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Mitsubishi Steel Information on special steel materials



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♦ Greetings

<Leveraging our people and technologies to continue to succeed in a time of change>

The Mitsubishi Steel Manufacturing Group has evolved over the years as an integrated materials/product manufacturer with core competencies in the production and processing of special steels.

Our history began in 1904, when Tokyo Spring Works, our predecessor, launched the production of small springs for spinning machines. Spring materials in those days were largely imported from Europe and the United States, with token volumes produced domestically. The materials became difficult to procure from the start of the First World War, so, to continue producing springs, Tokyo Spring Works began producing special steel on its own.

Our company thus acted as a true "startup," long before the term was introduced, to produce the materials needed to make springs. Ever since, it's been part our corporate DNA to manufacture everything we need in-house, ranging from materials to finished goods, and to meet the associated challenges as they arise.

◆ Mitsubishi Steel / Mitsubishi Steel Muroran Features of steel materials

Mitsubishi Steel is a pioneer in the world to produce structural steels for automobile through LF (Ladle refining furnace) Degassing-Bloom continuous casting process and left mark on quality improvement. Now, Mitsubishi Muroran is trying higher quality and productivity improvement in addition to savi ng energy to produce earth environmental friendly special steels through compounding pig iron with scrap.





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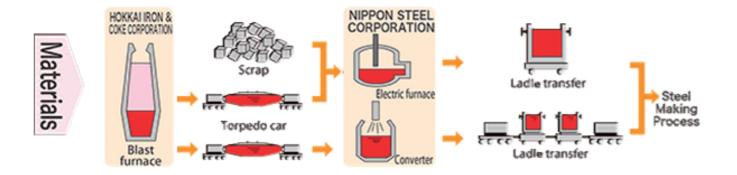
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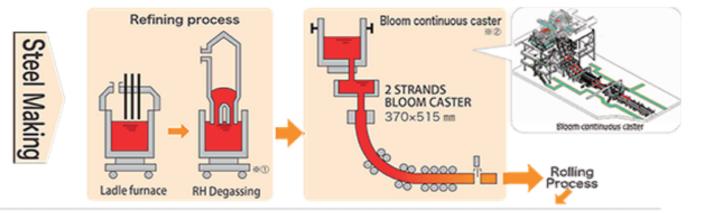
♦ Manufacturing Process : Mitsubishi Steel Muroran Inc.

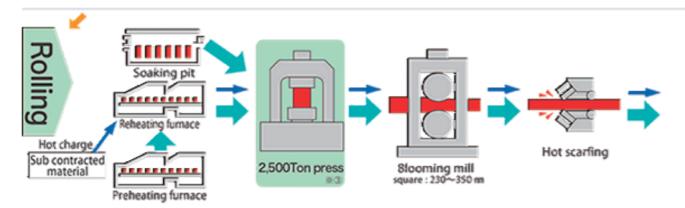
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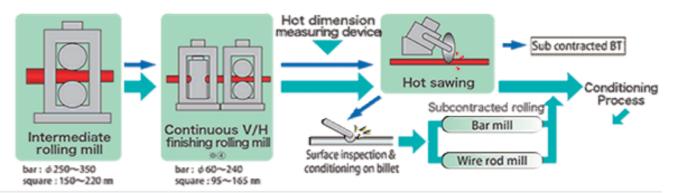
furnace) Degassing-Bloom continuous casting process and left mark on quality improvement. produce earth environmental friendly special steels through compounding pig iron with scrap.

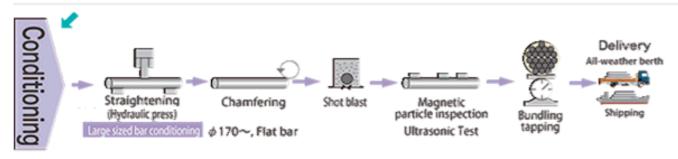
From Raw Material to Special Steel Products

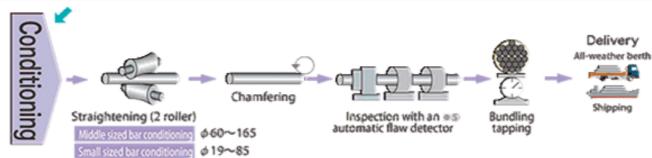












Ladle Refining Process

the combination of LF/RH degassing controls the chemical composition and molten steel temperature.



Bloom Continuous Caster

The continuous casting equipment is designed to produce large-section bloom castings with excellent internal quality and surface finish.



2,500ton in-line Press

Installed in-line with the blooming mill process, the 2500-ton press forges continuous casting blooms to enhance internal quality, particularly effective for large round bars.



Full Continuous V-H Rolling Machine

The fully automatic V-H tension-free rolling system with high rigidity rolls steel bars with high dimensional accuracy.



Automatic Inspection line

To ensure a stable supply of high-quality products, we have various high-speed, high-precision automatic non-destructive inspection equipment.



Delivery

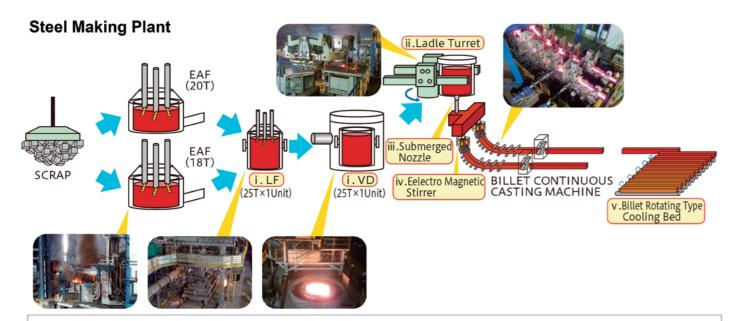
We respond promptly to customer needs with our network and agility.



♦ Manufacturing Process: JATIM TAMAN STEEL

PT. JATIM TAMAN STEEL MFG. is an overseas base for the steel business of the Mitsubishi Steel Group, with full As the only integrated special steel manufacturer in Indonesia, we supply special steel round bars and flat steel,

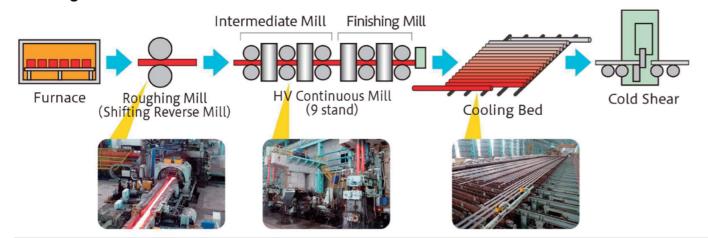
backup from Mitsubishi Steel to ensure superior quality. meeting the needs of our customers for local procurement.



(Features)

- 1. Rapid ladle exchange by ladle turret method
- 2. Non-oxidation casting using air gap nozzle between ladle, tundish, and mold
- 3. Reduction of center segregation and inclusions by electromagnetic stirring in the mold
- 4. Reduction of billet bending by adopting billet rotating cooling bed

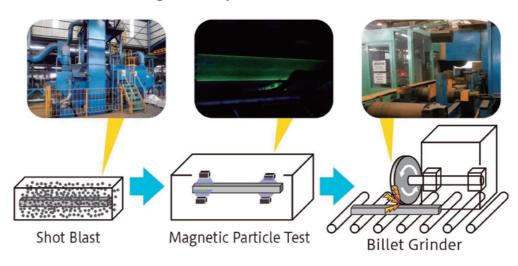
Rolling Mill



(Features)

- 1. Reduction of decarbonization and prevention of uneven heating by WB type heating furnace
- 2. Reduction of temperature difference in top tail (uniform quality throughout the length) and reduction of conveyance defects by shifting reverse rolling machine
- 3. Shortening of size change time by stand exchange device
- 4. Automation of operation control by introduction of process management system

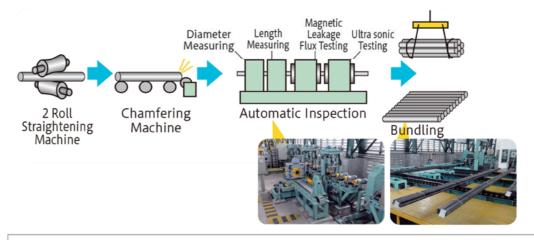
Billet Conditioning and Inspection Plant



(Features)

- 1. Prevention of defect outflow to the rolling process by implementing full inspection and maintenance of billets
- 2. Complete removal of surface defects by billet grinder

Round Bar Conditioning and Inspection Plant



(Features)

- 1. Full inspection conducted by automatic flaw detection equipment
- 2. Prevention of surface defect leakage by introducing Foerster's magnetic leakage flaw detector
- 3. Prevention of internal defect leakage by introducing Ryosho Electric's phased array ultrasonic flaw detector

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◆ Main Manufactured Steel Types : Mitsubishi Steel Muroran Inc.

Category	Applicable Standards	Steel Grade
Carbon Steel for Machine Structural Use	JIS	S10C~S58C、S09CK~S20CK
Structural Steel with Guaranteed Hardenability (H-Steel)	JIS	SMn420H~SMn443H SMn C 420H~SMnC443H SCr415H~SCr440H SCM415H~SCM822H SNC415H~SNC815H SNCM220H~SNCM420H
Alloy Steel for Machine Structural Use	JIS	SMn420~SMn443 SMnC420~SMnC443 SCr415~SCr445 SCM415~SCM822 SNC236~SNC836 SNCM220~SNCM815
Rolled Steel for General Structural Use	JIS	SS330~SS540
Alloy steel bolting materials for high temperature service	JIS	SNB7~SNB16
Microalloyed Steels	MITSUBISHI	S43C-V、SMT75、VM40、VMC15~VMC35
Boron Steel	MITSUBISHI	SMnB440、SMnB445
Spring Steel	JIS MITSUBISHI	SUP6~SUP13、HDS12、ZDS13
High Carbon Chromium Bearing Steel	JIS	SUJ2、SUJ3
International standards	AISI SAE ASTM	AlSI1020~AlSI9260、SAE1046~SAE9315、ASTMA105~350
Others	MITSUBISHI	DTM-100、MAC14、MAC24、MNP2

	D	φ60~φ350		
Manufacturing	Bar	φ19~φ59 (Contract manufacturing)		
Dimensions	0	□95~□350		
	Square	□80~□90 (Contract manufacturing)		

◆ Main Manufactured Steel Types : JATIM TAMAN STEEL

Main Manufactured Steel Types	Special Steel Products (Structural Carbon Steels & Alloy Steels, Spring Steels, Others)
Billet Size	Square 160
Manufacturing dimensions	Round Bar φ19 ~ φ90mm
Manufacturing dimensions	Flat Bar Width 50 ~ 130mm *Thickness 5 ~ 45mm

♦Examples of Applications



Automotive Products







Crankshaft Connecting Rods, Camshafts



Truck Leaf Springs



Springs for Automotive Suspension



Stabilizer



Construction Machinery Products

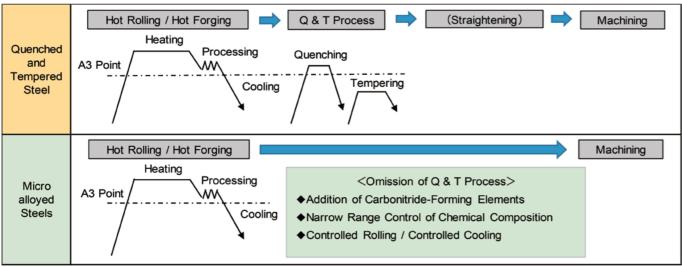


♦ Introduction of distinctive steel Types

1 Microalloyed Steels

Generally, machine structural steel undergoes heat treatment processes such as quenching and tempering to achieve the necessary properties (strength and toughness) required for parts. In contrast, non-quenched and tempered steel achieves the desired properties without undergoing quenching and tempering processes, instead retaining characteristics from hot rolling or hot forging. This steel is gaining attention as an environmentally friendly material due to its energy-saving benefits and process simplification.

(Overview of the process)



(Concept)

- A small amount of elements that form carbonitrides, such as vanadium, is added to the steel.
- By finely dispersing these carbonitrides during the cooling process, precipitation strengthening is achieved.
- Furthermore, to ensure stable properties, the chemical composition (carbon equivalent) is controlled within a narrow range.

(Benefits)

- Contributes to CO₂ reduction through energy savings, making it environmentally friendly and aiding in achieving carbon neutrality.
- Reduces the cost of heat treatment (even with an increase in material costs, the total cost is reduced).
- There is no distortion caused by heat treatment, allowing for the omission of straightening and subsequent stress-relief annealing.
- Simplified processes lead to shorter lead times and reduced intermediate inventory.

(Types

Based on application, it is categorized into types for hot forging and direct cutting.



2 Microalloyed Steels for Hot Forging (SC ·SMn series, VMC15, VMC25, VMC35)

This type of steel achieves the necessary properties (strength and toughness) for parts in its hot-forged state and is categorized into ferrite + pearlite type and bainite type based on the microstructure.

(Features)

- We offer steel grades that correspond to various strength levels.
- To enhance machinability, free-cutting elements such as sulfur (S) are added and adjusted.
 (Examples of Application)
- Ferrite + Pearlite Type: Connecting rods, crankshafts, yokes, flanges, shafts
- Bainite Type: Truck suspension parts (front axles, knuckles, arms), rod heads
 - <Chemical Composition>

◆Ferrite + Pearlite Type

mass%

Strength	Steel grade	С	Mn	Cr	V
≧740MPa	S40CV	0.40	0.70		
Grade	S43CV	0.43	0.70	0.40	0.00
≧780MPa	S45CV	0.45	1.20	0.10	0.08
Grade	S48CV	0.48	1.20	0.30	0.14
≧830MPa	SMNV45	0.45	1.10	0.30	0.14
Grade	SIVIIV45	0.45	~1.40		

◆Bainite Type

mass%

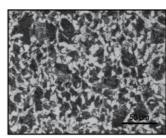
Strength	Steel grade	С	Mn	Cr	V
≧740MPa Grade	VMC15	0.15	1.70	0.30	0.10
≧880MPa	VMC25	0.25	2.00	0.50	0.30
Grade	VMC35	0.35	2.00	0.50	0.30

(Ferrite + Pearlite Structure)

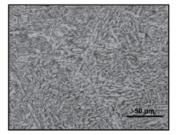
- Ferrite (white areas): Can dissolve up to only 0.02% carbon, making it soft and excellent in workability.
- Pearlite (dark areas): A layered structure where ferrite and cementite (iron carbide) alternate.

(Bainite Structure)

 A microstructure with fine plate-like structures, possessing higher toughness compared to the ferrite + pearlite structure.



Ferrite + Pearlite Structure



Bainite Structure

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3 Microalloyed Steels for Direct Machining (SMT75, SMT90)

This type of steel achieves the necessary properties (strength and toughness) for parts in its hot-rolled state.

(Features)

- We offer strength levels of 740 MPa grade and 880 MPa grade.
- To enhance machinability, free-cutting elements such as sulfur (S) are added and adjusted.
- Applicable to parts that undergo induction hardening.

(Examples of Application) Piston rods, pins, shafts

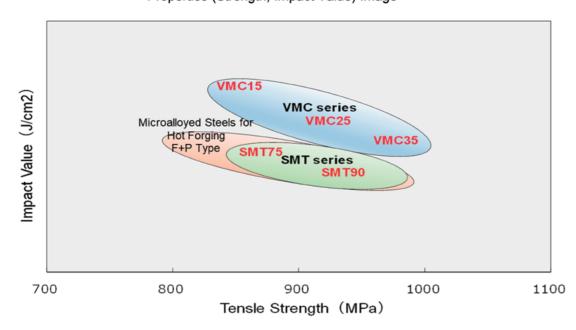
<Chemical Composition>

◆Ferrite + Pearlite Type

mass%

Strength	Steel grade	С	Mn	Cr	V
≧740MPa Grade	SMT75	0.32	1.00	0.15	0.08
≧880MPa Grade	SMT90	0.46	1.80	0.50	0.20

Properties (Strength, Impact Value) Image



Pre-Hardened Steels for Direct Machining (SCM440M-QT, DTM100)

This type of steel undergoes quenching and tempering heat treatment in advance to ensure the necessary properties (strength and toughness) for parts.

(Features)

- Since it can be directly machined, the process and delivery time are shortened.
- Due to the "non-deforming heat treatment" in a barrel furnace, no straightening is required after heat treatment, resulting in minimal bending (distortion) during machining. Additionally, even after induction hardening, distortion is minimal.
- To enhance machinability, free-cutting elements such as sulfur (S) are added and adjusted.

(Examples of Application) Tie bars and screws for injection molding machines, shafts

<Chemical Composition>

mass%

Steel grade	С	Si	Mn	Cr	Мо
SCM440M-QT	0.37~	0.15~	0.55~	0.85~	0.15~
	0.39	0.35	0.90	1.25	0.35
DTM100	0.40~	0.15~	0.80~	0.85~	0.15~
	0.44	0.35	1.20	1.25	0.35

(SCM440M-QT)

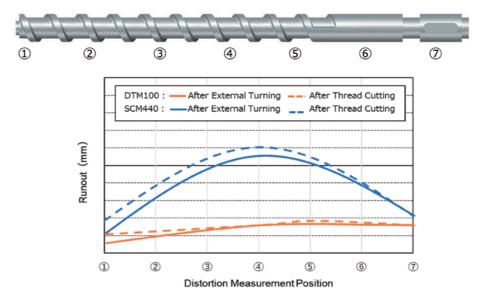
 It shares the same component system as SCM435H and SCM440H, and can be used as either heat-treated material.

(DTM100)

- The material is adjusted to a strength level of approximately 100 kgf/mm² (980 MPa).
- It is designed so that the hardness difference between the surface and the inner parts is minimal. It is designed with a composition to minimize the difference in hardness between the surface and the interior.

<Comparison of Distortion Occurrence> φ40×1290mmL

DTM100: Material (pre-hardened) → Cutting → External Turning → Thread Cutting SCM440: Material → Cutting → Quenching and Tempering → Straightening → Stress Relieving → External Turning → Thread Cutting



5 Steel for High-Temperature Carburizing (SCM420H)

Carburizing treatment is widely used as a surface hardening method for parts such as gears that require high fatigue strength. The higher the treatment temperature, the more rapidly carbon diffuses, which can significantly shorten the treatment time. It is also applicable to large parts that require deep carburized depths.

(Features)

- The pinning effect of precipitate particles suppresses grain growth at high temperatures.
- By significantly shortening the treatment time, CO₂ emissions generated during the heat treatment process can be reduced.
- It allows for the reduction of manufacturing lead time and energy consumption.

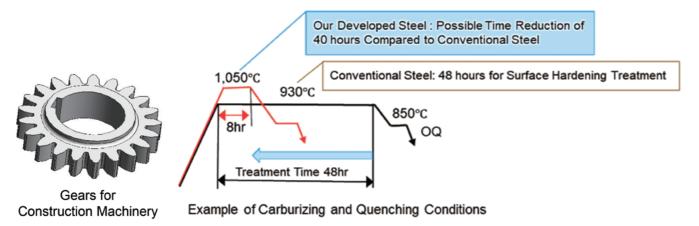
(Examples of Application) Large gears and other components requiring deep carburized depths.

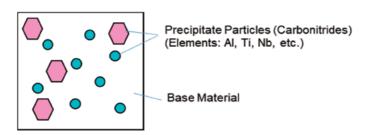
<Chemical Composition>

mass%

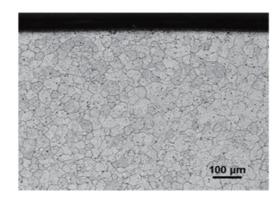
Steel grade	С	Si	Mn	Cr	Мо	Other elements
SCM420H	0.17	0.15	0.55	0.85	0.15	
Steel for High-	~	~	~	~	~	Trace Addition
Temperature Carburizing	0.23	0.35	0.95	1.25	0.30	

XThe precipitate particles from trace addition elements suppress grain growth, making it possible to extend this application to other steel grades.





Pinning Effect: Finely disperse precipitate particles in the base material to suppress grain growth



Grain Size After High-Temperature Carburizing: No Grain Growth

6 Steels for Nitriding (SCR430VS1, MAC24, NT100, NT200)

Nitriding treatment results in high hardness, excellent fatigue strength, wear resistance, and corrosion resistance. Additionally, since the treatment temperature is below the A1 transformation point, it features minimal heat treatment distortion and dimensional changes. We offer steels that can be selected according to the required strength level, capable of handling components from light to heavy loads.

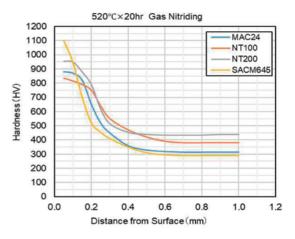
(Features)

- Low aluminum type to avoid alumina-based non-metallic inclusions.
- Excellent nitridability, allowing for shortened nitriding treatment time as a rapid nitriding steel.

(Examples of Application) Gears and shafts for construction machinery, wear-resistant parts

<Types of Nitriding steels>

Steel grade	Chemical Composition
SCR430VS1	Cr-V Based
MAC24	Cr-Mo Based
NT100 NT200	Cr-Mo-V Based (Precipitation Hardening Type)



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<Introduction to Nitriding Steels>

(SCR430VS1)

- Nitriding properties are ensured by the addition of Cr and V.
- To enhance machinability, free-cutting elements such as sulfur (S) are added and adjusted.
- Can be used as a substitute for SCM435H and SCM440H.

(MAC24)

- Nitriding properties are ensured by the increased addition of Cr and Mo.
- Exhibits high tempering resistance and excellent high-temperature strength.
- The nitrided layer is tough and suitable for parts requiring high surface pressure.
- Can be used as a substitute for JIS nitriding steel SACM645.

(NT100, NT200)

- Cr-Mo-V based, precipitation-hardening nitriding steel that hardens in the nitriding treatment temperature range.
- Exhibits high tempering resistance and excellent high-temperature strength.
- The nitrided layer is tough and suitable for parts requiring high surface pressure.
- Has a small mass effect and is applicable to large parts.

7 Lead-Free Free-Cutting Steel (SC Series Lead-Free Free-Cutting Steel MNP2)

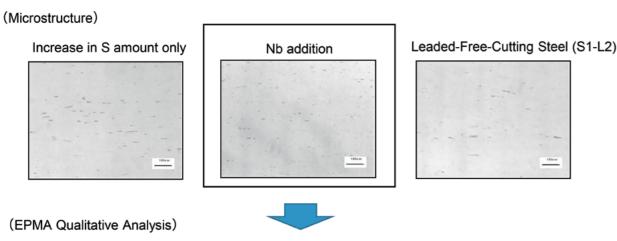
From the perspective of global environmental conservation, environmentally friendly materials are in demand. MNP2 is a lead-free free-cutting steel that ensures machinability by finely dispersing sulfur (S), a free-cutting element.

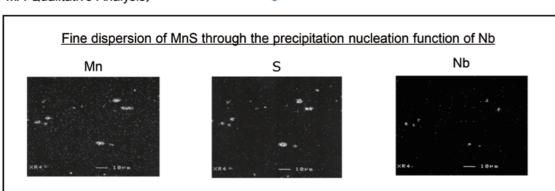
(Features)

- By increasing the amount of sulfur (S) and adding a trace amount of niobium (Nb), fine dispersion of manganese sulfide (MnS) inclusions is achieved.
- It possesses chip-breaking properties and excellent tool life comparable to traditional sulfur-added Lead-Free-Cutting Steels (S1: 0.04–0.07% S + L2: 0.1–0.3% Pb), along with equivalent mechanical properties and superior bending fatigue characteristics.
- Applicable to various base steels other than the SC series.

(Examples of Application) Gears and shafts for construction machinery, wear-resistant parts, and parts where traditional lead-free-cutting steel was applied.

<Inclusion Distribution> Achieved MnS refinement through Nb addition.





<Mechanical Properties> Equivalent to Leaded-Free-Cutting Steel (S1-L2)

Steel grade	YP Mpa	TS Mpa	EL %	RA %	Cp J/cm ²	Hardness HRC
Lead-Free Free-Cutting Steel (MNP2)	660	805	20	54	80	20
Leaded-Free-Cutting Steel (S45C S1L2)	658	803	21	56	83	20

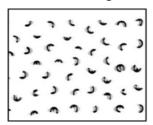
**Heat Treatment Conditions: Quenching and Tempering

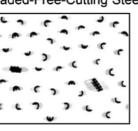
**Tensile Test Specimen Shape: JIS No. 4 Sub-size (d = 10 mm φ, GL = 35 mm)

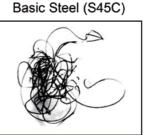
*Impact Test Specimen Shape: 2 mm U-Notch

<Chip Breaking Properties> Equivalent to Leaded-Free-Cutting Steel (S1-L2)

Lead-Free Free-Cutting Steel (MNP2) Leaded-Free-Cutting Steel (S1-L2)



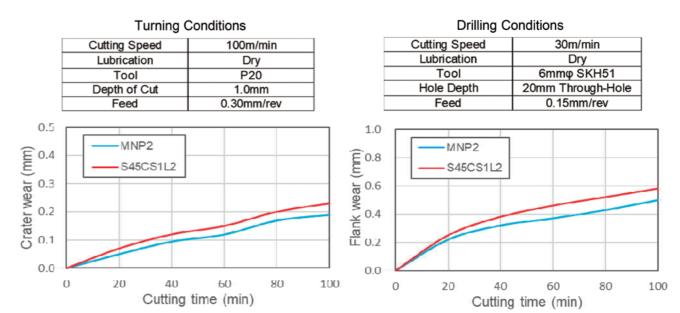




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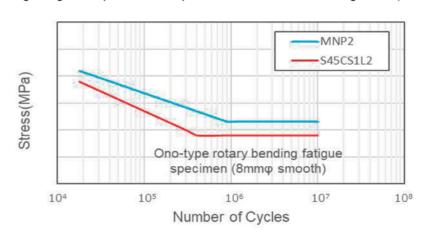
**Heat Treatment Conditions: Quenching and Tempering

<Tool Wear Amount> Superior to Leaded-Free-Cutting Steel (S1-L2)



*Heat Treatment Conditions: Quenching and Tempering

<Bending Fatigue Properties> Superior to Leaded-Free-Cutting Steel (S1-L2)



※Heat Treatment Conditions: Quenching and Tempering

8 High Cleanliness Bearing Steel

High carbon chromium bearing steel (SUJ2), used for rolling bearings, requires excellent fatigue life. Our company manufactures high cleanliness steel by optimizing and strictly controlling the manufacturing process.

(Features)

- By optimizing the manufacturing process (ladle refiningRH vacuum degassingcontinuous casting), we produce high
- We reduce the oxygen content in the steel and decrease both the amount and size of non-metallic inclusions.
- By controlling the quantity and size of non-metallic inclusions, which affect fatigue life, we achieve excellent fatigue

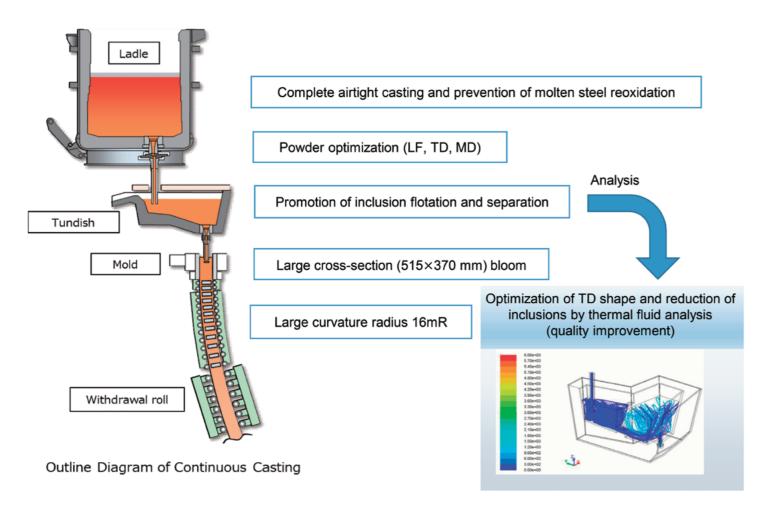
(Applications) Bearing components, bearing raceways, relatively large bearings with a diameter of φ60 or more

<Chemical Composition>

mass%

Steel grade	С	Si	Mn	Р	S	Cr
SUJ2	0.95∼ 1.10	0.15∼ 0.35	max 0.50	max 0.025	max 0.025	1.30~ 1.60

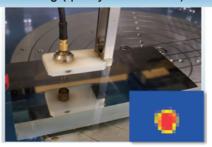
<Example of process optimization in continuous casting>



< Quality Evaluation > Feedback of evaluation results from various devices, continuous quality improvement (High-frequency ultrasonic flaw detection equipment) Detection of inclusions in large cross-sections



Detection of inclusions by ultrasonic testing (quality assessment)



(Automatic inclusion analysis equipment) Detection, measurement, and composition analysis of inclusions

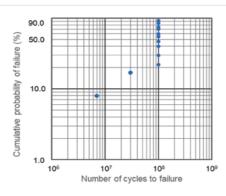


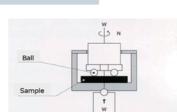
Analysis of inclusion composition (identification of process improvements)



(Rolling fatigue testing machine) Fatigue life measurement







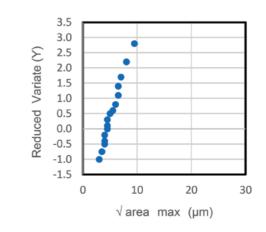
Outline of rolling fatigue test

Tost conditions

rest conditions				
Number of steel balls	6 balls			
Contact surface pressure (Pmax)	500kgf/mm ²			
Rotational speed	1,000rpm			
Test specimen	Quenched and tempered			
Number of tests	16			

(Microscopic observation) Prediction of the maximum size of inclusions using the extreme value statistical method





Test conditions

Inspected surface	Rolling direction		
Inspection standard area	S ₀ =100mm ²		
Number of inspections	n=16		
Inspections			

9Spring Steel

Our company is the only integrated spring manufacturer in Japan, from raw materials to finished products. Since successfully manufacturing the first industrial springs in Japan in 1904, we have accumulated nearly a century of rich experience. To produce high-performance products, we promote technology development and thorough quality control tailored to various applications, earning high trust across diverse fields.

(Features)

- We offer a wide range of products, including coil springs, leaf springs, and stabilizer materials, with a rich assortment of standard and developmental steels.
- By combining material development of raw materials with manufacturing process development of spring products, we can accommodate high-stress applications.

(Applications) Developed Steel for Automobile Suspension Coil Springs, Springs for automobile suspension,

Leaf springs for trucks. Coil springs for construction machinery. Stabilizers for automobiles

<Chemical Composition>

mass%

Steel grade	С	Si	Mn	Cr	V	В	
SUP9	0.52~ 0.60	0.15∼ 0.35	0.65∼ 0.95	0.65~ 0.95	-	-	
SUP9A	0.56∼ 0.64	0.15~ 0.35	0.70~ 1.00	0.70~ 1.00	-	-	
SUP10	0.47~ 0.55	0.15∼ 0.35	0.55∼ 0.90	0.80~ 1.10	0.15∼ 0.25	-	
SUP11A	0.56∼ 0.64	0.15∼ 0.35	0.55∼ 0.90	0.70~ 1.00	0.15∼ 0.35	min 0.0005	
SUP12	0.51~ 0.59	1.20~ 1.60	0.55~ 0.90	0.60~ 0.90	-	-	
HDS12	Developed Steel for Automobile Suspension Coil Springs						
ZDS13						9	



Springs for automobile suspension



Coil springs for construction machinery



Leaf springs for trucks



Stabilizers for automobiles

♦ Conclusion

<Toward a Sustainable Future>

The Mitsubishi Steel Group recognizes the importance of establishing a corporate structure that can respond to any changes in the business environment. By fulfilling our social responsibilities, we aim to become a more trusted company and contribute to the realization of a sustainable society through dialogue with stakeholders such as customers, business partners, shareholders, employees, and local communities.

In particular, we will focus on two initiatives: "reducing our own CO2 emissions" and "reducing CO2 emissions from our customers' factories and society as a whole." We look forward to your continued guidance and support.



