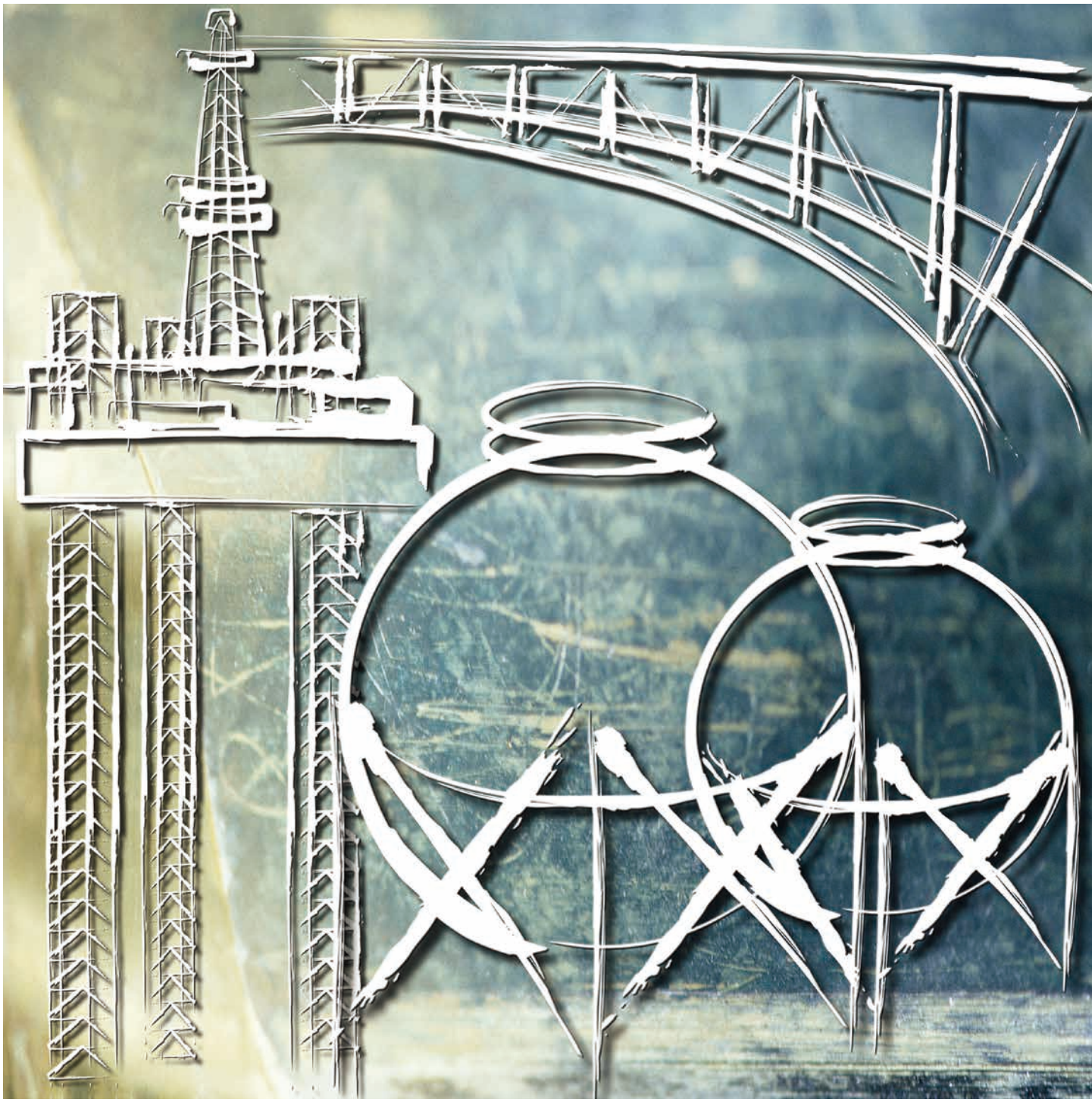
JFE-HITEN

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 – 1180N/mm^2 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.

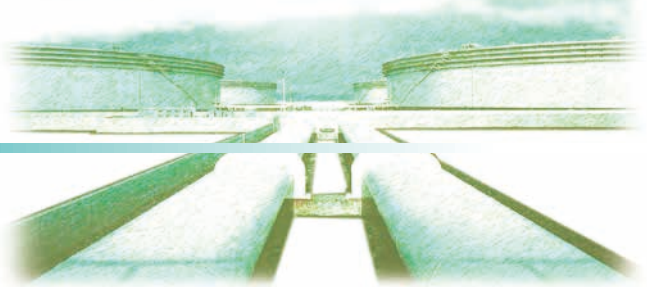
So, JFE Steel introduces here the features and characteristics of JFE-HITEN series.

CONTENTS

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

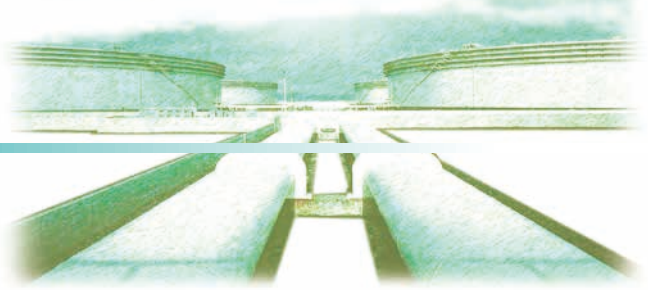
Type of Steel		JIS	ASTM	EN	WES **	Ship's class Standard ***	JFE Standard
Steel Plates for Structural Use	590N/mm^2 Class	G 3106 SM570*	A678 Gr.C Gr.D A841		HW 450 HW 450CF	A47 D47 E47 F47	JFE-HITEN570U2 JFE-HITEN570E JFE-HITEN590S JFE-HITEN590SL JFE-HITEN590AZ JFE-HITEN590 JFE-HITEN590U2 JFE-HITEN590E
					HW 490 HW 490CF	A51 D51 E51 F51	JFE-HITEN610 JFE-HITEN610U2 JFE-HITEN610E
	690N/mm^2 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^2 Class	G 3128 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^2 Class				HW 885		JFE-HITEN980S JFE-HITEN980
Steel Plates for Pressure Vessels	590N/mm^2 Class	G 3115 SPV450 G 3124 SEV345	A537 Cl. 2 A738 Gr.B A841	EN10028 P460N	HW 450	KPV46	JFE-HITEN570U2 JFE-HITEN570E JFE-HITEN590 JFE-HITEN590U2 JFE-HITEN590E
		G 3115 SPV490			HW 490	KPV50	JFE-HITEN610 JFE-HITEN610U2 JFE-HITEN610E
	690N/mm^2 Class		A543 Cl. 1		HW 620		JFE-HITEN690M
	780N/mm^2 Class		A517 A543 Cl. 2		HW 685		JFE-HITEN780M
	980N/mm^2 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

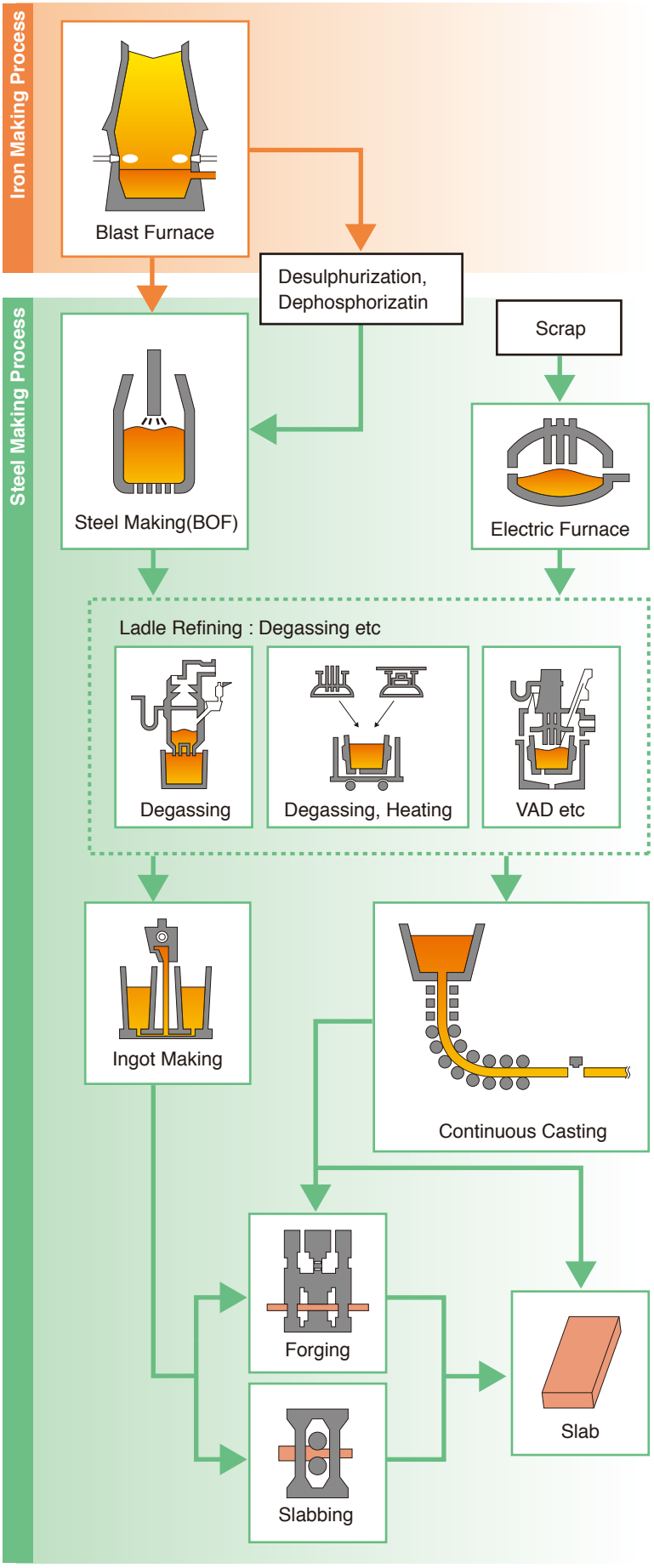
JFE-HITEN composes of various grades ranging widely in tensile strengths, corresponding to broad variety of usages. The grades and features of JFE-HITEN are shown as follows.

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^2)	Designation	Thickness (mm)	Yield Strength Min. (N/mm^2) *	Tensile Strength (N/mm^2) *	Features and Typical Applications
590	JFE-HITEN590 JFE-HITEN610 JFE-HITEN570U2 JFE-HITEN590U2 JFE-HITEN610U2 JFE-HITEN570E JFE-HITEN590E JFE-HITEN610E	6 – 150 6 – 150 6 – 100 6 – 75 6 – 75 6 – 100 6 – 75 6 – 75	450 490 460 450 490 460 450 490	590 – 710 610 – 730 570 – 700 590 – 710 610 – 730 570 – 700 590 – 710 610 – 730	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-HITEN590S JFE-HITEN590SL	6 – 40 6 – 50	450 450	590 – 710 590 – 710	S : Without Heat treatment for Civil Engineering and Industrial Machinery SL : Same as above with excellent toughness at low temperature (-40˚C)
690	JFE-HITEN690 JFE-HITEN710	6 – 100 6 – 108	590 620	690 – 820 710 – 840	Ni-free type for Tanks, Offshore Structures etc.
	JFE-HITEN690M JFE-HITEN710M	6 – 100 6 – 100	590 620	690 – 820 710 – 840	Ni type and Low carbon-equivalent for Bridges, Penstocks, Tanks, etc.
	JFE-HITEN690S	6 – 25	550	690 – 830	With reducing alloying elements and without Heat Treatment, for Civil Engineering and Industrial Machinery
780	JFE-HITEN780M	6 – 150	685	780 – 930	Ni type and Low Carbon-equivalent for Bridges, Penstocks, Offshore structures etc.
	JFE-HITEN780EX	6 – 60	685	780 – 930	High Performance with Relaxing Pre-heating for Bridges
	JFE-HITEN780S	5 – 160	685	780 – 930	Reducing alloying elements for Civil Engineering and Industrial Machinery
	JFE-HITEN780LE	5 – 203.2	685	780 – 930	High Weldability and excellent toughness at low temperature (-40˚C), for Civil Engineering and Industrial Machinery
980	JFE-HITEN980	6 – 120	885	950 – 1130	High Strength, High Weldability and Good Toughness for Penstocks
	JFE-HITEN980S	5 – 50.8	885	950 – 1130	For Civil Engineering and Industrial Machinery
	JFE-HITEN980LE	5 – 101.6	900	980 – 1150	High tensile strength steel plate with excellent low temperature toughness (-40˚C) for Civil Machinery and Industrial Machinery.
	JFE-HYD960LE	5 – 63.5	960	980 – 1150	Higher yield strength than conventional 980 grade steel, high weldability and excellent toughness at low temperature (-40˚C), for Civil Engineering and Industrial Machinery.
1180	JFE-HYD1100LE	12 – 32	1100	1180 – 1500	High tensile strength steel plate for Civil Machinery and Industrial Machinery. Has high yield stress, and excellent weldability and low temperature toughness (-40˚C).

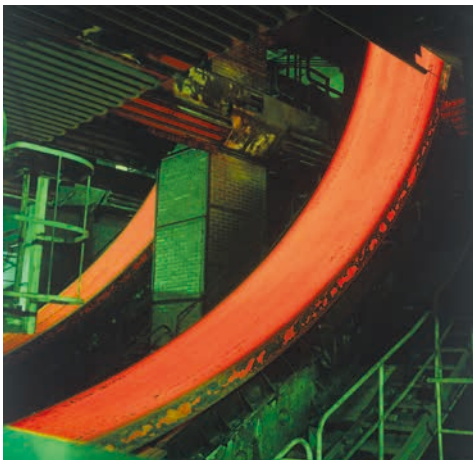
Note: Chemical compositions described in this catalogue are values by ladle analysis.
* In some cases, may be lower than the said control value due to plate thickness.

MANUFACTURING PROCESS



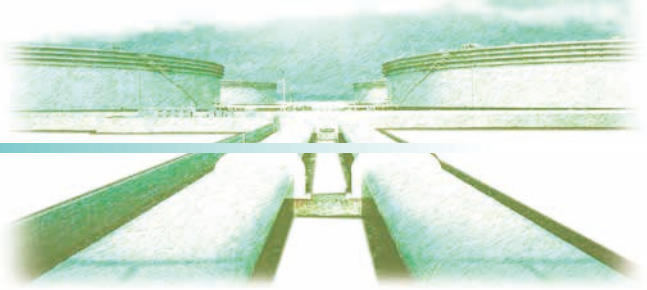
Blast furnace

Oxygen converter

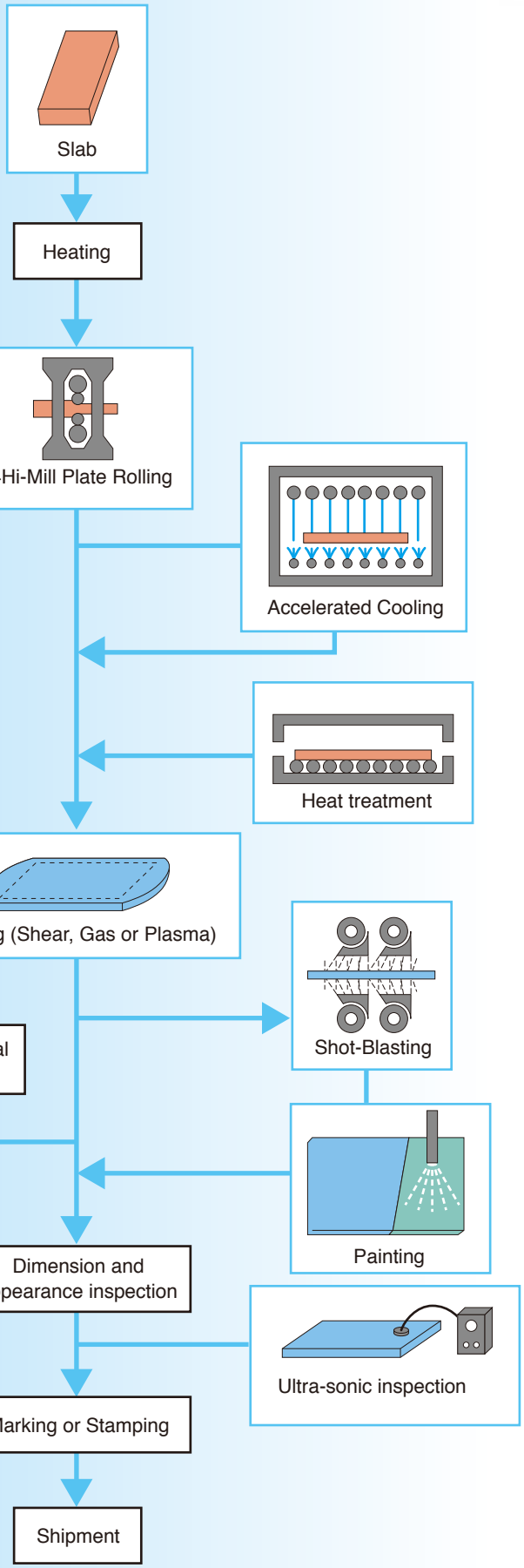


Continuous casting machine

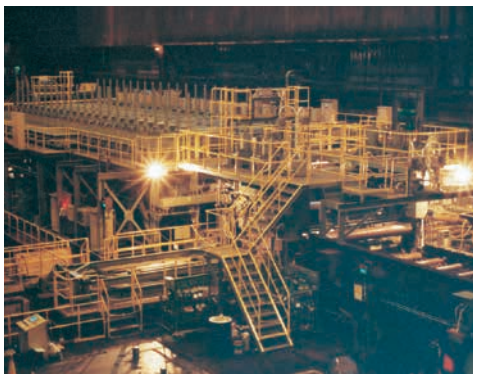
6000t Forging press



Rolling Process



Rolling Mill



Super-OLAC™

Heat treatment system

AVAILABLE SIZES

Without Heat Treatment

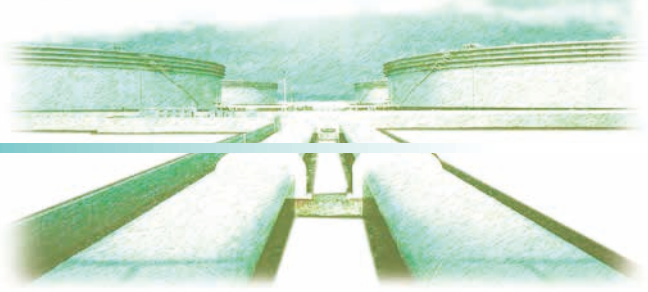
Product Length : m

Thickness mm \ Width mm	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
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 / 6.0	6.6 / 5.8	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 / 5.8	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 / 5.8	6	6	5	5	5				

1 In case of the diagonal-lined column A/B, 'A' shows the maximum product length. And the product length between 'B' and 6.1 m can not be provided.

2 The minimum product size is as follows ; 1 m wide and 3 m 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 – 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	20	15	13								
7.0 – 7.9											24	22	20	15							
8.0 – 8.9													22	18	16	13	11				
9.0 – 9.9															22	20	16	12			
10.0 – 11.9																		22	20	18	
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						
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							

Negotiable Range

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

JFE-HITEN STANDARDS

JFE-HITEN590 Series and JFE-HITEN690 Series

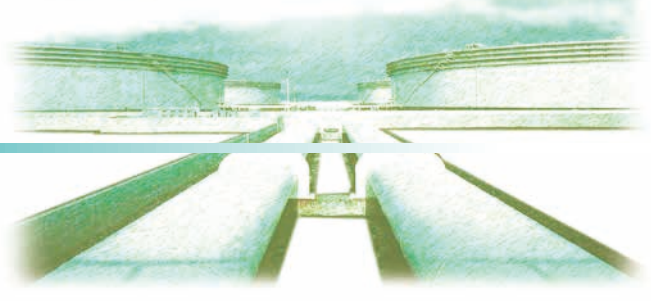
These series are suitable for a wide range of applications, such as bridges, cylindrical or spherical storage tanks, machine structures etc. By adding alloying elements to the Si-Mn based compositions depending on plate thickness, the carbon equivalent is kept low to improve weldability. Among these,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

Designation (Thickness mm)	Heat Treatment	Chemical Composition (%)											
		C	Si	Mn	P	S	Cu	Ni	Cr	Mo	V	Nb	B
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	—	—
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	—	—
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
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
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
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

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

Designation (Thickness mm)	Heat Treatment	Chemical Composition (%)												
		Thickness (mm)	C	Si	Mn	P	S	Cu	Ni	Cr	Mo	V	Nb	B
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
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



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.

				Tensile Test*1)						Bending Test (180°)*2)		Charpy Impact Test (2mmV)*3)		
	Ceq		Pcm	Yield Strength		Tensile Strength (N/mm²)	Elongation			Bending Radius		Test Temperature		Absorbed Energy (J)
	Thickness (mm)			Thickness (mm)	(N/mm²)		Thickness (mm)	(%)	Test Specimen	Thickness (mm)	(Test Specimen No.1)	Thickness (mm)	(℃)	
	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
	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
	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
	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
	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
	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/Test specimen: JIS Z 2241
*2) Test method/Test specimen: JIS Z 2248
*3) Test method/Test specimen: JIS Z 2242

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.

				Tensile Test*1)						Bending Test (180°)*2)		Charpy Impact Test (2mmV)*3)		
	Ceq		Pcm	Yield Strength		Tensile Strength (N/mm²)	Elongation			Bending Radius		Test Temperature		Absorbed Energy (J)
	Thickness (mm)			Thickness (mm)	(N/mm²)		Thickness (mm)	(%)	Test Specimen	Thickness (mm)	(Test Specimen No.1)	Thickness (mm)	(℃)	
	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
	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/Test specimen: JIS Z 2241
*2) Test method/Test specimen: JIS Z 2248
*3) Test method/Test specimen: JIS Z 2242

High Tensile Strength Steel Plates with Good Weldability

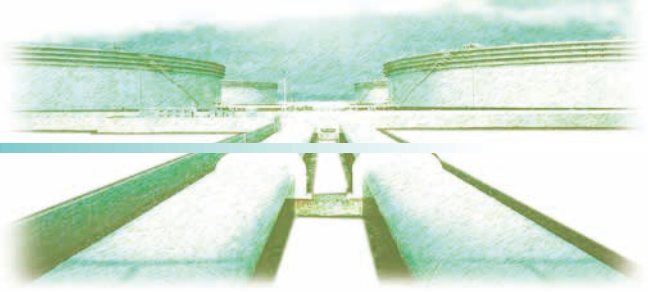
'U2' series, whose carbon content and Pcm values are controlled to less than 0.09 and 0.20% respectively along with carefull controller tramp elements exhibits outstanding resistance to HAZ (Heat Affected Zone) hardening and weld cracking. These properties are required for the fabrication of structures such as spherical tanks, penstocks and others,

Designation (Thickness mm)	Heat Treatment	Chemical Composition (%)												
		C	Si	Mn	P	S	Cu	Ni	Cr	Mo	V	Nb	B	
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	–	
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	–	
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	–	
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	

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 Pcm 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 (%)												
		C	Si	Mn	P	S	Cu	Ni	Cr	Mo	V	Nb	B	
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	—	
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	—	
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	—	



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.

	Tensile Test*1)								Bending Test (180°)*2)		Charpy Impact Test (2mmV)*3)		
	Ceq		Pcm	Yield Strength		Tensile Strength (N/mm²)	Elongation			Bending Radius		Test Temperature		Absorbed Energy (J)
	Thickness (mm)			Thickness (mm)	(N/mm²)		Thickness (mm)	(%)	Test Specimen	Thickness (mm)	(Test Specimen No.1)	Thickness (mm)	(℃)	
	—	—	≤ 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
	—	—	≤ 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
	—	—	≤ 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
	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 ≤ 60	− 20 − 25	≥ 47 ≥ 47

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

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

	Tensile Test*1)						Bending Test (180°)*2)		Charpy Impact Test (2mmV)*3)		
	Pcm	Yield Strength		Tensile Strength (N/mm²)	Elongation			Bending Radius		Test Temperature		Absorbed Energy (J)
		Thickness (mm)	(N/mm²)		Thickness (mm)	(%)	Test Specimen	Thickness (mm)	(Test Specimen No.1)	Thickness (mm)	(℃)	
	≤ 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
	≤ 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
	≤ 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/Test specimen: JIS Z 2241
*2) Test method/Test specimen: JIS Z 2248
*3) Test method/Test specimen: JIS Z 2242

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

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.

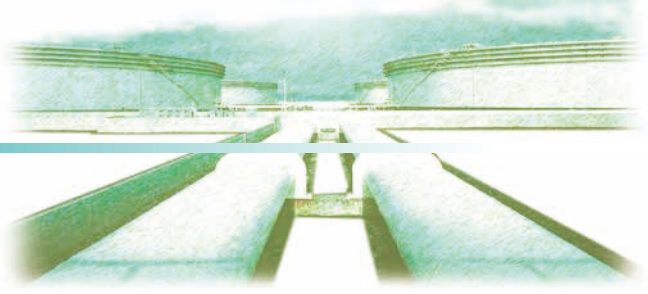
JFE-HITEN 780S/980S quenched and tempered steel plates come in thicknesses of up to 50mm with alloying

Designation (Thickness mm)	Heat Treatment	Chemical Composition (%)											
		Thickness (mm)	C	Si	Mn	P	S	Cu	Ni	Cr	Mo	V	Nb
JFE-HITEN590SA (6 – 40)	CR or TMCP	—	≤ 0.18	≤ 0.55	≤ 2.00	≤ 0.030	≤ 0.020	Other elements are added as required.					
JFE-HITEN590SB (6 – 40)	CR or TMCP	—	≤ 0.18	≤ 0.55	≤ 2.00	≤ 0.030	≤ 0.015	Other elements are added as required.					
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
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.					
JFE-HITEN780S (5 – 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
		50<t≤100	≤ 0.20					≤ 0.50	≤ 0.50	≤ 1.50	≤ 0.60		Ti:0.005/0.02
		100<t≤160	≤ 0.18					≤ 0.50	≤ 0.50	≤ 1.50	≤ 0.60		Ti: ≤ 0.03
JFE-HITEN780LE (5 – 203.2)	QT or TMCP	t ≤ 19	≤ 0.20	≤ 0.40	≤ 1.40	≤ 0.025	≤ 0.015	—	—	≤ 0.20	≤ 0.15	≤ 0.08	≤ 0.03
		19< t ≤ 32											
		32< t ≤ 40								≤ 0.80	≤ 0.40		
		40< t ≤ 50											
		50< t ≤ 70											
		70< t ≤ 160	≤ 0.18							≤ 1.50	≤ 0.80	≤ 0.10	
		160< t ≤ 203.2		≤ 0.55	≤ 1.60			≤ 0.60	≤ 1.00		≤ 0.60		
JFE-HITEN980S (5 – 50.8)	QT	—	≤ 0.18	≤ 0.35	≤ 1.20	≤ 0.020	≤ 0.020	≤ 0.70	≤ 2.00	≤ 0.80	≤ 0.80	≤ 0.08	≤ 0.02
JFE-HITEN980LE (5 – 101.6)	QT	t ≤ 32 32<t ≤ 50.8 50.8<t ≤ 101.6	≤ 0.18	≤ 0.40	≤ 1.40	≤ 0.020	≤ 0.015	—	—	≤ 0.80 ≤ 1.50 ≤ 1.50	≤ 0.60 ≤ 0.80 ≤ 0.80	≤ 0.10	≤ 0.03
JFE-HYD960LE (5 – 63.5)	QT or TMCP	t ≤ 32	≤ 0.18	≤ 0.70	≤ 1.70	≤ 0.020	≤ 0.010	—	—	≤ 1.00	≤ 0.60	≤ 0.08	—
		32< t ≤ 50.8	≤ 0.20								≤ 0.90		
		50.8< t ≤ 63.5											
JFE-HYD1100LE (12 – 32)	QT	—	≤ 0.20	≤ 0.70	≤ 1.70	≤ 0.020	≤ 0.010	—	—	≤ 1.00	≤ 0.90	≤ 0.08	—

Dimensional Tolerance, Shape, and Appearance

Designation	Dimensional Tolerance, Shape, and Appearance
590, 590U2, 590E 610, 610U2, 610E 690, 690M, 710, 710M 780EX, 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 980S, 980LE, HYD960LE, HYD1100LE	Dimensional tolerances of thickness, width, and length, flatness, and shape are in accordance with JIS G 3106.

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



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 and JFE-HYD960LE are 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.

				Tensile Test*1)						Bending Test (180˚)*2)		Charpy Impact Test (2mmV)*3)		
	B	Ceq	Pcm	Yield Strength Thickness (mm)	Yield Strength (N/mm²)	Tensile Strength (N/mm²)	Elongation Thickness (mm)	Elongation (%)	Test Specimen	Bending Radius Thickness (mm)	Bending Radius (Test Specimen No.1)	Test Temperature Thickness (mm)	Test Temperature (℃)	Absorbed Energy (J)
		≤ 0.45	—	—	≥ 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	—	—	—
		≤ 0.45	—									t ≤ 12 12< t	— − 10	— ≥ 47
	—	≤ 0.46	≤ 0.22	t ≤ 32 32< t	≥ 450 ≥ 430	590/710 570/705	t ≤ 16 16< t ≤ 20 20< t	≥ 20 ≥ 26 ≥ 20	No.5 No.5 No.4	—	1.5t	6 ≤ t ≤ 36 36< t	− 40 − 20	≥ 27 ** ≥ 27
		≤ 0.50	—	—	≥ 550	690/830	t ≤ 16 16< t	≥ 17 ≥ 25	No.5 No.5	—	1.5t	12< t	− 10	≥ 47
	≤ 0.005	≤ 0.53	—	t ≤ 75 75< t ≤ 160	≥ 685 ≥ 665	780/930 780/930	t ≤ 16 16< t ≤ 40 20< t	≥ 16 ≥ 24 ≥ 16	No.5 No.5 No.4	t ≤ 32 32< t	1.5t 2.0t	5≤ t ≤ 12 12< t ≤ 20 20< t ≤ 32 32< t ≤ 160	— − 5 − 15 − 20	— ≥ 35 ≥ 35 ≥ 35
	≤ 0.005	≤ 0.61	—											
	≤ 0.005	≤ 0.70	—											
	≤ 0.005	≤ 0.40*	—	—	≥ 685	780/930	t ≤ 16 16< t ≤ 40 20< t	≥ 16 ≥ 24 ≥ 16	No.5 No.5 No.4	t ≤ 32 32< t	1.5t 2.0t	5≤ t < 6 6≤ t < 12 12≤ t ≤ 203.2	— − 40 − 40	— ≥ 40 *** ≥ 40
	≤ 0.005	≤ 0.43*	—											
	≤ 0.005	≤ 0.47*	—											
	≤ 0.005	≤ 0.53*	—											
	≤ 0.005	≤ 0.65*	—											
	≤ 0.005	≤ 0.73*	—											
	≤ 0.005	≤ 0.75*	—											
	≤ 0.005	≤ 0.65	—	—	≥ 885	950/1130	t ≤ 16 16< t ≤ 50.8 20< t	≥ 12 ≥ 19 ≥ 12	No.5 No.5 No.4	t ≤ 32 32< t	2.0t 2.5t	5≤ t ≤ 12 12< t ≤ 20 20< t ≤ 32 32< t	— − 10 − 25 − 30	— ≥ 35 ≥ 35 ≥ 35
	≤ 0.005	≤ 0.58* ≤ 0.65* ≤ 0.71*	—	t ≤ 50.8 50.8< t ≤ 101.6	≥ 900 ≥ 830	980/1150 880/1080	t ≤ 16 16< t ≤ 50.8 20< t	≥ 12 ≥ 19 ≥ 12	No.5 No.5 No.4	t ≤ 32 32< t	2.0t 2.5t	5≤ t < 6 6≤ t < 12 12≤ t ≤ 101.6	— − 40 − 40	— ≥ 40 *** ≥ 40
	≤ 0.004	≤ 0.64*	—	t ≤ 50.8	≥ 960	980/1150	t ≤ 40 40< t	≥ 12	No.5 No.4	—	3.0t	5 ≤ t ≤ 50.8 50.8< t ≤ 63.5	− 40	≥ 27**** ≥ 19
	≤ 0.004	≤ 0.70*	—	50.8< t ≤ 63.5	≥ 930	950/1120								
	≤ 0.004	≤ 0.70*	—	—	≥ 1100	1180/1500	—	≥ 12	No.5	—	4.0t	—	− 40	≥ 27

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

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

** 6 ≤ t < 8.5
19J（1/2size）
8.5 ≤ t ≤ 12
24J（3/4size）

*** 6 ≤ t < 8.5
20J（1/2size）
8.5 ≤ t < 11
30J（3/4size）

****6 ≤ t < 8.5
14J（1/2size）
8.5 ≤ t < 11
20J（3/4size）

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

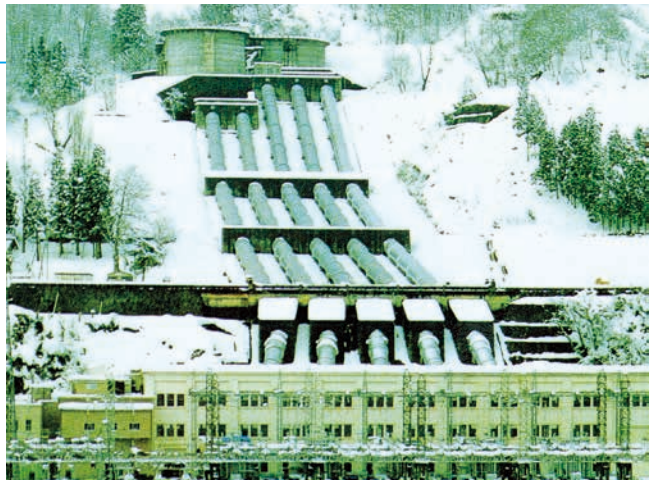
JFE-HITEN590, 610
JFE-HITEN610U2

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
JFE-HITEN980LE
JFE-HYD960LE
JFE-HYD1100LE

TYPICAL PROPERTIES OF JFE-HITEN

JFE-HITEN 610U2 — 590N/mm² Class High Tensile Strength Steel Plates with good Weldability

Chemical composition

(%)

Designation	Thickness (mm)	C	Si	Mn	P	S	P_{CM}
JFE-HITEN610U2	75	0.08	0.26	1.44	0.005	0.002	0.18
Conventional 590N/mm²grade	50	0.13	0.26	1.29	0.011	0.003	0.23

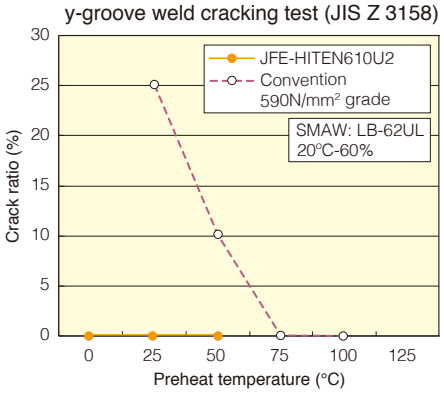
Other alloying elements are added.

Mechanical properties of plate

Designation	Tensile test			Charpy impact test		
	YS (N/mm²)	TS (N/mm²)	El* (%)	Temp. (˚C)	Dir.	Absorbed energy (J)
JFE-HITEN610U2	534	624	31*	- 10	L	275
Conventional 590N/mm²grade	566	668	50	- 10	L	269

*JIS No.4

y-groove weld cracking test (JIS Z 3158)



JFE-HITEN 610E — 590N/mm² Class High Tensile Strength Steel Plates for High Heat-input Welding

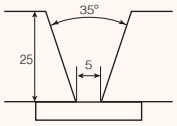
Chemical composition

(%)

Designation	Thickness (mm)	C	Si	Mn	P	S	P_{CM}
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/mm²)	Charpy impact test		
Groove configuration	Welding material	Heat input (kJ/cm)		Test location	Test temp. (˚C)	Absorbed energy (J)
 (mm)	DWS-1LG	120	617 618	Weld metal	0	113
					- 25	82
				Fusion line	0	244
					- 25	171
				Center of HAZ	0	271
					- 25	171

JFE-HITEN 780EX — 780N/mm² Class High Tensile Strength Steel Plates with High Weldability

Chemical composition

(%)

Designation	Thickness (mm)	C	Si	Mn	P	S	P_{CM}
JFE-HITEN780EX	34	0.08	0.20	1.05	0.004	0.001	0.22

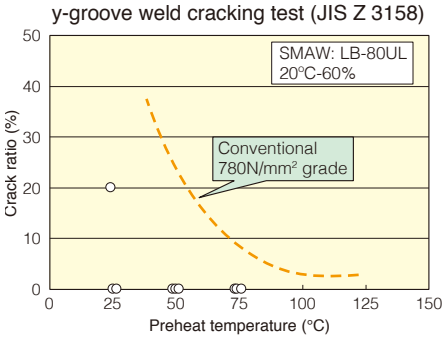
Alloying elements such as Cu,Ni,Cr are added.

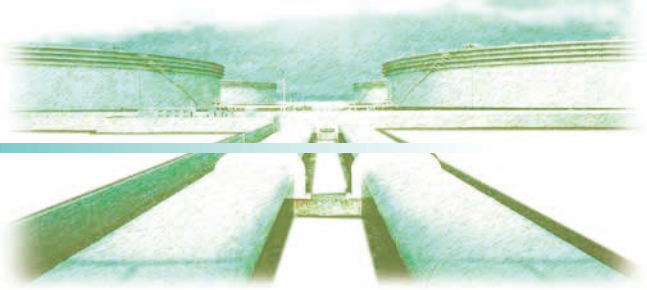
Mechanical properties of plate

Tensile test			Charpy impact test		
YS (N/mm²)	TS (N/mm²)	El* (%)	Temp. (˚C)	Dir.	Absorbed energy (J)
769	844	24	- 40	L	286

* JIS No.4

y-groove weld cracking test (JIS Z 3158)





JFE-HITEN 980 — 980N/mm² Class High Tensile Strength Steel Plates with High Weldability

Chemical composition

(%)

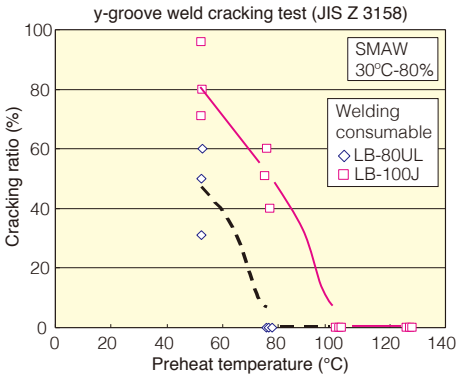
Thickness (mm)	C	Si	Mn	P	S	P_{CM}
75	0.09	0.25	1.14	0.005	0.001	0.27

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

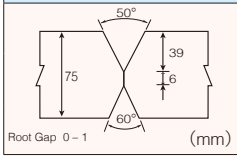
Mechanical properties of plate

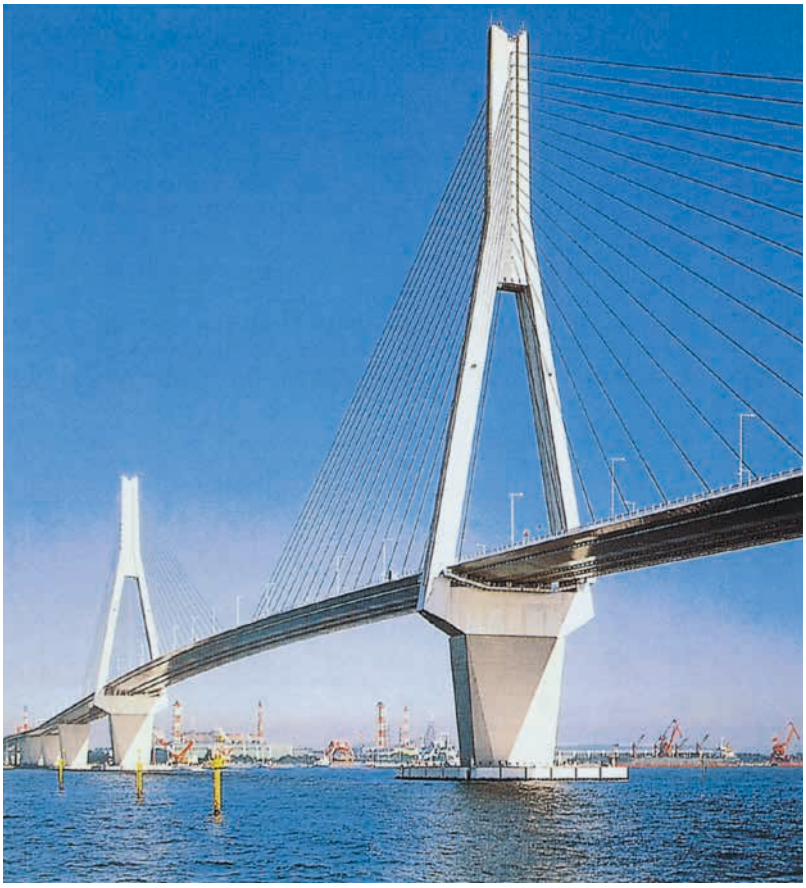
Tensile test (1/4 t)			Charpy impact test (1/4 t)		
YS (N/mm²)	TS (N/mm²)	El* (%)	Temp. (℃)	Dir	Absorbed energy (J)
930	977	25	0	C	208
			- 60	C	158

*JIS No.4



Mechanical properties of submerged arc welded joint

Welding condition			Tensile strength of welded joint (N/mm²)	Charpy impact test		
Groove configuration	Welding material	Heat input (kJ/cm)		Test location	Test temp. (℃)	Absorbed energy (J)
	PFH-100J/US -100J	45	977 981	Weld metal	- 10	109
				Fusion line		136
				Center of HAZ		248



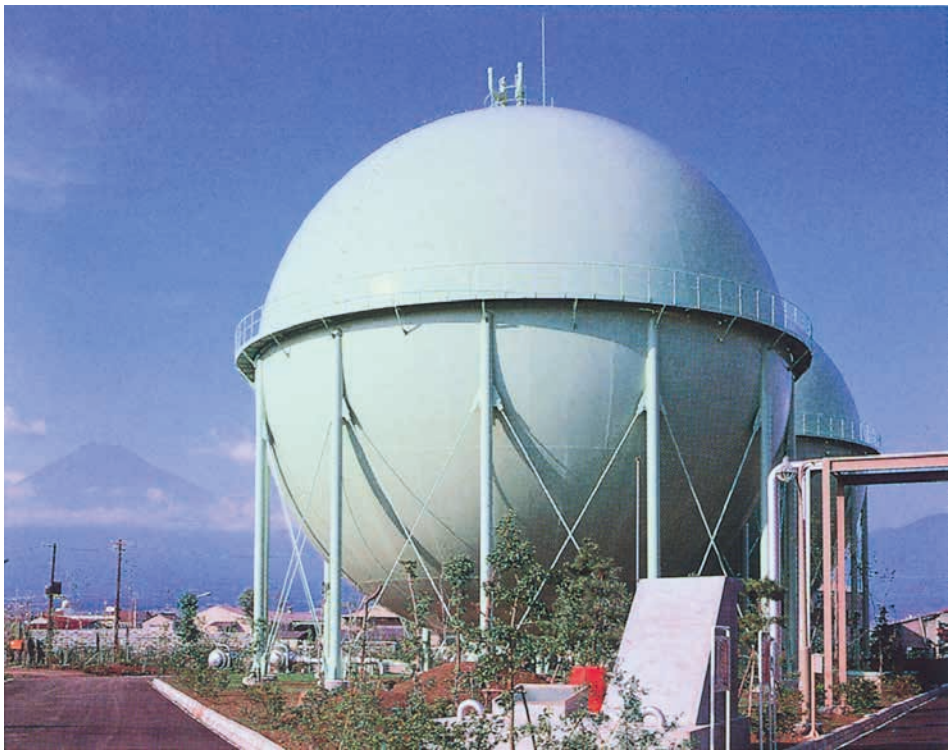
APPROVED OR AUTHORIZED PRODUCTS

Japan Welding Engineering Society (WES)

Grades of Strength	WES Approved JFE-HITEN Standard	WES Standard	
		WES 3001 Standard Equivalent Symbol	WES 3009 Standard Equivalent Symbol
540	JFE-HITEN540S	HW355RA	–
590	JFE-HITEN590	HW450QB	–
	JFE-HITEN590U2		HW450QCF
	JFE-HITEN590E		
	JFE-HITEN590SB	HW450NA	–
610	JFE-HITEN610	HW490QB	–
	JFE-HITEN610U2		HW490QCF
	JFE-HITEN610E		
690	JFE-HITEN690	HW550QB	
710	JFE-HITEN710	HW620QB	–
780	JFE-HITEN780	HW685QB	
980	JFE-HITEN980	HW855QB	–

Ship's Class Society

Grades of Strength	Society			
	ABS	LR	NK	DNVGL
570	A/D/E47	D/E46	A/D/E460	A/D/E460
610	A/D/E/F51	D/E50	A/D/E500	A/D/E500
670	A/D/E/F56	D/E55	A/D550	A/D/E550
720	A/D/E63	D/E62	A/D/E620	A/D/E620
770	A/D/E/F70	D/E69	A/D/E690	A/D/E/F690



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^2 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.

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.

Typical Welding Materials

Strength	JFE-HITEN	SMAW	SAW	CO_2 Arc Welding	Ar + CO_2 Arc Welding	Electro-gas Arc Welding
		KOBELCO	KOBELCO	KOBELCO	KOBELCO	KOBELCO
590N/mm^2 Class	590, 610 590S, 590SL 570U2, 590U2, 610U2 570E, 590E, 610E	LB62 LB62U LB62UL KSA-86	MF38×US40 MF38×US49 KB-110×KW-101B	MG60 DW60 KC-60	MIX60B KM-60	DWS60G DWS1LG
690N/mm^2 Class	690, 710, 690S 690M, 710M	LB106	MF38×US70	MG70	MGS70	—
780N/mm^2 Class	780M, 780EX 780S, 780LE	LB116 LB80UL	PFH80AK×US80BN PFH80AK×US80LT	MG80	MGS80	—
980N/mm^2 Class	980S 980	LB100B LB100J	PFH100A×US100A PFH100J×US100J	—	MGS100J	—

2) Re-Baking Before Use

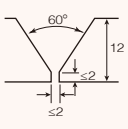
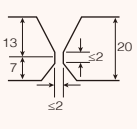
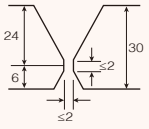
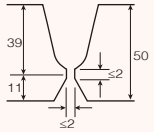
Low hydrogen type welding rods for shielded metal arc welding must be dried for about 1 hour at temperatures between 350 and 400˚C before use. Fluxes for submerged arc welding must also be fully dried for about 1 hour at 250 – 350˚C.

3) Edge Preparation

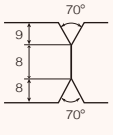
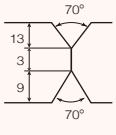
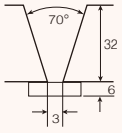
Edge preparation can be performed by gas cutting. When an intricate groove configuration is involved, or when high precision is required, edge preparation is performed by machining.

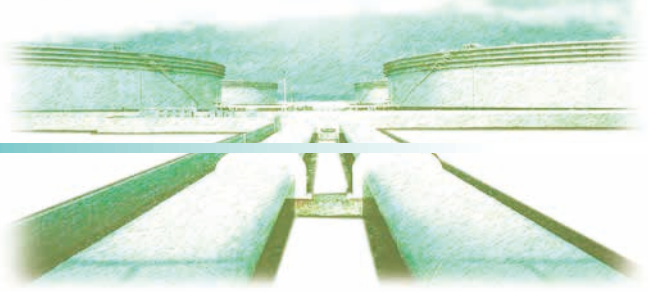
Typical Bevel Shapes

For Shielded Metal Arc Welding (SMAW)

Thickness (mm)	12	20	30	50
Unit : mm				

For Submerged Arc Welding (SAW)

25		32
		



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.

590N/mm^2 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^2 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^2 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.

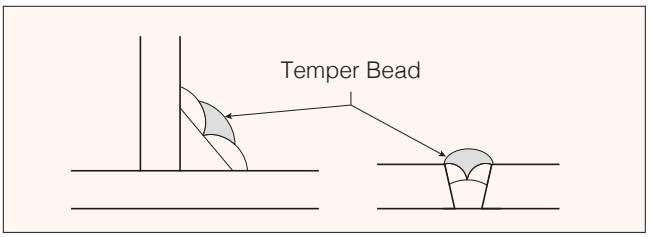
6) Welding

i) 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.

ii) It is recommended that arc length be as short as possible.

iii) 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.

iv) In case of SMAW for 690N/mm^2 and over grade, please adopt the Temper Bead Methods, as shown right.



v) 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.

vi) 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.

vii) Beside preheating, the control of interlayer temperature is recommended.

Cat.No.C1E-002-07

JFE Steel Corporation

https://www.jfe-steel.co.jp/en/

HEAD OFFICE
Hibiya Kokusai Building, 2-3 Uchisaiwaicho 2-chome, Chiyodaku, Tokyo 100-0011, Japan Phone: (81)3-3597-3111 Fax: (81)3-3597-4860

■ ASIA PACIFIC

SEOUL
JFE Steel Korea Corporation
16th Floor, 41, Cheonggyecheon-ro, Jongno-gu, Seoul, 03188, Korea
(Youngpung Building, Seorin-dong)
Phone: (82)2-399-6337 Fax: (82)2-399-6347

SHANGHAI
JFE Consulting (Shanghai) Co., Ltd.
Room 801, Building A, Far East International Plaza, 319 Xianxia Road, Shanghai 200051, P.R.China
Phone: (86)21-6235-1345 Fax: (86)21-6235-1346

BEIJING
JFE Consulting (Shanghai) Co., Ltd. Beijing Branch
821 Beijing Fortune Building No.5 Dongsanhuan North Road, Chaoyang District, Beijing, 100004, P.R.China
Phone: (86)10-6590-9051

GUANGZHOU
JFE Consulting (Guangzhou) Co., Ltd.
Room 3901 Citic Plaza, 233 Tian He North Road, Guangzhou, 510613, P.R.China
Phone: (86)20-3891-2467 Fax: (86)20-3891-2469

MANILA
JFE Steel Corporation, Manila Office
23rd Floor 6788 Ayala Avenue, Oledan Square, Makati City, Metro Manila, Philippines
Phone: (63)2-8886-7432 Fax: (63)2-8886-7315

HO CHI MINH CITY
JFE Steel Vietnam Co., Ltd.
Unit 1704, 17th Floor, MPlaza, 39 Le Duan Street, Dist 1, HCMC, Vietnam
Phone: (84)28-3825-8576 Fax: (84)28-3825-8562

HANOI
JFE Steel Vietnam Co., Ltd., Hanoi Branch
Unit 2314, 23rd Floor-West, Lotte Center Hanoi, 54 Lieu Giai Street, Cong Vi Ward, Ba Dinh District, Hanoi, Vietnam
Phone: (84)24-3855-2266 Fax: (84)24-3533-1166

BANGKOK
JFE Steel (Thailand) Ltd.
22nd Floor, Abdulrahim Place 990, Rama IV Road, Silom, Bangrak, Bangkok 10500, Thailand
Phone: (66)2-636-1886 Fax: (66)2-636-1891

YANGON
JFE Steel (Thailand) Ltd., Yangon Office
Unit 05-01, Union Business Center, Nat Mauk Road, Bocho Quarter, Bahan Tsp, Yangon, 11201, Myanmar
Phone: (95)1-860-3352

SINGAPORE
JFE Steel Asia Pte. Ltd.
16 Raffles Quay, No.15-03, Hong Leong Building, 048581, Singapore
Phone: (65)6220-1174 Fax: (65)6224-8357

JAKARTA
PT. JFE STEEL INDONESIA
6th Floor Summitmas II, JL Jendral Sudirman Kav. 61-62, Jakarta 12190, Indonesia
Phone: (62)21-522-6405 Fax: (62)21-522-6408

NEW DELHI
JFE Steel India Private Limited
806, 8th Floor, Tower-B, Unitech Signature Towers, South City-I, NH-8, Gurgaon-122001, Haryana, India
Phone: (91)124-426-4981 Fax: (91)124-426-4982

MUMBAI
JFE Steel India Private Limited, Mumbai Office
603-604, A Wing, 215 Atrium Building, Andheri-Kurla Road, Andheri (East), Mumbai-400093, Maharashtra, India
Phone: (91)22-3076-2760 Fax: (91)22-3076-2764

BRISBANE
JFE Steel Australia Resources Pty Ltd.
Level28, 12 Creek Street, Brisbane QLD 4000 Australia
Phone: (61)7-3229-3855 Fax: (61)7-3229-4377

■ MIDDLE EAST

DUBAI
JFE Steel Corporation, Dubai Office
P.O.Box 261791 LOB19-1208, Jebel Ali Free Zone Dubai, U.A.E.
Phone: (971)4-884-1833 Fax: (971)4-884-1472

■ NORTH, CENTRAL and SOUTH AMERICA

HOUSTON
JFE Steel America, Inc.
750 Town & Country Blvd., Suite 705, Houston, TX 77024, U.S.A.
Phone: (1)713-532-0052 Fax: (1)713-532-0062

MEXICO CITY
JFE Steel de Mexico S.A. de C.V.
Ruben Dario #281-1002, Col. Bosque de Chapultepec, C.P. 11580, CDMX. D.F. Mexico
Phone: (52)55-5985-0097

RIO DE JANEIRO
JFE Steel do Brasil LTDA
Praia de Botafogo, 228 Setor B, Salas 508 & 509, Botafogo, CEP 22250-040, Rio de Janeiro-RJ, Brazil
Phone: (55)21-2553-1132 Fax: (55)21-2553-3430

2503P(2009) JTR
Printed in Japan