METRIC HEAVY HEX STRUCTURAL BOLTS

IFI NOTES:

1. ***ANSI B18.2.3.7M-1979 (R 1989, 1995) is a standard developed through the procedures of The American Society of Mechanical Engineers. B18.2.3.7M is under the jurisdiction of ASME Standards Committee B18 and is the direct responsibility of Subcommittee 2.***

2. ***ISO 7412-1984 Hexagon Bolts for High-Strength Structural Bolting With Large Width Across Flats (Short Thread Length) - Product Grade C - Property Classes 8.8 and 10.9 is functionally interchangeable with products to this standard. The ANSI standard provides longer grip lengths and body lengths as standard, but it does not include the M12 as standard. The longer thread lengths of ISO 7411 do not facilitate interchangeability. The undersizing of bolt threads allowed within these two standards is a practice not acceptable in North America since it offers the possibility of thread stripping upon overtightening.***

3. ***Government requirements covering standard item selection, part numbers, quality assurance, and packaging have been omitted in this reprint of B18.2.3.7M. For this information, refer to the complete ANSI B18.2.3.7M which is reprinted with the permission of its publisher, The American Society of Mechanical Engineers, Three Park Avenue, New York, NY 10016-5990, U.S.A.***

GENERAL DATA

1. Scope

1.1 This standard covers the complete general and dimensional data for metric heavy hex structural bolts recognized as American National Standard.

1.2 The inclusion of dimensional data in this standard is not intended to imply that all of the sizes in conjunction with the various options described herein are stock production items. Consumers are requested to consult with manufacturers concerning lists of stock production heavy hex structural bolts.

2. Comparison With ISO Standards

2.1 Heavy hex structural bolts as presented in this standard have been coordinated, to the extent possible, with a draft ISO proposed standard. The dimensional differences between this ANSI standard and the ISO proposal are few, relatively minor, and none will affect the functional interchangeability of bolts manufactured to the requirements of either.

The following functional characteristics of bolts are in agreement between this ANSI standard and the ISO proposal:

Diameters and thread pitches
Body diameters
Widths across flats

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Bearing surface diameters
Head heights
Thread lengths (see Para. 15)
Thread dimensions
Nominal lengths

2.2 There will be two ISO standards for heavy hex structural bolts, with the only difference between them being length of thread. This ANSI standard is essentially identical to the proposed ISO standard for bolts with the shorter thread lengths.

2.3 Letter symbols designating dimensional characteristics are in accord with those used in ISO standards, except capitals have been used for data processing convenience instead of lower case letters used in ISO standards.

3. Dimensions

3.1 All dimensions in this standard are in millimeters, unless stated otherwise.

3.2 Symbols specifying geometric characteristics are in accord with American National Standard, Dimensioning and Tolerancing, ANSI Y14.5-1973.

4. Top of Head. The top of head shall be full form and chamfered or rounded. The diameter of the chamfer circle or the start of rounding shall be equal to the maximum width across flats within a tolerance of minus 15 percent.

5. Head Height. The head height is the distance, as measured parallel to the axis of the bolt, from the top of the head to the underhead bearing surface.

6. Wrenching Height. The wrenching height is the distance, measured at a corner of the hex, from the plane of the bearing surface to the last plane of full formed hex, i.e., the plane closest to the top of head at which the width across corners of the hex is within its specified limits.

7. Corner Fill. The rounding due to lack of fill at the six corners of the head shall be reasonably uniform.

8. True Position of Head. The axis of the hex head shall be located at true position with respect to the axis of the bolt (determined over a distance under the head equal to one bolt diameter) within a tolerance zone of diameter equal to 6 percent of the specified maximum width across flats.

9. Bearing Surface. The bearing surface shall be flat and washer faced. However, a die seam across the bearing face shall be permissible. Diameter of bearing surface shall not exceed the width across flats nor be less than the specified minimum washer face diameter. For referee purposes, measurement of bearing surface diameter shall be taken at mid-thickness of the washer face. The plane of the bearing surface shall be perpendicular to the axis of the body within the total runout specified in Table 1. The measurement of bearing face runout shall be made as close to the periphery of the washer face as possible while the bolt is held in a collet or other gripping device at a distance equal to one bolt diameter from the underside of the head. Angularity measurement shall be taken at a location to avoid interference from a die seam.

10. Body Diameter

10.1 Bolts shall be furnished with a full diameter body within the limits specified in Table 1.

10.2 There may be a reasonable swell, fin, or die seam on the body adjacent to the underside of head not to exceed the nominal bolt diameter by the following:

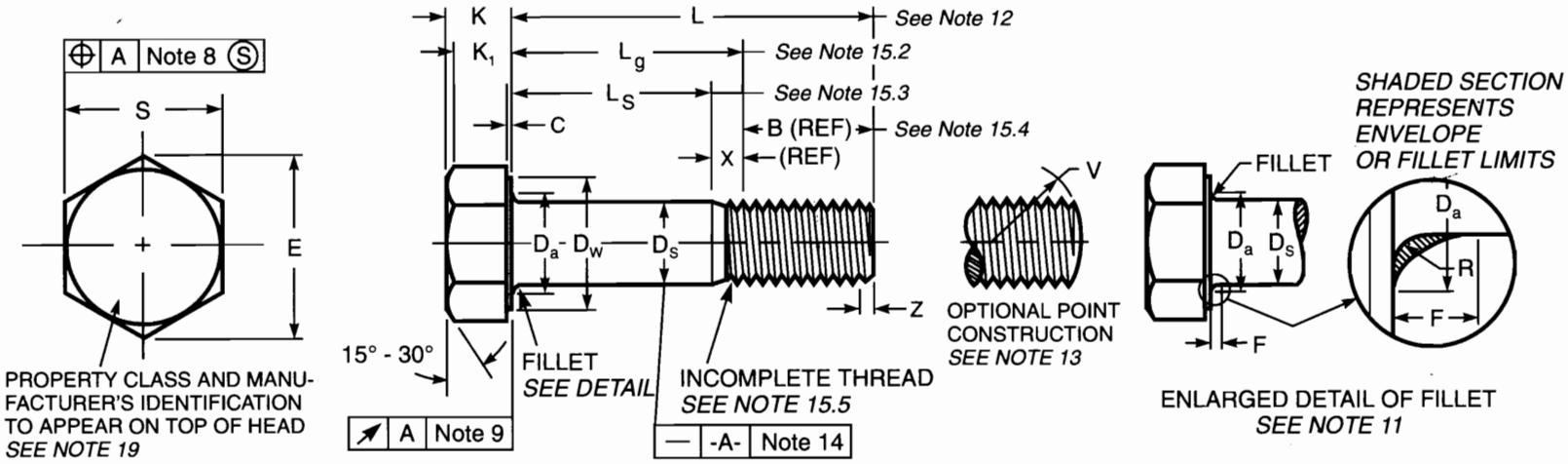

Table 1 Dimensions of Heavy Hex Structural Bolts

D	D_s		S		E		K		K_1	D_w		C		D_a	F	R	B (Ref)		X (Ref)
Nom Bolt Dia and Thread Pitch	Body Diameter		Width Across Flats		Width Across Corners		Head Height		Wrench-ing Height	Washer Face Dia	Runout of Bearing Surface FIM	Washer Face Thickness		Fillet Transi-tion Dia	Fillet Length	Fillet Radius	Thread Length		Transi-tion Thread Length
																	Bolt Length ≤ 100	Bolt Length > 100	
	Max	Min	Max	Min	Max	Min	Max	Min	Min	Min	Max	Max	Min	Max	Max	Min	Basic		Max
M16 × 2	16.70	15.30	27.00	26.16	31.18	29.56	10.75	9.25	6.5	24.9	0.48	0.8	0.4	18.2	3.0	0.6	31	38	6.0
M20 × 2.5	20.84	19.16	34.00	33.00	39.26	37.29	13.40	11.60	8.1	31.4	0.59	0.8	0.4	22.4	4.0	0.8	36	43	7.5
M22 × 2.5	22.84	21.16	36.00	35.00	41.57	39.55	14.90	13.10	9.2	33.3	0.63	0.8	0.4	24.4	4.0	0.8	38	45	7.5
M24 × 3	24.84	23.16	41.00	40.00	47.34	45.20	15.90	14.10	9.9	38.0	0.70	0.8	0.4	26.4	4.0	1.0	41	48	9.0
M27 × 3	27.84	26.16	46.00	45.00	53.12	50.85	17.90	16.10	11.3	42.8	0.77	0.8	0.4	30.4	5.0	1.2	44	51	9.0
M30 × 3.5	30.84	29.16	50.00	49.00	57.74	55.37	19.75	17.65	12.4	46.5	0.85	0.8	0.4	33.4	6.0	1.2	49	56	10.5
M36 × 4	37.00	35.00	60.00	58.80	69.28	66.44	23.55	21.45	15.0	55.9	1.01	0.8	0.4	39.4	6.0	1.5	56	63	12.0
See Notes	10				6, 7		5		6	9	9	9		11					

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Table 2 Maximum Grip Gaging Length and Minimum Body Lengths for Heavy Hex Structural Bolts

Nom Bolt Dia and Thread Pitch	M16 × 2		M20 × 2.5		M22 × 2.5		M24 × 3		M27 × 3		M30 × 3.5		M36 × 4	
L Nominal Length	L_g Max	L_s Min	L_g Max	L_s Min	L_g Max	L_s Min	L_g Max	L_s Min	L_g Max	L_s Min	L_g Max	L_s Min	L_g Max	L_s Min
45	14	8												
50	19	13	14	6.5										
55	24	18	19	11.5	17	9.5								
60	29	23	24	16.5	22	14.5	19	10						
65	34	28	29	21.5	27	19.5	24	15	21	12				
70	39	33	34	26.5	32	24.5	29	20	26	17	21	10.5		
75	44	38	39	31.5	37	29.5	34	25	31	22	26	15.5		
80	49	43	44	36.5	42	34.5	39	30	36	27	31	20.5	24	12
85	54	48	49	41.5	47	39.5	44	35	41	32	36	25.5	29	17
90	59	53	54	46.5	52	44.5	49	40	46	37	41	30.5	34	22
95	64	58	59	51.5	57	49.5	54	45	51	42	46	35.5	39	27
100	69	63	64	56.5	62	54.5	59	50	56	47	51	40.5	44	32
110	72	66	67	59.5	65	57.5	62	53	59	50	54	43.5	47	35
120	82	76	77	69.5	75	67.5	72	63	69	60	64	53.5	57	45
130	92	86	87	79.5	85	77.5	82	73	79	70	74	63.5	67	55
140	102	96	97	89.5	95	87.5	92	83	89	80	84	73.5	77	65
150	112	106	107	99.5	105	97.5	102	93	99	90	94	83.5	87	75
160	122	116	117	109.5	115	107.5	112	103	109	100	104	93.5	97	85
170	132	126	127	119.5	125	117.5	122	113	119	110	114	103.5	107	95
180	142	136	137	129.5	135	127.5	132	123	129	120	124	113.5	117	105
190	152	146	147	139.5	145	137.5	142	133	139	130	134	123.5	127	115
200	162	156	157	149.5	155	147.5	152	143	149	140	144	133.5	137	125
210	172	166	167	159.5	165	157.5	162	153	159	150	154	143.5	147	135
220	182	176	177	169.5	175	167.5	172	163	169	160	164	153.5	157	145
230	192	186	187	179.5	185	177.5	182	173	179	170	174	163.5	167	155
240	202	196	197	189.5	195	187.5	192	183	189	180	184	173.5	177	165
250	212	206	207	199.5	205	197.5	202	193	199	190	194	183.5	187	175
260	222	216	217	209.5	215	207.5	212	203	209	200	204	193.5	197	185
270	232	226	227	219.5	225	217.5	222	213	219	210	214	203.5	207	195
280	242	236	237	229.5	235	227.5	232	223	229	220	224	213.5	217	205
290	252	246	247	239.5	245	237.5	242	233	239	230	234	223.5	227	215
300	262	256	257	249.5	255	247.5	252	243	249	240	244	233.5	237	225

NOTES:

1. L_g is grip gaging length; L_s is body length.
2. Bolts with lengths above the heavy solid line are threaded full length.
3. For bolts with longer lengths, L_g and L_s values shall be computed from formulas as given in Note 15 of General Data.

1.25 mm for M16
1.50 mm for M20 thru M30
2.30 mm for M36

11. Fillet. The fillet at junction of head and shank shall be a smooth concave curve within an envelope of R minimum, and a smooth multi-radius curve tangent to the underside of head at a point no greater than one-half of D_a maximum from the axis of the bolt and tangent to the shank of the bolt at a distance no greater than F maximum from the underside of head.

12. Length. Recommended lengths of bolts are given in Table 2. The length of the bolt shall be measured parallel to the axis of the bolt from the underhead bearing surface to the extreme end of the shank. Length tolerances shall be as specified in Table 3.

13. Points. The end of the bolt shall be chamfered from a diameter equal to or slightly less than the thread root diameter to produce a length of chamfer or incomplete thread within the limits for Z specified in Table 4. The end of the bolt shall be reasonably square with the axis of bolt, and where pointed blanks are used, the slight rim or cup resulting from roll threading shall be permissible. At the manufacturer's option, the end of the bolt may have a rounded point of radius V as specified in Table 4.

14. Straightness. Shanks of bolts shall be straight within a maximum camber of 0.006 mm/mm of bolt length for bolts having nominal lengths of 300 mm or shorter; and within 0.008 mm/mm of bolt length for bolts having nominal lengths over 300 mm. The referee gage and gaging procedure for checking bolt straightness are given in Appendix I of ANSI B18.2.3.5M, page C–59.

Table 3 Length Tolerances

Nominal Length	Nominal Bolt Dia
	M16 thru M36
to 50 mm	± 1.2
over 50 to 80 mm	± 1.5
over 80 to 120 mm	± 1.8
over 120 to 150 mm	± 2.0
over 150 mm	± 4.0

Table 4 Dimensions of Points

Nom Bolt Dia and Thread Pitch	V	Z	
	Point Radius	Point Length	
	Approx	Max	Min
M16 × 2	22.4	3.00	1.00
M20 × 2.5	28.0	3.75	1.25
M22 × 2.5	30.8	3.75	1.25
M24 × 3	33.6	4.50	1.50
M27 × 3	37.8	4.50	1.50
M30 × 3.5	42.0	5.25	1.75
M36 × 4	50.4	6.00	2.00

V equals 1.4 times thread major diameter.
Z max equals 1.5 times thread pitch.
Z min equals 0.5 times thread pitch.

15. Thread Length

15.1 The length of thread on bolts shall be controlled by the maximum grip gaging length (L_g) and the minimum body length (L_s) as set forth in 15.2 thru 15.5.

15.2 Grip gaging length, L_g max, is the distance measured parallel to the axis of the bolt, from the underhead bearing surface to the face of a noncounterbored or noncountersunk standard GO thread ring gage assembled by hand as far as the thread will permit. For standard diameter-length combinations of bolts the values for L_g max are specified in Table 2. For diameter-length combinations not listed in Table 2, the maximum grip gaging length, as calculated and rounded to one decimal place, shall be equal to the nominal bolt length, L, minus the basic thread length, B, as specified in Table 1

(L_g max = L – B). L_g max shall be used as a criterion for inspection.

15.3 Body length, L_s min, is the distance, measured parallel to the axis of the bolt, from the underhead bearing surface to the last scratch of thread or the top of the extrusion angle, whichever is closest to the head. For standard diameter-length combinations of bolts the values of L_s min are given in Table 2. For diameter-length combinations not listed in Table 2, the minimum body length, as calculated and rounded to one decimal place, is equal to the maximum grip gaging length (as computed) minus the maximum transition thread length as given in Table 1 (L_s min = L_g max – X max). L_s min shall be used as a criterion for inspection. Bolts of nominal lengths which have a calculated L_s min value equal to or less than the length of 2.5 times the thread pitch shall be threaded full length. Bolts which are threaded full length shall have a minimum body length under the head equal to F as specified in Table 1.

15.4 Basic thread length, B, as specified in Table 1 is a reference dimension intended for calculation purposes only, and is the distance, measured parallel to the axis of the bolt, from the extreme end of the bolt to the last complete (full form) thread.

15.5 Transition thread length, X max, as specified in Table 1 is a reference dimension intended for calculation purposes only. It includes the length of incomplete threads and tolerances on grip gaging length and body length. The transition from full thread to incomplete thread shall be smooth and uniform. The major diameter of the incomplete threads shall not exceed the actual major diameter of the complete (full form) threads.

16. Thread Series. Threads shall be metric coarse thread series conforming to dimensions for general purpose external threads given in ASME B1.13, page A–20. The Class 6g tolerance shall apply to plain finish (unplated or uncoated) bolts, and to plated or coated bolts before plating or coating.

17. Thread Acceptability. Unless otherwise specified by the purchaser, gaging for screw thread dimensional acceptability shall be in accordance with Gaging System 21 as specified in ASME B1.3M, page A–46.

(IFI Note: Para. 17 is not included in ANSI B18.2.3.7M-1979. However, inclusion of this requirement in the next edition of this standard has been approved by the responsible technical committee. Paras. 18 thru 27 are renumbered accordingly.)

18. Material and Mechanical Properties. Chemical composition and mechanical requirements of steel bolts shall conform to ASTM A325M, page F–16 or ASTM A490M, page F–21.

19. Finish. Unless otherwise specified, screws and bolts shall be supplied with a natural (as processed) finish, unplated or uncoated.

20. Identification Symbols. Steel bolts shall be marked with the grade identification symbols and with the manufacturer's identification symbol. Minimum height of property class symbols shall be 0.4 mm. Markings shall be located on the top of the head and may be raised or recessed unless otherwise ordered by the purchaser. When raised, markings shall project not less than 0.3 mm above the surface of the head, and total head height (head plus markings) shall not exceed the specified maximum head height plus 0.4 mm.

21. Options. Options, where specified, shall be at the discretion of the manufacturer unless otherwise agreed upon by the manufacturer and the purchaser.

22. Terminology. For definition of terms relating to fasteners or component features thereof used in this standard, refer to American National Standard, Glossary of Terms for Mechanical Fasteners, ASME B18.12. See page K–37.

23. Workmanship. Bolts shall not contain an excess of surface imperfections which might affect their serviceability, such as burrs, seams, laps, loose scale and other irregularities.

24. Clearance Holes. The recommended sizes of clearance holes in material to be assembled using heavy hex structural bolts are the normal series given in IFI-527, page K–7.

25. Designation

25.1 Heavy hex structural bolts shall be designated by the following data preferably in the sequence shown: product name, nominal diameter and thread pitch, nominal length, steel property class, and protective coating, if required.

Note

It is common practice in ISO standards to omit thread pitch from the product size designation when screw threads are the metric coarse thread series, e.g., M20 is M20 × 2.5.

Examples:

Heavy hex structural bolt, M22 × 2.5 × 160, ASTM A325M, zinc galvanized.

Heavy hex structural bolt, M24 × 3 × 80, ASTM A490M.

26. Inspection and Quality Assurance. Unless otherwise specified by the purchaser in the original inquiry and purchase order, acceptability shall be based on conformance with the requirements specified in ANSI B18.18.1M, page L–5.

(IFI Note: Para. 26 is not included in ANSI B18.2.3.7M-1979. However, inclusion of this requirement in the next edition of this standard has been approved by the responsible technical committee. See also IFI Note page C–65.)

27. Referenced Standards. Titles and source of availability of all documents referenced in this standard are given on page K–41.