



Hot-dip galvanized steel bolts and associated nuts and washers for tower construction



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-

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Australian Standard®

Hot-dip galvanized steel bolts and associated nuts and washers for tower construction

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PREFACE

This Standard was prepared by the Australian members of Standards Australia/Standards New Zealand Committee ME-029, Fasteners, to supersede AS/NZS 1559—1997, *Hot-dip galvanized steel bolts and associated nuts and washers for tower construction*.

After consultation with stakeholders in both countries, Standards Australia and Standards New Zealand decided to develop this Standard as an Australian Standard rather than an Australian/New Zealand Standard.

The objective of this Standard is to provide designers and manufacturers with specifications for bolts, nuts and washers suitable for use in tower construction.

There are no ISO Standards for bolts for tower construction. IFI 541:1982, *Metric hex transmission tower bolts*, was used for guidance in the preparation of this Standard.

Bolts for tower construction have shorter thread lengths than specified in ISO 888:2012, *Fasteners—Bolts, screws and studs—Nominal lengths, and thread lengths*, to ensure that in a connection the shear planes will occur through the unthreaded shank. Other features are in accordance with the following ISO Standards:

ISO

272 Fasteners—Hexagon products—Widths across flats

885 General purpose bolts and screws—Metric series—Radii under the head

4759 Tolerances for fasteners

4759.1 Part 1: Bolts, screws, studs and nuts—Product grades A, B and C

The mechanical properties specified for tower bolts include appropriate shear strength and impact strength requirements suitable for the application.

Changes introduced in this edition of the Standard include the following:

- (a) Introduction of provisions for spring washers developed from the withdrawn Standard, AS 1968—1976, *Helical spring lock washers (metric series)*.
- (b) Marking for bolts and nuts has been changed to be consistent with ISO marking requirements.
- (c) A new section covering the requirements for identification and testing has been included.

Statements expressed in mandatory terms in notes to tables and figures are deemed to be requirements of this Standard.

The terms ‘normative’ and ‘informative’ are used in a Standard to define the application of the appendices or annexes to which they apply. A ‘normative’ appendix or annex is an integral part of a Standard, whereas an ‘informative’ appendix or annex is only for information and guidance.

CONTENTS

	<i>Page</i>
SECTION 1 SCOPE AND GENERAL	
1.1 SCOPE.....	4
1.2 APPLICATION	4
1.3 REFERENCED DOCUMENTS.....	4
1.4 DEFINITIONS.....	5
1.5 MARKING	7
1.6 DESIGNATION	8
1.7 PRODUCT REQUIREMENTS.....	9
 SECTION 2 BOLTS	
2.1 METHOD OF MANUFACTURE.....	10
2.2 SHAPE, DIMENSIONS AND FINISH.....	10
2.3 MATERIALS AND MECHANICAL PROPERTIES.....	19
2.4 TEST METHODS FOR BOLTS	20
 SECTION 3 NUTS	
3.1 GENERAL.....	23
3.2 SHAPE, DIMENSIONS AND FINISH.....	23
3.3 MATERIALS AND MECHANICAL PROPERTIES.....	24
3.4 FINISH	25
3.5 TEST METHODS FOR NUTS	25
 SECTION 4 FLAT WASHERS	
4.1 SHAPE, DIMENSIONS AND FINISH.....	26
4.2 FLATNESS.....	26
4.3 FINISH	26
4.4 MATERIALS AND MECHANICAL PROPERTIES.....	27
 SECTION 5 HELICAL SPRING WASHERS	
5.1 SHAPE AND DIMENSIONS	28
5.2 MATERIAL AND MECHANICAL PROPERTIES.....	29
5.3 FINISH	30
5.4 TEST METHODS FOR SPRING WASHERS	30
 SECTION 6 IDENTIFICATION, TESTING AND TEST REPORTS	
6.1 GENERAL.....	32
6.2 IDENTIFICATION.....	32
6.3 TESTING AND TEST REPORTS	32
6.4 TESTING OF DIMENSIONAL REQUIREMENTS.....	33
6.5 TESTING OF MECHANICAL PROPERTIES	35
6.6 TESTING OF FUNCTIONAL CHARACTERISTICS.....	36
 APPENDICES	
A BOLT CLAMPING LENGTHS.....	37
B PRODUCT CONFORMITY	44
C PURCHASING GUIDELINES.....	49

STANDARDS AUSTRALIA

Australian Standard**Hot-dip galvanized steel bolts and associated nuts and washers for tower construction**

SECTION 1 SCOPE AND GENERAL

1.1 SCOPE

This Standard specifies the requirements for hot-dip galvanized bolts, including step bolts, with ISO metric coarse pitch series threads for normal and low temperature applications in tower construction, and associated nuts and washers. Nominal bolt sizes and lengths are as follows:

- (a) Single-nut type tower bolts in diameters from 12 mm to 30 mm inclusive, with lengths from 35 mm to 160 mm inclusive.
- (b) Double-nut type tower bolts in diameters from 12 mm to 30 mm inclusive, with lengths from 50 mm to 125 mm inclusive.
- (c) Step bolts 16 mm, 20 mm, and 24 mm in diameter with lengths from 180 mm to 290 mm inclusive.

NOTE: Tower bolts have a thread length/bolt length relationship to enable threads to be excluded from shear planes when assembled.

This Standard uses the terminology 'bolt' to mean both tower bolts and step bolts. Where the terminology used is 'tower bolt' or 'step bolt', the reference only applies to tower bolts or step bolts, respectively (see Clause 1.4).

1.2 APPLICATION

Bolts, nuts and washers shall conform to the requirements of Section 1 and with the following sections as applicable:

- (a) Bolts..... Section 2.
- (b) Nuts..... Section 3.
- (c) Flat washers..... Section 4.
- (d) Helical spring washers Section 5.

1.3 REFERENCED DOCUMENTS

The following documents are referred to in this Standard:

AS	
1112	ISO metric hexagon nuts
1112.1	Part 1: Style 1—Product grades A and B
1275	Metric screw threads for fasteners
1391	Metallic materials—Tensile testing at ambient temperature
1442	Carbon steels and carbon-manganese steels—Hot rolled bars and semi-finished products

AS	
1544	Methods for impact tests on metals
1544.2	Part 2: Charpy V-notch
1815	Metallic materials—Rockwell hardness test
1815.1	Method 1: Test method (scales A, B, C, D, E, F, G, H, K, N, T)
1817	Metallic materials—Vickers hardness test
1817.1	Method 1: Test method (ISO 6507-1:1997, MOD)
4291	Mechanical properties of fasteners made of carbon steel and alloy steel
4291.1	Part 1: Bolts, screws and studs
AS ISO/IEC	
17025	General requirements for the competence and testing of calibration laboratories
AS/NZS	
1214	Hot-dip galvanized coatings on threaded fasteners (ISO metric coarse thread series) (ISO 10684:2004, MOD)
3678	Structural steel—Hot-rolled plates, floorplates and slabs
3679	Structural steel
3679.1	Part 1: Hot-rolled bars and sections
4291	Mechanical properties of fasteners made of carbon steel and alloy steel
4291.2	Part 2: Nuts with specified property classes—Coarse thread and fine pitch thread
ISO	
286	Geometrical product specifications (GPS)—ISO code system for tolerances on linear sizes
286-2	Part 2: Tables of standard tolerance classes and limit deviations for holes and shafts
6157	Fasteners—Surface discontinuities
6157-1	Part 1: Bolts, screws and studs for general requirements
16228	Fasteners—Types of inspection documents

1.4 DEFINITIONS

For the purpose of this Standard, the definitions below apply.

1.4.1 Clamping length (l_c)

The total thickness of materials to be clamped, including any coating and excluding the washer.

1.4.2 Concentricity tolerance

The allowable deviation of the shank with respect to the pitch diameter of the screw thread (see Figure 2.2).

1.4.3 Grip length (l_g)

The distance from the bearing surface of the bolt head to the nearest face of a 8g GO screw ring gauge, screwed on as far as practicable by hand. This dimension applies before hot-dip galvanizing.

1.4.4 Length (l)

The distance from the bearing surface of the bolt head to its extreme end.

1.4.5 Manufacturing lot

Quantity of fasteners of a single designation including product grade, property class and size (thread diameter and length), manufactured from bar, wire, rod or flat product from a single cast, processed through the same or similar steps at the same time or over a continuous time period, including the same heat treatment and/or coating process, if any.

1.4.6 May

Indicates the existence of an option.

1.4.7 Shall

Indicates that a statement is mandatory.

1.4.8 Should

Indicates a recommendation.

1.4.9 Step bolt

A type of bolt which, when fitted, is used to gain access to the tower structure.

1.4.10 Symmetry tolerance

The allowable deviation of the across-flats dimension with respect to the shank or the pitch diameter of the screw thread.

1.4.11 Thread length (*b*)

The difference between the nominal length of the bolt and the distance between the bearing surface of the head and the nearest face of a 8g GO screw ring gauge, screwed on as far as practicable to the bolt by hand before coating.

1.4.12 Thread runout (*a*)

For bolts with rolled threads—the distance from the top of the extrusion cone to the nearest face of a nut with no countersink when screwed on to the bolt as far as practicable by hand [see Figure 2.4(a)].

For bolts with cut threads—the distance from the last scratch of thread to the nearest face of a nut with no countersink when screwed on to the bolt as far as practicable by hand [see Figure 2.4(b)].

1.4.13 Tower bolt, double-nut type

A hexagonal-headed fastener, with a specific relationship of threaded length to overall length and a defined thread runout to avoid threads in the shear plane. A second nut is used for locking purposes.

1.4.14 Tower bolt, single-nut type

A hexagonal headed fastener, with a specific relationship of threaded length to overall length and a defined thread runout to avoid threads in the shear plane.

1.4.15 Transition diameter (*d_a*)

The diameter of the circle formed at the transition between the fillet radius and the bearing surface of the head.

1.4.16 Unthreaded shank length (*l_s*)

The distance from the bearing surface of the bolt head to the last scratch of thread, or top of the extrusion angle, whichever is closer to the head.

1.4.17 Upper yield strength (R_{eH})

The value of stress at the moment when the first decrease in force is observed (refer to AS 1391).

1.5 MARKING

1.5.1 Bolts

Bolts shall be marked in accordance with Figure 1.1 and the following:

- (a) The letters embossed or indented on top of the head or indented into one of the hexagon flats:
 - (i) Bolts for normal temperature application T.
 - (ii) Bolts for low temperature application TL.
- (b) The trade (identification) mark of the manufacturer embossed or indented on top of the head.

Bolts may be marked with the nominal bolt length, in millimetres.

1.5.2 Nuts

Nuts for use with bolts shall be marked with the identification mark of the manufacturer and with the property class mark and the letter 'Z' indicating the tolerance class of the thread as shown in Figure 1.2. The marking shall comprise indentation on the side or opposite side of the bearing surface.

1.5.3 Washers

There are no marking requirements for hot dip galvanized flat washers for use with bolts. To avoid a reduction in serviceability, hot dip galvanized helical spring washers shall not be marked.

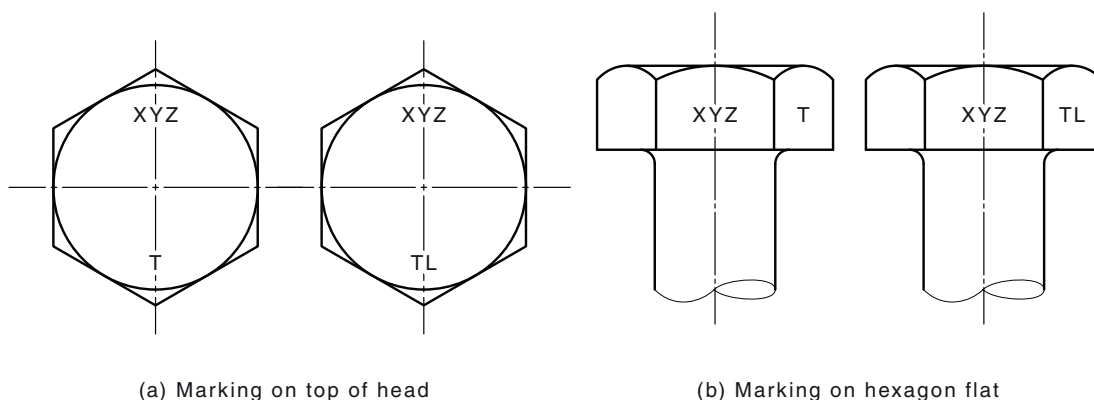


FIGURE 1.1 IDENTIFICATION MARKING OF BOLTS

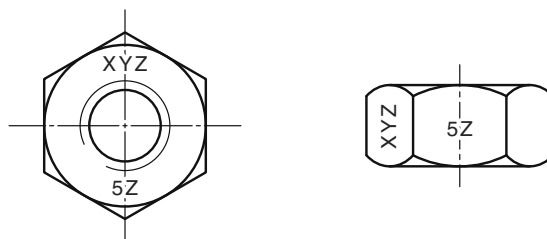


FIGURE 1.2 IDENTIFICATION MARKING OF NUTS

1.6 DESIGNATION

1.6.1 Bolts

The designation of bolts shall include the following:

- General product description.
- Reference to this Standard (i.e. AS 1559).
- The letter 'M' indicating that the product has a metric coarse pitch series thread followed by the nominal size (thread diameter), in millimetres.
- The nominal length, in millimetres.
- Hot dip galvanized coating in accordance with AS/NZS 1214.
- Any other features.

Examples:

- Hot dip galvanized single nut tower bolts 20 mm diameter and 50 mm long are designated as follows:
Single Nut Tower Bolt AS 1559—M20 × 50 – tZn.
- Hot dip galvanized double nut tower bolts 24 mm diameter and 90 mm long are designated as follows:
Double Nut Tower Bolt AS 1559—M24 × 90 – tZn.
- Hot dip galvanized step bolts 16 mm diameter and 180 mm length are designated as follows:
Step Bolt AS 1559—M16 × 180 – tZn.

1.6.2 Nuts

The designation of nuts for use with bolts for tower construction shall include the following:

- General product description.
- The number of this Australian Standard (i.e. AS 1559), or AS 1112.1.
- The nominal size (nominal bolt diameter), in millimetres.
- The property and thread tolerance class (see Clause 3.1).
- Hot dip galvanized coating in accordance with AS/NZS 1214.

Example:

A hexagon nut to suit 20 mm tower or step bolt size is designated as follows:

Hexagon Nut AS 1559—M20 – 5Z – tZn.

1.6.3 Flat washers

The designation of flat washers for use with nuts and bolts for tower construction shall include the following:

- (a) General product description.
- (b) The number of this Australian Standard (i.e. AS 1559).
- (c) The nominal size (nominal bolt diameter), in millimetres.
- (d) Hot dip galvanized coating in accordance with AS/NZS 1214.

Example:

Hot dip galvanized flat washers for use with 20 mm tower bolts are designated as follows:

Steel flat washer AS 1559—20 – tZn.

1.6.4 Helical spring washers

The designation of helical spring washers for use with nuts and bolts for tower construction shall include the following:

- (a) General product description.
- (b) The number of this Australian Standard (i.e. AS 1559).
- (c) The nominal size (nominal bolt diameter), in millimetres.
- (d) Hot dip galvanized coating in accordance with AS/NZS 1214.

Example:

Hot dip galvanized helical spring washers for use with 20 mm tower bolts are designated as follows:

Steel helical spring washer AS 1559—20 – tZn.

1.7 PRODUCT REQUIREMENTS

1.7.1 General

Requirements for evaluating product conformity are specified in Appendix B.

1.7.2 Dimensions, tolerances, materials and mechanical properties

Bolts, nuts, flat washers and spring washers manufactured to this Standard shall conform to the requirements in Sections 2, 3, 4, and 5 of this Standard, respectively.

1.7.3 Galvanized nut threading process

Hot-dip galvanized nuts shall be galvanized before they are threaded. Nuts shall not be re-threaded.

1.7.4 Finish and coating

Finish and coating shall be as specified in the relevant part of this Standard.

Hot-dip galvanizing of each component shall be under the control of the manufacturer of the components.

1.7.5 Functional characteristics of the assembly

The performance of the bolt assembly shall conform to the requirements given in Section 6 of this Standard.

S E C T I O N 2 B O L T S

2.1 METHOD OF MANUFACTURE

Bolts shall be—

- (a) hot or cold forged with or without secondary machining; or
- (b) machined from bar stock.

2.2 SHAPE, DIMENSIONS AND FINISH

2.2.1 Head

The heads of bolts shall be in accordance with Figure 2.1 and Table 2.1 and the dimensions given for M16, M20 and M24 are also applicable to step bolts. The dimensions given in Table 2.1 shall apply before hot-dip galvanizing.

2.2.2 Length

The length of bolts shall be as given in Table 2.3 for single-nut tower bolts, Table 2.4 for double-nut tower bolts and Table 2.5 for step bolts.

NOTE: Clamping lengths for tower bolts with flat washers and spring washers are given in Appendix A.

2.2.3 Ends

The ends of bolts shall be finished with a 45-degree chamfer to a depth slightly exceeding the depth of thread (see Figure 2.1).

2.2.4 Screw threads

2.2.4.1 General

The form of thread, diameters and associated pitches of bolts shall be the ISO coarse pitch series in accordance with AS 1275.

Screw threads shall be formed by thread rolling or thread cutting.

2.2.4.2 Tolerances

The screw threads shall be in accordance with tolerance class 8g of AS 1275.

The 8g tolerance class shall apply before hot-dip galvanizing.

2.2.5 Thread length

The thread lengths (b) for bolts shall be as shown in Table 2.2.

The nominal thread length of step bolts shall be as required to maintain the maximum grip length (l_g) given in Table 2.5.

The tolerances on the thread length shall be such that the grip lengths (l_g) and unthreaded shank lengths (l_s) given in Tables 2.2, 2.3, 2.4 and 2.5 are maintained.

2.2.6 Squareness, concentricity and symmetry of bolts

2.2.6.1 Squareness of bearing face

When determined as shown in Figure 2.2(a), the bearing face of the head shall be square, within the values given in Table 2.1, to the shank or pitch diameter of the screw thread. The values are based on an angle of two degrees.

2.2.6.2 *Concentricity of shank to screw thread measured as true position*

When determined as shown in Figure 2.2(b), the shank shall be concentric, within the values given in Table 2.1, to the pitch diameter of the screw thread, for a distance of 1.5 diameters from the nearest face of a 8g GO screw ring gauge screwed, as far as practicable, onto the thread by hand before coating.

2.2.6.3 *Symmetry of head to shank measured as true position*

When determined as shown in Figure 2.2(c), the head shall be symmetrical, within the values given in Table 2.1, to the shank or pitch diameter of the screw thread.

2.2.7 Chamfering and washer facing

Bolts shall have heads with a chamfer of 15 degrees to 30 degrees on their upper faces. The diameter of the circle formed by this chamfer shall be not less than 90% of the minimum width across-flats of the bolts.

Bolts shall have either a washer face or a full bearing face on the underside of the head (see Figure 2.1). The diameter and depth of the washer faces shall be as given in Table 2.1.

2.2.8 Shank

2.2.8.1 *Diameter*

The diameter (d_s) of the shank of bolts shall be as given in Table 2.1.

2.2.8.2 *Straightness*

Bolts shall be straight to within the tolerance shown in Figure 2.3.

2.2.9 Underhead fillet

The fillet junction of the head and shank shall be a smooth concave curve lying within an envelope defined by the minimum radius under the head (r) and a maximum profile defined by a tangent to a radius equal to the minimum value of r blending to the maximum transition diameter (d_a) on the underside of the head and the fillet length (l_f) on the shank as shown in Figure 2.1(b). The minimum values of r and the maximum values of l_f and d_a are given in Table 2.1.

2.2.10 Finish

2.2.10.1 *General*

Bolts shall be cleanly finished, sound, and free from defects detrimental to their end use. The surface discontinuities on bolts shall be not greater than the limits given in ISO 6157-1.

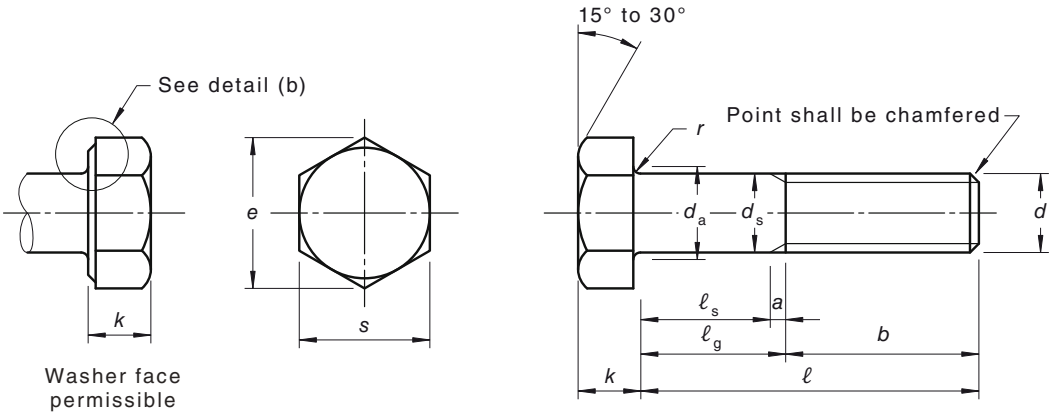
2.2.10.2 *Surface roughness*

All surfaces of bolts, except screw threads, may be in the as-forged or machined condition. Screw threads shall be machined or have a surface quality equivalent to machining.

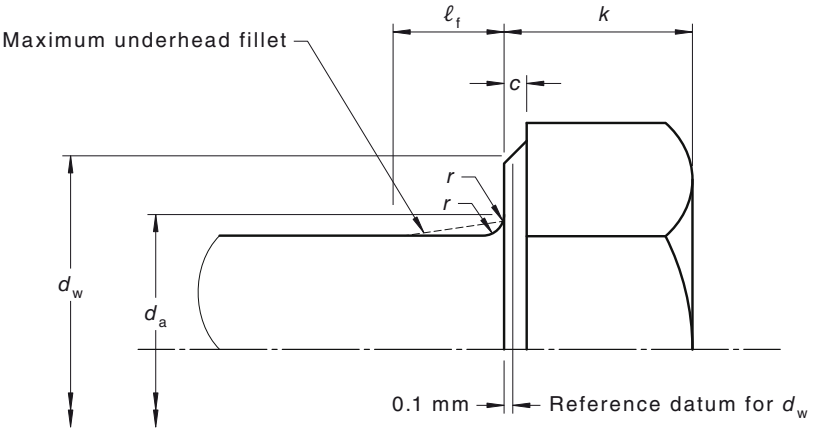
2.2.10.3 *Surface finish and coating*

Bolts shall be hot-dip galvanized in accordance with AS/NZS 1214. The coating shall be continuous and free from defects such as blisters, flux stains, dross, excessive projections or other imperfections which would impair the serviceability of the bolts.

NOTE: Heavier zinc coatings may be supplied subject to agreement between manufacturer and customer. In order to reduce the risk of interference on assembly of threads with hot dip galvanized coatings, the coating thickness on the mating bolts or screws or external threads should not exceed one quarter of the minimum clearance of the thread combination. Refer to AS/NZS 1214 for more information.

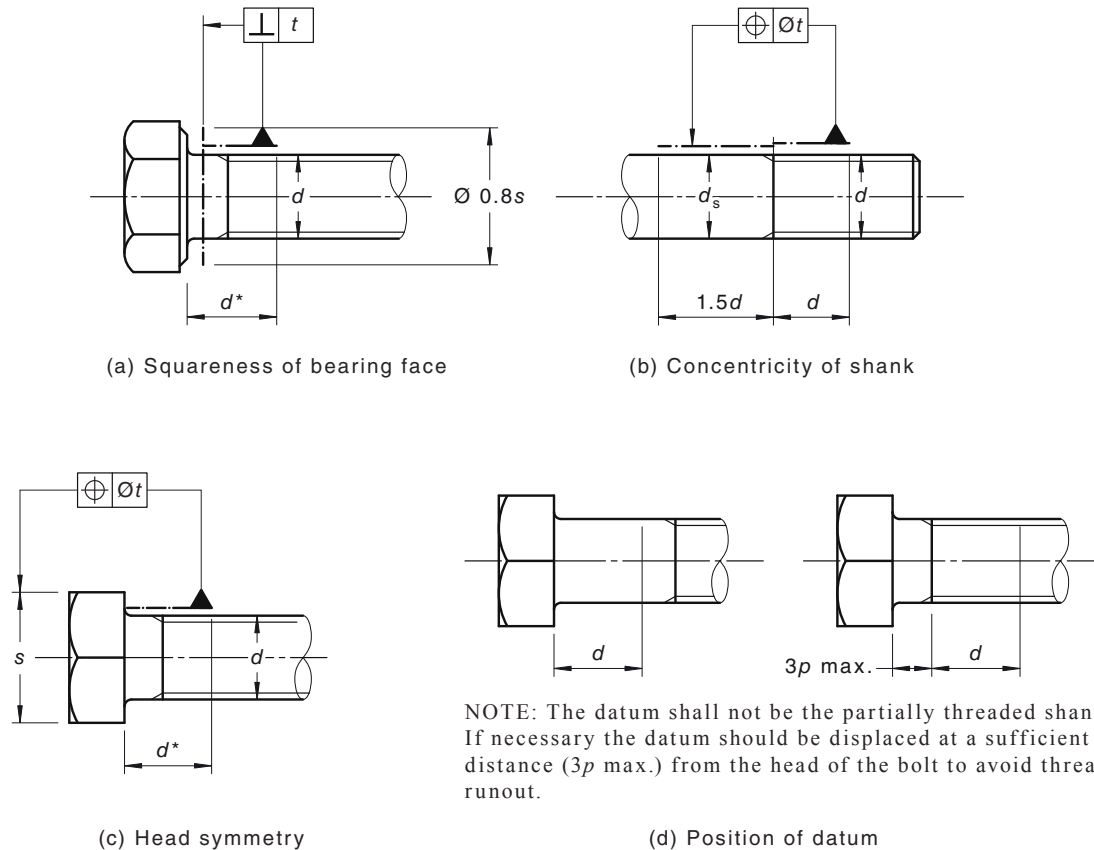


(a) Hexagon bolt



(b) Enlarged detail of fillet

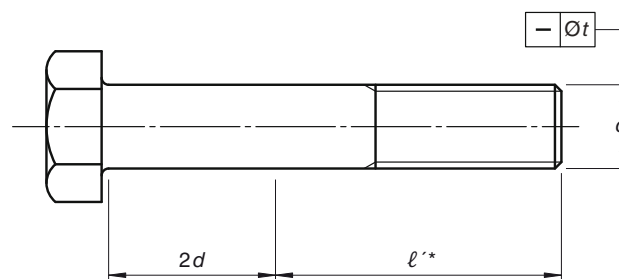
FIGURE 2.1 BOLTS



* See (d), Position of datum

DIMENSIONS IN MILLIMETRES

FIGURE 2.2 CONCENTRICITY, SYMMETRY, AND SQUARENESS OF BOLTS



* Straightness is applicable only for l'

FIGURE 2.3 TOLERANCES ON STRAIGHTNESS

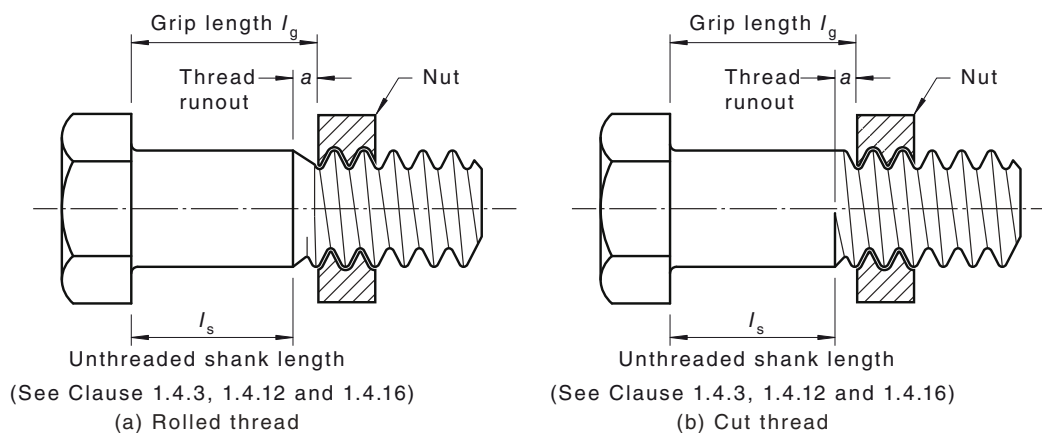


FIGURE 2.4 GRIP LENGTH AND THREAD RUNOUT FOR BOLTS

TABLE 2.1
GENERAL DIMENSIONS OF BOLTS

Thread designation	Pitch (p)	Thread runout (a)		Shank diameter (d_s)		Width across flats (s)		Width across corners (e)		Washer face dia. (d_w)		Depth of washer face (c)		Fillet details			Height of head (k)		Symmetry of head to body (see Note)	Concentricity tolerance	Squareness of bearing face to shank
		Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Transition dia. (d_a)	Radius under head (r)	Fillet length (l_f)	Min.	Max.			
M12	1.75	2.63	3.50	11.30	12.70	17.57	18.00	19.85	20.70	16.50	Actual size across flats		0.15	0.6	14.7	0.6	3.0	7.05	0.84	1.40	0.54
M16	2.00	3.00	4.00	15.30	16.70	23.16	24.00	26.17	27.70	22.00			0.20	0.8	18.7	0.6	3.0	9.25	0.84	1.40	0.68
M20	2.50	3.75	5.00	19.16	20.84	29.16	30.00	32.95	34.60	27.70			0.20	0.8	24.4	0.8	4.0	11.60	0.84	1.68	0.84
M22	2.50	3.75	5.00	21.16	22.84	33.00	34.00	37.29	39.30	31.35			0.20	0.8	26.4	0.8	4.0	13.10	1.00	1.68	0.84
M24	3.00	4.50	6.00	23.16	24.84	35.00	36.00	39.55	41.60	33.20			0.20	0.8	28.4	0.8	4.0	14.10	1.00	1.68	1.00
M30	3.50	5.25	7.00	29.16	30.84	45.00	46.00	50.85	53.10	42.70			0.20	0.8	35.4	1.0	5.0	17.65	1.00	1.68	1.28

NOTE: Values equal to FIM (full indicator movement).

TABLE 2.2
NOMINAL THREAD LENGTHS OF BOLTS

Thread designation	Single-nut bolts		Double-nut bolts	
	Basis for thread length	Nominal thread length (b), mm	Basis for thread length	Nominal thread length (b), mm
M12	$d + 9$	21.0	$1.8d + 9$	30.6
M16	$d + 9$	25.0	$1.8d + 10$	38.8
M20	$d + 8$	28.0	$1.8d + 10$	46.0
M22	$d + 9$	31.0	$1.8d + 13$	52.6
M24	$d + 7$	31.0	$1.8d + 11$	54.2
M30	$d + 6$	36.0	$1.8d + 8$	62.0

TABLE 2.3
LENGTHS OF TOWER BOLTS—SINGLE-NUT TYPE

Length (<i>l</i>)			M12		M16		M20		M22		M24		M30		millimetres
			Grip length (<i>l_g</i>) and unthreaded-shank length (<i>l_s</i>)												
			<i>l_s</i> (min.)	<i>l_g</i> (max.)	<i>l_s</i> (min.)	<i>l_g</i> (max.)	<i>l_s</i> (min.)	<i>l_g</i> (max.)	<i>l_s</i> (min.)	<i>l_g</i> (max.)	<i>l_s</i> (min.)	<i>l_g</i> (max.)	<i>l_s</i> (min.)	<i>l_g</i> (max.)	
Nom.	Min.	Max.	35	33.75	36.25	10.5	14.0	6.0	10.0	—	—	—	—	—	—
40	38.75	41.25	15.5	19.0	11.0	15.0	7.0	12.0	4.0	9.0	—	—	—	—	—
45	43.75	46.25	20.5	24.0	16.0	20.0	12.0	17.0	9.0	14.0	8.0	14.0	—	—	—
50	48.75	51.25	25.5	29.0	21.0	25.0	17.0	22.0	14.0	19.0	13.0	19.0	7.0	14.0	14.0
55	53.5	56.5	30.5	34.0	26.0	30.0	22.0	27.0	19.0	24.0	18.0	24.0	12.0	19.0	19.0
60	58.5	61.5	35.5	39.0	31.0	35.0	27.0	32.0	24.0	29.0	23.0	29.0	17.0	24.0	24.0
65	63.5	66.5	40.5	44.0	36.0	40.0	32.0	37.0	29.0	34.0	28.0	34.0	22.0	29.0	29.0
70	68.5	71.5	45.5	49.0	41.0	45.0	37.0	42.0	34.0	39.0	33.0	39.0	27.0	34.0	34.0
75	73.5	76.5	50.5	54.0	46.0	50.0	42.0	47.0	39.0	44.0	38.0	44.0	32.0	39.0	39.0
80	78.5	81.5	55.5	59.0	51.0	55.0	47.0	52.0	44.0	49.0	43.0	49.0	37.0	44.0	44.0
85	83.25	86.75	60.5	64.0	56.0	60.0	52.0	57.0	49.0	54.0	48.0	54.0	42.0	49.0	49.0
90	88.25	91.75	65.5	69.0	61.0	65.0	57.0	62.0	54.0	59.0	53.0	59.0	47.0	54.0	54.0
95	93.25	96.75	70.5	74.0	66.0	70.0	62.0	67.0	59.0	64.0	58.0	64.0	52.0	59.0	59.0
100	98.25	101.75	75.5	79.0	71.0	75.0	67.0	72.0	64.0	69.0	63.0	69.0	57.0	64.0	64.0
105	103.25	106.75	80.5	84.0	76.0	80.0	72.0	77.0	69.0	74.0	68.0	74.0	62.0	69.0	69.0
110	108.25	111.75	85.5	89.0	81.0	85.0	77.0	82.0	74.0	79.0	73.0	79.0	67.0	74.0	74.0
115	113.25	116.75	90.5	94.0	86.0	90.0	82.0	87.0	79.0	84.0	78.0	84.0	72.0	79.0	79.0

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