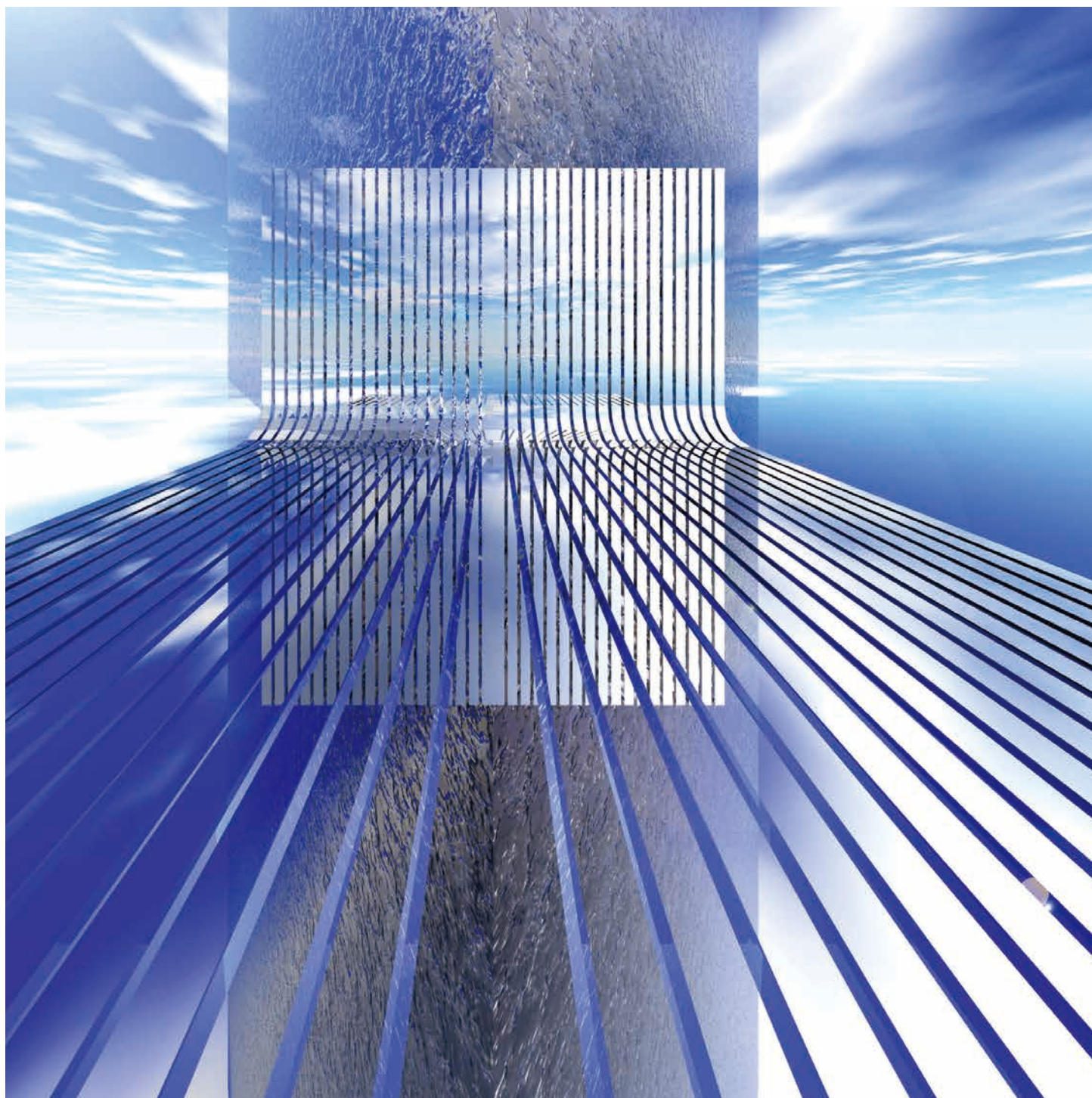




SPECIAL STEEL SHEET



JFE Steel Corporation



East Japan Works (Chiba)

JFE Steel Corporation produces various types of special steel sheets under an integrated quality control system using modern facilities mainly in Chiba and Keihin Area of East Japan Works. JFE’s special steel products support technical innovation and improved productivity at customers, and have won an excellent reputation for high dimensional accuracy, quenchability, and workability.

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“SUPERHOT” is a trademark of JFE Steel Corporation registered in Japan.

Characteristics

1. Uniform quality

Integrated operation control and highly computerized production processes ensure a high level of uniformity in product quality.

2. High dimensional accuracy and excellent surface quality

JFE's production plants boast some of the world's most advanced steelmaking, hot rolling, and cold rolling equipment, ensuring high dimensional accuracy and outstanding surface quality.

3. Wide product line

A wide range of steel grades and product dimensions are available to meet diverse customer requirements.

4. Strict quality control and inspection system

All products can be used with confidence thanks to scientific quality control and strict testing and inspection.

(JFE's steel sheet production system is certified under ISO 9001.)



East Japan Works (Keihin)

Application

Carbon steels for machine structure

Automotive clutch parts
Chain parts
Automotive seat belt parts
Springs and washers
Sprocket gears
Automotive AT parts

Chains



Alloy steels for machine structure

Automotive reclining seat gear parts
Door lock parts
Shock absorber

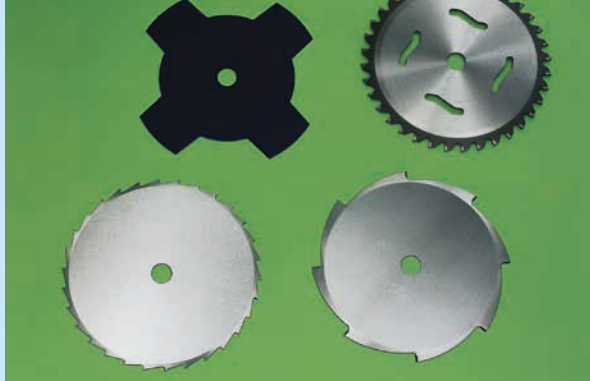
Gears



Alloy tool steels

Knives
Hand saws
Tools

Circular saw blades



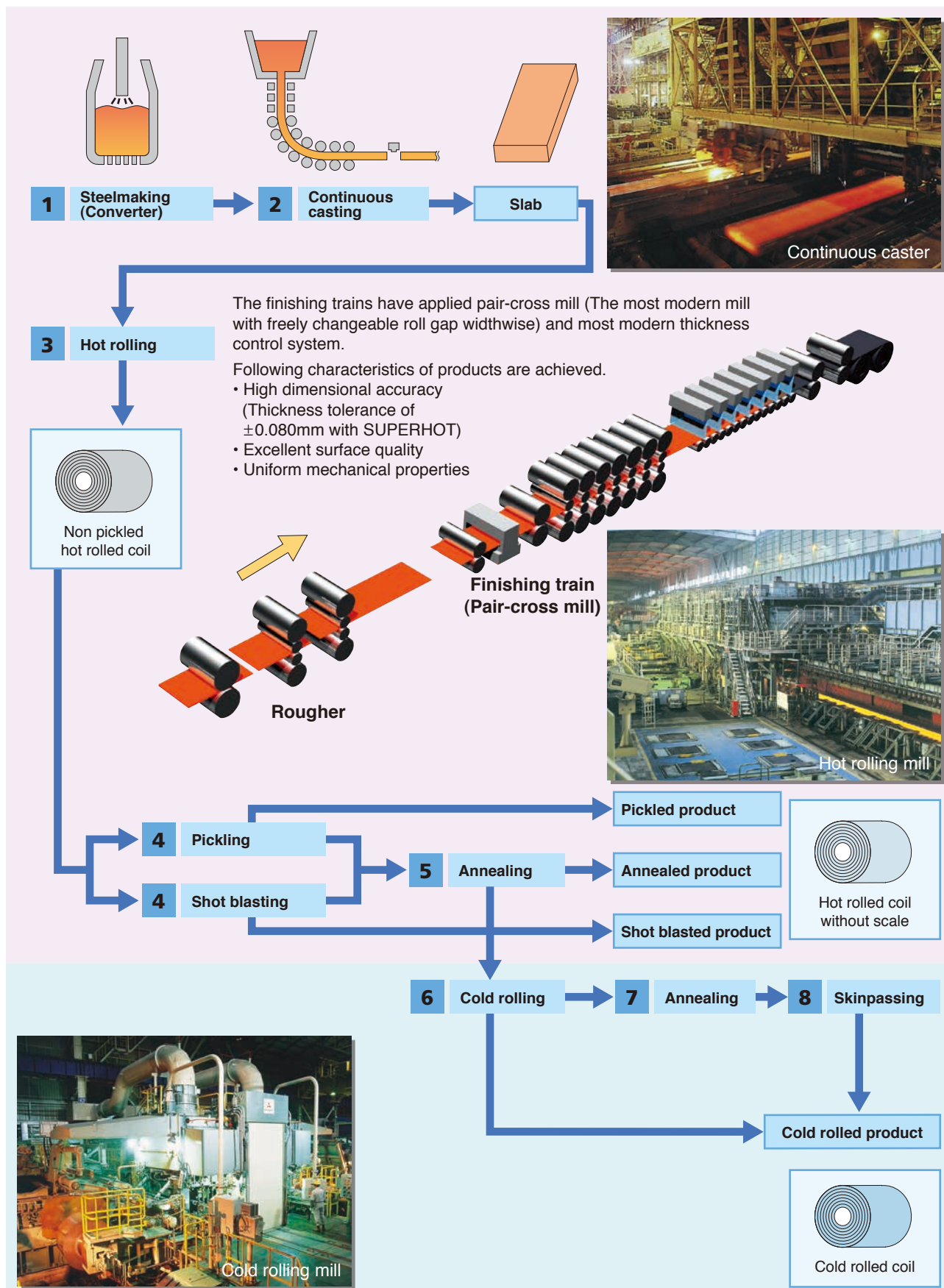
Carbon tool steels

Razor blades
Needles
Springs
Measures
Bearing parts

Hose bands, sheet springs



Manufacturing process



Applicable standard

Classification	Standard	Designation
Hot rolled steel sheet	Carbon steels for machine structural use	S-C
	Alloy steels for machine structural use	SMnC, SCr, SCM, SNCM
	Carbon tool steels	SK
	Alloy tool steels	SKS
	Spring steels	SUP
	High carbon chromium bearing steels	SUJ
	Carbon Steels	SAE
	Alloy Steels	SAE
Cold rolled steel sheet	Cold rolled special steel strip	S-CM, SK-M
	Carbon steels for machine structural use	S-C
	Carbon tool steels	SK
	Alloy tool steels	SKS
	Carbon Steels	SAE

Surface finish and heat treatment

Hot rolled steel sheet

Surface	Annealing	Remarks
Non pickled	Yes	Hot rolled coils are annealed with scale. Decarburized layer is generated at surface. Suitable for applications which needs grinding.
	No	As hot rolled with scale. Hardness because not annealed. Availability of working is subject to negotiation.
Pickled	Yes	Hot rolled and annealed after descaling at pickling line. Attractive surface and very little decarburized layer.
	No	Descaled at pickling line. Comparatively soft material suitable to applications which require no working or will be annealed by customers.
Shot blasted	Yes	Hot rolled and annealed after descaling by shot blasting. Suitable for applications which require rough surface finish and for thicker gauge which can not be pickled.
	No	Mechanically descaled by shot blasting. Rough finish surface and hardened surface. Suitable for punch working.

Cold rolled steel sheet

Surface	Annealing	Remarks
Bright finish	Yes	Carbon is spheroidized by annealing after cold rolling. Bright finish at skinpass after annealing with bright finish rolls.
	No	As cold rolled. Suitable for applications which require annealing by customer. Bright finish at cold rolling.
Dull finish	Yes	Spheroidized by annealing after cold rolling. Dull finish by skinpass rolling after annealing.
	No	As cold rolled with dull finish at cold rolling. Has advantage of less risk of defects than in bright finish.

Chemical composition

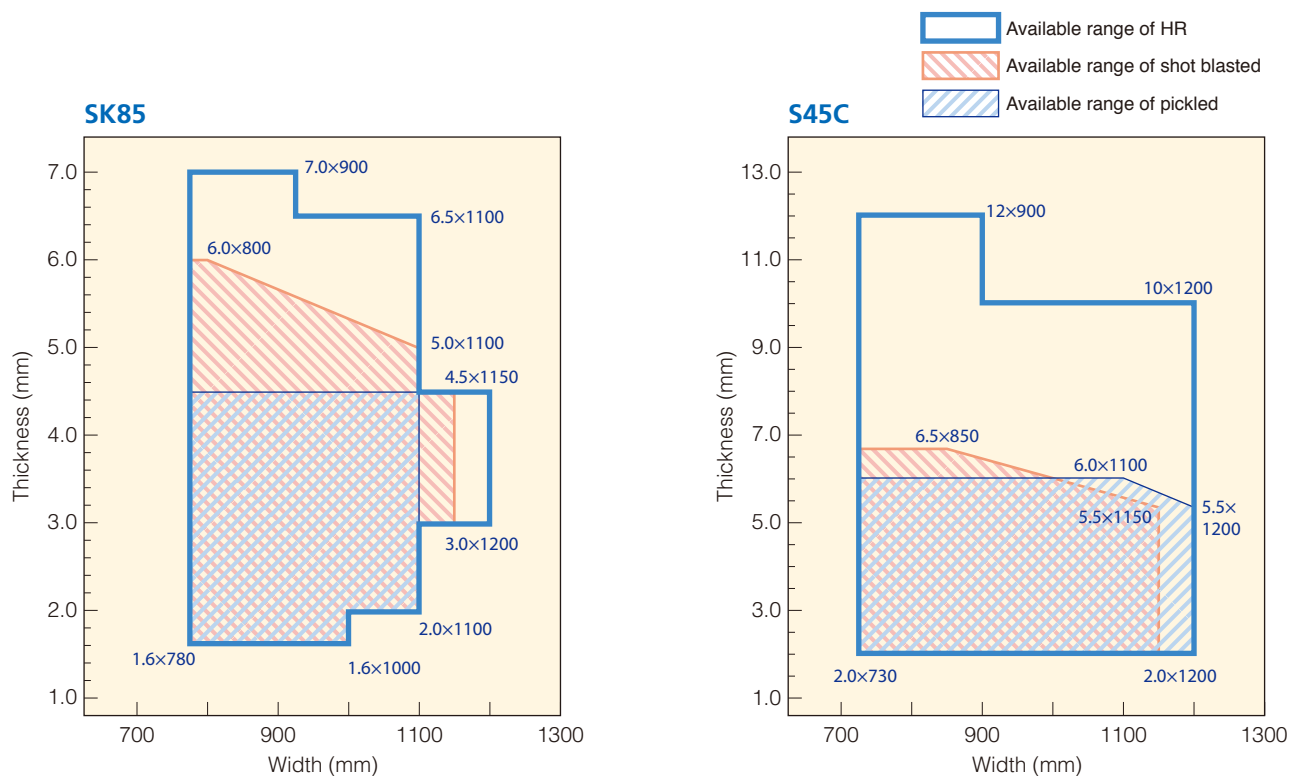
Classification	Designation		Chemical composition (%)										
	JIS	SAE	C	Si	Mn	P	S	Cu	Ni	Cr	Ni+Cr	Mo	V
Carbon steel	S20C		0.18-0.23	0.15-0.35	0.30-0.60	≤0.030	≤0.035	≤0.30	≤0.20	≤0.20	≤0.35		
	S35C(M)		0.32-0.38	0.15-0.35	0.60-0.90	≤0.030	≤0.035	≤0.30	≤0.20	≤0.20	≤0.35		
	S45C(M)		0.42-0.48	0.15-0.35	0.60-0.90	≤0.030	≤0.035	≤0.30	≤0.20	≤0.20	≤0.35		
	S50C(M)		0.47-0.53	0.15-0.35	0.60-0.90	≤0.030	≤0.035	≤0.30	≤0.20	≤0.20	≤0.35		
		SAE1050	0.48-0.55	0.15-0.35	0.60-0.90	≤0.030	≤0.050						
	S55C(M)		0.52-0.58	0.15-0.35	0.60-0.90	≤0.030	≤0.035	≤0.30	≤0.20	≤0.20	≤0.35		
		SAE1055	0.50-0.60	0.15-0.35	0.60-0.90	≤0.030	≤0.050						
	S60CM		0.55-0.65	0.15-0.35	0.60-0.90	≤0.030	≤0.035	≤0.30	≤0.20	≤0.20			
		SAE1060	0.55-0.65	0.15-0.35	0.60-0.90	≤0.030	≤0.050						
	S65CM		0.60-0.70	0.15-0.35	0.60-0.90	≤0.030	≤0.035	≤0.30	≤0.20	≤0.20			
		SAE1065	0.60-0.70	0.15-0.35	0.60-0.90	≤0.030	≤0.050						
	S70CM		0.65-0.75	0.15-0.35	0.60-0.90	≤0.030	≤0.035	≤0.30	≤0.20	≤0.20			
		SAE1070	0.65-0.75	0.15-0.35	0.60-0.90	≤0.030	≤0.050						
		SAE1074	0.70-0.80	0.15-0.35	0.50-0.80	≤0.030	≤0.050						
	S75CM		0.70-0.80	0.15-0.35	0.60-0.90	≤0.030	≤0.035	≤0.30	≤0.20	≤0.20			
Mn steel		SAE1541	0.36-0.44	0.15-0.35	1.35-1.65	≤0.030	≤0.050						
Mn-Cr steel	SMnC443		0.40-0.46	0.15-0.35	1.35-1.65	≤0.030	≤0.030	≤0.30	≤0.25	0.35-0.70			
Cr steel	SCr420		0.18-0.23	0.15-0.35	0.60-0.90	≤0.030	≤0.030	≤0.30	≤0.25	0.90-1.20			
Cr-Mo steel	SCM415		0.13-0.18	0.15-0.35	0.60-0.90	≤0.030	≤0.030	≤0.30	≤0.25	0.90-1.20		0.15-0.25	
	SCM420		0.18-0.23	0.15-0.35	0.60-0.90	≤0.030	≤0.030	≤0.30	≤0.25	0.90-1.20		0.15-0.25	
	SCM435		0.33-0.38	0.15-0.35	0.60-0.90	≤0.030	≤0.030	≤0.30	≤0.25	0.90-1.20		0.15-0.30	
Ni-Cr-Mo steel	SNCM220		0.17-0.23	0.15-0.35	0.60-0.90	≤0.030	≤0.030	≤0.30	0.40-0.70	0.40-0.60		0.15-0.25	
		SAE8620	0.18-0.23	0.15-0.35	0.70-0.90	≤0.030	≤0.040	≤0.35	0.40-0.70	0.40-0.60		0.15-0.25	
Carbon tool steel	SK85 (M)		0.80-0.90	0.10-0.35	0.10-0.50	≤0.030	≤0.030	≤0.25	≤0.25	≤0.30			
	SK95 (M)		0.90-1.00	0.10-0.35	0.10-0.50	≤0.030	≤0.030	≤0.25	≤0.25	≤0.30			
Alloy tool steel	SKS5		0.75-0.85	≤0.35	≤0.50	≤0.030	≤0.030	≤0.25	0.70-1.30	0.20-0.50			
	SKS51		0.75-0.85	≤0.35	≤0.50	≤0.030	≤0.030	≤0.25	1.30-2.00	0.20-0.50			
	SKS81		1.10-1.30	≤0.35	≤0.50	≤0.030	≤0.030	≤0.25	≤0.25	0.20-0.50			
Spring steel	SUP10		0.47-0.55	0.15-0.35	0.65-0.95	≤0.030	≤0.030	≤0.30		0.80-1.10			0.15-0.25
		SAE6150	0.48-0.53	0.15-0.35	0.70-0.90	≤0.030	≤0.040	≤0.35	≤0.25	0.80-1.10			≥0.15
High carbon Cr-bearing steel	SUJ2		0.95-1.10	0.15-0.35	≤0.50	≤0.025	≤0.025	≤0.25	≤0.25	1.30-1.60		≤0.08	

- Remarks -

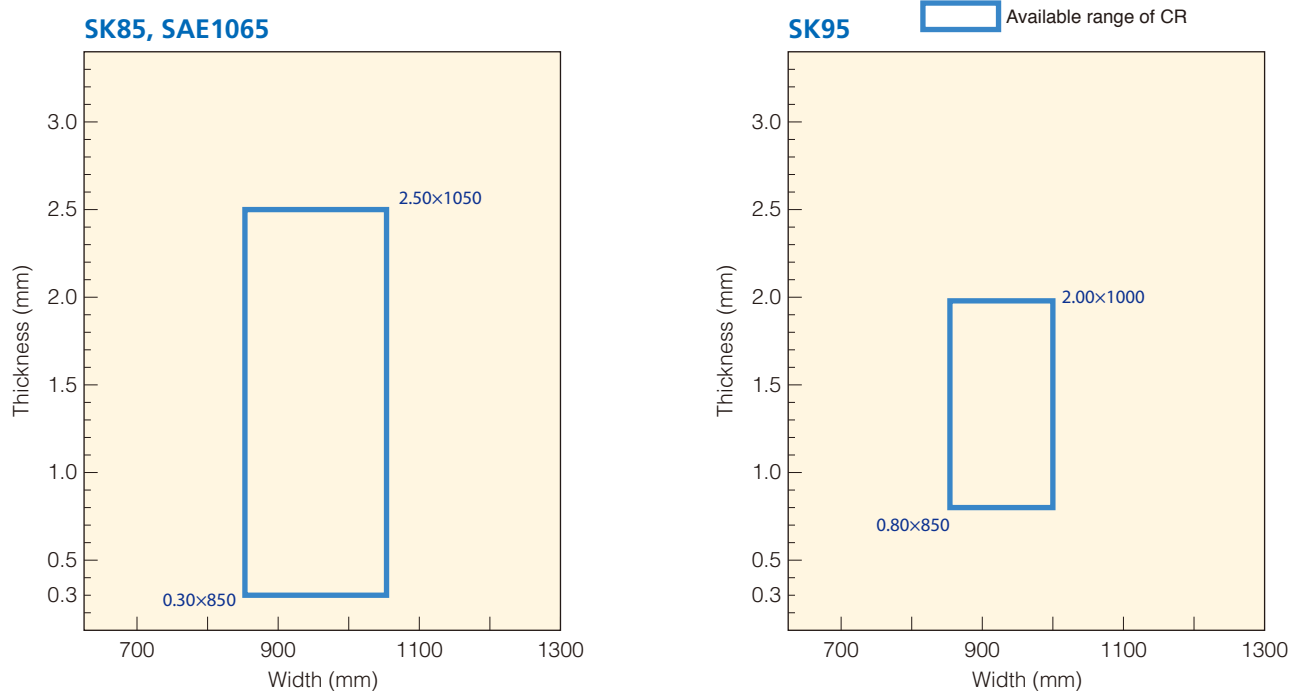
1. (M) means the order as cold rolled special steel strip is possible.
2. Si in SAE standard is 0.15%- 0.35% if not specified.
3. The standards not specified above, or special chemical compositions freely come to negotiation.

Available product size range

Hot rolled steel sheet



Cold rolled steel sheet



— Reference —

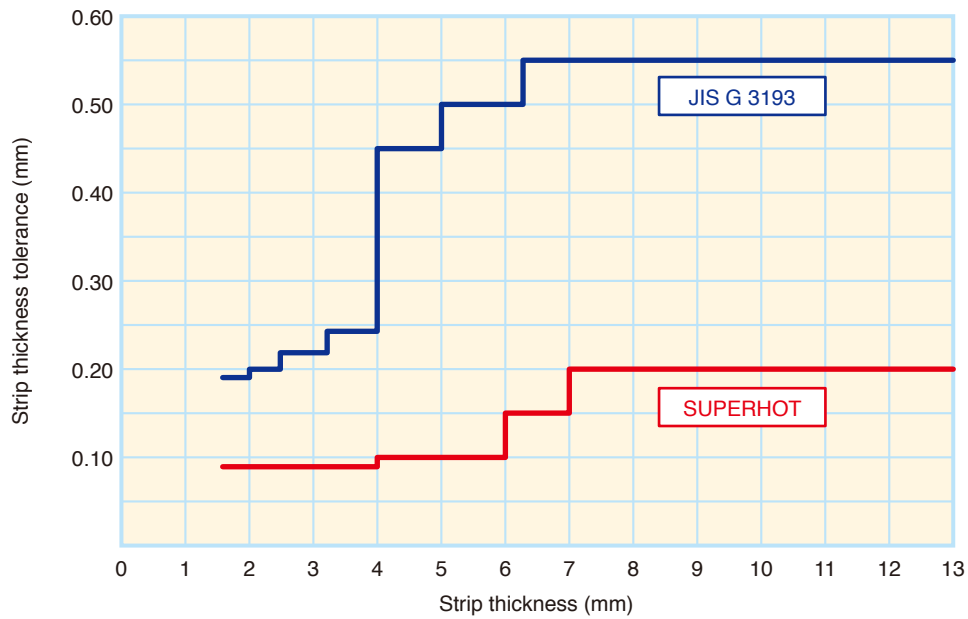
The standards not specified above and sizes outside the available area are subject to negotiation.

Dimensional tolerance

Hot rolled steel sheet

Basic standard is JIS G 3193 (Dimension, mass and permissible variation of hot rolled steel plates, sheets and strip).

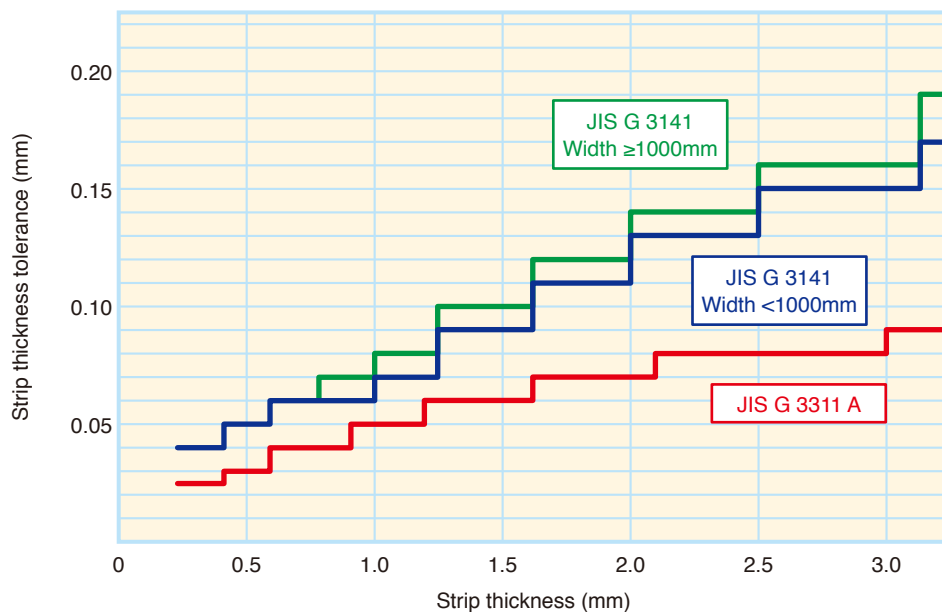
For high thickness accuracy, SUPERHOT tolerance can be applied (see figure).



Cold rolled steel sheet

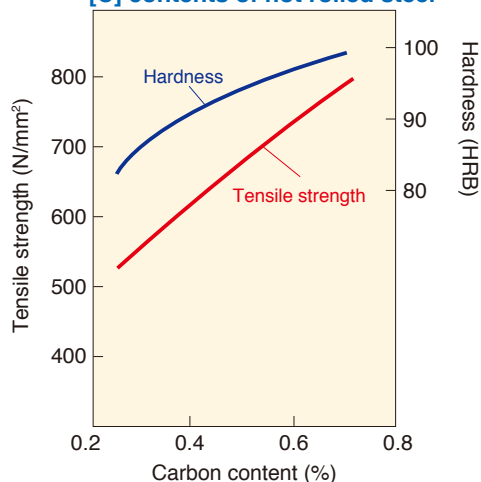
Basic standard is JIS G 3141 (Cold rolled steel coils and strips).

For high thickness accuracy, JIS G 3311 (Cold rolled special steel strip) can be applied.

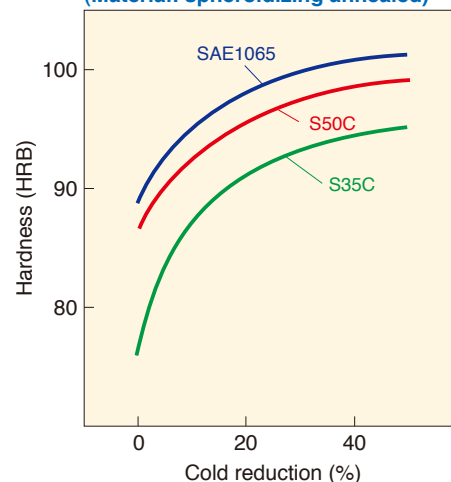


Mechanical properties by heat treatment

Relation between strength and [C] contents of hot rolled steel

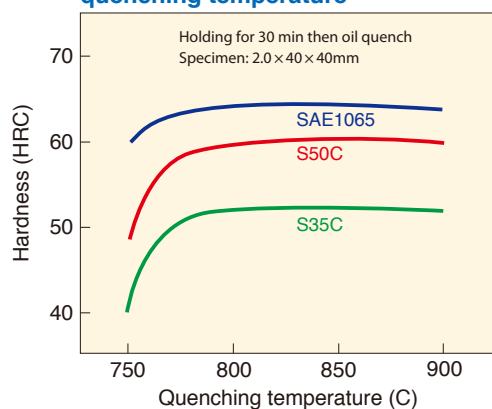


Relation between hardness and cold reduction
(Material: spheroidizing annealed)

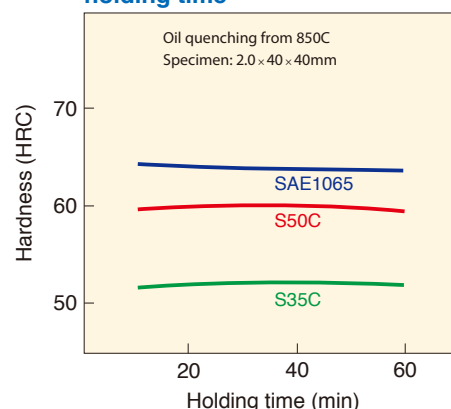


Relation between hardness and quenching condition (As-hot rolled)

Relation between hardness and quenching temperature

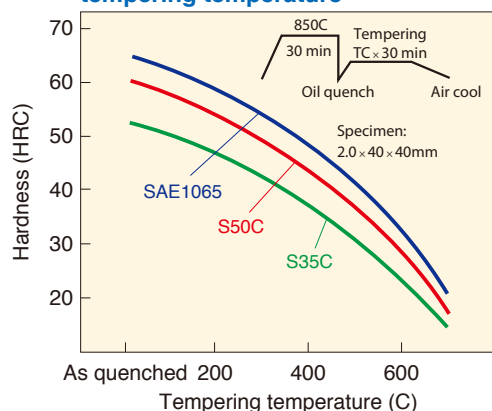


Relation between hardness and holding time

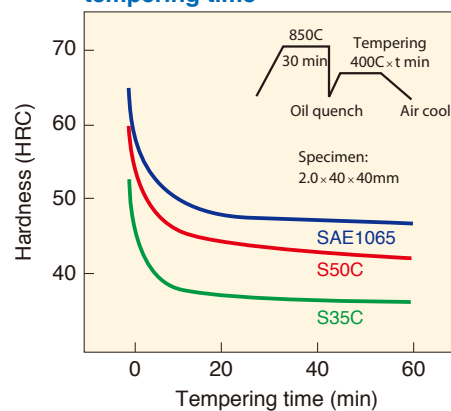


Relation between hardness and tempering condition (As-hot rolled)

Relation between hardness and tempering temperature

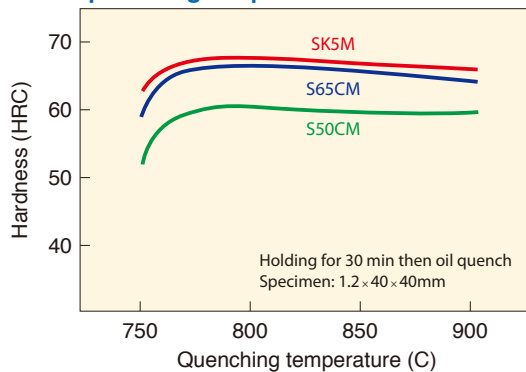


Relation between hardness and tempering time

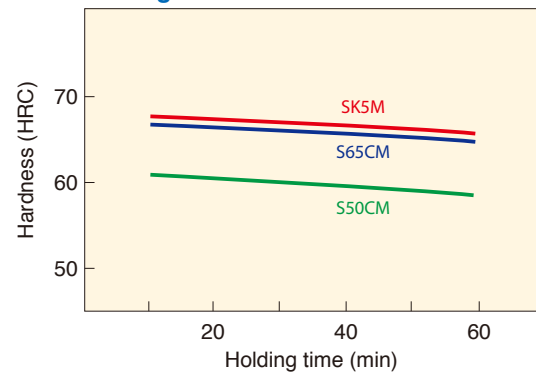


Relation between hardness and quenching condition (Cold rolled steel)

Relation between hardness and quenching temperature

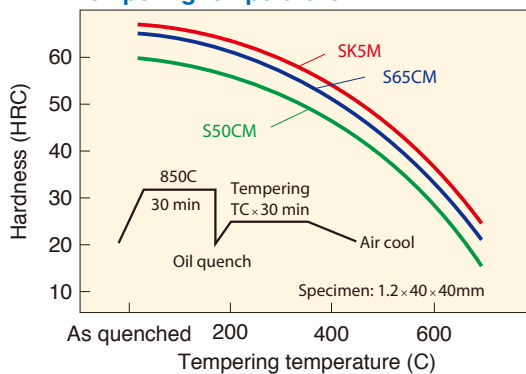


Relation between hardness and holding time

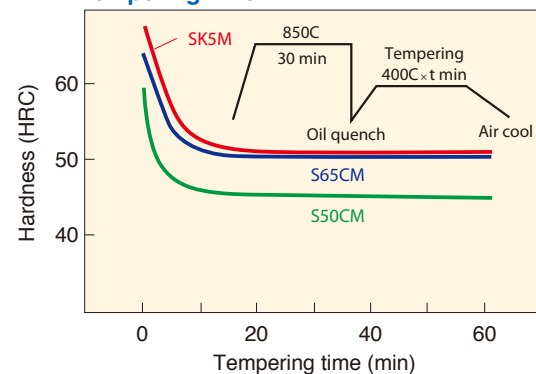


Relation between hardness and tempering condition (Cold rolled steel)

Relation between hardness and tempering temperature



Relation between hardness and tempering time



Effect of chemical elements

- | | | | |
|-----------|---|-----------|---|
| C | Forms semi-stable Fe ₃ C (Cementite) carbide. Stable phase is graphite. Improves quenchability, strength and anti-abrasion properties. C content of 0.77% is eutectoid, 0.02% - 0.77% is hypo-eutectoid and over 0.77% is hyper-eutectoid. The strength of carbon steel is increased by transformation of perlite, bainite to martensite in cooling from high temperature. | Cu | Improves quenchability. Dissolves cementite and promotes graphitization. Increases strength by generating precipitates at high temperature. Improves corrosion resistance. |
| Si | Increases strength as a solid solution strengthening element. Promotes spheroidization of cementite and graphitization. Improves impact values in the low temperature temper-brittleness range below 300°C in the same manner of Cr, Mo and V. | Ni | Forms stable austenite and lowers the transformation temperature. Multiple addition with Cr and Mo strengthens ferrite and extremely improves low temperature embrittlement. Promotes graphitization by dissolving cementite. |
| Mn | Stabilizes austenite and lowers the transformation temperature, improving quenchability. Increases strength without reducing toughness. Stabilizes cementite and suppresses graphitization. Fixes S as MnS and thereby prevents red brittleness. | Cr | Improves quenchability and prevents softening during temper by forming secondary carbides. Extremely suppresses graphitization by refining carbide particles. Improves corrosion resistance and anti-abrasion resistance. |
| P | Generally contained as an impurity. Segregates at grain boundaries reducing impact properties. Increases temper brittleness, but also increases strength, grindability and corrosion resistance. | Mo | Forms carbides, increasing resistance to temper softening. Promotes secondary hardening. Improves brittleness by preventing temper embrittlement. |
| S | Generally contained as an impurity. Lowers ductility during hot rolling. Red brittleness is caused by FeS. Red brittleness is prevented by adding Mn to form MnS, also resulting in improved grindability. | Al | Used as deoxidizer in steelmaking. Combines with N to form AlN and improves toughness by suppressing abnormally enlarged austenitic grains. |
| | | N | Combines with nitride creators. Improve toughness by refining grains and preventing abnormal coarsening of austenite. |

Introduction of functional products

SUPERHOT/SUPERHOT-F

JFE produces high carbon hot rolled steel sheet “**SUPERHOT**”, which is characterized by excellent thickness accuracy, surface quality, and workability in comparison with conventional hot rolled special steels, by applying an advanced rolling technology, cooling technology, and strict quality control. Newly developed “**SUPERHOT-F**” has superior elongation and hole expanding property which are almost equal to those of 440MPa class hot rolled steel sheet, and enables high workability like press forming or spin forming by achieving fine and uniform grain size.

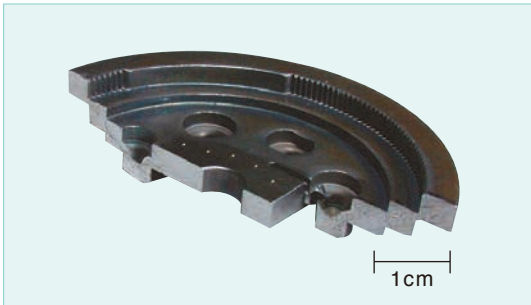
Characteristics

		SUPERHOT	SUPERHOT-F
Applicable range	Standard	Excellent thickness accuracy product and excellent surface quality products are applicable to all standards. Excellent quality thick sheet and excellent workability products are mainly applicable to SC, SCM and SCr.	S35C, S45C
	Thickness	1.6mm-13mm *	2.6mm-6.0mm
Characteristics	Gauge accuracy	Refer to strip thickness tolerance for SUPERHOT in p.7 and see graphs (C) in p.11.	
	Surface quality	Particular oxide pattern on surface originating in high Silicon contents, so-called red scale, is reduced to minimum. The example is shown in photo (B) of p.11.	
	Workability/ Quenchability	Because of its excellent workability, it is suitable to fine blanking, tough standing and slight curvature bending.	The elongation and hole expanding property of S35C of SUPERHOT-F are almost equal to those of 440 MPa class hot rolled steel sheet. (See table (D) and photo (E) in p.11.) Fine blanking or induction hardening can be applied.
	Example of application	Chain plates, seat belt tongues, recliner gears, and pole parking (See photo (A) below.)	Automotive drive train parts (Possible to switch manufacturing process from forging to press forming, or to achieve component integration.)

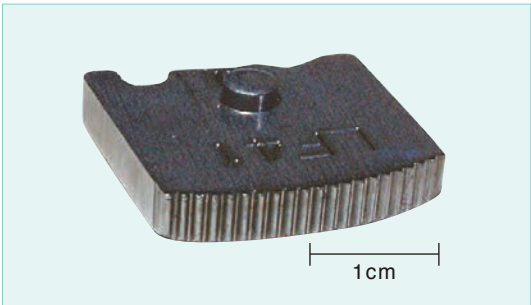
* Thickness range depends on Designation.

(A) Example of application of SUPERHOT

(Automotive reclining seat parts)

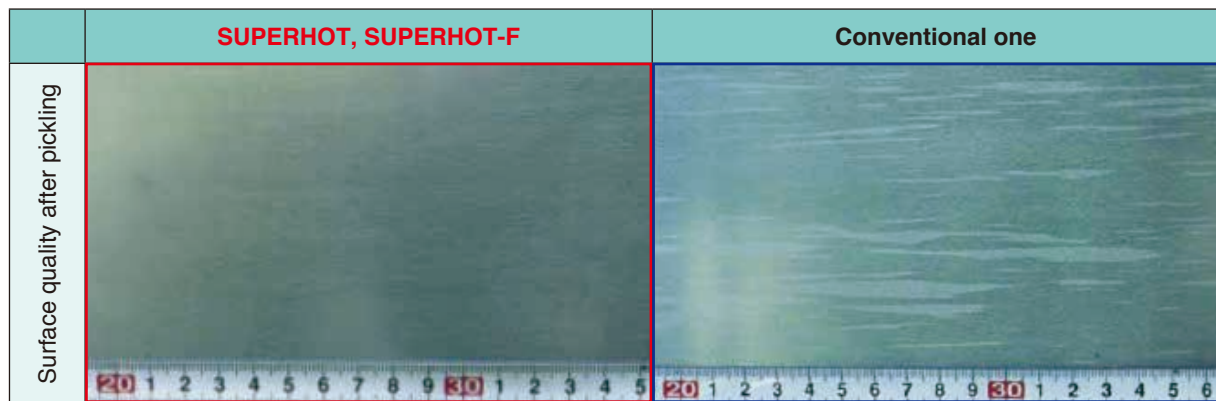


Gear plate

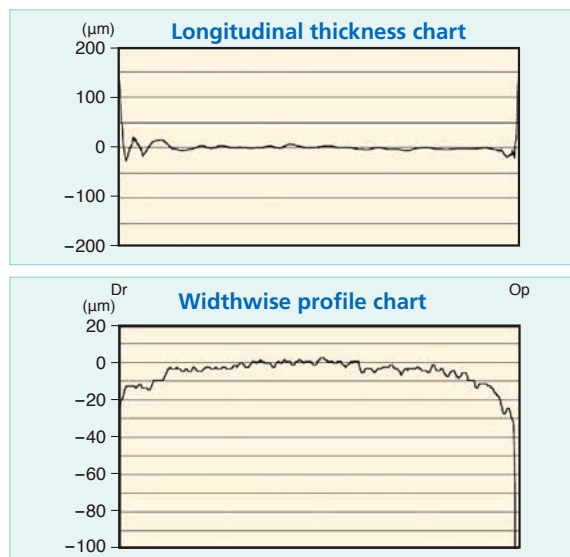


Rock gear

(B) Example of Surface quality



(C) Example of thickness measurement of 3.2mm×930mm (S55C)



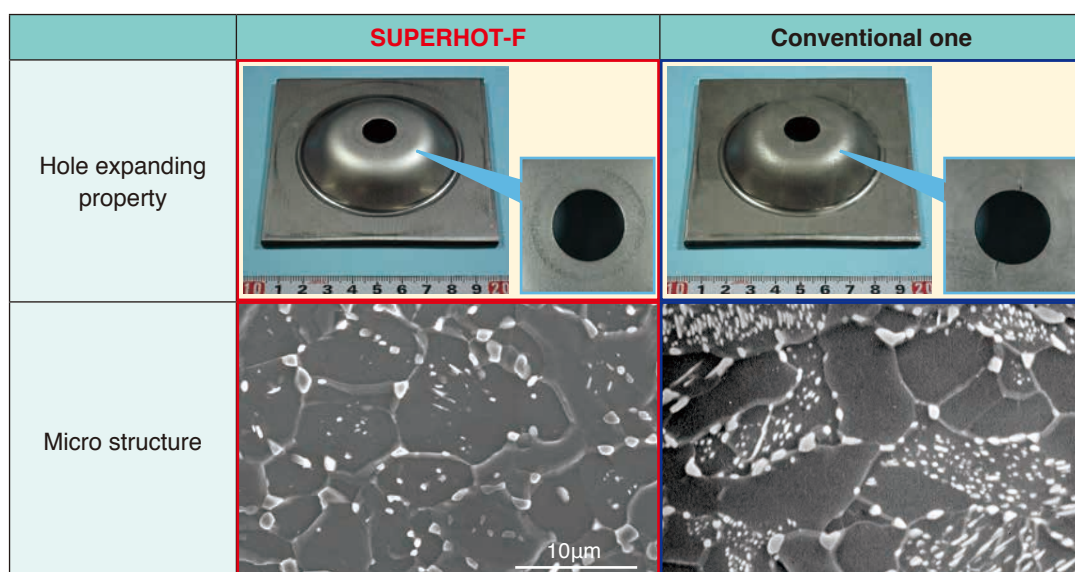
(D) Examples of mechanical properties of SUPERHOT-F

(t=4.0 mm)

Designation	Examples of mechanical properties			
	Yield point (N/mm ²)	Tensile strength (N/mm ²)	Elongation (%)	Hole expanding ratio using cylindrical punch* (%)
S35C	312	472	38	63
S45C	339	499	34	58

(E) Example of hole expanding test result of SUPERHOT-F

(λc = 50 % forming)



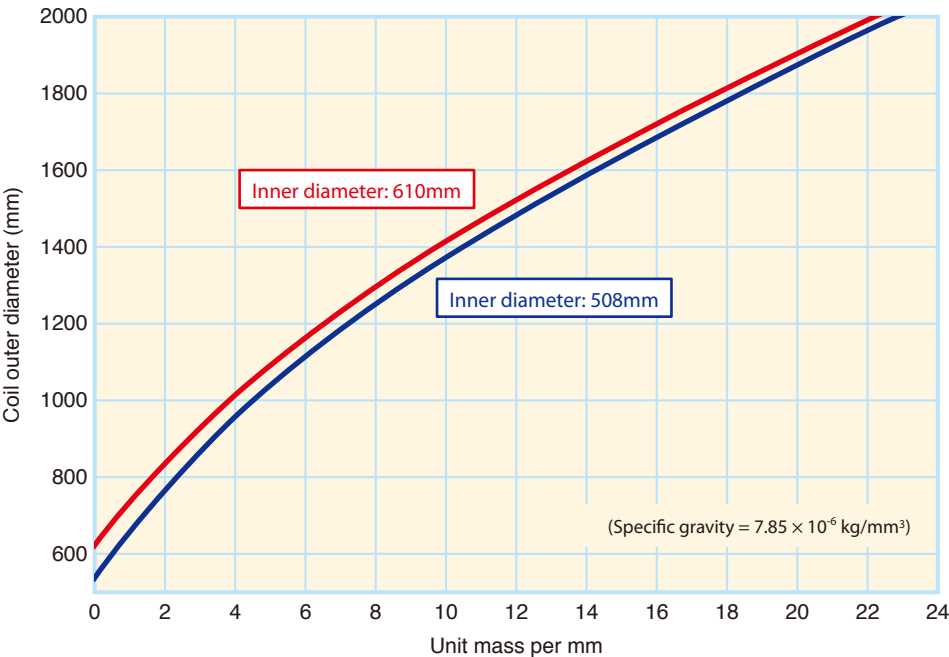
* Hole expanding test using cylindrical punch: This test is basically defined by JFS T1001 with exception of the following three points.
 1) Flat head cylindrical punch is used. 2) The hole is punched with 20% clearance. 3) The burr is facing the punch.

Hardness conversion table

(SAE J 417)

Vickers Hardness HV	Rockwell Hardness		Tensile Strength N/mm ² (kgf/mm ²)	Vickers Hardness HV	Rockwell Hardness		Tensile Strength N/mm ² (kgf/mm ²)	Vickers Hardness HV	Rockwell Hardness		Tensile Strength N/mm ² (kgf/mm ²)
	B Scale HRB	C Scale HRC			B Scale HRB	C Scale HRC			B Scale HRB	C Scale HRC	
940	—	68.0	—	540	—	51.7	1860 (190)	280	(103.5)	27.1	890 (91)
920	—	67.5	—	530	—	51.1	1825 (186)	275	—	26.4	875 (89)
900	—	67.0	—	520	—	50.5	1795 (183)	270	(102.0)	25.6	855 (87)
880	—	66.4	—	510	—	49.8	1750 (179)	265	—	24.8	840 (86)
860	—	65.9	—	500	—	49.1	1705 (174)	260	(101.0)	24.0	825 (84)
840	—	65.3	—	490	—	48.4	1660 (169)	255	—	23.1	805 (82)
820	—	64.7	—	480	—	47.7	1620 (165)	250	99.5	22.2	795 (81)
800	—	64.0	—	470	—	46.9	1570 (160)	245	—	21.3	780 (79)
780	—	63.3	—	460	—	46.1	1530 (156)	240	98.1	20.3	765 (78)
760	—	62.5	—	450	—	45.3	1495 (153)	230	96.7	(18.0)	730 (75)
740	—	61.8	—	440	—	44.5	1460 (149)	220	95.0	(15.7)	695 (71)
720	—	61.0	—	430	—	43.6	1410 (144)	210	93.4	(13.4)	670 (68)
700	—	60.1	—	420	—	42.7	1370 (140)	200	91.5	(11.0)	635 (65)
690	—	59.7	—	410	—	41.8	1330 (136)	190	89.5	(8.5)	605 (62)
680	—	59.2	—	400	—	40.8	1290 (131)	180	87.1	(6.0)	580 (59)
670	—	58.8	—	390	—	39.8	1240 (127)	170	85.0	(3.0)	545 (56)
660	—	58.3	—	380	(110.0)	38.8	1205 (123)	160	81.7	(0.0)	510 (53)
650	—	57.8	—	370	—	37.7	1170 (120)	150	78.7	—	490 (50)
640	—	57.3	—	360	(109.0)	36.6	1130 (115)	140	75.0	—	455 (46)
630	—	56.8	—	350	—	35.5	1095 (112)	130	71.2	—	425 (44)
620	—	56.3	—	340	(108.0)	34.4	1070 (109)	120	66.7	—	390 (40)
610	—	55.7	—	330	—	33.3	1035 (105)	110	62.3	—	—
600	—	55.2	—	320	(107.0)	32.2	1005 (103)	100	56.2	—	—
590	—	54.7	2055 (210)	310	—	31.0	980 (100)	95	52.0	—	—
580	—	54.1	2020 (206)	300	(105.5)	29.8	950 (97)	90	48.0	—	—
570	—	53.6	1985 (202)	295	—	29.2	935 (96)	85	41.0	—	—
560	—	53.0	1950 (199)	290	(104.5)	28.5	915 (94)				
550	—	52.3	1905 (194)	285	—	27.8	905 (92)				

Unit mass per mm



Hardness conversion table/Unit mass per mm

Instructions for ordering

When ordering, please give detailed information, including the following.

- **Detailed information on product requirements;**

Standard, dimensions, quantity, surface finish, packaging specifications (inner and outer diameter, mass conditions), delivery date requirements

- **Application and processing method;**

Intended application, processing method, any heat treatments, welding, and/or surface treatment to be applied, and any other requirements

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