NACHI

SPECIAL STEELS

The Fusion of Proprietary Refining and the Latest Steelmaking Technology Responds to the Need for Assured Quality and Short Delivery Periods.

An integrated production system from materials through to the finished product.

Our production system integrates a wide range of needs and technologies for making materials, tools, bearings and industrial furnaces.

A fusion of high-grade special-steel production technology.

Clean, high-quality materials born from proprietary refining technology.

Know-how for responding to a wide range of needs.

Products are brought to the market place by combining the technologies of refining, machining, heat treatment and coating.

A production system that caters to the demands of wide range, variable volume and short delivery periods.

A variety of steels, facilities and management systems are capable of delivering from forged products through to precision worked products.

Certified quality assurance.

An complete quality assurance system backed up by the Award for TPM (Total Productive Maintenance) Excellence, Deming Application Prize and ISO Certification.

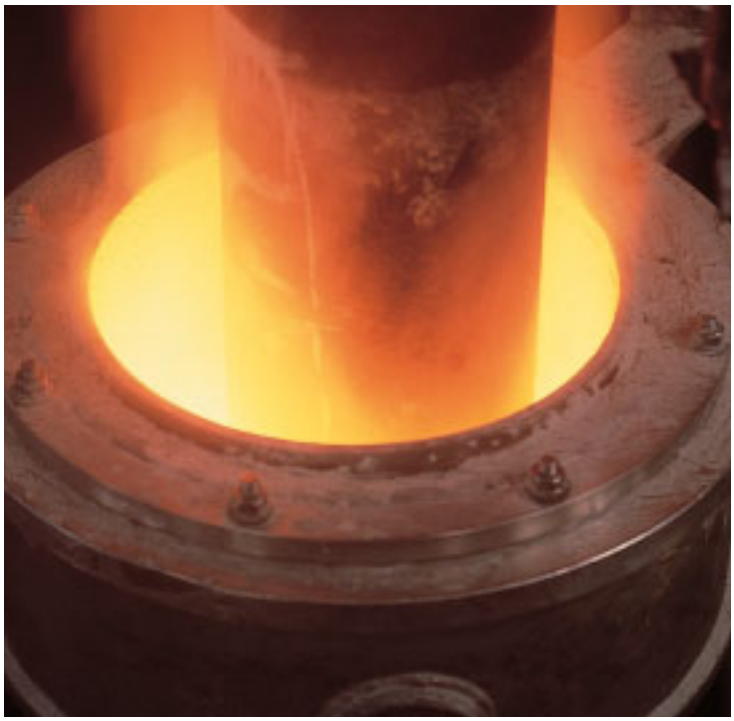
Clean Steel

High-purity, high-quality raw materials are used in our steels that we carefully produce by integrating Nachi proprietary refining methods and the very latest steelmaking technology. Advanced heat treatment and surface treatment technologies are also used to produce advanced steels which help to reduce the number of stages in the manufacturing process.

Easy-to-use Steel

Striving to improve such properties as wear resistance, hardness at high temperatures, toughness, hardenability, and gindability, steel is produced based on complete quality control, primarily through chemical composition, but also through structural refinements and impeccable care.

Electric arc furnace



ESR furnace

CONTENTS

High Speed Steels 3

High-carbon Chromium Bearing Steels 10

Martensitic Stainless Steels 10

Alloy Tool Steels 11

Sintered Products 13

Production Size Ranges 14

Quality-assured Steels

The quality of our steels is assured by careful process management that utilizes a wide range of measuring systems and equipment and inspection of semifinished and finished products.
Our steel product line-up supports an extensive range of steel types and dimensions to help us quickly respond to your specific needs.

Emission spectrometer

Highly Quality Steels

As an integrated producer of special steels, cutting tools and bearings, the steel division works closely with the users to continuously improve process technologies, based on the feedback received from our close interaction. This has helped us to improve the quality of steel, and to develop new steels for specific customer requirements.

Hardened bars

High Speed Steels

High Speed Steel Grade, Chemical Composition and Properties

Production Category	Category by Alloy Contents: Steel Type	Category by Alloy Contents: V Type	Designation: Nachi Grade	Ralated Standards: AISI	Ralated Standards: DIN WNr.	Ralated Standards: JIS	Chemical Composition (%): C	W	Mo	Cr	V	Co	Properties (1=worst to 10=best): Wear Resistance	Hot Hardness	Toughness	Grindability
Conventional methods (including ESR and VAR)	W・Mo		HM2	M2	1.3343	SKH51	0.85	6.0	5.0	4.0	2.0		5	5	8	5
			SKH9	M2	1.3343	SKH51	0.88	6.0	5.0	4.0	2.0		5	5	8	5
			HS12M	M2(H.C.)			1.00	6.0	5.0	4.0	2.0		6	5	7	5
			SKH9D				0.78	6.0	5.0	4.0	2.0		5	5	8	7
			HSU2C				0.90	6.3	2.3	4.0	1.5		5	5	8	6
			MDS7				0.80	1.8	4.8	4.3	1.2		4	4	9	7
			MDS3				0.70	1.0	2.0	4.3	1.2		4	4	9	6
			HM50	M50	1.3551		0.80		4.0	4.0	1.0		3	1	9	10
		High V	HM3	M3-2	1.3344	SKH53	1.20	6.0	5.5	4.0	3.0		9	6	7	3
			HM4	M4		SKH54	1.30	6.0	5.0	4.0	4.0		9	6	6	3
	W・Mo・Co		HM35	(M35)	1.3243	SKH55	0.90	6.0	5.5	4.0	2.0	5.0	6	7	5	5
			HS53M				1.05	6.0	6.0	4.0	2.5	5.0	9	7	5	3
			HS97R				1.10	7.5	5.5	3.9	1.8	9.0	8	9	5	8
			MATRIX2				0.70	1.0	5.0	4.0	1.0	8.0	5	7	6	8
			HS52R				1.00	8.0	3.5	4.0	1.8	7.0	7	8	4	6
		High V	HS93R	(T42)	1.3207	SKH57	1.30	10.0	3.5	4.0	3.5	10.0	10	9	2	2
			HS98M				1.30	8.0	6.0	4.5	3.5	13.0	10	10	1	2
	Mo		HM1	M1	1.3346		0.85	1.5	8.5	4.0	1.0		4	3	8	9
			HM7	M7	1.3348	SKH58	1.00	1.5	8.5	4.0	2.0		6	5	8	9
			HMT12				1.25	3.5	8.0	4.0	2.8		8	6	7	7
	Mo Co		HM33	M33			0.95	1.8	9.5	4.0	1.0	8.0	7	8	4	8
			HM42	M42	1.3247	SKH59	1.10	1.5	9.5	4.0	1.0	8.0	8	9	3	8
	W		SKH2	T1	1.3355	SKH2	0.80	18.0		4.0	1.0		5	5	6	8
	W・Co		SKH3	T4	1.3255	SKH3	0.80	18.0		4.0	1.0	5.0	6	7	3	7
			SKH4	T5	1.3265	SKH4	0.80	18.0		4.0	1.0	10.0	8	9	2	5
P/M methods	Mo W		FAX18	M42	1.3247	SKH59	1.10	1.5	9.5	4.0	1.0	8.0	8	9	8	8
			FAX31	M3-2	1.3344	SKH53	1.30	6.0	5.0	4.0	3.0		6	5	9	8
	Mo・W・Co	High V	FAX38				1.30	6.0	5.0	4.0	3.0	8.0	8	8	7	7
			FAX55	T15		SKH10	1.55	13.0		4.0	5.0	5.0	10	9	8	5
			FAX40	(T42)		SKH57	1.30	10.0	3.5	4.0	3.0	10.0	10	9	8	6
			FAXG1				—	—	—	—	—	—	10	9	6	4
			FAXG2				—	—	—	—	—	—	8	9	8	6

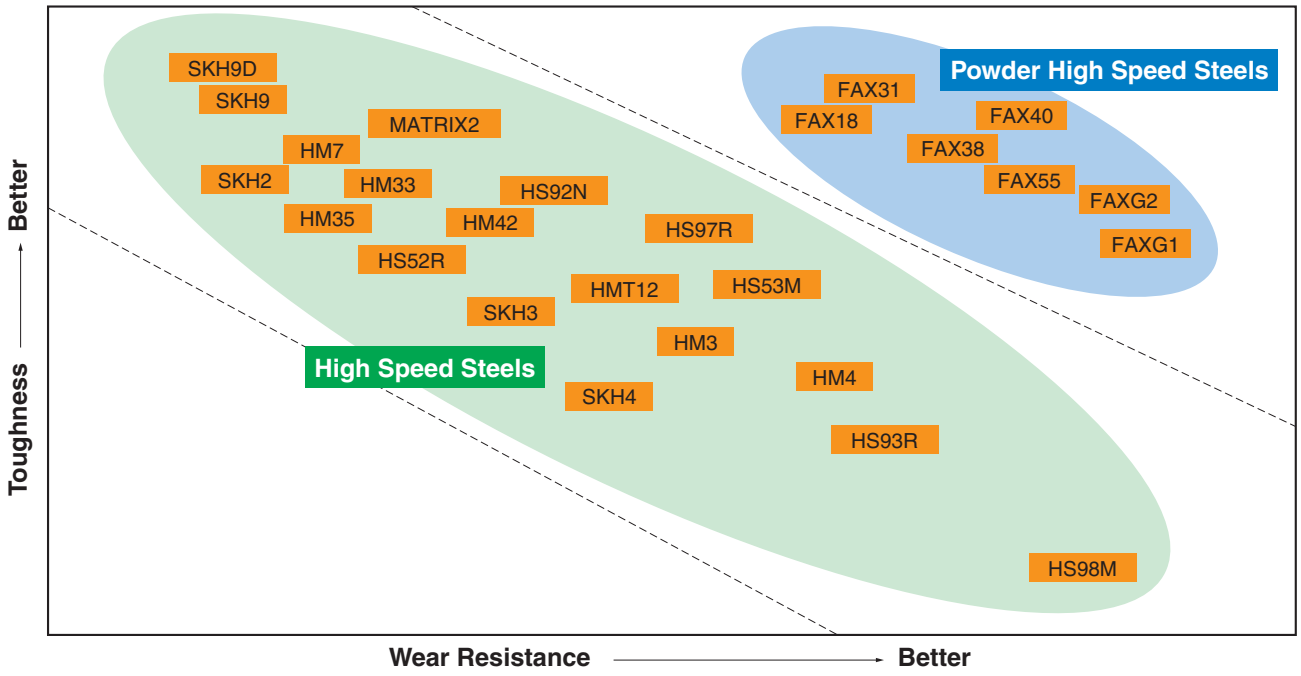
Applications and Heat Treatment

Nachi Grade	Cutting Tool									Wood-working tool/blade	Industrial blade	Mold/Dies	Pin/punch	Rolling Tool & Die	Wear-resistant machine component	Vane	Mandrel	Dot pin	Formed roll	High-temperature bearings	Heat Treatment		Hardness	
	Bit	Drill	Reamer	End mill	Milling cutter	Gear cutter	Broach	Saw tool	Screw cutter												Hardening Temp. (°C)	Tempering Temp. (°C)	Annealing (HB)	Working Hardness (HRC)
HM2	○	◎	◎		◎	◎	◎	◎	○	◎	◎	◎	◎	◎	◎	◎	◎	○	◎	◎	1150–1230°C	540–580°C	<255	58–66
SKH9	○	◎	◎		◎	◎	◎	◎	○	◎	◎	◎	◎	◎	◎	◎	◎	○	◎	◎				
HS12M	○				◎	○	○			○	○													64–67
SKH9D											○	○	◎	◎	○		○		○		1120–1200°C	540–590°C	<209	55–65
HSU2C												◎	◎								1140–1200°C		<212	58–62
MDS7								○	○	◎	○	○	◎	◎			○		○		1100–1180°C			60–66
MDS3									○			◎	◎				○		○		1080–1160°C	540–600°C	<235	57–64
HM50																				◎	1100–1120°C	540–580°C		61–64
HM3	○		○				○		○												1180–1230°C		<269	63–66
HM4	○		○				○		○														<277	
HM35	○	◎	◎	○	◎	◎	◎			○			○	○										64–67
HS53M	○	◎	○		○	◎	◎																	64–68
HS97R		○		◎		◎			◎												1180–1220°C			65–69
MATRIX2								◎		○											1125–1180°C	520–560°C	<235	65–67
HS52R					◎	◎															1160–1180°C	540–580°C	<277	65–68
HS93R	◎		○			○							○								1220–1250°C	520–580°C	<285	65–69
HS98M	◎																				1210–1240°C			
HM1		○	○		○				○	○											1190–1210°C	540–580°C	<248	63–66
HM7					○				◎														<255	
HMT12									◎												1180–1200°C		<285	64–66
HM33		◎			○	○							◎								1180–1200°C			65–68
HM42	◎			◎				◎		◎			◎								1160–1200°C			
SKH2	○									◎	◎				○				○		1200–1280°C		<232	63–66
SKH3	◎									◎	◎												<248	64–68
SKH4	◎									○	○										1200–1290°C		<285	65–69
FAX18	○			○	○		○	◎		○	○	○	○	○			○				1130–1200°C	540–600°C		62–68
FAX31												◎	◎	○			○				1130–1210°C			62–66
FAX38		◎	○		○	◎		○	◎			○	○	○				○			1160–1210°C	540–580°C		65–68
FAX55	○			○	○	◎		◎	○				○		○						1200–1240°C			66–69
FAX40		◎		○	○	○	○	○					○		○		○	○			1130–1240°C	540–600°C		63–69
FAXG1	◎			◎			◎						○		○						1140–1210°C	540–580°C	<330	66–70
FAXG2							◎	◎					○								1140–1200°C		<285	66–69

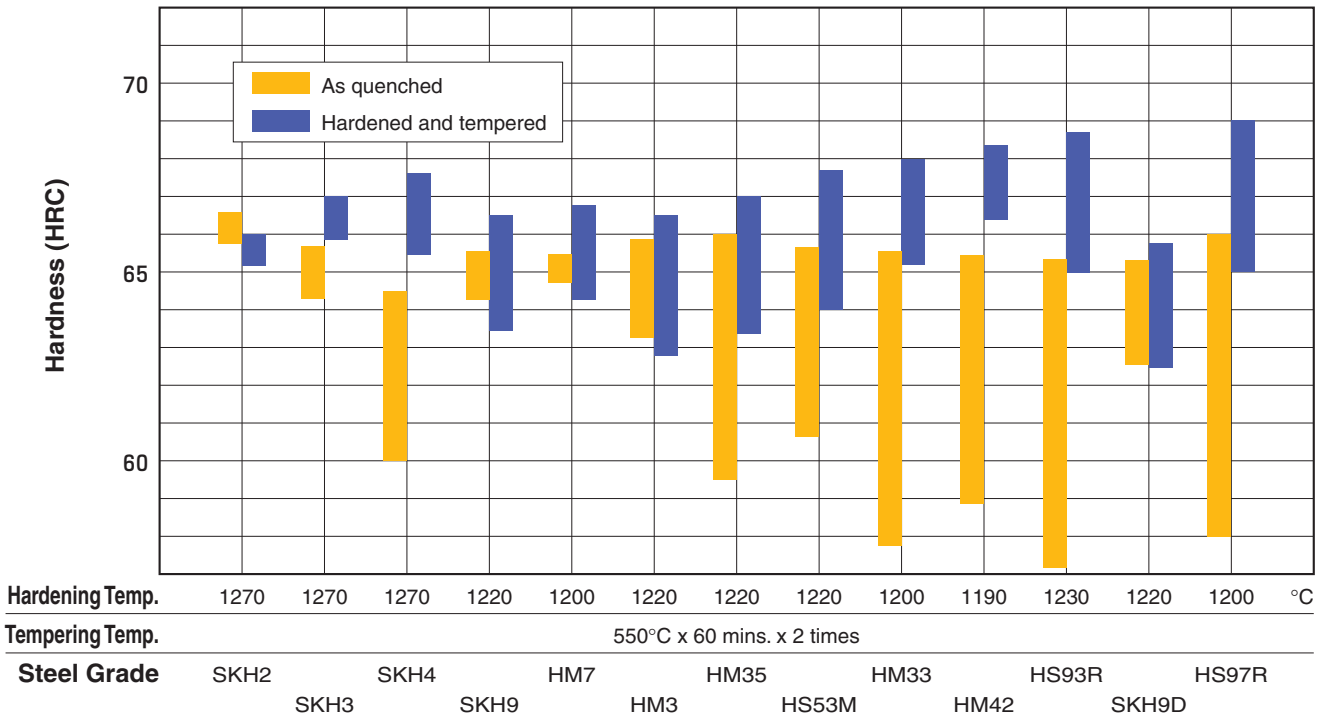
Properties of High-speed Steels

Ranking of Properties

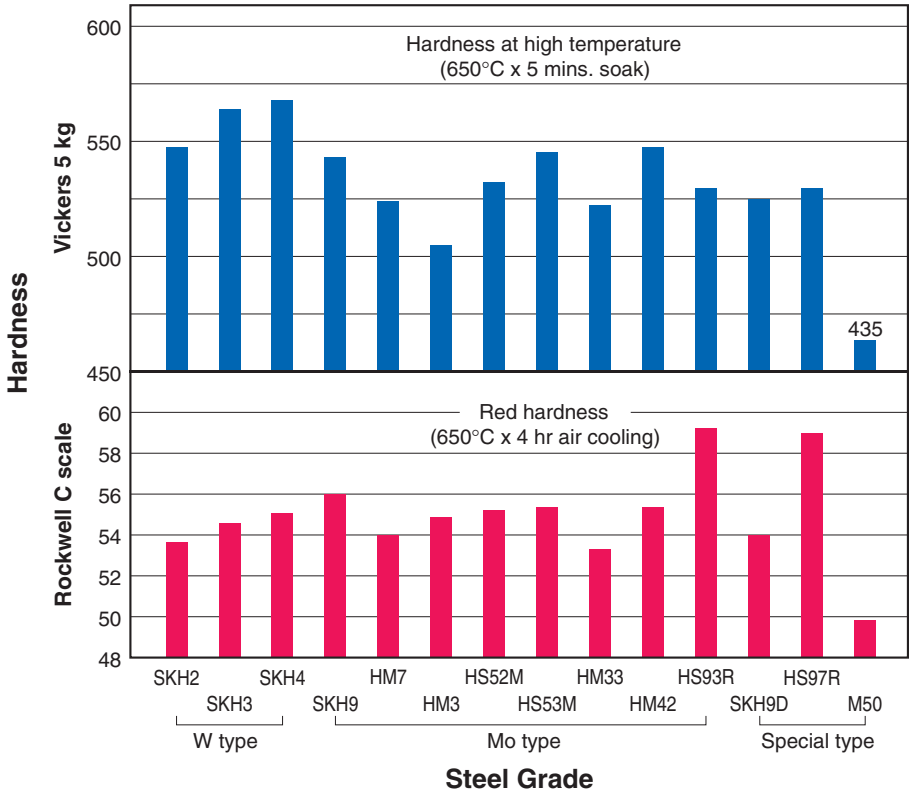
Select the proprietary developed steels (NACHI original steel grades) to meet your particular requirements.



Hardenability

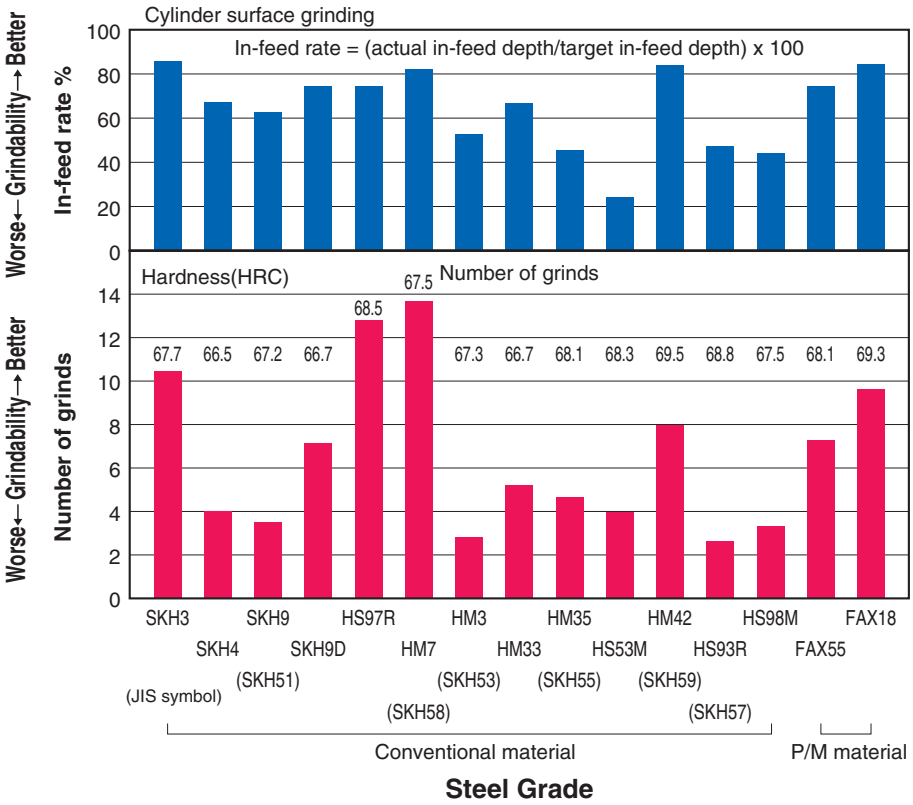


Hot Hardness



Hot hardness and red hardness of high speed steel at 650°C

Grindability

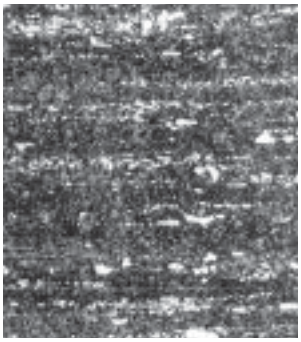


Machine Used	:NIPPEI Cylindrical Grinder
Grindstone	:WA603J7V10W ø610 x 65 x ø304.8
Peripheral Speed (grindstone)	:1820m/min
Specimen	:50ø x 260
Peripheral Speed (materials)	:9m/min
Grinding depth (aim in-feed)	:30μ/pass
Traversing feed	:500m/min
Coolant	:Simillon
Dressing	:110mm/min
In-feed of dressing	:30μ/pass x 2pass

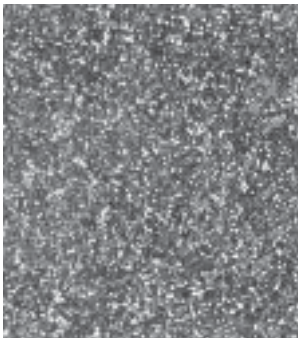
Properties of P/M High Speed Steels

Microstructure

P/M high speed steel has a uniform carbide structure, and outstanding properties can be obtained.



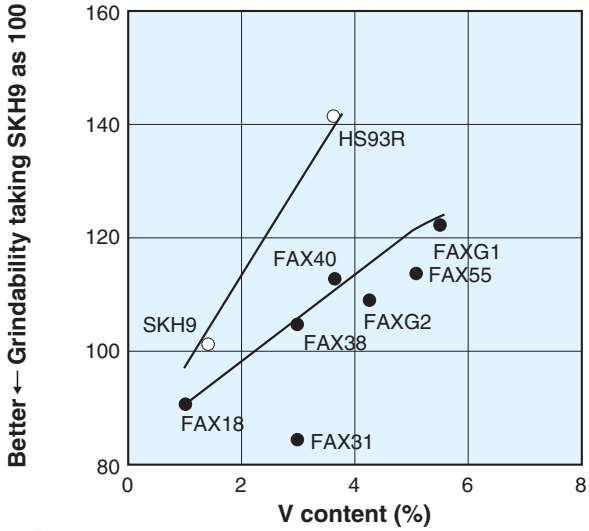
Conventional high speed steel



P/M high speed steel

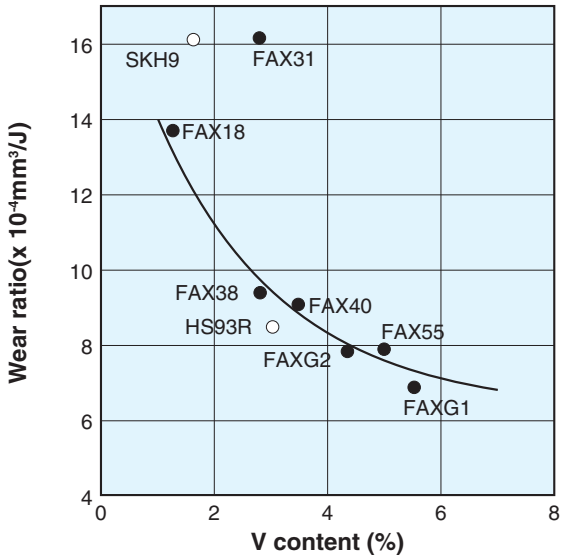
Grindability

Grindability is extremely good.



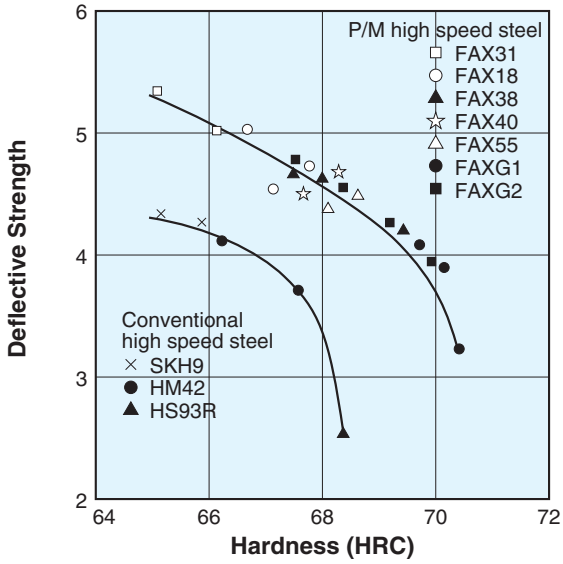
Wear resistance

Outstanding wear resistance can be obtained.



Toughness

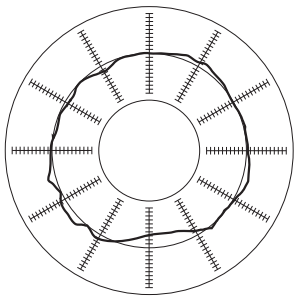
High toughness can be obtained even at high hardness levels.



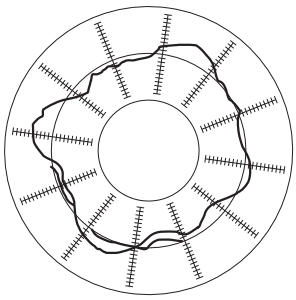
Deformation after heat treatment

Dimensional deformation is stable because of little heat treatment strain.

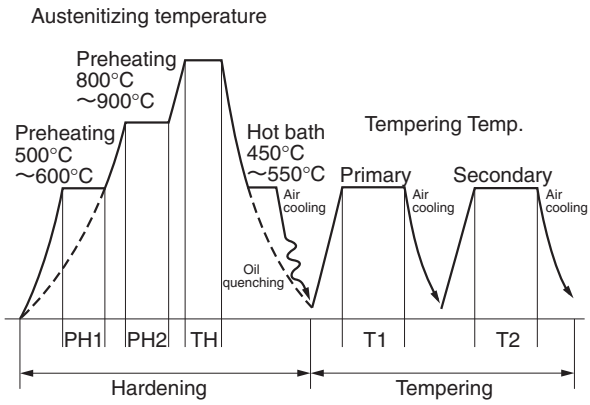
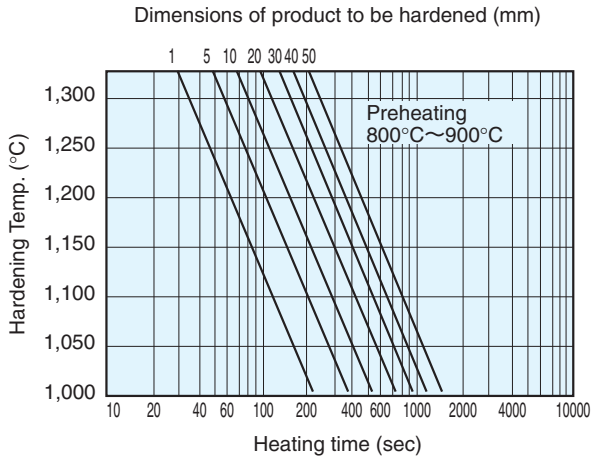
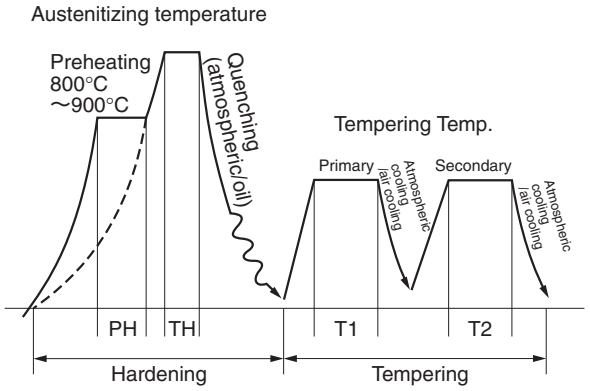
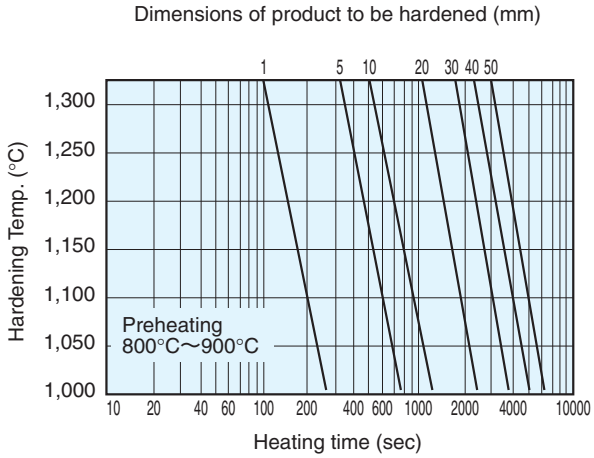
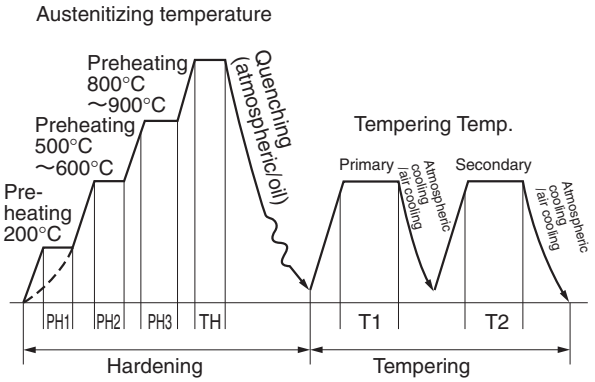
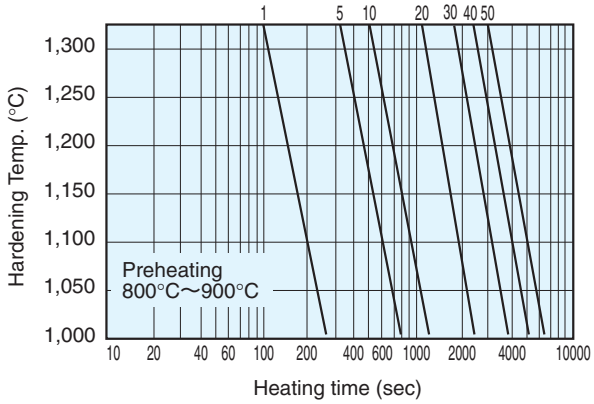
P/M high speed steel



Regular conventional high speed steel



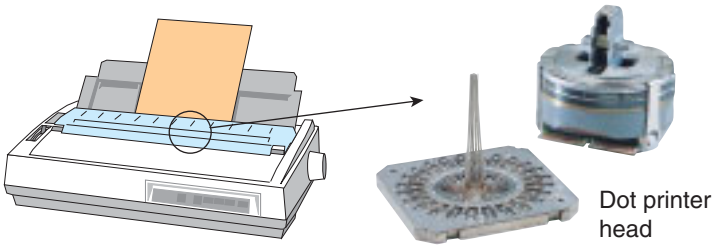
Heat Treatment

	Hardening and Tempering Heating Cycle	Austenitizing Time (TH)
By Salt Bath		
By Atmospheric Furnace		
By Vacuum Furnace		

Applications

Tools for DIY purposes Drills and Hacksaws

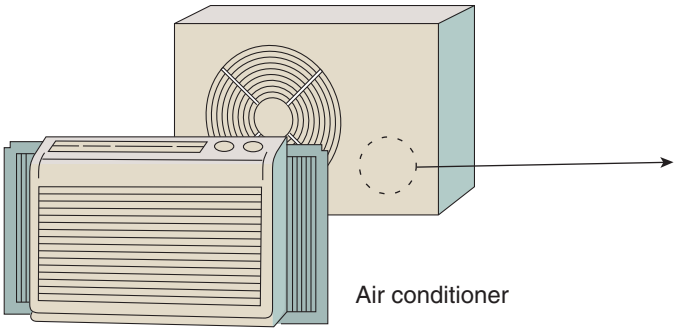
Printer wire for dot matrix printer

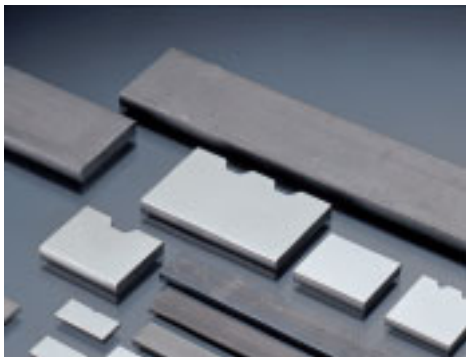


Mold parts (Ejector Sleeves) Machine parts

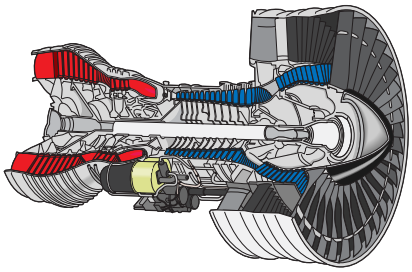
Motorized planer cutter blade

Rotary compressor vanes for air conditioner

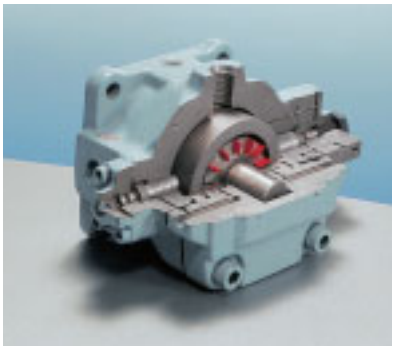




Surface broaches for turbine disc blades in jet engine

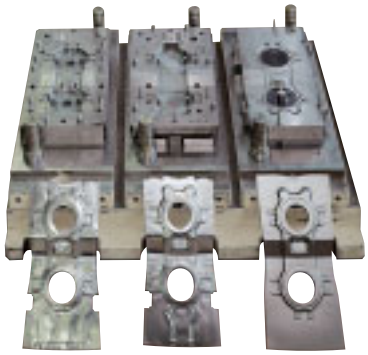


Vanes for hydraulic vane pump



Cold working tools

Precision molds and dies



High-carbon chromium Bearing Steels

Steel Grade			Chemical Composition (%)				Properties	Heat Treatment			Hardness		Main Application
NACHI	AISI SAE	JIS	C	Si	Mn	Cr		Annealing (°C)	Hardening (°C)	Tempering (°C)	Annealed hardness (HB)	Practical hardness (HRC)	
SUJ2	52100	SUJ2	1.00	0.3		1.5	High wear resistance and dimensional stability	750—790 SC	810—850 OQ	150—190 AC	Max201	62—65	Bearings Gages Rolls
SUJ3		SUJ3	1.00	0.6	1.0	1.0	Good hardenability		790—830 OQ		Max207		Large bearings

SC: Slow cooling OQ: Oil quenching AC: Air cooling

Martensitic Stainless Steels

Steel Grade			Chemical Composition (%)				Properties	Heat Treatment			Hardness		Main Application
NACHI	AISI SAE	JIS	C	Si	Mn	Cr		Annealing (°C)	Hardening (°C)	Tempering (°C)	Annealed hardness (HB)	Practical hardness (HRC)	
440C	440C	SUS440C	1.05	0.5		18.0	High corrosion resistance High wear resistance	800—920 SC	1010—1070 OQ	100—180 AC	Max269	58—62	High grade blades Bearings
14RM			Patent pending				Grindability, Cold workability 14RM>440C	800—850 SC			Max229	58—62	Bearings
13RA			0.65	0.2	0.2	13.0	High corrosion resistance	830—870 SC	1000—1050 OQ	150—200 AC	Max223	53—57	Knives Blades

SC: Slow cooling OQ: Oil quenching AC: Air cooling

Alloy Tool Steels

Chemical Composition and Heat Treatment of Alloy Tool Steels

Application	Steel Grade				Chemical Composition (%)									Heat Treatment			Hardness	
	NACHI	Related Standards																
		AISI	DIN WNr.	JIS	C	W	Mo	Cr	V	Co	Mn	Ni	Si	Annealing (°C)	Hardening (°C)	Tempering (°C)	Annealed hardness (HB)	Working hardness (HB)
Cold working	MDS9				1.05		1.6	9.3	0.5					830—880 SC	1000—1050 OQ	500—560 AC	Max210	55—62
Cold working	SRM6				0.75		1.3	1.0			2.0				820—860 OQ	150—400 AC		54—60
Cold working	ICS22				Patented grade									700—950 SC	900—950 CarburizeOQ	150—300 AC	Max197	58—64 on surface
Impact Resistance	SRS6				Patented grade									760—820 SC	860—900 OQ	150—600 AC	Max241	40—55
Hot working	MDS1				Patent pending									820—870 SC	1000—1050 OQ	520—600 AC	Max210	52—59
Hot working	HDN1				Patented grade									800—850 SC	1020—1070 OQ	550—650 AC	Max225	Max55

SC: Slow cooling OQ: Oil quenching AC: Air cooling

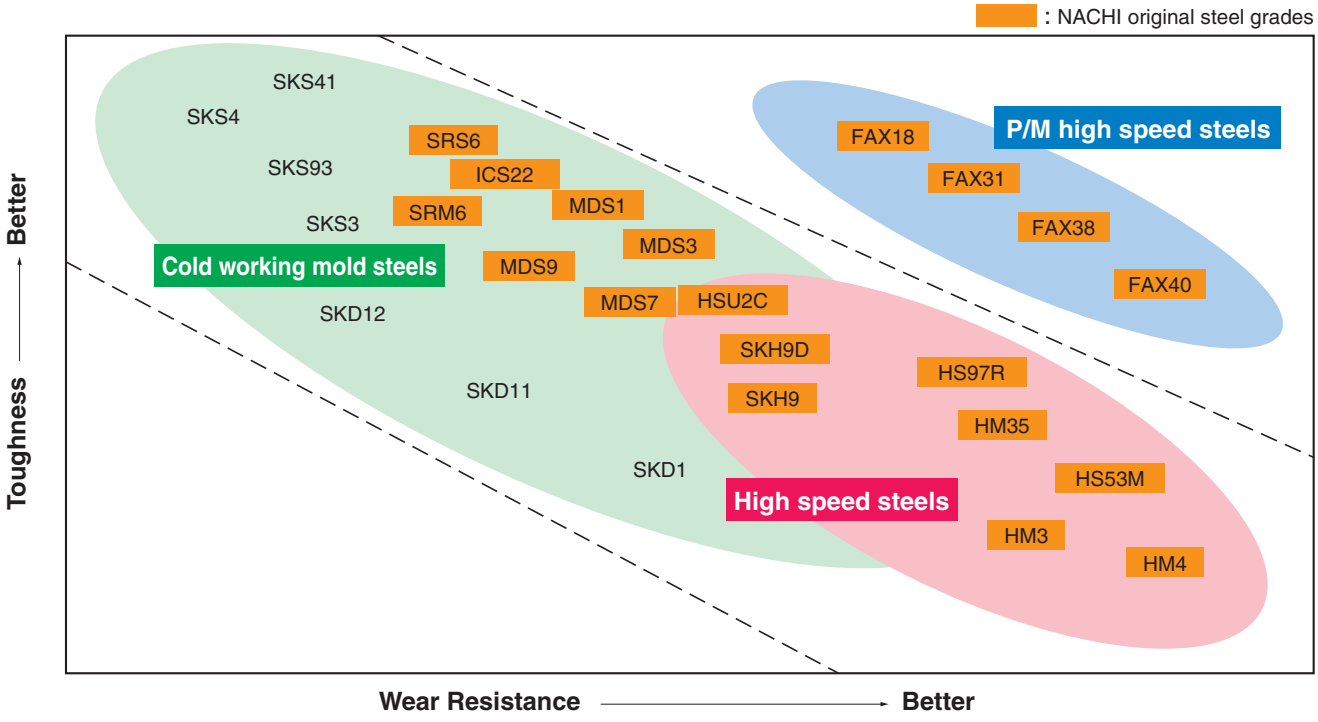
Principle Applications of Alloy Tool Steels

Category	Nachi Grade	Properties	Application
Cold working press molds and dies	MDS9	Less heat treatment deformation Good wear resistance	Cold-drawn dies, bending shaping dies, punch pins Cold-forged dies, press punches for tablets
Formed tools	MDS9 SRM6	Good wear resistance High toughness	Roll threading tools, Roll threading rolls Coining dies, Forming rolls, rolling rolls
Impact resistance tool	SRS6	High strength, toughness and hardenability	Chisels, shearing machine knives, shanks
Hot Forming Press Dies	HDN1 MDS1	Good heat checking sensitivity	Gears, bolts, nuts, hot woek dies for bearings
Hot Forming Press Dies	MDS1	High hot working strength	Punches, dies, sleeves, die-cast dies

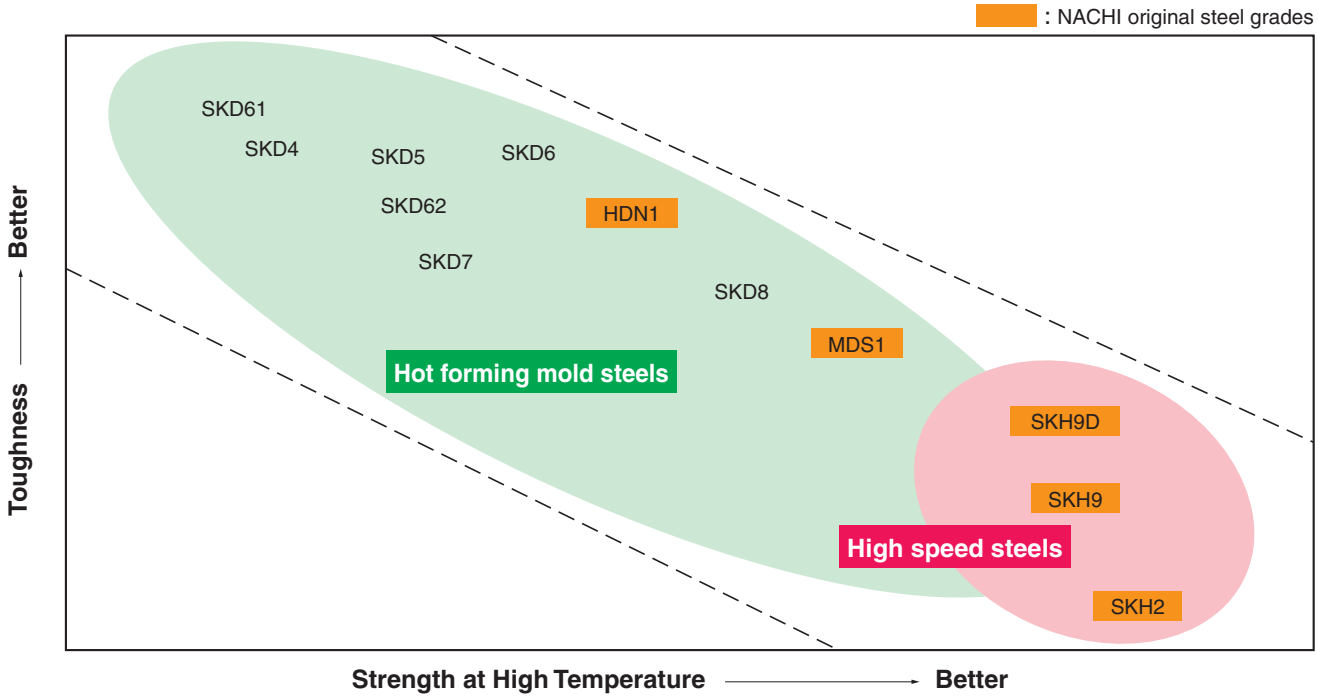
Ranking of Properties of Alloy Tool Steels

Select the proprietary developed steels (NACHI original steel grades) to meet your particular requirements.

Cold Working Mold Steels



Hot Forming Mold Steels



Sintered Products

Micron-hard wire

Category and Properties and Applications

Category	Grade	Properties	Hardness (HV)	Deflecrive Strength (Gpa)	Applications
P/M High Speed Steel	FAX40D	Standard type High toughness Good wear resistance	900	4.5	Dot printer pins Probe pins
	FAX40SS	High Vanadium type High wear resistance	950	4.5	Dot printer pins Wear resistant machine parts
Super Micro Grain Tungsten Carbide	HF13T	High strength type High wear resistance High buckling strength	1850	4.0	Pins and punches for precision mold
	HF14T	Standard type Good wear resistance Good toughness	1600	4.3	Pins and punches for precision mold Fine blanking punches for ceramic green sheet
	HF15T	High toughness type	1250	4.5	Dot printer pins

Shape and Dimensions

Shape	Nominal Diameter
Straight	ø0.07—0.6
Tapered	Tip dia. 0.07 & up Shaft dia. 0.20—0.6
Stepped	

High precision tolerance (+/-1 µm, etc.) and special shape is available on request.

Micron-hard (Ultra fine wire)

Cermet Inserts

Grades and Properties of NAX Series

Cermet Grade	Hardness (HRA)	Deflective strength (GPa)	Properties			Applications			Related Carbide Grade
			Wear resistance	Impact Resistance	Thermal Shock Resistance	Turning	Milling	Chip Saw	
NAX T	92.5	1.5							P10
NAX M	92.0	1.6							
NAX V	92.5	1.6							P15
NAXEE	91.5	1.8							P20
NAXLL	92.5	2.0							P25
NAXSS	92.0	2.0							

Production Size Ranges

Regular Steels

Group A	High Speed Steels Alloy Tool Steels Martensitic Stainless Steels

Group B	Bearing Steels Alloy Tool Steels (Some Grades For Cold Working)

Round Bars

Product Item	Standard Dimensions	
	Group A	Group B
Hot Rolled Bars	Diameter (mm) 13 19 25 31 37 43 49 55 80 110 14 20 26 32 38 44 50 57 85 114 15 21 27 33 39 45 51 60 90 120 16 22 28 34 40 46 52 65 95 17 23 29 35 41 47 53 70 100 18 24 30 36 42 48 54 75 104 Length 3000 to 4500	Diameter (mm) 13 19 25 31 37 43 49 55 80 110 14 20 26 32 38 44 50 57 85 114 15 21 27 33 39 45 51 60 90 120 16 22 28 34 40 46 52 65 95 130 17 23 29 35 41 47 53 70 100 140 18 24 30 36 42 48 54 75 104 150 Length 4000 to 5000

Product Item	Standard Dimensions			
	Group A		Group B	
	Diameter (mm)	Length (mm)	Diameter (mm)	Length (mm)
Forged and Turned Bars	50 to 100	2000 to 3000	50 to 100	2000 to 3000
	100 to 250	2000 to 4000	100 to 390	2000 to 4000

Square Bars

Product Item	Standard Dimensions	
	Group A (mm)	Group B (mm)
Hot Rolled Bars	8.5 13.0 17.0 22.23(7/8) 29.0 9.2 13.5 18.0 24.0 30.0 9.53(3/8) 14.0 19.0 25.0 32.0 10.0 14.5 19.05(3/4) 25.4(1.0) 34.0 10.2 15.88(5/8) 20.0 26.0 35.0 11.5 16.0 21.0 27.0 38.0 12.7 16.8 22.0 28.0 50.0	Dimensions in parentheses ( ) indicate inches.

Steel Coils

Product Item	Standard Dimensions	
	Group A	Group B
	Diameter (mm)	Diameter (mm)
Cold-drawn Coils	0.8 to 12.0	0.8 to 13.0

Straight Rods

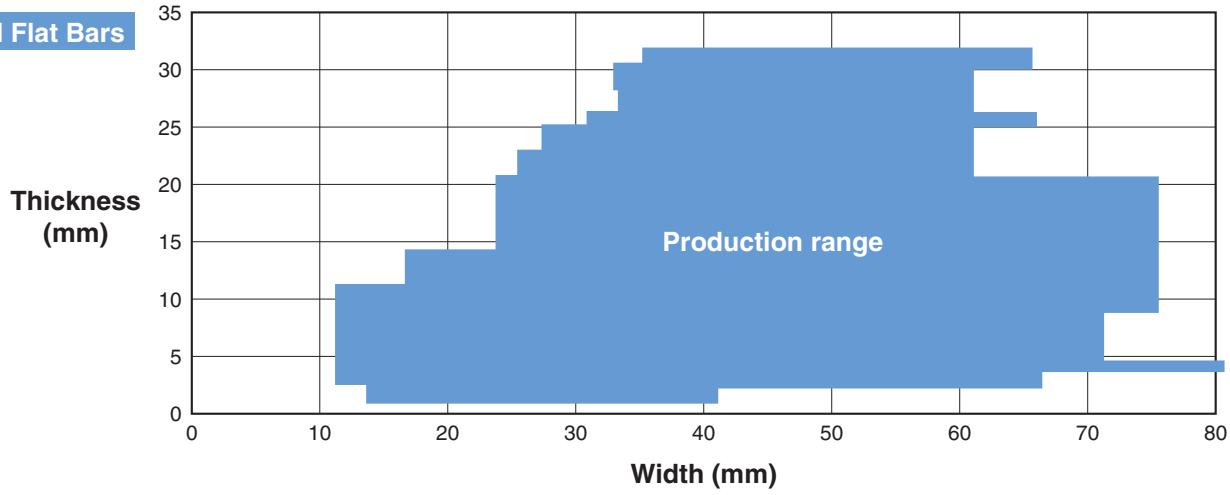
Product Item	Standard Dimensions			
	Group A		Group B	
	Diameter (mm)	Length (mm)	Diameter (mm)	Length (mm)
Cold drawn	More than 0.8 and 1.0 or less	1000 to 2000	More than 0.8 and 1.0 or less	1000 to 2000
	More than 1.0 and 3.0 or less	2000 to 3000	More than 1.0 and 4.1 or less	2000 to 3000
	More than 3.0 and 12.0 or less	3000 to 4000	More than 4.1 and 14.0 or less	3000 to 4000
Ground	More than 0.8 and 2.0 or less	2000 less	More than 0.8 and 2.0 or less	1000 to 2000
	More than 2.0 and 6.0 or less	3000 less	More than 2.0 and 6.0 or less	1500 to 2000
	More than 6.0 and 25.0 or less	3500 less	More than 6.0 and 13.4 or less	2000 to 3500
			More than 13.4 and 25.0 or less	2500 to 4000

Sheets & Plates

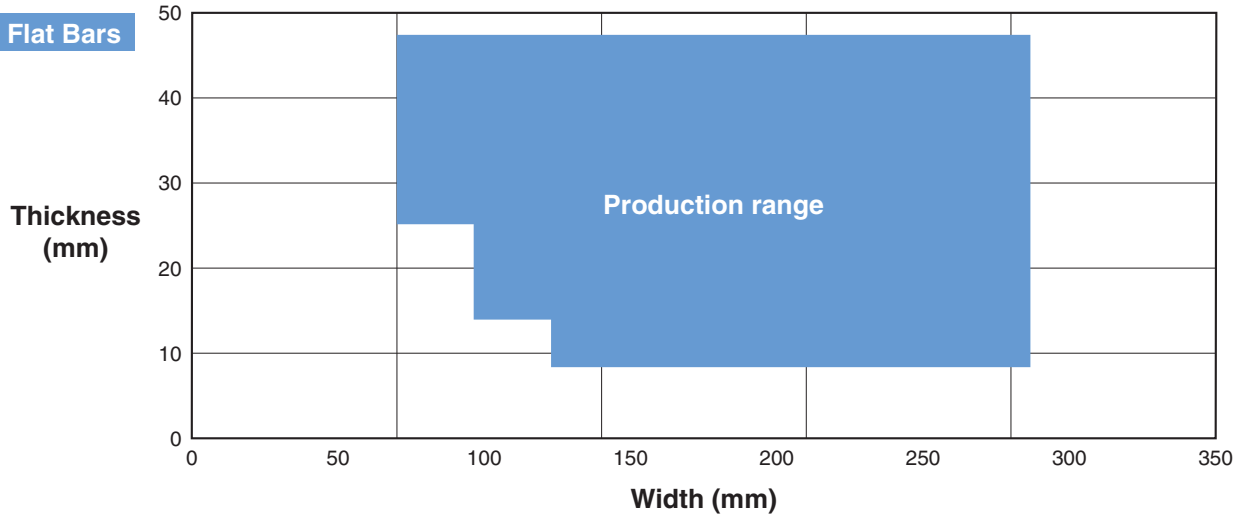
Product Item	Standard Dimensions					
	Group A			Group B		
	Thickness (mm)	Width (mm)	Length (mm)	Thickness (mm)	Width (mm)	Length (mm)
Cold-rolled Sheets	More than 0.5 and less than 2.5	550 to 600	1500 to 2000	More than 0.5 and less than 3.0	500 to 550	1500 to 2000
	More than 2.5 and less than 6.0	550 to 600	1500 to 2200	More than 3.0 and less than 6.0	500 to 600	1500 to 2000
	More than 6.0 and less than 7.0	550 to 600	1500 to 2000	More than 6.0 and less than 7.0	500 to 600	1000 to 2000
	More than 7.0 and less than 8.0	550 to 600	1000 to 1800	More than 7.0 and less than 8.0	500 to 600	1000 to 1800
	More than 8.0 and less than 9.0	500 to 550	1000 to 1600	More than 8.0 and 14.0 or less	500 to 600	1000 to 1500
	More than 9.0 and 10.0 or less	500 to 550	1000 to 1500			
Hot-rolled Sheets	More than 4.5 and less than 6.0	550 to 600	1500 to 2000	More than 4.0 and less than 8.0	550 to 600	1500 to 2200
	More than 6.0 and less than 7.0	550 to 600	1000 to 2000	More than 8.0 and less than 14.0	550 to 600	1000 to 2200
	More than 7.0 and less than 8.0	550 to 600	1000 to 1800	More than 14.0 and less than 20.0	500 to 550	1000 to 1500
	More than 8.0 and 12.0 or less	500 to 550	1000 to 1500			

Hot Rolled Flat Bars

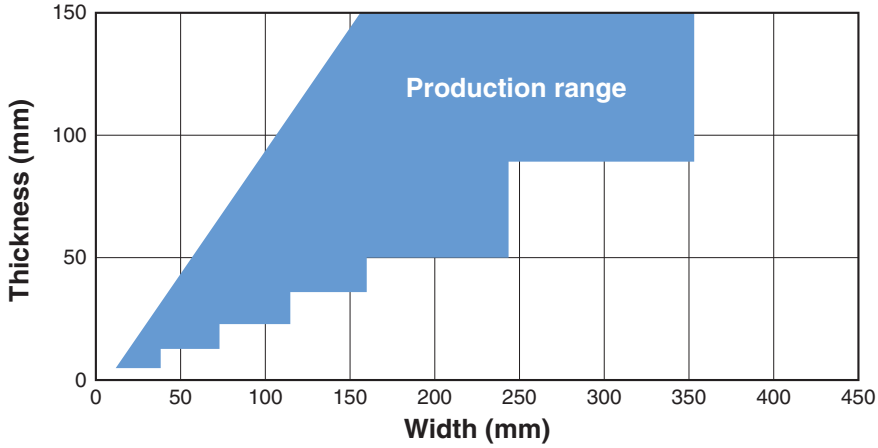
Small Flat Bars



Wide Flat Bars



Forged Flat Bars



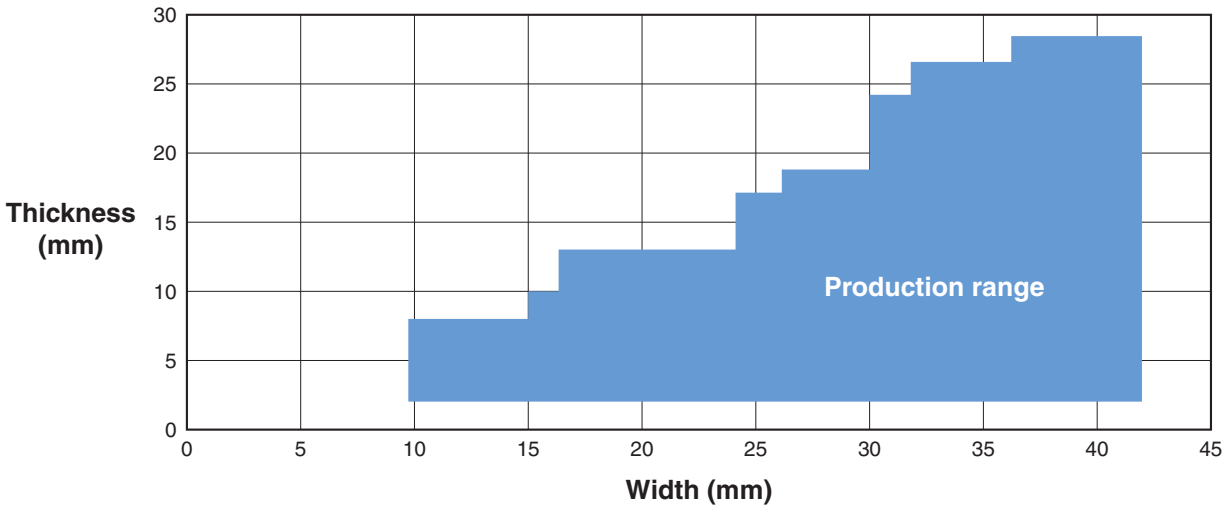
Examples of Products

Round bars

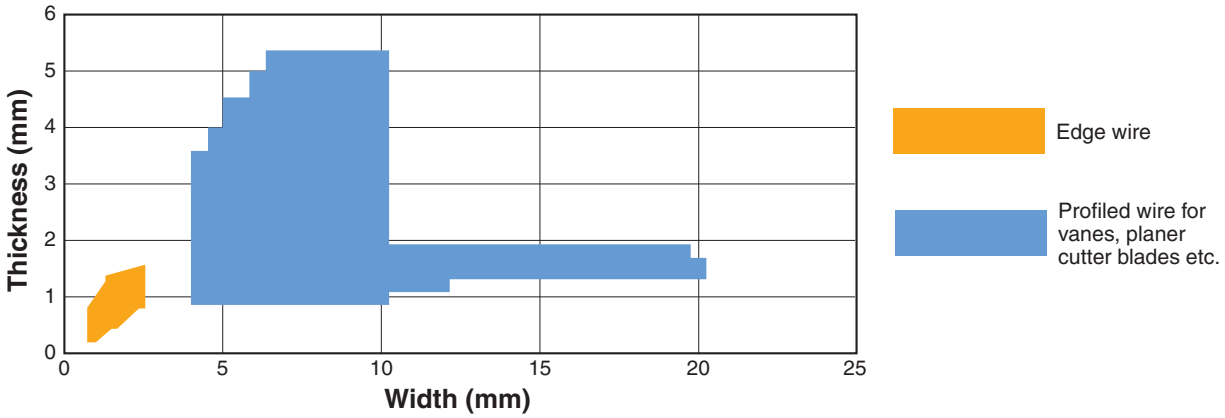
Sheets

Precision Worked Products

Cold Drawn Flat Bars



Precision Drawn Wires (Turk's head rolling)



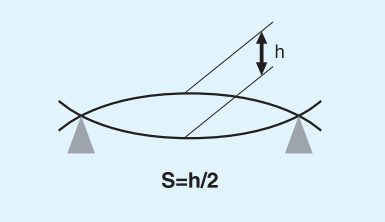
Pre-shape/Profiled rods or wires

Hardened Bars

Production Range

Surface conditions	Diameter (mm)			Standard length (mm)		Cut length (mm)		Surface defect depth (mm)
		Tolerance	Deviation		Tolerance		Tolerance	
Ground	ϕ2.0 to 3.0	+0/-0.014	<0.005	2,000	+10/-0	20 to 100	+0.5/-0	0
	ϕ3.1 to 6.0	+0/-0.018	<0.006					
	ϕ6.1 to 10.0	+0/-0.022	<0.007			101 to 500	+1.0/-0	
	ϕ10.1 to 16.0	+0/-0.027	<0.008					
Precision Drawn	ϕ0.2 to 0.9	+0/-0.012	<0.004	1,000	+10/-0	20 to 100	+0.5/-0	0.01
	ϕ1.0 to 1.1	+0/-0.014	<0.005	1,500	+10/-0			
	ϕ1.1 to 2.5	+0/-0.020	<0.006	2,000	+10/-0	101 to 500	+1.0/-0	
	ϕ2.6 to 3.6	+0/-0.025	<0.008					
Unground	ϕ2.0 to 3.0	+0.04/-0.02	<0.030	2,000	+10/-0	20 to 100	+0.5/-0	<0.02
	ϕ3.1 to 6.0	+0.06/-0.02	<0.040					<0.05
	ϕ6.1 to 10.0	+0.08/-0.02	<0.050			101 to 500	+1.0/-0	<0.12
	ϕ10.1 to 16.0	+0.10/-0.02	<0.060					<0.15

Straightness

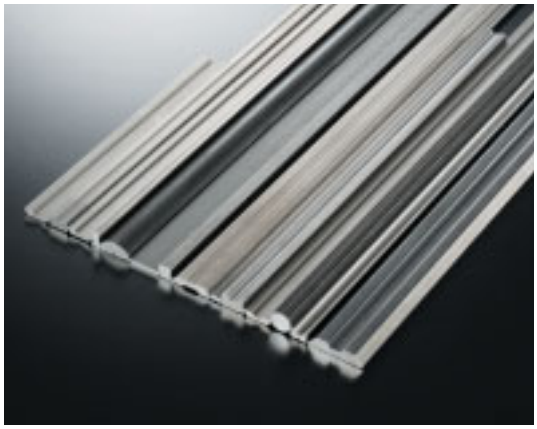


Length (mm)	Straightness (s)
20 to 50	≦0.020
51 to 75	≦0.045
76 to 100	≦0.080
101 to 175	≦0.150
176 to 200	≦0.200
201 to 2000	(L/1000)×1.0 ※L=200 to 2000

Applicable Steel Type/Heat Treatment Hardness

Steel type	NACHI	Standard		Hardness (HRC)	
		JIS	AISI	For cutting tools	For metal forming
High-speed tool steel	SKH9	SKH51	M2	64-66	58-61 61-64
	HM35	SKH55	M35	65-67	60-64
	HM33		M33	65-67	60-64
	HM42	SKH59	M42	66-68	60-65
Powdered high-speed tool steel	FAX38	SKH40		66-68	64-68
Martensitic stainless steel	440C	SUS440C	440C	55-60	55-60
	420J2	SUS420J2	420B	51-54	51-54

* Other grades and hardness are available upon request.



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