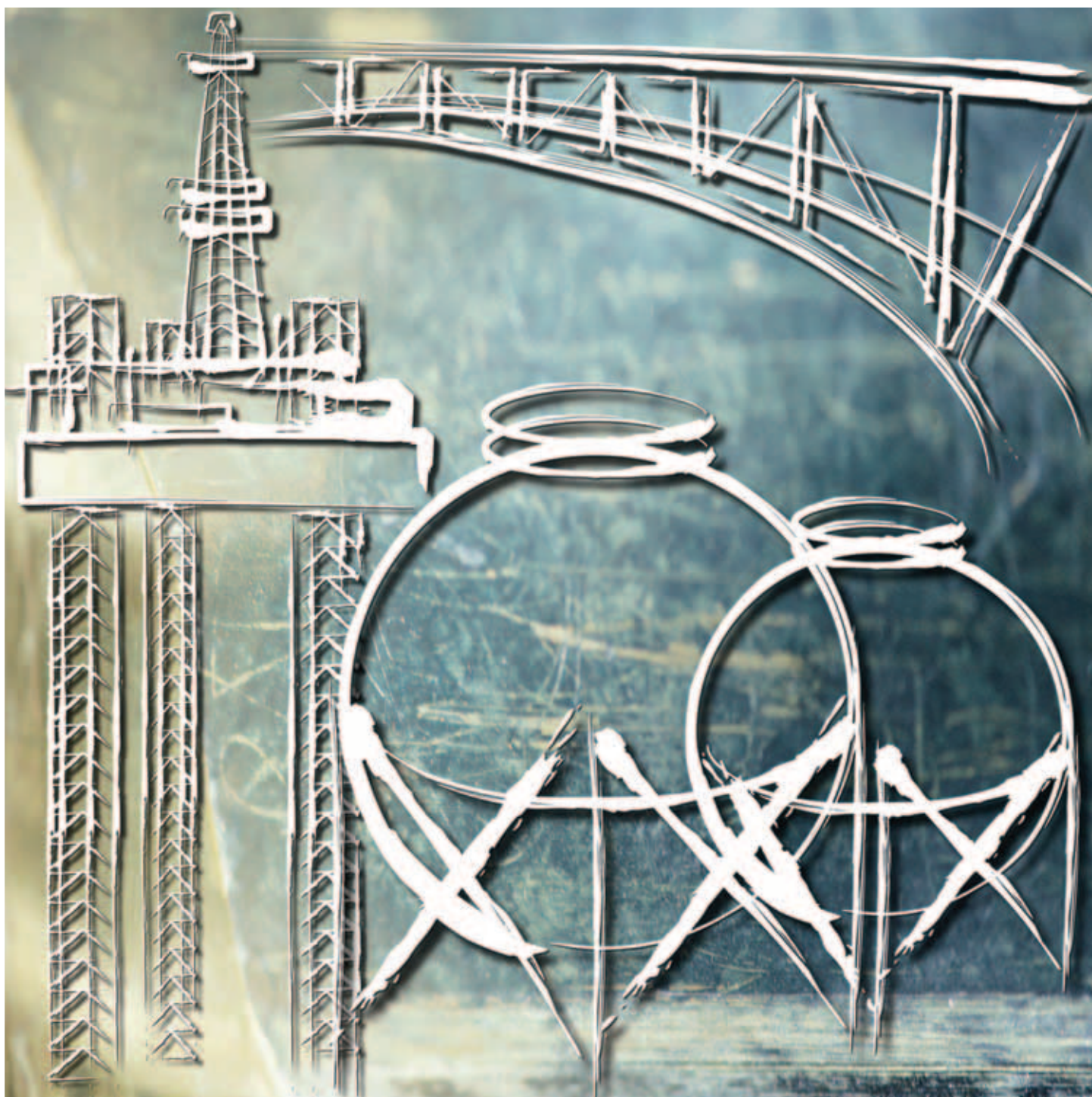




JFE

# JFE-HITEN

## HIGH STRENGTH STEEL PLATES



JFE Steel Corporation

# INTRODUCTION

In accordance with the technical evolution, structures or pressure vessels are becoming bigger, and more highly pressurized recently. To maintain the safety of those structures, consequently, customers have required high strength steel plates with good weldability and high toughness.

To meet the rapidly growing customer requirements, JFE Steel has developed wide range of high tensile strength steel plates such as 590~980N/mm<sup>2</sup> class, with their own special characteristics. These are called JFE-HITEN, and JFE Steel wins a popularity in the world.

These products are used in ships, storage tanks, spherical gas holders, pressure vessels, bridges, penstocks, machineries, off-shore structures, etc, and receive valuable reliance from customers.

So, JFE Steel introduces here the features and characteristics of JFE-HITEN series.

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▲ East Japan works (Keihin)



▲ West Japan works (Kurashiki)



▲ West Japan works (Fukuyama)

## JFE's High Tensile Strength Steel Plates (JFE-HITEN)

### High Strength

JFE-HITEN is low-alloyed high-strength steel plate manufactured by TMCP, or quenched and tempered. Because JFE-HITEN offers high strength, it results in a significant reduction in the weight of welded structures.

### Good Weldability

JFE-HITEN, of which chemical composition is controlled by specific procedure, offers low carbon equivalent and excellent weldability. JFE Steel also supplies welding materials suitable for JFE-HITEN effectively, and thereby enjoys acceptances by customers.

### Excellent Notch Toughness

JFE-HITEN offers high notch toughness because it is produced by closely controlling the chemical composition and heat treatment conditions. Application of JFE-HITEN ensures construction of structures providing high reliability against brittle fracture.

### Excellent Uniformity and Clean Surface

Rolled on the most modern plate mill under rigid quality control, JFE-HITEN has excellent uniformity in properties, flatness and surface finish. In addition, slab surfaces are carefully scarfed, powerful water jets are used during rolling, and non-oxidizing atmosphere furnaces are used for heat treatment. Consequently, JFE-HITEN has smooth, and clean surfaces.

### Good Workability

Because JFE-HITEN features good ductility, it offers not only good formability, but also good machinability, making it easy to drill and cut.

### Wide Range of Sizes

JFE-HITEN are available in widths of up to 5,350mm, and in lengths of up to 27,000mm, and then contributes to saving expenses.



# JFE'S HIGH TENSILE STRENGTH STEEL PLATE PRODUCTS SPECIFIED BY TYPICAL STANDARDS

Type of Steel		JIS	ASTM	EN	WES **	Ship's class Standard ***	JFE Standard
Steel Plates for Structural Use	590N/mm <sup>2</sup> Class	G3106 SM570 *	A678 Gr.C Gr.D A841		HW 450 HW 450CF	A47 D47 E47 F47	JFE-HITEN570U2 JFE-HITEN570E JFE-HITEN590S JFE-HITEN590SL JFE-HITEN590AZ JFE-HITEN590 JFE-HITEN590U2 JFE-HITEN590E
							HW 490 HW 490CF
	690N/mm <sup>2</sup> Class				HW 550 HW 620	A56 D56 E56 A63, 63N D63, 63N E63	JFE-HITEN690S JFE-HITEN690 JFE-HITEN690M JFE-HITEN710 JFE-HITEN710M
	780N/mm <sup>2</sup> Class	G3128 SHY685 SHY685N SHY685NS	A514 A709 Gr.100		HW 685	A70, 70N D70, 70N E70, 70N F70, 70N	JFE-HITEN780EX JFE-HITEN780S JFE-HITEN780LE JFE-HITEN780M
	980N/mm <sup>2</sup> Class				HW 885		JFE-HITEN980S JFE-HITEN980
Steel Plates for Pressure Vessels	590N/mm <sup>2</sup> Class	G3115 SPV450 G3124 SEV345	A537 Cl. 2 A738 Gr.B A841	EN10028 P460N	HW 450	KPV46	JFE-HITEN570U2 JFE-HITEN570E JFE-HITEN590 JFE-HITEN590U2 JFE-HITEN590E
							HW 490
	690N/mm <sup>2</sup> Class		A543 Cl. 1		HW 620		JFE-HITEN690M
	780N/mm <sup>2</sup> Class		A517 A543 Cl. 2		HW 685		JFE-HITEN780M
	980N/mm <sup>2</sup> Class				HW 885		JFE-HITEN980

JFE supplies high tensile strength steel plates based on JIS SM570 with high weldability, which are SM570TMC,

\* SM570TMC-LB, SM570-EX, SM570-EG respectively.

TMC : Produced by TMCP, with high weldability (JIS std.)

LB : Extremely Low carbon Bainite for excellent weldability with fully on-lined process

EX : With high weldability

EG : For high heat input welding

When ordered by WES Designation, corresponding JFE-HITEN approved by WES is applied. Please refer to details

\*\* on page18, "Approved or Authorized Products".

\*\*\* Ship's class society approval is shown on page18, "Approved or Authorized Products".

In case of application of the official specification, JFE steel grades are available depending on usages or characteristics.

Please consult with JFE.

# GRADES OF JFE-HITEN

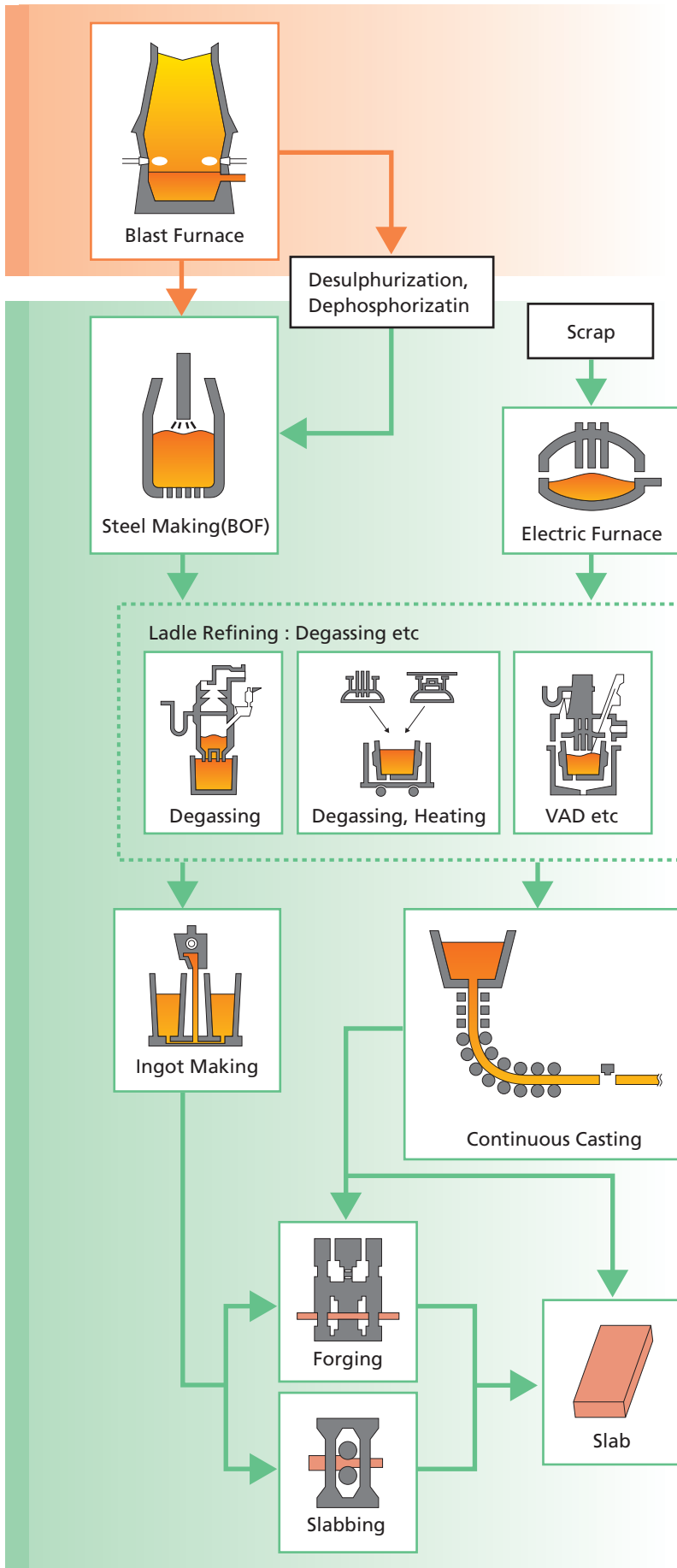
JFE-HITEN composes of various grades ranging widely in tensile strengths, corresponding to broad variety of usages. The grades and features of JFE-HITEN are shown as follows.

Besides the JFE-HITEN series, JFE Steel also produces high strength steel plates to both domestic and overseas specifications - ASTM, ASME, JIS, EN, etc. And thereby, addition or modifications of these standards for each grade can be made according to the customer's requirements. Please consult with JFE Steel.

Strength (N/mm <sup>2</sup> )	Designation	Thickness (mm)	Yield Strength Min. (N/mm <sup>2</sup> )	Tensile Strength (N/mm <sup>2</sup> )	Features and Typical Applications
590	JFE-HITEN590	6 ~ 150	450	590 ~ 710	For Bridges, Penstocks, Tanks, Offshore structures U2 : High Tensile Strength Steel Plates with High Weldability  E : High Tensile Strength Steel Plates with High Weldability for High Heat Input Welding
	JFE-HITEN610	6 ~ 150	490	610 ~ 730	
	JFE-HITEN570U2	6 ~ 100	450	590 ~ 710	
	JFE-HITEN590U2	6 ~ 75	450	590 ~ 710	
	JFE-HITEN610U2	6 ~ 75	490	610 ~ 730	
	JFE-HITEN570E	6 ~ 100	450	570 ~ 700	
	JFE-HITEN590E	6 ~ 75	450	590 ~ 710	
	JFE-HITEN610E	6 ~ 75	490	610 ~ 730	
	JFE-HITEN590S	6 ~ 40	450	590 ~ 710	
	JFE-HITEN590SL	6 ~ 50	450	590 ~ 710	
690	JFE-HITEN690	6 ~ 100	590	690 ~ 820	Ni-free type for Tanks, Offshore Structures etc.  Ni type and Low carbon-equivalent for Bridges, Penstocks, Tanks, etc.  With reducing alloying elements and without Heat Treatment, for Civil Engineering and Industrial Machinery
	JFE-HITEN710	6 ~ 100	620	710 ~ 840	
	JFE-HITEN690M	6 ~ 100	590	690 ~ 820	
	JFE-HITEN710M	6 ~ 100	620	710 ~ 840	
	JFE-HITEN690S	6 ~ 25	550	690 ~ 830	
780	JFE-HITEN780M	6 ~ 150	685	780 ~ 930	Ni type and Low Carbon-equivalent for Bridges, Penstocks, Offshore structures etc.  High Performance with Relaxing Pre-heating for Bridges  Reducing alloying elements for Civil Engineering and Industrial Machinery  High Weldability and excellent toughness at low temperature (-40 C), for Civil Engineering and Industrial Machinery
	JFE-HITEN780EX	6 ~ 60	685	780 ~ 930	
	JFE-HITEN780S	6 ~ 160	685	780 ~ 930	
	JFE-HITEN780LE	6 ~ 32	685	780 ~ 930	
980	JFE-HITEN980	6 ~ 120	885	950 ~ 1130	High Strength, High Weldability and Good Toughness for Penstocks  For Civil Engineering and Industrial Machinery
	JFE-HITEN980S	6 ~ 50	885	950 ~ 1130	

Note: Chemical compositions described in this catalogue are values by ladle analysis.

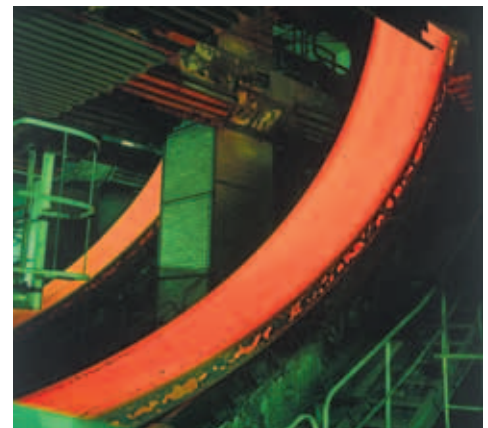
# MANUFACTURING PROCESS



Blast furnace



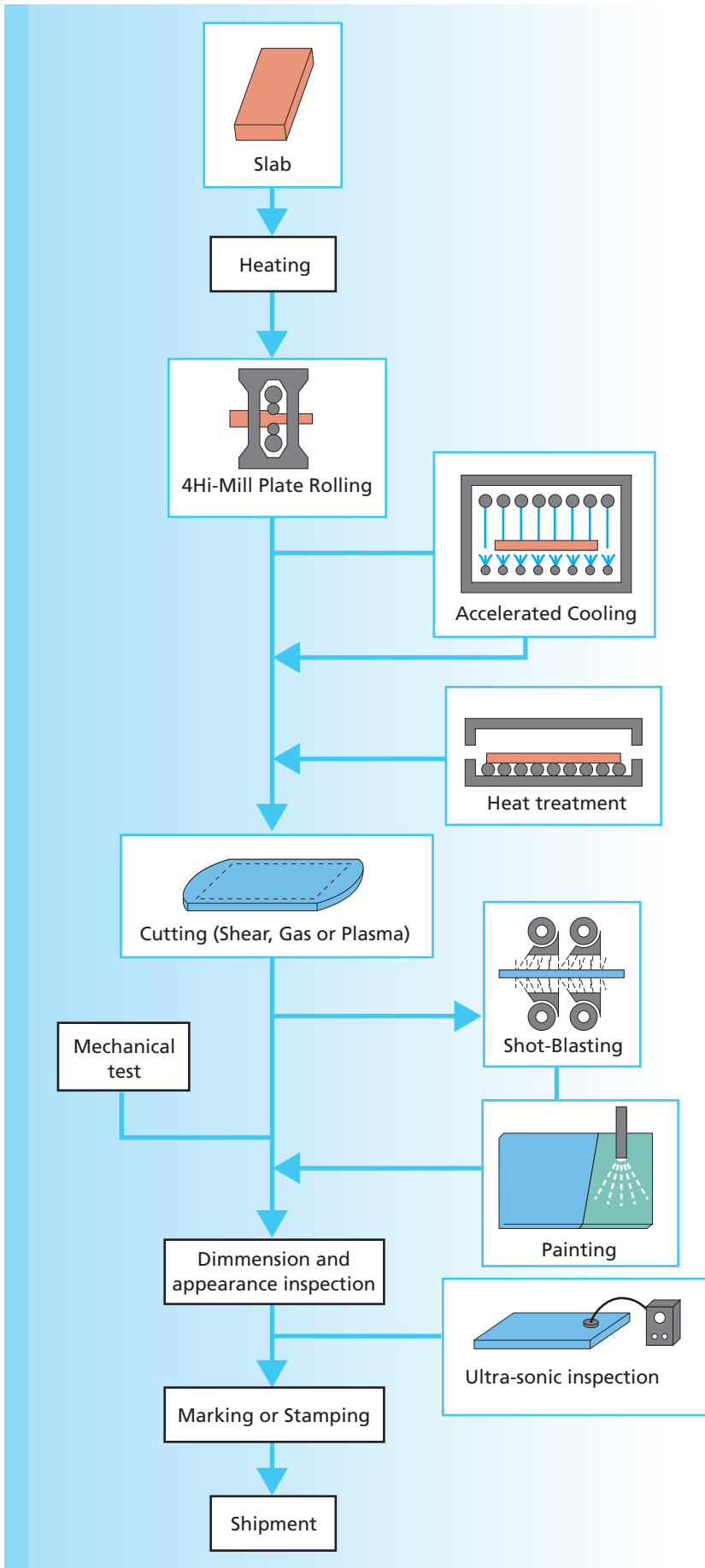
Oxygen converter



Continuous casting machine



6000t Forging press



Rolling Mill



Super-OLAC



Heat treatment system

# AVAILABLE SIZES

## Without Heat Treatment

Thickness mm	Width mm	Product Length : m																																			
		1000 ~ 1400	1401 ~ 1600	1601 ~ 1800	1801 ~ 2000	2001 ~ 2200	2201 ~ 2400	2401 ~ 2600	2601 ~ 2800	2801 ~ 3000	3001 ~ 3200	3201 ~ 3400	3401 ~ 3600	3601 ~ 3800	3801 ~ 4000	4001 ~ 4200	4201 ~ 4400	4401 ~ 4600	4601 ~ 4800	4801 ~ 5000	5001 ~ 5200	5201 ~ 5300	5301 ~ 5350														
6.0 ~ 6.9																	22	22	19	16	13.5	13.5															
7.0 ~ 9.0																	25		22	20	16	13.5	13.5														
9.1 ~ 11.9																			20	20	20	16															
12.0 ~ 13.9																					22	16															
14.0 ~ 25.0																					25	16															
25.1 ~ 28.0																	27		25		16																
28.1 ~ 32.0																			25		24	23	20	16													
32.1 ~ 38.0																			25		24	23	22	21	20	19	18	16									
38.1 ~ 45.0																			24	23	23	20	19	19	18	17	16	16	16								
45.1 ~ 50.0																	25		23	22	21	20	20	18	17	16	16	15	14	14	14						
50.1 ~ 55.0																			24	24	21	21	20	19	18	18	16	16	15	14	14	13	13	13			
55.1 ~ 60.0																			24	22	21	19	19	17	16	16	15	14	13	13	12	12	12	11			
60.1 ~ 65.0																			24	23	21	20	18	18	17	16	15	15	14	13	12	12	11	11	10	9.5	
65.1 ~ 70.0																			24	24	22	21	19	18	17	16	15	14	14	13	12	12	11	11	10	10	9.5
70.1 ~ 75.0		24	23	24	23	21	20	18	17	15	15	15	14	13	13	12	11	11	10	10	9.2	9	8.5	Not Available													
75.1 ~ 80.0		23	23	22	21	21	19	18	17	15	14	14	13	12	12	11	11	10	10	9.6	9.2	9	8.5														
80.1 ~ 90.0		20	20	20	19	19	17	16	15	14	13	12	11	11	10	10	9.7	9.2	8.8	8.5	8.2	8	7.5														
90.1 ~ 100.0		18	18	18	17	17	15	14	13	12	11	11	10	10	9.6	9.1	8.7	8.3	8	7.6	7.3																
100.1 ~ 110.0		16	16	16	16	15	14	13	12	11	10	10	9.7	9.1	9	8.3	8	7.6	7.2	7	6.7	5.8															
110.1 ~ 120.0		15	15	15	14	14	13	12	11	10	10	9.4	8.8	8.4	8	7.6	7.2	6.9	6.6	6	6																
120.1 ~ 130.0		14	14	14	13	13	12	11	10	9.8	9.2	8.6	8.2	7.7	7.3	7.0	6.7	6.0	6	6	5.1	5.3															
130.1 ~ 140.0		13	13	13	12	12	11	10	9.7	9	8.5	8	7.5	7.1	7	6	6	5.1	5.1	5.1	5.3																
140.1 ~ 150.0		12	12	12	11	11	10	9.7	9.1	8.4	7.9	7.4	7	6.7	6	6	5	5	5																		

- 1 In case of the diagonal-lined column  $\begin{matrix} A \\ \diagdown \\ B \end{matrix}$ , 'A' shows the maximum product length. And the product length between 'B' and 6.1m can not be provided.
- 2 The minimum product size is as follows ; 1 m wide and 3m long.
- 3 Please consult with JFE prior to ordering the product width between 5,201 and 5,350 mm.

# Heat Treated

Product Length : m

Thickness mm	Width mm	1000	1601	1801	2001	2201	2401	2601	2801	3001	3201	3401	3601	3801	4001	4201	4401	4601	4801	5001	5201	5301
		~ 1600	~ 1800	~ 2000	~ 2200	~ 2400	~ 2600	~ 2800	~ 3000	~ 3200	~ 3400	~ 3600	~ 3800	~ 4000	~ 4200	~ 4400	~ 4600	~ 4800	~ 5000	~ 5200	~ 5300	~ 5350
6.0 ~ 6.9											22	20	15	13	Not Available							
7.0 ~ 7.9												24	22	20	15	Not Available						
8.0 ~ 8.9													22	18	16	13	11	Not Available				
9.0 ~ 9.9															22	20	16	12	Not Available			
10.0 ~ 11.9																			22	20	18	Negotiable Range
12.0 ~ 13.9																					22	
14.0 ~ 26.0										25												
26.1 ~ 28.0																						
28.1 ~ 30.0																			24	24	22	
30.1 ~ 35.0															24	24	23	22	21	21	20	
35.1 ~ 40.0													24	23	22	21	20	19	18	18	17	
40.1 ~ 45.0												23	22	20	19	19	18	17	16	16	15	
45.1 ~ 50.0										23	22	20	19	18	17	17	16	15	15	14	14	
50.1 ~ 60.0					24	24	22	20	19	18	17	16	15	14	14	13	13	12	11	11		
60.1 ~ 70.0		23	20	24	22	20	19	17	16	15	14	14	13	12	12	11	11	10	10	10		
70.1 ~ 80.0	22	20	18	21	19	18	16	15	14	13	13	12	11	11	10	10	9.7	9.3	8.9	8.7		
80.1 ~ 90.0	20	18	16	19	17	16	14	13	13	12	11	10	10	9.8	9.4	8.9	8.5	8.3	7.9			
90.1 ~ 100.0	18	16	14	17	15	14	13	12	11	10	10	9.8	9.3	8.8	8.4	8.0	7.7	7.3	7.0			
100.1 ~ 110.0	16	14	13	15	14	13	12	11	10	9.9	9.4	8.8	8.4	8.0	7.6	7.3	6.9 / 6.0	6.6 / 5.7	6.4 / 5.5			
110.1 ~ 120.0	15	13	12	14	13	11	11	10	9.7	9.1	8.5	8.1	7.7	7.3	6.9 / 6.0	6.6 / 5.7	6.3 / 5.8	5.2				
120.1 ~ 130.0	13	12	11	13	11	11	10	9.5	8.9	8.3	7.9	7.3	7.0	6.7	6.4 / 5.5	5.2	5.0					
130.1 ~ 140.0	11	10	9.7	11	10	9.7	9.4	8.7	8.2	7.7	7.2	6.8	6.5 / 5.6	5.3	4.8	Not Available						
140.1 ~ 150.0	10	10	9.6	10	9.7	9.4	8.7	8.1	7.6	7.1	6.7	6.4 / 5.5	5.2	4.9	Not Available							

- 1 In case of the diagonal-lined column  $\begin{matrix} A \\ \diagdown \\ B \end{matrix}$ , 'A' shows the maximum product length. And the product length between 'B' and 6.1m can not be provided.
- 2 The minimum product size is as follows ; 1 m wide and 3m long.
- 3 Please consult with JFE prior to ordering the product width between 5,201 and 5,350 mm.



# JFE-HITEN STANDARDS

## JFE-HITEN590, 690 Series

These series are suitable for a wide range of applications, such as bridges, cylindrical or spherical storage tanks, machine structures etc. By adding alloying elements to the Si-Mn based compositions depending on plate thickness, the carbon equivalent is kept low to improve weldability. Among these, 'M' series are

designed to lower carbon equivalent, resulting in high weldability and low temperature toughness, and therefore, can be applied for construction of penstocks or offshore structures in low temperature regions.

Designation (Thickness mm)	Heat Treatment	Chemical Composition(%)											Tensile Test*1)						Bending Test (180°)*2)		Charpy Impact Test (2mmV)*3)					
		C	Si	Mn	P	S	Cu	Ni	Cr	Mo	V	B	Thickness (mm)	Ceq	PCM	Yield Point or Proof		Tensile Strength (N/mm <sup>2</sup> )	Elongation		Bending Radius		Test Temperature		Absorbed Energy (J)	
																Thickness (mm)	Stress (N/mm <sup>2</sup> )		Thickness (mm)	(%)	Test Specimen	Thickness (mm)	Test Specimen No.1	Thickness (mm)		(°C)
JFE-HITEN590 (6~150)	QT	≤0.16	0.15/0.55	≤1.50	≤0.025	≤0.015	≤0.30	≤1.00	≤0.30	≤0.30	≤0.08	-	t ≤ 50 50 < t ≤ 75 75 < t	≤0.44 ≤0.46 ≤0.48	≤0.26 ≤0.28 ≤0.28	-	≥450	590/710	t ≤ 16 16 < t ≤ 50 20 < t	≥20 ≥28 ≥20	No.5 No.5 No.4	-	1.5t	12 < t	-10	≥47
JFE-HITEN610 (6~150)	QT	≤0.16	0.15/0.55	≤1.50	≤0.025	≤0.015	≤0.30	≤1.00	≤0.30	≤0.30	≤0.08	-	t ≤ 50 50 < t ≤ 75 75 < t	≤0.45 ≤0.47 ≤0.49	≤0.26 ≤0.28 ≤0.28	t ≤ 75 75 < t	≥490 ≥470	610/730	t ≤ 16 16 < t ≤ 50 20 < t	≥19 ≥27 ≥19	No.5 No.5 No.4	-	1.5t	12 < t ≤ 32 32 < t	-10 -15	≥47 ≥47
JFE-HITEN690 (6~100)	QT	≤0.16	≤0.35	≤1.20	≤0.025	≤0.015	≤0.40	≤1.00	≤0.70	≤0.50	≤0.08	≤0.005	t ≤ 50 50 < t	≤0.54 ≤0.58	-	t ≤ 75 75 < t	≥590 ≥570	690/820	t ≤ 16 16 < t ≤ 50 20 < t	≥17 ≥25 ≥17	No.5 No.5 No.4	t ≤ 32 32 < t	1.5t 2.0t	12 < t ≤ 32 32 < t ≤ 50 50 < t	-15 -20 -30	≥47 ≥47 ≥47
JFE-HITEN710 (6~100)	QT	≤0.16	≤0.35	≤1.20	≤0.025	≤0.015	≤0.40	≤1.00	≤0.70	≤0.50	≤0.08	≤0.005	t ≤ 50 50 < t	≤0.55 ≤0.59	-	t ≤ 75 75 < t	≥620 ≥600	710/840	t ≤ 16 16 < t ≤ 50 20 < t	≥17 ≥25 ≥17	No.5 No.5 No.4	t ≤ 32 32 < t	1.5t 2.0t	12 < t ≤ 32 32 < t ≤ 50 50 < t	-15 -20 -30	≥47 ≥47 ≥47
JFE-HITEN690M (6~100)	QT	≤0.14	≤0.35	≤1.20	≤0.015	≤0.015	≤0.40	0.30/1.30	≤0.70	≤0.50	≤0.05	≤0.005	t ≤ 50 50 < t	≤0.53 ≤0.57	-	t ≤ 75 75 < t	≥590 ≥570	690/820	t ≤ 16 16 < t ≤ 50 20 < t	≥17 ≥25 ≥17	No.5 No.5 No.4	t ≤ 32 32 < t	1.5t 2.0t	12 < t ≤ 32 32 < t ≤ 50 50 < t	-15 -20 -30	≥47 ≥47 ≥47
JFE-HITEN710M (6~100)	QT	≤0.14	≤0.35	≤1.20	≤0.015	≤0.015	≤0.40	0.30/1.30	≤0.70	≤0.50	≤0.05	≤0.005	t ≤ 50 50 < t	≤0.53 ≤0.57	-	t ≤ 75 75 < t	≥620 ≥600	710/840	t ≤ 16 16 < t ≤ 50 20 < t	≥17 ≥25 ≥17	No.5 No.5 No.4	t ≤ 32 32 < t	1.5t 2.0t	12 < t ≤ 32 32 < t ≤ 50 50 < t	-15 -20 -30	≥47 ≥47 ≥47

Note: \*1) Test method: JIS Z 2241, Test specimen: JIS Z 2201

\*2) Test method: JIS Z 2248, Test specimen: JIS Z 2204

\*3) Test method/Test specimen: JIS Z 2242

## JFE-HITEN780 Series and JFE-HITEN980

780M has better low-temperature toughness and higher weldability than 780F through its reduced carbon equivalent, and been widely applied to bridges, penstocks, offshore structures and others, including low temperature applications.

As the development of higher strength steel has made it possible to reduce the weight of structures, JFE has

furthered this trend by introducing its highest-class steel plate 980.

Providing good weldability by optimizing alloying elements, 980 is suitable for penstocks and other applications in a low temperature environment where good toughness is required.

Designation (Thickness mm)	Heat Treatment	Chemical Composition(%)													Tensile Test*1)						Bending Test (180°)*2)		Charpy Impact Test (2mmV)*3)					
		Thickness (mm)	C	Si	Mn	P	S	Cu	Ni	Cr	Mo	V	Nb	B	Thickness (mm)	Ceq	PCM	Yield Point or Proof		Tensile Strength (N/mm <sup>2</sup> )	Elongation		Bending Radius		Test Temperature		Absorbed Energy (J)	
																		Thickness (mm)	Stress (N/mm <sup>2</sup> )		Thickness (mm)	(%)	Test Specimen	Thickness (mm)	Test Specimen No.1	Thickness (mm)		(°C)
JFE-HITEN780M (6~150)	QT	t ≤ 100 100 < t	≤0.14 ≤0.18	≤0.35 ≤0.35	≤1.20 ≤1.20	≤0.015 ≤0.015	≤0.015 ≤0.015	≤0.50 ≤0.50	0.30/1.50 0.30/1.50	≤0.70 ≤0.80	≤0.60 ≤0.60	≤0.05 ≤0.05	- -	≤0.005 ≤0.005	t ≤ 50 50 < t ≤ 100 100 < t	≤0.53 ≤0.57 ≤0.62	≤0.30 ≤0.32 -	t ≤ 75 75 < t	≥685 ≥665	780/930	t ≤ 16 16 < t ≤ 50 20 < t	≥16 ≥24 ≥16	No.5 No.5 No.4	t ≤ 32 32 < t	1.5t 2.0t	12 < t ≤ 32 32 < t ≤ 50 50 < t	-20 -25 -35	≥47 ≥47 ≥47
JFE-HITEN980 (6~120)	QT	-	≤0.14	≤0.35	≤1.20	≤0.010	≤0.005	≤0.70	≤4.00	≤0.80	≤0.80	≤0.15	≤0.02	≤0.005	t ≤ 50 50 < t ≤ 100 100 < t	≤0.59 ≤0.62 ≤0.71	≤0.29 ≤0.33 ≤0.36	t ≤ 75 75 < t ≤ 100 100 < t	≥885 ≥865 ≥865	950/1130 950/1130 930/1110	t ≤ 16 16 < t ≤ 50 20 < t	≥12 ≥19 ≥12	No.5 No.5 No.4	t ≤ 32 32 < t	2.0t 2.5t	12 < t	-60	≥47

Note: \*1) Test method: JIS Z 2241, Test specimen: JIS Z 2201

\*2) Test method: JIS Z 2248, Test specimen: JIS Z 2204

\*3) Test method/Test specimen: JIS Z 2242

# JFE-HITEN STANDARDS

## High Tensile Strength Steel Plates with Good Weldability

'U2' series, whose carbon content and P<sub>CM</sub> values are controlled to less than 0.09 and 0.20% respectively along with careful control of tramp elements exhibits outstanding resistance to HAZ (Heat Affected Zone) hardening and weld cracking. These properties are required for the fabrication of structures such as spherical

tanks, penstocks and others, giving 'U1','U2' series a good reputation with customers.

JFE-HITEN 780EX, developed by the same product design as above, has high strength and good weldability especially for bridges.

Designation (Thickness mm)	Heat Treatment	Chemical Composition(%)													Tensile Test*1)					Bending Test (180°)*2)		Charpy Impact Test (2mmV)*3)						
		C	Si	Mn	P	S	Cu	Ni	Cr	Mo	V	Nb	B	P <sub>CM</sub>	Yield Point or Proof		Tensile Strength (N/mm <sup>2</sup> )	Elongation			Bending Radius		Test Temperature (°C)	Absorbed Energy (J)				
															Thickness (mm)	Stress (N/mm <sup>2</sup> )		Thickness (mm)	(%)	Test Specimen	Thickness (mm)	Test Specimen No.1			Thickness (mm)	Test Specimen No.1		
JFE-HITEN570U2 (6~100)	QT	≤0.09	0.15/0.55	≤1.60	≤0.025	≤0.010	≤0.30	≤0.30	≤0.30	≤0.30	≤0.06	≤0.03	-	≤0.20	t ≤ 16 16 < t ≤ 40 40 < t ≤ 75 75 < t	≥460 ≥450 ≥430 ≥420	570/700	t ≤ 16 16 < t ≤ 50 20 < t	≥20 ≥28 ≥20	No.5 No.5 No.4	t ≤ 32 32 < t	1.5t 2.0t	12 < t	- 5	≥47			
JFE-HITEN590U2 (6~75)	QT	≤0.09	0.15/0.55	1.20/1.60	≤0.025	≤0.010	≤0.30	≤0.30	≤0.30	≤0.30	≤0.06	≤0.03	-	≤0.20	-	≥450	590/710	t ≤ 16 16 < t ≤ 50 20 < t	≥20 ≥28 ≥20	No.5 No.5 No.4	t ≤ 32 32 < t	1.5t 2.0t	12 < t ≤ 32 32 < t ≤ 50 50 < t	5 - 5 -10 -20	≥47 ** ≥47 ≥47 ≥47			
JFE-HITEN610U2 (6~75)	QT	≤0.09	0.15/0.55	1.20/1.60	≤0.025	≤0.010	≤0.30	≤0.30	≤0.30	≤0.30	≤0.06	≤0.03	-	≤0.20	-	≥490	610/730	t ≤ 16 16 < t ≤ 50 20 < t	≥19 ≥27 ≥19	No.5 No.5 No.4	t ≤ 32 32 < t	1.5t 2.0t	12 < t ≤ 32 32 < t ≤ 50 50 < t	0 - 5 -15 -25	≥47 ** ≥47 ≥47 ≥47			
JFE-HITEN780EX (6~60)	QT	≤0.09	≤0.55	0.60/1.50	≤0.015	≤0.010	≤0.50	0.30/1.50	≤0.80	≤0.60	≤0.05	≤0.03	≤0.005	-	t ≤ 34 34 < t ≤ 60	≤0.53 * ≤0.57 *	≤0.23 ≤0.25	t ≤ 50 50 < t ≤ 60	≥685 ≥665	780/930 760/910	t ≤ 16 16 < t ≤ 50 20 < t	≥16 ≥24 ≥16	No.5 No.5 No.4	t ≤ 32 32 < t	1.5t 2.0t	12 < t ≤ 32 32 < t ≤ 50 50 < t	-20 -25	≥47 ≥47

Note: \*1) Test method: JIS Z 2241, Test specimen: JIS Z 2201  
\*2) Test method: JIS Z 2248, Test specimen: JIS Z 2204  
\*3) Test method/Test specimen: JIS Z 2242

\*WES + Cu/13 (Cu ≥ 0.30)  
\*\* 6 ≤ t ≤ 8      \*\* 8 < t ≤ 10.5  
24J (1/2size)      35J (3/4size)      \*\* 10.5 < t < 12  
39J (3/4size)

## High Tensile Strength Steel Plates for High Heat-input Welding

This series offer extremely low susceptibility to weld cracking by keeping their carbon content and P<sub>CM</sub> values in low levels. They also possess superior HAZ toughness, even when high heat input welding such as

electro-gas welding is applied in the fabrication of tanks and other structures.

Designation (Thickness mm)	Heat Treatment	Chemical Composition(%)													Tensile Test*1)					Bending Test (180°)*2)		Charpy Impact Test (2mmV)*3)			
		C	Si	Mn	P	S	Cu	Ni	Cr	Mo	V	Nb	B	P <sub>CM</sub>	Yield Point or Proof		Tensile Strength (N/mm <sup>2</sup> )	Elongation			Bending Radius		Test Temperature (°C)	Absorbed Energy (J)	
															Thickness (mm)	Stress (N/mm <sup>2</sup> )		Thickness (mm)	(%)	Test Specimen	Thickness (mm)	Test Specimen No.1			Thickness (mm)
JFE-HITEN570E (6~100)	QT	≤0.09	0.15/0.55	≤1.60	≤0.020	≤0.010	≤0.30	≤0.30	≤0.30	≤0.30	≤0.06	≤0.03	-	≤0.20	t ≤ 16 16 < t ≤ 40 40 < t ≤ 75 75 < t	≥460 ≥450 ≥430 ≥420	570/700	t ≤ 16 16 < t ≤ 50 20 < t	≥20 ≥28 ≥20	No.5 No.5 No.4	t ≤ 32 32 < t	1.5t 2.0t	12 < t	- 5	≥47
JFE-HITEN590E (6~75)	QT	≤0.09	0.15/0.55	1.00/1.60	≤0.020	≤0.010	≤0.30	≤0.30	≤0.30	≤0.30	≤0.06	≤0.03	-	≤0.20	-	≥450	590/710	t ≤ 16 16 < t ≤ 50 20 < t	≥20 ≥28 ≥20	No.5 No.5 No.4	t ≤ 32 32 < t	1.5t 2.0t	6 t ≤ 20 20 < t ≤ 32 32 < t ≤ 50 50 < t	5 - 5 -10 -20	≥47 ** ≥47 ≥47 ≥47
JFE-HITEN610E (6~75)	QT	≤0.09	0.15/0.55	1.00/1.60	≤0.020	≤0.010	≤0.30	≤0.30	≤0.30	≤0.30	≤0.06	≤0.03	-	≤0.20	-	≥490	610/730	t ≤ 16 16 < t ≤ 50 20 < t	≥19 ≥27 ≥19	No.5 No.5 No.4	t ≤ 32 32 < t	1.5t 2.0t	6 t ≤ 20 20 < t ≤ 32 32 < t ≤ 50 50 < t	0 - 5 -15 -25	≥47 ** ≥47 ≥47 ≥47

Note: \*1) Test method: JIS Z 2241, Test specimen: JIS Z 2201  
\*2) Test method: JIS Z 2248, Test specimen: JIS Z 2204  
\*3) Test method/Test specimen: JIS Z 2242

\*\* 6 ≤ t ≤ 8      \*\* 8 < t ≤ 10.5  
24J (1/2size)      35J (3/4size)      \*\* 10.5 < t < 12  
39J (3/4size)

# JFE-HITEN STANDARDS

## High Tensile Strength Steel Plates for Civil Engineering and Industrial Machinery

JFE-HITEN 590S/690S are economical and have good weldability with high toughness because they are produced by controlled rolling or TMCP with optimum chemical composition. They are, suitable for civil engineering and industrial machinery, even in cold regions.

JFE-HITEN 780S/980S quenched and tempered steel plates come in thicknesses of up to 50mm with alloying elements reduced to minimum amounts to provide good weldability and high economy. They suite

for uses in civil engineering and industrial machinery.

JFE-HITEN 780LE is manufactured by using JFE's leading technologies including controlled rolling and minimum micro-alloying, consequently, providing good weldability and high toughness over in low temperature (-40°C) regions.

Designation (Thickness mm)	Heat Treatment	Chemical Composition(%)															Tensile Test*1)					Bending Test (180°)*2)		Charpy Impact Test (2mmV)*3)							
		Thickness (mm)	C	Si	Mn	P	S	Cu	Ni	Cr	Mo	V	Nb	B	Ceq	P <sub>CM</sub>	Yield Point or Proof		Tensile Strength (N/mm <sup>2</sup> )	Elongation			Bending Radius		Test Temperature		Absorbed Energy (J)				
																	Thickness (mm)	Stress (N/mm <sup>2</sup> )		Thickness (mm)	(%)	Test Specimen	Thickness (mm)	Test Specimen No.1	Thickness (mm)	(°C)					
JFE-HITEN590SA (6~40)	CR or TMCP	-	≦0.18	≦0.55	≦2.00	≦0.030	≦0.020	Other elements are added as required.							≦0.45	-	-	≧450	590/710	t ≦ 16	≧20	No.5	t ≦ 32	1.5t	-	-	-				
JFE-HITEN590SB (6~40)		-	≦0.18	≦0.55	≦2.00	≦0.030	≦0.015	Other elements are added as required.							≦0.45	-				16 < t ≦ 50	≧28	No.5			32 < t	2.0t	12 < t	-10	≧47		
JFE-HITEN590SL (6~50)	CR or TMCP	-	≦0.16	0.20/0.55	0.80/1.60	≦0.030	≦0.015	-	-	-	≦0.35	≦0.08	≦0.05	-	≦0.46	≦0.22	t ≦ 32	≧450	590/710	t ≦ 16	≧20	No.5	-	1.5t	6 ≦ t ≦ 36	-40	≧27 **				
JFE-HITEN690S (6~25)	CR or TMCP	-	≦0.15	≦0.55	≦2.00	≦0.030	≦0.015	Other elements such as Nb, V and Ti are added as required.							≦0.50	-	-	≧550	690/830	t ≦ 16	≧17	No.5	-	1.5t	12 < t	-10	≧47				
JFE-HITEN780S (6~160)	QT	t ≦ 50	≦0.25	≦0.55	≦1.60	≦0.030	≦0.015	-	-	≦0.70	≦0.30	≦0.10	Ti:0.005/0.02	≦0.005	≦0.53	-	-	≧685	780/930	t ≦ 16	≧16	No.5	t ≦ 32	1.5t	6 < t ≦ 20	-	-				
		50 < t ≦ 100	≦0.20	≦0.55	≦1.60	≦0.030	≦0.015	≦0.50	≦0.50	≦1.50	≦0.60	≦0.10	Ti:0.005/0.02	≦0.005	≦0.61	-				75 < t ≦ 160	≧665	16 < t ≦ 32			≧24	No.5	32 < t	2.0t	12 < t ≦ 20	-5	≧35
		100 < t ≦ 160	≦0.18	≦0.55	≦1.60	≦0.030	≦0.015	≦0.50	≦0.50	≦1.50	≦0.60	≦0.10	Ti:≦0.03	≦0.005	≦0.65	-				20 < t	≧16	No.4			20 < t	≧16	No.4	32 < t	2.0t	20 < t ≦ 32	-15
JFE-HITEN780LE (6~32)	TMCP	t ≦ 19	≦0.20	≦0.40	≦1.40	≦0.025	≦0.015	-	-	≦0.20	≦0.15	≦0.08	-	≦0.005	≦0.40 *	-	-	≧685	780/930	t ≦ 16	≧16	No.5	-	1.5t	6 ≦ t ≦ 32	-40	≧40 ***				
		19 < t												≦0.43 *	16 < t ≦ 32					≧24	No.5	32 < t			2.0t	20 < t	≧16	No.4	32 < t	2.5t	20 < t ≦ 32
JFE-HITEN980S (6~50)	QT	-	≦0.18	≦0.35	≦1.20	≦0.020	≦0.015	≦0.70	≦2.00	≦0.80	≦0.80	≦0.08	≦0.02	≦0.005	≦0.65	-	-	≧885	950/1130	t ≦ 16	≧12	No.5	t ≦ 32	2.0t	12 < t ≦ 20	-10	≧35				
																			16 < t ≦ 50	≧19	No.5	32 < t	2.5t	20 < t ≦ 32	-25	≧35					
																			20 < t	≧12	No.4			32 < t	-30	≧35					

Note: \*1) Test method: JIS Z 2241, Test specimen: JIS Z 2201

\*2) Test method: JIS Z 2248, Test specimen: JIS Z 2204

\*3) Test method/Test specimen: JIS Z 2242

\* C+Mn/6+(Cu+Ni)/15+(Cr+Mo+V)/5

\*\* 6 ≦ t < 8.5      \*\*\* 6 ≦ t < 8.5

19J (1/2size)      20J (1/2size)

8.5 ≦ t ≦ 12      8.5 ≦ t ≦ 12

24J (3/4size)      30J (3/4size)

## Dimensional Tolerance, Shape, and Appearance

Designation	Dimensional Tolerance, Shape, and Appearance
590, 590U2, 590E 610, 610U2, 610E 690, 690M, 710, 710M 780M 980	Dimensional tolerances of thickness, width, and length, flatness, and shape are in accordance with JIS G 3115.
570U2, 570E 590S, 590SL 690S 780S, 780LE, 780EX 980S	Dimensional tolerances of thickness, width, and length, flatness, and shape are in accordance with JIS G 3193.

Above specifications are negotiable in order to meet customer's requirement.



# APPLICATIONS AND TYPICAL PLATE PRODUCTS

## Bridges

JFE-HITEN570U2  
JFE-HITEN570E  
JFE-HITEN690M  
JFE-HITEN780M  
JFE-HITEN780EX



## Oil Tanks

JFE-HITEN610  
JFE-HITEN610U2  
JFE-HITEN610E



## Various Spherical Holders

JFE-HITEN590, 610  
JFE-HITEN610U2



## Various Offshore Structures

JFE-HITEN590, 610  
JFE-HITEN590, 610U2  
JFE-HITEN690M  
JFE-HITEN780M



## Gates, Penstocks

JFE-HITEN590, 610  
JFE-HITEN590, 610U2  
JFE-HITEN780M  
JFE-HITEN980



## Civil Engineering and Industrial Machinery

JFE-HITEN590S  
JFE-HITEN690S  
JFE-HITEN780S  
JFE-HITEN780LE  
JFE-HITEN980S



# TYPICAL PROPERTIES OF JFE-HITEN

## JFE-HITEN 610U2 — 590N/mm<sup>2</sup> Class High Tensile Strength Steel Plates with good Weldability

### Chemical composition (%)

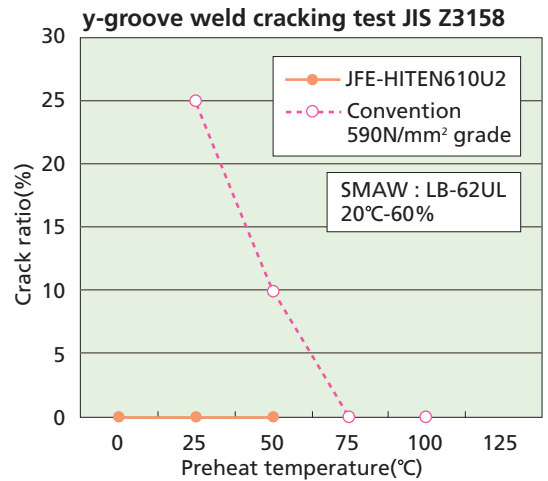
Designation	Thickness (mm)	C	Si	Mn	P	S	P <sub>CM</sub>
JFE-HITEN610U2	75	0.08	0.26	1.44	0.005	0.002	0.18
Conventional 590N/mm <sup>2</sup> grade	50	0.13	0.26	1.29	0.011	0.003	0.23

Other alloying elements are added.

### Mechanical properties of plate

Designation	Tensile test			Charpy impact test		
	YS (N/mm <sup>2</sup> )	TS (N/mm <sup>2</sup> )	El (%)	Temp. (°C)	Dir.	Absorbed energy (J)
JFE-HITEN610U2	534	624	31*	-10	L	275
Conventional 590N/mm <sup>2</sup> grade	566	668	50	-10	L	269

\* JIS No.4



## JFE-HITEN 610E — 590N/mm<sup>2</sup> Class High Tensile Strength Steel Plates for High Heat-input Welding

### Chemical composition (%)

Designation	Thickness (mm)	C	Si	Mn	P	S	P <sub>CM</sub>
JFE-HITEN610E	25	0.08	0.20	1.33	0.008	0.003	0.17

Other alloying elements are added.

### Mechanical properties of electro-gas arc welded joint

Welding condition			Tensile strength of welded joint (N/mm <sup>2</sup> )	Charpy impact test Absorbed energy (J)			
Groove configuration	Welding material	Heat input (kJ/mm)		Test location	Test temp.(°C)		
	DWS-1LG	12	617 618	Weld metal	0	-25	
					Fusion line	244	171
					Center of HAZ	271	171

## JFE-HITEN 780EX — 780N/mm<sup>2</sup> Class High Tensile Strength Steel Plates with High Weldability

### Chemical composition (%)

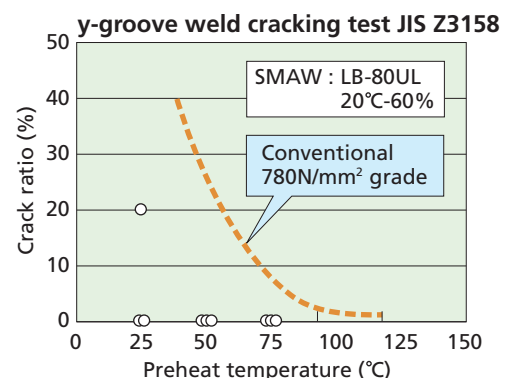
Designation	Thickness (mm)	C	Si	Mn	P	S	P <sub>CM</sub>
JFE-HITEN780EX	34	0.08	0.20	1.05	0.004	0.001	0.22

Alloying elements such as Cu, Ni, Cr are add.

### Mechanical properties of plate

Tensile test			Charpy impact test		
YS (N/mm <sup>2</sup> )	TS (N/mm <sup>2</sup> )	El* (%)	Temp. (°C)	Dir.	Absorbed energy (J)
769	844	24	-40	L	286

\* JIS No.4



# JFE-HITEN 980 — 980N/mm<sup>2</sup> Class High Tensile Strength Steel Plates with High Weldability

## Chemical composition (%)

Tickness (mm)	C	Si	Mn	P	S	P <sub>CM</sub>
75	0.09	0.25	1.14	0.005	0.001	0.27

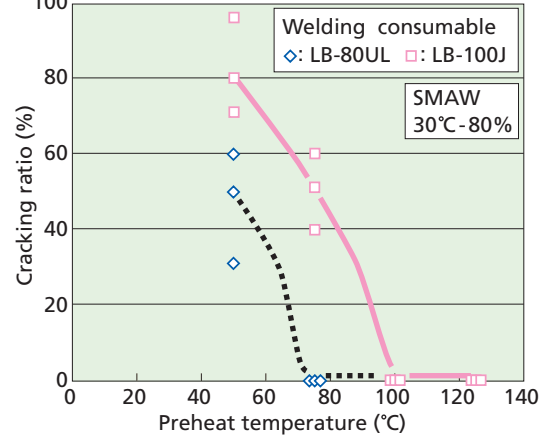
Alloying elements such as Cu, Ni, Cr are added.

## Mechanical properties of plate

Tensile test (1/4t)			Charpy impact test (1/4t)		
YS (N/mm <sup>2</sup> )	TS (N/mm <sup>2</sup> )	EI* (%)	Temp. (°C)	Dir.	Absorbed energy (J)
930	977	25	0	T	208
			-60	T	158

\* JIS No.4

## y-groove weld cracking test JIS Z3158



## Mechanical properties of submerged arc welded joint

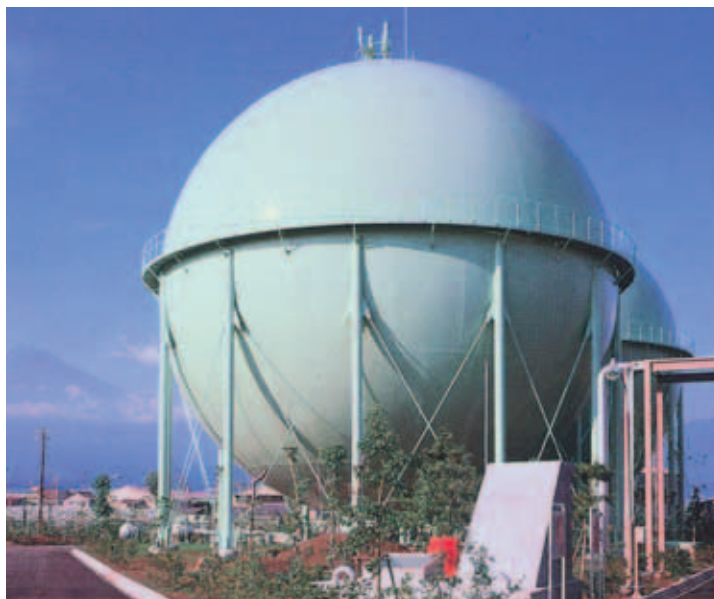
Welding condition			Tensile strength of welded joint (N/mm <sup>2</sup> )	Charpy impact test		
Groove configuration	Welding material	Heat input (kJ/mm)		Notch location	Test temp. (°C)	Absorbed energy (J)
	PFH-100J/US-100J	4.5	977	Weld metal	-10	109
			981	Fusion line		136
				Center of HAZ		248



# APPROVED OR AUTHORIZED PRODUCTS

## Japan Welding Engineering Society (WES)

JFE Designation	WES Approval
590	WES 3001
610	WES 3001
590S	WES 3001
590U2	WES 3001,3009
610U2	WES 3001,3009
590E	WES 3001,3009
610E	WES 3001,3009
690	WES 3001
710	WES 3001
690M	—
690S	—
780M	WES 3001
780S	—
980	WES 3001
980S	—



## Ship's Class Society

Grades of Strength	Society		
	NK	LR	KR
570	A/D/E/F47	D/E46	A/D/E46
610	A/D/E/F51	D/E50	
670	A/D/E56	D/E55	
720	A/D/E63 A/D63N	D/E62	
770	A/D/E/F70 A/D/E/F70N	D/E69	



# RECOMMENDED PRACTICES FOR WORKING AND FABRICATION

## 1. General

The JFE-HITEN series, despite their high strength, offers outstanding workability. In fabricating JFE-HITEN steel plates, however, it is recommended that the manufacturing process should be taken into full consideration in order not to impair mechanical properties.

## 2. Marking

Plates subjected to bending, should be avoided from chisel or punch marks on the outer surface because cracking might be induced.

## 3. Cutting and Drilling

Plates should not be punched for holes. Drilling is recommended. JFE-HITEN steels can be gas-cut as easily as mild steel. Gas cutting produces a hardened layer up to 2 mm in depth. When bending plates, particularly those of 690N/mm<sup>2</sup> or higher tensile-strength steels, removal of the hardened layer by grinding or other methods is recommended. Gas-cut edges supposed to be welded do not require this removal since the hardened layer is removed by the weld penetration.

## 4. Cold Working

Because of their high strength, JFE-HITEN steel plates require a larger bending force than mild steel, but their high ductility makes them easy to cold works.

High-strength steel plates exhibit a greater spring back than mild steel, so attention is necessary during the working process. It is desirable to bend these plates parallel to the direction of rolling, with a bend to a smaller radius, edges should be rounded by grinding, as the crack susceptibility of a plate edge increases as bend radius decreases.

## 5. Hot Forming and Warm Forming

Working quenched and tempered plates at a temperature over the tempering temperature: Excessive temperature causes deterioration in the properties of the steel. Hot working can also change the properties of control-rolled and TMCP plates, so the customer is requested to consult JFE about specific working conditions.

## 6. Post Weld Heat Treatment (PWHT)

JFE-HITEN steel plates exhibit outstanding welded-joint toughness in the as-welded condition, so they do not require post-weld heat treatment to recover toughness. Quenched and tempered plates may be post-weld heat treated, if necessary, at temperatures not exceeding the tempering temperature.

For TMCP plates, please consult JFE Steel in advance.

# RECOMMENDED PRACTICES FOR WORKING AND FABRICATION

## 7. Welding

JFE-HITEN steel plates are welded by such conventional methods as shielded metal arc welding, submerged arc welding, gas metal arc welding, and electro-gas arc welding. Welding by any of these methods produces satisfactory weldments.

### 1) Welding materials

For the welding of quenched and tempered high strength steels, it is necessary to use welding rods with low hydrogen as well as automatic welding materials of high basicity and superior toughness, in order to prevent the occurrence of various possible weld defects, associated with the combination of steel plates and welding materials.

Typical welding materials are shown below.

### 2) Re-Baking Before Use

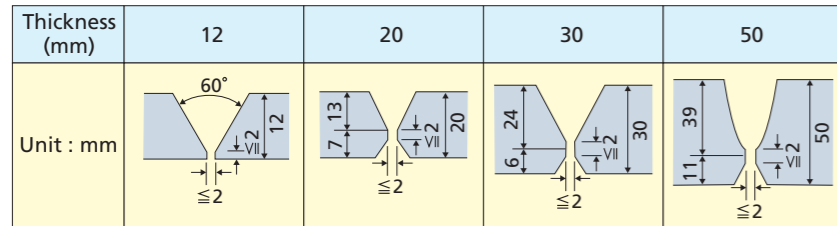
Low hydrogen type welding rods for shielded metal arc welding must be dried for about 1 hour at temperatures between 350 and 400°C before use. Fluxes for submerged arc welding must also be fully dried for about 1 hour at 250~350°C.

### 3) Edge Preparation

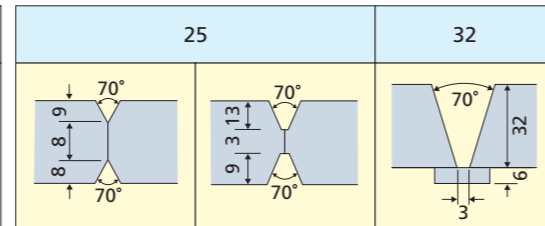
Edge preparation can be performed by gas cutting. When an intricate groove configuration is involved, or when high precision is required, edge preparation is performed by machining.

#### Typical Bevel Shapes

For Shielded Metal Arc Welding(SMAW)



For Submerged Arc Welding(SAW)



### 4) Preheating Treatment

In order to determine the preheating temperature, variables including welding materials, plate thickness, welding method, environmental conditions, constraint conditions, etc., must be taken into consideration.

#### Typical Welding Materials

Strength	JFE-HITEN	SMAW		SMAW		CO <sub>2</sub> Arc Welding		Ar + CO <sub>2</sub> Arc Welding		Electro-gas Arc Welding
		JFE Steel	KOBELCO	JFE Steel	KOBELCO	JFE Steel	KOBELCO	JFE Steel	KOBELCO	KOBELCO
590N/mm <sup>2</sup> Class	590, 610 590S, 590SL 570U2, 590U2, 610 U2 570E, 590E, 610E	KSA-86	LB62 LB62U LB62UL	KB-110 × KW-101B KB-80C × KW-101B KF-300A × KW-101B KF-300A × KW-50C	MF38 × US40	KC-60	MG60 DW60	KM-60	MIX60B	DWS60G, DWS1LG
690N/mm <sup>2</sup> Class	690, 710, 690S 690M, 710M	—	LB106	KB-80C × KW-102B	MF38 × US70	—	MG70	—	MGS70	—
780N/mm <sup>2</sup> Class	780M, 780EX 780S, 780LE	—	LB116 LB80UL	—	PFH80AK × US80BN PFH80AK × US80LT	—	MG80	—	MGS80	—
980N/mm <sup>2</sup> Class	980S 980	—	LB100B LB100J	—	PFH100A × US100A PFH100J × US100J	—	—	—	MGS100J	—

590N/mm<sup>2</sup> class JFE-HITEN can be butt welded without preheating, however, preheating is recommended depending on the above conditions. Preheating temperatures between 50 and 100°C are sufficient.

With higher weldability steel 'U', 'E' series, the preheating temperature may be further lowered or unnecessary.

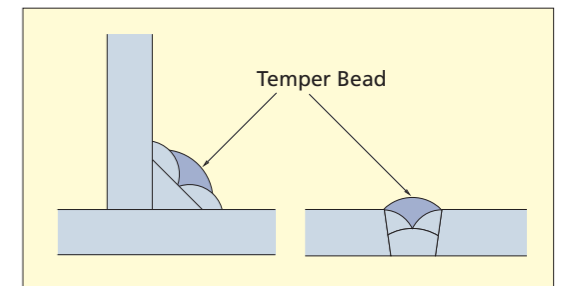
With 690N/mm<sup>2</sup> or higher tensile strength steel plates, a higher preheating temperature between 100 and 175°C is required to prevent cold cracking, though the specific temperature varies based on the above conditions. Please consult with us. Finally, these 690N/mm<sup>2</sup> and over class HITEN involves '-LE', '-EX' grades with relaxing preheating also.

### 5) Tack Welding

Tack welding conditions are the same as those for normal welding, however, it is recommended that welding beads be over 50mm in length. It is absolutely essential that arc striking be performed in the bevel or on other steel plate, and not on the base metal.

### 6) Welding

- ① In case of welding by covered electrodes, it is recommended at the outset that a back start be done for about 30mm in the groove, giving straight beading.
- ② It is recommended that arc length be as short as possible.
- ③ Weaving will impair heat input required for welding. If weaving is applied, the width of weaving must be less than 1.5 times rod diameter.
- ④ In case of SMAW for 690N/mm<sup>2</sup> and over grade, please adopt the Temper Bead Methods, as shown right.
- ⑤ Slag removal is not easy for low hydrogen type electrode, particularly compared to ilmenite type or cellulose type, but it is requested to do it by all means. Pre-heating helps to remove slag preferably.
- ⑥ In case of submerged-arc welding, phenomena such as embrittlement and softening at heat affected zone must be considered.



Care must therefore be taken concerning the heat input of welding.

- ⑦ Beside preheating, the control of interlayer temperature is recommended.



## Total Steel

### Total Steel of Australia Pty Ltd

ABN 34 001 201 850

#### Administration

Suite 10, 35-37 Railway Parade  
Engadine, New South Wales 2233  
PO Box 70 Engadine NSW 2233  
Telephone: (02) 8508 4800  
Fax: (02) 9520 8628  
Email: [admin@totalsteel.com.au](mailto:admin@totalsteel.com.au)

#### Sydney

46 Anzac Avenue  
Smeaton Grange, New South Wales 2567  
Box 3205 Narellan DC NSW 2567  
Telephone: (02) 4648 8111  
Fax: (02) 4647 8011  
Email: [sydney@totalsteel.com.au](mailto:sydney@totalsteel.com.au)

#### Melbourne

207-211 Fitzgerald Road  
Laverton North, Victoria 3026  
PO Box 477 Laverton VIC 3028  
Telephone: (03) 9369 8855  
Fax: (03) 9369 8866  
Email: [melbourne@totalsteel.com.au](mailto:melbourne@totalsteel.com.au)

#### Brisbane

106 Mica Street  
Carole Park, Queensland 4300  
PO Box 265 Carole Park QLD 4300  
Telephone: (07) 3723 9200  
Fax: (07) 3271 1699  
Email: [brisbane@totalsteel.com.au](mailto:brisbane@totalsteel.com.au)

#### Perth

53-75 McDowell Street  
Welshpool, Western Australia 6106  
PO Box 626 Welshpool DC WA 6986  
Telephone: (08) 9351 6800  
Fax: (08) 9351 6868  
Email: [perth@totalsteel.com.au](mailto:perth@totalsteel.com.au)

#### Darwin

48 Dawson Street  
East Arm  
NT 0822  
Tel: (08) 8984 4324  
Fax: (08) 8947 4615  
Email: [darwin@totalsteel.com.au](mailto:darwin@totalsteel.com.au)

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