

AVAILABLE THICKNESS and APPLICABLE STANDARDS

YP class	Standard Max. thickness	API2W ^(*)	EN10225	NORSOK M-120	BS7191 ^(*) (TMCP)	Ship classification
YP315	100mm	42				YP32 (A,D,E,F)
YP355	100mm	50,50T	S355G9,G10	S355 (Y20,Y25)	355D,EM,EMZ	YP36 (A,D,E,F)
YP390	100mm					YP40 (A,D,E,F)
YP420	100mm	60	S420G1,G2	S420 (Y30,Y35)		YP420 (A,D,E,F)
YP460	80mm		S460G1,G2	S460 (Y40,Y45)	450EM,EMZ	YP460 (A,D,E,F)
YP500	70mm			S500 (Y50,Y55)		YP500 (A,D,E,F)
YP550	50mm					YP550 (A,D,E,F)

(*)1 Lower Limit of Al content should be deleted for TiO and HTUFF steel.

SUPPLY RECORDS

Year	Project name	Area	YP class (MPa)	Quantity (kMT)	Max.thick (mm)	CVN(HAZ) (°C)	CTOD(HAZ) (°C)	Remarks
1984	Oseberg I	North Sea	YP355	64	120	-40	-10	First application of TMCP
1985	Harmony & Heritage	California	YP355	9	89	-40	-10	
1988	Oseberg II	North Sea	YP380	13	100	-40	-10	
1989	Draugen	North Sea	YP420	10	70	-40	-10	First application of TiO
1990	Goodwyn A	Australia	YP355	15	100	-30	+0	
1990	Maui B	New Zealand	YP355	7	65	-30	+0	
1991	Brage	North Sea	YP420	36	100	-40	-10	
1992	Troll	North Sea	YP355	10	80	-40	-10	
1992	Heidrun	North Sea	YP420	24	100	-40	-10	
1993	Troll Olje	North Sea	YP420	13	100	-40	-10	
1996	Ursa	Gulf of Mexico	YP420	10	76	-40	-10	
1998	Oseberg South	North Sea	YP420	6	60	-40	-10	
1998	Asgard B	North Sea	YP355	13	70	-40	-10	
2000	Bayu undan	Timor Sea	YP460/355	36	80	-40	-10	First application of HTUFF
2000	Grane	North Sea	YP500	4	70	-40	-10	
2001	Kvitebjorn	North Sea	YP500	3	60	-40	-10	
2001	ACG	Caspian Sea	YP460/355	22	80	-40	-10	
2002	Belanak	Asia	YP355	11	100	-40	-10	
2002	Thunder Horse	Gulf of Mexico	YP500/355	5	100	-40	not required	
2002	Western Libya	Mediterranean Sea	YP460	5	80	-40	-10	
2003	Kristin	North Sea	YP420	12	100	-40	-10	
2003	Atlantis	Gulf of Mexico	YP500/355	3	100	-40	not required	
2003	Sakhalin II	Russia	YP460	18	100	-60	-40 (*1)	
2003	Amenam	West Africa	YP460	2	51	-40	not required	
2004	Sakhalin II	Russia	YP420	6	80	-40	-10	
2004	Kashagan	Caspian Sea	YP355	7	50	-60	-36	
2005	Tangguh	Asia	YP460	2	60	-40	-10	
2006	Seadrill Gva etc.	North Sea	YP500	1	55	-40	not required	
2007	Tombua Landana	West Africa	YP420	3	100	-40	-10	
TOTAL				370	(*1) CTOD: Information only			

WELDING MATERIALS

Steel grade	Welding process	Product name (*1) (Shield Gas)	AWS classification	Applications		
				Position	CVN (°C)	CTOD (°C) (*2)
YP355MPa~ YP460MPa	Submerged Arc Welding	NB-55L × Y-D	A5.23 F8A8-EG-G A5.23 F8A8-EG-G	Flat position welding	-40~ -60	-10~ -40
	Flux Cored Arc Welding	SF-36E(CO ₂)	A5.29 E81T1-G	All position welding	-40~ -60	-10~ -40
		SF-50L(Ar-CO ₂)	A5.29 E80T5-G	Flat butt, & Flat horizontal fillet welding	-40~ -60	-10~ -40
	Covered Arc Welding	N-12SN	A5.5 E8016-G	All position welding	-40~ -60	-10~ -40
YP500MPa	Gas Metal Arc Welding	YM-36E(Ar-CO ₂)	A5.18 ER70S-G	All position welding	-40~ -60	-10~ -40
	Submerged Arc Welding	NB-60L × Y-DM3	A5.23 F8A8-EG-G A5.23 F8A8-EG-G	Flat position welding	-40~ -60	-10~ -40
	Flux Cored Arc Welding	SF-50A(Ar-CO ₂)	A5.29 E91T1-G	All position welding	-40~ -60	-10
	Covered Arc Welding	L-60LT	A5.5 E9016-G	All position welding	-40~ -60	-10

(*)1Nippon Steel & Sumikin Welding Co.,Ltd.

(*)2CTOD: Information only



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TMCP steel plates for Offshore Structures
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Nippon Steel's
TMCP steel plates
for Offshore Structures



Features

1. Improvement of HAZ toughness
Applying manufacturing technology for the refinement of effective grain size in the heat affected zone (HAZ) of welded joints, Nippon Steel's high strength plate for offshore structures has excellent HAZ toughness at low temperature (especially CTOD properties).
2. Enhancing Flexibility in Design and Usage
Since Nippon Steel's offshore structural plate has high strength and high toughness, it enable to reduce the steel weight, and is applicable to large-sized structures and suitable in the extremely severe environment.
3. Excellent Weldability
Lowering Ceq and P_{cm} by Thermo-mechanical control process (TMCP) technology, Nippon Steel's offshore structural plate greatly improves the weldability of high strength steel plate.
・ Greater resistance to cold cracking
・ Lower maximum hardness of welded joints
4. Outstanding Workability
Nippon Steel's offshore structural plate permits cold forming, bending, shearing and gas cutting.

On the Leading Edge:Nippon Steel

Nippon Steel Corporation

INTRODUCTION

Nippon Steel produces high strength and high toughness steel plates for offshore structures through manufacturing technologies such as TMCP and HTUFF.[®] Nippon Steel's plates are used for many offshore structures throughout the world.

- Practicably Reducing Weight of Offshore Structures
- Enhancing Usability in Extremely Severe Environment

- Highly Enhancing Customer's Flexibility in Design and Usage
- Realizing Considerable Cost-Down in Fabrication and Installation

TMCP : Thermo-mechanical control process
HTUFF : Super High HAZ Toughness Technology with Fine Microstructure Imparted by Fine Particles

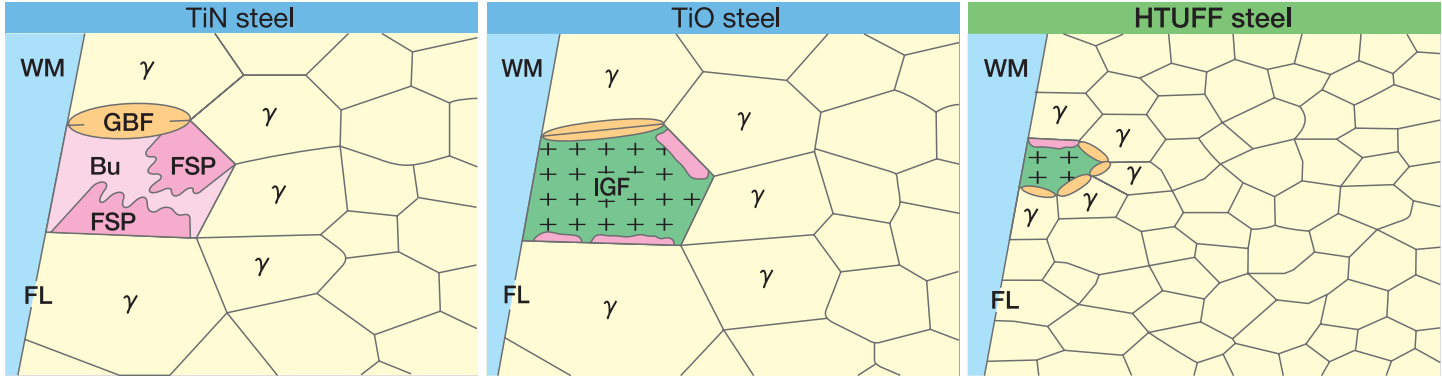
IMPROVEMENT of HAZ TOUGHNESS

Basic Concept

Metallurgical factors	Measures
Refinement of effective grain size in HAZ	<ul style="list-style-type: none">• Inhibition of austenite grain coarsening by fine precipitation such as TiN• Utilization of intra-granular ferrite (IGF) nucleated from precipitation such as Ti₂O₃• Utilization of both the above measures by dispersing high-temperature-stable oxide and sulfide particles; HTUFF[®]
Decrease of MA-constituent	<ul style="list-style-type: none">• Reduction in Carbon content and Carbon equivalent• Reduction in Silicon and Niobium content
Improvement of matrix toughness	<ul style="list-style-type: none">• Fixation of free Nitrogen such as TiN, AlN, etc.• Addition of Nickel

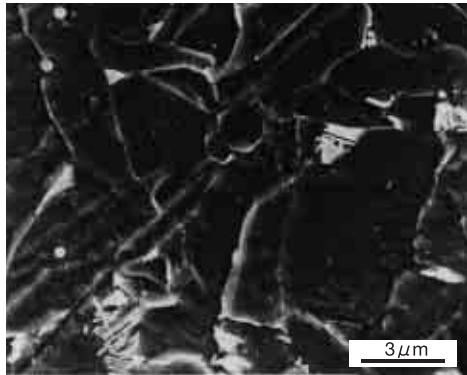
HAZ:Heat Affected Zone

Concept of controlling microstructure

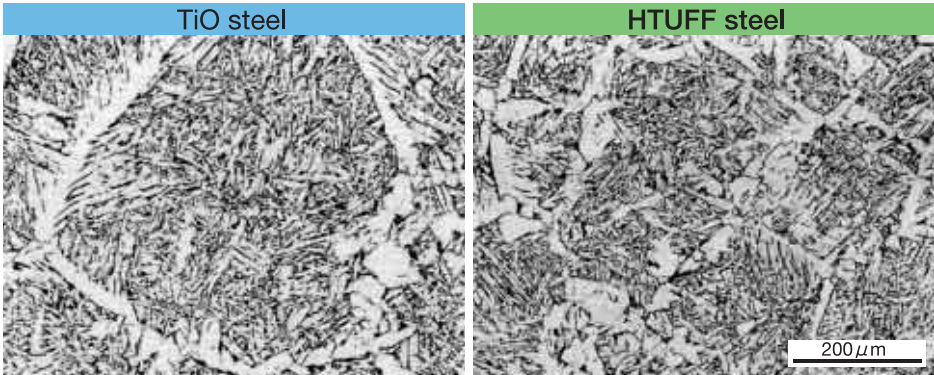


WM: Weld Metal FL: Fusion Line γ : Austenite GBF: Grain Boundary Ferrite FSP: Ferrite Side Plate IGF: Intra-granular Ferrite Bu: Upper Bainite

IGF formed in HAZ of HTUFF



Comparison of HAZ microstructure of TiO steel and HTUFF steel



TYPICAL PROPERTIES

Chemical Composition (mass%)

YP class (MPa)	HAZ CTOD requirement (℃)	Thickness (mm)	Steel	C	Si	Mn	P	S	Others	Ceq	Pcm	
YP355	-10	40	A	0.08	0.18	1.54	0.004	0.002	Cu,Ni, Nb,Ti	0.35	0.16	
YP420		80	B	0.08	0.17	1.55	0.005	0.002		0.38	0.20	
		63	C	0.08	0.18	1.55	0.006	0.003		0.39	0.19	
		100	D	0.08	0.16	1.58	0.004	0.002		0.41	0.19	
		YP460	75	E	0.08	0.18	1.60	0.005		0.002	0.42	0.20
		YP500	70	F	0.09	0.12	1.63	0.007		0.002	0.44	0.21
YP550		50	G	0.08	0.09	1.88	0.004	0.002		0.50	0.22	
YP420	-50	75	H	0.06	0.08	1.54	0.002	0.002	0.42	0.18		

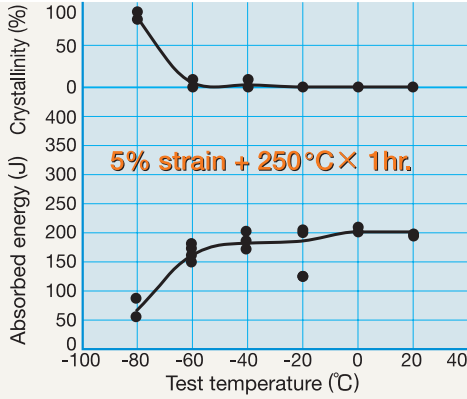
Ceq=C+Mn/6+(Ni+Cu)/15+(Cr+Mo+V)/5, Pcm=C+Si/30+Mn/20+Cu/20+Ni/60+Cr/20+Mo/15+V/10+5B

Mechanical Properties

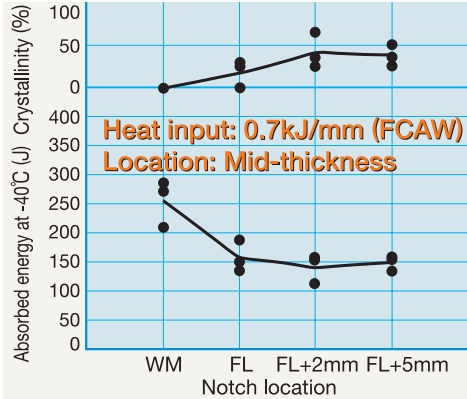
YP class (MPa)	Thickness (mm)	Steel	Tensile test (Trans.)				Charpy impact test (Trans.)					
			YS (MPa)	TS (MPa)	EL (%)	YS/TS ratio (%)	Surface or Quarter-thickness			Mid-thickness		
							Temp. (°C)	vE (J)	vTrs (°C)	Temp. (°C)	vE (J)	vTrs (°C)
YP355	40	A	428	528	33	81	-40	354	<-80	-40	307	-70
	80	B	431	536	32	80	-40	366	-85	-40	247	-55
YP420	63	C	476	573	28	83	-40	310	-75	-40	178	-50
	100	D	489	566	30	86	-40	348	-80	-40	308	-65
YP460	75	E	499	602	23	83	-40	270	-70	-40	240	-50
YP500	70	F	522	629	22	83	-40	215	-95	-40	139	-50
YP550	50	G	588	659	28	89	-40	271	<-120	-40	127	-95
YP420	75	H	465	531	35	88	-100	316	-112	-70	324	-100

Properties of YP500MPa HTUFF steel plate (steel F)

Strain-aged properties



HAZ charpy impact properties



HAZ CTOD properties

