NAW-TEN Ni-Added Advanced Weathering Steels

Any steel structure exposed to a corrosive environment, such as salt laden air, must be designed to provide optimum long term performance with a minimal level of normal maintenance. Conventional steel used in corrosive environments requires a protective coating to be applied in accordance with AS/NZS 2312. Conventional weathering steels develop a self-protective coat over time which inhibits corrosion; however, this is not effective enough for use in areas with airborne salts greater than 0.05mdd.

Advanced weathering steels with modified composition, including additional Nickel, produced by Nippon Steel Corporation can be used in coastal areas with airborne salts greater than 0.05mdd.

There are a number of advantages to using weathering steels:

- Initial cost saving through elimination of a protective coating (which should be balanced against the higher cost of the weathering steel itself);
- Reduced construction time;
- Reduced cost and time of maintenance over the length of the bridge life, including indirect costs arising from road and rail traffic delays;
- Environmental, (e.g. no repeated abrasive blasting or painting debris), health and safety benefits (e.g. access for maintenance can be difficult, may require rope qualified personnel);
- The weathered appearance of the bridge can be more suitable aesthetically.

Perhaps the most significant benefit is the reduction of maintenance costs and nil requirement for re-painting costs over the service life of the bridge, as illustrated below:



Fig. Life cycle cost for bridge constructed with painted conventional steel and bared weathering steel.



NAW-TEN Grades

Nippon Steel Corporation manufactures two grades of advanced Ni-added weathering steels with guaranteed weathering alloy index levels, the *v*-Values. The *v*-Value indicates the effect of the weathering properties of the steel on corrosion rate; the higher the *v*-Value, the more resistance to corrosion.

The applicability of **NAW-TEN** steel grades is dependent on evaluation of the environment of the site, including the concentration of deposited salt, degree of wetness, prevailing winds, topography, etc. As a general guideline, **NAW-TEN12** is most suitable for C3-C4 corrosion zones and **NAW-TEN15** for C4-C5 zones.

NAW-TEN Specification Tables

NAW-TEN complies to JIS G 3114 with the chemical components excluded and, as with JIS weathering steel, all mechanical properties are guaranteed. Steel plate sizes are similar to those for JIS weathering steel, a range is available for tensile strengths of 40 - 60 kilos.

Brand Name	Plate	Chemical Composition (%)							
	Thickness	С	Si	Mn	Р	S	Cu	Ni	Cr
NAW-TEN12 490	6≤t≤100	≤ 0.18	0.15 - 0.65	≤ 1.40	≤ 0.035	≤ 0.035	≤ 0.08	0.70 - 1.70	≤ 0.08
NAW-TEN12 570									
NAW-TEN15 490	6≤ t ≤ 100	≤ 0.18	0.15 - 0.65	≤ 1.40	≤ 0.035	≤ 0.035	≤ 0.08	2.50 - 3.50	≤ 0.08
NAW-TEN15 570									

Brand Name	Plate Thickness (mm)	<i>v</i> -Value	Mechanical Properties							
					Elongation		Impact Test V-notch			
			Yield Point (N/mm2)	Tensile Strength (N/mm2)	Thickness (mm)	Min. Elongation (%)	Temperature (deg. C)	Absorbed energy (J)		
NAW-TEN12 490	C + + + 100	≥1.20	\geq 365 (t \leq 16) \geq 355 (16 < t \leq 40) \geq 225 (40 < t \leq 75)	400 610	t≤16	15	-	27		
			$\geq 335 (40 < t \le 75)$ $\geq 325 (75 < t \le 100)$	490 - 610	40 < t	21	0	47		
NAW-TEN12 570	65 t 5 100		$\geq 460 (t \le 16)$ $\geq 450 (16 < t \le 40)$ $\geq 430 (40 < t \le 75)$ $\geq 420 (75 < t \le 100)$	570 - 720	t≤16 16 <t 40<t< td=""><td>19 26 20</td><td>-5</td><td>47</td></t<></t 	19 26 20	-5	47		
NAW-TEN15 490	≥ 6≤t≤100	≥1.50 6≤t≤100	 ≥ 365 (t ≤ 16) ≥ 355 (16 < t ≤ 40) > 225 (40 < t ≤ 75) 	400 610	t≤16	15	0	27		
			$\geq 325 (40 < t \le 75)$ $\geq 325 (75 < t \le 100)$	490 - 610	40 < t	21	U	47		
NAW-TEN15 570			$\geq 460 (t \le 16)$ $\geq 450 (16 < t \le 40)$ $\geq 430 (40 < t \le 75)$ $\geq 420 (75 < t \le 100)$	570 - 720	t≤16 16 <t 40<t< td=""><td>19 26 20</td><td>-5</td><td>47</td></t<></t 	19 26 20	-5	47		





NAW-TEN Connections - Welding & Bolting

For the construction of bridges and other structures made from **NAW-TEN** steel, both welding consumables and high strength bolts with matched chemical compositions are specified by Nippon Steel Corporation to prevent dissimilar metal galvanic corrosion in the weld, i.e. differing corrosion rates and appearances of weld metal to parent metal.

Table 1. Welding Consumables for Nippon Steel Corp.'s Ni-added Coastal Weathering Steels

Steel Material	Type of Steel (Tensile Strength)	Covered Arc Welding Electrode	Solid Wire	Flux Core	d Wire	Welding Material for Submerged Arc Welding	
		All Positions		All Positions	Fillet	Butt	Fillet
1%Ni type NAW-TEN 12	400-MPa class	N-11	YM-1N	SF-50WLN	-		NE 920 y
	490-MPa class					Y-204B	Y-204B
	570-MPa class	L-60S	YM-70C	SF-60T	-		
3%Ni type NAW-TEN 15	400-MPa class	CT-50N	YM-3N	SF-50WN	SM-50FWN	NF-320M x	
	490 MPa class					Y-3NI	NF-820 x T-3NI
	570 MPa class	CT-60N		SF-60WN	SM-60FWN	NB-55LM x Y-3NI	. 514

NAW-TEN weathering steels have been used to build structures and bridges in Japan for over 20 years and offer significant economic benefits with the reduced Life Cycle Costs.





Left, Hokuriku Bullet Train Railway Bridge on the coast, built with NAW-TEN15 in 2000. Above, Shimane Museum less than 5km from coast, built with NAW-TEN15 in 2006.

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