BRITISH STANDARD

BS 7371 :
Part 2 : 1993

Coatings on metal fasteners

Part 2. Specification for torque/clamping force relationship

BSI
STANDARDS

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the General Mechanical Engineering Standards Policy Committee (GME/-) to Technical Committee GME/9, upon which the following bodies were represented:

BEAMA Ltd.
British Constructional Steelwork Associaton Ltd.
British Industrial Fasteners Federation
British Railways Board
British Steel Industry
British Steel Industry (Wire Section)
Gauge and Tool Makers' Association
Ministry of Defence
Society of Motor Manufacturers and Traders Ltd.
Washer Manufacturers' Association of Great Britain

The following bodies were also represented in the drafting of the standard, through subcommittees and panels:

British Turned-parts Manufacturers' Association
EEA (The Electronic and Business Equipment Association)
Institute of Metal Finishing
Metal Finishing Association
Stainless Steel Fabricators' Association of Great Britain

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Foreword

This Part of BS 7371 has been prepared under the authority of the General Mechanical Engineering Standards Policy Committee to provide part of a series of standards on coatings on metal fasteners.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Specification

0 Introduction

BS 7371 deals with the performance of coatings on metal fasteners and accessories.

This Part of BS 7371 specifies the requirements for torque/clamping force relationship.

BS 7371 : Part 1 : 1991 *Specification for general requirements and selection guidelines* is supplementary to this and all other Parts of the standard.

Further Parts of the standard to incorporate the following are in preparation.

Specification for electroplated zinc and cadmium coatings

Specification for electroplated nickel, nickel/chromium and copper/nickel/chromium coatings

Specification for electroplated tin and tin/lead coatings

Specification for electroplated coatings for special purposes

Specification for mechanically applied zinc and cadmium coatings

Specification for mechanically applied coatings for special purposes

Specification for phosphate and oil coatings

Specification for organic coatings

Specification for zinc flake non-electrolytically applied cured coatings

This Part of BS 7371 is intended to ensure that successive production batches of coated fasteners will give repeatable clamping forces when assembled with controlled torque.

NOTE. The data incorporated in table 1 is for test purposes only and is not intended to be a table of assembly torques.

1 Scope

This Part of BS 7371 specifies test requirements to ensure that standard fasteners with ISO metric screw threads to BS 3643 sizes M3 to M39 inclusive, coated or uncoated, satisfy a specific torque/clamping force relationship when tested at a temperature of between 15 °C and 30 °C. It also specifies toxicity and dryness requirements of integral and supplementary lubricants.

NOTE 1. Strength requirements conform to BS EN 20898 : Part 1 and Part 2 and dimensions are specified in the relevant standards for products to be coated.

NOTE 2. Unless stated otherwise, all references to nuts and bolts in BS 7371 relate to coatings on both flanged and non-flanged products. All references to bolts apply also to screws.

NOTE 3. This Part of BS 7371 is not applicable to bolts, screws and nuts with performance specifications containing an alternative torque/clamping force test, e.g. prevailing torque nuts.

NOTE 4. The coating on the abutment face against which the fastener is tightened in an application, including the washer component of screw or nut and washer assemblies may influence the torque/clamping force relationship (see clause 5).

2 References

2.1 Normative references

This Part of BS 7371 incorporates, by reference, provisions from specific editions of other publications. These normative references are cited at the appropriate points in the text and the publications are listed on the inside back cover. Subsequent amendments to, or revisions of, any of these publications apply to this Part of BS 7371 only when incorporated in it by updating or revision.

2.2 Informative references

This Part of BS 7371 refers to other publications that provide information or guidance. Editions of these publications current at the time of issue of this standard are listed on the inside back cover, but reference should be made to the latest editions.

3 Definitions

For the purposes of this Part of BS 7371, the definitions given in BS 7371 : Part 1 apply together with the following.

3.1 clamping force

Force which is applied by the bearing face of the fastener against a mating component after application of a specified tightening torque.

3.2 galling

Condition whereby excessive friction between high spots results in localized welding with subsequent removal of particles of metal and further roughening of the rubbing surfaces of one or both of the mating parts.

3.3 high speed assembly

An assembly using a power device of suitable torque capacity with a free running speed representative of normally available power assembly equipment.

4 Lubrication

Coatings for fasteners and accessories which incorporate a lubricant constituent shall not require the addition of a supplementary lubricant.

Coatings for fasteners and accessories which do not incorporate a lubricant constituent shall not gall. A supplementary lubricant may be used to prevent galling if necessary (see **6.2**).

The torque/clamping force performance of fasteners which are supplied with either integral or supplementary lubrication shall not deteriorate when the fasteners are stored indoors for a period of 6 months. The storage temperature shall be within the range 5 °C to 40 °C.

NOTE. If a supplementary lubricant is not permitted on coatings which do not contain an integral lubricant, parts may not be able to conform to this standard.

5 Torque/clamping force

The torque necessary to develop the clamping force given in table 1 shall be measured on a representative sample in accordance with clause **7** of BS 7371 : Part 1 : 1991 by the method described in annex A, and shall be within the values for applied torque in table 1.

Screw and washer assemblies and nut and washer assemblies shall be tested with the washer component removed.

Fasteners with ISO metric fine pitch screw threads, thread rolling and cutting screws and bolts, screws and nuts with special underhead configurations, those with a shank area less than the stress area of the screw thread, or those which are too short to pass through the test equipment, shall not be tested in accordance with annex A but their torque/clamping force shall be assessed by testing standard fasteners coated by the same process in the same coating production run (see **2.2** of BS 7371 : Part 1 : 1991).

NOTE. Data is given in table 1 for nominal diameters larger than M24. Due to the limitations of test equipment, such parts may be evaluated in accordance with annex A, by comparison with standard fasteners of a smaller diameter coated by the same process and taken from the same production run.

6 Surface condition of lubricated parts

6.1 Toxicity

In the applied condition, the lubricant shall not constitute a health hazard to the user, or emit an unpleasant odour and shall not cause staining of the skin.

6.2 Dryness

The parts shall be dry to the touch such that when held with a filter paper (see note), and applying hand pressure for 5 s minimum, there shall be no visible staining of the filter paper when viewed without using supplementary magnification. For referee purposes this test shall be carried out using a force of 10 N.

NOTE. For dryness testing use an ashless filter paper[1)] with the following properties:

a) 85 g/m^2 mass per unit area;

b) 0.21 mm thickness;

c) 0.01 % ash content *m/m*;

d) 20 μm to 25 μm particle retention.

7 Lubricant performance

When applied to ISO metric coarse pitch threaded bolts, screws and nuts the lubricants shall ensure conformity to the torque/clamping force specified in clause **5** and table 1.

All fasteners treated with a lubricant shall be suitable for high-speed assembly (see **3.3**).

8 Corrosion resistance

Corrosion tests described in all other parts of BS 7371 shall apply subsequent to application of the lubricant material.

[1)] For information on the availability of a suitable filter paper, apply to Information Services, BSI, Linford Wood, Milton Keynes, MK14 6LE.

Table 1. Clamping force and applied torque for bolts, screws and nuts (ISO metric coarse pitch threads)

Nominal diameter	Clamping force[1]					Applied torque[2]									
	Property class														
	4.6 and 4.8[3]	8.8 or 8	9.8 or 9	10.9 and 10.9 or 10	12.9 or 12	4.6 and 4.8[2]		8.8 or 8		9.8 or 9		10.9 and 10.9 or 10		12.9 or 12	
						Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
	kN	kN	kN	kN	kN	Nm	Nm	Nm	Nm	Nm	Nm	Nm	Nm	Nm	Nm
M3	0.85	2.2	—	3.1	3.7	0.41	0.61	1.2	1.6	—	—	1.5	2.3	1.8	2.7
M4	1.49	3.8	—	5.5	6.4	0.95	1.43	2.5	3.7	—	—	3.7	5.3	4.2	6.2
M5	2.4	6.2	6.9	8.9	10.4	1.9	2.9	5	7.4	5.6	8.2	7.2	10.6	8.4	12.4
M6	3.39	8.7	9.8	12.9	14.6	3.25	4.9	8.4	12.4	9.5	14	12.5	17.9	14.2	20.8
M8	6.18	15.9	17.8	22.8	26.6	7.9	11.9	20	30	22.5	33.5	29	43	34	50
M10	9.75	25.3	28.3	36.1	42.2	15.6	23.4	41	60	46	66	59	85	68	100
M12	14.3	36.7	41.1	52.5	61.4	27.4	41	71	105	80	118	102	150	119	175
M14	19.4	50	56.1	71.6	84	43.5	65.3	112	168	127	187	161	240	189	282
M16	26.5	68.2	76.5	97.5	114	67.8	102	175	260	198	292	250	371	293	434
M18	32.4	86.2	—	119	140	93.3	140	255	372	—	—	353	513	415	603
M20	41.3	110	—	152	178	132	198	355	520	—	—	491	718	574	840
M22	51.2	136	—	189	220	180	270	500	705	—	—	675	989	787	1160
M24	59.6	159	—	220	256	229	343	620	928	—	—	857	1280	997	1490
M27	77.3	206	—	286	334	334	500	900	1330	—	—	1250	1850	1460	2160
M30	94.5	253	—	350	408	454	680	1230	1810	—	—	1700	2500	1980	2920
M33	117	312	—	432	505	618	927	1660	2460	—	—	2300	3410	2690	3980
M36	138	368	—	509	594	795	1190	2140	3160	—	—	2960	4370	3450	5100
M39	165	440	—	608	710	1030	1540	2770	4100	—	—	3830	5660	4480	6610

[1]The clamping forces specified are equal to 75 % of the proof load of the property classes of bolts as specified in BS EN 20898 : Part 1 : 1992

[2]The applied torques are not intended to be used as assembly torques (see clause **0**).

[3]The clamping forces specified for property class 4.6 and 4.8 are equal to 75 % of the proof load for property class 4.6 as specified in BS EN 20898 : Part 1 : 1992

Annex A (normative)
Torque/clamping force test

A.1 Principle

The torque/clamping force test shall be conducted at a temperature of 20 °C using torque and clamping force measuring devices (**A.2.1** and **A.2.2**). For referee purposes the driving speed shall not exceed 30 r/min.

A.2 Apparatus

NOTE. See figures A.1 and A.2 for plans of test fixtures where p is the thread pitch.

A.2.1 *Torque measuring device*, a torque wrench or torque sensing power device accurate to within 2 % of the torque specified for the fastener to be tested. For referee purposes, the measuring device shall be chosen so that all readings fall within the upper half of its torque range.

A.2.2 *Clamping force measuring device*, a device capable of measuring the actual clamping force generated as the fastener is tightened. The device shall be accurate to within 3 % of the specified test clamping force. The bolt clearance hole in the backing plate shall be the same diameter and tolerance as the test washer.

A.2.3 *Test bolt for nut testing*, the test bolt shall have threads produced by thread rolling of tolerance class 6 g minimum to 4 h maximum in conformity with BS 3643 : Part 2 1981. Bolt length shall be such that a minimum of two thread pitches as measured from the end of the bolt will protrude through the nut when the nut is seated against the test washer. Thread length shall be such that a minimum of two full threads are within the grip after the nut is tightened.

The bolt end shall be chamfered. The thread surface shall be free of burrs or other contamination that can affect an accurate determination of the performance of the nut.

The bolt shall have physical properties in accordance with BS EN 20898 : Part 1 : 1992, appropriate to the property class of the nut to be tested.

The bolt shall have the same finish (metallic coating) as the nut tested. When testing a nut with non-metallic or zinc flake coatings, a test bolt zinc electroplated with a nominal thickness of 8 μm, with a yellow chromate conversion coating and lubricated in accordance with this standard shall be used.

A.2.4 *Test nut for bolt testing*, nut with thread conforming to tolerance class 6 H in accordance with BS 3643 : Part 2 : 1981 shall have physical properties in accordance with BS EN 20898 : Part 2 : 1992, appropriate to the property class of the bolt to be tested.

The nut shall have the same finish (metallic coating) as the bolt to be tested.

When testing a bolt or screw with non-metallic and zinc flake coatings, a test nut zinc electroplated with a nominal thickness of 8 µm, with a yellow chromate conversion coating and lubricated in accordance with this standard shall be used.

A.2.5 *Test washer*, plain washer made from carbon steel, quenched and tempered to a surface hardness of 500 HV to 600 HV and a core hardness of 450 HV to 490 HV and uncoated shall be used. The abutment face shall be clean and lubricant free.

The dimensions of the test washer shall be as specified in table A.1.

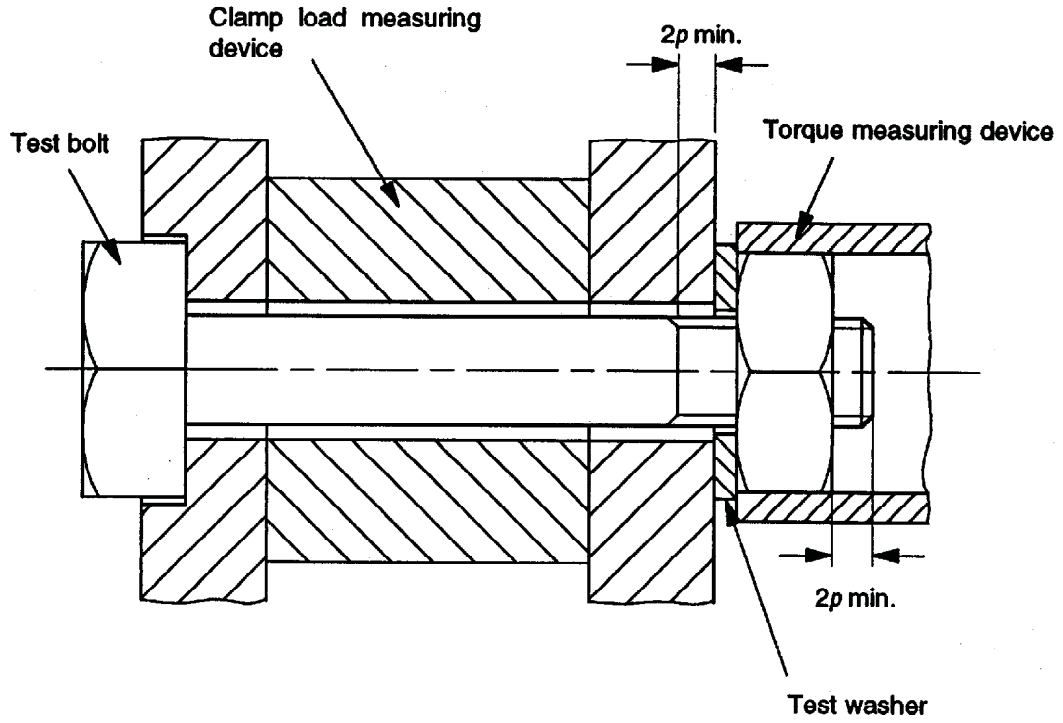
The faces shall be flat and parallel within a tolerance zone of 4 % of the specified minimum thickness. The surface roughness of the abutment face shall fall within the range 0.2µm to 0.4 µm (see BS 1134 : Part 2 : 1990). The abutment face of the washer shall be larger than the bearing surface of the bolt, screw or nut to be tested. The test washer shall be designed such that, when assembled into the test equipment, rotation of the washer is prevented during tightening of the nut, bolt or screw, and the internal diameter is located so as to avoid contact with the bolt or screw underhead radius. Any device used to prevent rotation shall not intrude into the contact area of the fastener to be tested.

NOTE. A multi-holed plate may be used in place of test washers provided that it conforms to the requirements for hardness, dimensions, thickness, surface condition, flatness and parallelism, and is located in the test equipment such that the hole avoids contact with the bolt or screw underhead radius.

Table A.1 Dimensions of test washers

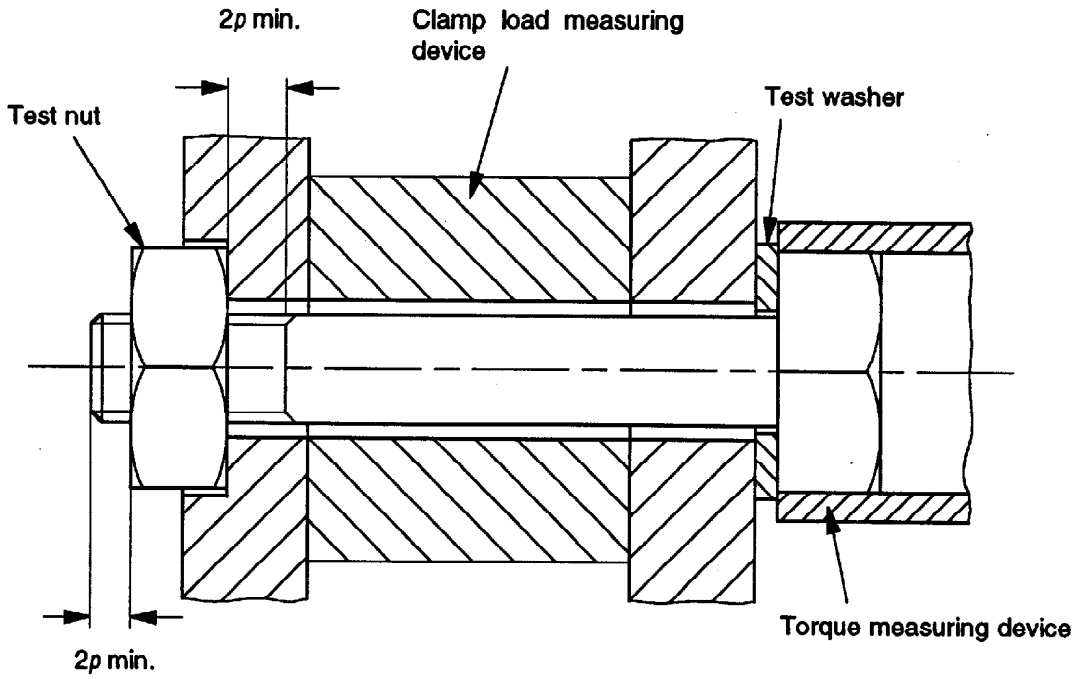
Nominal size of part to be tested	Minimum thickness	Internal diameter	
		max.	min.
M 3	0.45	3.8	3.7
M 4	0.7	4.9	4.8
M 5	0.9	5.9	5.8
M 6	1.4	7.1	6.9
M 8	1.4	9.5	9.3
M 10	1.8	11.5	11.3
M 12	2.3	14	13.8
M 14	2.3	16	15.8
M 16	2.7	18	17.8
M 18	2.7	20.5	20.3
M 20	2.7	22.7	22.5
M 22	2.7	24.7	24.5
M 24	3.7	26.7	26.5

NOTE. For sizes above M 24 see clause **5.**



NOTE. The test washer shall be prevented from turning.

Figure A.1. Plan of a test fixture for nut testing



NOTE. The test washer shall be prevented from turning.

Figure A.2. Plan of a test fixture for bolt testing

A.3 Procedure

Insert a test bolt (**A.2.3**) or nut (**A.2.4**) in the clamping force measuring device and place a test washer (**A.2.5**) under the clamping face of the fastener to be tested. Tighten either manually with a torque wrench (**A.2.1**) (a recommended technique is described in annex B), or with an equivalent torque sensing power device (**A.2.1**).

Tighten the fastener to be tested until the clamping force specified in table 1, appropriate to the property class of the fastener, is achieved. The applied torque shall be within the values specified in table 1. During tightening, prevent the test bolt or nut, as appropriate, from rotating.

Use a new bolt for testing each nut and a new nut for testing each bolt. Re-prepare the abutment face of the washer between each test or use a new washer.

In cases of dispute perform a referee test using an automatic torque sensing power device. Maintain a continuous and steady driving speed until rotation has continued to beyond the specified clamping force. Evaluate a continuous record (such as that produced by an X against Y plotter) of torque and clamping force to determine the torque for the clamping force specified in table 1.

Annex B (informative)

Recommended testing technique for use with manual torque wrenches

B.1 General

This is a recommended method for measuring the torque characteristics of fasteners, employing a manual torque wrench.

B.2 Apparatus

NOTE. See figures A.1 and A.2 for plans of test fixtures where P is the thread pitch.

B.2.1 *Hand torque wrenches,* of a size suitable for the range of test torque values anticipated.

B.2.2 *Clamping force measuring device,* to hold the test fastener and test washer, and to measure the clamping force produced by tightening the fastener to be tested. (A strain gauge load cell is preferred, but a hydraulic cell is acceptable.) (See figures A.1 and A.2 where P is the thread pitch.)

B.3 Test procedure

The test method to determine torque/clamping force performance is specified in annex A.

List of references (see clause 2)

Normative references

BSI standards publications

BRITISH STANDARDS INSTITUTION, London

BS 1134 :	*Assessment of surface texture*
BS 1134 : Part 2 : 1990	*Guidance and general information*
BS 7371 :	*Coatings on metal fasteners*
BS 7371 : Part 1 : 1991	*Specification for general requirements and selection guidelines*
BS EN 20898 :	*Mechanical properties of fasteners*
BS EN 20898 : Part 1 : 1992	*Bolt, screws and studs*
BS EN 20898 : Part 2 : 1992	*Nuts with specified proof load values*

Informative references

BSI standards publications

BRITISH STANDARDS INSTITUTION, London

BS 3643	*ISO metric screw threads*
BS 3643 : Part 2 : 1981	*Specification for selected limits of size*

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