NIPPON STEEL

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Steel Plates
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Introduction

Increasingly higher functionality and quality are demanded for steel plates. This is a reflection of technological progress in various application fields, as well as diversification of usage environments.

Through our total control system and operational technology realized through thorough quality control, excellent equipment, the technology we have cultivated, and our vast experience, we at NIPPON STEEL will continue to create products that accurately meet the demands of any field, both qualitatively and quantitatively.

Under a new organizational system, we will work diligently every day as we strive for quality and turnaround times that rank number one in the world.

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Features

1. Wide Product Availability / Various Uses

We provide a **wide product availability** including steel plates that satisfy official standards in Japan and overseas, high tensile strength steel for welded structures, abrasion resistant steel, atmospheric corrosion resistant steel, low-temperature service steel, and steel for building, as well as materials that are suitable for a **wide variety of uses,** from offshore structures (production), line pipes (transport), tanks (storage) and other high-function steel for use in energy fields.

In addition, we also accept orders for steel with special specifications, such as extra-thick steel plates for molds, electromagnetic soft iron, and chromium molybdenum steel for use in high temperatures. We also provide shot blasting and primer coating upon request. We also manufacture extra-heavy thick steel plates for use in nuclear power plants, thermal power plants, hydraulic power plants, petrochemical plants and the like.

2. Stable Quality

We use our excellent equipment and technology and vast experience to manufacture products with **stable quality** under strict control throughout all process including pig iron manufacturing, steel manufacturing, heating, rolling and cooling.

3. Flawless Surface

Using material (slabs) manufactured under a strict quality control system, we manufacture **steel plates with flawless surface** by removing scales from the steel plates with high pressure water jets during the rolling process.

In addition, in the transport and heat treatment, etc. of steel plates, manufacturing is conducted using state-of-the-art equipment.

4. On-time Delivery

We strive for **on-time delivery** by making the most of the advantageous seaside location of each steel mill and our control systems for each individual product under process control that effectively utilizes a computer system.

5. Precise Consulting

The engineering divisions at our head office and various branch offices can **precisely** provide consulting on the quality characteristics, applications, and processing methods of steel plates as well as technical cooperation during use, based on their vast experience and comprehensive technical capabilities.

6. Wide Range of Sizes

We can manufacture steel plates in a **wide range of sizes,** with thicknesses of 6 mm to a maximum of 560 mm, widths up to 5300 mm, and lengths up to 28 m. We can manufacture extra-heavy thick steel plates with a maximum thickness of 560 mm, maximum width of 4500 mm and maximum unit mass of 40 tons.

Available Grades

＊ For a comparison of the old Nippon Steel specifications and old Sumitomo Metal specifications, please see page 56.

Our company manufactures thick steel plates that meet various standards. Products with NIPPON STEEL standards are unique to our company. An excerpt of these standards is included in another chapter. We also respond to requests involving standards other than those listed below.

Type of steel / Standard	NIPPON STEEL specifications (brand)	JIS specification	Other Standards
Steels for general structures	—	JIS G 3101 (Rolled Steel for General Structures): SS330, 400, 490, 540	ASTM A283 ASME SA283 DIN17100
Steels for welded structures	CORSPACE™ series FCA™	JIS G 3106 (Rolled Steel for Welded Structures): SM400A, B, C, 490A, B, C, 490YA, YB, 520B, C JIS G 3140 (Higher Yield Strength Steel Plates for Bridge): SBHS400	ASTM (A36, A440, A441, A529, A572, A633, A709) ASME (SA36, SA440, SA441, SA529, SA572, SA633, SA709) BS4360, 7191 DIN17102 ISO630 EN10025 IS2062, 8500, 2002 AS3678
Weldable high-strength steels	WEL-TEN™ series CORSPACE™ series FCA™	JIS G 3106 (Rolled Steel for Welded Structures): SM570 JIS G 3140 (Higher Yield Strength Steel Plates for Bridges): SBHS500, 700	ASTM (A537, A514, A517, A710, A841) ASME (SA537, SA514, SA517, SA710, SA841) ISO4950/3
Steels for building structures	BT-HT series BT-LYP™ series NSFR™ series	JIS G 3136 (Rolled Steel for Building Structures): SN400A, B, C, 490B, C	
Steels for ships	NSafe™–Hull HIAREST™ FCA™	—	ASTM A131 NK, LR, AB, BV, CR, GL, NV, KR CCS, RS, RINA
Low-temperature steels	N-TUF™ series	JIS G 3126 (Carbon Steel Plate for Low-temperature Pressure Vessels): SLA235A, B, 325A, B, 360 JIS G 3127 (Nickel Steel Plate for Low-temperature Pressure Vessels): SL2N255, SL3N255, 275, 440, SL9N520, 590	ASTM (A537, A841, A203, A353, A553, A645) ASME (SA537, SA841, SA203, SA353, SA553, SA645, SA844) NK, LR, AB, NV, GL, RINA Low-temperature steel plates
Nickel steel plates for low temperature service	—	JIS G 3127 (Nickel Steel Plate for Low-temperature Pressure Vessels): SL2N255, SL3N255, 275, 400 SL7N590, SL9N520, 590	ASTM A553, A841 Grade G, A844 ASME SA553, SA844 EN10028 NK, LR, AB, NV, GL, RINA Low-temperature steel plates
Medium-to-high-temperature steels	—	JIS G 3103 (Carbon Steel Plate and Molybdenum Steel Plate for Boilers and Pressure Vessels): SB410, 450, 480, 450M, 480M JIS G 3119 (Manganese-Molybdenum Steel Plate and Manganese-Molybdenum-Nickel Steel Plate for Boilers and Pressure Vessels): SBV1A, 1B, 2, 3 JIS G 3120 (Manganese-Molybdenum Steel Plate and Manganese-Molybdenum-Nickel Alloy Steel Plate Quenched and Tempered Pressure Vessels): SQV1A, 1B, 2A, 2B, 3A, 3B JIS G 4109 (Chrome-Molybdenum Steel Plate for Boilers and Pressure Vessels): SCMV1, 2, 3, 4, 5, 6	ASTM (A204, A225, A299, A302, A387, A515, A533, A542, A543, A537, A517, A710) ASME (SA204, SA225, SA299, SA302, SA387, SA515, SA533, SA542, SA543, SA537, SA517, SA710) BS1501 DIN17155 NF A36–206 EN10028 AS1548 NK, LR, AB, BV, CR, GL, NV, KR, CCS RINA Plates for boilers

Type of steel / Standard	NIPPON STEEL specifications (brand)	JIS specification	Other Standards
Intermediate temperature steels	—	JIS G 3115 (Plate for Pressure Vessels): SPV235, 315, 355, 450, 490 JIS G 3118 (Carbon Steel Plate for Normal to Medium-temperature Pressure Vessels): SGV410, 450, 480	ASTM (A285, A455, A516, A537) ASME (SA285, SA455, SA516, SA537) BS1501 DIN17155 NF A36–295 EN10028
Atmospheric corrosion resistant steels	COR–TEN™ series NAW–TEN™ series	JIS G 3114 (Hot-rolled Corrosion-resisting Steel for Welded Structures): SMA400A, B, C /–W, –P, 490A, B, C/–W, –P, 570 / –W, –P JIS G 3125 (Highly Corrosion-resisting Steel): SPA–H JIS G 3140 (Higher Yield Strength Steel Plates for Bridge): SBHS400W, 500W, 700W	ASTM (A242, A588, A709) JRS–SPA–H ISO4952
Seawater corrosion resistant steels	MARILOY™ series	—	—
Sulfuric acid resistant steels	S–TEN™ series	—	—
Corrosion resistant steel for crude oil tankers	NSGP™ series	—	Corrosion resistant steel for Classification society specification cargo oil tanks
Steel plates for linepipes	—	—	API 5L Gr.A, B, X42, X52, X56, X60 X65, X70, X80, X100 CSA Z245.1
Structural steel materials for offshore service	—	—	API 2H Gr.42, 50 API 2W Gr.50, 60 EN10225 S355, 420, 460 NORSOK Y20, Y30, Y40, Y50 SHELL GR345, 414, 552
Steels for machine structural use	—	JIS G 4051 (Carbon Steel for Machine Structural Use): S10C ~ S58C JIS G 4053 (Chrome-Molybdenum Steels): SCM415 ~ 440 JIS G 4401 (Chrome-Molybdenum Steels): SK4 ~ 7	AISI 1008, 1015, 1020, 1021 SAE 1008, 1015, 1020, 1021
Abrasion resistant steels	ABREX™ series	—	—
Electromagnetic soft iron plates	NS–MIP™	—	—
Hot-dip galvanized steel plates	NAGP™	—	—

Authorized Steel Grades by Product Type

■ Steel Plates for Hulls

Ship register	Authorized steel grade
Nippon Kaiji Kyokai (NK) Lloyd's Register of Shipping (LR) Bureau Veritas (BV) American Bureau of Shipping (ABS) Det Norske Veritas (NV) Chinese Register of Shipping (CR) Korean Register of Shipping (KR) German Lloyd's Register of Shipping (GL) Register of Italy (RI) Chinese Classification Society (CCS) Russian Classification Society (RS)	Mild Steel A, B, D, E A32, D32, E32, F32 A36, D36, E36, F36 A40, D40, E40, F40 A43, D43, E43, F43 A47, D47, E47, F47 A420, D420, E420, F420, A460, D460, E460 A500, D500, E500, F500, A550, D550, E550, F550 A620, D620, E620, F620, A690, D690, E690, F690 ※The approved steel grades vary depending on the classification society. Please contact us for details. ※Corrosion resistant steel for Cargo Oil Tanker (-RCB, -RCW) is under qualiying.

■ High Tensile Strength Steel Plates (WES)

Society	Corresponding grade	NIPPON STEEL specifications	Old specifications
Japan Welding Engineering Society (WES)	HW355	**WEL-TEN540**	SUMITEN540
	HW450	**WEL-TEN590**	SUMITEN590
	HW450B, HW450CF, LT450-IV-40G-15A	**WEL-TEN590EX**	SUMITEN590F
	HW490	**WEL-TEN610**	SUMITEN610
	HW490B, HW490CF, LT490-IV-40G-15A	**WEL-TEN610EX**	SUMITEN610F
	HW550	**WEL-TEN690**	SUMITEN690
	HW685	**WEL-TEN780**	SUMITEN780
	HW685	**WEL-TEN780E**	SUMITEN780S
	HW885	**WEL-TEN950**	SUMITEN950

■ Steel Plates for Low-temperature Service (WES)

Society	Corresponding grade	NIPPON STEEL specifications	Old specifications
Japan Welding Engineering Society (WES)	LT285-III-80G-30A	**N-TUF295 (N-TUF295N)**	SLT285
	LT325-II-70G-30A, LT325-IV-50G-25A	**N-TUF325**	SLT325A
	LT325-III-90G-50A, LT325-IV-80G-40A, LT325-VI-70G-30A	**N-TUF325**	SLT325B
	LT360-II-90G-40A, LT360-IV-90G-40A	**N-TUF365**	SLT360
	LT440-VI-105G-80A	**N-TUF570**	SLT3N440
	LT450-I-80G-60A, LT450-II-80G-50A, LT450-III-70G-40A, LT450-V-60G-20A	**N-TUF490**	SUMITEN590LT
	LT490-I-80G-60A, LT490-II-80G-50A, LT490-III-70G-40A, LT490-V-50G-20A	**N-TUF490**	SUMITEN610LT

■ Steel Plates for Low-temperature Service (Ship Building Standards)

Ship register	Authorized steel grade
Nippon Kaiji Kyokai (NK)	KL24A, B, KL27, KL33, KL37, KL7N60, KL9N60
American Bureau of Shipping (AB)	V-039, V-051, V-060, VH-039, VH-051, VH-060, 9%Ni QT
Lloyd's Register of Shipping (LR)	LT-AH (LT-AH27S, LT-AH32, LT-AH36, LT-AH40), LT-DH (LT-DH27S, LT-DH32, LT-DH36, LT-DH40) LT-EH (LT-EH27S, LT-EH32, LT-EH36, LT-EH40), LT-FH (LT-FH27S, LT-FH32, LT-FH36, LT-FH40), 3½Ni, 5Ni
Det Norske Veritas (NV)	NV2-2, NV4-2, NV2-3, NV4-3, NV2-4, NV2-4L, NV4-4, NV4-4L, 3.5Ni, 5Ni

■ Steel Plates for Boilers and Pressure Vessels

Society	Authorized steel grade	Remarks
Japan Welding Engineering Society (WES)	SMT245, 295, 345	(WES3005)
Nippon Kaiji Kyokai (NK)	KP42, KP46, KP49, KPA46, KPA49	for Boilers
	KPV24, KPV32, KPV36, KPV46, KPV50	for Pressure Vessels
Lloyd's Register of Shipping (LR)	360AR, 410AR, 460AR, 360, 410, 460, 490, 360FG, 410FG, 460FG, 490FG	for Boilers
American Bureau of Shipping (AB)	MA, MB, MC, MD, ME, MF, MG, H, I, J	—
German Lloyd's Register of Shipping (GL)	410W	—

■ Pre-Qualification for Offshore Structures

Authorized standards	Authorized steel grade
API	2W Gr.50, Gr.60
EN10225	S355, S420, S460
NORSOK	Y20, Y30, Y40, Y50
SHELL	GR345, GR414, GR552

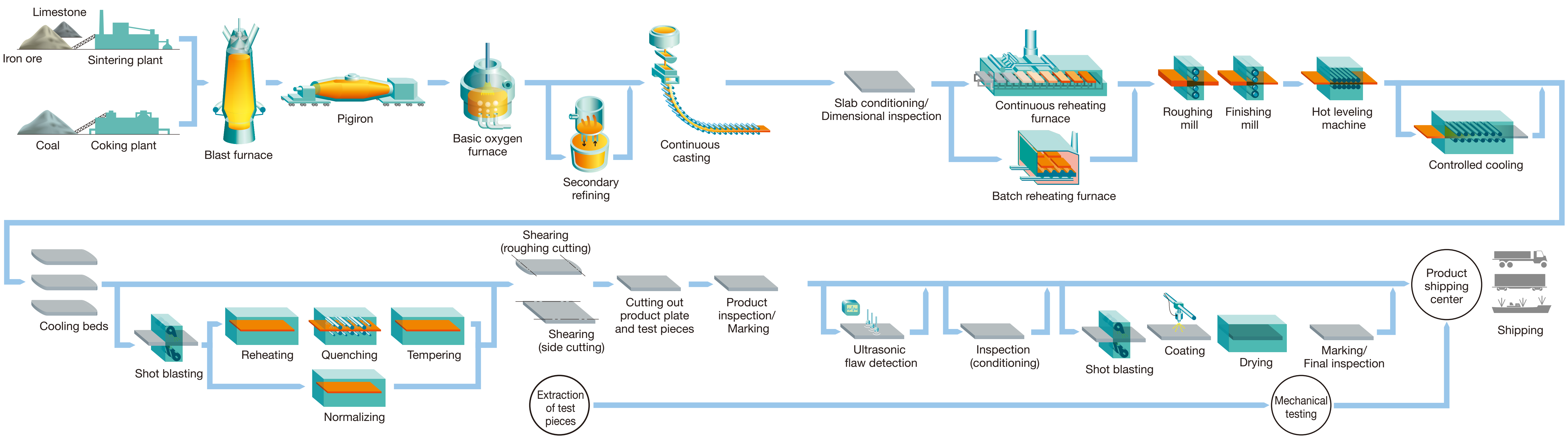
■ CE Mark

Authorized standards	Authorized steel grade
EN10025-2	S355JR, S355J0 +AR S355JR, S355J0, S355J2, S355K2 +N S355JR, S355J0, S355J2, S355K2 +M
EN10025-4	S355M, S355ML

■ Others

Society	Authorized standards	Corresponding grade
Vereinigung der Technishen berwachungs Verein (TÜV)	EN10025-2	S235JR ~ S450J0
	EN10028-2	P235GH ~ X10CrMoVNb9-1
	EN10028-3	P275NH ~ P460NL2
	EN10028-4	11MnNi5-3 ~ X7Ni9
	AD 2000-Merkblätt	W1, W10
	TRD	101

Manufacturing Process and Quality Control Points



Thermo-Mechanical Control Process (TMCP)

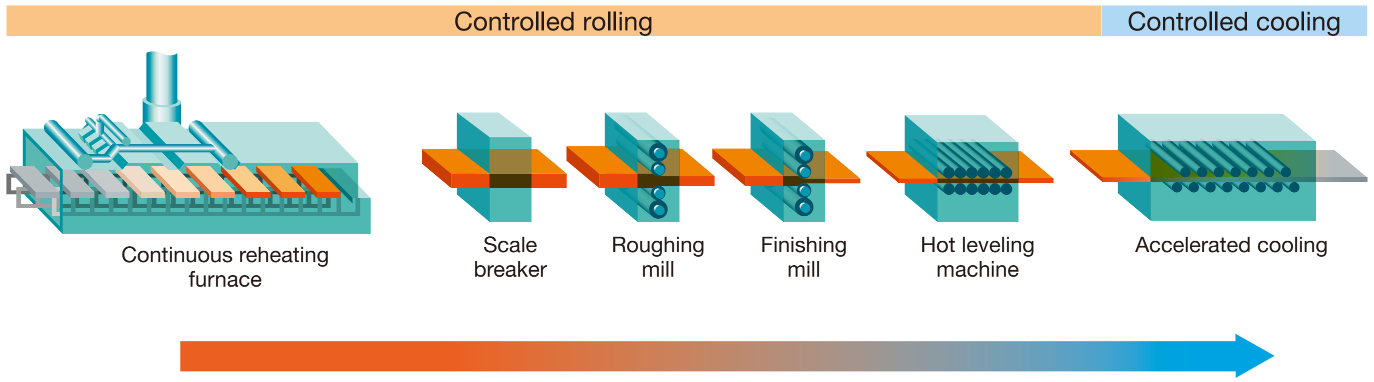
TMCP is applied in high tensile strength thick steel plates of 490 N/mm² or greater, and achieves marked and major improvement in characteristics such as low-temperature toughness and weldability. TMCP is used in a wide variety of fields such as shipbuilding, marine structures, bridges, architecture, industrial machinery, line pipes and tanks.

1. Summary of TMCP

TMCP is a manufacturing process of steel plates based on a combination of controlled rolling and controlled cooling.

When high tensile strength steel of tensile strength ratings of 490 N/mm² or more is manufactured by TMCP, major reduction in the amount of alloying elements added can be achieved, along with lower carbon levels. An outline of equipment used in TMCP is shown in Fig. 1.

Fig. 1 TMCP equipment layout



※TMCP (Thermo-Mechanical Control Process)
A collective name for all methods of manufacturing steel plates with controlled rolling or controlled rolling combined with accelerated cooling.
For details on TMCP, please see the reference material (p.36 to 40)

2. Characteristics of TMCP high tensile strength steel

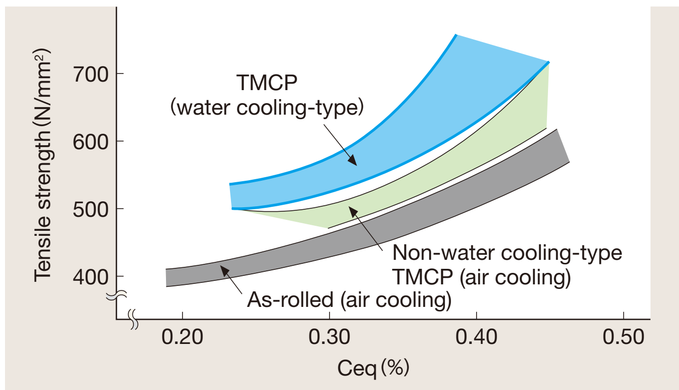
(1) Low Ceq (carbon equivalent)

Toughness has been improved as a result of realization of low Ceq and utilization of TMCP.

(2) About the advantages of using TMCP high tensile strength steel plates (For details, please see page 38 of the reference material for the time of use) Weldability is greatly improved, and as a result, the following advantages are obtained during use.

- Due to the low P_{CM} level (weld crack sensitivity composition), the preheating temperature at the time of welding can be lower than that of conventional high tensile strength steel
- The maximum hardness of the welded joints can be made lower than that of conventional high tensile strength steel
- Improving toughness of welded joints
- Less deterioration in mechanical properties of the material by linear heat

Fig. 2 Relationship between the conventional manufacturing process and the TMCP Process in terms of Ceq and strength (plate thickness of 20 to 30 mm)



3. Example Applications of TMCP High Tensile Steel

(1) Shipbuilding and offshore structures

These steel plates have been approved by the classification societies in the table below.

Standards of classification societies approved by TMCP (examples)

Classification	Y.P.315N/mm²			Y.P.355N/mm²			Y.P.390N/mm²		
	A-Grade	D-Grade	E-Grade	A-Grade	D-Grade	E-Grade	A-Grade	D-Grade	E-Grade
NK	●	●	●	●	●	●	●	●	●
ABS	●	●	●	●	●	●	●	●	●
DNV	●	●	●	●	●	●	●	●	●
LR	●	●	●	●	●	●	●	●	●
BV	●	●	●	●	●	●	●	●	●

- Application examples
  Shipbuilding: Tankers, cargo vessels, container ships, refrigerator vessels, etc.
  Offshore structures: Jack-up rigs, semi-submersible rigs, crane barge, etc.

(2) BT-HT325, 355, 385, 400 and 500 for building structures

(3) It has been applied in a wide range of uses such as industrial machinery, line pipes, tanks, general uses and the like.

4. High-toughness, High-strength Steel Plates for Low-temperature Applications

In response to user requests, TMCP is increasingly applied to the manufacture of high-strength and high-toughness steel plates for lower-temperature service applications (offshore structures, jackets, offshore facilities, etc.)

5. Examples Applications in standards

Standards	Specifications
ASTM	A841 (Steel Plates for Pressure Vessels), A844 (9% Ni Steel Plates)
JIS	G 3106 SM Grade, G 3114 SMA Grade, G 3136 SN Grade, G3140 SBHS
EN	EN10025 (Structural Steel), EN10028 (Pressure Vessel Steel), EN10225 (Offshore structural steel)
API	API 2W (Offshore structural steel)

400 N/mm^2-class Tensile Strength Steel Plates (As-rolled)

Available Sizes

Thickness (mm)		1000 to 1200	Over 1200 to 1400	1400~1600	1600~1800	1800~2000	2000~2200	2200~2400	2400~2600	2600~2800	2800~3000	3000~3200	3200~3400	3400~3600	3600~3800	3800~4000	4000~4200	4200~4400	4400~4500	4500~4600	4600~4800	4800~5000	5000~5200
6																	21.0	18.0					
Over 6	7 or less				25.0												25.0	22.0	22.0	22.0	22.0		
7	8											25.0					25.0	25.0	22.0	22.0	22.0		
8	9																25.0	25.0	25.0	22.0	22.0		
9	10				26.0												25.0	25.0	25.0	23.0	23.0	22.0	22.0
10	12																25.0	25.0	25.0	23.0	23.0	23.0	23.0
12	14				27.0						26.0				25.0	25.0	25.0	25.0	25.0	24.0	24.0	23.0	23.0
14	16														25.0	25.0	25.0	25.0	25.0	24.0	24.0	23.0	23.0
16	18								27.0							26.0		25.0	25.0	25.0	25.0	24.0	24.0
18	20																	25.0	25.0	25.0	25.0	24.0	24.0
20	22											27.0	27.0	27.0	27.0	27.0	27.0	27.0	27.0	27.0	26.0	25.0	24.0
22	24											27.0	27.0	27.0	27.0	27.0	27.0	26.0	26.0	25.0	24.0	23.0	22.0
24	26											28.0	28.0	28.0	28.0	27.0	25.0	25.0	25.0	23.0	22.0	21.0	21.0
26	28	25.0										28.0	28.0	28.0	26.0	25.0	25.0	24.0	23.0	22.0	21.0	20.0	19.0
28	30											28.0	27.0	26.0	25.0	24.5	23.0	22.0	21.5	20.0	19.0	19.0	18.0
30	32							28.0				27.0	26.0	25.0	23.5	22.5	21.5	20.5	20.0	19.0	18.0	17.0	17.0
32	34										27.0	26.0	25.0	23.5	22.5	21.0	20.0	19.0	19.0	18.0	17.0	16.0	16.0
34	36										26.0	25.0	23.5	22.0	21.0	20.0	19.0	18.0	17.5	17.0	16.0	15.0	15.0
36	38									26.0	25.0	23.5	22.5	21.0	20.0	19.0	18.0	17.0	17.0	16.0	15.0	14.0	14.0
38	40								27.0	25.0	24.0	22.5	21.0	20.0	19.0	18.0	17.0	16.5	16.0	15.0	14.0	14.0	13.0
40	42							27.0	25.0	24.0	22.5	21.0	20.0	19.0	18.0	17.0	16.0	15.0	15.0	14.0	14.0	13.0	13.0
42	44							26.0	24.5	23.0	21.5	20.0	19.0	18.0	17.0	16.0	15.0	14.5	14.0	14.0	13.0	12.0	12.0
44	46						27.0	25.0	23.5	22.0	20.5	19.0	18.0	17.0	16.0	15.5	14.5	14.0	13.5	13.0	12.0	12.0	11.0
46	48			27.0	27.0	27.0	26.0	24.5	22.5	21.0	19.5	18.5	17.0	16.5	15.5	14.5	14.0	13.5	13.0	12.0	12.0	11.0	11.0
48	50			26.0	26.0	26.0	25.0	23.5	21.5	20.0	19.0	17.5	16.5	16.0	15.0	14.0	13.5	12.5	12.5	12.0	11.0	11.0	10.0
50	52	24.0	24.0	25.0	25.0	25.0	24.0	22.5	21.0	19.5	18.0	17.0	16.0	15.0	14.0	13.5	13.0	12.0	12.0	11.0	11.0	10.0	10.0
52	54			24.0	24.0	24.0	23.0	21.5	20.0	18.5	17.5	16.5	15.5	14.5	14.0	13.0	12.5	12.0	11.5	11.0	10.0	10.0	10.0
54	56			23.0	23.0	23.0	22.5	21.0	19.5	18.0	17.0	16.0	15.0	14.0	13.0	12.5	12.0	11.5	11.0	11.0	10.0	10.0	9.5
56	58	23.0		23.0	23.0	22.0	21.5	20.0	18.5	17.5	16.0	15.0	14.0	13.5	13.0	12.0	11.5	11.0	10.5	10.0	10.0	9.5	9.0
58	60			23.0	23.0	22.0	21.0	19.5	18.0	16.5	15.5	14.5	14.0	13.0	12.5	11.5	11.0	10.5	10.5	10.0	9.5	9.0	9.0
60	65			23.0	20.5	20.0	19.0	18.0	16.5	15.5	14.5	13.5	12.5	12.0	11.5	11.0	10.0	9.5	9.5	9.0	9.0	8.5	8.0
65	70			23.0	20.5	18.5	18.0	16.5	15.5	14.5	13.5	12.5	12.0	11.0	10.5	10.0	9.5	9.0	9.0	8.5	8.0	8.0	7.5
70	75	23.0	22.5	20.0	18.0	17.0	16.5	15.5	14.5	13.5	12.5	11.5	11.0	10.5	10.0	9.5	9.0	8.5	8.5	8.0	7.5	7.5	7.0
75	80	23.0	22.5	20.0	18.0	16.0	15.5	14.5	13.5	12.5	11.5	11.0	10.0	9.5	9.0	8.5	8.5	8.5	8.5	7.5	7.0	7.0	6.5
80	85	23.0	20.0	17.5	16.0	15.0	14.5	13.5	12.5	11.5	11.0	10.0	9.5	9.0	8.5	8.5	8.5	8.5	8.5	7.0	6.5	6.0	6.0
85	90	23.0	20.0	17.5	16.0	14.5	14.0	13.0	12.0	11.5	11.0	9.5	9.0	8.5	8.5	8.5	8.5	8.5	8.5	6.5	6.5	6.0	6.0
90	95	21.0	18.0	16.0	14.5	13.0	13.0	12.0	11.5	11.5	11.0	9.0	8.5	8.5	8.5	8.5	8.5	8.5	8.5				
95	100	21.0	18.0	16.0	14.5	13.0	12.5	11.5	11.5	11.5	11.0	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5				
100	105	19.0	16.5	14.5	13.0	12.0	12.0	11.5	11.5	11.5	11.0	8.5	8.5	8.5	8.5	8.5	8.5	8.0	8.0				
105	110	19.0	16.5	14.5	13.0	12.0	12.0	11.5	11.5	11.5	11.0	8.5	8.5	8.5	8.5	8.5	8.5	8.0	8.0				

Standard size range / Standard size range For sizes of over 25m in length, please consult us in advance.

Thickness (mm)		1000 to 1200	Over 1200 to 1400	1400~1600	1600~1800	1800~2000	2000~2200	2200~2400	2400~2600	2600~2800	2800~3000	3000~3200	3200~3400	3400~3600	3600~3800	3800~4000	4000~4200	4200~4400	4400~4500	4500~4600	4600~4800	4800~5000	5000~5200
110	115	17.5	15.0	13.5	12.5	12.0	12.0	11.5	11.5	11.5	11.0	8.5	8.5	8.5	8.5	8.0	8.0	7.5	7.0				
115	120	17.5	15.0	13.5	12.5	12.0	12.0	11.5	11.5	11.5	11.0	8.5	8.5	8.5	8.5	8.0	8.0	7.5	7.0				
120	125	13.0	13.0	12.5	12.5	12.0	12.0	11.5	11.5	11.0	10.0	8.5	8.5	8.5	8.0	7.5	7.0	7.0	6.5				
125	130	13.0	13.0	12.5	12.5	12.0	12.0	11.5	11.5	11.0	10.0	8.5	8.5	8.5	8.0	7.5	7.0	7.0	6.5				
130	135				12.5	12.0	12.0	11.5	11.0	10.0	9.5	8.5	8.5	8.0	7.5	7.0	6.5	6.5	6.0				
135	140				12.5	12.0	12.0	11.5	11.0	10.0	9.5	8.5	8.5	8.0	7.5	7.0	6.5	6.5	6.0				
140	145				12.5	12.0	12.0	11.0	10.0	9.5	8.5	8.0	7.5	7.0	7.0	6.5	6.0	6.0	5.5				
145	150		13.0		12.5	12.0	12.0	11.0	10.0	9.5	8.5	8.0	7.5	7.0	7.0	6.5	6.0	6.0	5.5				
150	155				12.5	11.0	11.0	10.0	9.5	8.5	8.0	7.5	7.0	7.0	6.5	6.0	6.0	5.5	5.0				
155	160				12.5	11.0	11.0	10.0	9.5	8.5	8.0	7.5	7.0	7.0	6.5	6.0	6.0	5.5	5.0				
160	165				11.5	10.5	10.5	9.5	9.0	8.0	7.5	7.0	6.5	6.5	6.0	5.5	5.5	5.0	5.0				
165	170				11.5	10.5	10.5	9.5	9.0	8.0	7.5	7.0	6.5	6.5	6.0	5.5	5.5	5.0	5.0				
170	175		12.5		11.0	10.0	10.0	9.0	8.5	7.5	7.0	6.5	6.5	6.0	5.5	5.5	5.0	5.0	4.5				
175	180				11.0	10.0	10.0	9.0	8.5	7.5	7.0	6.5	6.5	6.0	5.5	5.5	5.0	5.0	4.5				
180	185		11.5		10.5	9.0	9.0	8.5	8.0	7.5	7.0	6.5	6.0	5.5	5.5	5.0	5.0	4.5					
185	190				10.5	9.0	9.0	8.5	8.0	7.5	7.0	6.5	6.0	5.5	5.5	5.0	5.0	4.5					
190	195		11.0		10.0	9.0	9.0	8.0	7.5	7.0	6.5	6.0	5.5	5.5	5.0	5.0	4.5	4.5					
195	200				10.0	9.0	9.0	8.0	7.5	7.0	6.5	6.0	5.5	5.5	5.0	5.0	4.5	4.5					
200	210		10.5		9.5	8.5	8.5	7.5	7.0	6.5	6.0	5.5	5.5	5.0	5.0	4.5	4.5						
210	220		10.0		9.0	8.0	8.0	7.5	6.5	6.0	6.0	5.5	5.0	5.0	4.5	4.5	4.0						
220	230		9.5		8.5	7.5	7.5	7.0	6.5	6.0	5.5	5.0	5.0	4.5	4.5	4.0							
230	240		9.0		8.0	7.0	7.0	6.5	6.0	5.5	5.5	5.0	4.5	4.5	4.0	4.0							
240	250				8.0	7.0	7.0	6.5	6.0	5.5	5.0	4.5	4.5	4.0	4.0								
250	260		8.5		7.5	6.5	6.5	6.0	5.5	5.0	5.0	4.5	4.5	4.0	4.0								
260	270		8.0		7.0	6.5	6.5	6.0	5.5	5.0	4.5	4.5	4.0	4.0									
270	280				7.0	6.0	6.0	5.5	5.0	5.0	4.5	4.0	4.0	3.5									
280	290		7.5		6.5	6.0	6.0	5.5	5.0	4.5	4.5	4.0	4.0	3.5									
290	300				6.5	5.5	5.5	5.0	5.0	4.5	4.0	4.0	3.5										
300	310		7.0		6.0	5.5	5.5	5.0	4.5	4.5	4.0	3.5	3.5										
310	320				6.0	5.5	5.5	5.0	4.5	4.0	4.0	3.5	3.5										
320	330		6.5		6.0	5.0	5.0	4.5	4.5	4.0	3.5	3.5	3.5										
330	340				5.5	5.0	5.0	4.5	4.0	4.0	3.5	3.5											
340	350				5.5	5.0	5.0	4.5	4.0	4.0	3.5	3.5											
350	360		6.0		5.5	4.5	4.5	4.5	4.0	3.5	3.5	3.0											
360	370				5.0	4.5	4.5	4.0	4.0	3.5	3.5	3.0											
370	380				5.0	4.5	4.5																
380	390		5.5		5.0	4.5	4.5																
390	400				4.5	4.0	4.0																

※For sizes of over 400mm in thickness, advance consultation is requested.

Notes to Table of Available Sizes

(1) The figures in the table show maximum length (m).
(2) For lengths in ( ), advance consultation is requested.
(3) The minimum length shall be 3m.
(4) For size ranges enclosed with a line, advance consultation is requested.
(5) For the applicable plate thicknesses in each standard, refer to the excerpted standards described on after.

Application Ranges for Shot Blasting and Primer Treatment are as Follows.

Thickness: 6~127mm
Width: 1,000~5,200mm
Length: 3,000~28,000mm
For one-side shot blasting of plates with thicknesses less than 15mm, advance consultation is requested.

Available sizes of mild and special steel plates conforming to the representative standards are shown below. Regarding the standards not shown below, see the tables for similar standards. Sizes other than those shown below are available upon advance consultation.

490 N/mm²-class Tensile Strength Steel Plates (As-rolled) Available Sizes

Standard size range (shaded) / Standard size range (unshaded): For sizes of over 25m in length, please consult us in advance.

Thickness (mm)		1000 to 1200	Over 1200 to 1400	1400～1600	1600～1800	1800～2000	2000～2200	2200～2400	2400～2600	2600～2800	2800～3000	3000～3200	3200～3400	3400～3600	3600～3800	3800～4000	4000～4200	4200～4400	4400～4500	4500～4600	4600～4800	4800～5000	5000～5200
6														23.0	23.0	19.0	18.0	18.0					
Over 6	7 or less													25.0	23.0	23.0	18.0	18.0					
7	8								25.0					25.0	25.0	23.0	21.0	18.0	18.0	18.0	18.0		
8	9													25.0	25.0	25.0	25.0	22.0	22.0	22.0	22.0		
9	10				26.0									25.0	25.0	25.0	25.0	25.0	23.0	23.0	23.0	22.0	
10	12													25.0	25.0	25.0	25.0	25.0	25.0	23.0	23.0	23.0	23.0
12	14				27.0						26.0				25.0	25.0	25.0	25.0	25.0	24.0	24.0	23.0	23.0
14	16														25.0	25.0	25.0	25.0	25.0	24.0	24.0	23.0	23.0
16	18								27.0							26.0		25.0	25.0	25.0	25.0	24.0	24.0
18	20																	25.0	25.0	25.0	25.0	24.0	24.0
20	22													27.0				27.0	27.0	27.0	26.0	25.0	24.0
22	24																	26.0	26.0	25.0	24.0	23.0	22.0
24	26											28.0	28.0	28.0	28.0	27.0	25.0	25.0	25.0	23.0	22.0	21.0	21.0
26	28	25.0										28.0	28.0	28.0	26.0	25.0	25.0	24.0	23.0	22.0	21.0	20.0	19.0
28	30											28.0	27.0	26.0	25.0	24.5	23.0	22.0	21.5	20.0	19.0	19.0	18.0
30	32						28.0					27.0	26.0	25.0	23.5	22.5	21.5	20.5	20.0	19.0	18.0	17.0	17.0
32	34										27.0	26.0	25.0	23.5	22.5	21.0	20.0	19.0	19.0	18.0	17.0	16.0	16.0
34	36										26.0	25.0	23.5	22.0	21.0	20.0	19.0	18.0	17.5	17.0	16.0	15.0	15.0
36	38									26.0	25.0	23.5	23.0	21.0	20.0	19.0	18.0	17.0	17.0	16.0	15.0	14.0	14.0
38	40								27.0	25.0	24.0	23.0	23.0	20.0	19.0	18.0	17.0	16.5	16.0	15.0	14.0	14.0	13.0
40	42							27.0	25.0	24.0	23.0	23.0	23.0	19.0	18.0	17.0	16.0	15.0	15.0	14.0	14.0	13.0	13.0
42	44							26.0	24.5	23.0	23.0	23.0	23.0	18.0	17.0	16.0	15.0	14.5	14.0	14.0	13.0	12.0	12.0
44	46						27.0	25.0	23.5	23.0	23.0	23.0	23.0	17.0	16.0	15.5	14.5	14.0	13.5	13.0	12.0	12.0	11.0
46	48			27.0	27.0	27.0	26.0	24.5	23.0	23.0	23.0	23.0	23.0	16.5	15.5	14.5	14.0	13.5	13.0	12.0	12.0	11.0	11.0
48	50			26.0	26.0	26.0	25.0	23.5	23.0	23.0	23.0	23.0	23.0	16.0	15.0	14.0	13.5	12.5	12.5	12.0	11.0	11.0	10.0
50	52	24.0	24.0	25.0	25.0	25.0	24.0	22.5	21.0	19.5	18.0	17.0	16.0	15.0	14.0	13.5	13.0	12.0	12.0	11.0	11.0	10.0	10.0
52	54	23.0	23.0	24.0	24.0	24.0	23.0	21.5	20.0	18.5	17.5	16.5	15.5	14.5	14.0	13.0	12.5	12.0	11.5	11.0	10.0	10.0	10.0
54	56				23.0	23.0	22.5	21.0	19.5	18.0	17.0	16.0	15.0	14.0	13.0	12.5	12.0	11.5	11.0	11.0	10.0	10.0	9.5
56	58				22.0	22.0	21.5	20.0	18.5	17.5	16.0	15.0	14.0	13.5	13.0	12.0	11.5	11.0	10.5	10.0	10.0	9.5	9.0
58	60		23.0		22.0	22.0	21.0	19.5	18.0	16.5	15.5	14.5	14.0	13.0	12.5	11.5	11.0	10.5	10.5	10.0	9.5	9.0	9.0
60	65				20.0	20.0	19.0	18.0	16.5	15.5	14.5	13.5	12.5	12.0	11.5	11.0	10.0	9.5	9.5	9.0	9.0	8.5	8.0
65	70				18.5	18.0	18.0	16.5	15.5	14.5	13.5	12.5	12.0	11.0	10.5	10.0	9.5	9.0	9.0	8.5	8.0	8.0	7.5
70	75	23.0	22.5	20.0	17.0	17.0	16.5	15.5	14.5	13.5	12.5	11.5	11.0	10.5	10.0	9.5	9.0	8.5	8.5	8.0	7.5	7.5	7.0
75	80	23.0	22.5	20.0	16.0	16.0	15.5	14.5	13.5	12.5	11.5	11.0	10.0	9.5	9.0	8.5	8.5	8.5	8.5	7.5	7.0	7.0	6.5
80	85	23.0	20.0	17.5	15.0	15.0	14.5	13.5	12.5	11.5	11.0	10.0	9.5	9.0	8.5	8.5	8.5	8.5	8.5	7.0	6.5	6.5	6.0
85	90	23.0	20.0	17.5	14.5	14.0	14.0	13.0	12.0	11.5	11.0	9.5	9.0	8.5	8.5	8.5	8.5	8.5	8.5	6.5	6.5	6.0	6.0
90	95	21.0	18.0	16.0	13.0	13.0	13.0	12.0	11.5	11.5	11.0	9.0	8.5	8.5	8.5	8.5	8.5	8.5	8.0				
95	100	21.0	18.0	16.0	13.0	12.5	12.5				11.0	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.0				
100	105										11.0	8.5	8.5	8.5	8.5	8.5	8.0	8.0	7.5				
105	110		13.0						11.5		11.0	8.5	8.5	8.5	8.5	8.5	8.0	8.0	7.5				
110	115										10.5	8.5	8.5	8.5	8.0	8.0	7.5	7.0	6.5				
115	120					12.0					10.5	8.5	8.5	8.5	8.0	8.0	7.5	7.0	6.5				
120	125							11.5	11.0	10.5	9.5	8.5	8.5	8.0	7.5	7.0	7.0	6.5	6.0				
125	130							11.5	11.0	10.5	9.5	8.5	8.5	8.0	7.5	7.0	7.0	6.5	6.0				
130	135							11.0	10.5	9.5	9.0	8.5	8.0	7.5	7.0	6.5	6.5	6.0	5.5				
135	140	13.0		12.5				11.0	10.5	9.5	9.0	8.5	8.0	7.5	7.0	6.5	6.5	6.0	5.5				
140	145					11.5		10.5	9.5	9.0	8.5	8.0	7.5	7.0	6.5	6.0	6.0	5.5	5.5				
145	150							10.5	9.5	9.0	8.5	8.0	7.5	7.0	6.5	6.0	6.0	5.5	5.5				
150	155					10.5		9.5	9.0	8.5	7.5	7.0	7.0	6.5	6.0	5.5	5.5	5.0	5.0				
155	160							9.5	9.0	8.5	7.5	7.0	7.0	6.5	6.0	5.5	5.5	5.0	5.0				
160	165		12.5			10.0		9.0	8.5	8.0	7.5	7.0	6.5	6.0	5.5	5.5	5.0	5.0	4.5				
165	170							9.0	8.5	8.0	7.5	7.0	6.5	6.0	5.5	5.5	5.0	5.0	4.5				
170	175		12.0			9.5		8.5	8.0	7.5	7.0	6.5	6.0	5.5	5.5	5.0	5.0	4.5					
175	180							8.5	8.0	7.5	7.0	6.5	6.0	5.5	5.5	5.0	5.0	4.5					
180	185		11.0			9.0		8.0	7.5	7.0	6.5	6.0	5.5	5.5	5.0	4.5	4.5	4.5					
185	190							8.0	7.5	7.0	6.5	6.0	5.5	5.5	5.0	4.5	4.5	4.5					
190	195		10.5			8.5		7.5	7.0	6.5	6.0	5.5	5.5	5.0	4.5	4.5	4.0						
195	200							7.5	7.0	6.5	6.0	5.5	5.5	5.0	4.5	4.5	4.0						
200	210		10.0			8.0		7.5	6.5	6.0	6.0	5.5	5.0	4.5	4.5	4.0							
210	220		9.5			7.5		7.0	6.5	6.0	5.5	5.0	5.0	4.5	4.0	4.0							
220	230		9.0			7.0		6.5	6.0	5.5	5.0	5.0	4.5	4.5	4.0								
230	240		8.5					6.5	6.0	5.5	5.0	4.5	4.5	4.0	4.0								
240	250					6.5		6.0	5.5	5.0	4.5	4.5	4.0	4.0	3.5								
250	260		8.0					6.0	5.5	5.0	4.5	4.0	4.0	3.5									
260	270		7.5			6.0		5.5	5.0	4.5	4.5	4.0	4.0	3.5									
270	280							5.0	5.0	4.5	4.0												
280	290		7.0			5.5		5.0	4.5	4.5													
290	300							5.0	4.5	4.0													

490 N/mm²-class Tensile Strength Steel Plates (TMCP:Thermo-Mechanical Control Process) Available Sizes

Standard size range (shaded) / Standard size range (unshaded): For sizes of over 25m in length, please consult us in advance.

Thickness (mm)		1000 to 1200	Over 1200 to 1400	1400～1600	1600～1800	1800～2000	2000～2200	2200～2400	2400～2600	2600～2800	2800～3000	3000～3200	3200～3400	3400～3600	3600～3800	3800～4000	4000～4200	4200～4400	4400～4500	4500～4600	4600～4800	4800～5000	5000～5200
12					26.0						25.0					24.0				23.0			
Over 12	14 or less				27.0						26.0					25.0		24.0	24.0	24.0	24.0	23.0	23.0
14	16																	25.0	25.0	24.0	24.0	23.0	23.0
16	18								27.0							26.0			25.0			24.0	24.0
18	20																					24.0	24.0
20	22													27.0				27.0	27.0	27.0	26.0	25.0	24.0
22	24																	26.0	25.0	24.0	23.0	23.0	22.0
24	26											28.0	28.0	28.0	28.0	26.0	25.0	25.0	24.5	23.0	22.0	21.0	20.0
26	28											28.0	28.0	27.0	26.0	25.0	24.0	23.0	22.5	21.0	20.0	19.0	18.0
28	30	25.0										28.0	27.0	25.0	25.0	23.5	22.5	21.5	21.0	19.0	19.0	18.0	17.0
30	32						28.0					27.0	25.0	24.0	22.5	21.5	20.5	19.5	19.0	18.0	17.0	17.0	16.0
32	34										27.0	25.0	24.0	22.5	21.5	20.0	19.5	18.5	18.0	17.0	16.0	16.0	15.0
34	36									27.0	25.0	24.0	22.5	21.5	20.0	19.0	18.0	17.5	17.0	16.0	15.0	15.0	14.0
36	38								27.0	25.0	24.0	22.5	21.5	20.0	19.0	18.0	17.0	16.5	16.0	15.0	14.0	14.0	13.0
38	40								26.0	24.5	23.0	21.5	20.0	19.0	18.0	17.0	16.5	15.5	15.0	14.0	14.0	13.0	12.0
40	42							27.0	25.0	23.0	21.5	20.5	19.0	18.0	17.0	16.0	15.5	14.5	14.5	13.0	13.0	12.0	12.0
42	44							25.0	24.0	22.0	20.5	19.5	18.0	17.0	16.5	15.5	14.5	14.0	13.5	13.0	12.0	12.0	11.0
44	46						26.0	25.0	23.0	21.0	20.0	18.5	17.5	16.5	15.5	15.0	14.0	13.5	13.0	12.0	12.0	11.0	11.0
46	48			26.0	26.0	26.0	25.0	23.5	22.0	20.5	19.0	17.5	16.5	15.5	15.0	14.0	13.5	13.0	12.5	12.0	11.0	11.0	10.0
48	50	24.5	24.5	25.0	25.0	25.0	24.5	23.0	21.0	19.5	18.0	17.0	16.0	15.0	14.5	13.5	13.0	12.5	12.0	11.0	11.0	10.0	10.0
50	52	23.5	23.5	24.0	24.0	24.0	23.5	22.0	20.0	18.5	17.5	16.5	15.5	14.5	13.5	13.0	12.5	12.0	11.5	11.0	10.0	10.0	9.5
52	54	22.5	22.5	23.0	23.0	23.0	22.5	21.0	19.5	18.0	17.0	15.5	15.0	14.0	13.0	12.5	12.0	11.5	11.0	10.0	10.0	9.5	9.0
54	56	21.5	21.5	22.0	22.0	22.0	21.5	20.5	18.5	17.5	16.0	15.0	14.5	13.5	12.5	12.0	11.5	11.0	10.5	10.0	9.5	9.0	9.0
56	58	21.0	21.0	22.0	22.0	22.0	21.0	19.5	18.0	17.0	15.5	14.5	14.0	13.0	12.5	11.5	11.0	10.5	10.5	9.5	9.0	9.0	8.5
58	60	20.0	20.0	21.0	21.0	21.0	20.0	19.0	17.5	16.0	15.0	14.0	13.5	12.5	12.0	11.5	10.5	10.0	10.0	9.5	9.0	8.5	8.0
60	65	17.0	14.0	19.0	19.0	19.0	18.0	17.0	16.0	14.0	13.5	13.0	12.0	11.5	11.0	10.5	10.0	9.5	9.0	8.5	8.0	8.0	7.5
65	70	15.0	13.5	18.0	18.0	18.0	17.0	15.0	14.0	13.5	13.0	12.0	11.5	10.5	10.0	9.5	9.0	8.5	8.5	8.0	7.5	7.0	7.0
70	75	14.0	13.5	16.0	16.0	16.0	16.0	14.0	13.5	13.0	12.0	11.0	10.5	10.0	9.5	9.0	8.5	8.0	8.0	7.0	7.0	6.5	6.5
75	80	13.5	13.5	15.0	15.0	15.0	15.0	13.5	13.0	12.0	11.0	10.5	10.0	9.5	9.0	8.5	8.0	7.5	7.5	6.5	6.5	6.0	6.0
80	85			13.5				13.0	12.0	11.0	10.5	10.0	9.0	8.5	8.0	8.0	7.5	7.0	7.0				
85	90			13.0				12.5	11.5	10.5	10.0	9.0	8.5	8.0	7.5	7.5	7.0	6.5	6.5				
90	95			12.5				11.5	11.0	10.0	9.5	8.5	8.0	7.5	7.5	7.0	6.5	6.5	6.0				
95	100			12.0				11.0	10.0	9.5	9.0	8.5	8.0	7.5	7.0	6.5	6.5	6.0	6.0				

Weldable High-tensile Strength Steel Plates: WEL-TEN™ Series

1. Outline of Series and Specifications

WEL-TEN™ Series is high tensile and superior weldability steel featuring a rich variety of product categories. It has a wide range of applications, including pressure vessels, oil storage tanks, penstock, bridges, buildings, construction equipment, and industrial equipment.

Brand name	Applicable plate thickness (mm)	Chemical composition (%) [1]													
		C	Si	Mn	P	S	Cu	Ni	Cr	Mo	V	Nb	Ti	B	Ceq [2]	PCM [2]
WEL–TEN540	6≦t≦50	≦0.20	≦0.55	≦1.70	≦0.035	≦0.035	—	—	—	—	—	—	—	—	≦0.45	≦0.32
WEL–TEN590	6≦t≦200	≦0.16	≦0.55	≦2.00	≦0.030	≦0.025	≦0.50	≦1.20	≦0.50	≦0.40	≦0.10	≦0.05	—	≦0.005	≦0.44 (t≦50) ≦0.46 (t≦75) ≦0.49 (t≦100) ≦0.52 (t≦150) ≦0.56 (t≦200)	≦0.26 (t≦50) ≦0.28 (t≦100) ≦0.30 (t≦150) ≦0.31 (t≦200)
WEL–TEN610	6≦t≦200	≦0.16	≦0.55	≦2.00	≦0.030	≦0.025	≦0.50	≦1.20	≦0.50	≦0.40	≦0.10	≦0.05	—	≦0.005	≦0.45 (t≦50) ≦0.47 (t≦75) ≦0.50 (t≦100) ≦0.53 (t≦150) ≦0.57 (t≦200)	≦0.26 (t≦50) ≦0.28 (t≦100) ≦0.30 (t≦150) ≦0.31 (t≦200)
WEL–TEN690	6≦t≦100	≦0.16	≦0.55	≦2.00	≦0.030	≦0.025	≦0.50	≦1.30	≦0.60	≦0.60	≦0.10	≦0.05	—	≦0.005	≦0.50 (t≦50) ≦0.55 (t≦75) ≦0.60 (t≦100)	≦0.28 (t≦50) ≦0.32 (50<t)
WEL–TEN780	6≦t≦200	≦0.16	≦0.55	≦2.00	≦0.020	≦0.015	≦0.50	0.40–2.00 (t≦100) 0.40–3.00 (100<t)	≦0.80	≦0.60	≦0.10	≦0.05	—	≦0.005	≦0.60 (t≦100) ≦0.63 (t≦150) ≦0.67 (t≦200)	≦0.30 (t≦50) ≦0.32 (t≦100) ≦0.34 (t≦150) ≦0.36 (t≦200)
WEL–TEN950	6≦t≦150	≦0.16	≦0.55	≦2.00	≦0.015	≦0.010	≦0.50	0.50–3.50 (t≦100) 0.50–4.50 (100<t)	≦1.20	≦0.90	≦0.10	≦0.03	—	≦0.005	≦0.76	≦0.34 (t≦50) ≦0.36 (t≦75) ≦0.38 (t≦150)
WEL–TEN590E	6≦t≦100	≦0.18	≦0.55	≦2.00	≦0.030	≦0.025	—	—	—	—	—	—	—	—	≦0.52	≦0.30
WEL–TEN690E	6≦t≦100	≦0.18	≦0.55	≦2.00	≦0.030	≦0.025	≦0.50	—	≦1.60	≦0.60	≦0.10	—	—	≦0.005	≦0.55 (t≦50) ≦0.60 (t≦100)	≦0.32
WEL–TEN780E	6≦t≦60	≦0.22	≦0.55	≦2.00	≦0.025	≦0.015	≦0.50	—	≦1.60	≦0.60	≦0.10	—	—	≦0.005	≦0.60 (t≦50) ≦0.63 (t≦60)	≦0.34
WEL–TEN950E	6≦t≦50	≦0.22	≦0.55	≦2.00	≦0.025	≦0.020	≦0.50	—	≦1.60	≦1.10	≦0.10	—	—	≦0.005	≦0.76	≦0.38

Brand name	Mechanical properties											
	Tensile test					Impact test (test piece:JIS No.4, 2mm V-notich, L direction)				Bending test (test piece: JIS No.1) [3]		
	Yield point or proof stress (N/mm²)	Tensile strength (N/mm²)	Elongation		Test piece JIS	Thickness (mm)	Test temperature (℃)	Absorbed energy (J)		Inside bending radius		
			Thickness (mm)	Min. elongation (%)				Average value	Each value	Bending angle	Thickness (mm)	Radius
WEL–TEN540	≧355	≧540	t≦16 16<t 20<t	20 28 23	No.5 No.5 No.4	12<t≦50	0	47	27	180	—	1.5t
WEL–TEN590	≧450 (t≦50) ≧430 (50<t)	590～710 (t≦75) 570～690 (75<t)	t≦16 16<t 20<t	20 28 20	No.5 No.5 No.4	12<t≦32 32<t	−5 −10	47	27	180	t≦32 32<t	1.5t 2.0t
WEL–TEN610	≧490 (t≦50) ≧470 (50<t)	610～730 (t≦75) 590～710 (75<t)	t≦16 16<t 20<t	19 27 20	No.5 No.5 No.4	12<t≦32 32<t	−10 −15	47	27	180	t≦32 32<t	1.5t 2.0t
WEL–TEN690	≧550 (t≦50) ≧530 (50<t)	690～830 (t≦50) 670～810 (50<t)	t≦16 16<t 20<t	17 25 17	No.5 No.5 No.4	12<t≦32 32<t	−15 −20	47	27	180	t≦32 32<t	1.5t 2.0t
WEL–TEN780	≧685 (t≦50) ≧665 (50<t)	780～930 (t≦50) 760～910 (50<t)	t≦16 16<t 20<t	16 24 16	No.5 No.5 No.4	12<t≦32 32<t	−20 −25	47	27	180	t≦32 32<t	1.5t 2.0t
WEL–TEN950	≧885 (t≦50) ≧865 (50<t)	950～1130	t≦16 16< 20<t	13 19 13	No.5 No.5 No.4	12<t≦32 32<t	−25 −30	47	27	180	t≦32 32<t	1.5t 2.0t
WEL–TEN590E	≧450 (t≦50) ≧430 (50<t)	590～710 (t≦50) 570～690 (50<t)	t≦16 16<t 20<t	20 28 20	No.5 No.5 No.4	12<t	−5	47	27	180	t≦32 32<t	1.5t 2.0t
WEL–TEN690E	≧550 (t≦50) ≧530 (50<t)	690～830 (t≦50) 670～810 (50<t)	t≦16 16<t 20<t	18 26 18	No.5 No.5 No.4	12<t	−10	47	27	180	t≦32 32<t	1.5t 2.0t
WEL–TEN780E	≧685 (t≦50) ≧665 (50<t)	780～930 (t≦50) 760～910 (50<t)	t≦16 16<t 20<t	16 24 16	No.5 No.5 No.4	12<t	−15	47	27	180	t≦32 32<t	1.5t 2.0t
WEL–TEN950E	≧885	950～1130	t≦16 16<t 20<t	13 19 13	No.5 No.5 No.4	12<t	−20	47	27	180	—	2.0t

		Steel types				
		Blanks	E	RE	C	EX
		Standard	Economy	Non-heat treated	Cr-added	Weldability
Approximate application thickness (mm)		150 (200) or less	100 or less	32 or less	150 or less	100 or less
Tensile strength class	540	○ (0℃)	—	—	—	—
	590	○ (−5℃)	○ (−5℃)	○ (−5℃)	—	○ (−5℃)
	610	○ (−10℃)	—	—	—	○ (−10℃)
	690	○ (−15℃)	○ (−10℃)	○ (−15℃)	—	—
	780	○ (−20℃)	○ (−15℃)	○ (—)	○ (−20℃)	○ (−20℃)
	950	○ (−25℃)	○ (−20℃)	○ (—)	—	—

＊With respect to the standards in the table above, it is possible to add the following special requirements upon request.
① SR guaranteed steel (-SR), ② Lamellar tear-resistant guaranteed steel (-Z35, etc.), ③ Low-temperature specifications < below the stipulated impact test temperature service> (-LT), ④ Constant yield strength specifications (-H)
(Example of specified specifications: WEL-TEN590-SR, etc.)

Remarks:
1) When necessary, alloying elements other than those shown in the tale may be added.
2) Carbon equivalent, Ceq, and weld crack sensitivity, PCM, are calculated for added elements using the following equation.
$C_{eq}=C+Si/24+Mn/6+Ni/40+Cr/5+Mo/4+V/14$ (%)
$P_{CM}=C+Si/30+Mn/20+Cu/20+Ni/60+Cr/20+Mo/15+V/10+5B$ (%)
3) In the bending test, cracks shall not occur in the outside of test piece.
The bending test can be eliminated unless otherwise specified.

Brand name	Applicable plate thickness (mm)	Chemical composition (%)[1] C	Si	Mn	P	S	Cu	Ni	Cr	Mo	V	Nb	Ti	B	C_{eq}[2]	P_{CM}[2]	Mechanical properties – Tensile test: Yield point or proof stress (N/mm²)	Tensile strength (N/mm²)	Elongation: Thickness (mm)	Elongation: Min. elongation (%)	Test piece JIS	Impact test (test piece:JIS No.4, 2mm V-notich, L direction): Thickness (mm)	Test tempera-ture (℃)	Absorbed energy (J): Average value	Absorbed energy (J): Each value	Bending test (test piece: JIS No.1)[3] Inside bending radius: Bending angle	Thickness (mm)	Radius
WEL–TEN590RE	4.5≦t≦36	≦0.12	≦0.55	≦2.00	≦0.030	≦0.025	≦0.40	≦0.40	—	≦0.15	—	—	≦0.15	—	≦0.45	—	≧450	590~710	t≦16 16<t 20<t	20 28 20	No.5 No.5 No.4	12<t≦32 32<t	–5 –10	47	27	180	—	1.0t
WEL–TEN690RE	4≦t≦20	≦0.14	≦0.55	≦2.00	≦0.030	≦0.025	≦0.40	≦0.40	—	≦0.15	—	—	≦0.25	—	≦0.50	—	≧590	690~830	t≦16 16<t	17 25	No.5 No.5	12<t≦20	–15	47	27	180	—	1.5t
WEL–TEN780RE	4≦t≦9	≦0.16	≦0.55	≦2.00	≦0.030	≦0.025	≦0.40	≦0.40	—	≦0.15	—	—	≦0.30	—	≦0.55	—	≧685	780~930	t≦9	15	No.5	—	—	—	—	180	—	1.5t
WEL–TEN950RE	3≦t≦8	≦0.16	≦0.55	≦2.00	≦0.025	≦0.020	—	≦0.50	—	—	—	—	≦0.30	≦0.005	≦0.50	—	≧885	950~1250	t≦6 6<t	8 11	No.5 No.5	—	—	—	—	180	—	1.5t
WEL–TEN780C	6≦t≦150	≦0.16	≦0.55	≦2.00	≦0.025	≦0.015	≦0.50	≦0.35	0.30 ~1.20	≦0.60	≦0.10	≦0.05	—	≦0.005	≦0.62(t≦50) ≦0.68(t≦100) ≦0.70(t≦150)	≦0.30(t≦50) ≦0.32(t≦75) ≦0.34(t≦100) ≦0.37(t≦150)	≧685(t≦50) ≧665(50<t)	780~930(t≦50) 760~910(50<t)	t≦16 16<t 20<t	16 24 16	No.5 No.5 No.4	12<t≦150	–20	47	27	180	t≦32 32<t	1.5t 2.0t
WEL–TEN590EX	6≦t≦76	≦0.09	≦0.40	≦2.00	≦0.030	≦0.025	≦0.50	≦0.80	≦0.30	≦0.35	≦0.10	≦0.05	—	≦0.005	—	≦0.20	≧450(t≦50) ≧430(50<t)	590~710	t≦16 16<t 20<t	20 28 20	No.5 No.5 No.4	12<t≦32 32<t	–5 –10	47	27	180	t≦32 32<t	1.5t 2.0t
WEL–TEN610EX	6≦t≦76	≦0.09	≦0.40	≦2.00	≦0.030	≦0.025	≦0.50	≦0.80	≦0.30	≦0.35	≦0.10	≦0.05	—	≦0.005	—	≦0.20	≧490(t≦50) ≧470(50<t)	610~730	t≦16 16<t 20<t	19 27 20	No.5 No.5 No.4	12<t≦32 32<t	–10 –15	47	27	180	t≦32 32<t	1.5t 2.0t
WEL–TEN780EX	6≦t≦50	≦0.07	≦0.55	0.60~1.50	≦0.020	≦0.015	0.80~1.30	≦1.50	≦0.80	≦0.60	≦0.10	≦0.05	—	—	≦0.55	—	≧685	780~930	t≦16 16<t 20<t	16 24 16	No.5 No.5 No.4	12<t≦32 32<t	–20 –25	47	27	180	t≦32 32<t	1.5t 2.0t
WEL–TEN590EXS	6≦t≦40	≦0.07	≦0.40	≦2.00	≦0.030	≦0.025	≦0.30	≦0.60	≦0.30	≦0.30	≦0.10	≦0.05	—	—	—	≦0.18	≧450	590~710	t≦16 16<t 20<t	20 28 20	No.5 No.5 No.4	12<t≦32 32<t	–5 –10	47	27	180	t≦32 32<t	1.5t 2.0t
WEL–TEN610EXS	6≦t≦40	≦0.07	≦0.40	≦2.00	≦0.030	≦0.025	≦0.30	≦0.60	≦0.30	≦0.30	≦0.10	≦0.05	—	—	—	≦0.18	≧490	610~730	t≦16 16<t 20<t	19 27 20	No.5 No.5 No.4	12<t≦32 32<t	–10 –15	47	27	180	t≦32 32<t	1.5t 2.0t

Remarks:
1) When necessary, alloying elements other than those shown in the tale may be added.
2) Carbon equivalent, Ceq, and weld crack sensitivity, P_{CM}, are calculated for added elements using the following equation.

C_{eq}=C+Si/24+Mn/6+Ni/40+Cr/5+Mo/4+V/14 (%)

P_{CM}=C+Si/30+Mn/20+Cu/20+Ni/60+Cr/20+Mo/15+V/10+5B (%)

3) In the bending test, cracks shall not occur in the outside of test piece.
The bending test can be eliminated unless otherwise specified.

* With respect to the standards in the table above, it is possible to add the following special requirements upon request.
① SR guaranteed steel (-SR), ② Lamellar tear-resistant guaranteed steel (-Z35, etc.), ③ Low-temperature specifications < below the stipulated impact test temperature service> (-LT), ④ Constant yield strength specifications (-H)
(Example of specified specifications: WEL-TEN590-SR, etc.)


Crude oil storage tanks


Penstock branching section


Track crane


Jack up rig offshore structure

2. Available Sizes

■ Tensile Strengths 540, 570, 590, 610

Standard size range | Please consult us in advance.

Thickness (mm)	Width (mm)	1000 to 1200	Over 1200 to 1400	1400 ～ 1600	1600 ～ 1800	1800 ～ 2000	2000 ～ 2200	2200 ～ 2400	2400 ～ 2600	2600 ～ 2800	2800 ～ 3000	3000 ～ 3200	3200 ～ 3400	3400 ～ 3600	3600 ～ 3800	3800 ～ 4000	4000 ～ 4200	4200 ～ 4400	4400 ～ 4500
6														22.0	20.0				
Over 6	7 or less													25.0	23.0	21.0			
7	8													25.0	25.0	23.0	21.0		
8	9													25.0	25.0	25.0	25.0	21.0	
9	10													25.0	25.0	25.0	25.0	25.0	
10	24													25.0	25.0	25.0	25.0	25.0	25.0
24	26													25.0	25.0	25.0	25.0	24.0	23.5
26	28					25.0								25.0	25.0	24.5	23.5	22.5	22.0
28	30													25.0	24.5	23.0	22.0	21.0	20.5
30	32													24.0	22.5	21.5	20.5	19.5	19.0
32	34												24.0	22.5	21.5	20.0	19.0	18.5	18.0
34	36											24.0	22.5	21.0	20.0	19.0	18.0	17.5	17.0
36	38										24.0	22.5	21.5	20.0	19.0	18.0	17.0	16.5	16.0
38	40									24.5	23.0	21.5	20.0	19.0	18.0	17.0	16.5	15.5	15.0
40	42									23.5	21.5	20.5	19.0	18.0	17.0	16.5	15.5	15.0	14.5
42	44								24.0	22.0	20.5	19.5	18.5	17.5	16.5	15.5	15.0	14.0	14.0
44	46								23.0	21.5	20.0	19.0	17.5	16.5	15.5	15.0	14.0	13.5	13.0
46	48							24.0	22.0	20.5	19.0	18.0	16.5	16.0	15.0	14.0	13.5	13.0	12.5
48	50			24.5				23.0	21.0	19.5	18.0	17.0	16.0	15.0	14.5	13.5	13.0	12.5	12.0
50	52			23.5				22.0	20.5	19.0	17.5	16.5	15.5	14.5	14.0	13.0	12.5	12.0	11.5
52	54					22.5	22.5	21.0	19.5	18.0	17.0	16.0	15.0	14.0	13.5	12.5	12.0	11.5	11.0
54	56		23.0			21.5	21.5	20.5	19.0	17.5	16.5	15.0	14.5	13.5	13.0	12.0	11.5	11.0	11.0
56	58					21.5	21.0	19.5	18.0	17.0	15.5	14.5	14.0	13.0	12.5	11.5	11.0	10.5	10.5
58	60					21.5	20.5	19.0	17.5	16.5	15.0	14.0	13.5	12.5	12.0	11.5	11.0	10.5	10.0
60	65		23.0		20.5	18.5	18.5	17.5	16.0	15.0	14.0	13.0	12.5	11.5	11.0	10.5	10.0	9.5	9.0
65	70				20.5	18.5	17.5	16.0	15.0	14.0	13.0	12.0	11.5	11.0	10.0	9.5	9.0	9.0	8.5
70	75	23.0	22.5	20.0	18.0	16.0	16.0	15.0	14.0	13.0	12.0	11.5	10.5	10.0	9.5	9.0	8.5	8.0	8.0
75	80	23.0	22.5	20.0	18.0	16.0	15.0	14.0	13.0	12.0	11.5	10.5	10.0	9.5	9.0	8.5	8.0	7.5	7.5
80	85	22.5	20.0	17.5	16.0	14.5	14.0	13.0	12.0	11.0	10.5	10.0	9.0	8.5	8.0	7.5	7.0	7.0	6.5
85	90	22.5	20.0	17.5	16.0	14.5	13.0	12.5	11.5	10.5	10.0	9.5	9.0	8.5	8.0	7.5	7.0	7.0	6.5
90	95	20.0	18.0	16.0	14.5	13.0	12.5	11.5	11.0	10.0	9.5	8.5	8.0	7.5	7.0	6.5	6.5	6.0	6.0
95	100	20.0	18.0	16.0	14.5	13.0	12.0	11.0	10.5	9.5	9.0	8.5	8.0	7.5	7.0	6.5	6.5	6.0	6.0
100	110	18.5	16.5	14.5	13.0	12.0	11.0	10.0	9.5	8.5	8.0	7.5	7.0	7.0	6.5	6.0	6.0	5.5	5.5
110	120	17.0	15.0	13.5	12.0	11.0	10.0	9.0	8.5	8.0	7.5	7.0	6.5	6.0	6.0	5.5	5.5		
120	130	13.0	13.0	12.5	11.0	10.0	9.5	8.5	8.0	7.0	7.0	6.5	6.0	5.5	5.5	5.0			
130	140	13.5	13.0	11.5	10.5	9.5	8.5	8.0	7.5	7.0	6.5	6.0	5.5	5.5					
140	150	13.5	12.5	11.0	9.5	9.0	8.0	7.5	7.0	6.5	6.0	5.5	5.0						
150	155				(14.0)				(13.0)	(12.0)	(11.0)	(11.0)							
155	160								(13.0)	(12.0)	(11.0)								
160	165				(13.0)				(12.0)	(11.0)	(11.0)								
165	175								(12.0)	(11.0)									
175	190				(12.0)				(11.0)										
190	200				(11.0)														

■ Tensile Strengths 590RE

Thickness (mm)	Width (mm)	1000 to 1200	Over 1200 to 1400	1400 ～ 1600	1600 ～ 1800	1800 ～ 2000	2000 ～ 2200	2200 ～ 2400	2400 ～ 2600	2600 ～ 2800	2800 ～ 3000	3000 ～ 3200	3200 ～ 3400	3400 ～ 3600	3600 ～ 3800	3800 ～ 4000	4000 ～ 4200	4200 ～ 4400	4400 ～ 4500
6						15.0													
Over 6	7 or less					18.0													
7	8										18.0	18.0	18.0						
8	9													18.0	18.0				
9	10													23.0	18.0	18.0			
10	12													23.0	23.0	23.0	23.0	15.0	15.0
12	22													23.0	23.0	23.0	23.0	23.0	23.0
22	24					23.0								23.0	23.0	23.0	23.0	23.0	20.0
24	26													23.0	23.0	23.0	20.0	19.0	18.0
26	28													23.0	23.0	20.0	19.0	18.0	17.0
28	30													20.0	20.0	19.0	18.0	17.0	16.0
30	32												20.0	19.0	19.0	18.0	17.0	16.0	15.0
32	34							21.0	19.0	18.0	17.0	16.0	15.0	14.0	13.0	12.0	12.0	11.0	11.0
34	36						22.0	20.0	18.0	17.0	16.0	15.0	14.0	13.0	12.0	12.0	12.0	11.0	10.0

■ Tensile Strengths 690, 780, 950

Standard size range | Standard size range. Consult us in case that plate length is up to 14m. | Please consult us in advance.

Thickness (mm)	Width (mm)	1000 to 1200	Over 1200 to 1400	1400 ～ 1600	1600 ～ 1800	1800 ～ 2000	2000 ～ 2200	2200 ～ 2400	2400 ～ 2600	2600 ～ 2800	2800 ～ 3000	3000 ～ 3200	3200 ～ 3400	3400 ～ 3600	3600 ～ 3800	3800 ～ 4000	4000 ～ 4200	4200 ～ 4400	4400 ～ 4500
6						16.0						12.0							
Over 6	7 or less					20.0						14.0							
7	8											15.0							
8	9											20.0							
9	10					21.0						20.0	20.0						
10	12																		
12	14														21.0	21.0			
14	16														22.0	21.0	21.0	15.0	15.0
16	18														22.0	22.0	21.0	21.0	21.0
18	20														22.0	22.0	22.0	21.0	21.0
20	26														22.0	22.0	22.0	22.0	22.0
26	28														22.0	22.0	22.0	21.0	21.0
28	30														22.0	22.0	21.0	20.0	20.0
30	32														22.0	21.0	19.0	19.0	18.0
32	34														20.0	19.0	18.0	18.0	17.0
34	36				22.0									20.0	19.0	18.0	17.0	17.0	16.0
36	38												20.0	19.0	18.0	17.0	16.0	16.0	15.0
38	40											21.0	19.0	18.0	17.0	16.0	16.0	15.0	14.0
40	42										21.0	20.0	18.0	17.0	16.0	16.0	15.0	14.0	14.0
42	44									21.0	20.0	19.0	18.0	17.0	16.0	15.0	13.0	13.0	13.0
44	46									21.0	19.0	19.0	17.0	16.0	15.0	14.0	13.0	13.0	13.0
46	48								21.0	20.0	18.0	17.0	16.0	15.0	14.0	14.0	13.0	12.0	12.0
48	50								20.0	19.0	18.0	16.0	15.0	15.0	14.0	13.0	12.0	12.0	12.0
50	52							21.0	20.0	18.0	17.0	16.0	15.0	14.0	13.0	13.0	12.0	11.0	11.0
52	54							20.0	19.0	17.0	16.0	15.0	14.0	13.0	12.0	12.0	11.0	11.0	11.0
54	56						21.0	20.0	18.0	17.0	16.0	15.0	14.0	13.0	12.0	12.0	11.0	10.0	10.0
56	58						21.0	20.0	18.0	17.0	16.0	15.0	14.0	13.0	12.0	11.0	10.0	10.0	10.0
58	60						20.0	18.0	17.0	16.0	15.0	14.0	13.0	12.0	11.0	11.0	10.0	10.0	10.0
60	65					20.0	18.0	17.0	16.0	14.0	13.0	13.0	12.0	11.0	10.0	10.0	9.0	9.0	9.0
65	70				21.0	19.0	17.0	16.0	14.0	13.0	12.0	12.0	11.0	10.0	10.0	9.0	8.0	8.0	8.0
70	75		20.0			18.0	16.0	15.0	13.0	12.0	12.0	11.0	10.0	10.0	9.0	9.0	8.0	8.0	8.0
75	80		19.0		18.0	16.0	15.0	14.0	13.0	12.0	11.0	10.0	9.0	9.0	8.0	8.0	7.0	7.0	7.0
80	85		18.0		17.0	15.0	14.0	13.0	12.0	11.0	10.0	9.0	9.0	8.0	8.0	7.0	7.0	7.0	7.0
85	90		17.0		16.0	15.0	13.0	12.0	11.0	10.0	10.0	9.0	8.0	8.0	7.0	7.0	(14.0)	(14.0)	(13.0)
90	95		16.0		15.0	14.0	12.0	11.0	10.0	10.0	9.0	8.0	8.0	7.0	(14.0)	(14.0)	(14.0)	(13.0)	(12.0)
95	100		15.0			13.0	12.0	11.0	10.0	9.0	9.0	8.0	(14.0)	(14.0)	(14.0)	(14.0)	(13.0)	(12.0)	(12.0)
100	105		14.0			12.0	11.0	10.0	9.0	9.0	8.0	(14.0)	(14.0)	(14.0)	(14.0)	(13.0)	(12.0)	(11.0)	(11.0)
105	110				13.0	12.0	11.0	10.0	9.0	8.0	(14.0)	(14.0)	(14.0)	(14.0)	(13.0)	(12.0)	(11.0)	(11.0)	(11.0)
110	115		13.0			11.0	10.0	9.0	9.0	(14.0)	(14.0)	(14.0)	(14.0)	(13.0)	(12.0)	(11.0)	(11.0)		
115	120		12.0			11.0	10.0	9.0	8.0	(14.0)	(14.0)	(14.0)	(14.0)	(12.0)	(12.0)	(11.0)			
120	125					10.0	9.0	9.0	(14.0)	(14.0)	(14.0)	(14.0)	(12.0)	(12.0)	(11.0)				
125	130					10.0	9.0	(14.0)	(14.0)	(14.0)	(14.0)	(13.0)	(12.0)	(11.0)	(11.0)				
130	135		11.0			10.0	9.0	(14.0)	(14.0)	(14.0)	(14.0)	(12.0)	(11.0)	(11.0)					
135	140				10.0	9.0	(14.0)	(14.0)	(14.0)	(14.0)	(13.0)	(12.0)	(11.0)						
140	145		10.0			9.0	(14.0)	(14.0)	(14.0)	(14.0)	(12.0)	(11.0)	(11.0)						
145	150					(14.0)	(14.0)	(14.0)	(14.0)	(13.0)	(12.0)	(11.0)							
150	155				(14.0)				(13.0)	(12.0)	(11.0)	(11.0)							
155	160								(13.0)	(12.0)	(11.0)								
160	165				(13.0)				(12.0)	(11.0)	(11.0)								
165	175								(12.0)	(11.0)									
175	190				(12.0)				(11.0)										
190	200				(11.0)														

■ Tensile Strengths 690RE

Thickness (mm)	Width (mm)	1000 to 1200	Over 1200 to 1400	1400 ～ 1600	1600 ～ 1800	1800 ～ 2000	2000 ～ 2200	2200 ～ 2400	2400 ～ 2600	2600 ～ 2800	2800 ～ 3000	3000 ～ 3200	3200 ～ 3400	3400 ～ 3600	3600 ～ 3800	3800 ～ 4000	4000 ～ 4200	4200 ～ 4400	4400 ～ 4500
6 or over	7 or less			18.0			16.0	16.0											
Over 7	8 or less						20.0	19.0	19.0	17.0									
8	9						20.0	20.0	19.0	19.0									
9	10						20.0	20.0	20.0	20.0	20.0								
10	12			21.0			21.0	20.0	20.0	20.0	20.0	20.0							
12	14						21.0	21.0	21.0	20.0	20.0	20.0	20.0	19.0					
14	16						21.0	21.0	21.0	21.0	21.0	20.0	20.0	20.0	20.0				
16	18						21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	20.0	20.0	19.0		
18	20						21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	20.0	20.0	20.0	20.0

Abrasion-resistant Steel Plates: ABREX™ Series

1. Outline of Series and Specifications（ABREX™400, 450, 500, 600）

ABREX™ Series is steel with abrasion resistance 2~5 times that of conventional mild steel.

It is applied in fields requiring abrasion resistance such as the bucket of shovel loaders, conveyer hoppers, dump truck load carriers, and the blades of bulldozers.

Brand name	Applicable plate thickness (mm)	Chemical composition (%) 1)										Brinell hardness HB 3)	
		C	Si	Mn	P	S	Ni	Cr	Mo	B	P_{CM} 2)	Min.	Max.
ABREX400	6(4.0)≦t≦100	≦0.21	≦0.70	≦2.00	≦0.025	≦0.010	≦1.00	≦1.20	≦0.60	≦0.005	≦0.30(t≦25) ≦0.35(25<t)	360	440
ABREX450	6(4.0))≦t≦100	≦0.23	≦0.70(t≦50) ≦1.20(50<t)		≦0.025			≦1.20(t≦50) ≦1.50(50<t)			≦0.36(t≦50) ≦0.40(50<t)	410	490
ABREX500	6(4.5)≦t≦100	≦0.35			≦0.015						≦0.42(t≦50) ≦0.45(50<t)	450	550
ABREX600	8≦t≦25	≦0.45	≦0.70		≦0.015			≦1.20			≦0.54	550	650

Remarks:
1) When necessary, alloying elements other than those shown in the tale may be added.
2) Weld crack sensitivity, P_{CM}, are calculated for added elements using the following equation.
P_{CM}=C+Si/30+Mn/20+Cu/20+Ni/60+Cr/20+Mo/15+V/10+5B (%)
3) Hardness test shall be carried out in accordance with JIS Z 2243 (method of Brinell hardness Test).

Abrasion-resistant Steel Plates for Low Temperatures: ABREX™ LT Series

1. Outline of Series and Specifications（ABREX™400LT, 450LT, 500LT）

The ABREX™ LT series is steel that has excellent abrasion resistance, as well as high notch toughness performance even in low temperature (–40˚C) environments.

Brand name	Applicable plate thickness (mm)	Chemical composition (%) 1)										Brinell hardness HB 3)		Impact test 4)	
		C	Si	Mn	P	S	Ni	Cr	Mo	B	P_{CM} 2)	Min.	Max.	Temperature (˚C)	Absorbed energy (J)
ABREX400LT	6(4.0)≦t≦60	≦0.21	≦1.20	≦2.00	≦0.020	≦0.010	≦1.00	≦1.20	≦0.60	≦0.005	≦0.30(t≦25) ≦0.35(25<t)	360	440	–40	≧27 (Average)
ABREX450LT	6(4.0)≦t≦50	≦0.28			≦0.020			≦1.20(t≦25) ≦1.50(25<t)			≦0.36(t≦25) ≦0.40(25<t)	410	490		
ABREX500LT	6(4.5)≦t≦80	≦0.35			≦0.015						≦0.42(t≦25) ≦0.45(25<t)	450	550		≧21 (Average)

Remarks:
1) When necessary, alloying elements other than those shown in the tale may be added.
2) Weld crack sensitivity, P_{CM}, is calculated for added elements using the following equation.
P_{CM}=C+Si/30+Mn/20+Cu/20+Ni/60+Cr/20+Mo/15+V/10+5B (%)
3) Hardness test shall be carried out in accordance with JIS Z 2243 (method of Brinell hardness Test).
4) Impact tests shall be applicable in case that plate thickness is over 12mm.

2. Available Sizes

■ ABREX™400, 400LT

ABREX400LT: t≦60mm

Standard size range / Please consult us in advance.

Thickness (mm)		1000 to 1200	Over 1200 to 1400	1400 ～ 1600	1600 ～ 1800	1800 ～ 2000	2000 ～ 2200	2200 ～ 2400	2400 ～ 2600	2600 ～ 2800	2800 ～ 3000	3000 ～ 3200	3200 ～ 3400	3400 ～ 3600	3600 ～ 3800	3800 ～ 4000	4000 ～ 4200	4200 ～ 4400	4400 ～ 4500
4 or over	4.5 or less																		
Over 4.5	5 or less			8															
5	6			10															
6	7																		
7	8																		
8	9			18				15											
9	10																		
10	12																		
12	14																		
14	16																		
16	18																		
18	20																		
20	30																		
30	32																	22	22
32	34																22	21	20
34	36			23												22	21	20	19
36	38														22	20	19	19	18
38	40												22	22	20	19	18	18	17
40	42												20	20	19	18	17	16	16
42	44											22	20	20	18	18	17	16	16
44	46										22	21	19	19	18	17	16	15	15
46	48										21	20	18	18	17	16	15	15	14
48	50									22	20	19	17	17	16	15	15	14	14
50	52									21	20	19	17	17	16	14	14	13	13
52	54									21	19	18	16	16	15	14	14	13	13
54	56								22	20	18	17	15	15	14	13	13	12	12
56	58							22	21	19	17	17	15	15	14	13	13	12	12
58	60						22	22	20	18	16	16	14	14	13	12	12	12	11
60	65			22				20	19	17	15	15	13	13					
65	70			20				18	17	16	14								
70	75			19				17	16	15	13								
75	80			18				16	15										
80	85			17				15											
85	90			16															
90	95			15															
95	100			14															

■ ABREX™450, 450LT, 500, 500LT

ABREX450LT: t≦50mm, ABREX500LT: t≦80mm

Standard size range / Please consult us in advance.

Thickness (mm)		1000 to 1200	Over 1200 to 1400	1400 ～ 1600	1600 ～ 1800	1800 ～ 2000	2000 ～ 2200	2200 ～ 2400	2400 ～ 2600	2600 ～ 2800	2800 ～ 3000	3000 ～ 3200	3200 ～ 3400	3400 ～ 3600	3600 ～ 3800	3800 ～ 4000	4000 ～ 4200	4200 ～ 4400	4400 ～ 4500
4 or over	4.5 or less			8															
Over 4.5	5or less																		
5	6			10															
6	7																		
7	8																		
8	9			18															
9	10							13											
10	12																		
12	14																		
14	16																		
16	18																		
18	20																		
20	30																		
30	32																	22	22
32	34																22	21	20
34	36			23												22	21	20	19
36	38														22	20	19	19	18
38	40												22	22	20	19	18	18	17
40	42												20	20	19	18	17	16	16
42	44											22	20	20	18	18	17	16	16
44	46										22	21	19	19	18	17	16	15	15
46	48										21	20	18	18	17	16	15	15	14
48	50									22	20	19	17	17	16	15	15	14	14
50	52									21	20	19	17	17	16	14	14	13	13
52	54									21	19	18	16	16	15	14	14	13	13
54	56								22	20	18	17	15	15	14	13	13	12	12
56	58							22	21	19	17	17	15	15	14	13	13	12	12
58	60						22	22	20	18	16	16	14	14	13	12	12	12	11
60	65			22				20	19	17	15	15	13	13					
65	70			20				18	17	16	14								
70	75			19				17	16	15	13								
75	80			18				16	15										
80	85			17				15											
85	90			16															
90	95			15															
95	100			14															

Low-temperature Steel Plates: N-TUF™ Series

1. Outline of Series and Specifications

N-TUF Series is steel featuring outstanding high notch toughness in low temperature and very low temperature environments. It is applicable for steel for storage and transport vessels for liquefied petroleum gas, chemical equipment, and pressure vessels.

Brand name	Applicable plate thickness (mm)	Chemical composition (%) [1]									Mechanical properties							
		C	Si	Mn	P	S	Ni	Cr	Mo	V	Yield point or proof stress (N/mm²)	Tensile strength (N/mm²)	Elongation: Thickness (mm)	Elongation: Min. elongation (%)	Elongation: Test piece JIS	Bending test [2]: Bending angle (°)	Bending test [2]: Inside bending radius/Thickness	Impact test
N–TUF295	6≦t≦50	≦0.14	0.15~0.35	1.00~1.60	≦0.030	≦0.030	—	—	—	—	≧295	420~540	t<21	10.8+5√t	No.5	180	1.0t	Steel plates are subjected to the impact test in accordance with the characteristic properties of plates, thickness classification, temperature classification and test temperatures according to application stress, prescribed in WES3003 (valuation criterion of rolled steels for low temperature application) of the Japan Welding Association Standards, and the average absorbed energy of a set of three test pieces thus obtained shall be 50% or more the maximum absorbed energy. However, the maximum absorbed energy shall denote the average absorbed energy in case when the impact test is conducted at room temperature on a set of three test pieces extracted from an optional plate of steel plates of identical molten steel and with identical heat-treatment conditions and thickness, and the percent shear is 100% for each test piece.
													21≦t	24	No.4			
N–TUF325	6≦t≦32	≦0.14		1.00~1.60			—	—	—	—	≧325	440~560	t<21	9.4+5√t	No.5		1.5t	
													21≦t	22	No.4			
N–TUF365	6≦t≦50	≦0.14		1.00~1.60			≦0.70	—	—	—	≧365	490~610	t<21	7.4+5√t	No.5		1.5t	
													21≦t	20	No.4			
N–TUF490	6≦t≦50	≦0.16		0.90~1.60			≦0.60	≦0.40	≦0.30	≦0.08	≧490	610~740	t<21	3.6+5√t	No.5		1.5t	
													21≦t	17	No.4			
N–TUF570	6≦t≦26	≦0.14		≦0.70			2.00~2.75	≦0.50	≦0.55	—	≧570	670~800	t<21	2.2+5√t	No.5		1.5t	
													21≦t	15	No.4			

Remarks:
1) When necessary, alloying elements other than those shown in the tale may be added.
2) In the bending test, cracks shall not occur in the outside of test piece.
The bending test can be eliminated unless otherwise specified.

2. Available Sizes

Please refer to page 28 for the scope of production.

Sulfuric Acid-resisting Steel Plates: S-TEN™ Series

1. Outline of Series and Specifications

S-TEN Series is steel with high sulfuric acid resistance for places where dew point corrosion occurs caused by sulfuric acid gas or exhaust gas. It is applicable in fields requiring resistance to sulfuric and hydrochloric acids such as boiler heat exchangers and related facilities, air preheaters, dust collectors, and smokestacks.

Brand name [1]	Applicable plate thickness (mm)	Chemical composition (%) [2]									Mechanical properties						
		C	Si	Mn [3]	P	S	Cu	Cr	Ti	Other	Yield point or proof stress (N/mm²)	Tensile strength (N/mm²)	Elongation: Thickness (mm)	Elongation: Min. elongation (%)	Elongation: Test piece JIS	Bending test [5]: Bending angle (°)	Bending test [5]: Inside bending radius/Thickness
S–TEN1	1.6≦t≦20.2	≦0.14	≦0.55	≦1.60	≦0.025	≦0.025	0.25~0.50	—	—	Sb ≦0.15	≧245 (t≦16) ≧235 (t≦20.2)	400~510	t≦16	18	No.1A [4]	180	1.5t
													16<t	22	No.1A [4]		
													t≦20.2	23	No.5		
S–TEN2	2.0≦t≦20.2	≦0.14	0.15~0.55		≦0.035	≦0.035		0.50~1.00	≦0.15	—	≧325 (t≦16) ≧315 (t≦20.2)	490~610	t≦16	17	No.1A [4]	180	1.5t
													16<t	21	No.1A [4]		
													t≦20.2	22	No.5		

Remarks:
1) S-TEN1 plate macufactured at NIPPON STEEL's plate mills conforms to JIS G 3106 SM400A, and S–TEN2 to JIS G 3106 SM490A.
2) When necessary, alloying elements other than those shown in the tale may be added.
3) The Mn standard value of S-TEN1 is 2.5×[C]≦Mn.
4) Applied in the case of manufacture as JIS G 3106.
5) In the bending test, cracks shall not occur in the outside of test piece.
The bending test can be eliminated unless otherwise specified.

2. Available Sizes

Please refer to page 28 for the scope of production.

A smoke stack at garbage incineration site

A smoke stack at a generation plant

Ni-Added Weathering Steel Plates: NAW-TEN™ Series

1. Outline of Series and Specifications

NAW-TEN Series is steel featuring superior salt resistance under non-coating specifications (in an uncoated state or after rust stabilization treatment). It is applied in fields requiring high salt resistance such as bridges and other structures with non-coating specifications.

<table>
<tr><th colspan="2" rowspan="3">Brand name</th><th rowspan="3">Applicable plate thickness (mm)</th><th colspan="9">Chemical composition (%) 1)</th><th colspan="7">Mechanical properties</th></tr>
<tr><th rowspan="2">C</th><th rowspan="2">Si</th><th rowspan="2">Mn</th><th rowspan="2">P</th><th rowspan="2">S</th><th rowspan="2">Cu</th><th rowspan="2">Ni</th><th rowspan="2">Cr</th><th rowspan="2">v-Value 2)</th><th colspan="5">Tensile test</th><th colspan="2">Impact test V notch</th></tr>
<tr><th>Yield point or proof stress (N/mm²)</th><th>Tensile strength (N/mm²)</th><th>Elongation
Thickness (mm)</th><th>Elongation
Min. elongation (%)</th><th>Test piece JIS</th><th>Temperature (°C)</th><th>Absorbed energy (J)</th></tr>
<tr><td rowspan="3">NAW-TEN12-400</td><td>A</td><td rowspan="3">6≦t≦100</td><td rowspan="14">≦0.18</td><td rowspan="14">0.15~0.65</td><td rowspan="3">≦1.25</td><td rowspan="14">≦0.035</td><td rowspan="14">≦0.035</td><td rowspan="7">0.50~1.00</td><td rowspan="7">0.70~1.70</td><td rowspan="14">≦0.08</td><td rowspan="7">1.20≦</td><td rowspan="3">≧245(t≦16)
≧235(16<t≦40)
≧215(40<t≦100)</td><td rowspan="3">400~540</td><td rowspan="3">t≦16
16<t
40<t</td><td rowspan="3">17
21
23</td><td rowspan="3">1A号
1A号
4号</td><td>—</td><td>—</td></tr>
<tr><td>B</td><td rowspan="2">0</td><td>27</td></tr>
<tr><td>C</td><td>47</td></tr>
<tr><td rowspan="3">NAW-TEN12-490</td><td>A</td><td rowspan="3">6≦t≦100</td><td rowspan="4">≦1.40</td><td rowspan="3">≧365(t≦16)
≧355(16<t≦40)
≧335(40<t≦75)
≧325(75<t≦100)</td><td rowspan="3">490~610</td><td rowspan="3">t≦16
16<t
40<t</td><td rowspan="3">15
19
21</td><td rowspan="3">1A号
1A号
4号</td><td>—</td><td>—</td></tr>
<tr><td>B</td><td rowspan="2">0</td><td>27</td></tr>
<tr><td>C</td><td>47</td></tr>
<tr><td colspan="2">NAW-TEN12-570</td><td>6≦t≦100</td><td>≧460(t≦16)
≧450(16<t≦40)
≧430(40<t≦75)
≧420(75<t≦100)</td><td>570~720</td><td>t≦16
16<t
20<t</td><td>19
26
20</td><td>5号
5号
4号</td><td>-5</td><td>47</td></tr>
<tr><td rowspan="3">NAW-TEN15-400</td><td>A</td><td rowspan="3">6≦t≦100</td><td rowspan="3">≦1.25</td><td rowspan="7">0.30~0.50</td><td rowspan="7">2.50~3.50</td><td rowspan="7">1.50≦</td><td rowspan="3">≧245(t≦16)
≧235(16<t≦40)
≧215(40<t≦100)</td><td rowspan="3">400~540</td><td rowspan="3">t≦16
16<t
40<t</td><td rowspan="3">17
21
23</td><td rowspan="3">1A号
1A号
4号</td><td>—</td><td>—</td></tr>
<tr><td>B</td><td rowspan="2">0</td><td>27</td></tr>
<tr><td>C</td><td>47</td></tr>
<tr><td rowspan="3">NAW-TEN15-490</td><td>A</td><td rowspan="3">6≦t≦100</td><td rowspan="4">≦1.40</td><td rowspan="3">≧365(t≦16)
≧355(16<t≦40)
≧335(40<t≦75)
≧325(75<t≦100)</td><td rowspan="3">490~610</td><td rowspan="3">t≦16
16<t
40<t</td><td rowspan="3">15
19
21</td><td rowspan="3">1A号
1A号
4号</td><td>—</td><td>—</td></tr>
<tr><td>B</td><td rowspan="2">0</td><td>27</td></tr>
<tr><td>C</td><td>47</td></tr>
<tr><td colspan="2">NAW-TEN15-570</td><td>6≦t≦100</td><td>≧460(t≦16)
≧450(16<t≦40)
≧430(40<t≦75)
≧420(75<t≦100)</td><td>570~720</td><td>t≦16
16<t
20<t</td><td>19
26
20</td><td>5号
5号
4号</td><td>-5</td><td>47</td></tr>
</table>

Remarks:
1) When necessary, alloying elements other than those shown in the tale may be added.
2) *v*-Value (mass %):
v-Value = 1/{ (1.0-0.16 [C]) x (1.05-0.05 [Si]) x (1.04-0.016 [Mn]) x (1.0-0.5 [P]) x (1.0+1.9 [S]) x (1.0-0.10 [Cu]) x (1.0-0.12 [Ni]) x (1.0-0.3 [Mo]) x (1.0-1.7 [Ti]) }
(ref. *J. of JSCE* (2003), No. 738, I-64, pp271-281. (in Japanese)

■ Except for chemical composition, its mechanical specifications conform to JIS G 3114.

2. Available Sizes

Please refer to page 29 for the scope of production.

Bridge

Bridge

Shimane Museum of Ancient Izumo (Shimane Prefecture)

Highly Corrosion-resisting Steel Plates: COR-TEN™ Series

1. Outline of Series and Specifications

COR-TEN Series is steel with superior corrosion resistance (weatherability). It is used under non-coating specifications or after rust stabilization treatment. It is applied in fields requiring structures with excellent weatherability such as bridges and other structures with non-coating specifications.

2. Available Sizes

Please refer to page 29 for the scope of production.

Brand name		Applicable plate thickness (mm)	Chemical composition (%) [1]: C	Si	Mn	P	S	Cu	Ni	Cr	V	Mechanical properties – Tensile test: Yield point or proof stress (N/mm²)	Tensile strength (N/mm²)	Elongation: Thickness (mm)	Elongation: Min. elongation (%)	Test piece JIS	Bending test [3] – Inside bending radius: Bending angle (°)	Thickness (mm)	Radius	Impact test: Temperature (℃)	Absorbed energy (J)
COR–TEN490	A	6≦t≦50	≦0.17	0.30~0.65	0.80~1.25	≦0.035	≦0.035	0.30~0.40	0.05~0.30	0.45~0.65	0.02~0.10	≧360 (t≦16)	490~610	t≦16	15	No.1A	—	—	—	—	—
	B											≧355 (16<t≦40)		16<t	19	No.1A	—	—	—	0	27
	C											≧335 (40<t)		40<t	21	No.4	—	—	—	0	47
COR–TEN570 [2]		6≦t≦50	≦0.17	0.30~0.65	0.80~1.25	≦0.035	≦0.035	0.30~0.40	0.05~0.30	0.45~0.65	0.02~0.10	≧460 (t≦16) ≧450 (16<t≦40) ≧430 (40<t)	570~720	t≦16 16<t 20<t	19 26 20	No.5 No.5 No.4	—	—	—	–5	27
COR–TEN O		1.6≦t≦76	≦0.12	0.25~0.75	0.20~0.50	0.070~0.150	≦0.035	0.25~0.55	≦0.65	0.30~1.25	—	≧355 (t≦20) ≧325 (20<t≦38) ≧295 (38<t)	≧490 (t≦20) ≧460 (20<t≦38) ≧430 (38<t)	t≦5 5<t t≦38 38<t	22 18 21 23	No.5 No.1A No.1A No.4	180	t≦5 5<t	1.0t 1.5t	—	—

* As a general rule, manufacturing process is as-rolled. However, appropriate heat treatment shall be applicable when required. When normalizing is requested at the order, an "N" is added to the end of the type code.

Remarks:
1) When necessary, alloying elements other than those shown in the tale may be added.
2) The yield point of COR-TEN™ 570 can be set at 490 N/mm² or more in accordance with the customer's request. However, in this case, the tensile strength shall be 570~740 N/mm².
3) In the bending test, cracks shall not occur in the outside of test piece. The bending test can be eliminated unless otherwise specified.

Corrosion-resistant Steel Plates for Export: COR-TEN™

1. Outline of Series and Specifications

COR-TEN Steel is best known weathering high-strength low-alloy steel in the world since 1933.

This standard is the original one of USS.

Because of its superior atmospheric corrosion resistance, it can be used either bare or painted, dependent upon application.

2. Available Sizes

Please refer to page 29 for the scope of production.

Brand name	Applicable plate thickness (mm)	Chemical composition (%): C	Si	Mn	P	S	Cu	Other	Mechanical properties: Thickness (mm)	Yield point or proof stress (N/mm²)	Tensile strength (N/mm²)	Elongation: Test piece	GL (mm)	Min. elongation (%)
COR–TEN A	t≦12.7	≦0.12	0.25~0.75	0.20~0.50	0.07~0.15	≦0.050	0.25~0.55	Cr 0.50~1.25 Ni ≦0.65	t≦12.7	≧345	≧485	ASTM A6M ASTM A370	50 200	22 18
COR–TEN B	t≦200	≦0.19	0.30~0.65	0.80~1.25	≦0.040	≦0.050	0.25~0.40	Cr 0.50~1.25 V 0.02~0.10 Ni ≦0.40	t≦100	≧345	≧485		50 200	21 18
									100<t≦125	≧315	≧460		50	21
									125<t≦200	≧290	≧435		50	21
COR–TEN B-QT	t≦38								t≦38	≧485	620~760		50	19
COR–TEN C	t≦25	≦0.19	0.30~0.65	0.80~1.35	≦0.040	≦0.050	0.25~0.40	Cr 0.40~0.70 V 0.04~0.10 Ni ≦0.40	t≦25	≧415	≧550		50 200	21 16

Seawater-resistant Steel Plates for Welded Structures: MARILOY™

1. Outline of Series and Specifications

MARILOY Series is steel featuring seawater resistance. It has the strength, toughness, and workability appropriate for use in offshore structures. It has been used in many structures requiring seawater resistance.

Brand name	Applicable plate thickness (mm)	Chemical composition (%) [1]: C	Si	Mn	P	S	Cr	Mechanical properties – Tensile test: Yield point or proof stress (N/mm²)	Tensile strength (N/mm²)	Elongation: Thickness (mm)	Elongation: Min. elongation (%)	Test piece JIS	Bending test [2] – Inside bending radius: Bending angle (°)	Radius
MARILOY S400A	3.2≦t≦32	≦0.14	≦0.55	≦1.50	≦0.030	≦0.030	0.80~1.30	≧245 (t≦16) ≧235 (16<t≦32)	≧400	t≦5 5<t≦16 16<t	23 19 22	No.5 No.1A No.1A	180	1.0t

Remarks:
1) When necessary, alloying elements other than those shown in the tale may be added.
2) In the bending test, cracks shall not occur in the outside of test piece. The bending test can be eliminated unless otherwise specified.

Low-Temperature Steel Plates — Available Sizes

■ N–TUF™295, 325, 365, 490

* Please refer to page 18 for N-TUF570.

Standard size range

Width (mm) / Thickness (mm)		1000 to 1200	Over 1200 to 1400	1400 ~ 1600	1600 ~ 1800	1800 ~ 2000	2000 ~ 2200	2200 ~ 2400	2400 ~ 2600	2600 ~ 2800	2800 ~ 3000	3000 ~ 3200	3200 ~ 3400	3400 ~ 3600	3600 ~ 3800	3800 ~ 4000	4000 ~ 4200	4200 ~ 4400	4400 ~ 4500
6						16.0						12.0							
Over 6	7 or less					20.0						14.0							
7	8											15.0							
8	9											20.0							
9	10					21.0						20.0	20.0						
10	12											21.0	21.0	21.0					
12	14											21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0
14	16															21.0	21.0	21.0	21.0
16	18																21.0	21.0	21.0
18	20																	21.0	21.0
20	22																		
22	24																		
24	26																		
26	28					22.0												21.0	21.0
28	30																21.0	20.0	20.0
30	32															21.0	19.0	19.0	18.0
32	34														20.0	19.0	18.0	18.0	17.0
34	36													20.0	19.0	18.0	17.0	17.0	16.0
36	38												20.0	19.0	18.0	17.0	16.0	16.0	15.0
38	40											21.0	19.0	18.0	17.0	16.0	16.0	15.0	14.0
40	42										21.0	20.0	18.0	17.0	16.0	16.0	15.0	14.0	14.0
42	44									21.0	20.0	19.0	18.0	17.0	16.0	15.0	13.0	13.0	13.0
44	46									21.0	19.0	19.0	17.0	16.0	15.0	14.0	13.0	13.0	13.0
46	48								21.0	20.0	18.0	17.0	16.0	15.0	14.0	14.0	13.0	12.0	12.0
48	50								20.0	19.0	18.0	16.0	15.0	15.0	14.0	13.0	12.0	12.0	12.0

Sulfuric Acid Corrosion Resistant Steel Platse — Available Sizes

■ S–TEN™1, 2

Standard size range

Width (mm) / Thickness (mm)		1000 to 1200	Over 1200 to 1400	1400 ~ 1600	1600 ~ 1800	1800 ~ 2000	2000 ~ 2200	2200 ~ 2400	2400 ~ 2600	2600 ~ 2800	2800 ~ 3000	3000 ~ 3200	3200 ~ 3400	3400 ~ 3600	3600 ~ 3800	3800 ~ 4000	4000 ~ 4200	4200 ~ 4400	4400 ~ 4500
6			16.0																
Over 6	7 or less																		
7	8						20.0												
8	9																		
9	10																		
10	12																		
12	14						23.0												
14	16																		
16	18																		
18	20																		

Atmospheric Corrosion Resistant Steel Plates (As-Rolled) — Available Sizes

■ COR–TEN™O, A, B, C, COR–TEN™490, NAW–TEN™12, 15

* Please refer to page 18 for COR-TEN570 and COR-TEN B-QT.

Standard size range

Width (mm) / Thickness (mm)		1000 to 1200	Over 1200 to 1400	1400 ~ 1600	1600 ~ 1800	1800 ~ 2000	2000 ~ 2200	2200 ~ 2400	2400 ~ 2600	2600 ~ 2800	2800 ~ 3000	3000 ~ 3200	3200 ~ 3400	3400 ~ 3600	3600 ~ 3800	3800 ~ 4000	4000 ~ 4200	4200 ~ 4400	4400 ~ 4500
6								15.0											
Over 6	7 or less													15.0					
7	8													15.0	15.0	15.0			
8	9															15.0	15.0	15.0	15.0
9	10																		
10	12																		
12	14																		
14	16																		
16	18																		
18	20																		
20	22																		
22	24								23.0										
24	26																	22.0	22.0
26	28																22.0	21.0	20.0
28	30														22.0	21.0	20.0	19.0	19.0
30	32													22.0	21.0	20.0	19.0	18.0	18.0
32	34													21.0	20.0	19.0	18.0	17.0	17.0
34	36													20.0	19.0	18.0	17.0	16.0	16.0
36	38													19.0	18.0	17.0	16.0	15.0	15.0
38	40													18.0	17.0	16.0	15.0	14.0	14.0
40	42													14.0	13.0	12.0	12.0	11.0	11.0
42	44													14.0	13.0	12.0	12.0	11.0	11.0
44	46													14.0	13.0	12.0	12.0	11.0	11.0
46	48													14.0	13.0	12.0	12.0	11.0	11.0
48	50													14.0	13.0	12.0	12.0	11.0	11.0
50	52				21.5	19.5	19.5	18.0	17.0	15.5	14.5	14.0	13.0	12.5	11.5	11.5	11.0	10.5	10.0
52	54				21.5	19.5	19.5	18.0	17.0	15.5	14.5	14.0	13.0	12.5	11.5	11.5	11.0	10.5	10.0
54	56				21.5	19.5	19.5	18.0	17.0	15.5	14.5	14.0	13.0	12.5	11.5	11.5	11.0	10.5	10.0
56	58		23.0		21.5	19.5	19.5	18.0	17.0	15.5	14.5	14.0	13.0	12.5	11.5	11.5	11.0	10.5	10.0
58	60				21.5	19.5	19.5	18.0	17.0	15.5	14.5	14.0	13.0	12.5	11.5	11.5	11.0	10.5	10.0
60	65				18.5	17.0	17.0	15.5	14.5	13.5	12.5	12.0	11.5	11.0	10.0	9.5	9.0	9.0	8.5
65	70				18.5	17.0	17.0	15.5	14.5	13.5	12.5	12.0	11.5	11.0	10.0	9.5	9.0	9.0	8.5
70	75		22.5	20.0	16.0	15.0	15.0	13.5	12.5	12.0	11.0	10.5	10.0	9.5	9.0	8.5	8.5	8.5	8.5
75	80		22.5	20.0	16.0	15.0	15.0	13.5	12.5	12.0	11.0	10.5	10.0	9.5	9.0	8.5	8.5	8.5	8.5
80	85		20.0	17.5	14.5	13.0	13.0	12.5	11.5	11.5	11.0	9.5	9.0	8.5	8.5	8.5	8.5	8.5	8.5
85	90		20.0	17.5	14.5	13.0	13.0	12.5	11.5	11.5	11.0	9.5	9.0	8.5	8.5	8.5	8.5	8.5	8.5
90	95	21.0	18.0	16.0	13.0	12.0	12.0	11.5	11.5	11.5	11.0	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.0
95	100	21.0	18.0	16.0	13.0	12.0	12.0	11.5	11.5	11.5	11.0	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.0
100	105							11.5	11.5	11.5	11.0	8.5	8.5	8.5	8.5	8.5	8.0	8.0	7.5
105	110							11.5	11.5	11.5	11.0	8.5	8.5	8.5	8.5	8.5	8.0	8.0	7.5
110	115		13.0					11.5	11.5	11.5	10.5	8.5	8.5	8.5	8.0	8.0	7.5	7.0	6.5
115	120					12.0		11.5	11.5	11.5	10.5	8.5	8.5	8.5	8.0	8.0	7.5	7.0	6.5
120	125			12.5				11.5	11.0	10.5	9.5	8.5	8.5	8.0	7.5	7.0	7.0	6.5	6.0
125	130			12.5				11.5	11.0	10.5	9.5	8.5	8.5	8.0	7.5	7.0	7.0	6.5	6.0
130	135			12.5				11.0	10.5	9.5	9.0	8.5	8.0	7.5	7.0	6.5	6.5	6.0	5.5
135	140			12.5				11.0	10.5	9.5	9.0	8.5	8.0	7.5	7.0	6.5	6.5	6.0	5.5
140	145			12.5		11.5		10.5	9.5	9.0	8.5	8.0	7.5	7.0	6.5	6.0	6.0	5.5	5.5
145	150			12.5				10.5	9.5	9.0	8.5	8.0	7.5	7.0	6.5	6.0	6.0	5.5	5.5

High Tensile Steel Plates for Building Structures: BT–HT™ Series

1. Outline of Series and Specifications

The BT-HT (BUILTEN™) series is high tensile strength steel that has no decrease in yield point even in thicker guage. Almost all of this series is manufactured by applying an accelerated cooling process (TMCP). While it is high tensile strength steel, it has excellent weldability and to date it has been applied in various architectural structures.

Brand name		Applicable plate thickness (mm)	Chemical composition (%) [1]														Mechanical properties										
																	Tensile test						Through thickness tensile test		Impact test V notch		
			C	Si	Mn	P	S	Cu	Ni	Cr	Mo	V	Nb	Other	C_{eq} [3]	P_{CM} [3]	Yield point or proof stress (N/mm^2)	Tensile strength (N/mm^2)	Yield ratio [4] (%)	Elongation: Thickness (mm)	Elongation: Min. elongation (%)	Elongation: Test piece JIS	Average value of 3 test pieces (%)	Each value (%)	Thickness (mm)	Tem-perature (℃)	Absorbed energy (J)
BT–HT325	B	40<t≦100	≦0.18(t≦50) ≦0.20(t≦100)	≦0.55	≦1.60	≦0.030	≦0.015	—	—	—	—	—	—	—	≦0.38(t≦50) ≦0.40(t≦100)	≦0.24(t≦50) ≦0.26(t≦100)	325～445	490～610	≦80	t≦50 40<t	21 23	No.1A No.4	—	—	40<t	0	≧27
	C					≦0.020	≦0.008																≧25	≧15			
BT–HT355	B	40<t≦100	≦0.20	≦0.55	≦1.60	≦0.030	≦0.015	—	—	—	—	—	—	—	≦0.40(t≦50) ≦0.42(t≦100)	≦0.26(t≦50) ≦0.27(t≦100)	355～475	520～640	≦80	t≦50 40<t	19 21	No.1A No.4	—	—	40<t	0	≧27
	C					≦0.020	≦0.008																≧25	≧15			
BT–HT385	B	12≦t≦100	≦0.20	≦0.55	≦2.00	≦0.030	≦0.015	—	—	—	—	—	—	f_{HAZ} [2] ≦0.58%	≦0.44(12≦t<19) ≦0.40(19≦t≦50) ≦0.42(50<t≦100)	≦0.26(t≦50) ≦0.27(50<t)	385～505	550～670	≦80	t≦32 32<t	15 20	No.1A No.4	—	—	12≦t	0	≧70
	C	16≦t≦100				≦0.020	≦0.008																≧25	≧15			
BT–HT440 (SA440)	B	19≦t≦100	≦0.18	≦0.55	≦1.60	≦0.030	≦0.008	—	—	—	—	—	—	—	≦0.44(t≦40) ≦0.47(t≦100)	≦0.28(t≦40) ≦0.30(t≦100)	440～540	590～740	≦80	—	26	No.5	—	—	19≦t	0	≧47
	C					≦0.020															20	No.4	≧25	≧15			
	B–SP		≦0.12			≦0.030										≦0.22					26	No.5	—	—		0	≧70
	C–SP					≦0.020															20	No.4	≧25	≧15			
BT–HT630	B	9≦t≦100	≦0.16	≦0.35	0.60～1.60	≦0.030	≦0.015	≦1.50	≦2.00	≦0.80	≦0.60	≦0.60	≦0.05	—	≦0.60	≦0.35	630～750	780～930	≦85	9≦t≦16 16<t≦20 20<t	16 24 16	No.5 No.5 No.4	—	—	9≦t	0	≧47
	C																						≧25	≧15			
BT–HT400C		16<t≦100	≦0.20	≦0.55	≦2.00	≦0.020	≦0.008	—	—	—	—	—	—	f_{HAZ} [2] ≦0.58%	≦0.40	≦0.26	400～550	490～640	≦90	t≦50 40<t	21 23	No.1A No.4	≧25	≧15	16<t	0	≧70
BT–HT500C		19≦t≦100	≦0.18	≦0.55	≦2.00	≦0.020	≦0.008	—	—	—	—	—	—	—	≦0.44(t≦40) ≦0.47(t≦100)	≦0.28(t≦40) ≦0.30(t≦100)	500～650	590～740	≦90	19≦t 20<t	26 20	No.5 No.4	≧25	≧15	19≦t	0	≧70
BT–HT700 (H–SA700)	A	6≦t≦50	≦0.25	≦0.55	≦2.00	≦0.030	≦0.015	—	—	—	—	—	—	—	≦0.65	≦0.32	700～900	780～1000	≦98	6≦t≦20 20<t≦50 20<t≦50	16 16 24	No.5 No.4 No.5	—	—	12<t	0	≧47
	B					≦0.025									≦0.60	≦0.30							—	—		–20	≧47
BT–HT880	B	9≦t≦50	≦0.16	≦0.55	≦1.50	≦0.015	≦0.008	—	—	—	—	—	—	—	≦0.62	≦0.34	880～1060	950～1130	≦98	9≦t≦16 16<t≦20 20<t≦50	13 19 13	No.5 No.5 No.4	—	—	9≦t≦12 [5] 12<t≦50	0	≧53 ≧70
	C																						≧25	≧15			

Remarks:
1) When necessary, alloying elements other than those shown in the tale may be added.
2) f_{HAZ} ≦ 0.58% [for vE0℃ (multi-pass welding) ≧ 70J]
f_{HAZ}=C+Mn/8+6（P+S）+12N−4Ti（%）
f_{HAZ} (%): a chemical composition parameter for estimating the HAZ (Heat Affected Zone) toughness of building column–beam welding.
The content of Ti should be consideredas 0 when it is equal to or less than 0.005 mass%.
3) Carbon equivalent, Ceq, and weld crack sensitivity, P_{CM}, are calculated for added elements using the following equation.
Ceq=C+Si/24+Mn/6+Ni/40+Cr/5+Mo/4+V/14（%）
P_{CM}=C+Si/30+Mn/20+Cu/20+Ni/60+Cr/20+Mo/15+V/10+5B（%）
4) Yield ratio = Yield point or 0.2% proof stress/tensile strength × 100%
5) Tested by 7.5mm– subsize specimen.

Fire-resistant Steel Plates for Building Structures: NSFR™ Series

1. Outline of Series and Specifications

The NSFR series is steel that has extremely high proof stress even in high temperatures. With the NSFR series, fireproof covering can be greatly reduced, and depending on the fire conditions and design conditions of the architectural structure, it is possible to design uncoated steel-frame buildings. To date, it has been applied in many cases.

Brand name		Equivalent JIS symbol	Applicable plate thickness (mm)	Chemical composition (%) [1]									Mechanical properties											
													Tensile test						Through thickness tensile test	Impact test V notch			High temperature proof stress (600℃) Thickness (mm)	
				C	Si	Mn	P	S	Cr	Mo	Other	PCM [2]	Yield point or proof stress (N/mm²)	Tensile strength (N/mm²)	Yield ratio (%)	Elongation: Thickness (mm)	Elongation: Min. elongation (%)	Elongation: Test piece JIS	Average value of 3 test pieces (%)	Each value (%)	Tem-perature (℃)	Absorbed energy (J)	t≦40	40<t≦100
NSFR400	B	SN400B	6≦t≦100	≦0.15	≦0.35	0.60~1.40	≦0.030	≦0.015	≦0.70	0.30~0.70	Nb+V+Ti ≦0.10	≦0.26	≧235 (t<12) 235–355 (t≦40) 215–335 (t≦100)	400~510	— ≦80 ≦80	6≦t≦16 16<t≦50 40<t≦100	≧18 ≧22 ≧24	No.1A No.1A No.4	—	—	0	≧27	≧157	≧143
	C	SN400C	16≦t≦100				≦0.020	≦0.008					235–355 (t≦40) 215–335 (t100)		≦80 ≦80	t=16 16<t≦50 40<t≦100	≧18 ≧22 ≧24	No.1A No.1A No.4	≧25	≧15				
NSFR490	B	SN490B	6≦t≦100	≦0.15	≦0.55	≦1.60	≦0.030	≦0.015	≦0.70	0.30~0.90	Nb+V+Ti ≦0.10	≦0.26	≧325 (t<12) 325–445 (t≦40) 295–415 (t≦100)	490~610	— ≦80 ≦80	6≦t≦16 16<t≦50 40<t≦100	≧17 ≧21 ≧23	No.1A No.1A No.4	—	—			≧217	≧197
	C	SN490C	16≦t≦100				≦0.020	≦0.008					325–445 (t≦40) 295–415 (t100)		≦80 ≦80	t=16 16<t≦50 40<t≦100	≧17 ≧21 ≧23	No.1A No.1A No.4	≧25	≧15				

* The performance of this steel in normal temperatures satisfies the applicable JIS, so it will be marketed as a JIS product.
* This steel has low carbon levels, so it is stipulated by P_{CM}, and thus Ceq does not apply.

Remarks:
1) When necessary, alloying elements other than those shown in the tale may be added.
2) Weld crack sensitivity, P_{CM}, is calculated for added elements using the following equation.
P_{CM}=C+Si/30+Mn/20+Cu/20+Ni/60+Cr/20+Mo/15+V/10+5B (%)

Steel Plates for Elasto-plastic Hysteretic-type Dampers for Building Structures: BT-LYP

1. Outline of Series and Specifications

The BT-LYP series are low yield point steel plates that are used for elasto-plastic hysteretic dampers, etc., which cause earthquake energy to be absorbed. To date, it has been applied in many cases.

Brand name	Applicable plate thickness (mm)	Chemical composition (%) [1]							Mechanical properties						
									Tensile test					Impact test V notch	
		C	Si	Mn	P	S	Other	Ceq [2]	Lower yield stress or proof stress (N/mm²)	Tensile strength (N/mm²)	Yield ratio (%)	Elongation: Min. elongation (%)	Elongation: Test piece JIS	Temperature (℃)	Absorbed energy J)
BT–LYP100	6≦t≦50	≦0.01	≦0.03	≦0.20	≦0.025	≦0.015	N≦0.006	≦0.36	80~120	200~300	≦60	≧50	No.5	0	≧27
BT–LYP225	6≦t≦50	≦0.10	≦0.05	≦0.50			N≦0.006	≦0.36	205~245	300~400	≦80	≧40	No.5	0	≧27

* Please consult with us before use.

Remarks:
1) When necessary, alloying elements other than those shown in the tale may be added.
2) Carbon equivalent, Ceq, is calculated for added elements using the following equation.
C_{eq}=C+Si/24+Mn/6+Ni/40+Cr/5+Mo/4+V/14 (%)

■ The yield point (yield resistance) is low, at 100 N/mm² (B-LYP 100) or 225 N/mm² (B-LYP 225), and furthermore, the range of variance in the yield point (proof stress) has been controlled to be narrow.

■ The expansion performance is guaranteed to be 50% or higher (B-LYP 100) or 40% or higher (B-LYP 225), so it has the deformation performance necessary for use for dampers, which are required to have great plastic deformation capability.

Conference center (application of steel Unbonded Braces)

Electromagnetic Soft Iron Plates: NS–MIP™

1. Outline of Series and Specifications

NS-MIP™ is steel that has excellent magnetic properties due to the fact that the impurities are made to be extremely limited in volume and granularized. To date, it has been applied in MRI devices used for medical purposes, direct current electromagnets such as lifting magnets, particle accelerators such as cyclotrons, and the like.

Brand name	Applicable plate thickness (mm)	Chemical composition (%) 1)					Mechanical properties 2)				
							Tensile test				
									Elongation		
		C	Si	Mn	P	S	Yield point or proof stress (N/mm²)	Tensile strength (N/mm²)	Thickness (mm)	Elongation (%)	Test piece JIS
NS–MIP250	6≦t≦270	≦0.02	≦0.02	≦0.20	≦0.020	≦0.010	≧100	≧250 (t≦50) ≧220 (50<t)	t≦16 16<t≦50 50<t	18 22 24	No.1A No.1A No.4

Remarks:
1) When necessary, alloying elements other than those shown in the tale may be added.
2) The procedure of mechanical test shall conform to the provision of JIS G 3136.

* Please consult us on available size.
* Available annealed (air-cooled) or rolled.

Brand name	Magnetic flux density (T) 3)				
	B_1	B_2	B_3	B_5	B_{25}
NS–MIP250	≧0.70	≧1.10	≧1.25	≧1.35	≧1.55

Remarks:
3) B_1, B_2, B_3, B_5 and B_{25} respectively indicate the magnetic flux density at
1 = Oe (79.6 A/m), 2 = Oe (159.2 A/m), 3 = Oe (238.8 A/m),
5 = Oe (398 A/m), 25 = Oe (1990 A/m).
Test specimens will be fabricated, then thermally treated in the same way as the host material, and then measured.
(Compliant with JIS C 2504-1990 Soft magnetic iron plates)

Information Required for Order

About Specifications

(1) When plates are to be produced to a standard specification, grade designations and other symbols should be clearly indicated.
(2) When plates are to be produced to special specifications as to chemical composition, mechanical properties, thickness, tolerances, etc., NIPPON STEEL should be consulted in advance.
(3) Heat treatment, ultrasonic examination, sulphur print and other special requirements should be clearly indicated.

About Intended Application and Fabrication Method

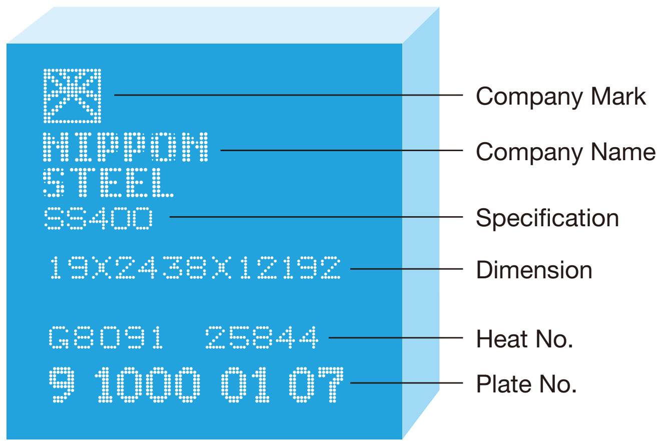
(1) Information about the application for which the ordered plate is intended-e.g., tank heads, shell plates, bridge beam flanges-should be given in as much detail as possible.
(2) The fabrication method to be employed and fabrication conditions-e.g., cold forming, hot forming, bending radius and direction, drawing, welding and cutting-should be clearly described.

Inquiries about plates that have already been delivered should include information about the contract number, specification number, product dimensions and the plate number (heat number) .

Examples of Marking

Marking

Plates are shipped without bundling and are loaded in bulk. Example of marking is shown below.



Conclusions

Summary

At NIPPON STEEL, we will continue to combine the technology we have accumulated to date with the results of uninterrupted development by our research laboratories and manufacturing and development divisions, as we strive to develop and manufacture various types of products that adapt to usage environments, purposes and demands that change with the times.


Bridge

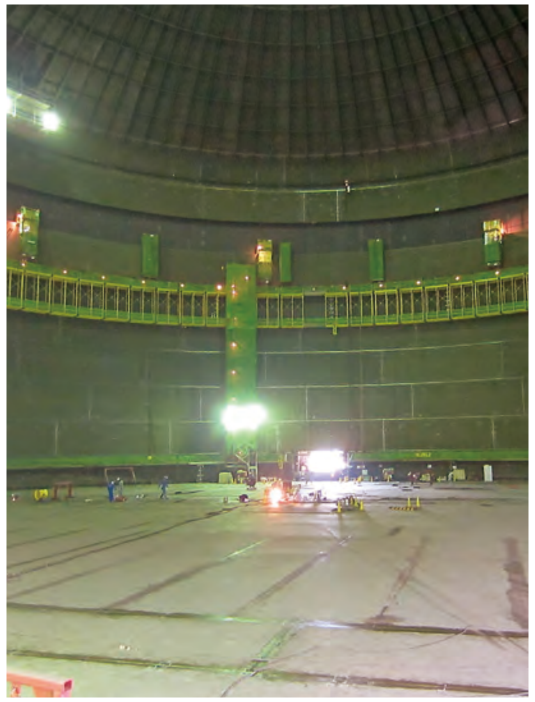

Offshore structure


Dump truck


Huge oil tanker


Building


TOKYO SKYTREE™
(Commissioning Entity: TOBU RAILWAY CO.,LTD. & TOBU TOWER SKYTREE CO.,LTD.)


LNG tank

Reference for Use of Steel Plates

1.TMCP

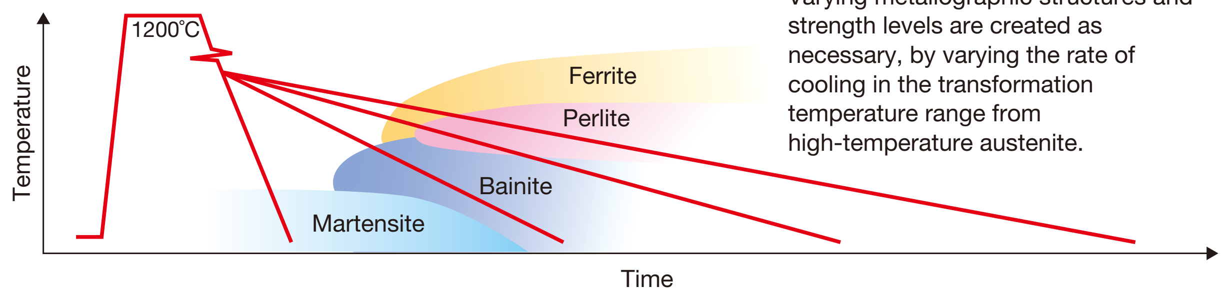
(1) The Metallographic Structure and Strength of Steel

As shown in Fig. 1, the metallographic structure and strength of steel vary greatly depending on the rate of cooling in the transformation temperature range (800 to 300℃). The transformation temperature range exists within the range over which high-temperature austenite cools to a low temperature. If the cooling is done slowly, a mixed structure of ferrite and pertly (partially bainite) with a tensile strength in the 400 to 500 MPa range, is formed. If the cooling is done more rapidly, the steel will have a bainite structure with a strength in the 600 to 800 MPa range. When cooled even more rapidly, a martensite structure with a strength of 800 MPa or more is obtained.

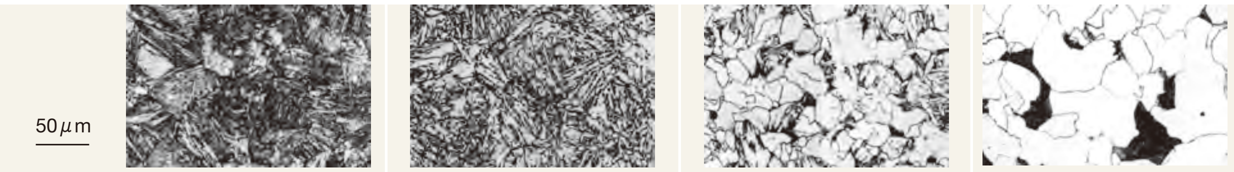
As described above, the metallographic structure varies depending on differences in the cooling rate. Therefore, controlling the cooling rate in the temperature range in which transformation occurs is important.

However, in conventional heat treatment methods, after heating the steel to a high temperature (austenite region), only two options can be used. One is to cool plates by air as cooled, and the other is to cool it as fast as possible using water (quenching). Furthermore, there were limited means for reducing the grain size and they were mainly based on controlling the heating temperature.

Fig. 1 The relationship between the cooling rate of the transformation temperature zone and metallographic structure as well as the strength level



Varying metallographic structures and strength levels are created as necessary, by varying the rate of cooling in the transformation temperature range from high-temperature austenite.



Cooling rate	100°C/sec (rate)	10°C/sec (rate)	1°C/sec (rate)	0.1°C/sec (rate)
Metallographic structure	Martensite	Bainite	Refined Ferrite & Bainite	Ferrite & Bainite
Strength level	Over 800MPa	800MPa	500MPa	400MPa

(2) Definition of TMCP

TMCP is a technique that, compared to conventional manufacturing processes, has a greatly expanded range of control of the metallographic structure and enables drastic reduction in grain size.

TMCP is an abbreviated name of a type of steel manufacturing technique formed from the initials of Thermo-Mechanical Control Process. TMCP achieves a new structural control technique not found in conventional heat treatment methods, by combining reheating, rolling and cooling. The key technology is found in the implantation of new grain seeds (nucleus) by means of rolling, and in the reduction of grain size by means of cooling following the rolling. By combining the effect of the working in the rolling process and the effect of the control of the cooling rate in the transformation temperature range in the cooling process, a new structural control technique not found in conventional heat treatment methods was achieved.

(3) TMCP and Grain Refinement

The basic way of thinking about reducing the grain size is that if the inside of the steel (steel plate) can be filled with a greater quantity of grains, the size of each individual grain can made small, as shown in Fig. 3. In other words, if a large number of grains are continuously formed, and furthermore if the growth of each grain is inhibited, then fine microstructures will be obtained. The key technology in TMCP is the creation of a large number of nuclei by means of rolling, and the inhibition of the growth of the grains by cooling following the rolling.

The metallographic structure control technique of TMCP is not limited to the reduction of grain size. As shown in Fig. 4, the necessary characteristics can be acquired by continuously controlling the metallographic structure in each process, from the steel making process to the reheating, rolling, and controlled cooling processes of the steel plates. In addition to ferrite, TMCP can also control a wide range of high-strength metallographic structures such as martensite and bainite.

(4) Effect by Applying TMCP

The biggest effect of TMCP is that through the reduction of grain size and the control of metallographic structure, it is now possible to manufacture thick steel plates that have the same strength while having a drastically lower carbon equivalent (amount of alloy added). This contributes to improving efficiency in the construction of structures and to assurance of safety and reliability, through prevention of low-temperature cracking during welding, improved toughness of the welded joints and so on. TMCP is now used in most uses of thick steel plates, such as shipbuilding, architecture, bridges, line pipe, pressure vessels, and so on.

Fig. 2 The effect of reducing Ceq by applying TMCP

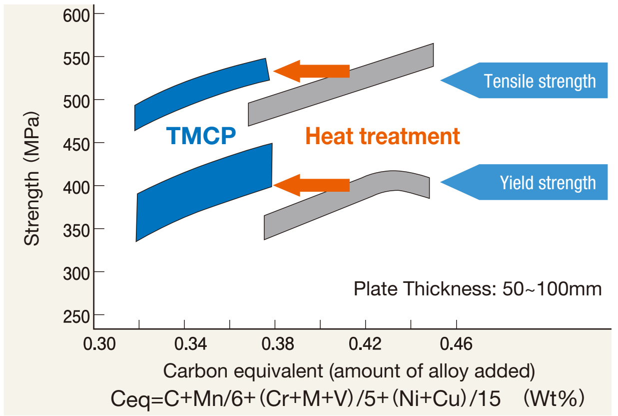
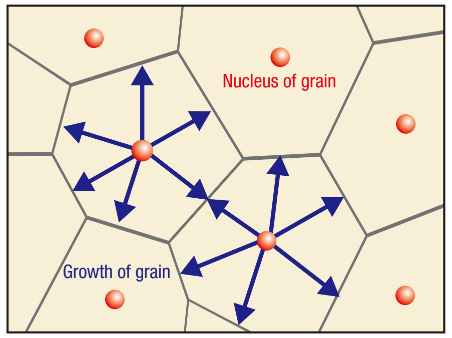
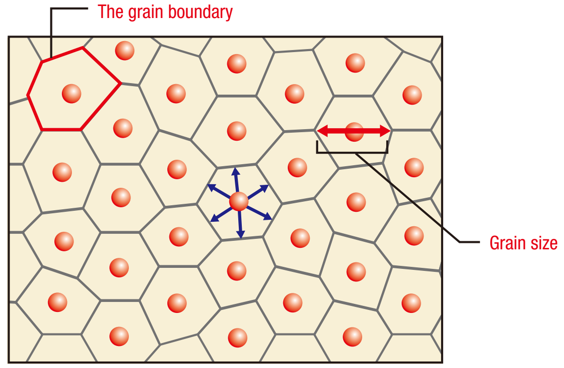


Fig. 3 Schematic image of grain size following to the balance of crystal nucleation and growth

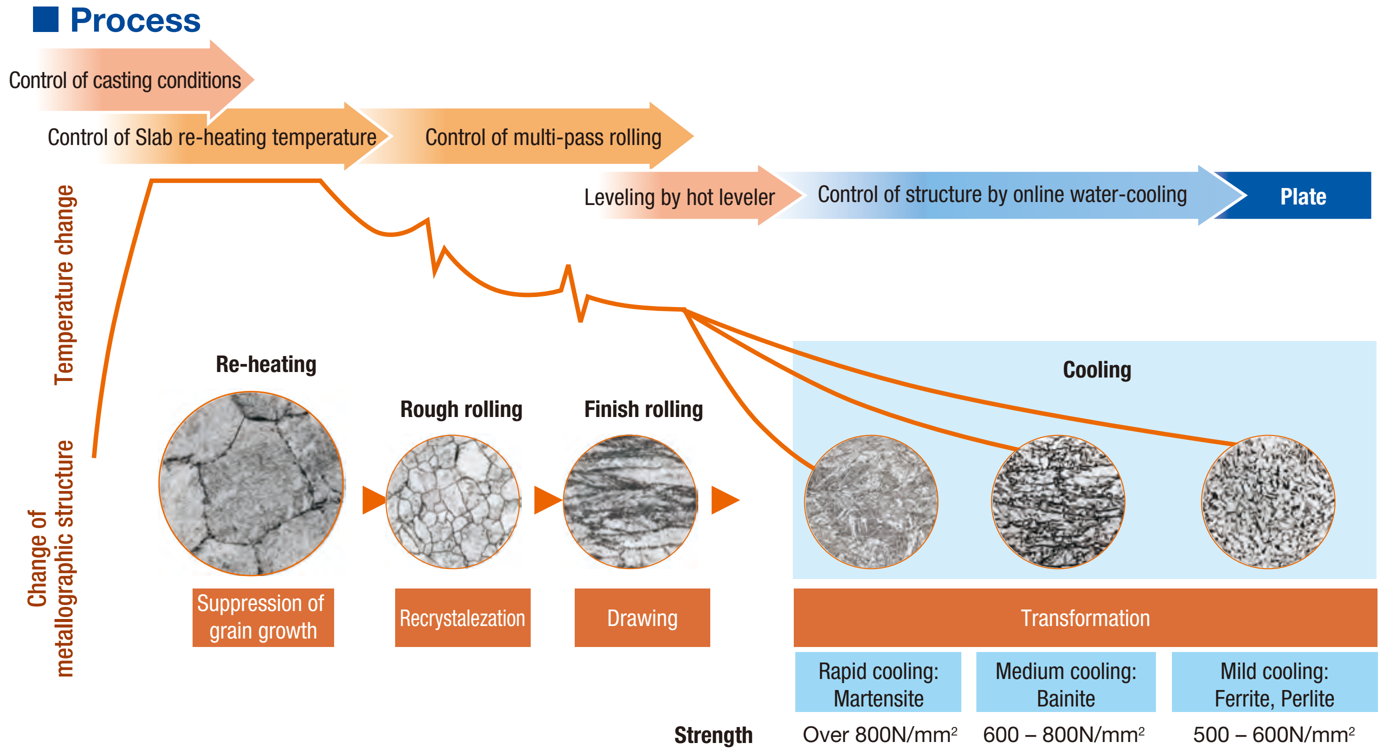


The size of grains is determined after the grain seeds (nucleus) are formed, when they grow to the point where they bump into each other.



By causing a large number of cores to form at once and inhibiting their growth, the grains can be made small.

Fig. 4 Continuous change of microstructure in TMCP



2. Welding

(1) The Metallographic Structure and Strength of Steel

In most cases, steel plates are manufactured with the expectation that they will be welded. Generally speaking, the portion affected by welding heat will change as described below, although this will vary depending on the welding method.

A. Structure of the Welding Heat-affected Zone

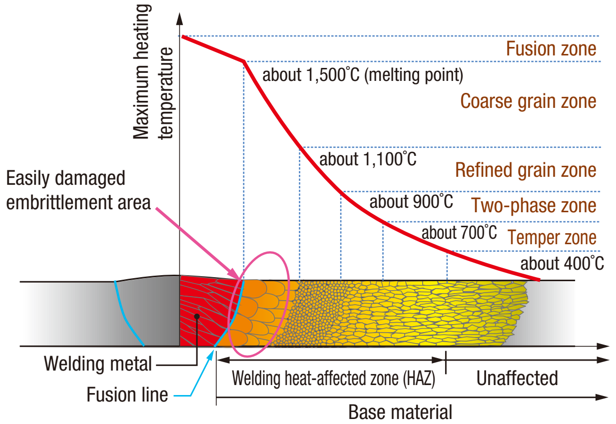


Fig. 5 Diagram of Fe-C equilibrium state and its relationship with the welding thermal cycle

Table 1: Structure of the weld heat-affected zone of steel

Structural type	Range of heating temperature (Approx.)	Remarks
Fusion zone	Melting temperature ≧(1500℃)	Range between melting and solidification, presenting dendritic structure.
Coarse grain zone	>1250℃	Section where grain has grown coarse. Likely to harden and crack.
Fine grain zone	1100～900℃	Refined by recrystallization. Good in mechanical properties such as toughness.
Two-phase zone (Inter-critically reheated)	900～700℃	Only pearlite becomes transformed or globurized. When cooled slowly, good in toughness, but when cooled rapidly, martensite is often produced and toughness deteriorates.
Temper zone	700～400℃	Embrittlement may occur due to thermal stress and precipitation. Microscopically no change.
Base metal zone	400℃～ room temperature	Base metal section with no thermal effect.

B. Hardening of HAZ

As the weld metal (WM) of non-heat treated steel plates has a kind of cast structure, the heat affected zone (HAZ) usually increases more in hardness due to the hardening effect than the base metal (BM).

The harder the HAZ, the lower the ductility, leading to probable cold cracking in welding or use. Therefore, steel grades and welding conditions must be determined carefully so that the maximum hardness of HAZ may be as low as possible. The carbon equivalent is widely used to estimate the maximum hardness.

The relationship between the maximum hardness and the carbon equivalent is shown in Fig. 7.

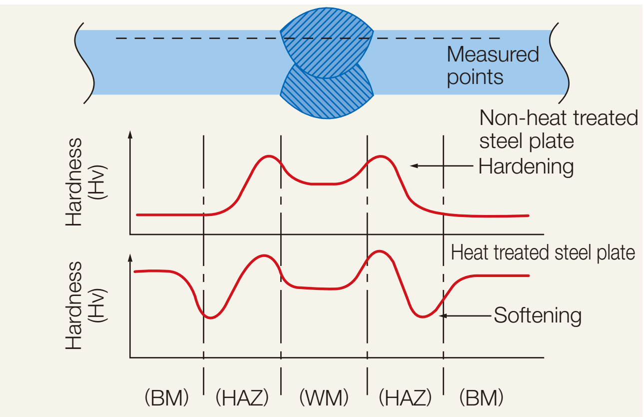


Fig. 6 Hardness of weld zone

Maximum hardness

(Hmax) =a·Ceq+b

(a and b are constants that depend on joint conditions.)

Carbon equivalent

$$(Ceq) = C + \frac{Si}{24} + \frac{Mn}{6} + \frac{Ni}{40} + \frac{Cr}{5} + \frac{Mo}{4} + \frac{V}{14} \ (\%)$$

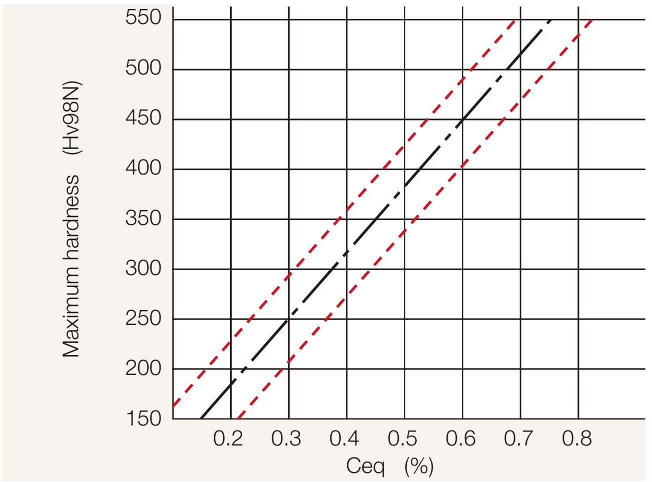


Fig. 7 Relationship between the maximum hardness and the carbon equivalent

In contrast, as the HAZ of heat-treated steel plate is heated at a high temperature above tempering temperature, softening phenomenon occurs. (Fig. 6)

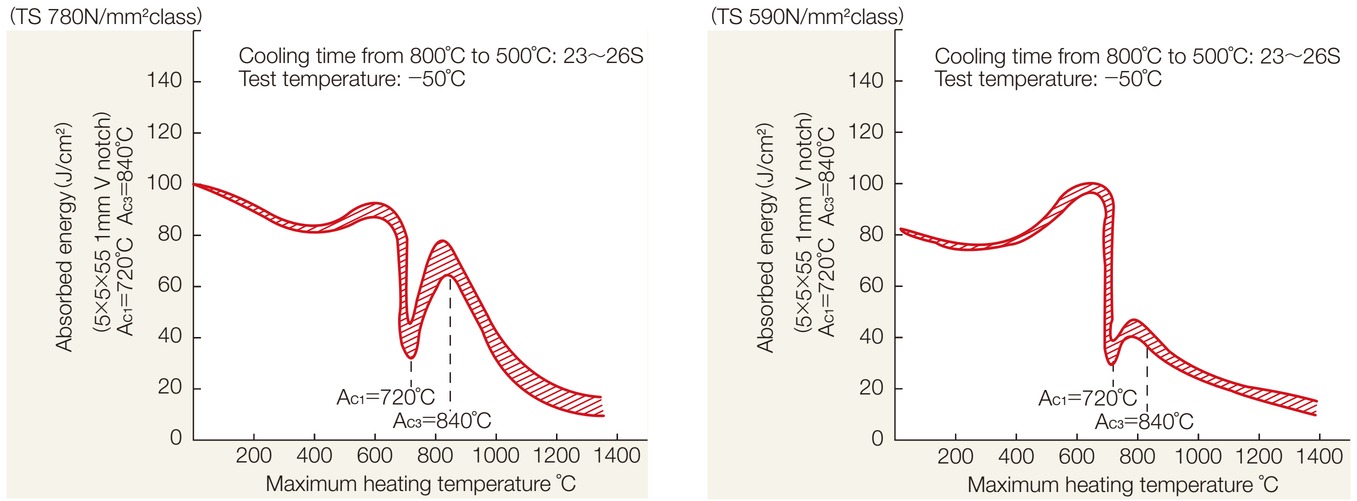
Therefore, it is necessary to conduct welding work with weld heat input as small as possible.

C. Degradation in Notch Toughness

In respect to HAZ notch toughness of high tensile strength steel plates, two kinds of embrittlement are observed as shown in Fig. 8 in response to the maximum heating temperature. One is in the coarse grain zone (near the maximum heating temperature of 1350℃) near the bond that is produced by coarse grain growth. Another is generated as a result of heating just above A_{C1}. This zone is embrittled by the notch effect on impact as a result of formation of hard and brittle martensitic structure by subsequent cooling due to large contents of alloying elements in austenite partially transformed in a way of $\alpha \rightarrow \gamma$.

Since around the weld bond, notch effects due to discontinuous shapes and weld defects are overlapped, embrittlement of the bond may well be a significant issue. Additionally, the larger the weld heat input, the greater the bond embrittlement.

Fig. 8 Embrittled zone of HAZ of high tensile strength steel plate



(2) Defects in The Weld Zone

Weld defects chiefly related to steel plates are summarized below.

Table 2: Weld defects and their countermeasures

Defect	Cause	Defect	Cause
Blow hole	(1) Excessive hydrogen or carbon monoxide in the arc atmosphere (2) Rapid cooling of the deposit (3) Excessive sulfur in the base metal (4) Oil/grease, paint, rust, etc. adhered to the joint (5) Inappropriate arc length and current value (6) Much humidity of the electrode or the joint (7) Presence of thick zinc coating	HAZ cracking	(1) Excessive hydrogen in the arc atmosphere (2) Great quenching ability of the base metal (Excessive P_{CM}: $P_{CM} = C + \frac{Si}{30} + \frac{Mn}{20} + \frac{Cu}{20} + \frac{Ni}{60} + \frac{Cr}{20} + \frac{Mo}{15} + \frac{V}{10} + 5B$) (3) Excessive constraint (excessive plate thickness)
		Degradation in ductility and notch brittleness of deposited steel	(1) Excessive cooling rate (2) Inappropriate welding rod (3) Addition of carbon and alloying elements from the base metal
Crack in deposited steel	(1) Excessive toughness of the joint (2) Presence of defects such as blow hole in deposited steel (3) Bad core wire or insufficiently dried welding rod (4) Non-conforming joints (5) Small and narrow beads due to too narrow joint angle (6) Excessive addition of carbon and alloying elements from the base metal (7) Angular change due to tensile at the weld bottom (8) Large sulfur content in the base metal	Degradation in ductility and notch brittleness of base metal HAZ	(1) Excessive cooling rate (2) Great quenching ability of the base metal (3) Strain aging of the base metal (4) Excessive hydrogen in the arc atmosphere
		Linear structure	(1) Excessive cooling rate in the weld zone (2) Excessive amounts of carbon and sulfur contents in the base metal (3) Much involvement of deoxidized products (4) Excessive dissolution of hydrogen

A. Weld Crack

There are two kinds of weld cracks. One is low-temperature cracks that occur at a comparatively low temperature and the other is high-temperature cracks that occur during melting and solidification. Low-temperature cracks include underbead cracks, root cracks, and transverse micro-cracks in the weld metal. Though they rarely occur in low-carbon steel, they easily do in high-carbon steel, so even low alloy steels call for special caution. They are caused due to chemical composition (especially the carbon equivalent) in view of material, therefore, weld cracks are associated with the extent of hardening and the base metal's heat-treatment, resulted from welding. Weld heat input, hydrogen embrittlement, residual stress, and stress concentration also affect weld cracks. For this reason, it is important to give proper preheating and postheating treatments, use low-hydrogen electrodes, and consider constraint conditions for welding.

On the other hand, as the carbon content increases, high-temperature cracks tend to occur easily. They typically occur at starting points of beads and in the crater zone.

Low-temperature cracking is a type of delayed fracture that occurs when hydrogen diffusing from the weld metal acts on the hardened zone, to which strong restraint stress is being applied as a result of the fact that thermal contraction during welding is prevented. Therefore, the prevention of low-temperature cracking requires comprehensive consideration of three parameters: ① weld hardenability of base metal, ② intensity of restraint and ③ the amount of diffusible hydrogen. The weld cracking parameter (Pc) shown below is commonly used to predict low-temperature cracking.

$Pc = C+Si/30+Mn/20+Cu/20+Ni/60+Mo/15+V/10+5B+K/40000+H60$
$= P_{CM}+K/40000+H/60$
$= P_{CM}+t/600+H/60$ (in case of y-groove weld cracking test)

Here K: Restraint intensity factor (kgf / mm・mm)
t: plate thickness (mm)
H: Diffusible hydrogen content of the weld metal (glycerin method) (cc/100g)

Fig. 10 shows the relationship between the parameters in Pc and low-temperature cracking behavior. We can see that precise prediction of low-temperature cracking behavior is made possible by the Pcformula.

In actual welding, preheating and post-heating are performed to prevent weld cracking. JIS Z3138 "Oblique y-groove weld cracking test" is commonly used to determine the temperature for the above. The preheating temperature, which is determined by this test, and the P_C formula have a good relationship, as shown in Fig. 11, and its mathematic representation is as follows.

$T_0 = 1440\,Pc - 392$ (3)
T_0: Preheating temperature for prevention of cracking (℃)

Generally speaking, the reduction of preheating and post-heating with consideration for the actual construction period and cost aspects is a major need of customers. The way to meet this need is to reduce the P_{CM} of the steel, i.e., the amount of carbon and other alloying elements added, while satisfying the various characteristics that are required. At present, the technique used as the means to achieve the above is TMCP, which makes it possible to achieve high strength with a small amount of alloying elements. TMCP is applied in a wide variety of fields in which the reduction of preheating and post-heating is demanded.

B. Notch Toughness

Notch toughness can be substantially controlled by proper welding work. In view of materials, it is adversely affected by carbon-equivalent-dependent weld hardening and embrittlement that are caused by entry of hydrogen, nitrogen and oxygen. Moreover, some steel plates including appropriate amounts of V, Al, Ni, etc. improve in toughness to a considerable extent due to increasingly refined grain.

Fig. 9 Types of weld cracks

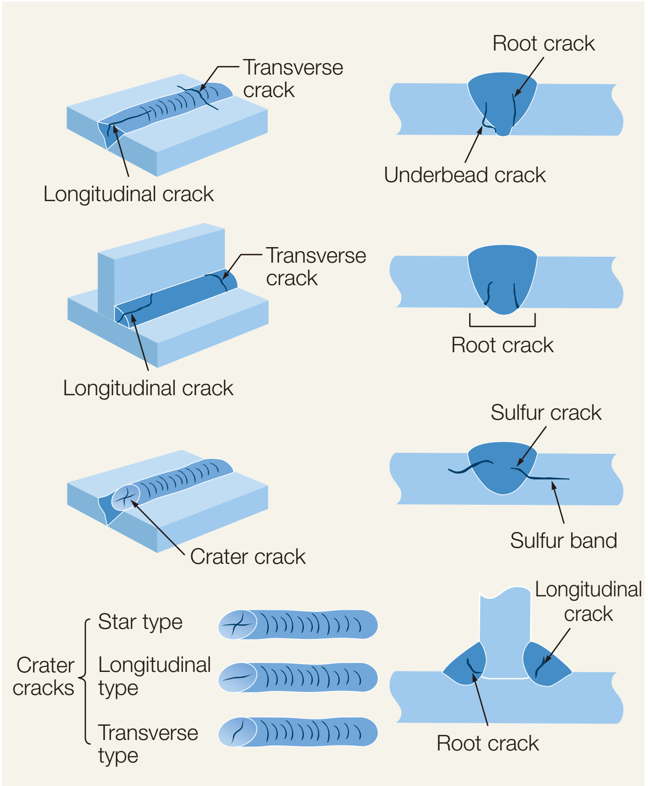


Fig. 10 Relationship between Pc and cross section crack ratio

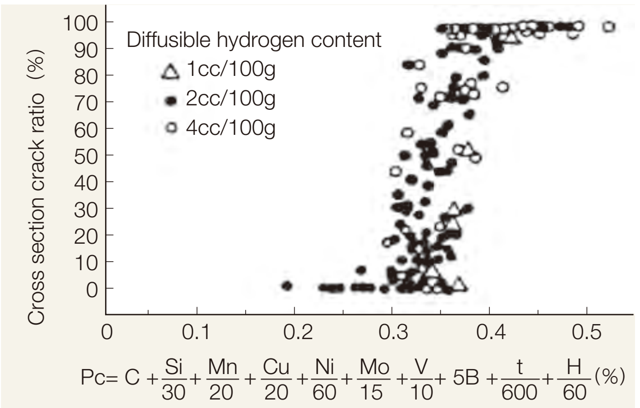
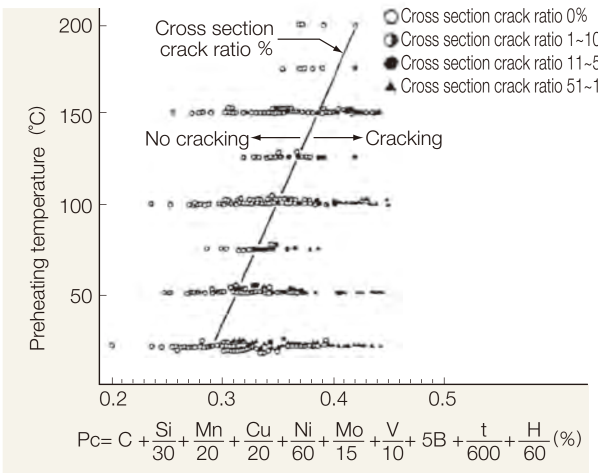


Fig. 11 Relationship between Pc and preheating temperature



3. Magnetic arc blow during welding

When the material is magnetized, magnetic arc blow is caused in cases of direct current welding, making it difficult to perform welding. While this is not a problem with ordinary 400 to 490 N/mm^2 class steel plates, steel with high nickel content is easily magnetized, and the occurrence of magnetic arc blow can become marked with 780 and 950 N/mm^2 class steel plates and 9% nickel steel.

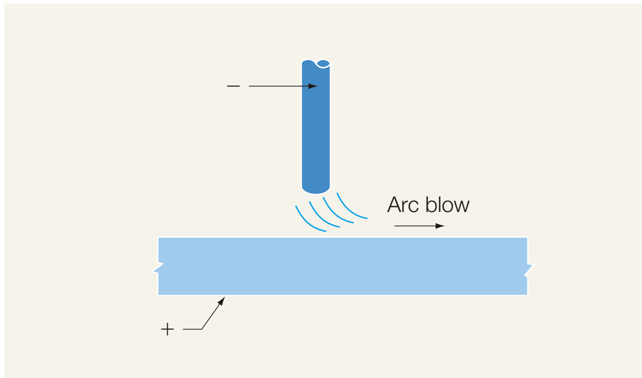
Countermeasures for the occurrence of magnetic arc blow during welding at the job site are shown below.

(1) Changing the welding method

- Change from direct current to alternating current
  With direct current welding, the effect of magnetic arc blow is great.
  If manual welding is to be used, consider whether alternating current can be used.
- Change the slant of the welding rod
  Magnetic arc blow can be alleviated depending on the slant of the welding arc.

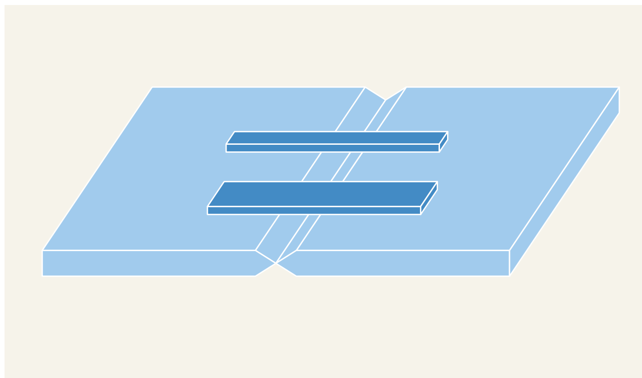
(2) Changing the grounding method

- The remanent magnetism in the steel plate changes depending on the grounding method.
- Increase the number of ground points on the steel plate from 1 to 2.
- Change the attachment location of the ground
  (Magnetic arc blow occurs in the direction opposite the ground point)



(3) Short circuiting the magnetism of the subject material (installing tab plates)

Bridge the material to be welded with other steel plates (tab plates) to short circuit the magnetism. The magnetism will flow through the bridged locations, so the remanent magnetism of the groove face will be alleviated.



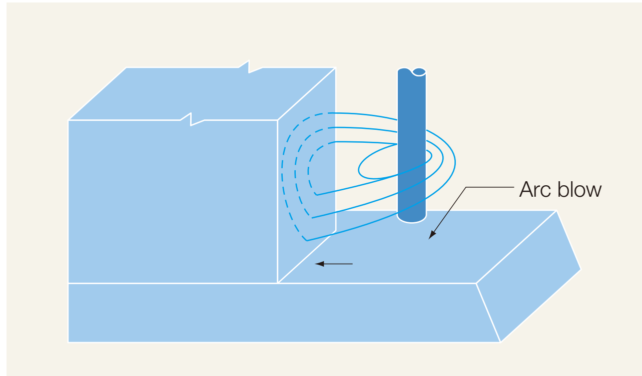
(4) Alleviating remanent magnetism with magnets

The magnetism of the groove face can be alleviated when a permanent magnet or a magnetic particle inspection magnet is brought close to the steel plate to change the direction of the remanent magnetism.

(5) Installing supplemental material (steel)

Install supplemental material (steel) on the opposite side of the magnetic arc blow.

In the case of a lap joint, the magnetic arc blow will occur in the lapped material, so the remanent magnetism can be alleviated by placing a steel plate on the opposite side as well.



(6) Heating the groove face

The remanent magnetism can decrease even as a result of heating at or below the magnetic transformation point.

(7) Placement of the subject material

The remanent magnetism of the steel plate is affected by the power supply and the like.

Changing the way the material is placed can result in a change in the remanent magnetism of the groove face.

4. Lamellar Tear

In recent years, as steel structures have become larger and more complicated, welded joints with strict restrictions in terms of structure, function or appearance have been employed in various fields, and there is an increasing number of cases in which greater tensile stress is applied in the through-thickness -direction.

(1) What is Lamellar Tear?

Lamellar tear is a phenomenon in which cracking parallel to the surface of the steel plate occurs in a cross joint, T-joint, corner joint or other welded joint that is subject to tensile stress in the through-thickness direction of the plate. Causes include those that originate simply in non-metallic inclusions (mainly MnS), as well as those that originate in root cracking. To check for lamellar tear-resistance, there are direct methods such as the Z window restraint cracking test. A commonly used simple method is to make the evaluation by combining the reduction of area value in through-thickness tension testing and the amount of sulfur in the steel. The WES3008 Standard of the Japan Welding Engineering Society and JIS G3199 stipulate lamellar tear-resistant steel in which the reduction of area value is guaranteed, and the non-metallic inclusions in the steel and the compositional segregation are also reduced.

Fig. 12 Diagram of occurrence of lamellar tear

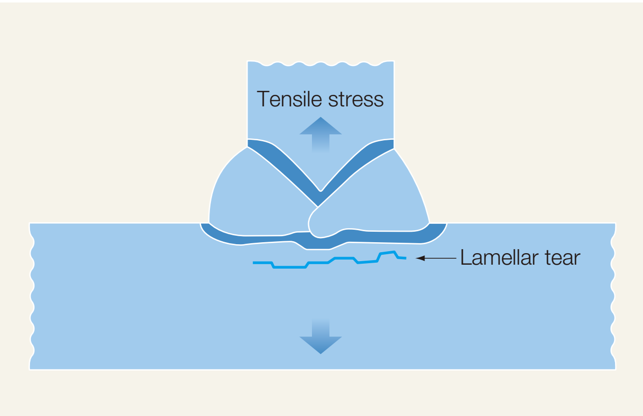


Fig. 13 The relationship between the reduction of area of the through-thickness direction ϕz and the quantity of S (from WES3008-1999)

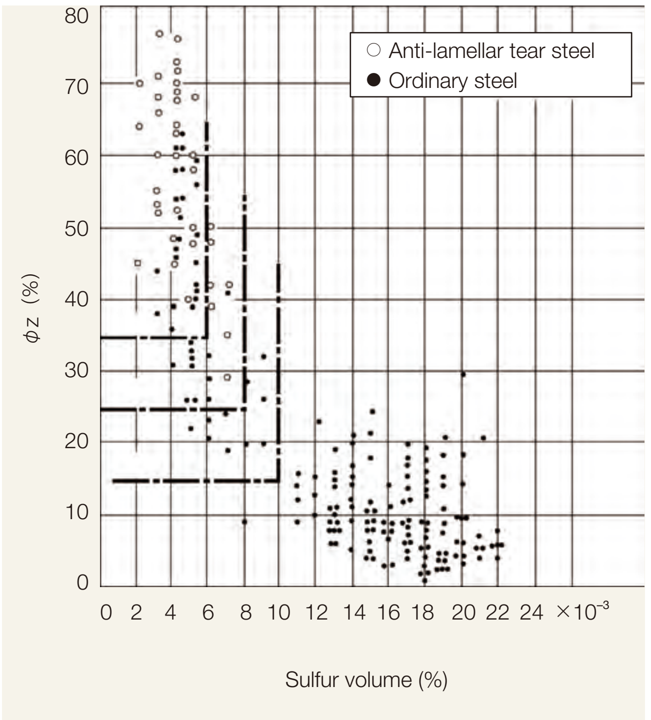


Table 3: The reduction of area of the through-thickness direction of the anti-lamellar tear steel according to JISG3199

Class No.	Average	Individual	Quantity of S (%)	
Z15 (S)	Over 15%	Over 10%	0.010 or less	Applied by agreement between the parties to the transfer.
Z25 (S)	Over 25%	Over 15%	0.008 or less	
Z35 (S)	Over 35%	Over 25%	0.006 or less	

Remarks: The rating refers to The Japan Welding Engineering Society specifications WES3008.
The indication of S by the Class No. is given if S content is specified.

(2) Method of prevention for lamellar tear

For welded structure members at risk of lamellar tear, the occurrence of lamellar tear can be suppressed with countermeasures related to the welding procedure and the use of lamellar tear-resistant steel.

5. Hardenability by Gas Cutting

The neighboring section of the gas-cut surface of a steel plate sometimes becomes harder than the other sections due to the quenching effect. The greater the carbon equivalent, the greater the hardenability as is the case with high tensile strength steel plates and atmospheric corrosion-resistant steel plates. (See paragraphs concerning welding.)

Some examples of NIPPON STEEL's examination results on hardening due to gas cutting are shown below. It is understood that the hardened section is at most within 3mm from the cut face. Such hardening does not matter in regular bending or cutting work. The thick steel plates manufactured by our company have good workability, so the harmful effects caused by gas cutting are minimal and the plates can be used with peace of mind. If heating is conducted before or after the gas cutting, to soften the plates, the workability and cutability are further improved.

Fig. 14 Results of hardenability tests of WEL-TEN590 steel plates by gas cutting (plate thickness=25mm)

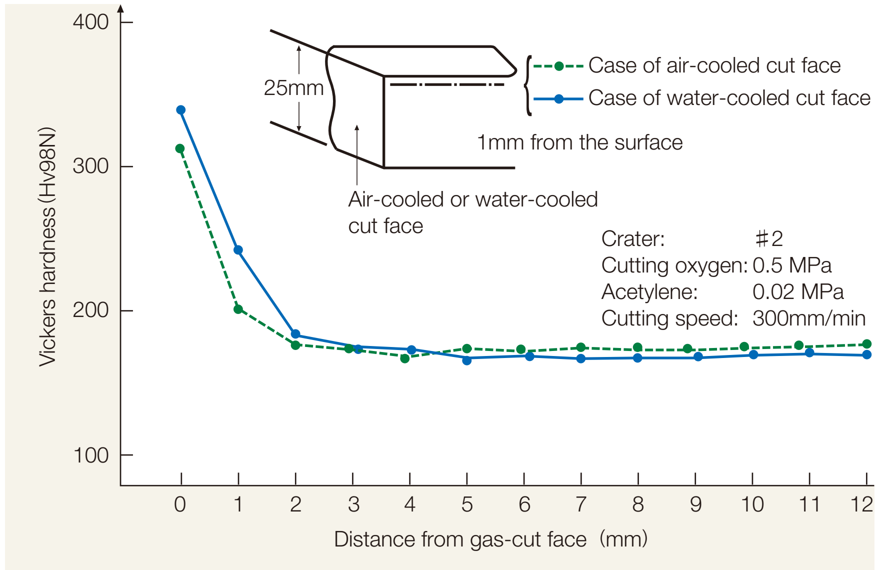
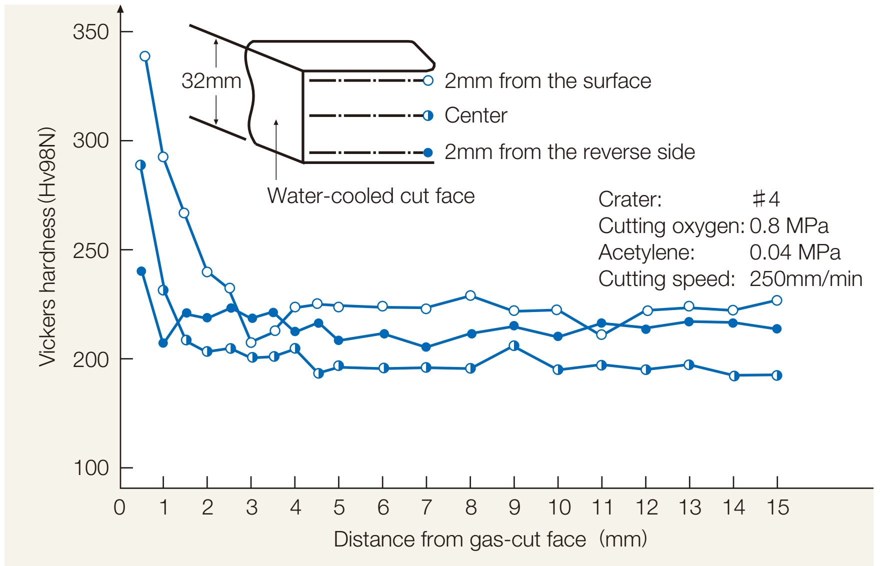


Fig. 15 Results of hardenability tests of WEL-TEN590 steel plates by gas cutting (plate thickness=32mm)



6. Cautions for Cold Forming

(1) Cutting Plan

When steel plates are cold-formed, thorough consideration must be given starting with the cutting plan.

A. Directional Difference in Properties of Steel Sheets

When a steel plate is bent during forming, the extent of cracking can differ greatly according to the bending direction (Fig. 16).

In particular, cracks tend to occur easily along inclusions that have been elongated at a right angle to the hot rolling direction (Fig. 17), so bendability and flange creation can be extremely poor in such direction.

Therefore, as part of the cutting plan, consideration should be made so that, as much as possible, the direction of severe bending, tensile, or ironing becomes the same as the rolling direction (Fig. 18).

Fig. 16 Relationship between end face cracking and shear plane orientation & clearance
Materials tested: SS400
6.0mmt Bend radius: 6.0mm
Bending angle: 180˚

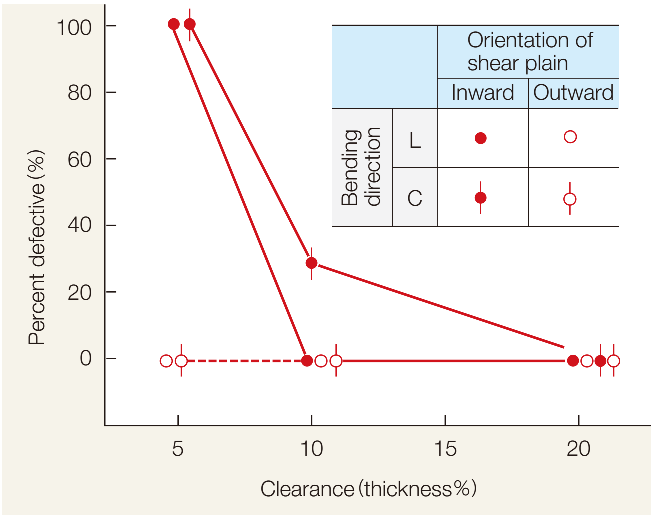


Fig. 17 Bending at right angle to the rolling direction (Mark C)

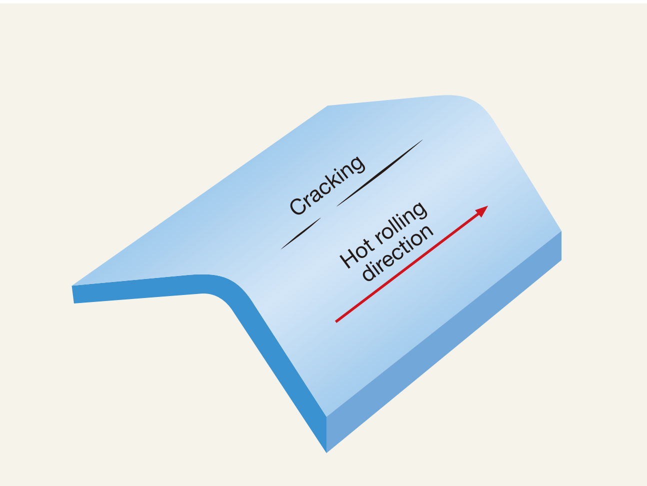
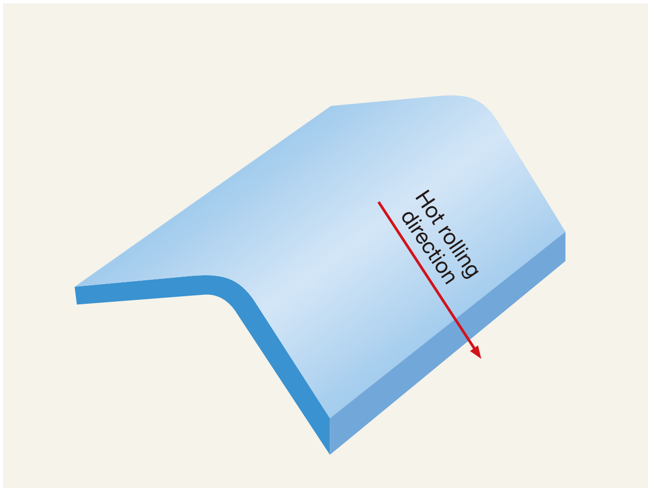


Fig. 18 Bending parallel to the hot rolling direction (Mark L)



B. Orientation of Shear Plane

When steel plates are formed with their cross section as sheared, a great difference arises whether they are formed with their shear plane inside or outside of the bending. Specifically, there can be minor cracks in "a broken-out section" which covers an area of about half the sheared-end face, and furthermore burrs will be present.

For this reason, if a plate is bent with a broken-out plane outside (Fig. 20), end face cracks are likely to occur. It is necessary to prevent cracking in consideration of bending so that a broken-out plane may be present inside.

Fig. 16 also indicates that the clearance degree in shearing affects the formation of work-hardened layers and thus influences the end face workability.

Fig. 19 Shear plane

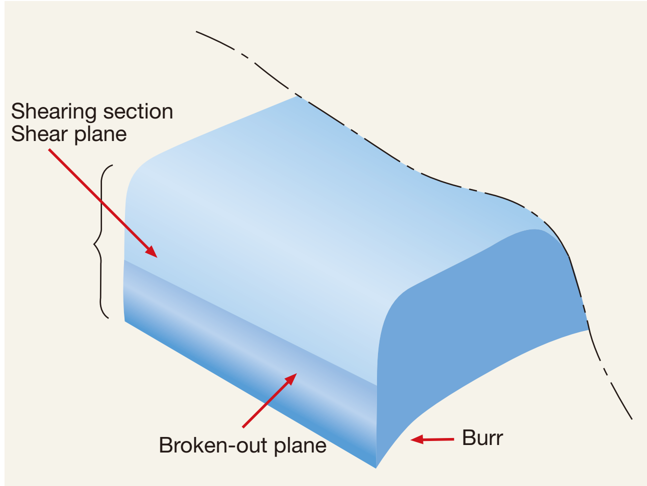
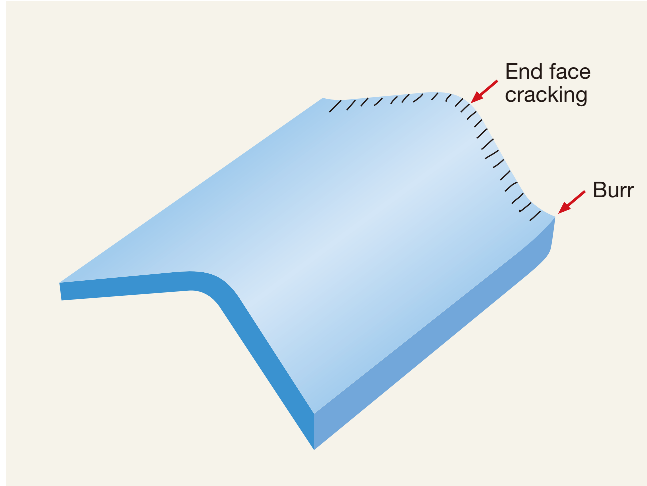


Fig. 20 Bending with burrs outside



C. Cutting and Annealing of The Cut Face

As cut faces produced by shear, etc. have minor cracks, burrs and hardened layers on their cross sections, they are poor in formability and in conditions where end face cracks are likely to occur.

Under such circumstances, cracks can be prevented by treating the cut faces by such means as cutting and removing, rounding the corner of a cut face and removing burrs, or heating and annealing the end face with a gas burner.

(2) Design of Moulds

The bend radius must be greater than the minimum bend radius of a steel plate. The minimum bend radius is a specific property determined by the thickness and quality of a steel plate. It can be said that the smaller the minimum bend radius, the better the workability of the steel plate. Moreover, the greater the thickness of the steel plate, the greater the minimum bend radius. Thus, thick steel plates are more difficult to bend than thin steel plates.

The steel plates produced by NIPPON STEEL are manufactured to be especially easy to form, so our steel sheets have an outstanding reputation in the industry. Of course, there is a limit to formability according to the forming method used. Should your product require severe forming, please consult your sales representative in advance to ensure the best match of steel plates for your intended purpose.

Usually, when a plate is bent by 180˚ in the direction at a right angle to the rolling direction (Fig. 17), the minimum limit of bend radius is twice the plate thickness for plates of not more than 25mm in thickness, and three times the plate thickness for plates of 25~50mm in thickness. The minimum bend radius has something to do also with width size, and the wider the steel plate, the more difficult the bending. However, when it comes to steel plates with width 8~10 times or more than their thickness, the effect of width size can be neglected, so it is generally not necessary to consider this factor.

7. Cautions for Hot Forming

(1) For Non-heat Treated Steel

Iron must be heated to a sufficient extent (above 900˚C, the A3 transformation temperature) so that it may be properly formed. Hence the saying, "Strike when the iron is hot!" But if the iron is heated too long or too much, overheating or burning may occur, which leads to plate cracking during the forming stage or marked deformation or defects even if forming can be accomplished. Especially Al-killed steel, characterized by its fine-grained structure, has a relatively narrow hot-shortness range, so special caution must be exercised during hot forming so that its steel properties may be well considered and the temperature properly controlled.

If low-temperature toughness is strictly required, it may be necessary to adjust the heating temperature to the lower side, or to carry out normalizing after hot forming. Depending on the steel quality and heating period, overheating can occur at temperatures over 1000˚C or so. From a structural standpoint, as steel grains become coarse, the steel surface becomes rough or the mechanical properties deteriorate. Thus, the level of fineness after heat treatment should also be considered.

Burning produces a kind of steel embrittlement at high temperature. This occurs because soluble compositions present on the grain boundary of the steel dissolve if the metal is heated too much (about 1300˚C or more) or for too long a time period. The result of such burning is the plate's tendency to develop fine cracks and a deterioration of its mechanical properties.

Aluminum embrittlement is special hot shortness peculiar to fine-grained Al-killed steel that occurs in the heating range of 800 to 1000˚C. Within this range, the mechanical properties of Al-killed steel deteriorate, so that high-degree forming cannot be achieved. This is the result of the formation of fine-grain aluminum nitrides scattered along the steel's grain boundary, leading to a splinter phenomenon since the nitride deposits are so difficult to deform. The more residual aluminum that is present in the steel, the higher the splintering risk. In contrast, silicon-killed steel and rimmed steel are not associated with such risk. Customers are asked to inform their NIPPON STEEL representative in advance when fine-grained steel is required for high-temperature forming, so we can supply you with the necessary information on our range of specially alloyed steel products.

Moreover, even if the steel does not actually deteriorate, heating to levels of 600 to 700˚C can change its mechanical properties from the original condition. Representative examples of local heating test results that clearly showed such changes are given on the following pages.

A. Example 1: Results of heating tests on steel plates of YP355 N/mm² class (32mm plate thickness)

	C	Si	Mn	P	S	Cu	Nb
Chemical composition (%)	0.15	0.03	1.34	0.012	0.015	0.07	0.03
Treatment	Air cooling and water cooling (at water temperature of 10˚C) after heating for 1 hour						

Fig. 21 Results of tensile tests using JIS 4 specimens

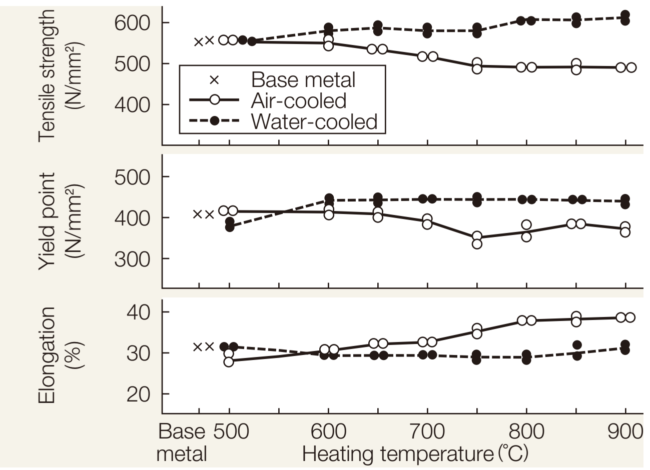
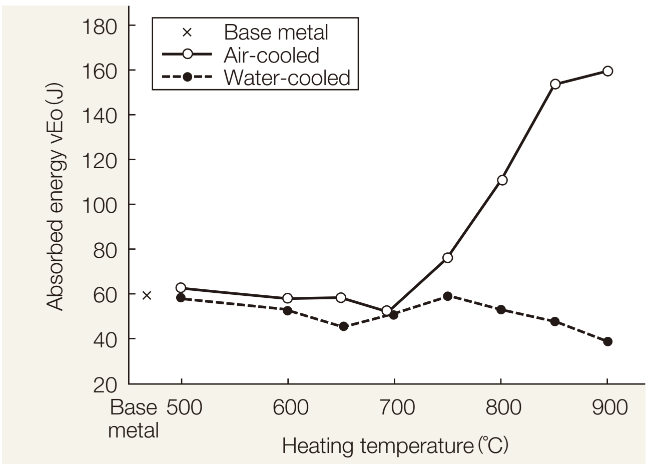


Fig. 22 Results of V-notch Charpy impact tests (Absorbed energy at 0˚C)



B. Example 2: Results of heating tests on WEL-TEN 590 steel plates (13mm plate thickness)

	C	Si	Mn	P	S	Cu	Cr	Ni	Mo	V	Sol.Al
Chemical composition (%)	0.14	0.34	1.40	0.018	0.013	0.07	0.03	0.02	0.01	0.07	0.04
Treatment	Air cooling and water cooling (at water temperature of 10˚C) after heating for 1 hour										

Fig. 23 Results of tensile tests using JIS 5 specimens

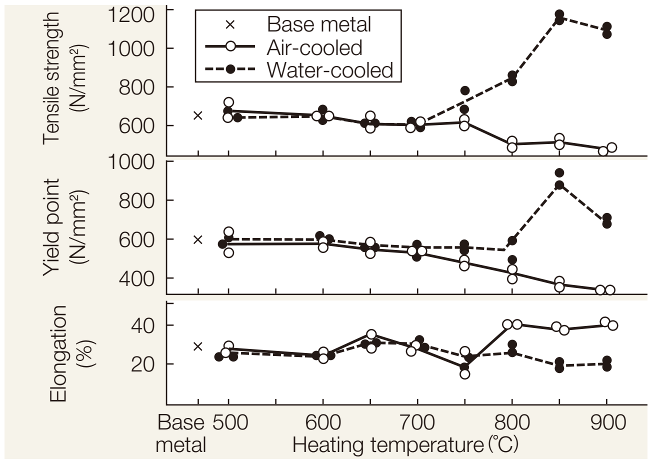
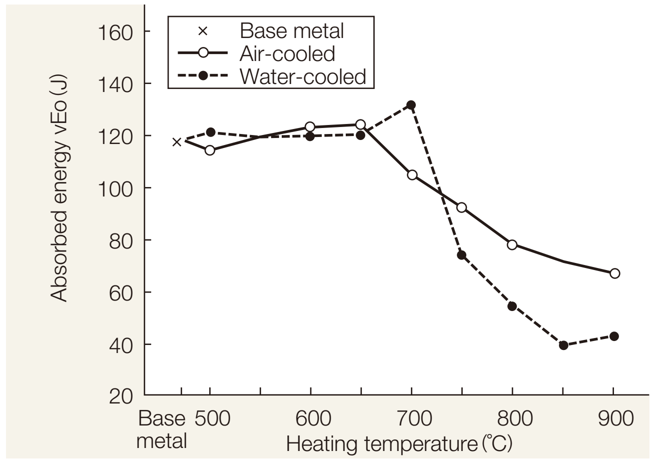


Fig. 24 Results of V-notch Charpy impact tests (Absorbed energy at 0˚C)



C. Example 3: Results of heating tests on WEL-TEN 590 steel plates (32mm plate thickness)

	C	Si	Mn	P	S	Cu	Cr	Ni	Mo	Sol.Al
Chemical composition (%)	0.12	0.32	1.25	0.018	0.017	0.07	0.06	0.53	0.12	0.02
Treatment	Air cooling and water cooling (at water temperature of 10˚C) after heating for 1 hour									

Fig. 25 Results of tensile tests using JIS 4 specimens

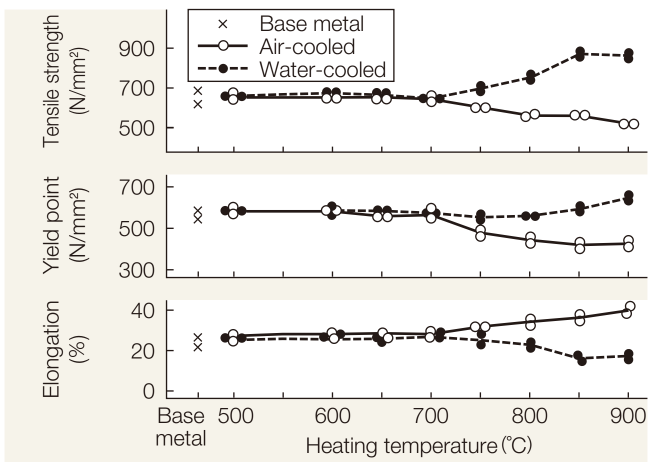
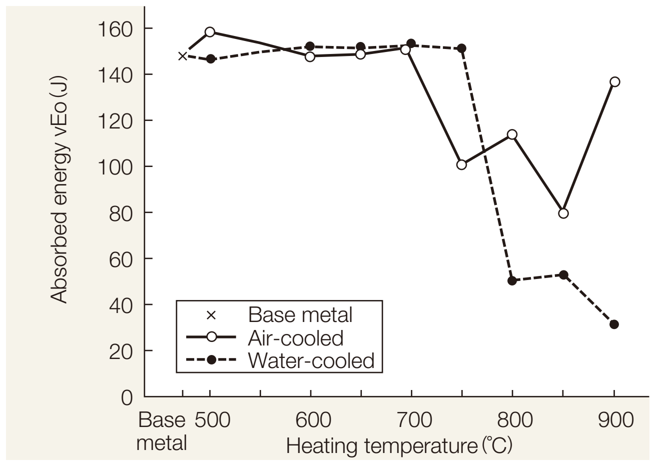


Fig. 26 Results of V-notch Charpy impact tests (Absorbed energy at 0˚C)



(2) For Heat-treated Steel

The quality of heat-treated steel improves in respect to strength and toughness through quenching & tempering (QT). The approach used for QT depends on a variety of factors, including the type of steel, alloying elements, thickness, fineness, and intended use.

When steel is heated at too high a temperature or for too long, the tempering effect becomes null, resulting in deterioration of the good properties of steel. As a result, such steel cannot be hot-formed, or cracking and other problems may occur. If strain-relieving annealing is required, or should you have any concerns or questions about heat treatment, please ask your NIPPON STEEL sales representative. In general, the appropriate heat treatment condition is 580˚C x 2 hours / 25mm thickness.

(3) For TMCP Steel

Thermo-Mechanical Controlled Process (TMCP) steel obtains strength and toughness levels that are equal to or better than those of heat-treated steel through controlled rolling and controlled water cooling without off-line reheating.

However, if TMCP steel is reheated, its properties may markedly deteriorate due to structural changes. For this reason, hot forming cannot be conducted on TMCP steel.

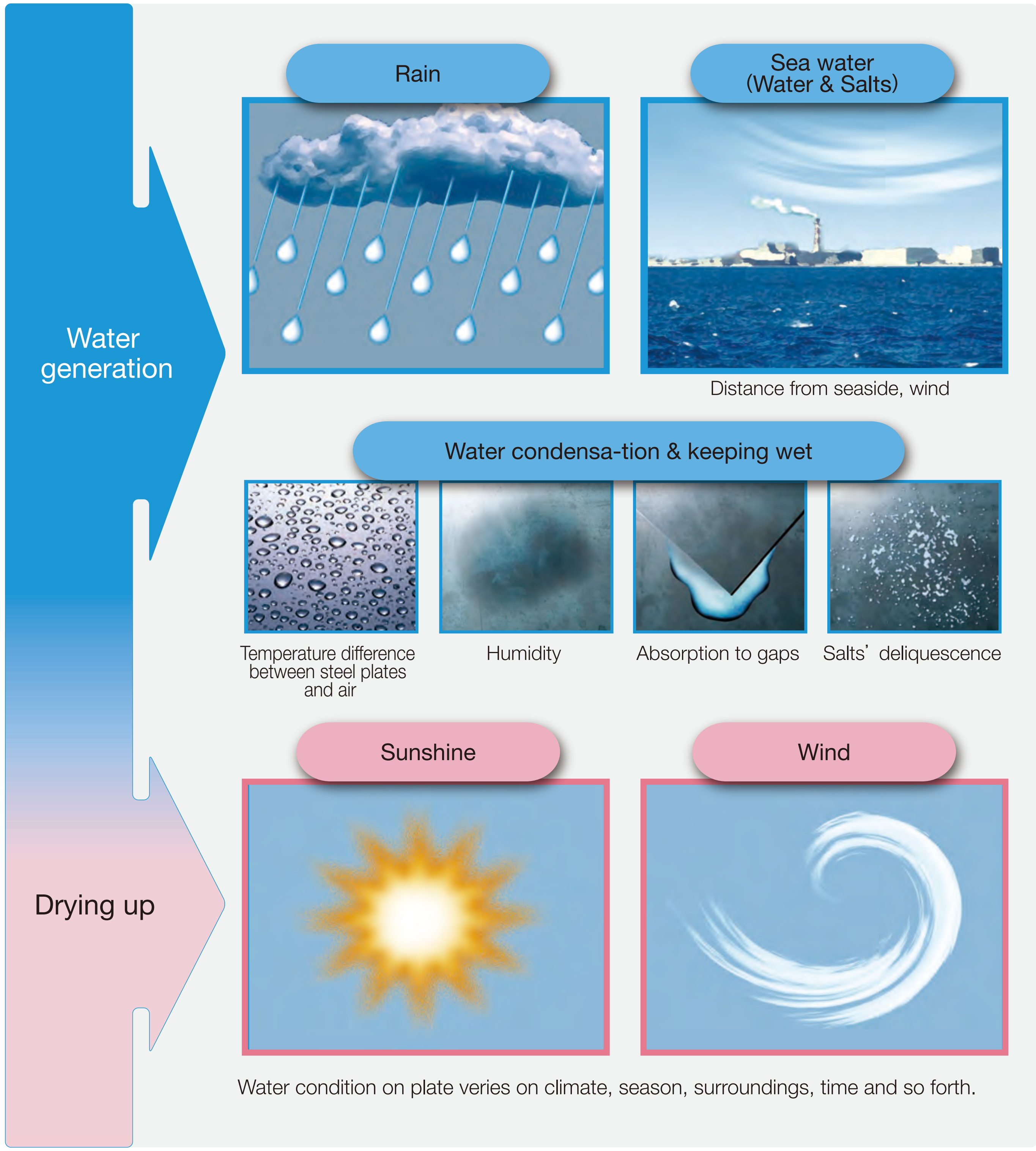
If strain-relieving annealing is required, please consult your NIPPON STEEL representative. Caution is necessary because even if steel batches go through the same TMCP process, the conditions can differ depending on the rolling temperature and whether the water cooling process is conducted or not.

8. Corrosion and the Safekeeping of Steel Plates

1. On Conditions of Iron Rusting

Generally, iron is tend to rust easily with water. That's why iron has the property of easy dissolution into water and reacts with oxigen. Furthermore iron corrosion accelerates in exist of chloride(NaCℓ). These depend on the factors shown in Fig. 27.

Fig. 27 Condition of water generation and drying up



2. Anti-local Corrosion Measure

We will recommend that we have at first you grasp the outbreak situation as a way of thinking of local corrosion end run. Please have you examine the reasonable measures that you matched with the situation, and reference carry out the factor / measures map which we will show in a list shown below later.

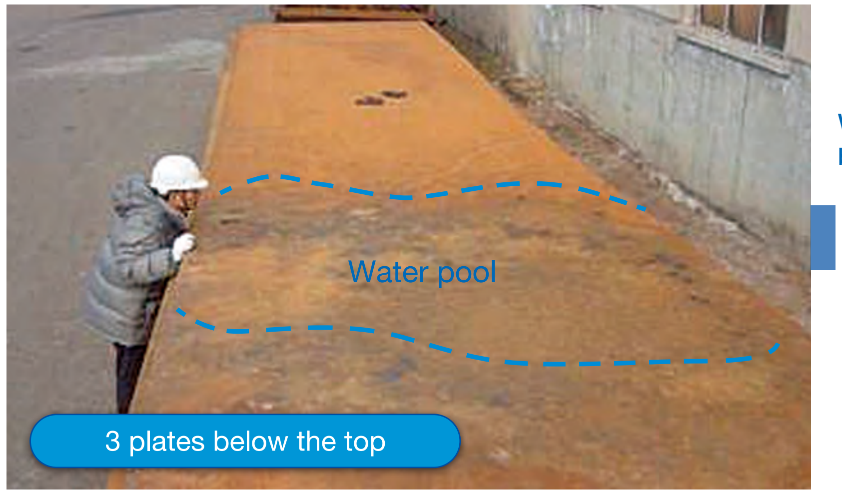
Table 4: Example of Local corrosion outbreak factor / measures map

<table>
<tr><th colspan="2">Factor</th><th colspan="5">Measures</th></tr>
<tr><td rowspan="5">Water</td><td>Rain</td><td rowspan="4">Factor exclusion</td><td rowspan="3">Wet Prevention</td><td rowspan="2">Indoor safe keeping</td><td>Cover</td><td rowspan="5">Long-term safekeeping evasion</td></tr>
<tr><td>Seawater (+ Salt)</td><td>Distance security from the shore</td></tr>
<tr><td rowspan="3">Dew condensation</td><td colspan="2">Concrete pavement
Prevention of stagnant water
Difference of temperature reduction (A safekeeping place change)</td></tr>
<tr><td>Drying</td><td colspan="2">Ventilation</td></tr>
<tr><td colspan="2">Prevention of rust</td><td colspan="2">Painting</td></tr>
</table>

3. Example of Local Corrosion (Outdoor Condition, about 1 Month)

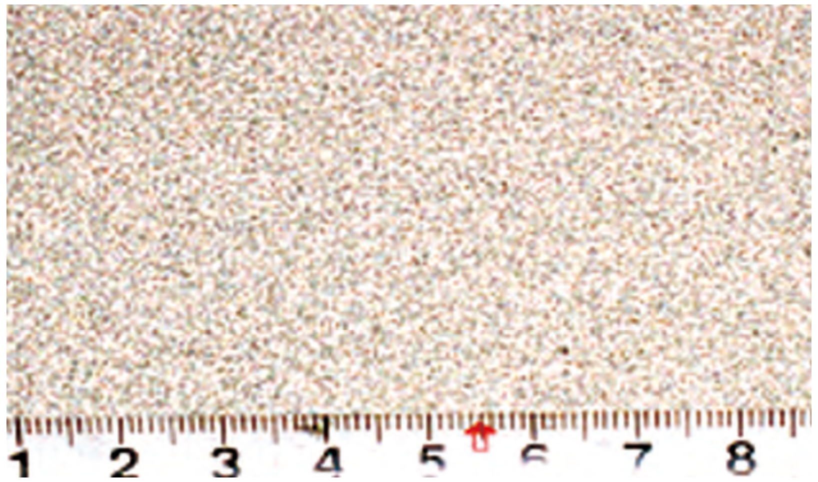
In general there are two types of corrosion,overall and local.
We will show the example of local corrosion below.

The overall corrosion occurs in outdoor storage.

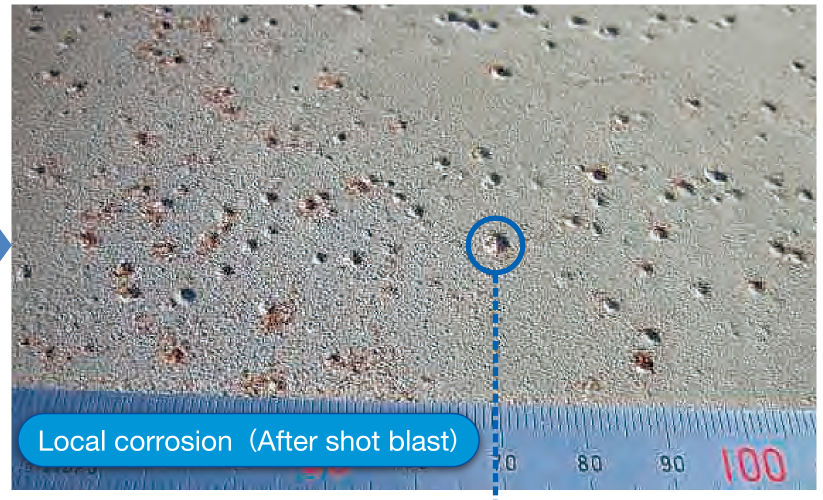


When a water pool exists between the gap,,,

Without a water pool



Overall corrosion (After shot blast)

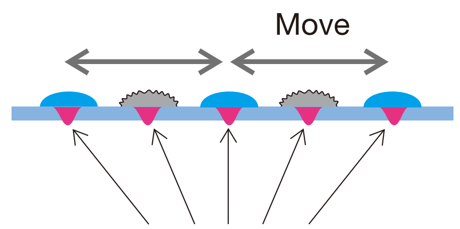
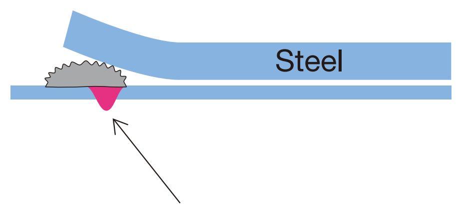


In about 1 month, the local corrosion breaks out !

Cross section of microstructure

The local corrosion progressing rapidly makes many problems, surface imperfection, thickness less than the minus tolerance, holes through the thickness and so on. In this case, there is no deformation of microstructure.

Table 5: Comparison between overall and local corrosion

	General corrosion	Corrosion initiation site
Mechanism	 Nucleation site of corrosion (Fine dispersion, movement)	 Nucleation site of corrosion (Corrosion depth grows at the fixed site)
Feature	• Nearly uniform corrosion on entire surface	(1) Localized corrosion at the gap (2) Difficult to dry (3) NaCℓ is likely to concentrate

Reference Tables of Standards

Steel Plates for Structural Use

Strength Level (T.S. N/mm²)	Standards					
	NIPPON STEEL Specifications	JIS	ASTM	DIN & VDEh	BS EN	ISO
330 or over	—	G 3101 SS300	A283 Gr.B, C	DIN17100U, RSt34–1 St37–1, 2, 3	BS EN10025 Gr.S185	ISO R630 Fe33 Fe37A, B, C, D
400 or over	—	G 3101 SS400	A36, A283 Gr.D	DIN17100U, RSt42–1	BS EN10025 GR.S275JR	ISO R630 Fe42A, 44A
		G 3106 SM400A	A572 Gr.42 A633 Gr.A	DIN17100, RSt42–2 St42–3, RSt46–2	BS EN10025 Gr.S275J0	ISO R630 Fe42B, 44B
		G 3106 SM400B	A573 Gr.58, 65	DIN17100, RSt42–3 RSt46–3	BS EN10025 Gr.S275J2G3	ISO R630 Fe42C, 44C
		G 3106 SM400C	A529 Gr.50, 55		BS EN10025 Gr.S275J2G4	ISO R630 Fe42D, 44D
490 or over	—	G 3106 SM490A, B, C	A573 Gr.70	DIN17100, St50–1, 2	BS EN10025 Gr.S355JR	—
	—	G 3106 SM490YA, YB G 3106 SM520B, C G 3140 SBHS400	A572 Gr.50, 60 A633 Gr.C, D	DIN17100, St52–3	BS EN10025 Gr.S355J0, J2G3	ISO R630, Fe52B, D Fe52C, D
	WEL-TEN540	—	A572 Gr.65 A633 Gr.E A678 Gr.B	—	BS EN10025 Gr.S355J2G4 K2G3K2G4	—
590 or over	WEL-TEN590	G 3106 SM570 G 3140 SBHS500	A678 Gr.C	DIN17100, St60–1, 2	BS EN10025 Gr.E335	—
685 or over	WEL-TEN690 WEL-TEN780 WEL-TEN950	G 3128 SHY685N, NS G 3140 SBHS700	A514 Gr.A~T A517 Gr.A~T	DIN17100, St70–2	BS EN10025 Gr.E360	—

Carbon Steel for Boilers and Pressure Vessels

Strength Level (N/mm²)		Standards				
Y.P.	T.S.	JIS	ASTM	DIN & VDEh	BS EN	ISO
165	310	—	A285 Gr.A	DIN17155–HI	—	—
185	340	—	A285 Gr.B		—	—
205	380	—	A285 Gr.C	DIN17155–HII	BS EN10028 Gr.P275N, H	—
295	520	—	A299	DIN17155 19Mn6	—	—
205	380	—	—	DIN17155–HII (Si Killed)	—	—
225	410	G 3103 SB410	A515 Gr.60	DIN17155–HIII (Si Killed)	—	—
245	450	G 3103 SB450	A515 Gr.65	DIN17155–17Mn4	—	—
265	480	G 3103 SB480	A515 Gr.70	DIN17155–19Mn6	—	—
205	380	—	A516 Gr.55	DIN17155–HII	BS EN10028 Gr.P275N, H	ISO 2604/IV P 5
225	410	G 3118 SGV410	A516 Gr.60	DIN17155–HIII	—	ISO 2604/IV P 7
245	450	G 3118 SGV450	A516 Gr.65	DIN17155–17Mn4	—	ISO 2604/IV P 11
265	480	G 3118 SGV480	A516 Gr.70	DIN17155–19Mn6	BS EN10028 Gr.P275N, H	ISO 2604/IV P 16
205	380	—	—	DIN17155–HII VDEhW680 TTSt41	BS EN10028 Gr.P275N, H	—
225	410	G 3115 SPV235	—	DIN17155–HII VDEhW680 TTSt45	—	—
345	480	G 3115 SPV355	A537 Cl.1, A841 Cl.2	DIN17155–19Mn6	BS EN10028 Gr.P355N, NH	—
355	450	—	—	—	BS EN10028 Gr.P355M, MH	—
345	560	—	A612	—	—	—
415	550	G 3115 SPV410	A537 Cl.2, A841 Cl.2	—	—	—
420	500	—	—	—	BS EN10028 Gr.P420M, MH	—
450	570	G 3115 SPV450	—	—	BS EN10028 Gr.P460N, NH	—
345, 430	480, 550	—	A737 Gr.B, C	—	—	—

Low-Alloy Steel for Boilers and Pressure Vessels

Strength Level (N/mm²)		Standards					Remarks
Y.P.	T.S.	JIS	ASTM	DIN & VDEh	BS EN	ISO	
255	450	G 3103 SB450M	A204 Gr.A	WSN5423 16Mo5	—	ISO 2604/IV P 28	1/2 Mo
275	440	—	—	—	BS EN10028 Gr.16Mo3 (1/4Mo)	—	
275	480	G 3103 SB480M	A204 Gr.B	DIN17155 15Mo3 (1/4Mo)	—	—	
295	520	—	A204 Gr.C	WSN5423 16Mo5	—	—	
315	520	G 3119 SBV1A	A302 Gr.A	—	—	ISO 2604/IV P 30	
345	550	G 3119 SBV1B	A302 Gr.B	—	—	—	
		G 3119 SBV2	A302 Gr.C	—	—	—	Mn–1/2Mo–1/2Ni
		G 3119 SBV3	A302 Gr.D	—	—	—	Mn–12/Mo–3/4Ni
225, 315	380, 480	G 4109 SCMV–1	A387 Gr.2 Cl.1, 2	—	—	ISO 2604/IV P 33	2/3Cr–1/2Mo
225, 275	380, 450	G 4109 SCMV–2	A387 Gr.12 Cl.1, 2	DIN17155 13CrMo44	BS EN10028 Gr.13CrMo4–5	ISO 2604/IV P 32	1Cr–1/2Mo
245, 315	410, 520	G 4109 SCMV–3	A387 Gr.11 Cl.1, 2	—	—	—	1 ･1/4Cr–1/2Mo
		G 4109 SCMV–4	A387 Gr.22 Cl.1, 2	WSN7380 10CrMo9 10	BS EN10028 Gr.11CrMo9–10	ISO 2604/IV P 34	2 ･1/4Cr–1Mo
205, 315	410, 520	G 4109 SCMV–5	A387 Gr.21 Cl.1, 2	—	—	—	3Cr–Mo
		G 4109 SCMV–6	A387 Gr.5 Cl.1, 2	WSN7380 12CrMo19 5	—	—	5Cr–1/2Mo
		—	A387 Gr.7 Cl.1, 2	—	—	—	7Cr–1/2Mo
		—	A387 Gr.9 Cl.1, 2	—	—	—	9Cr–1Mo
345	550	G 3120 SQV1A	A533 Type A Cl.1	—	—	—	Mn–1/2Mo
480	620	G 3120 SQV1B	A533 Type A Cl.2	—	—	—	
570	690	—	A533 Type A Cl.3	—	—	—	
345	550	G 3120 SQV3A	A533 Type C Cl.1	—	—	—	Mn–1/2Mo–3/4Ni
480	620	G 3120 SQV3B	A533 Type C Cl.2	—	—	—	
570	690	—	A533 Type C Cl.3	—	—	—	
345, 480, 570	550, 620, 690	—	A533 Type D Cl.1, 2, 3	—	—	—	Mn–1/2Mo–1/2Ni
380	580	G 4110 SCMVQ4E	A542 Type A, B, Cl.4	—	—	—	2 ･1/4Cr–1Mo QT
415	580	G 4110 SCMVQ4V	A832 Gr.22V	—	—	—	2 ･1/4Cr–1Mo–V NT
		G 4110 SCMVQ5V	A832 Gr.21V, 23V Cl.1, 2, 3	—	—	—	3Cr–1Mo–V NT
585, 690	725, 795	—	A542 Cl.1, 2	—	—	—	2 ･1/4Cr–1Mo
515, 415	655, 585	—	A542 Cl.3, 4a	—	—	—	

Low-temperature Steel Plates

Strength Level (N/mm²)		Standards						Remarks
Y.P.	T.S.	NIPPON STEEL Specifications	JIS	ASTM	DIN & VDEh	BS EN	ISO	
235	400	—	G 3126 SLA235A, B	—	—	—	—	
275	400	—	—	A662 Gr.A	VDEh W680 TTSt41	—	—	
295	400	N–TUF 295	—	—	—	—	—	
325	440	N–TUF 325	G 3126 SLA325A, B	—	—	—	—	
325	450	—	—	A662 Gr.B	VDEh W680 TTSt45	—	—	
350	490	—	—	A537 Cl.1 A841 Cl.1	—	BS EN10028 Gr.P355NL1, NL2	—	
355	450	—	—	—	—	BS EN10028 Gr.P355ML1, ML2	—	
365	480	—	—	A662 Gr.C	—	—	ISO 2604/IV P 16	
365	490	N–TUF 365	G 3126 SLA365	—	—	—	—	
490	610	N–TUF 490	—	—	—	—	—	
570	670	N–TUF 570	—	—	—	—	—	
255	450	—	G 3127 SL2N255	A203 Gr.A	—	—	—	2 ･1/4Ni
275	490	—	—	A203 Gr.B	—	—	—	
255	450	—	G 3127 SL3N255	A203 Gr.D	VDEh W680 10Ni14	—	ISO 2604/IV P 43	3 ･1/2Ni
275	490	—	G 3127 SL3N275	A203 Gr.E	—	—	ISO 2604/IV P 44	3 ･1/2Ni
520	690	—	G 3127 SL9N520	A353	—	—	ISO 2604/IV P 45	9Ni (N Type)
590	690	—	G 3127 SL7N590 G 3127 SL9N590	A553、 A841 Grade G、 A844	VDEh W680 X8Ni9	BS EN10028 Gr.X8Ni9 (HT690) X7Ni9		9Ni (QT Type)
345	550	—	G 3120 SQV2A	A533 Type B Cl.1	—	—	—	Mn–1/2Mo–12/Ni
480	620	—	G 3120 SQV2B	A533 Type B Cl.2	—	—	—	
570	690	—	—	A533 Type B Cl.3	—	—	—	
585	725	—	—	A543 Type B, C Cl.1	—	—	—	3Ni–1 ･3/4Cr–1/2Mo
690	795	—	—	A543 Type B, C Cl.2	—	—	—	
485	620	—	—	A543 Type B, C Cl.3	—	—	—	

Corresponding Industry Codes for Ship Building Standards

• Steel Type: Rolled Steel Plate for Hulls (Mild Steel)

Strength Level (N/mm^2) Y.P.	T.S.	Corresponding ASTM	Grade	NK Japan	AB USA	LR UK	BV France	GL Germany	NV Norway	DNV-GL Norway Germany	CR Taiwan	RS Russia	KR ROK	CCS China
≧235	400/490	A131	A	KAM	AAM	LAM	BAM	GAM	NAM	VLAM	CAM	PAM	KRAM	CSAM
				KAS	AAS	LAS	BAS	GAS	NAS	VLAS	CAS	PAS	KRAS	CSAS
				KAK	AAK	LAK	BAK	GAK	NAK	VLAK	CAK	PAK	KRAK	CSAK
				KAN	—	LAN	BAN	—	NAN	VLAN	CAN	—	KRAN	—
			B	KBS	ABS	LBS	BBS	GBS	NBS	VLBS	CBS	PBS	KRBS	—
				KBK	ABK	LBK	BBK	GBK	NBK	VLBK	CBK	PBK	KRBK	CSBK
				KBN	—	—	BBN	—	NBN	VLBN	CBN	—	KRBN	—
			D	—	—	LDS	BDS	—	—	—	—	PDS	—	—
				KDK	ADK	LDK	BDK	GDK	NDK	VLDK	CDK	PDK	KRDK	CSDK
				KDN	ADN	LDN	BDN	GDN	NDN	VLDN	CDN	PDN	KRDN	CSDN
			E	KEN	AEN	LEN	BEN	GEN	NEN	VLEN	CEN	PEN	KREN	CSEN

• Steel Type: Rolled Steel Plate for Hulls (High Tensile Strength Steel)

Strength Level (N/mm^2) Y.P.	T.S.	Corresponding ASTM	Grade	NK Japan	AB USA	LR UK	BV France	GL Germany	NV Norway	DNV-GL Norway Germany	CR Taiwan	RS Russia	KR ROK	CCS China
≧265	400/510	—	—	—	—	—	—	—	N27A N27D N27E	VL27A VL27D VL27E	—	—	—	—
≧315	470/590	A131	AH32	K32A	A32A	L32A	B32A	G32A	N32A	VL32A	C32A	P32A	KR32A	CS32A
			DH32	K32D	A32D A32DN	L32D	B32D	G32D	N32D	VL32D	C32D	P32D	KR32D	CS32D
			EH32	K32E	A32E	L32E	B32E	G32E	N32E	VL32E	C32E	P32E	KR32E	CS32E
≧355	490/620	A131	AH36	K36A	A36A	L36A	B36A	G36A	N36A	VL36A	C36A	P36A	KR36A	CS36A
			DH36	K36D	A36D A36DN	L36D	B36D	G36D	N36D	VL36D	C36D	P36D	KR36D	CS36D
			EH36	K36E	A36E	L36E	B36E	G36E	N36E	VL36E	C36E	P36E	KR36E	CS36E
≧390	530/650	A131	AH40	K40A	A40A	L40A	—	—	N40A	VL40A	—	—	—	—
			DH40	K40D	A40D	L40D	—	—	N40D	VL40D	—	—	—	—
			EH40	K40E	A40E	L40E	—	—	N40E	VL40E	—	—	—	—

• Steel Type: Steel for Boilers and Pressure Vessels

Strength Level (N/mm^2) Y.P.	T.S.	Corresponding ASTM, JIS	NK Japan	AB USA	LR UK	BV France	GL Germany	NV Norway	DNV-GL Norway Germany	CR Taiwan	RS Russia	KR ROK	CCS China
≧165	310/450	A285 Gr.A	—	APMA	—	—	—	—	—	—	—	—	—
≧185	345/485	A285 Gr.B	—	APMB	—	—	—	—	—	—	—	—	—
≧205	380/515	A285 Gr.C	—	APMC	—	—	—	—	—	—	—	—	—
≧205	380/520		—	APMD	LP360, AR	—	—	NP360–0N	VLP360-0N	—	—	—	—
≧225	410/550	A515 Gr.60	KP42	APME	LP410, AR	—	—	NP410–0N	VLP410-0N	CP1410	—	KRP42	—
≧245	450/590	A515 Gr.65	KP46	APMF	LP460, AR	—	—	NP460–0N	VLP460-0N	CP1450	—	KRP46	—
≧265	480/620	A515 Gr.70	KP49	APMG	—	—	—	NP490–0N	VLP490-0N	C36E	P36E	KR36E	CS36E
≧205	380/520	A516 Gr.55	—	APK	LLT0–360 LP360FG	BP360	—	NP360–1FN NP410–1FN	VLP360-1FN VLP410-1FN	—	—	—	—
≧225	410/550	A516 Gr.60	—	APL	LP410FG	BP410	—	NP460–1FN	VLP460-1FN	—	—	—	—
≧245	450/590	A516 Gr.65	—	APM	LP460FG	BP460	—	NP490–1FN	VLP490-1FN	CP2450	—	—	—
≧265	480/620	A515 Gr.70	—	APN	LP490FG	BP510	—	NP510–1FN	VLP510-1FN	CP2480	—	—	—
≧235	410/510	G 3115 SPV235	KPV24	—	LLT0–410	—	—	NP410–1FN	VLP410-1FN	CPV0235	—	KRPV24	—
≧315	490/610	G 3115 SPV315	KPV32	—	LLT20–410	—	—	NP460–1FN	VLP460-1FN	CPV0315	—	KRPV32	—
≧355	520/640	G 3115 SPV355	KPV36	—	LLT0–490	—	—	NP490–1FN	VLP490-1FN	CPV0355	—	KRPV36	—
≧450	570/700	G 3115 SPV450	KPV46	—	LLT20–490	—	—	NP510–1FN	VLP510-1FN	CPV0450	—	KRPV46	—
≧490	610/740	G 3115 SPV490	KPV50	—	—	—	—	—	—	—	—	KRPV50	—
1/2Mo		A204 Gr.A	KPA46	APH	—	BPM430	—	NPM440 (0.3Mo)	VLP0.3MO	—	—	KRP46A	—
		A204 Gr.B	KPA49	API	—	BPM510	—	—	—	—	—	KRP49A	—
		A204 Gr.C	—	APJ	—	BPMV510	—	—	—	—	—	—	—
2/3Cr–1/2Mo		A387 Gr.2	—	—	—	BPCM450	—	—	—	—	—	—	—
1Cr–1/2Mo		A387 Gr.12	—	—	LPCM470	BPCM470	—	NPCM470	VLP1CR0.5MO	—	—	—	—
1 ·1/4Cr–1/2Mo		A387 Gr.11	—	—	—	—	—	—	—	—	—	—	—
2 ·1/4Cr–1Mo		A387 Gr.22	—	—	LPCM480	BPCM480	—	NPCM480	VLP2.25CR1MO	—	—	—	—
3Cr–1Mo		A387 Gr.21	—	—	—	—	—	—	—	—	—	—	—
5Cr–1/2Mo		A387 Gr.5	—	—	—	—	—	—	—	—	—	—	—

• Steel Type: Steel for Low-Temperature Service

Strength Level (N/mm^2) Y.P.	T.S.	Corresponding JIS	NK Japan	AB USA	LR UK	BV France	GL Germany	NV Norway	DNV-GL Norway Germany	CR Taiwan	RS Russia	KR ROK	CCS China
≧235	400/510	G 3126 SLA235A, B	KL24A, B	ABV	—	—	—	NL23, 24, 24L	VLL23、24、24L	—	—	KRL24A, B	—
≧325	440/560	G 3126 SLA325A, B	KL33	—	LT–EH32, –FH32	—	—	NL43, 44, 44L	VLL43、44、44L	—	—	KRL33	—
≧365	490/610	G 3126 SLA365	KL37	ABVH	LT–EH36, –FH36	—	—	—	—	—	—	KRL37	—
1/2Ni			—	—	—	BLNA, BLNB	—	—	—	—	—	—	—
1 ·1/2～2 ·1/4Ni		G 3127 SL2N255	KL2N30	—	1 ·1/2Ni	BL1N	—	NLN1N	VLL1.5NI	—	—	KRL2N30	—
3 ·1/2Ni		G 3127 SL3N255, 275	KL3N32	—	3 ·1/2Ni	BL3N	—	NLN3N	VLL3.5NI	—	—	KRL3N32	—
5Ni		G 3127 SL5N590	KL5N43	—	5Ni	BL5N	—	NLN5N	VLL5NI	—	—	KRL5N43	—
9Ni		G 3127 SL9N520	KL9N53	—	9Ni	BL9N	—	NLN9N	VLL9NI	—	—	KRL9N53	—
		G 3127 SL9N590	KL9N60	—	—	—	—	—	—	—	—	KRL9N60	—

NIPPON STEEL Specifications
Table of Correlations between Old and New Specifications

1) Weldable High-strength Steel Plates

Old Nippon Steel	Old Sumitomo Metal Industries	NIPPON STEEL
NES540	SUMITEN540	**WEL–TEN540**
WEL–TEN590	SUMITEN590	**WEL–TEN590**
—	SUMITEN590K, 590M	**WEL–TEN590E**
WEL–TEN590RE	—	**WEL–TEN590RE**
WEL–TEN590H	—	—
WEL–TEN590CF	SUMITEN590F	**WEL–TEN590EX**
WEL–TEN590SCF	—	**WEL–TEN590EXS**
—	SUMITEN590W	—
—	SUMITEN590LT	—
WEL–TEN610	SUMITEN610	**WEL–TEN610**
WEL–TEN610CF	SUMITEN610F	**WEL–TEN610EX**
WEL–TEN610SCF	—	**WEL–TEN610EXS**
—	SUMITEN610W	—
—	SUMITEN610LT	—
WEL–TEN690	SUMITEN690	**WEL–TEN690**
—	SUMITEN690S, 690M	**WEL–TEN690E**
WEL–TEN690C	—	—
WEL–TEN690RE–A, B	—	**WEL–TEN690RE**
WEL–TEN690EX	—	—
—	SUMITEN730	—
—	SUMITEN730S	—
WEL–TEN780	SUMITEN780	**WEL–TEN780**
WEL–TEN780A, B	—	—
WEL–TEN780C	SUMITEN780S	**WEL–TEN780C**
WEL–TEN780E	SUMITEN780M, 780S	**WEL–TEN780E**
WEL–TEN780RE	—	**WEL–TEN780RE**
WEL–TEN780EX	—	**WEL–TEN780EX**
WEL–TEN780P	—	—
—	SUMITEN780SW	—
—	SUMITEN780W	—
WEL–TEN950	SUMITEN950	**WEL–TEN950**
WEL–TEN950PE	SUMITEN950M	**WEL–TEN950E**
WEL–TEN950RE	—	**WEL–TEN950RE**

2) Abrasion-resistant Steel Plates

Old Nippon Steel	Old Sumitomo Metal Industries	NIPPON STEEL
—	SUMIHARD–K340	—
WEL–HARD400 WEL-TEN AR360E	SUMIHARD–K400	**ABREX400**
WEL-TEN AR400E	SUMIHARD–K450	**ABREX450**
WEL–HARD500 WEL-TEN AR500E	SUMIHARD–K500	**ABREX500**

3) Corrosion-resistant Steel

Old Nippon Steel	Old Sumitomo Metal Industries	NIPPON STEEL
S–TEN1	CR1A–400	**S–TEN1**
S–TEN2	—	**S–TEN2**
NAW400	CR2–400	**NAW400**
NAW490	CR2–490	**NAW490**
—	CR2/2M–590	—
COR–TEN 490A, B, C	CR2M–490	**COR–TEN 490A, B, C**
COR–TEN570	CR2M–590	**COR–TEN570**
COR–TEN A	CR4A–400	**COR–TEN A**
COR–TEN B	CR2M–490	**COR–TEN B**
COR–TEN C	CR2M–590	**COR–TEN C**
COR–TEN O	CR2R–H	**COR–TEN O**
—	CR4A–400	—
MARILOY S400A, B, C	—	**MARILOY S400A, B, C**
MARILOY G400A, B, C	CR4B–400	**MARILOY G400A, B, C**
MARILOY P490A, B, C	CR4A–490	**MARILOY P490A, B, C**
MARILOY S490A, B, C	—	**MARILOY S490A, B, C**
MARILOY G490A, B, C	CR4B–490	**MARILOY G490A, B, C**
MARILOY T490A, B, C	CR4T–490	**MARILOY T490A, B, C**
NAW–TEN 12–400A, B, C	—	**NAW–TEN 12–400A, B, C**
NAW–TEN 12–490A, B, C	—	**NAW–TEN 12–490A, B, C**
NAW–TEN12–570	—	**NAW–TEN12–570**
NAW–TEN 15–400A, B, C	—	**NAW–TEN 15–400A, B, C**
NAW–TEN 15–490A, B, C	—	**NAW–TEN 15–490A, B, C**
NAW–TEN15–570	—	**NAW–TEN15–570**

4) Low-temperature Steel Plates

Old Nippon Steel	Old Sumitomo Metal Industries	NIPPON STEEL
N–TUF295N	SLT285	**N–TUF295**
N–TUF325, 325N	SLT325A, 325B	**N–TUF325**
N–TUF365	SLT360	**N–TUF365**
N–TUF490	—	**N–TUF490**
N–TUF570	SLT3N440	**N–TUF570**
—	SLT2N255	—
—	SLT3N255	—
N–TUFCR130	SLT3N275	**N–TUFCR130**
N–TUFCR196	—	**N–TUFCR196**
—	SLT9N520	—
—	SLT9N590	—

＊For the time being, production can be continued by agreement on the handling of specifications, even if the specifications have been eliminated or have lost their name.

＊Please ask about those standard products made to special specifications that are not included in the above.

5) Building Structures Steel

Old Nippon Steel	Old Sumitomo Metal Industries	NIPPON STEEL
BT–HT325B, 325C	T–DAC325B, 325C	**BT–HT325B, 325C**
BT–HT355B, 355C	T–DAC355B, 355C	**BT–HT355B, 355C**
BT–HT385B, 385C	T–DAC385B, 385C	**BT–HT385B, 385C**
BT–HT400C	—	**BT–HT400C**
BT–HT440B, 440C	SA440B, 440C	**BT–HT440B, 440C**
BT–HT440B–SP, 440C–SP	—	**BT–HT440B–SP, 440C–SP**
BT–HT500C	—	**BT–HT500C**
BT–HT630B, 630C	—	**BT–HT630B, 630C**
H–SA700A, 700B	H–SA700A, 700B	**BT–HT700A, 700B**
—	SSS1000	**BT–HT880B, 880C**
BT–LYP100	SLY100	**BT–LYP100**
BT–LYP225	SLY225	**BT–LYP225**
NSFR400B, 400C	—	**NSFR400B, 400C**
NSFR490B, 490C	—	**NSFR490B, 490C**

6) Electromagnetic Mild Steel

Old Nippon Steel	Old Sumitomo Metal Industries	NIPPON STEEL
N–SMIP–1	SSM250	**NS–MIP250**