

Automotive parts - Hexagon head bolts and hexagon head screws

1. Scope

This standard specifies cold forged hexagon head bolts and hexagon head screws (hereinafter referred to as “bolts”) for use on automobiles.

Remark 1: This standard is not applicable to bolts for which weldability, heat resistance at 300 °C or above, and cold resistance at -50 °C or below are required.

Remark 2: Bolts not based on the body of the standard are specified in Annex 1.

2. Normative reference

The following standards contain provisions which, through reference in this Standard, constitute provisions of this Standard. Only the edition of indicated year constitutes the provision of this Standard but the revision and amendment made thereafter are not applied.

JIS B0101: 1994	Screw threads and fasteners - Vocabulary
JIS B0205: 1997	Metric coarse screw threads
JIS B0207: 1997	Metric fine screw threads
JIS B0209: 1997	Limits of sizes and tolerances for metric coarse screw threads
JIS B0211: 1997	Limits of sizes and tolerances for metric fine screw threads
JIS B0251: 1975	Limit gauges for metric coarse screw threads
JIS B0252: 1975	Limit gauges for metric fine screw threads
JIS B0601: 1994	Surface roughness - definitions and designation
JIS B1021: 1985	Tolerance system for threaded fasteners
JIS B1041: 1993	Fasteners - Surface discontinuities - Part 1: Bolts, screws and studs for general requirements
JIS B1051: 1991	Mechanical properties of steel bolts and screws
JIS B1071: 1985	Method of verification for size and geometry of threaded fasteners
JIS B1091: 2003	Fasteners - Acceptance inspection
JIS B1180: 1994	Hexagon head bolts and hexagon head screws
JIS D0201: 1995	Automobile parts - General rules of electroplating
JIS Z2201: 1980	Test pieces for tensile test for metallic materials

3. Definitions

Definitions of main terms used in this standard are specified in **JIS B0101**.

4. Type of bolts

Type of bolts shall be classified depending on their shapes in accordance with **Table 1**.

Table 1 Type of bolts

Type		Shape of shank	Shape of head	Applicable nominal diameter mm	Applicable Attached table
Normal type	Type 1	Bolt with pitch diameter body ⁽¹⁾	Trimmed type	5 to 24	Attached Table 1
			Upset type	5 to 12	
	Type 2	Bolt with nominal diameter body ⁽¹⁾	Trimmed type	6 to 24	
			Upset type	6 to 12	
Small type	Type 1	Bolt with pitch diameter body ⁽¹⁾	Trimmed type	8 to 24	Attached Table 2
			Upset type	8 to 12	
	Type 2	Bolt with nominal diameter body ⁽¹⁾	Trimmed type	8 to 24	
			Upset type	8 to 12	

Note:⁽¹⁾

A bolt with pitch diameter body includes a complete screw thread (i.e., a thread threaded to the head).

Remark: Preference for use is given to bolt with pitch diameter body.

5. Mechanical properties

5.1 Strength division

Strength division of bolts shall be in accordance with **Table 2**.

Table 2 Strength division

Strength division	Column I	4.8	5.8	6.8	8.8	9.8	10.9
	Column II	4T	5T	6T	7T	—	

Remark: Strength division Column II will be abolished in the near future.

5.2 Mechanical properties corresponding to strength division

Mechanical properties corresponding to strength division of bolts shall be in accordance with **Tables 3** and **4**.

Table 3 Mechanical properties of bolts classified into strength division column 1

Mechanical properties			Strength division							
			4.8	5.8	6.8	8.8		9.8 (2)	10.9	
						d ≤ 16	d > 16			
Tensile strength ⁽³⁾ MPa			Nominal	400	500	600	800	800	900	1000
			Min.	420	520	600	800	830	900	1040
Hardness	Vickers hardness ⁽⁴⁾ HV		Min.	130	160	190	250	255	290	320
			Max.	250		250	320	335	360	380
	Rockwell hardness	HRB ⁽⁴⁾	Min.	71	82	89				
			Max.	99.5						
		HRC ⁽⁴⁾	Min.	—			22	23	28	32
			Max.	—			32	34	37	39
Surface hardness HV			Max.	—			(5)			
Proof load stress ⁽⁶⁾ MPa				310	380	440	580	600	650	830
Wedge tensile strength			Same as the minimum value of tensile strength ⁽⁷⁾							

Table 3 (Continued)

Mechanical properties			Strength division						
			4.8	5.8	6.8	8.8		9.8 (2)	10.9
						<i>d</i> ≤ 16	<i>d</i> > 16		
Strength of head percussion			Crack shall not be produced at the under head fillet ⁽⁸⁾ .						
Decarburization at threaded portion ⁽⁹⁾	Height of non-decarburized part <i>E</i> mm	Min.	—		1/2 <i>H</i> ₁			2/3 <i>H</i> ₁	
	Depth of ferrite decarburized layer <i>G</i> mm	Max.	—		0.015				

Note:⁽²⁾

This division applies to bolts having nominal diameter of 16 mm or less.

Note:⁽³⁾

Minimum value of tensile strength shall be applied to bolts having nominal length of $2.5 d$ or more.

Further, the break of bolts shall be produced at threaded portion or shank, but not be produced at the under head fillet.

Note:⁽⁴⁾

Minimum hardness value shall be applied to bolts having nominal length less than $2.5 d$ or when tensile test cannot be conducted.

Note:⁽⁵⁾

The difference between surface hardness and core hardness shall not exceed 30 in Vickers hardness (when test load is 2.94 N.) Further, the surface hardness of bolts classified into Strength division 10.9 shall not exceed 390 HV.

Note:⁽⁶⁾

Permanent set to proof load stress shall not be produced.

Note:⁽⁷⁾

The thread shall endure a load equal to the minimum value of tensile strength and the break may be produced at threaded portion or shank, but is shall not be produced at the under head fillet, provided that a complete screw thread should be allowed when cracks that caused break are produced at the free threaded portion and developed into break after they have enlarged to the under fillet or to the head.

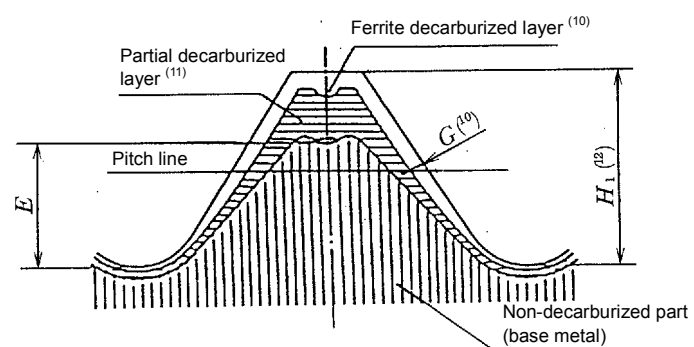
Note:⁽⁸⁾

In the case of complete screw thread, cracks may be produced at the first thread ridge of head side as long as the head is not wrested away.

Note:⁽⁹⁾

See Figure 1.

Remark: The symbol " d " in the Table represents nominal diameter (mm) of bolts.



Unit: mm

Pitch of the thread P			0.8	1	1.25	1.5	1.75	2	2.5	3
$H_1^{(12)}$			0.491	0.613	0.767	0.920	1.074	1.227	1.534	1.840
E (Min.)	Strength division	8.8, 9.8	0.245	0.307	0.384	0.460	0.537	0.614	0.767	0.920
		10.9	0.327	0.409	0.511	0.613	0.716	0.818	1.023	1.227

Note:⁽¹⁰⁾

In the surface layer of thread ridge in which carbon is lost and ferrite only is left, the symbol "G" represents the depth of ferrite decarburized layer from the surface on the pitch line.

Note:⁽¹¹⁾

In this layer, slight martensite can be observed, and because carbon is reduced, hardness is definitely lower than that of base metal.

Note:⁽¹²⁾

Height of thread ridge in maximum material condition.

Figure 1 Decarburization of threaded portion

Table 4 Mechanical properties of bolts classified into strength division column II

Mechanical properties			Strength division				
			4T	5T	6T	7T	
Wedge tensile strength ⁽¹³⁾ MPa			Min.	392	490	588	686
Hardness	Vickers hardness HV		Min.	122	150	180	213
			Max.	241	253	286	294
	Rockwell hardness	HRB	Min.	60	76	88	—
			Max.	98	100	103	—
		HRC	Min.	—	—	—	15
			Max.	—	—	—	29
Yield stress or proof stress ⁽¹⁴⁾ MPa			Min. (Reference)	294	343	441	539

Note:⁽¹³⁾

In the test of wedge tensile strength, break of bolts may be produced at threaded portion or shank but it shall not be produced at under head fillet.

Note:⁽¹⁴⁾

Yield stress or proof stress is given for reference. If required, test shall be made with No. 4 test piece taken from a bolt specified in **JIS Z2201** or its equivalent test piece.

However, if yield stress is not definite, proof stress at permanent set of 0.2 % should be adopted.

6. Shape, dimensions and geometrical tolerance

Shape, dimensions and geometrical tolerance of bolts shall be in accordance with **Attached Tables 1 and 2**.

7. Screw threads

Screw threads of bolts shall be in accordance with **Table 5**. However, maximum allowable dimension of plated screw threads shall be in accordance with maximum allowable dimensions of male thread with a tolerance of 4 h.

Table 5 Permissible limit of dimensions of screw threads

Type of threads	Permissible limit of dimension
Metric coarse screw thread in JIS B0205	6 g specified in JIS B0209
Metric fine thread in JIS B0207	6 g specified in JIS B0211

8. Surface condition

Surface condition of a bolt shall be in accordance with the following **a)** and **b)** as well as that specified in **11**.

a) Permissible limit of surface defects shall be in accordance with **Table 6**.

b) Detrimental defect on use such as burrs, rust, bank of zinc / chromate composite coating shall not be present.

Table 6 Permissible limit of surface defects

Type of surface defects	Permissible limits
Quench crack	Quench is impermissible in any case of depth, length and portion
Forging crack	a) Cracks produced on top of head of bolt and of $1\ d$ or less in length and $0.04\ d$ or less in width or depth are permissible. b) Cracks produced at raised periphery of head of the indented head bolts and screws and of $0.04\ d$ or less in width or depth are permissible.
Forging bursts and shear bursts	a) Bursts caused in side face of head of bolt are permissible if they do not reach the crown circle at top of head (chamfer circle) of bearing surface of bolt. The width across corners shall not be reduced smaller than the minimum value of the standard by bursts caused in intersection of two side planes. b) If shear bursts caused at edge of head of indented head bolts and screws are $0.06\ d$ or less in width and their depth from indented portion does not exceed indented portion of bolt, they are permissible.
Raw material seams and laps	Seams on threaded portion, shank or head are permissible if their depth is $0.03\ d$ or less. If seams or laps reach the head of bolt and their width and depth do not exceed the allowable limits specified for bursts, they are permissible.
Voids	a) Voids in the surface are permissible if their depth is $0.02\ d$ (Max. 0.25 mm) or less. b) Voids in the bearing surface are permissible if total area of them does not exceed 10 % of bearing surface area.
Folds	Folds on bearing surface or interior corner below the bearing surface are not permissible. Folds on exterior corner are permissible.
Tool marks	Tool marks in shank, fillet and bearing surface caused by machining are permissible if their surface roughness as specified in JIS B0601 is $3.2\ \mu\text{m}Ra$ or less.
Damages	Damages such as dents, scraps, nicks and gouges are permissible if function or usability is not impaired. Dents, scrapes, nicks and gouges located at first to third threads of screw are permissible if the screw is allowed to be screwed into go-ring gauge at torque of $0.001\ d^3\ \text{N}\cdot\text{m}$ or less. Example: For nominal diameter of 10 mm, $0.001 \times 10^3 = 1\ \text{N}\cdot\text{m}$

Remark 1: Surface defects and permissible limits shall be in accordance with **JIS B1041**.

Remark 2: The symbol d in the table represents nominal diameter (mm) of bolts.

9. Material and heat treatment

Material and heat treatment of bolts shall be generally in accordance with **Table 7**. Minimum tempering temperature in this table shall be bound to apply to bolts classified into 8.8 to 10.9 in Strength division Column I and bolts classified into 7T in Strength division Column II.

However, material and heat treatment other than those specified in **Table 7** may be applied based on an agreement between the parties concerned when all mechanical properties of bolts satisfy what are specified in **Table 3** or **4**.

Table 7 Material and heat treatment

Strength division	Material and heat treatment	Chemical components %				Tempering temperature ⁽²⁰⁾ °C (Min.)
		C		P	S	
		Min.	Max.	Max.	Max.	
4.8 and 4T	Carbon steel	—	0.55	0.05	0.06	—
5.8 and 5T						
6.8 and 6T						
8.8 ⁽¹⁵⁾ and 7T	Additive (example: B, Mn or Cr)-contained carbon steel, hardening and tempering	⁽¹⁹⁾ 0.15	0.40	0.035	0.035	425
	Carbon steel, hardening and tempering	0.25	0.55			
9.8	Additive (example: B, Mn or Cr)-contained carbon steel, hardening and tempering	⁽¹⁹⁾ 0.15	0.35			
	Carbon steel, hardening and tempering	0.25	0.55			
<u>10.9</u> ⁽¹⁶⁾	Additive (example: B, Mn or Cr)-contained carbon steel, hardening and tempering	⁽¹⁹⁾ 0.15	0.35	0.035	0.035	340
10.9 ⁽¹⁷⁾	Carbon steel, hardening and tempering	0.25	0.55	0.035	0.035	425
	Additive (example: B, Mn or Cr)-contained carbon steel, hardening and tempering	⁽¹⁹⁾ 0.20				
	Alloy steel ⁽¹⁸⁾ , hardening and tempering	0.20				

Note: ⁽¹⁵⁾

For bolts of more than 20 mm in nominal diameter requiring sufficient hardenability, it is desirable to use material classified into Strength division 10.9.

Note: ⁽¹⁶⁾

When the materials in this column is to be used for bolts classified into Strength division 10.9, the material shall be identified by drawing underline to the symbol of strength division.

Note: ⁽¹⁷⁾

For materials classified into this strength division, sufficient hardenability shall be considered such that the centre of section of threaded portion of bolts has an approximately 90 % martensite structure in hardening condition before tempering.

Note: ⁽¹⁸⁾

This alloy steel classified into this strength division shall contain one or more alloy elements out of chrome (Cr), nickel (Ni), molybdenum (Mo) and vanadium (Va).

Note:⁽¹⁹⁾

For boron steel of which carbon content is 0.25 % or less (analysis value of melted steel), the content of Mn shall be 0.6 % or more for a bolt classified into Strength division 8.8 and 0.7 % or more for one classified into Strength divisions 9.8 or 10.9.

Note:⁽²⁰⁾

When a bolt classified into Strength division 8.8 to 10.9 or 7T is tested in accordance with **4.3** (Retempering test) of **JIS B1051**, mean value of hardness shall not show a difference of more than HV20 in Vickers hardness.

10. Surface treatment

Surface treatment of bolts shall be generally in accordance with **Table 8**. However, purchaser shall give instructions when bolts are not surface treated or when they are applied with other surface treatment. Besides, bolts electroplated coating of zinc classified into Strength division 9.8 or 10.9 shall be treated by removal of hydrogen embrittlement. The requirements for the treatment shall be based on an agreement between the parties concerned.

Table 8 Surface treatment

Type of surface treatment		Symbol of types of plating ⁽²¹⁾	Applicable standard
Electroplated coating of zinc	Yellow chromate	Ep-Fe/Zn5C [MFZn5C] or Ep-Fe/Zn8C [MFZn8C]	As per JIS D0201
	Green chromate	Ep-Fe/Zn5G or Ep-Fe/Zn8G	
Electroplated coating of zinc	Two coats Two bakes ⁽²²⁾	—	—

Note:⁽²¹⁾

For symbols of type of plating, symbols as indicated in parenthesis which have been used conventionally may be used.

Note:⁽²²⁾

Mass of deposit, corrosion resistance, etc. of zinc / chromate composite coating shall be based on an agreement between the parties. **Annex 3** shows excerpt from **JDIS K5311** of Nihon Dacro Industry standard.

11. Grade of finish

Grade of finish of bolts shall be in accordance with **JIS B0601** and surface roughnesses of bearing surface and shank shall be 3.2 μmRa and 6.3 μmRa , respectively.
Besides, thread portion shall be finished smoothly.

12. Test method of mechanical properties

Test methods of mechanical properties and retempering shall be in accordance with **Table 9**.

Table 9 Test method of mechanical properties

Test item		Test method	
		Method for Column I in Strength division	Method for Column II in Strength division
Tensile strength of product		As per 4.2.2 (Tensile test of product) of body of JIS B1051	As per 3.2.2 (Tensile test of product) of Appendix of JIS B1051
Wedge tensile strength		As per 4.2.3 (Wedge tensile strength) of body of JIS B1051	As per 3.2.3 (Wedge tensile strength) of Appendix of JIS B1051
Hardness	Hardness	As per 4.2.5 (1) (Hardness test) of body of JIS B1051	As per 3.2.4 (Hardness test) of Appendix of JIS B1051
	Surface hardness	As per 4.2.5 (2) (Hardness test) of body of JIS B1051	—
Proof load stress		As per 4.2.4 (Proof load test) of body of JIS B1051	—
Strength of head percussion		As per 4.2.6 (Head percussion test) of body of JIS B1051	—
Decarburization of threaded portion		As per 4.2.8 (Decarburization test) of body of JIS B1051	—
Retempering		As per 4.3 (Retempering test) of body of JIS B1051	—

13. Inspection**13.1 Inspection of mechanical properties**

Inspection of mechanical properties shall be conducted in accordance with **12** based on the following items **a)** and **b)** and shall meet the requirements specified in **5** and **9**.

a) Inspection programme

Inspection of mechanical properties to the strength division of bolts shall be in accordance with the inspection programme specified in **Table 11**.

In addition, bolts subject to the inspection programme shall be classified into those marked with ○ and those marked with ● of **Table 10**.

Table 10 Division of bolts to be inspected

Division of bolts to be inspected	○	●
Condition to be applied	Bolts having a nominal length of less than $2.5 d$	Bolts having a nominal length of $2.5 d$ or more

Remark: Symbol d in the Table represents nominal diameter (mm) of bolts.

b) Items to be inspected for determining acceptability

Inspection items to determine acceptability about mechanical properties corresponding to strength division of bolts shall correspond to bolts marked with ○ and ● described in the strength division column in **Table 11**. Besides, if tensile strength test for bolts cannot be carried out in the inspection programme because the nominal length is too short, the capacity of testing machine is too small, etc., acceptability shall be determined on those testable items marked with ○ and ● of **Table 11**.

Table 11 Inspection programme

Inspection item		Strength division									
		Column I						Column II			
		4.8	5.8	6.8	8.8	9.8	10.9	4T	5T	6T	7T
Tensile strength of product ⁽²³⁾		●	●	●	●	●	●	—	—	—	—
Wedge tensile strength		● ○	● ○	● ○	● ○	● ○	● ○	● ○	● ○	● ○	● ○
Hardness ⁽²⁴⁾	Min.	○	○	○	○	○	○	● ○	● ○	● ○	● ○
	Max.	● ○	● ○	● ○	● ○	● ○	● ○	—	—	—	—
Surface hardness ⁽²⁵⁾		—	—	—	● ○	● ○	● ○	—	—	—	—
Proof load stress		●	●	●	●	●	●	—	—	—	—
Strength of head percussion ⁽²⁶⁾		○	○	○	○	○	○	—	—	—	—
Decarburization at threaded portion ⁽²⁷⁾		—	—	—	● ○	● ○	● ○	—	—	—	—
Change in hardness after retempering		—	—	—	● ○	● ○	● ○	—	—	—	● ○

Note:⁽²³⁾

This test may be omitted for bolts that have passed the wedge tensile strength test.

Note:⁽²⁴⁾

Hardness of core part should be tested in either of Vickers or Rockwell hardness, provided that acceptability is determined with reference to measurement of Vickers hardness when a doubt arises about measurement data. To simplify test procedure, tensile strength test of those marked with ● should be replaceable by inspecting minimum hardness of the core part, provided that final determination of acceptability shall be made by tensile strength inspection.

Note:⁽²⁵⁾

Surface hardness test may be omitted for bolts that have passed decarburization inspection for hardness. However, this test must be conducted for bolts classified into strength division 10.9.

Note:⁽²⁶⁾

This inspection shall apply only to bolts of 16 mm or less in nominal diameter and for which wedge tensile strength test cannot be performed because the bolts are too short in length.

Note:⁽²⁷⁾

Decarburized layer shall be inspected by microscope or based on hardness. Inspection based on hardness shall be applied to only bolts classified into Strength division 8.8 or higher having a pitch of 1.25 mm or more.

13.2 Inspection of shape, dimensions and geometrical tolerance

Inspection of shape, dimensions and geometrical tolerance shall meet the requirements specified in 6 by the measurement method of dimension of each part and geometrical deviation specified in JIS B1071 or an alternative method.

13.3 Inspection of screw threads

Inspection of screw threads shall meet the requirements specified in 7 by the measurement method of precision of external thread in JIS B1071 or an alternative method.

13.4 Surface condition inspection

Surface condition inspection shall meet the requirements specified in 8 by conducting the following inspections a) to c).

- a) Surface roughness shall be inspected in accordance with surface roughness measurement method specified in JIS B1071 or by an alternative method.