BRITISH STANDARD

BS 7644 :
Part 1 : 1993

Direct tension indicators

Part 1. Specification for compressible washers

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 Association Ltd.
British Industrial Fasteners Federation
British Railways Board
British Steel Industry
British Steel Industry (Wire Section)
Gauge and Tool Makers' Association
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:

Galvanizers' Association
Steel Construction Institute

This British Standard, having been prepared under the direction of the General Mechanical Engineering Standards Policy Committee, was published under the authority of the Standards Board and comes into effect on 15 April 1993

The following BSI references relate to the work on this standard:
Committee reference GME/9
Draft for comment 90/80390 DC

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Contents

Foreword

This Part of BS 7644 has been prepared under the authority of the General Mechanical Engineering Standards Policy Committee.

It is one Part of a standard for direct tension indicators for use in bolted joints.

BS 7644 : Part 2 provides a specification for nut faced and bolt faced washers which if used with the washers specified in this standard as part of a bolted joint gives an indication of the tension developed in the bolt used in the joint when the joint is tightened.

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

Specification

1 Scope

This Part of BS 7644 specifies requirements for the general dimensions, tolerances, materials and performance of compressible washer-type direct tension indicators for use in a steel-to-steel connection with high strength friction grip bolts and nuts conforming to BS 4395 : Part 1 : 1969 and Part 2 : 1969.

Two grades of indicator are specified, grade 1 (general grade) and grade 2(higher grade) for use with bolts and nuts conforming to BS 4395 : Part 1 and Part 2, respectively.

The indicators are intended to demonstrate the preload achieved in the bolt and may be used either alone or with bolt face washers or nut face washers conforming to BS 7644 : Part 2 : 1993. Guidance in the use of compressible washer-type direct tension indicator is given in annex A of this standard.

NOTE. Compressible washer-type direct tension indicators are also known as load indicating washers.

2 References

2.1 Normative references

This Part of BS 7644 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 7644 only when incorporated in it by updating or revision.

2.2 Informative references

This Part of BS 7644 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 Dimensions

Before installation, the general dimensions and tolerances of compressible washer-type direct tension indicators shall be as given in table 1 and figure 1. The size and number of protrusions on the indicator shall be not less than four and sufficient to meet the performance requirements of clause **4**. All the protrusions on an indicator shall be spaced at equal angular intervals. They shall have a radial position such that allowing for clearance and tolerance, when correctly assembled they will be in contact with the bearing surface of the bolt, the nut face washer or the bolt face washer.

Table 1. Dimensions of compressible washer-type direct tension indicators

Dimensions in millimetres

Nominal bolt diameter	Internal diameter d_1		External diameter d_2		Washer thickness h_1	Height over protrusions h_2
	Min.	Max.	Min.	Max.	Min.	Max.
M12	12.80	13.50	25.0	30.5	2.50	5.50
M16	16.80	17.50	31.0	36.5	3.00	6.00
M20	21.00	21.80	38.0	43.5	3.50	6.50
M22	23.00	23.80	43.0	48.5	4.00	7.00
M24	25.00	25.80	48.0	53.5	4.00	7.00
M27	28.00	29.00	54.0	60.0	4.00	7.00
M30	31.00	32.00	57.0	63.0	4.00	7.00
M33	34.00	35.00	67.0	76.0	4.00	7.50
M36	37.20	38.00	77.0	83.0	4.00	7.50

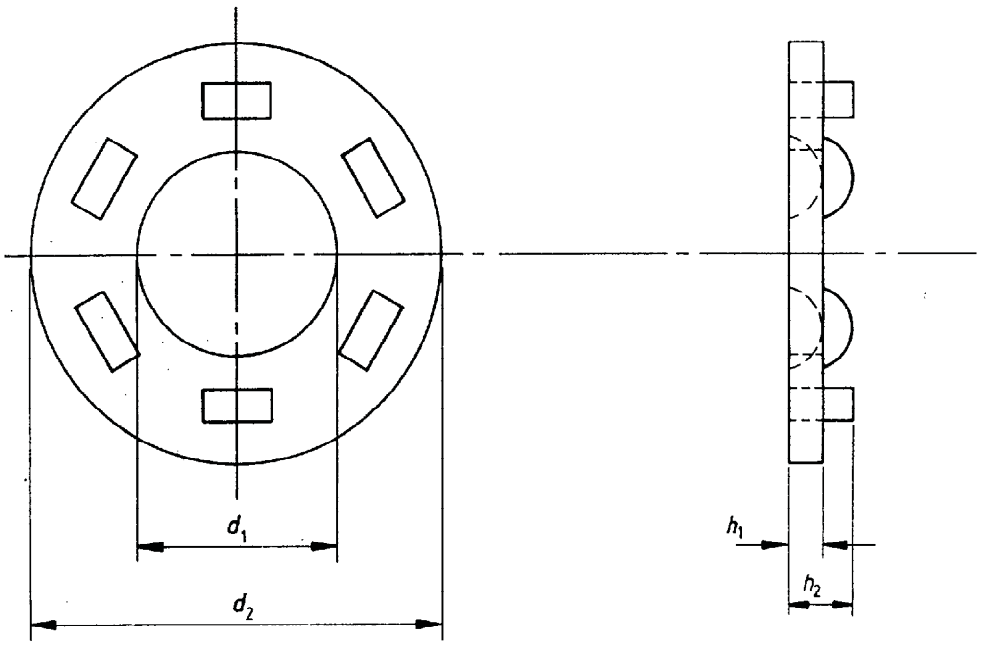


Figure 1. Dimensions of compressible washer-type direct tension indicators

4 Performance

Samples indicators shall be tested by the manufacturer after the final production process, i.e. after surface treatment. The number of tests per heat treatment lot performed by the manufacturer shall be in accordance with BS 6587 : 1985 AQL 1.5 sample size 8, acceptance number Ac.0.

The indicator loads in table 2 are the compressive loads to be applied in order to compress the protrusions on the indicators to give the indicator gaps as shown in table 3.

The indicators shall be tested on a calibrated load measuring device. The load requirement of table 2 shall be met and the indicators compressed to the average gaps given in table 3.

The load measuring device shall permit the measurement of the gap and load at the same time; the gap shall be measured by either a feeler gauge or a dial gauge.

NOTE. Any additional process, including protective coating performed after themanufacturers' final treatment, is liable to significantly alter the load characteristic of the indicator.

Table 2. Indicator loads at appropriate gap (see table 3)

Load in kilonewtons

Nominal bolt diameter	Grade 1		Grade 2	
	Min.	Max.	Min.	Max.
M12	49.4	59.3	—	—
M16	92.1	110.5	103.9	140.5
M20	144	173	161.8	219.0
M22	177	212	200.2	270.8
M24	207	248	233.4	316
M27	234	281	303	409
M30	286	343	370	500
M33	—	—	459	621
M36	418	502	—	—

NOTE. The values of minimum load for grade 1 and minimum/maximum values for grade 2 correspond to the preloads specified in BS 4604 : Part 1 and Part 2.

Table 3. Average indicator gaps

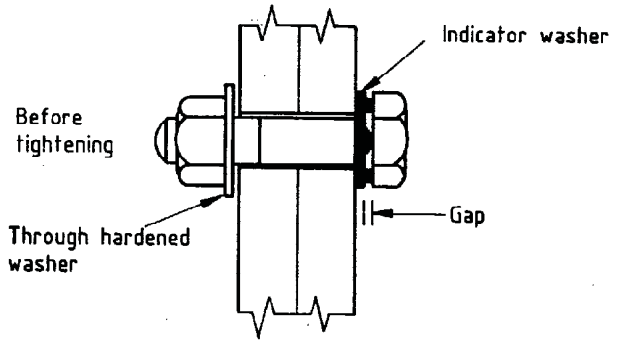
Dimensions in millimetres

Indicator position[1]	Grade 1	Grade 2	
	Maximum average gap[2]	Maximum average gap[2]	Minimum average gap[3]
Under bolt head, when nut is rotated (figure 2a) Under nut, when bolt is rotated (figure 3a)	0.40	0.50	0.40
Under nut, when nut is rotated (figure 2b) Under bolt head, when bolt is rotated (figure 3b)	0.25	0.35	0.25

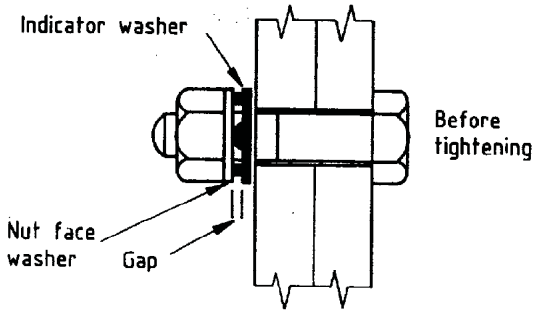
[1]Tests have shown the need for a smaller gap when the indicator is used under the rotating component. Indicators fitted as specified will result in the same loads being attained when the bolts are tightened to the specified gaps.

[2]Maximum average gap : to achieve at least the minimum load in table 2.

[3]Minimum average gap : not to exceed maximum load in table 2.

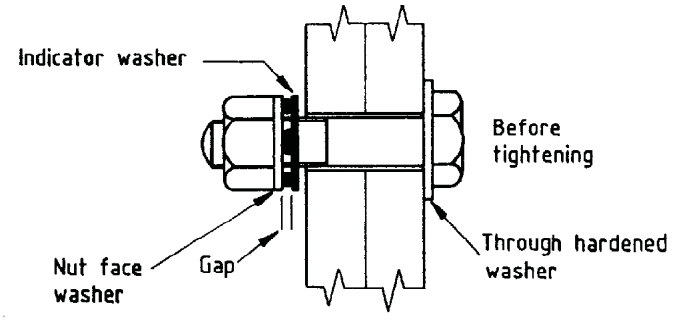


a) Under bolt head fitting

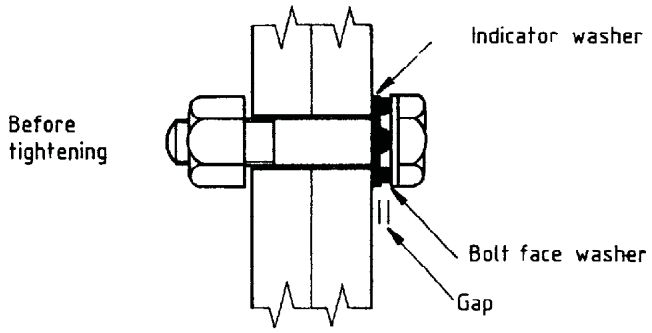


b) Under nut fitting

Figure 2. Bolt tightening by rotation of the nut (normal method of assembly)



a) Under nut fitting



b) Under bolt head fitting

Figure 3. Bolt tightening by rotation of the bolt (alternative method of assembly)

5 Characteristics

The characteristics of the indicators shall be as given in table 4.

The indicators shall not be electroplated or subjected to any process which could result in hydrogen embrittlement.

6 Manufacturer's certification

The manufacturer shall supply with all indicators the relevant test certificate containing the following information :

a) manufacturer's name;

b) customer's order number;

c) batch reference number;

d) nominal diameter of indicator;

e) cast number of steel used for production of indicator;

f) test load results;

g) surface finish.

7 Marking and identification

All indicators shall be marked with the manufacturer's identification. Additionally:

a) grade 1 shall be marked with 'M';

b) grade 2 shall be marked with either 'M' and '10.9' or 'M' and '2'.

The marking shall be indented on the indicator face from which the protrusions project.

Table 4. Characteristics of indicators		
Characteristic	**Requirement**	
Indicator grade	Grade 1	Grade 2
Material	Steel	
Heat treatment	Hardened and tempered	
Tolerances[1)]	Product grade C	
	BS 6322 : Part 3 : 1992	
Finish	Any one of the following: a) As processed b) Sheradized to BS 4921 : 1988 c) Mechanical plating to the thickness specified in BS 729 : 1971 or BS 1706 : 1990 as appropriate	
Associated bolts and nuts	BS 4395 : Part 1 : 1969	BS 4395 : Part 2 : 1969
Associated washers	BS 4395 : Part 1 : 1969	BS 4395 : Part 2 : 1969
Bolt face and nut face washers	BS 7644 : Part 2 : 1993	
Acceptability	BS 6587 : 1985	
[1)]For dimensions not given in table 1.		

8 Designation

When designating for the purpose of an enquiry or order, the following information shall be given:

a) general product description, i.e. direct tension indicators;

b) the letter 'M' indicating that the product is ISO metric;

c) the nominal size (thread diameter of the associated bolt) of the product in millimetres;

d) the strength grade i.e. grade 1 or grade 2;

e) the number of this British Standard, i.e. BS 7644 : Part 1 : 1993;

f) details of coating (if required), and the relevant British Standard, e.g. BS 4921.

Example: The designation of a compressible washer-type direct tension indicator for use with M20 bolts and nuts conforming to BS 4395 : Part 2, and with sherardized coating conforming to class 2 of BS 4921 is as follows:

Direct tension indicator, M20, grade 2 of BS 7644 : Part 1, sherardized to BS 4921 class 2.

Annexes

Annex A (informative)

Use of compressible washer-type direct tension indicators

Indicators are normally fitted under the bolt head and the bolt is normally tightened by rotation of the nut, as shown in figure 2a. Limited access to the bolt head for the purposes of inspecting the indicator gap may require the indicator to be fitted under the nut. When used in this manner the appropriate nut face washer (see BS 7644 : Part 2) is fitted between the indicator protrusions and the nut (see figure 2b).

A condition of limited space and access results in the indicator being fitted under the nut, and the bolt tightened by rotation of the bolt head. In this case a nut face washer (see BS 7644 : Part 2) is fitted between the indicator protrusions and the bearing surface of the nut as shown in figure 3a.

Where there is limited space for positioning of the bolt, combined with limited access for inspection of the indicator gap, it is necessary to fit the indicator under the bolt head and to tighten the assembly by rotation of the bolt head. In this case a bolt face washer (see BS 7644 : Part 2) is fitted between the indicator protrusions and the bearing surface of the nut (see figure 3b).

Due to dimensional tolerances in steelwork and alignment of components, the indicator does not always compress evenly. When checking the gap, the average gap should be measured as shown in figure A.1.

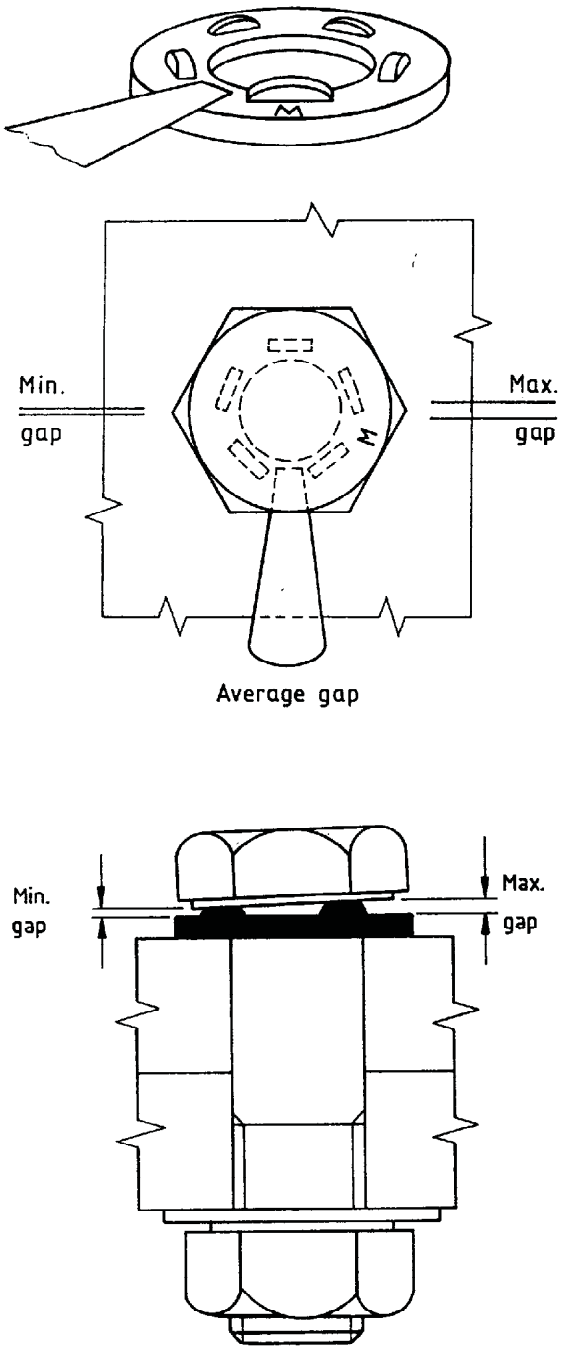


Figure A.1 Checking the indicator gap

Annex B (informative)

Corrosion protection of indicator measuring gap.

Tests have shown that two coats of paint completely seal the measuring gap of the indicator, preventing the ingress of any moisture.

For most conditions, the normal steelwork paint specification is adequate. However, where additional protection is considered necessary, a butyl rubber sealing compound may be applied over the indicator after installation and any inspection requirements have been completed.

List of references (see clause 2)

Normative references

BSI standards publications

BRITISH STANDARDS INSTITUTION, London

BS 729 : 1971	*Specification for hot dip galvanized coatings on iron and steel articles*
BS 1706 : 1990	*Method for specifying electroplated coatings of zinc and cadmium on iron and steel*
BS 4395 :	*Specification for high strength friction grip bolts and associated nuts and washers for structured engineering*
BS 4395 : Part 1 : 1969	*General grade*
BS 4395 : Part 2 : 1969	*Higher grade bolts and nuts and general grade washers*
BS 4921 : 1988	*Specification for sherardized coatings on iron or steel*
BS 6322 :	*Tolerances for fasteners*
BS 6322 : Part 3 : 1992	*Specification for tolerances of plain washers for bolts, screws and nuts with nominal thread diameters from 1 mm up to and including 150 mm. Product grades A and C*
BS 6587 : 1985	*Method of acceptance inspection for fasteners*
BS 7644 :	*Direct tension indicators*
BS 7644 : Part 2 : 1993	*Specification for nut face and bolt face washers*

Informative references

BSI standards publications

BRITISH STANDARDS INSTITUTION, London

BS 4604 :	*Specification for the use of high strength friction grip bolts in structural steelwork. Metric series*
BS 4604 : Part 1 : 1970	*General grade*
BS 4604 : Part 2 : 1970	*Higher grade (parallel shank)*

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Direct tension indicators
Part 1. Specification for compressible washers

Corrections

Table 2. Indicator loads at appropriate gap

Delete the heading and substitute the following.

Table 2. Indicator loads at appropriate gap (see table 3)	
	Load in kilonewtons

Table 3. Average indicator gaps

In the heading of column 2 delete 'Maximum average gap[3)]' and substitute 'Maximum average gap[2)]'.

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