ASME B18.2.3.10M-1996

SQUARE HEAD BOLTS (METRIC SERIES)

AN AMERICAN NATIONAL STANDARD

The American Society of Mechanical Engineers

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This Standard will be revised when the Society approves the issuance of a new edition. There will be no addenda or written interpretations of the requirements of this Standard issued to this edition.

The American Society of Mechanical Engineers
345 East 47th Street New York, NY 10017

FOREWORD

(This Foreword is not a part of ASME B18.2.3.10M-1996.)

ASME Standards Committee B18 for the Standardization of Bolts, Nuts, Rivets, Screws, Washers, and Similar Fasteners (formerly American National Standards Committee B18), was originated in March 1922 as Sectional Committee B18 under the aegis of the American Engineering Standards Committee (later the American Standards Association, the United States of America Standards Institute and, as of October 6, 1969, the American National Standards Institute, Inc.) with the Society of Automotive Engineers and the American Society of Mechanical Engineers as joint sponsors. Subcommittee 2 was subsequently established and charged with the responsibility for the technical content of standards covering external drive bolts, screws and nuts.

At its meeting on December 4, 1974, Committee B18 authorized preparation of a series of standards for metric fasteners. Subcommittee 2 was assigned responsibility for developing standards for metric hex bolts, screws and nuts (later, for external drive and similar threaded fasteners).

Eventually, a need for metric square head bolts was also recognized, for example, in applications as bolster mounting bolts in mechanical power presses.

In January 1992, Subcommittee 2 prepared the draft standard for metric square head bolts, based on metric hex bolts by merely changing the hexagon to a square with the same width across flats, since there was no International Standard for square head bolts.

This Standard was approved by letter ballot of ASME Standards Committee B18 and Subcommittee 2 on July 26, 1995, and was subsequently approved by the secretariat and submitted to the American National Standards Institute for designation as an American National Standard. This was granted on December 4, 1996.

ASME B18 STANDARDS COMMITTEE
Standardization of Bolts, Nuts, Rivets, Screws, Washers, and Similar Fasteners

(The following is the roster of the Committee at the time of approval of this Standard.)

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SQUARE HEAD BOLTS (METRIC SERIES)

1 INTRODUCTORY NOTES

1.1 Scope

1.1.1 This Standard covers the general and dimensional data for standard metric series square head bolts.

1.1.2 The inclusion of dimensional data in this Standard is not intended to imply that all of the products described are stock production items. Consumers should consult with suppliers concerning the availability of products.

1.2 Comparison With ISO Standards

1.2.1 There is no ISO product standard for square head bolts. This Standard is similar to ISO 4016, Hexagon head bolts — Product grade C, and ISO 4018, Hexagon head screws — Product grade C, but with square head. For the same nominal size, this Standard differs from ISO 4016 or ISO 4018 as follows:

(a) The head is square, instead of hexagonal, but with the same width across flats. Tolerances for widths across flats and across corners agree with ISO 4759/1.

(b) Threads are tolerance class 6g, instead of 8g.

(c) Tolerances on bolt length are increased for sizes over M16 of lengths up to 150 mm.

(d) An optional reduced hammer body, with or without full size shoulder, is added.

(e) Material and property class choices are added.

1.2.2 Letter symbols designating dimensional characteristics agree with ISO 225, Fasteners — Bolts, screws and studs — Symbols and designators of dimensions, except where capitals have been used instead of lowercase letters used in the ISO standards.

1.3 Terminology

For definitions of terms relating to fasteners or component features thereof used in this Standard, refer to ANSI B18.12, Glossary of Terms for Mechanical Fasteners.

1.4 Dimensions

All dimensions in this Standard are given in millimeters (mm), and apply before any coating, unless otherwise stated.

Dimensioning and tolerancing in this Standard are in accord with ASME Y14.5M, Dimensioning and Tolerancing.

1.5 Designation

Square head bolts shall be designated by the following data, preferably in the sequence shown: product name and designation of the standard, nominal diameter and thread pitch, nominal length, steel property class or material identification, and protective coating, if required.

NOTE: It is common practice in ISO standards to omit the thread pitch from the product size designation when screw threads are the metric coarse pitch series, e.g., M10 is M10 × 1.5.

EXAMPLES:

Square head bolt B18.2.3.10M, M20 × 2.5 × 80, class 4.6, zinc plated per ASTM F 871M and ASTM B 633 Fe/Zn type II

Square head bolt B18.2.3.10M, pointed, M16 × 2 × 80, class 10.9

Square head bolt B18.2.3.10M, M6 × 1 × 30, CRES (Corrosion Resistant Steel) A1–50 ASTM F 738M

Square head bolt B18.2.3.10M, type R, pointed, M12 × 1.75 × 60, Alloy 651 silicon bronze

1.6 Referenced Standards

ANSI and ISO standards may be obtained from the American National Standards Institute, 11 West 42nd Street, New York, NY 10036-8002. Alternatively, ANSI, ANSI/ASME, ASME/ANSI and ASME B1, B18, or Y14 standards may be obtained from the ASME Order Department, 22 Law Drive, Box 2300, Fairfield, NJ 07007-2300.

ASTM standards may be obtained from the American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

SAE standards may be obtained from the Society of Automotive Engineers, Inc., 400 Commonwealth Drive, Warrendale, PA 15096-0001.

2 GENERAL DATA

2.1 Head

2.1.1 Top of Head. The top of the head shall be full form and chamfered as shown in Table 1.

2.1.2 Head Height. The head height is the distance, measured parallel to the axis of the bolt, from the under head bearing surface to the top of the head. See para. 2.10.

2.1.3 Wrenching Height. The wrenching height is the height from the bearing surface to the last plane where the widths across flats and corners are within their specified limits.

2.1.4 True Position of Head. The axis of the square head shall be located at true position with respect to the axis of the shank, determined over a length under the head equal to one bolt diameter, within a tolerance zone of diameter t_1, specified in Table 1, regardless of feature size.

2.1.5 Bearing Surface. The bearing surface may be flat or washer faced, at the option of the supplier. If washer faced, the washer face shall have thickness not more than C max, and diameter, measured 0.1 mm from the bearing surface, of not less than D_w min. A 0.5 mm maximum height die seam fin across the bearing surface is permissible. The bearing surface shall be perpendicular within 2 deg. to the axis of the body, determined over a length under the head equal to one bolt diameter. Angularity measurement shall be taken at a location to avoid interference from a die seam.

2.2 Underhead Fillet

The fillet at the junction of the head and shank shall be a smooth concave curve within an envelope of R min and a radius tangent to the shank and to the bearing surface at a point equal to one-half of the maximum fillet transition diamteter ($0.5D_a$ max) from the axis of the shank.

2.3 Body Diameter

2.3.1 On bolts which are not threaded full length, the body diameter shall be within the limits for D_s, unless the purchaser specifies bolts with "reduced diameter body" or "Type R" (see para. 2.3.2).

On bolts which are threaded full length, the diameter of the unthreaded length under the head shall not be greater than the maximum full size body diameter, D_s max, nor less than the minimum reduced body diameter, D_2 min.

2.3.2 Bolts of nominal lengths which are not threaded full length according to Table 3 may be obtained with reduced diameter body. When "reduced diameter body" or "Type R" is specified, the reduced body diameter shall be within the limits for D_2. At the option of the supplier, bolts with reduced diameter body may be supplied with shoulder under the head of diameter D_s and length L_2.

2.4 Bolt Length

The bolt length, L, is the distance from the bearing surface of the head to the end of the bolt. The recommended bolt lengths are given in Table 2. Tolerances on bolt length are specified in Table 4.

2.5 Points

Unless otherwise specified, bolts may be either non-pointed or pointed (chamfered or rounded) at the option of the supplier. The length from the end of the bolt to the first full formed thread at major diameter, as determined by the distance the end of the bolt enters into a cylindrical NOT GO major diameter ring gage, shall not exceed U max. A chamfered point shall have a diameter equal to or slightly less than the thread root diameter. The bolt may have a rounded point of radius R_e.

2.6 Straightness

On bolts of minimal lengths greater than two times nominal diameter ($L > 2D$), that portion of the bolt shank which is more than two diameters ($2D$) from the head shall be straight within a maximum camber of 0.1 mm + $0.004(L - 2D)$ for M8 and smaller bolts, and 0.1 mm + $0.005(L - 2D)$ for M10 and larger bolts. A gage and procedure for checking bolt straightness are given in Appendix I.

2.7 Threads

2.7.1 Thread Series and Class. Screw threads shall be coarse series general purpose metric screw threads with tolerance class 6g conforming to ASME B1.13M, Metric Screw Threads — M Profile, unless otherwise specified by the purchaser. For bolts with additive finish, size limits for tolerance class 6g apply prior to coating, and the thread after coating is subject to acceptance using a basic (tolerance position h) size

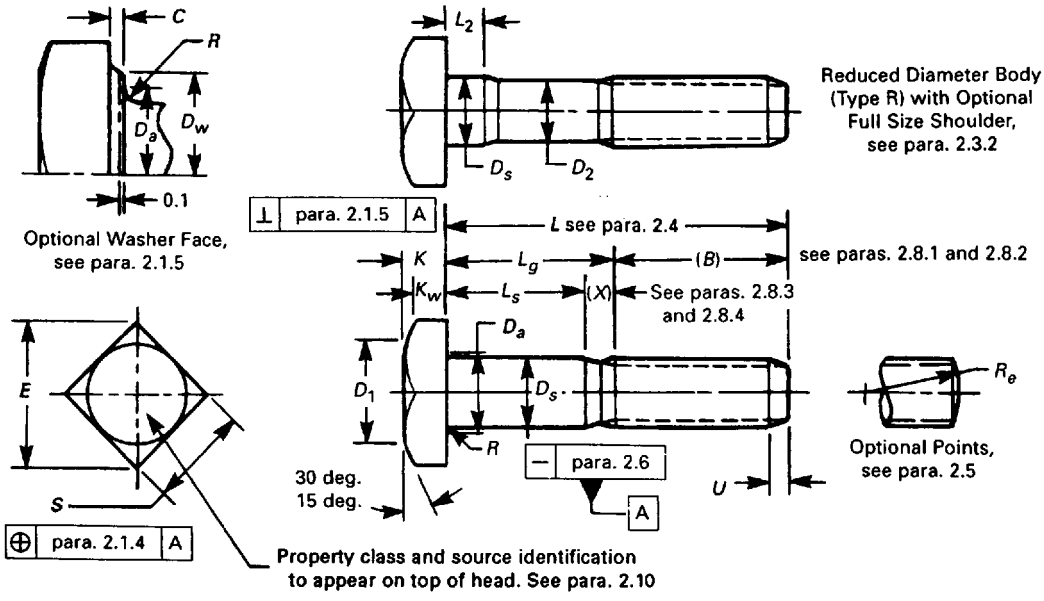


TABLE 1 DIMENSIONS OF SQUARE HEAD BOLTS

D	Thread Size		M6	M8	M10	M12	M16	M20	M24	M30
P	Thread Pitch		1	1.25	1.5	1.75	2	2.5	3	3.5
C	Washer Face Thickness (see para. 2.1.5)	max	0.5	0.6	0.6	0.6	0.8	0.8	0.8	0.8
D_a	Fillet Transition Diameter (see para. 2.2)	max	7.2	10.2	12.2	14.7	18.7	24.4	28.4	35.4
D_f	Head Top Chamfer Diameter (see para. 2.1.1)	max	10.0	13	16.0	18.0	24.0	30.0	36.0	46.0
		min	8.5	11	13.6	15.3	20.4	25.5	30.6	39.1
D_s	Full Size Body Diameter (see para. 2.3.1) or Shoulder Diameter (see para. 2.3.2)	max	6.48	8.58	10.58	12.7	16.7	20.84	24.84	30.84
		min	5.52	7.42	9.42	11.3	15.3	19.16	23.16	29.16
D_w	Washer Face Diameter (see para. 2.1.5)	min	8.74	11.47	14.47	16.47	22	27.7	33.25	42.75
D_2	Reduced Body Diameter (see para. 2.3.2)	max	5.39	7.26	9.08	10.95	14.77	18.49	22.13	27.79
		min	5.21	7.04	8.86	10.68	14.50	18.16	21.80	27.46
E	Square Width Across Corners	max	14.14	18.38	22.62	25.45	33.94	42.42	50.91	65.05
		min	12.53	16.34	20.24	22.84	30.11	37.91	45.50	59.80
K	Head Height (see paras. 2.1.2, 2.10)	max	4.38	5.68	6.85	7.95	10.75	13.4	15.9	19.75
		min	3.62	4.92	5.95	7.05	9.25	11.6	14.1	17.65
K_w	Wrenching Height (see para. 2.1.3)	min	2.53	3.44	4.16	4.93	6.47	8.12	10.29	12.35
L_2	Shoulder Length (see para. 2.3.2)	max	4	5	6	7	9	11	13	16
		min	3	4	5	6	8	10	12	15
R	Fillet Radius (see para. 2.2)	min	0.25	0.4	0.4	0.6	0.6	0.8	0.8	1
R_e	Point Radius (see para. 2.5)	approx	8.4	11.2	14	16.8	22.4	28	33.6	42
S	Square Width Across Flats	max	10.00	13.00	16.00	18.00	24.00	30.00	36	46
		min	9.64	12.57	15.57	17.57	23.16	29.16	35	45
t_1	Head Position Tolerance Zone Diameter (see para. 2.1.4)		1.16	1.4	1.4	1.4	1.68	1.68	2	2
U	Point Length (see para. 2.5)		2	2.5	3	3.5	4	5	6	7

TABLE 2 STANDARD NOMINAL LENGTHS L, GRIP LENGTHS L_g, AND BODY LENGTHS L_s

DxP	M6x1		M8x1.25		M10x1.25		M12x1.25		M16x1.25		M20x1.25		M24x1.25		M30x1.25	
L nom	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	L_g max	L_s min	L_g max
12		3														
16		3		4												
20		3		4		4.5										
25		3		4		4.5		5.3								
30	7	12		4		4.5		5.3		6						
35	12	17		4		4.5		5.3		6						
40	17	22	11.75	18		4.5		5.3		6		7.5				
45	22	27	16.75	23	11.5	19		5.3		6		7.5				
50	27	32	21.75	28	16.5	24		5.3		6		7.5		9		
55	32	37	26.75	33	21.5	29	16.25	25		6		7.5		9		
60	37	42	31.75	38	26.5	34	21.25	30		6		7.5		9		10.5
65			36.75	43	31.5	39	26.25	35	17	27		7.5		9		10.5
70			41.75	48	36.5	44	31.25	40	22	32		7.5		9		10.5
80			51.75	58	46.5	54	41.25	50	32	42	21.5	34		9		10.5
90					56.5	64	51.25	60	42	52	31.5	44		9		10.5
100					66.5	74	61.25	70	52	62	41.5	54	31	46		10.5
110							71.25	80	62	72	51.5	64	41	56		10.5
120							81.25	90	72	82	61.5	74	51	66	36.5	54
130									76	86	65.5	78	55	70	40.5	58
140									86	96	75.5	88	65	80	50.5	68
150									96	106	85.5	98	75	90	60.5	78
160									106	116	95.5	108	85	100	70.5	88
180											115.5	128	105	120	90.5	108
200											135.5	148	125	140	110.5	128
220													132	147	117.5	135
240													152	167	137.5	155
260															157.5	175
280															177.5	195
300															197.5	215

GENERAL NOTES

(a) See paras. 2.4 and 2.8.

(b) The recommended diameter–length combinations are those for which the maximum grip gaging lengths, L_g max, are tabulated.

(c) Diameter–length combinations above the thick stepped line are threaded full length.

(d) Standard nominal lengths over 300 mm are in increments of 20 mm.

TABLE 3 THREAD LENGTHS[1]

D×*P* Nominal Bolt Diameter and Thread Pitch	(*B*) Thread Length, Basic (ref): Bolt Lengths *L*≤125	(*B*) Thread Length, Basic (ref): Bolt Lengths *L*>125 ≤200	(*B*) Thread Length, Basic (ref): Bolt Lengths *L*>200	(*X*) Transition Thread Length, max (ref)	Bolts Threaded Full Length: *L* Bolt Lengths, under	Bolts Threaded Full Length: *A* Unthreaded Length Under Head, max
M6×1	18	24	37	5	30	3
M8×1.25	22	28	41	6.25	40	4
M10×1.5	26	32	45	7.5	45	4.5
M12×1.75	30	36	49	8.75	55	5.3
M16×2	38	44	57	10	65	6
M20×2.5	46	52	65	12.5	80	7.5
M24×3	54	60	73	15	100	9
M30×3.5	66	72	85	17.5	120	10.5

NOTE:
(1) See para. 2.8.

TABLE 4 LENGTH TOLERANCES

Nominal Bolt Length, *L*	Nominal Bolt Diameter, *D*: M6 thru M16	M20 and M24	M30
	Length Tolerance		
over 6 thru 10	±0.75	...	...
over 10 thru 18	±0.9	...	...
over 18 thru 30	±1.05	±2	...
over 30 thru 50	±1.25	±2	±2.5
over 50 thru 80	±1.5	±2.5	±3
over 80 thru 120	±1.75	±3	±3.5
over 120 thru 150	±2	±3.5	±4
over 150 thru 180	±4	±4	±4
over 180 thru 250	±4.6	±4.6	±4.6
over 250 thru 315	±5.2	±5.2	±5.2
over 315 thru 400	±5.7	±5.7	±5.7
over 400 thru 500	±6.3	±6.3	±6.3

GO thread gage and tolerance class 6g thread gage for either minimum material, LO or NOT GO.

2.7.2 Thread Gaging. Unless otherwise specified, dimensional acceptability of threads shall be determined based on System 21, ASME B1.3M, Screw Thread Gaging Systems for Dimensional Acceptability — Inch and Metric Screw Threads (UN, UNR, UNJ, M and MJ).

2.8 Thread Length

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 paras. 2.8.1 through 2.8.4.

2.8.1 Grip gaging length, L_g, is the distance, measured parallel to the axis of the bolt, from the under head bearing surface to the face of a noncounterbored, noncountersunk standard GO thread ring gage assembled by hand as far as the thread will permit. L_g max is a criterion for inspection. 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:

(a) Bolts of nominal lengths shorter than the sum of the basic thread length plus the maximum transition thread length plus the nominal bolt diameter ($L < B + X$ max $+ D$) shall be threaded full length. For bolts which are threaded full length, L_g max $= A$ max, as specified in Table 3.

(b) For longer bolts which are not threaded full length, the maximum grip gaging length shall be equal to the nominal bolt length minus the basic thread length specified in Table 3 (L_g max $= L - B$).

2.8.2 Basic thread length, B, specified in Table 3 is a reference dimension intended for calculation purposes only, and is the distance, measured parallel to the axis of the bolt, from the end of the bolt to the last complete (full form) thread.

2.8.3 Body length, L_s, is the distance, measured parallel to the axis of the bolt, from the under head bearing surface to the last scratch of thread or the top of the extrusion angle, whichever is closer to the head. For standard diameter–length combinations of bolts, the values for L_s min are specified in Table 2. For diameter–length combinations not listed in Table 2, the minimum body length shall be equal to the maximum grip gaging length minus the maximum transition thread length specified in Table 3 (L_s min $= L_g - X$ max).

Bolts of nominal lengths which have a calculated minimum body length less than the nominal bolt diameter (L_s min $< D$) are threaded full length (see para. 2.8.1). The thread shall not extend into the underhead fillet.

2.8.4 Maximum transition thread length, X max, specified in Table 3 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 form 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. For bolts of property class 10.9 and higher strength materials (tensile strength 1040 MPa and higher), the transition threads shall have a rounded root contour no radius of which shall be less than the specified minimum radius at the root of the full form thread.

2.9 Material and Mechanical Properties

2.9.1 Steel. Unless otherwise specified, steel bolts shall conform to the requirements of ASTM F 568, Carbon and Alloy Steel Externally Threaded Metric Fasteners, or SAE J1199, Mechanical and Material Requirements for Metric Externally Threaded Steel Fasteners.

2.9.2 Corrosion-Resistant Steels. Unless otherwise specified, bolts made of corrosion resistant steels shall conform to the requirements of ASTM F 738M, Stainless Steel Metric Bolts, Screws, and Studs.

2.9.3 Nonferrous Metals. Unless otherwise specified, nonferrous bolts shall conform to the requirements of ASTM F 468M, Nonferrous Bolts, Hex Cap Screws, and Studs for General Use [Metric].

2.10 Identification Symbols

Markings shall be located on the top of the head, and may be raised or recessed unless otherwise specified by the purchaser. When raised, markings shall project not less than 0.1 mm for M12 and smaller bolts, and 0.3 mm for M16 and larger bolts, above the surface of the head; and total head height (head plus markings) shall not exceed the specified maximum head height plus 0.1 mm for M6 bolts, 0.2 mm for M8 and M10 bolts, 0.3 mm for M12 bolts, and 0.4 mm for M16 and larger bolts.

2.10.1 Property Class Symbols. Each bolt shall be marked in accordance with the requirements of the applicable specification for its chemical and mechanical requirements. Minimum height of property class sym-

bols shall be 1.5 mm for M6 bolts, 2.3 mm for M8 and M10 bolts, 3.2 mm for M12 bolts, and 4 mm for M16 and larger bolts.

2.10.2 Source Symbols. Each bolt shall be marked to identify its source (manufacturer or private label distributor).

2.11 Finish

Unless otherwise specified, bolts shall be furnished with a natural (as processed) finish, unplated or uncoated, in a clean condition, and lightly oiled.

2.12 Workmanship

Bolts shall be free from surface imperfections such as burrs, seams, laps, loose scale, and other surface irregularities which could affect their serviceability.

When control of surface discontinuities is required, the purchaser shall specify conformance to ASTM F 788/F 788M, Surface Discontinuities of Bolts, Screws, and Studs, Inch and Metric Series.

2.13 Inspection and Quality Assurance

Unless otherwise specified, acceptability of bolts shall be determined according to ASME B18.18.1M, Inspection and Quality Assurance for General Purpose Fasteners.

2.14 Dimensional Conformance

2.14.1 Unless otherwise specified, the following designated characteristics shall be inspected to the inspection levels shown in accordance to ASME B18.18.2M, Inspection and Quality Assurance for High Volume Machine Assembly Fasteners, and shall be within their specified limits.

Characteristic	Inspection Level
Thread Acceptability	C
Width Across Corners, E	C
Head Height, K	C
Grip Length, L_g, max	B

If verifiable in-process inspection is used according to ASME B18.18.3M or B18.18.4M, the final inspection level sample sizes of those standards shall apply.

2.14.2 For non-designated dimensional characteristics, ASME B18.18.1M shall apply. Should a non-designated dimensional characteristic be determined to be at variance, it shall be considered conforming to this Standard if the user who is the installer accepts the variance based on form, fit, and function considerations.

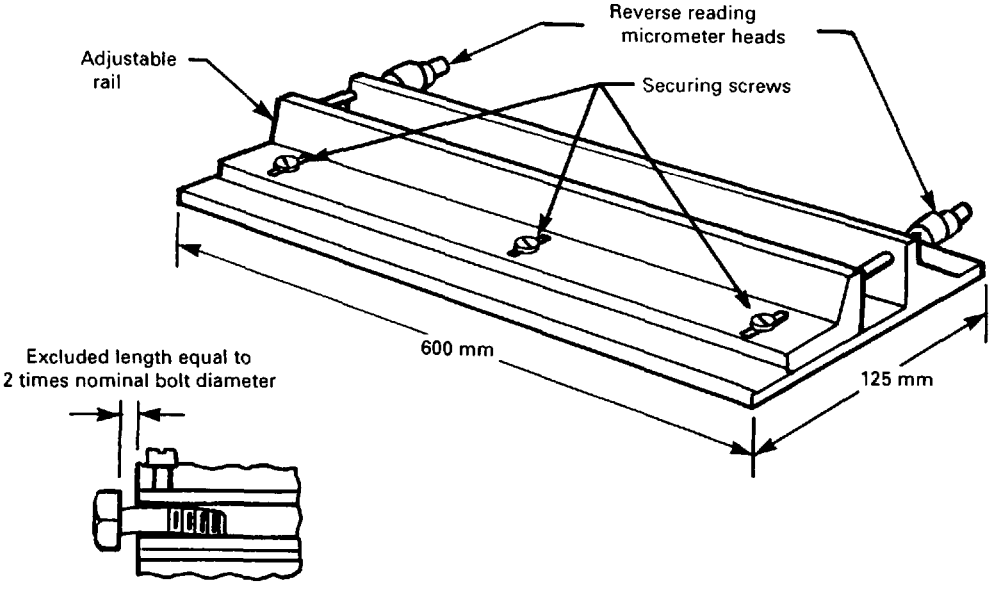
APPENDIX I
GAGE AND GAGING FOR CHECKING BOLT STRAIGHTNESS

(This Appendix is a part of ASME B18.2.3.10M-1996 and is placed after the main text for convenience.)

The conformance of bolts to shank straightness or camber limitations set forth in the bolt specifications may be checked by use of the typical gage illustrated below in accordance with the following procedure:

The allowable camber shall be calculated by applying the applicable formula to the length to be inspected, and shall be expressed as a two-place decimal. The camber thus derived shall be added to the specified maximum body diameter and the moveable rail of the gage shall be adjusted to provide a parallel space between the rails equal to this distance by obtaining common readings on both micrometer heads. The moveable rail shall then be locked in place by tightening the securing screws.

The bolt shall then be inserted between the rails, excluding from the gage a length equal to two times the nominal bolt diameter under the head or neck. The bolt shall next be rotated by hand through a full 360 deg. Any interference occurring between the bolt and the gage which is sufficient to prevent rotation shall indicate excessive camber.



AMERICAN NATIONAL STANDARDS FOR BOLTS, NUTS, RIVETS, SCREWS, WASHERS, AND SIMILAR FASTENERS

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