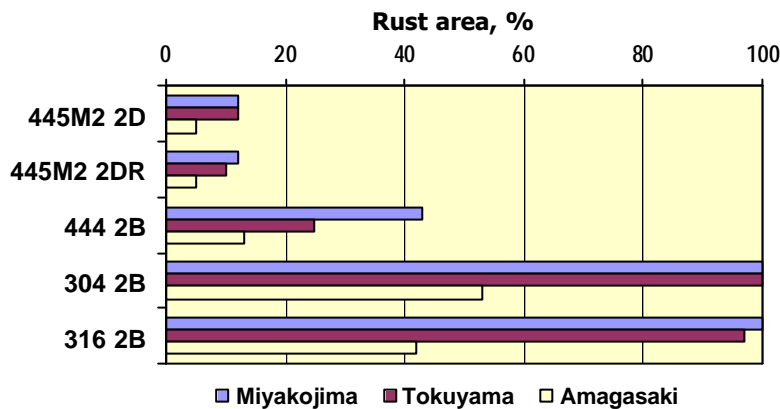
**445M2** has higher yield strength and lower tensile strength than the austenitic grades, and is slightly harder. It behaves in a similar way to grade 350 carbon steel or Zinalume G350 in forming operations such as bending and roll forming. It has a similar work hardening coefficient and hence springback after cold forming.

**CORROSION RESISTANCE**

The corrosion resistance of 445M2 is excellent. Atmospheric corrosion resistance is often measured by the Pitting Resistance Equivalent (PRE), see table of typical compositions. The PRE adds the beneficial effect of molybdenum (Mo) to the chromium (Cr) content, these two elements being the prime determinants of corrosion resistance.

The additions of niobium (Nb), titanium (Ti) and aluminium (Al) further improve the corrosion resistance in atmospheric applications, and suppress the loss of chromium from welds, retaining corrosion resistance after welding. For full corrosion resistance the visible welding oxide and low chromium layer must be removed by pickling and passivation.

**Natural exposure experience in marine environments**



Miyakojima: severe marine, subtropical (25°N), 1.5 km from Pacific Ocean

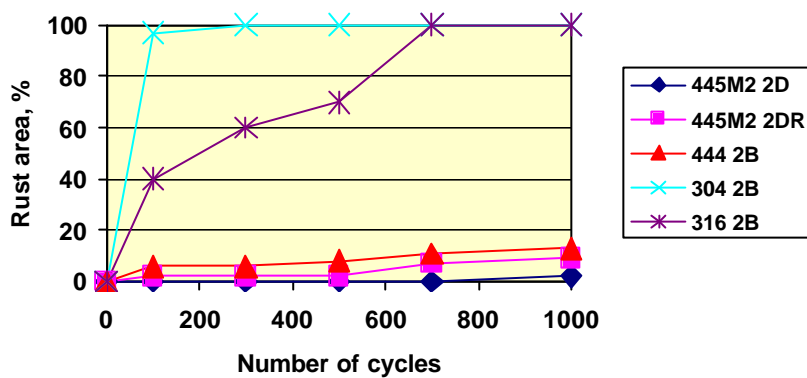
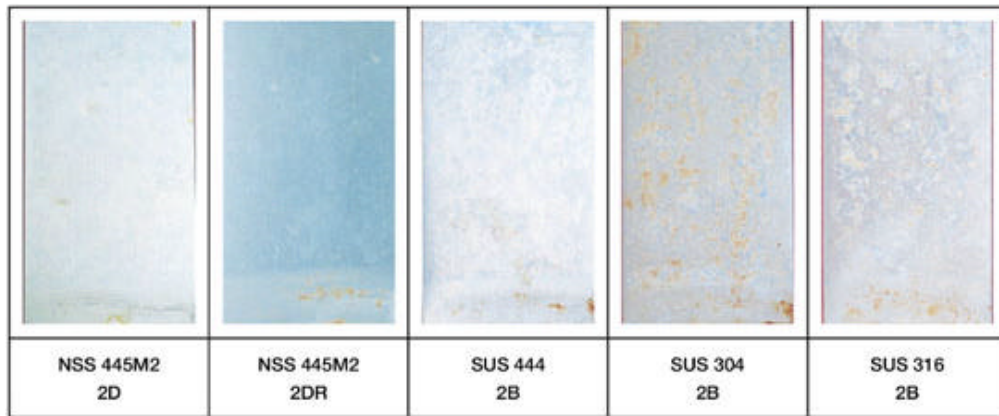
Tokuyama: marine industrial (34°N), 5 km from Japan Inland Sea

Amagasaki: marine industrial (34°N), 1.5 km from Japan Inland Sea (near Osaka & Kobe)

鋼種	素材	TIG溶接材
NSS 445M2 2DR		
SUS 444 2B		
SUS 304 2B		
SUS 316 2B		

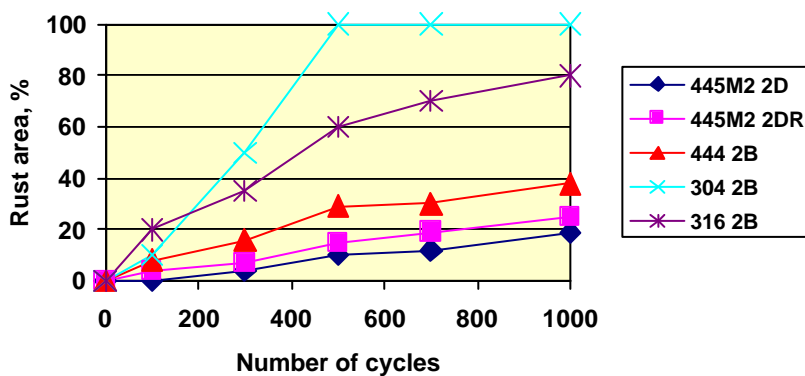
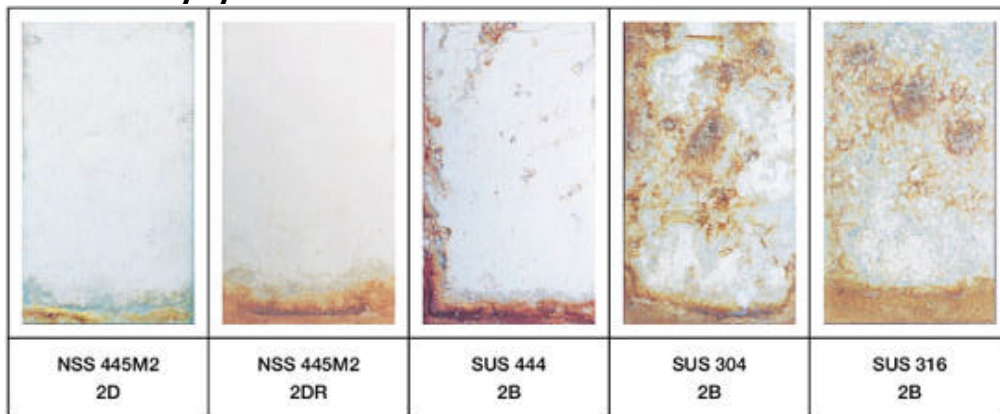
Appearance of parent sheet (left) and welds (right), which were exposed at Miyakojima for two years with the welding oxide untreated. Miyakojima has a highly aggressive severe marine subtropical atmosphere

Results of laboratory weather simulated corrosion tests



This accelerated test simulates an exposed roof by cycling between a salt spray, drying, washing with fresh water, then drying. It predicts rusting behaviour of material which is exposed and rain washed, or sheltered but maintained by regular washing.

Results of laboratory cyclic corrosion tests



This accelerated test simulates eaves, where salt particles are deposited and not washed away by rainwater. It predicts rusting behaviour of material which is sheltered but not maintained by regular washing.

**Welding**

**445M2** can be welded readily by GTAW (TIG) welding. It has an adequate but smaller window of acceptable welding current and speed than grade 316, but larger than grade the older ferritic grade 444. It is usually used in light gauges ( $\leq 1.6$  mm) to avoid the embrittlement endemic with welded ferritic stainless steels.



**Swimming Centre,  
Miyagi Prefecture,  
northern Japan.**

The roof uses 41 tonnes (13,000 square metres) of 0.4 mm 445M2 with a 2DR finish.

**Surface Finish**

445M2 is usually used in architectural applications with a 2DR finish. This is produced by skin pass rolling the strip with shot blasted rolls. The resulting surface is a uniform matt grey of low reflectivity. It does not show surface damage as the more reflective finishes do. The corrosion resistance is slightly worse than the smoother 2D finish, but 445M2 with a 2DR finish offers much better corrosion resistance than the other common grade/finish combinations used in architecture, especially N4 finish. Contact Austral Wright Metals for a sample of the finish.

**Cleaning Stainless Steel in Architectural Applications**

All materials will corrode in a sufficiently aggressive environment, but the corrosion rate of stainless steels is substantially less than that of carbon steel, usually at least 1,000 times slower. In architecture, regular cleaning will eliminate the cosmetic surface rusting referred to in the information above.

Cleaning is intended to remove deposits of salt resulting from drying of salt spray from the ocean. Salt is highly soluble, so water washing is usually adequate. If soiling with other materials develops, a detergent and water wipe with a soft cloth or high pressure blast will be needed. This should be followed with a water rinse.

The frequency of cleaning required will depend on the proximity to the source of salt and other pollutants. In most marine environments, quarterly to annual cleaning will be required. Where severe industrial pollution is present, this may need to be increased to monthly.

As a rule of thumb, the stainless should be washed at the same time as the windows.