

TOTAL P.03

0.15-0.35 0.80-1.20

0.80-1.00

0.30Ti
0.10Al
0.15-
0.30Ti

Iron, sulphur and phosphorus contents are not listed, but are specified; see appropriate standard for more

Cr, 0.020-0.035%
Mn, 0.020-0.030%
Ni, 0.015-0.038%

Correlate the various metal designations from country to country, let alone comparing several countries and view that chemical composition may be similar, but not identical, and that manufacturing technologies may vary. Cross references made in this table are, at best, only listed as a guide to assist in finding comparable metal designations.

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S

P

MN

SI

C

S45C	0.42-0.48	0.15-0.45	0.60-0.90	0.030-0.035
S40C	0.37-0.43	0.15-0.35	0.60-0.90	0.030-0.035
S10C	0.08-0.13	0.15-0.35	0.30-0.60	0.030-0.035

Chapter 17 International Cross References - Carbon & Alloy Steels

JAPANESE CROSS REFERENCES FOR CARBON STEELS

1008	0.12	0.35	0.50	0.040	0.040	0.20Cr, 0.20Ni, 0.25Cu, Ni+Cr = 0.30
1028	0.25-0.35	0.35	0.30-1.00	0.040	0.040	
1048	0.45-0.55	0.40	0.40-1.00	0.040	0.025	
1015	0.18-0.23	0.15-0.35	0.30-0.60	0.025	0.025	0.20Cr, 0.20Ni, 0.20Cu
1010	0.07-0.12	0.15-0.35	0.30-0.60	0.030	0.035	
1012	0.08-0.13	0.15-0.35	0.30-0.60	0.030	0.035	
1015	0.10-0.15	0.15-0.35	0.30-0.60	0.030	0.035	
1017	0.13-0.18	0.15-0.35	0.30-0.60	0.030	0.035	
1020	0.15-0.20	0.15-0.35	0.30-0.60	0.030	0.035	
1022	0.18-0.23	0.15-0.35	0.30-0.60	0.030	0.035	
1025	0.20-0.25	0.15-0.35	0.30-0.60	0.030	0.035	
1028	0.22-0.28	0.15-0.35	0.30-0.60	0.030	0.035	
1035	0.25-0.31	0.15-0.35	0.30-0.60	0.030	0.035	
1037	0.27-0.33	0.15-0.35	0.30-0.60	0.030	0.035	
1040	0.32-0.38	0.15-0.35	0.30-0.60	0.030	0.035	
	0.37-0.43	0.15-0.35	0.30-0.60	0.030	0.035	

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JAPANESE CROSS REFERENCES FOR CARBON STEELS¹⁾ (Continued)

JIS	AISI	SAE	UNS	Other
1042	S43C	0.40-0.46	0.15-0.35	0.80-0.90
1043	S45C	0.42-0.48	0.15-0.45	0.80-0.90
1045	S50C	0.47-0.53	0.15-0.35	0.80-0.90
1050	S55C	0.50-0.56	0.15-0.35	0.80-0.90
1055	S55C	0.52-0.58	0.15-0.35	0.80-0.90
1055	S55C	0.55-0.61	0.15-0.35	0.80-0.90
1060	S59C	0.30-0.36	0.15-0.35	1.20-1.50
1536	SMn1H, SMn433H	0.25-0.41	0.15-0.35	1.35-1.65
1541	SMn2H, SMn438H	0.40-0.46	0.15-0.35	1.35-1.65
1541	SMn3H, SMn433H	0.30-0.36	0.15-0.35	1.20-1.50
1536	SMn1	0.35-0.41	0.15-0.35	1.35-1.65
1541	SMn2	0.40-0.46	0.15-0.35	1.35-1.65
1541	SMn3	0.17-0.23	0.15-0.35	1.20-1.50
1522	SMn21	0.30-0.36	0.15-0.35	1.20-1.50
1524	SMn433	0.40-0.46	0.15-0.35	1.35-1.65
1538	SMn443	0.35-0.41	0.15-0.35	1.35-1.65
1541	SMn438	0.75-0.90	0.15-0.35	0.30-0.60
1078	SUP3	0.90-1.10	0.15-0.35	0.30-0.60
1095	SUP4			

0.200%, 0.20Ni, 0.30Cu, Ni+Cr = 0.35
 0.200%, 0.20Ni, 0.30Cu, Ni+Cr = 0.35


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Chapter 17 International Cross References - Carbon & Alloy Steels 317
 CROSS REFERENCES FOR CARBON STEELS¹⁾ (Continued)

SUM11	0.08-0.13	0.08-0.13	0.08-0.13	0.08-0.13
SUM12	0.13	0.13	0.13	0.13
SUM21	0.08-0.13	0.08-0.13	0.08-0.13	0.08-0.13
SUM22	0.08	0.08	0.08	0.08

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<p>Notes: (1) "Protective atmosphere" shall mean an atmosphere, usually made up of heat-absorbing gas, neutral salt bath, etc., used for preventing oxidation and decarbonization during the heating treatment.</p> <p>(2) "Tempering at a low temperature" shall mean a tempering treatment performed at a temperature of 250 °C or lower to reduce the brittleness caused by quenching.</p> <p>(3) Heating treatment in the atmosphere is also acceptable as a way of tempering.</p> <p>4. Standard Specifications</p> <p>The standard hardness of quenched and tempered structural steel and similar steel materials are listed in Table 2 together with the codes. For Class A, however, no standard specifications are provided. For Classes B and C, special hardness may also be specified, if necessary, beside the specifications provided in the table.</p> <p style="text-align: center;">Table 2</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th rowspan="2">Treatment code</th> <th rowspan="2">Standard hardness range HV (98 to 490 N) (10 to 50 kgf)</th> <th colspan="3">Other characteristics (Reference)</th> </tr> <tr> <th>HRC</th> <th>HB</th> <th>Tensile strength (MPa) (kgf/mm²)</th> </tr> </thead> <tbody> <tr> <td>TSH5102G-A</td> <td>Specified for individual materials</td> <td style="text-align: center;">—</td> <td></td> <td style="text-align: center;">—</td> </tr> <tr> <td>TSH5102G-B</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>TSH5102G-B7</td> <td>230 to 290</td> <td>20 to 28</td> <td rowspan="14" style="text-align: center;">—</td> <td>686 (10) min.</td> </tr> <tr> <td>TSH5102G-B8</td> <td>260 to 320</td> <td>25 to 33</td> <td>784 (10) min.</td> </tr> <tr> <td>TSH5102G-B9</td> <td>285 to 350</td> <td>29 to 36</td> <td>882 (10) min.</td> </tr> <tr> <td>TSH5102G-B10</td> <td>310 to 370</td> <td>32 to 38</td> <td>980 (10) min.</td> </tr> <tr> <td>TSH5102G-B11</td> <td>340 to 390</td> <td>34 to 39</td> <td>1078 (10) min.</td> </tr> <tr> <td>TSH5102G-B12</td> <td>370 to 440</td> <td>38 to 44</td> <td>1176 (10) min.</td> </tr> <tr> <td>TSH5102G-B13</td> <td>400 to 470</td> <td>41 to 47</td> <td>1274 (10) min.</td> </tr> <tr> <td>TSH5102G-B14</td> <td>430 to 500</td> <td>44 to 49</td> <td>1372 (10) min.</td> </tr> <tr> <td>TSH5102G-C</td> <td>Specified for individual materials</td> <td style="text-align: center;">—</td> <td></td> <td style="text-align: center;">—</td> </tr> <tr> <td>TSH5102G-C7</td> <td>230 to 290</td> <td>20 to 28</td> <td>223 to 285</td> <td>686 (10) min.</td> </tr> <tr> <td>TSH5102G-C8</td> <td>260 to 320</td> <td>25 to 33</td> <td>255 to 311</td> <td>784 (10) min.</td> </tr> <tr> <td>TSH5102G-C9</td> <td>285 to 340</td> <td>29 to 35</td> <td>285 to 311</td> <td>882 (10) min.</td> </tr> </tbody> </table> <p>Remarks: 1. If a deviation in hardness occurs between different sites of the component due to its shape and size, the hardness specified in the table shall apply to the standard site of the component.</p> <p>2. Numerals at the end of the treatment numbers represent a tenth of the tensile strength value (MPa) (kgf/mm²) in the reference column of the table.</p>			Treatment code	Standard hardness range HV (98 to 490 N) (10 to 50 kgf)	Other characteristics (Reference)			HRC	HB	Tensile strength (MPa) (kgf/mm ²)	TSH5102G-A	Specified for individual materials	—		—	TSH5102G-B					TSH5102G-B7	230 to 290	20 to 28	—	686 (10) min.	TSH5102G-B8	260 to 320	25 to 33	784 (10) min.	TSH5102G-B9	285 to 350	29 to 36	882 (10) min.	TSH5102G-B10	310 to 370	32 to 38	980 (10) min.	TSH5102G-B11	340 to 390	34 to 39	1078 (10) min.	TSH5102G-B12	370 to 440	38 to 44	1176 (10) min.	TSH5102G-B13	400 to 470	41 to 47	1274 (10) min.	TSH5102G-B14	430 to 500	44 to 49	1372 (10) min.	TSH5102G-C	Specified for individual materials	—		—	TSH5102G-C7	230 to 290	20 to 28	223 to 285	686 (10) min.	TSH5102G-C8	260 to 320	25 to 33	255 to 311	784 (10) min.	TSH5102G-C9	285 to 340	29 to 35	285 to 311	882 (10) min.
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Remarks: 3. The values for HRC and HB are provided for reference purposes in the case of process management, etc. Their limits are intentionally made strict in consideration of possible calculation errors.

4. Attention must be paid to TSH5102G-C9 since this treatment may even hamper machining.

5. Qualities

5.1 Hardness

After all machining processes are finished, the standard site⁽⁴⁾ of the component specified in drawings should have the specified hardness down to the depth shown in Table 3.

Note: (4) If a standard site is not specified in drawings, the functionally most important site of the component shall be used for it.

Table 3

Type	Region of specified hardness (mm deep)
TSH5102G-A	6 min. from the surface
TSH5102G-B	6 min. from the surface
TSH5102G-C	3 min. from the surface

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5.2 Decarbonization and Carburization

The tolerances for the decarbonization and the carburization of a component treated by quenching and tempering shall be as in Table 4. If necessary, however, it may be otherwise specified through consultations with the section(s) involved.

Table 4





Type	Ferrite decarburized depth (mm)	Total decarburized depth (mm)	Superficial hardness HV (98 N) (10 kgf)
TSH5102G-A	—	—	Hardness range wider than the prescribed lower and upper limits by 30 each ⁽⁵⁾ .
TSH5102G-B	—	—	
TSH5102G-C	0.05 max.	0.30 max.	—

Note: (5) For TSH5102G-B9 (HV: 285 to 350), for example, the superficial hardness must be HV (98 N) (10 kgf) =255 to 380.
For threaded components, however, the hardness specified in TSB1001G shall apply.


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<p>5.3 Metal Structure A quenched and tempered material should possess the intended normal metal structure, depending on the types of steel and treatment. The metal structure should be free from harmful defects such as substantial crystal grain growth.</p> <p>5.4 Appearance No defects such as cracks and flaws and harmful oxide film should be observed on the surface.</p> <p>6. Test Methods Quality characteristics specified in this standard should be tested according to the following.</p> <p>(1) Hardness Follow TSG2200G.</p> <p>(2) Decarbonization Follow TSG2107G.</p> <p>(3) Carburization Follow TSG2108G.</p> <p>7. Instructions in Drawings</p> <p>7.1 Items to be Specified See Table 5 for the items to be specified in drawings and how to give instructions in drawings.</p>															
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<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th colspan="2" style="text-align: center;">Items to be specified</th> <th style="text-align: center;">Mode of instruction</th> </tr> </thead> <tbody> <tr> <td style="width: 10%; text-align: center;">Required</td> <td style="width: 40%;">Treatment type and specification</td> <td style="text-align: center;"> TSH5102G -  Type Specification </td> </tr> <tr> <td rowspan="3" style="text-align: center;">Upon necessity</td> <td>Upper and lower limits of hardness (except for standard specifications)</td> <td style="text-align: center;">Hardness: HV ○○○ to ○○○ (expressed in terms of Vickers hardness unless otherwise specified)</td> </tr> <tr> <td>Standard site</td> <td style="text-align: center;">Standard site: ○○ site</td> </tr> <tr> <td>Other characteristics, treatment conditions, etc.</td> <td style="text-align: center;">Describe in a suitable manner.</td> </tr> </tbody> </table>			Items to be specified		Mode of instruction	Required	Treatment type and specification	TSH5102G -  Type Specification	Upon necessity	Upper and lower limits of hardness (except for standard specifications)	Hardness: HV ○○○ to ○○○ (expressed in terms of Vickers hardness unless otherwise specified)	Standard site	Standard site: ○○ site	Other characteristics, treatment conditions, etc.	Describe in a suitable manner.
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	Standard site	Standard site: ○○ site													
	Other characteristics, treatment conditions, etc.	Describe in a suitable manner.													
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<p>7.2 Examples of Instructions in Drawings In making a note in the heat treatment column of a drawing, follow the examples below:</p> <p>Ex. 1 Instruction for the standard hardness range</p> <div style="border: 1px solid black; padding: 5px; margin: 10px 0;"> <p>材料処理・表面処理 (HEAT & SURFACE TREATMENT)</p> <p>TSH5102G-B7</p> </div> <p>Ex. 2 Instruction for a special hardness range</p> <div style="border: 1px solid black; padding: 5px; margin: 10px 0;"> <p>材料処理・表面処理 (HEAT & SURFACE TREATMENT)</p> <p>TSH5102G-B HV 000 to 000</p> </div> <p>Ex. 3 Instruction for a standard site</p> <div style="border: 1px solid black; padding: 5px; margin: 10px 0;"> <p>材料処理・表面処理 (HEAT & SURFACE TREATMENT)</p> <p>TSH5102G-B7 Standard site: A site</p> </div>		
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8. Reference

In giving an instruction in a drawing, refer to Table 6 for the standard specification to be chosen for a given combination of material, size and quenching-tempering treatment type.

Table 6 (reference)

Treatment type	TSH5102G-B			TSH5102G-C		
	Mid-sized Over ϕ 18 to 25 incl.	Small-sized ϕ 13 max.	Large-sized ϕ 25 min.	Mid-sized Over ϕ 18 to 25 excl.	Small-sized ϕ 13 max.	
Steel class						
Carbon steel	S45	7	7, 8, 9	—	7	
	S48			7		
	S50				7, 8	
	S53	—	—	7		
Alloy steel	SCr40	8, 9, 10	8, 9, 10	7, 8		
	SCM40	9, 10, 11	9, 10, 11	7, 8, 9	7, 8, 9	

- Remarks: 1. Numbers in the table correspond to those at the end of the codes in Table 2.
 2. In determining the hardness specification for TSH5102G-A, consult the section(s) involved.
 3. In determining the hardness for free-cutting lead steel and free-cutting resulfurized steel, stretch the standard specifications designed for basic steels.
 4. In determining the hardness for steels not shown in the table and impossible to be judged from the table, consult the section(s) involved.


Applicable Standards

- TSE1001G Mechanical Properties of Externally Threaded Fasteners
- TSG2107G Test Method for Decarburized Layer of Steels
- TSG2108G Test Method for Carburized Layer of Steels
- TSE2200G Hardness Test Method for Metals

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QUENCHING AND TEMPERING

1. Scope

This standard covers the quenching and tempering treatment of steel or cast iron parts to be used as automotive components and of their materials. However, special items such as bolts, nuts, springs, and washers are excluded since treatment techniques and strength requirements are specified in another standard or through a number.

Remark: In this standard, units and numerical values given in { } are based on the customary units system, and are given for reference.

2. Definitions

2.1 Quenching

"Quenching" shall refer to a process in which a component or material is heated for a period of time at an appropriate temperature higher than the transformation point and then rapidly cooled, to give it special hardness.

2.2 Tempering

"Tempering" shall refer to a process of reheating, performed after quenching, at an appropriate temperature lower than the transformation point, to reduce the brittleness caused by quenching and obtain necessary hardness.

3. Classification

Types of quenching-tempering processes and their codes are listed in Table 1.

Table 1

Treatment code	Description	Applications (reference)
TSH5102G-A	Quenching in a protective atmosphere ⁽¹⁾ followed usually by tempering at a low temperature ⁽²⁾ .	Knock pins, etc.
TSH5102G-B	Quenching and tempering ⁽³⁾ in a protective atmosphere performed after major machining processes are over.	Ball joint studs, bolts, flat spring components, etc.
TSH5102G-C	Quenching and tempering performed usually before the machining processes. No protective atmosphere.	Crankshafts, connecting rods, steering knuckles, chassis springs, etc.

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