Hardening and Hardness Test Methods

Standard Material Sizes 1

■ Heat Treatment for Steel Materials

Name	Vickers Hardness (HV)	Hardening Depth (mm)	Strain	Applicable Materials	Typical Material	Reference
Through hardening	750 or Less	Full Depth	Varies according to materials.	High Carbon Steel C>0.45%	01 Tool Steel JIS-SKS21 52100 Bearing Steel M2 Tool Steel JIS-SKS93 W1-9 Tool Steel 1045 Carbon Steel	·Operation of heating copper to an appropriate temperature over transformation point and quickly cooling it in an appropriate medium in order to increase hardness or improve strength. ·Not applicable to long or precision parts, such as spindles, etc.
Carburization	500 or Less	Standard 0.5 Up to 2	Moderate	Low Carbon Steel C<0.3%	SCM415 Alloy Steel JIS-SNCM220	·Applicable to partial hardening ·Hardening depth should be specified on drawings. ·Applicable to precision parts.
Induction Hardening	750 or Less	1~2	High	Medium Carbon Steel C 0.3~0.5%	1045 Carbon Steel	·A surface hardening method that uses high frequency induction current to quickly heat and cool the steel surface. ·Applicable to partial hardening ·Expensive in small-volume lots. ·High fatigue resistance.
Nitriding	900~1000	0.1~0.2	Low	Nitriding Steel	JIS-SCM645	·A surface hardening method that forms hardening layer of hard nitride compounds on the steel surface ·Obtains highest degree of hardness among all hardening techniques. ·Fit for mass production. ·Applicable to spindles for sliding bearing.
TUFFTRIDE is the trademark of Durferrit GmbH, Germany (salt bath process).	Carbon Steel 500 Stainless Steel 1000	0.01~0.02	Low	Steel Material	1045 Carbon Steel SCM415 Alloy Steel W1-10 Tool Steel Stainless Steel	·Tufftride is one of the nitriding methods called soft-nitriding (salt bath process). ·High fatigue resistance and abrasion resistance ·Same corrosion resistance as zinc plating. ·Not applicable to precision parts because of incapability of polishing after heat treatment. ·Applicable to oil free bearings.
Bluing	—	—	—	Wire Rod	JIS-SWP-B	·Low temperature annealing. ·Removes internal stress during forming to enhance elasticity.

■ Hardness Test Methods and Applicable Parts

Testing Method	Principle	Applicable Heat-Treated Parts	Features	Reference
Brinell Hardness	·A (steel or super hard alloy) ball indenter is used to indent the test surface. Hardness is given as a quotient divided by the surface area of the dent, computed from the diameter.	·Annealing ·Normalized parts ·Anchored materials	·Applicable to uneven materials and forged products because indent is large. ·Not applicable to small or thin specimens.	JIS Z2243
Rockwell Hardness	·This standard or test load is applied via a diamond or ball indenter. Hardness is read on a tester.	·Hardening tempered parts ·Carburized surfaces ·Nitrided parts ·Thin sheets such as copper, brass, bronze, etc.	·Hardness value obtained quickly. ·Applicable to intermediate testing of actual products. ·Caution is required as there are 30 types.	JIS Z2245
Shore Hardness	·The specimen is set on a table. A hammer is dropped from a uniform height. Hardness is based on how height the hammer bounces.	·Hardening tempered parts ·Nitrided parts ·Large carburized parts, etc.	·Extremely easy to operate and data can be obtained quickly. ·Applicable to large parts. ·Indent is kept shallow, therefore is applicable to actual products. ·Portable, as being compact and light weight.	JIS Z2246
Vickers Hardness	·Uses a diamond 136°square pyramid indenter. Hardness value is obtained from the surface area of the dent, computed from the experimental load and the length of the diagonal lines of the dent.(Automatically calculated)	·This hardening layers by induction hardening, carburizing, nitriding, electrolytic plating, ceramic coating, etc. ·Hardening layer depth in carburized and nitrided parts.	·Applicable to small and thin specimens. ·Applicable to all materials because of diamond indenter.	JIS Z2244

■ General Steel Materials

Type	Material Code	Shapes	Unit	Standard Dimensions
Rolled Steel for General Structure	1018 Carbon Steel	Flat Bar	t	6,9,12,13,14,16,19,22,25,28,30,32,35,38,40,45,50,55,60,65,70,75,80,85,90,95,100,105
		Square Bar	_	9,13,16,19,22,25,32,38,44,50,65,75,90,100
Polished Steel Bar (Cold-Drawn)	JIS SS400D	Flat and Square Steel Bar	t	Width W
			2	6,8,10,12,16,20
			3	6,8,9,10,12,13,16,19,22,25,32,38,50
			4	10,13,16,19,20,22,25,32
			4.5	11,13,16,19,22,25,32,38,50
			5	8,10,13,16,19,20,22,25,30,32,38,50
			6	9,10,13,16,19,20,22,25,32,38,44,50,60,65,75,90,100,125
			8	10,12,13,16,19,22,25,30,32,38
			9	12,13,16,19,22,25,32,38,44,50,60,65,75,90,100,125
			10	13,15,16,20,22,25,30,32,38,40,50,60,65,100
			12	16,19,22,32,38,44,45,50,60,65,75,90,100,125
			16	19,22,25,32,38,44,50,60,65,75,90,100,125
			19	22,25,32,38,44,50,60,65,75,90,100,125
			22	25,32,38,44,50,60,65,75,90,100,125
			25	32,38,44,50,60,65,75,90,100,125
			30	50,65,75,100,125
			32	50,65,75,100,125
			38	50,65,75,100,125
		Square Bar	_	2.5,3,4,4.5,5,5.5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,24,25,28,30,32,34,35,36,38,40,42,44,45,50,55,60,65,70,75,80,85,90,100,110,120,130
		Hexagonal Bar	Opposite side H	3,5,6,7,8,9,10,11,12,13,14,17,19,21,22,23,24,26,27,29,30,32,35,36,38,41,46,50,54,55,58,60,63,65,67,70,71,75,77,80,85,90,95,100,115
		Round Bar	D	2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,36,37,38,40,42,43,44,45,46,48,50,55,60,65,70,75,80,85,90,95,100,105,110,115,120,130,140,150,160,170,180,190,200
Cold-Rolled Steel Plate	Low Carbon Steel	Steel Plate	t	0.4,0.5,0.6,0.7,0.8,1,1.2,1.6,2,2.3,3.2
Hot-rolled Steel Plate	Low Carbon Steel	Steel Plate	t	(1.2),1.6,2.3,2.6,3.2,4.5
Carbon Steel for Machine Structural Use	1045 Carbon Steel (Polished)	Round Bar	D	2,2.5,3,3.5,4,4.5,6,7,8,9,9.5,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30,32,33,34,35,36,38,40,42,44,45,46,48,50,55,60,65,70,75,80,85,90,95,100,105,110,115,120,125,130
	1049 Carbon Steel	Flat Bar	t	6,9.5,12.7,13,16,19,22,25,27,32,38,45,50,55,65,75,85,95,105,115,125,135,145,155,(165),(175),(185),(205)
		Square Bar	_	12.7,13,16,19,25,28,32,38,44,50,55,65,75,90,100,110,120,130,155
Carbon Tool Steel	JIS-SKS93	Flat Bar	t	2,3,4,5,6,7,8,9,10,12,13,16,19,22,25,27,32,38,43,50,53,65,75,90,105,130,155
	JIS-SKS93	Square Bar	_	10,13,16,19,22,25,28,32,38,45,50,55,65,75,90,105,130,(155),(210)
	W1-9 Tool Steel -DG8	Round Bar	D	2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,22,23,24,25,26,28,30,32,36,38,40,42,45,48,50,55,60,65,70,75,80
Alloy Tool Steel	01 Tool Steel	Flat Bar	t	2,3,4,5,6,7,8,9,10,12,13,16,19,22,25,27,32,38,43,50,53,65,75,90,105,130,155,(160)
		Square Bar	_	10,13,16,19,22,25,28,32,36,38,45,50,55,65,75,90,105,130,(155),(210)
		Round Bar	D	13,16,19,22,25,28,32,38,42,46,50,55,60,65,70,80,85,90,100,110,120,130,150,160,180
Chrome Molybdenum Steel	4137 Alloy Steel	Hexagonal Bar	Opposite side H	6,7,8,9,10,11,12,13,14,17,19,21,22,23,24,26,27,30,32,35,36,38,41,46,50,54,55
		Round Bar	D	4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,30,32,34,35,36,38,40,42,45,46,48,50
Sulfuric and Sulfur Compound Free Cutting Steel	12L14 Carbon Steel	Round Bar	D	3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,20,22,23,24,25,26,28,30,32,34,35,36,38,40
High Carbon Chrome Bearing Steel	52100 Bearing Steel	Round Bar	D	13,16,19,22,25,28,(30),32,(34),36,38,42,(44),46,(48),50,55,60,65,70,75,80,85,90,95,100,110,120,130,140,150,(160),(170),(180),(190),(200),(210),(220),(230),(240),(250)