



## **Recent technology and advanced products in the steel production for energy development and shipbuilding**

### **1.Introduction**

### **2.Outline of Steel as the functional material**

### **3.Manufacturing Process of High performance steel**

#### **(1) Newest Steel Making Process & Plate mill**

#### **(2) Thermo Mechanical Controlled Rolling Process**

### **4. Recent advanced products in the steel**

#### **(1) For Ship-building**

#### **(2) For Offshore structures and Wind power structure**

#### **(3) For Building & Bridge Construction**

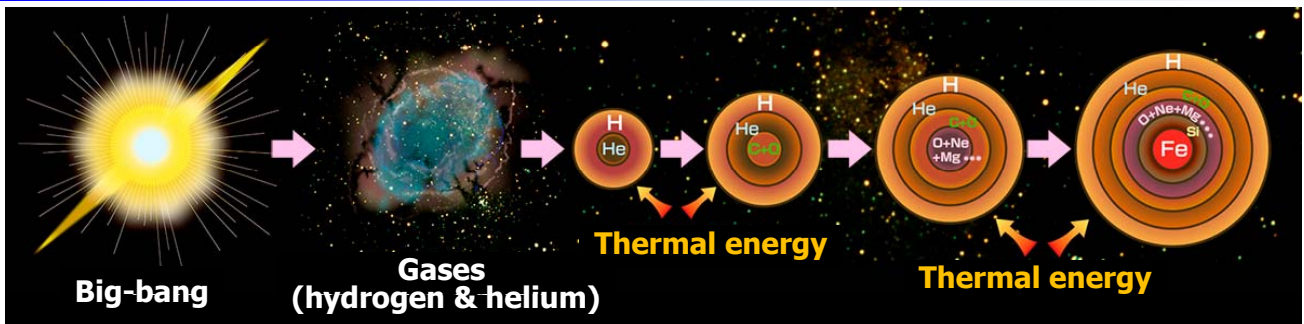
#### **(4) Atmospherics Resistance**

#### **(5) Anti-Severe Environment**

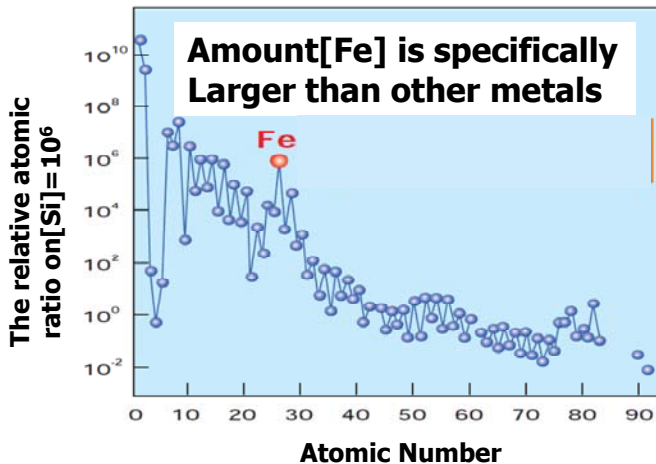
### **5. Processing Technology System of steel structure**

### **6.Conclusion**

# "Earth" is born as a star of iron



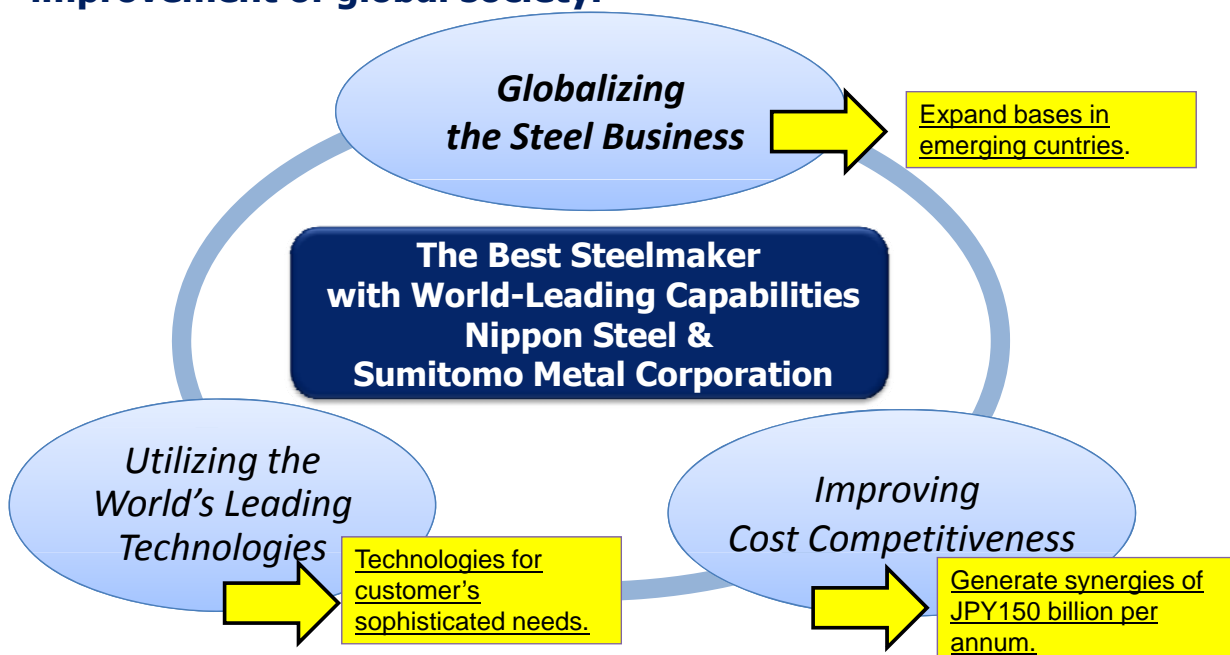
Abundance of elements in the universe



Earth consists of oxides of iron, silicon and magnesium. The most amount of is covered with **iron**, it accounts for 34.6% of the total weight. In this way the earth lump of iron.

## Creating the Best Steelmaker with World-Leading Capabilities

Maximize the potential of steel through utilization of world-leading technology. Contribute to the growth of global economies and the improvement of global society.



■ NSSMC Group will pursue world-leading technologies and manufacturing capabilities, and contribute to society by providing excellent products and services.

# Expand Local Production in Emerging Countries

- Continue to produce in Japan as the core base
- Supply high quality products in growth markets

- Produce in Japan as the core base
- Develop and manufacture leading-edge products

**AMERICAS**

- Capture local demands
- From Brazil and the other countries

**ASIA**

- Growth Market

**JAPAN**

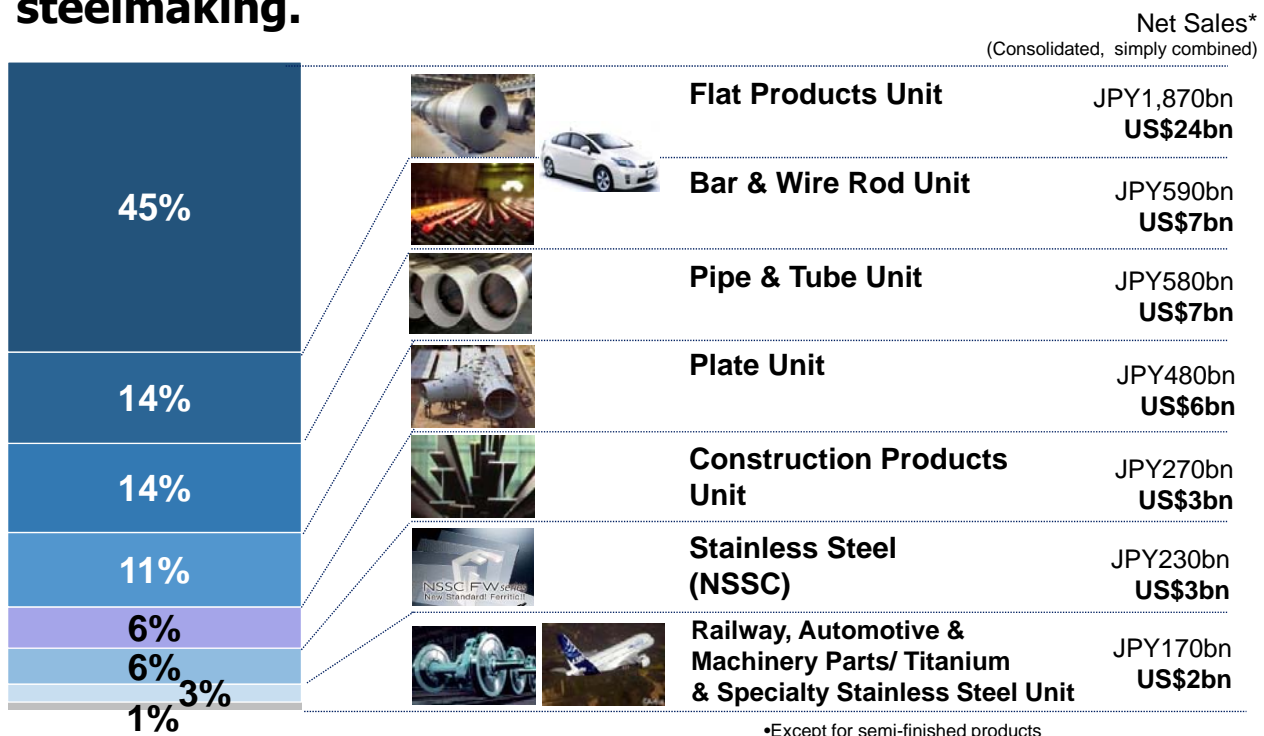
- Re-organize / expand manufacturing , processing, and sales bases

Re-organize and Expand the Bases including Integrated Steelworks e.g. in ASIA / AMERICAS

**Target: 60 - 70 million tons of global production**

## Supplying a wide range of product types

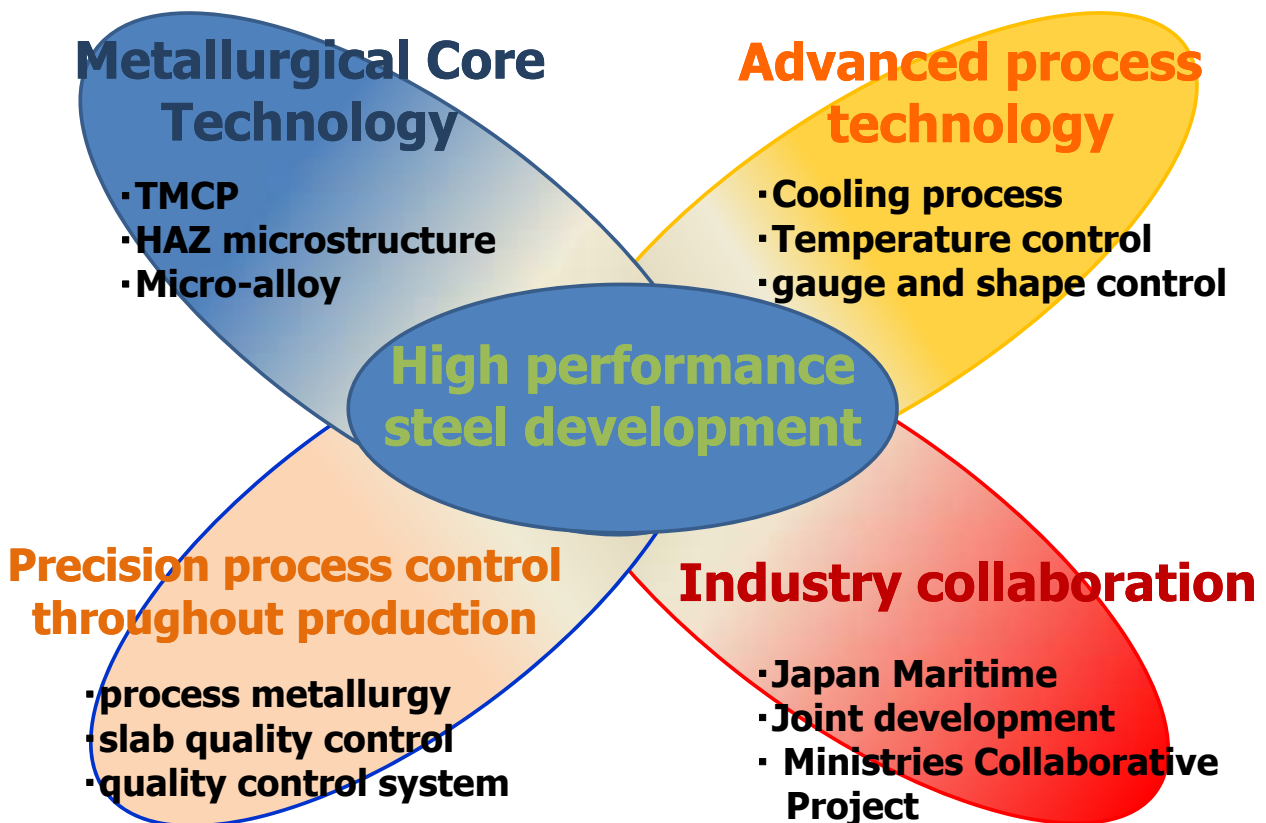
**NSSMC will pursue manufacturing strength based on steelmaking.**



# NSSMC's Plate Mills; Kashima, Oita, Kimitsu, Nagoya

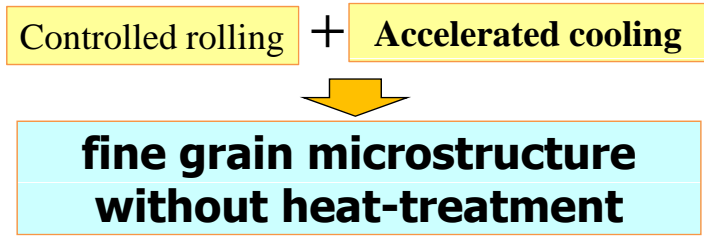
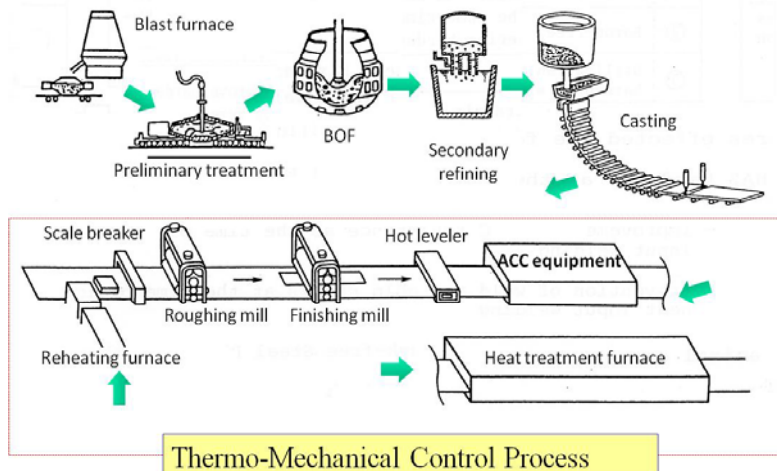


# Requirements for development of high performance steel



# TMCP Process and NSSMC&USIMINAS's ACC Equipment

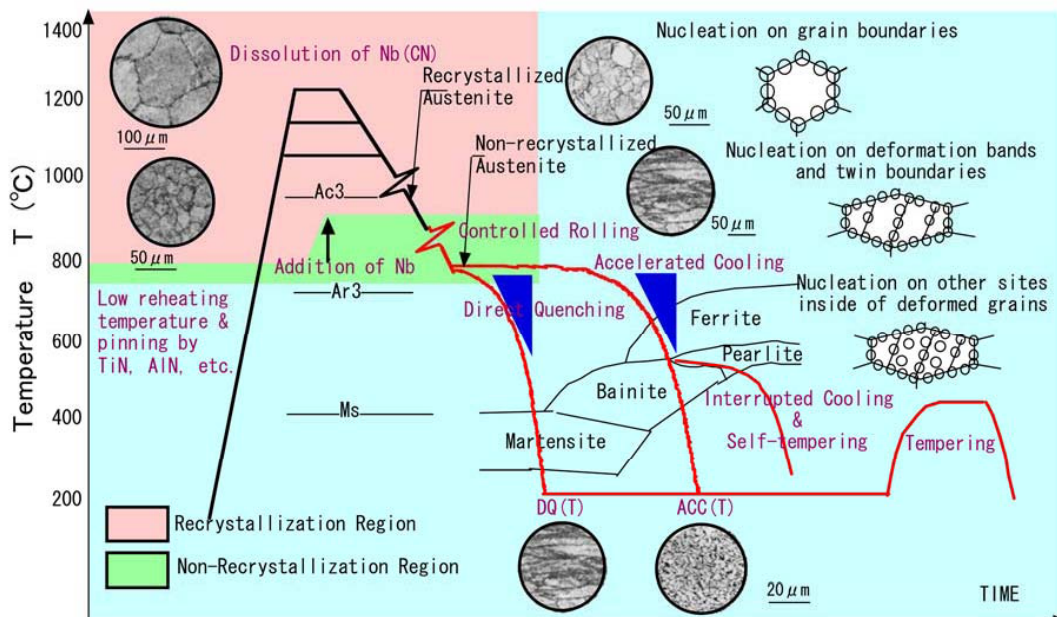
## TMCP(Thermo-Mechanical control process ) On-Line controlled water cooling just after rolling



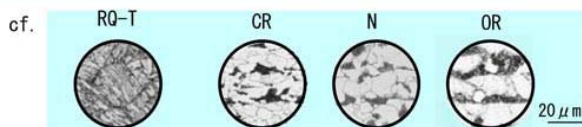
Accelerated cooling equipment

## TMCP process(thermo-mechanical control process)

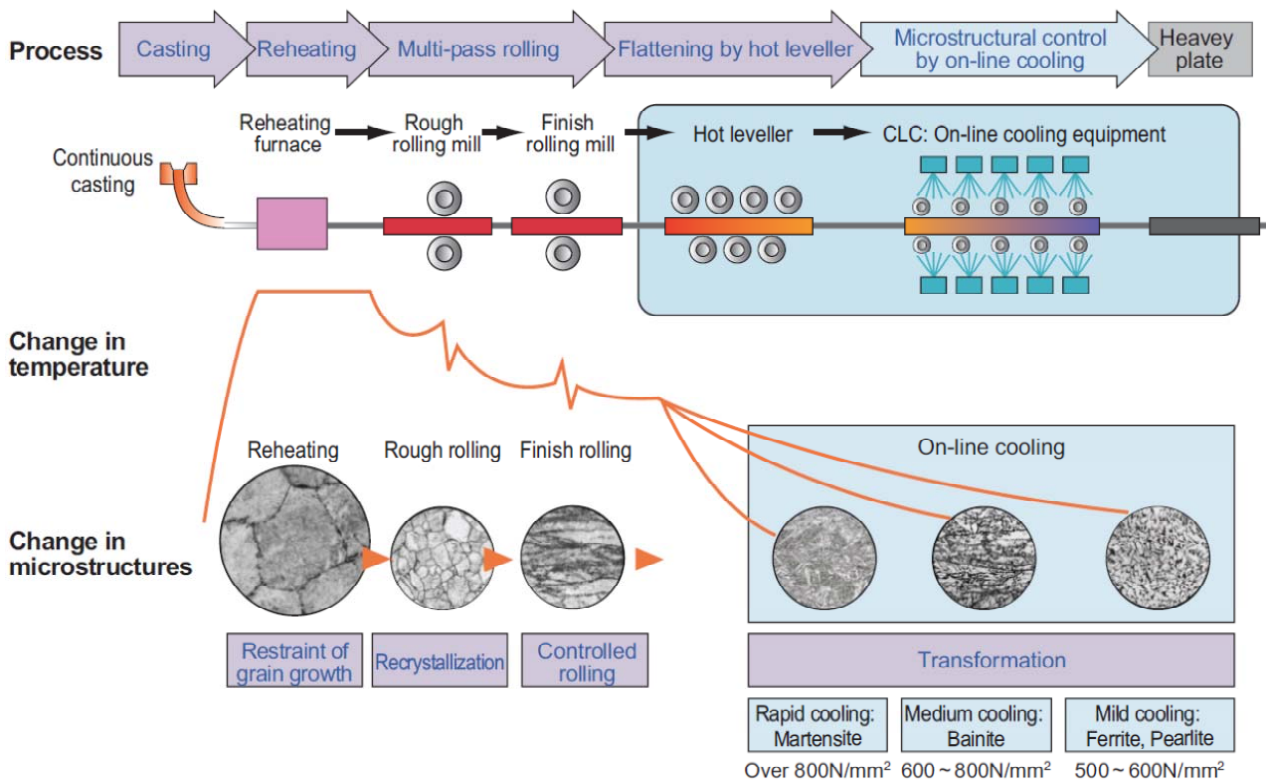
Highly control of chemical composition, reheating, rolling, & cooling in order to get very fine microstructure→High toughness & good weldability.



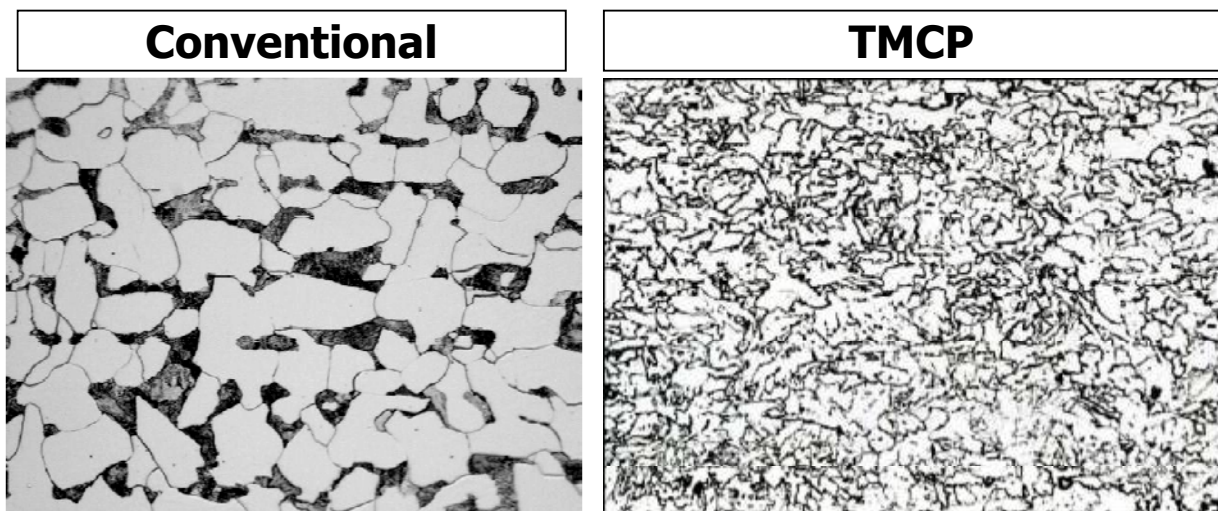
**Various Microstructure for TMCP**



# Schematic illustration of TMCP & micro structural changes



# Microstructure of TMCP plates



**TMCP steel shows much finer microstructure compared with conventional steel.**

→ **TMCP improves strength and toughness, and can decrease the amount of additional alloy.**

# Latest topics of steel plates for ship building

## Direction of development

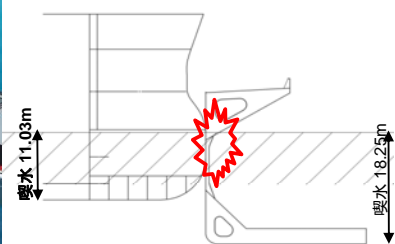
Basically; **Reducing Ship Building Cost** (for Ship Yards)

- High-Tensile Strength Steel
  - For Large Heat-input , Automatic-Welding
  - Easy Fabrication; No Pre/Post-Heating While Welding
- ⇒ *TMCP Steel for Easy Fabrication and Automatic Large Heat-input Welding*

Recently ; **Improving Ship Performance** (for Owners)

- Higher Arrestability, Anti-Brittle-Crack Steel
- ⇒ *Microstructure Control Technology*
- Anti-Fatigue
- ⇒ *Peening Technology*
- Anti-Corrosive Steel for Cargo Tank of Oil Tanker
- ⇒ *Corrosion Resistance Technology*
- Higher Safety at Collision
- ⇒ *Impact absorption Technology*

## Specific examples of the collision deformation at serious Impact accident



**Collision ship (large oil tanker)  
crude oil loading state**



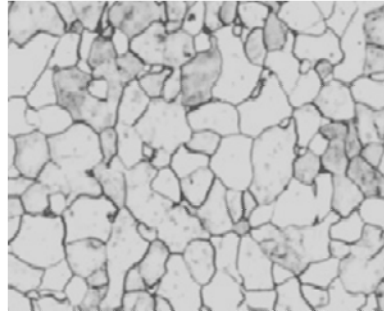
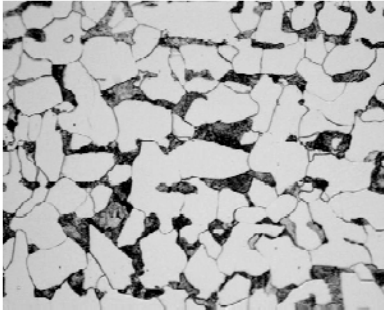
**Bombarded ship (bulk Carrier) cargo full state**

Impact Speed : 5not  
Conventional Steel **Break Out**  
NSafe™-Hull Steel **Non-break**

# Micro-Structure of Developed Steel

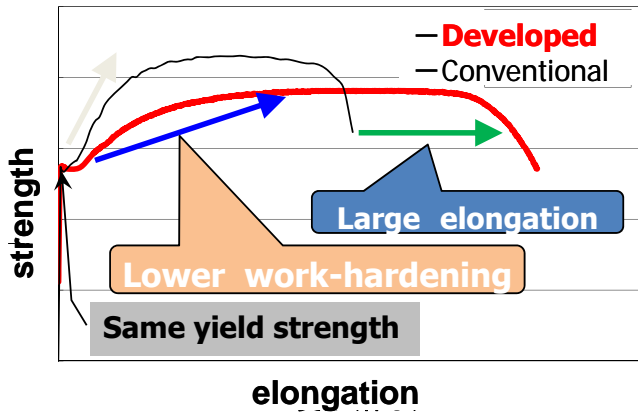
Conventional

Developed NSafe®Hull Steel



- Extra-low carbon cont. & highest purity

- Most-advanced rolling technology to improve strength & toughness



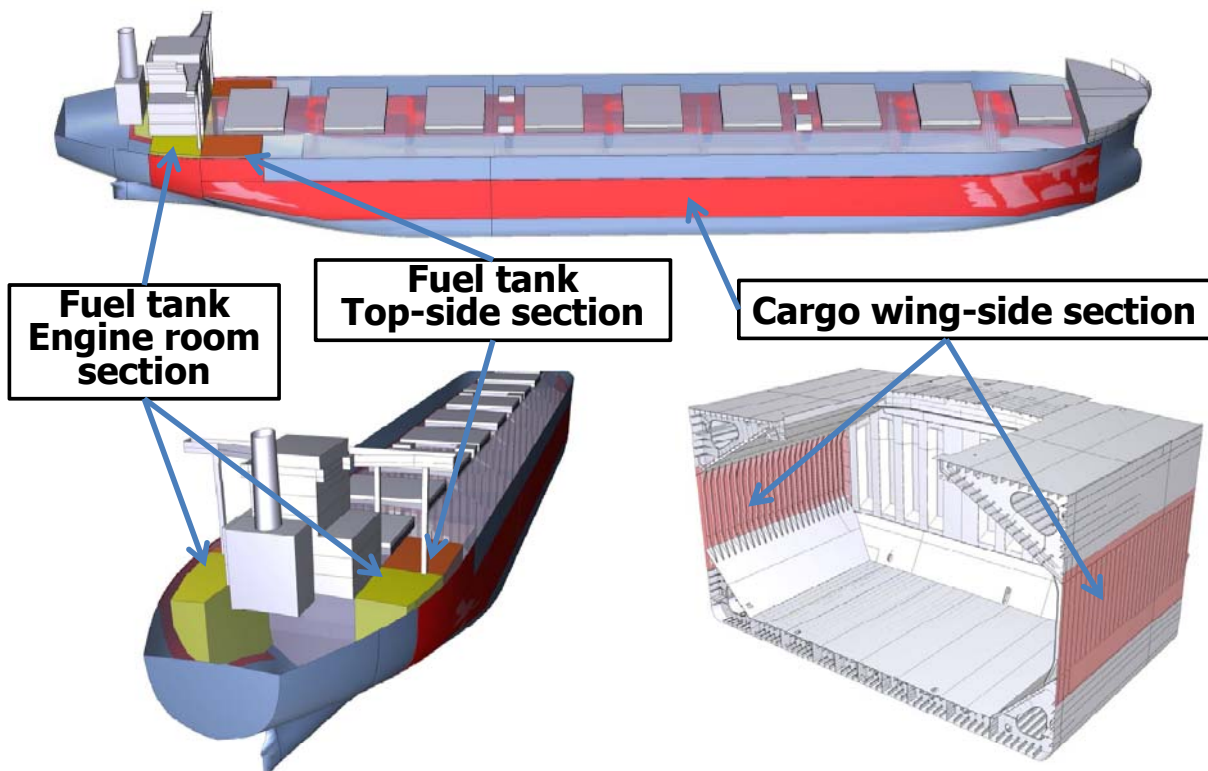
- Same yield strength as that of conventional steel

- Lower work-hardening

- Large elongation

***NS-Ship-Safety235 has high deformability.***

## High ductility steel (NSafe™ over Hull) application point





# Example of Brittle Fracture



**Crack Speed: usually over 1000m/sec**  
**It came suddenly**



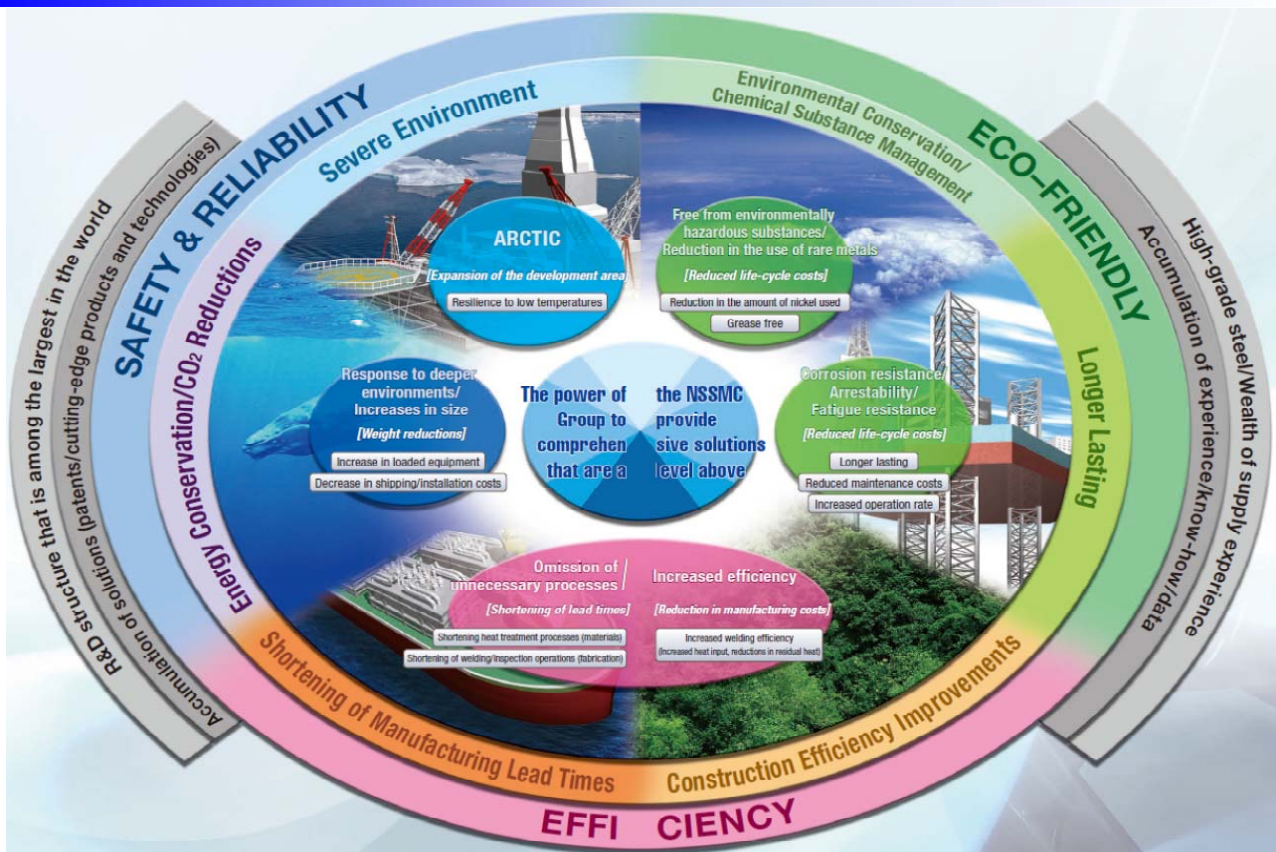
**The brittle crack goes through the base plate.**



**Test temperature: -10°C**  
**Grade: Conventional EH40**  
**vE-40°C: 170J**

**Base plate with 170J at -40°C can not arrest the brittle crack.**

# NSSMC & USIMINAS Solution for High Grade



# New advanced steel material for Jack up Rig



Jack Up Rig

**Solution**

- Expansion of the development area
- Weight reductions
- Reduced life-cycle costs
- Shortening of lead times/Reduction in manufacturing costs

**High Strength Thick Steel Plates for RACK & CHORD (YP690)**

Extra thick high strength steel plates with high toughness that meet classification society requirements.

[Plate Unit]



**For Cantilevers/TMCP-type/ EQ51 Steel Plates**

High strength steel plates with shortened manufacturing lead times made possible through adopting the TMCP.

[Plate Unit]



**For Jacking System/High Tensile Strength Steel Plates for Cantilevers (YP500-690)**

A wide range of high strength steel plates with high toughness that meet classification society requirements.

[Plate Unit]

**Low Temperature High Strength Tough Steel Plates for FLOATING/HULL Use (F-grade steel/YP355-420)**

Steel plates that meet classification society requirements and impact test standards at -60°C.

[Plate Unit]

**High Strength Pipe for Bracing**

High strength material for bracing (Jack Up Rig).

[Pipe & Tube Unit]



# New advanced steel material for Platform

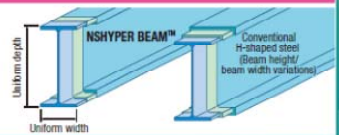


Fixed Platform

**NSHYPER BEAM™**

Save fabrication cost and time to build up beam.

[Construction Products Unit]



**Low Temperature CVN H-shapes**

Up to -40°C/50J.

[Construction Products Unit]



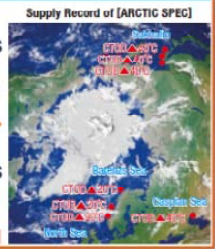
**Steel Plates for -40°C (ARCTIC) Usage Environments**

YP420 grade steel plates suited for use in -40°C (ARCTIC) environments/maximum plate thickness of 4" (world first).

**Steel Plates for -20°C (ARCTIC) Usage Environments**

YP420 grade steel plates suited for use in -20°C (ARCTIC) environments.

[Plate Unit]



# New advanced steel material for FLNG



FLNG

### A841 Grade G for Ship LNG Storage Tanks (Ni: 6.0-7.5%)

Steel plates that reduce the amount of nickel used (Ni 6.0-7.5%) while having an equal or improved level of performance as that found with 9% Ni steel. [\[Plate Unit\]](#)

### Steel Resistant to Sulfuric Acid and Hydrochloric Acid Dew-point Corrosion for TOPSIDE MODULE Use [S-TEN™1]

S-TEN1 exhibits the best resistance to sulfuric acid and hydrochloric acid dew-point corrosion found in the flue-gas treatment equipment used with coal-fired or oil-fired boilers etc. S-TEN1 offers a rich product line ranging from hot-rolled sheets (plates), cold-rolled sheets and pipe and tubes to welding materials. [\[Flat Unit\]](#) [\[Plate Unit\]](#) [\[Pipe & Tube Unit\]](#)

### Ni Base Alloy for Heat Exchanger Tubes and Piping

Alloy 625, alloy C276, NSSMC845, alloy 825 with excellent corrosion resistance to sea water and sour gas. [\[Pipe & Tube Unit\]](#)

### High Corrosion Resistant Alloy for Heat Exchanger Tube and Piping

S31254, YUS270, super austenitic stainless steel with excellent corrosion resistance to sea water. [\[Pipe & Tube Unit\]](#)

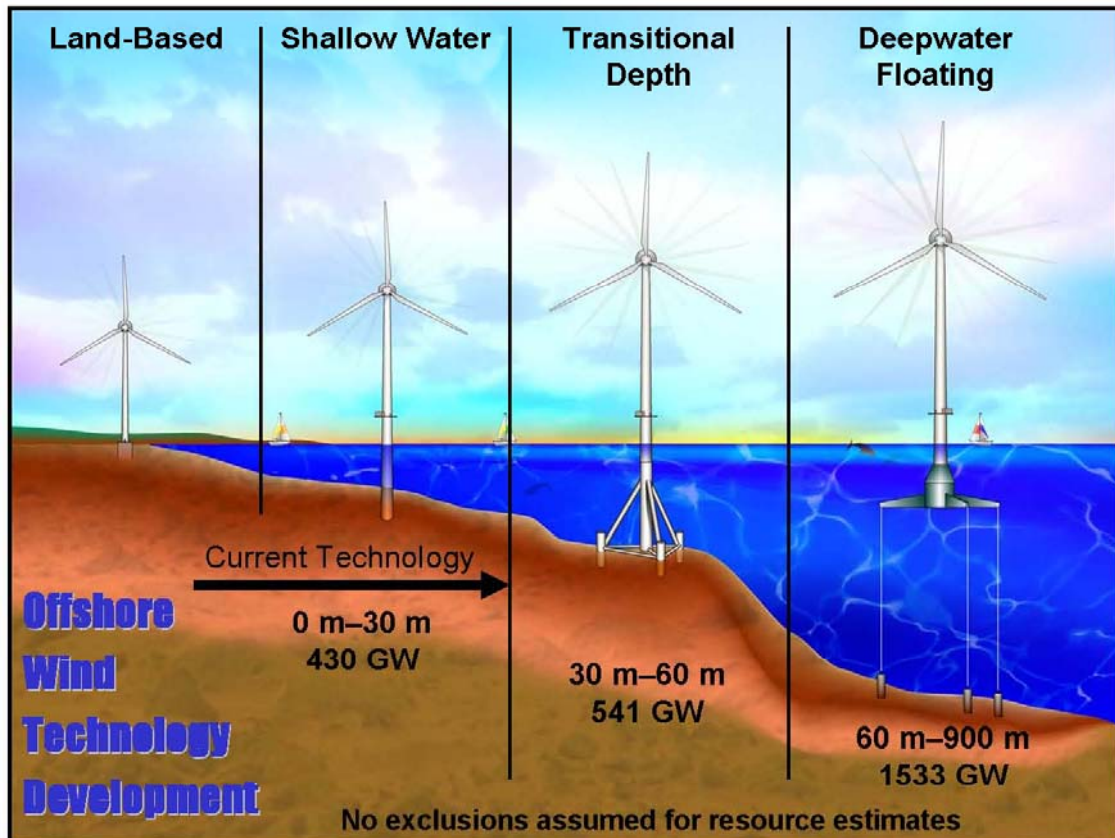
### Duplex Stainless Steel for Heat Exchanger Tube and Piping

DP3W, S32750, super duplex stainless steel with excellent corrosion resistance to sea water. [\[Pipe & Tube Unit\]](#)

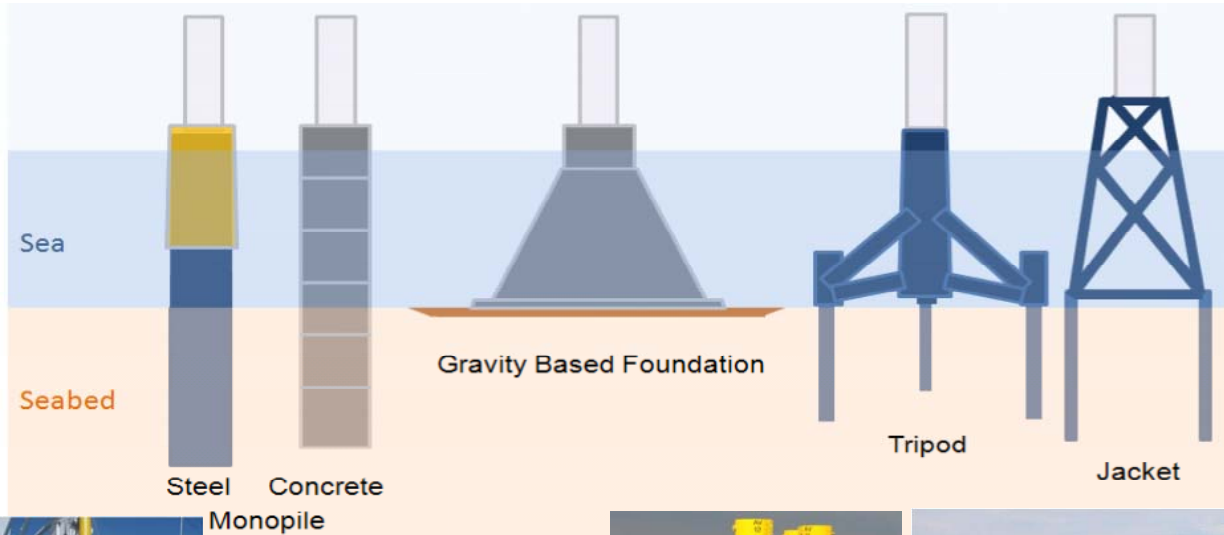
### Marily™

Excellent corrosion resistance to seawater and equal weldability to carbon steel. [\[Pipe & Tube Unit\]](#)

# Wind Power structure



# Types of foundation (Monopiles & Jackets)



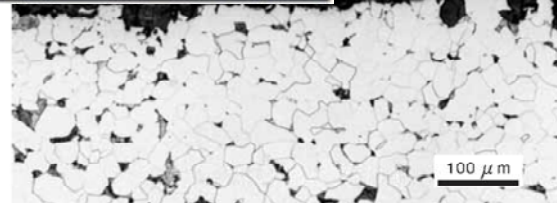
# Review Progress of Steel for Bridge



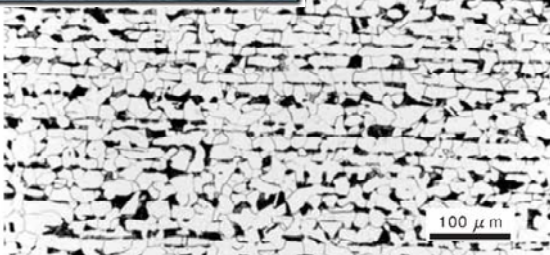
1910 Amarube, West Japan Railway Corp.



1923 Eitai Bridge Tokyo



1994 Trans-Tokyo Bay Highway



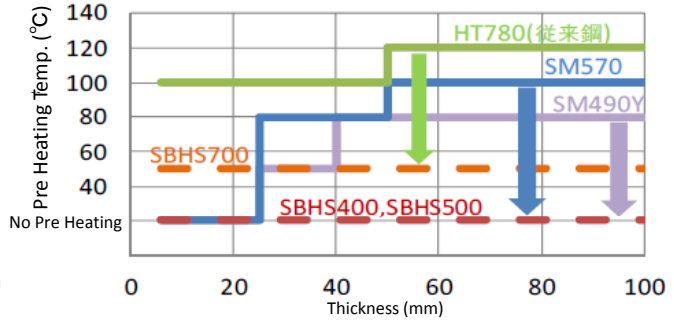
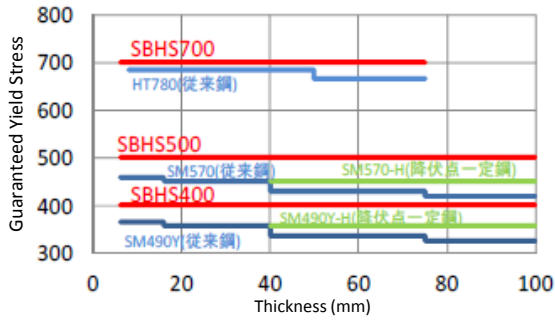
2010 Tokyo Gate Bridge  
BHS500 Applied



Fine Grain in Microstructure

# HT780Mpa Steel for Bridges

## (SBHS: Bridge High performance Structure)



To guarantee the yield strength is the same value up to maximum thickness.

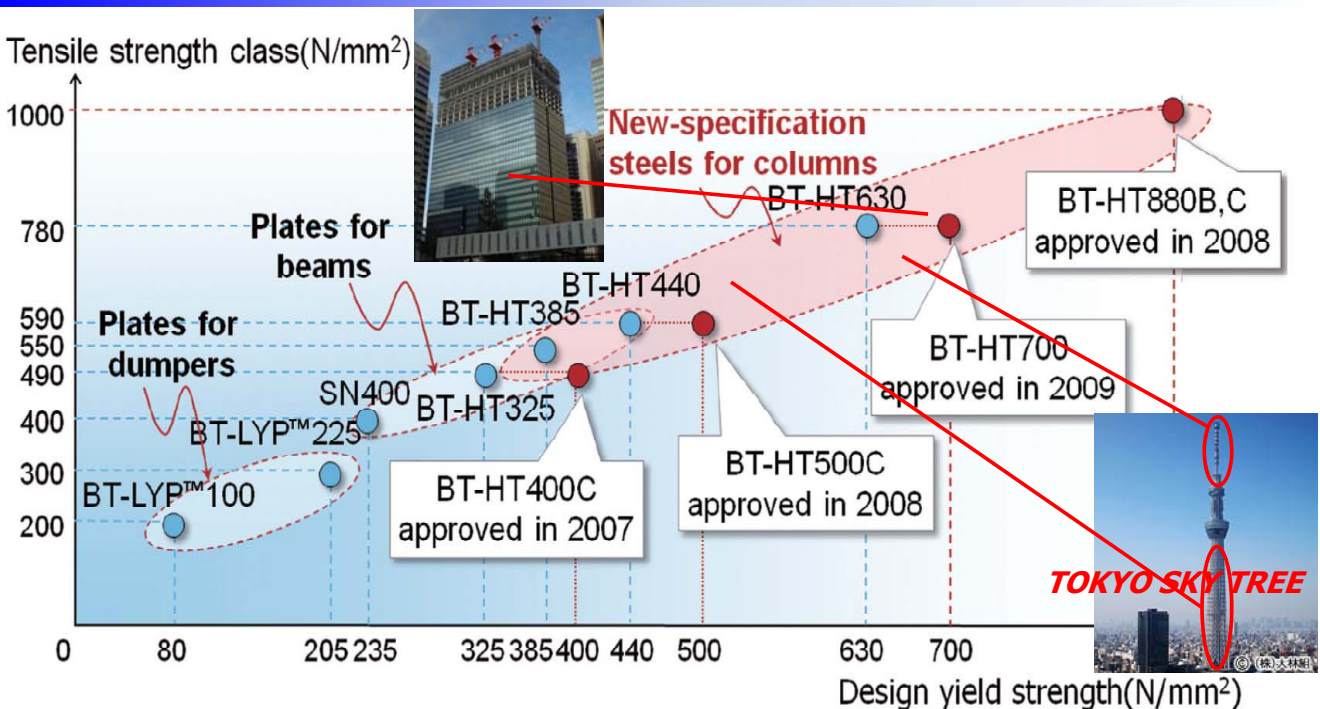
SBHS has good weldability (low Pcm)

Point: Using of BHS500 reduce the total weight of steel materials for the bridge by 3% and cut the total cost of construction by 12%.

In addition, We can supply Weathering Steel as well.



# NSSMC's steel plate used for building structure



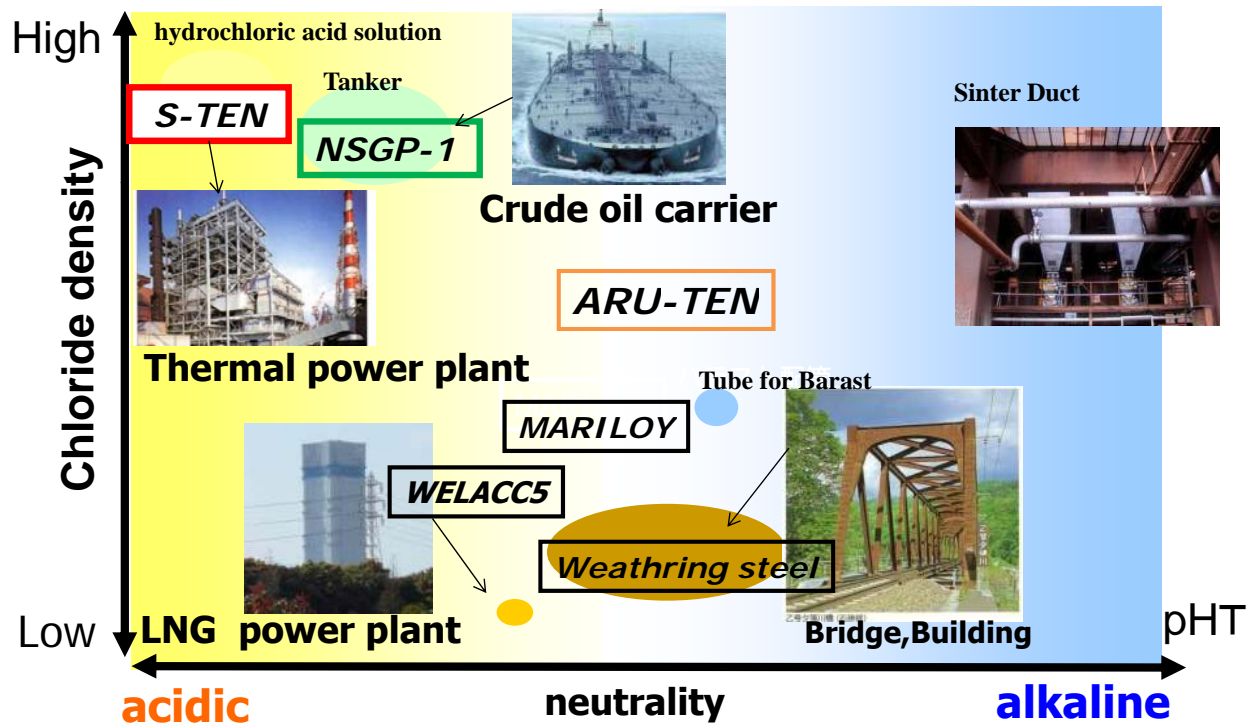
Thin & lighter structure by taking advanced high design steel.

The reduction of the pillars, provides flexible open space.

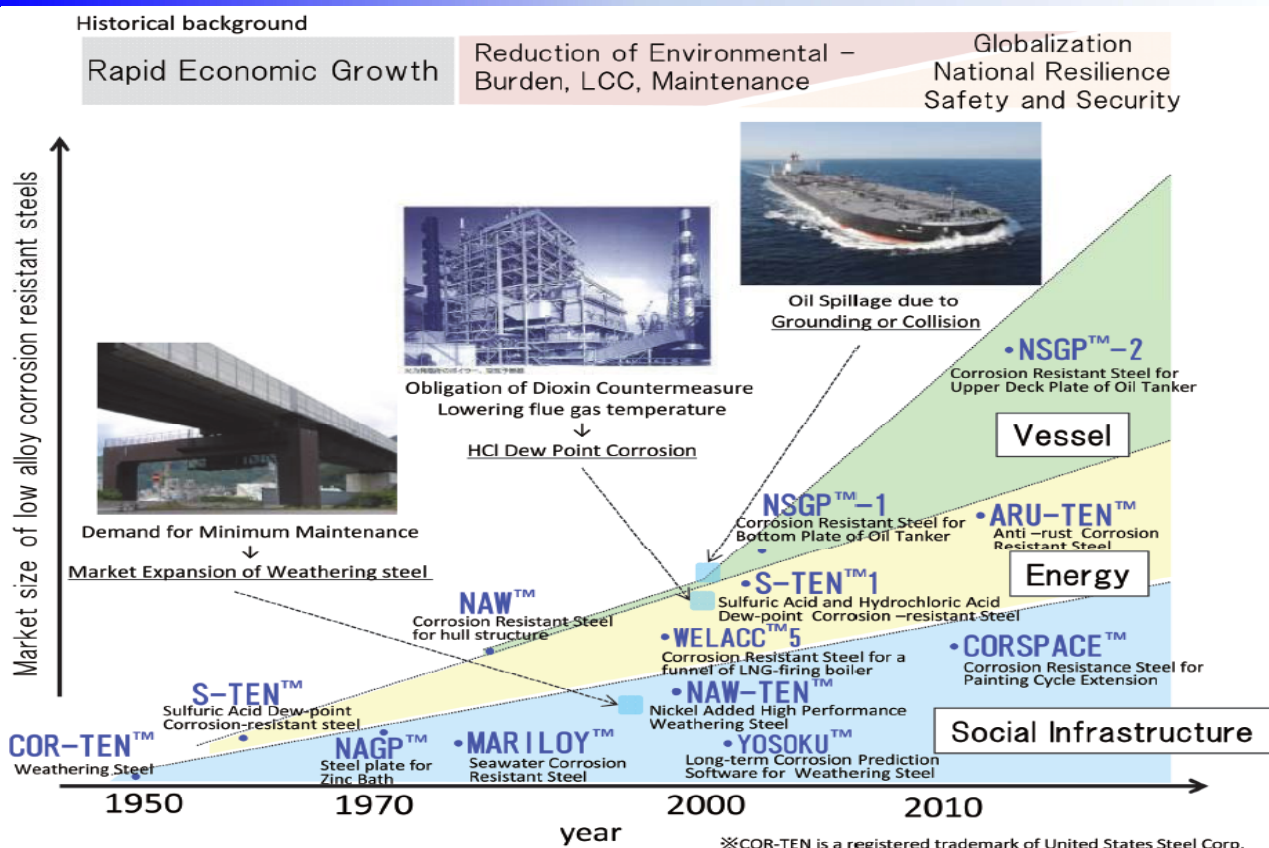
And , transportation and processing of CO2 emissions at each stage.

# Atmospheric corrosion resistant steel

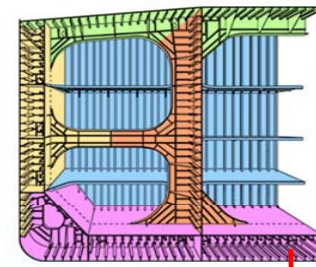
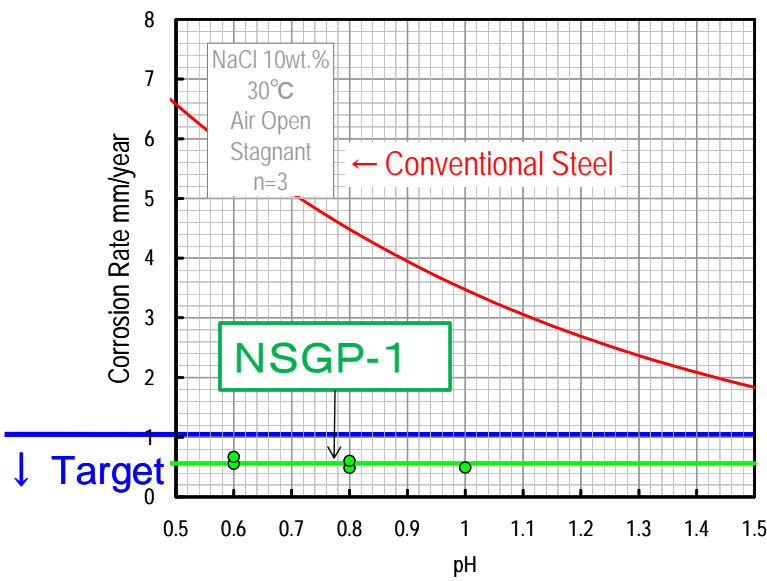
Corrosion-resistant material is present in accordance with each corrosive environment



# Development of corrosion resistant steel plates in NSSMC



# Corrosion resistant steel for pitting corrosion on cargo oil tanks of crude oil carrier (NSGP™-1)



Oil-cargo tank

100-1000Pits/Tank



**NSGP™-1 provides superior corrosion resistance**  
 (NaCl 10% of part weight at 0.8 pH) *NSGP-1(Nippon Steel's Green Protect-1)*

## corrosion-resistant steel ; S-TEN™

→It's a **sulfuric acid(S-TEN1 & S-TEN2)** and **hydrochloric acid(S-TEN1)** dew-point corrosion-resistant steel



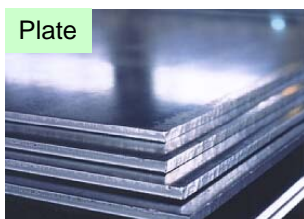
Waste treatment plant (plastics)



Thermal power plant of coal (spray seawater against dust)



Cement plant (receiving waste)



Plate



Cold rolled steel

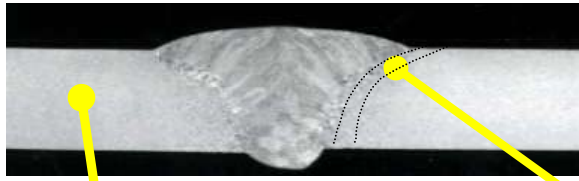


pipe

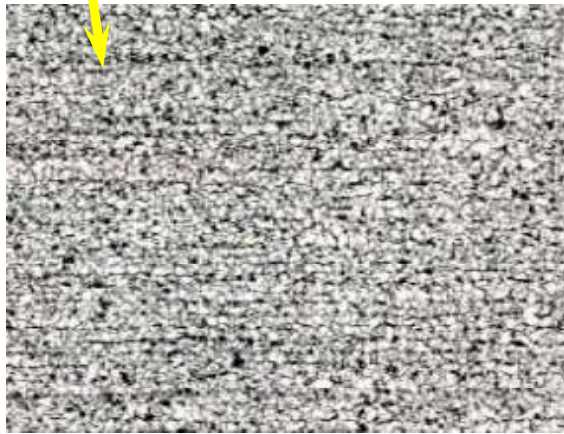


Welding consumable

# Microstructure of Welded joints



*Coarsened Grain shows deteriorated toughness*



Base materials

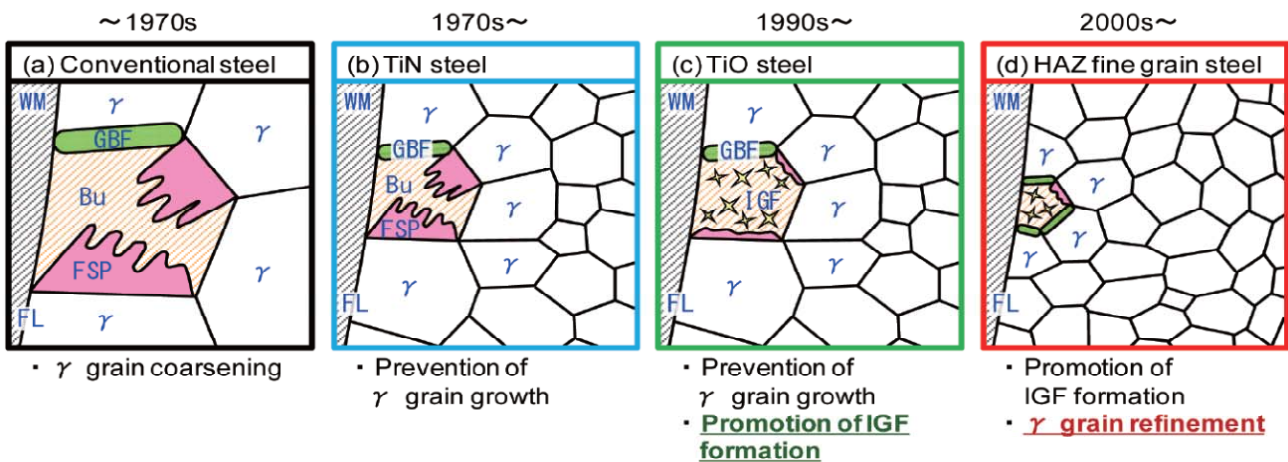


HAZ(Heat Affected Zone)

## Problem of HAZ ( Heat Affected Zone)toughness

# Progress of HAZ toughening technology HTUFF in NSSMC

**HTUFF** : super **H**igh haz **T**oughness technology with **F**ine microstructure imparted by **F**ine particles



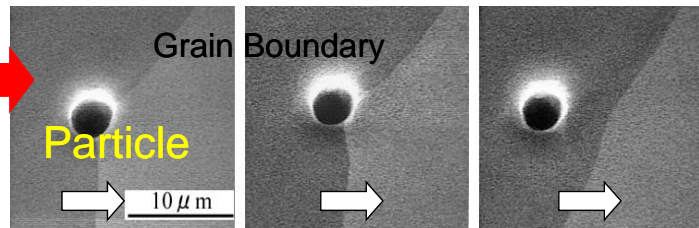
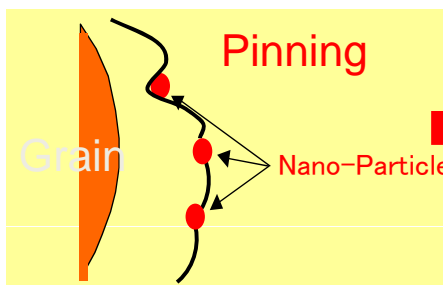
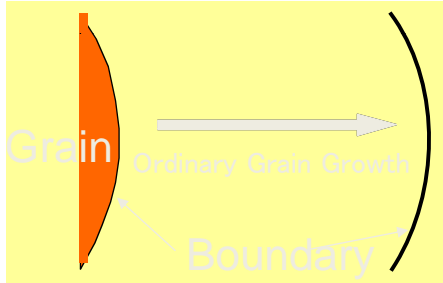
WM: Weld Metal, FL: Fusion Line,  $\gamma$ : Austenite, GBF: Grain Boundary Ferrite, FSP: Ferrite Side Plate, IGF: Intra Granular Ferrite, Bu: Upper Bainite

**Prevent grain coarsening by pinning and/or intra-granular ferrite formation**

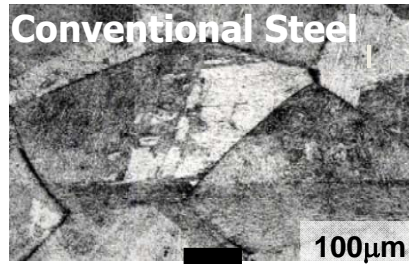


# HTUFF Technical Example

HTUFF steel show fine grain microstructure even on large heat input conditions of EG welding ( $\sim 40\text{kJ/mm}$ ).



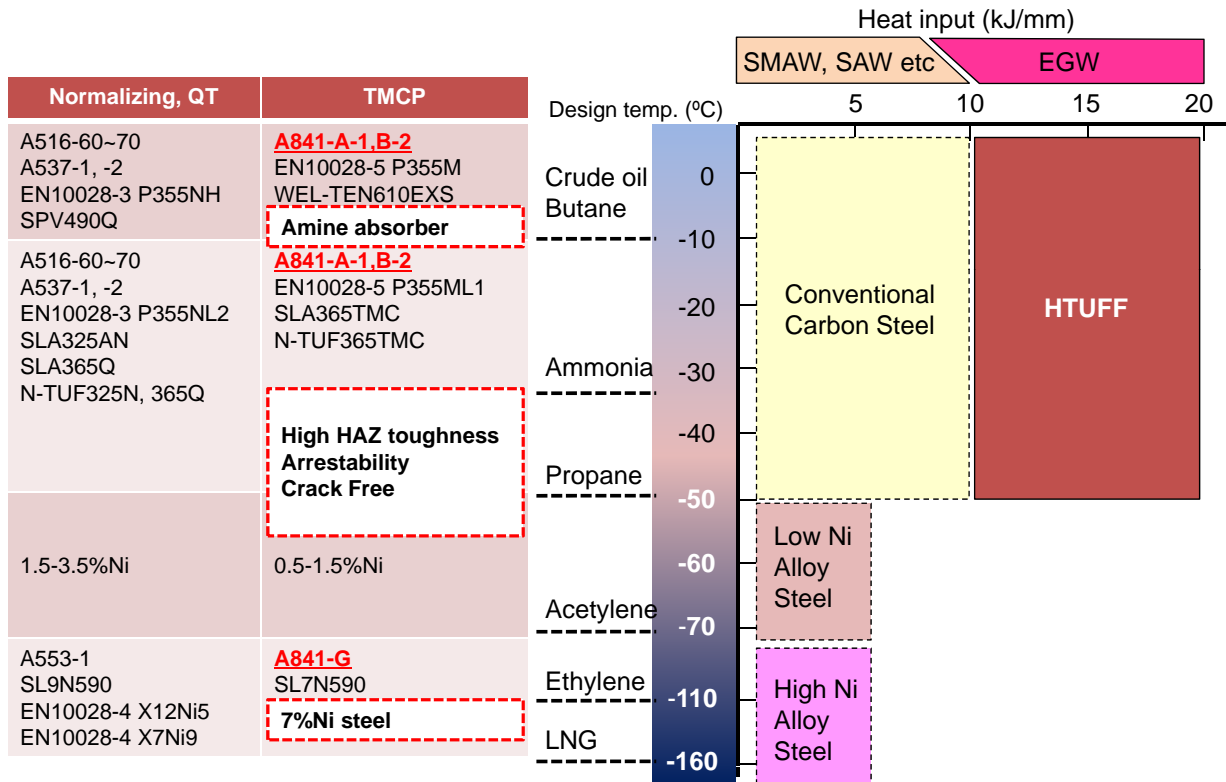
## HAZ Microstructures (EGW)



## Available plate products & Characteristics

Type of Steel	NSSMC Brand(TM)	Internatinal Standards	Japanese Standards(JIS)
General structure	-	<ASTM>A283	SS340~540
Welded structure	-	<ASTM>A36,A572,A709, <API>5LX52~X65, <UK>BS4360	SM400~520
Building structure	BT-HT325~620, BT-LYP100,225, NSFR400~520	<ASTM>A1043	SN400,490
Ships	NSGP-1,2,3	<NK,LR,AB,BV,CR,GL,NV,KR etc>, A-F Gr.,YP24~70	-
High Strength	WEL-TEN590,610 Series, WEL-TEN780 950 Series, WEL-TEN AR 235~500, WEL-HARD400 500 ABREX Series	<ASTM>A537,A514,A517, <API>5LX70,X80	SM570,SHY685
Abrasion Resistance	-	-	-
Low-temperature	N-TUF 295~570, N-TUF CR130,196	<ASTM>A537,A203,A553, <NK,LR,AB,NV,GL etc.>	SLA235~360,SL2N255, SL3N255~440,SL9N590
Medium-temperature	-	<ASTM>A285,A516,A537, <U.K.>BS1501, <EN>10028	SPV235~490, SGV410~480
Medium-to-High temperature	-	<ASTM>A299,A302,A387,A542,A543, <U.K.>BS1501, <EN>10028, <NK,LR,AB,NV,GL etc.>	SB410~480M, SBV1~3, SQV1,2, SCMV1~4
Aomospheric corrosion to resistance	COR-TEN 0,490,570, NAW400,490, 3%Ni-added	<ASTM>A588,A709	SMA400~570
Sulphic acid resistance	S-TEN Series	-	-
Machine structural	-	<AISI>1008,1015,1020,1021	S10C~S55C,SCM440

# Products Line-up of TMCP Steel Plates



## Available plate products & Characteristics

### 1. Large application range for various environment

- ① Tensile strength: **200~1200Mpa**
- ② Using temperature: **-196°C~500°C**
- ③ Thickness: **<100μm up to 300mm**
- ④ Width: **up to 5,300mm**
- ⑤ Unit weight: **up to 30t**

### 2. Advanced manufacturing facilities and process

- ① **High precision control** for chemical composition
- ② Developed continuous casting machine for **clean & defect free.**
- ③ **Microstructure control** with TMCP.
- ④ **Oxide metallurgy** for improving HAZ toughness.

### 3. High ability of Solution offering for customers

**Courteous cooperation with customers, and technical support for application the materials**