

*Indian Standard***TECHNICAL SUPPLY CONDITIONS FOR
THREADED STEEL FASTENERS****PART 14 STAINLESS STEEL THREADED FASTENERS***(Second Revision)*

(Incorporating Amendment No. 1)

1. Scope — Covers the requirements of bolts, screws, studs and nuts made from austenitic, ferritic and martensitic grades of corrosion-resistant stainless steels.

1.1 Applicability — It is applicable only to fasteners after completion of manufacture;

- a) with nominal thread diameters from 1.6 up and including 39 mm,
- b) of any triangular ISO metric screw threads with diameters and pitches according to IS : 4218 'ISO metric screw threads', and
- c) of any shape;

and additionally for nuts of any shape provided that:

- a) width across flats or outside diameter is not less than 1.45 times nominal diameter, and
- b) effective thread engagement is at least 0.6 times nominal diameter.

1.2 This standard does not define corrosion or oxidation resistance in particular environments. It does specify grades for fasteners made from corrosion resistant stainless steels. Some have mechanical properties allowing use at temperatures down to -200°C in air. Some have oxidation resistance allowing use at temperatures up to $+800^{\circ}\text{C}$ in air.

1.3 Acceptable corrosion and oxidation performances and mechanical property values allowing use at elevated or sub-zero temperatures shall be the subject of agreement between the user and the manufacturer wherever appropriate to the proposed service environment.

2. Designation System — The designation of the stainless steel threaded fasteners is given in Table 1. The steel grades and property classes are designated by a four-character identifier consisting of a letter followed by three digits. The letter indicates the general composition groups of steels as follows:

- A — for austenitic steels
- C — for martensitic steels
- F — for ferritic steels

The first digit following the letter indicates the type of alloying elements present for the particular Group A, C or F. The last two digits indicate the property class (metallurgical condition).

Examples:

- a) A2 — 70 indicates:
austenitic steel, cold worked, minimum 700 N/mm^2 tensile strength
- b) C3 — 80 indicates:
martensitic 16 percent Cr Steel, hardened and tempered, minimum 800 N/mm^2 tensile strength.

3. Marking

3.1 Bolts and Screws — All Hexagon head screws and bolts and socket cap screws of M5 thread diameter and greater shall be clearly marked in accordance with the designation system given in 2. This marking may be applied to other types of bolts and screws where it is technically possible to do so on the head portion only.

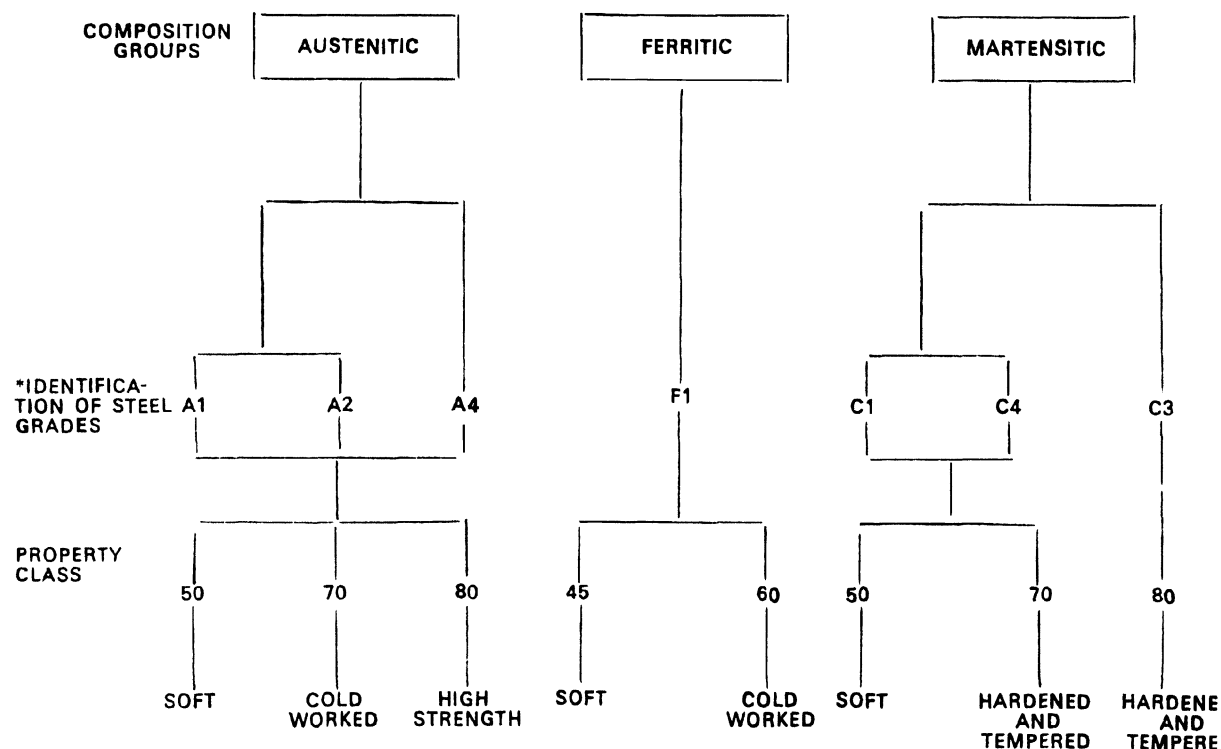
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Price Group 6

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TABLE 1 DESIGNATION SYSTEM FOR STAINLESS STEEL THREADED FASTENERS
(Clause 2)



* See Table 2 for steel grades and composition groups.

The marking shall include the steel grade and property class and also the manufacturer's identification mark (see Fig. 1). Additional marking can be applied at the option of the manufacturer or at the specific request of the purchaser. This additional marking should not be liable to cause confusion with any other standardized marking or identification.

3.2 Studs and Other Fasteners — Marking of studs and other fasteners shall be agreed between the user and the manufacturer.

3.3 Nuts — Nuts shall be marked with the steel grade and with the manufacturer's identification mark in the case of nuts of M5 thread diameter and greater (see Fig. 2), where this is technically possible for the manufacturer. Marking of one nut face is acceptable and shall be by indentation only when applied to the bearing surface of the nuts. Alternatively marking on the side of the nuts is permissible. Property class marking and designation of nuts is necessary where the nuts do not meet the minimum proof load stress of the highest property class for the steel grade.

3.4 Packages and Containers — Marking of the designation is mandatory on all packages or containers of all sizes.

4. Finish — Unless otherwise specified, stainless steel fasteners shall be supplied clean and bright.

5. Magnetic Properties — All austenitic stainless steel fasteners are normally non-magnetic. After cold working, some magnetic properties may be evident.

6. Chemical Composition — The composition ranges of steels suitable for the different steel grades for fasteners are given in Table 2.

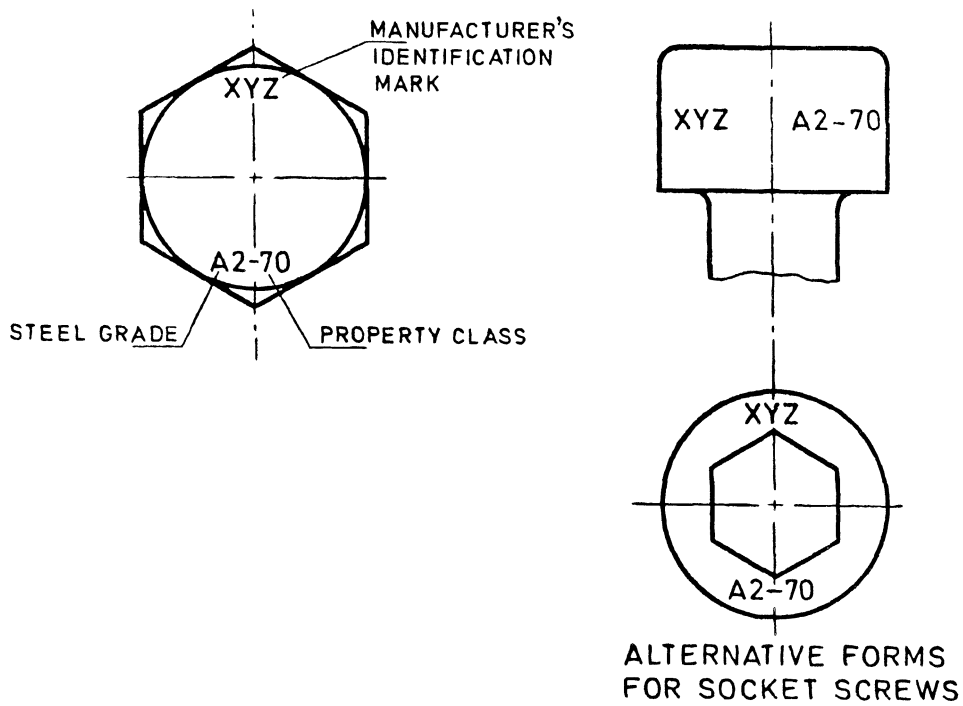


FIG. 1 EXAMPLES OF MARKING OF BOLTS AND SCREWS

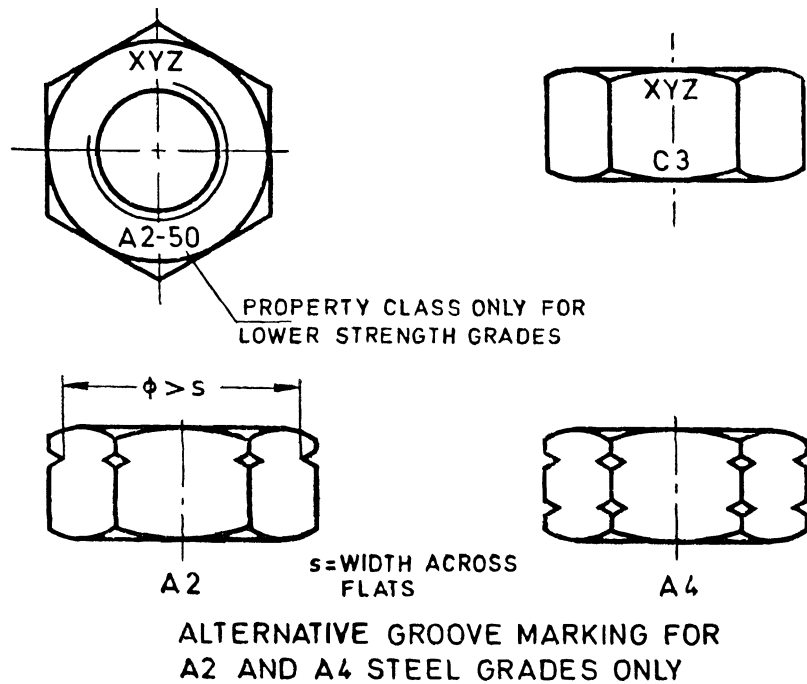


FIG. 2 EXAMPLES OF MARKING OF NUTS AND ALTERNATIVE MARKING PRACTICE

Note — For marking of left-hand thread, see IS : 1367 (Part 18) - 1979 "Technical supply conditions for threaded steel fasteners : Part 18 Marking and mode of delivery (second revision)".

IS : 1367 (Part 14) - 1984

At the discretion of the manufacturer, fasteners may be manufactured from all steels corresponding to the grade required, except where the user specifies steels covered by particular national specification. Alternative steels may be used provided that they give the physical and mechanical properties to the required steel grade and property class and have equivalent corrosion resistance. When alternative compositions are used, consultation between the manufacturer and the user may be necessary in order to ensure suitability for the intended application. Only when all these conditions are met parts shall be marked and/or described according to the designation system described in 2.

Austenitic steel fasteners of grades A2 and A4 shall not show any grain-boundary carbide network and shall be resistant to inter-crystalline corrosion tests as defined in IS 10461 'Method for determination of resistance to intergranular corrosion of austenitic stainless steels : Part 1 Corrosion test in nitric acid medium by measurement of loss in mass (Huoy test), and Part 2 Corrosion test in sulphuric acid/copper sulphate medium in the presence of copper turnings (Monypenny Strauss test).

Grade A1 fasteners can also be supplied resistant to inter-crystalline corrosion subject to prior agreement with the manufacturer.

TABLE 2 STAINLESS STEEL FASTENERS — GRADE COMPOSITION RANGES

(Table 1, and Clause 6)

Group	Grade	Chemical Composition, Percent ⁽¹⁾								Corresponding Nearest Grade in IS : 1570 (Part 5)	Footnotes Ref
		C	Si	Mn	P	S	Cr	Mo ⁽⁸⁾	Ni		
Austenitic	A1	0.12	1.0	2.0	0.20	0.15 to 0.35	17.0 to 19.0	0.6	8.0 to 10.0	07Cr18Ni9	(2) (3)
	A2	0.08	1.0	2.0	0.05	0.03	17.0 to 20.0		8.0 to 13.0	04Cr18Ni11	(3) (4) (6) (7)
	A4	0.08	1.0	2.0	0.05	0.03	16.0 to 18.5	2.0 to 3.0	10.0 to 14.0	04Cr17Ni12-Mo2Ti20	(3) (4) (6)
Martensitic	C1	0.09 to 0.15	1.0	1.0	0.05	0.03	11.5 to 14.0		1.0	12Cr13	(5)
	C3	0.17 to 0.25	1.0	1.0	0.04	0.03	16.0 to 18.0		1.5 to 3.0	15Cr16Ni2	(5)
	C4	0.08 to 0.15	1.0	1.5	0.06	0.15 to 0.35	12.0 to 14.0	0.6	1.0	12Cr13	(2) (5)
Ferritic	F1	0.12	1.0	1.0	0.04	0.03	15.5 to 18.0		0.5	05Cr17	(3) (6) (7)

- (1) Values are maximum unless otherwise indicated.
- (2) Sulphur may be replaced by selenium.
- (3) May contain titanium $\geq 5 \times C$ up to 0.8 percent maximum.
- (4) May contain copper up to 4.0 percent maximum.
- (5) Carbon content may be higher at the option of the manufacturer, where required to obtain the specified mechanical properties in larger diameters.
- (6) May contain niobium (columbium) and/or tantalum $10 \times C$ up to 1.0 percent maximum.
- (7) Molybdenum may also be present at the option of the manufacturer.
- (8) If for some applications a maximum molybdenum content is essential, this must be stated at the time of ordering by the purchaser.

7. Mechanical Properties

7.1 Tests for Acceptability

7.1.1 Bolts, screws and studs of M5 nominal thread diameter and smaller — Testing shall be carried out by one of the following acceptance tests:

- a) tensile strength, minimum (see 8.2); and
- b) breaking torque, minimum (see 8.5).

Note — Torque test values are valid only for austenitic steel grades.

7.1.2 Bolts, screws and studs above M5 nominal thread diameter

7.1.2.1 Tensile strength, minimum (see 8.2)

7.1.2.2 Stress — At 0.2 percent permanent strain, *Min* (yield strength) (see 8.3).

7.1.2.3 Extension value — At fracture, *Min* (see 8.4).

7.1.2.4 Hardness test — Applicable only to Grades C1 and C3 when hardened and tempered (see 8.7).

7.1.3 Nuts of all nominal thread diameters

7.1.3.1 Proofload — At corresponding bolt grade minimum tensile strength (see 8.6).

7.1.3.2 Hardness test — Applicable only to Grades C1 and C3 when hardened and tempered (see 8.7).

7.2 Mechanical Property Values — The mechanical properties specified for the various grades and property classes are given in Tables 3, 4 and 5.

These mechanical property values apply to products of sizes up to and including eight diameters in length ($8d$), for A1, A2 and A4-70 and 80, and F1-60. This length limitation does not apply to fasteners of the soft and the hardened and tempered property classes, for example, A1-, A2- and A4-50, F1-45, C1-, C3-, C4-50, 70 and 80. For fasteners of greater length strengthened by cold working, mechanical property values shall be agreed upon between the user and the manufacturer. The agreed values will depend upon the grade of steel and the type of manufacturing process employed.

Minimum breaking torque values for other steel and property grades shall be agreed upon between the user and the manufacturer.

TABLE 3 MECHANICAL PROPERTIES OF MARTENSITIC AND FERRITIC GRADE FASTENERS

Group	Grade	Property Class	Bolts, Screws and Studs			Nuts	Bolts, Screws, Studs and Nuts						
			Tensile Strength* R_m N/mm ² <i>Min</i>	Stress at 0.2 Percent Permanent Strain $R_{p0.2}$ N/mm ² <i>Min</i>	Extension† A_L <i>Min</i>		Proof Load Stress S_p N/mm ²	Hardness					
								HV		HB		HRC	
								<i>Min</i>	<i>Max</i>	<i>Min</i>	<i>Max</i>	<i>Min</i>	<i>Max</i>
Martensitic	C1	5	500	250	0.2d	500	—	—	—	—	—	—	
		70	700	410	0.2d	700	220	330	209	314	20	34	
	C3	80	800	640	0.2d	800	240	340	228	323	21	35	
Martensitic	C4	50	500	250	0.2d	500	—	—	—	—	—	—	
		70	700	410	0.2d	700	220	330	209	314	20	34	
Ferritic	F1‡	45	450	250	0.2d	450	—	—	—	—	—	—	
		60	600	410	0.2d	600	—	—	—	—	—	—	

*All tensile stress values are calculated and reported in terms of the nominal tensile stress area of the thread (see Appendix A).

†The extension measurements are determined in accordance with the test procedure in 8.4 and are on the actual screw or bolt length and not on a prepared test piece gauge length of $5d$ of the test piece (see Appendix B).

‡Maximum diameter for F1 is M24.

TABLE 4 MECHANICAL PROPERTIES OF AUSTENITIC GRADE FASTENERS
(Clause 7.2)

Group	Grade	Property Class	Diameter Range	Bolts, Screws and Studs			Nuts
				Tensile* Strength R_m N/mm ² Min	Stress at 0.2 Percent Permanent Strain $R_{p 0.2}$ N/mm ² Min	Extension† A_L Min	Proof Load Stress S_p N/mm ²
Austenitic	A1; A2 and A4	50	≤ M39	500	210	0.6d	500
		70	≤ M20‡	700	450	0.4d	700
		80	≤ M20‡	800	600	0.3d	800

*All tensile stress values are calculated and reported in terms of the nominal tensile stress area of the thread (see Appendix A).

†The extension measurements are determined in accordance with the test procedure in 8.4 and are on the actual screw or bolt length and not on a prepared test piece gauge length of 5d of the test piece (see Appendix B).

‡Above M20 the higher strength property classes should have the property values specially agreed upon between the user and the manufacturer because at the tensile strength values given above alternative values of stress at 0.2 percent permanent strain may occur.

TABLE 5 BREAKING TORQUE (T_m), FOR SCREWS OF M5 AND SMALLER
(Clause 7.2)

Thread Size (Coarse Series)	Breaking Torque, Min — Austenitic Grade Only		
	Property Class 50 N.m	Property Class 70 N.m	Property Class 80 N.m
M1.6	0.15	0.2	0.27
M2	0.3	0.4	0.56
M2.5	0.6	0.9	1.2
M3	1.1	1.6	2.1
M4	2.7	3.8	4.9
M5	5.5	7.8	10.0

8. Methods of Test

8.1 General — All length measurements shall be made by methods with an accuracy of ±0.05 mm or better. All tensile and load tests shall be performed with testing machines equipped with self-aligning grips in order to prevent any non-axial loading (see 8.2, 8.3, 8.4, 8.6 and Fig. 3).

8.2 Determination of Tensile Strength (R_m) — Tests shall be carried out on complete bolts and screws in the finished condition, in accordance with the test procedure specified in IS : 1608-1972 'Method for tensile testing of steel products (first revision)' and IS : 1367 (Part 3)-1979 'Technical supply conditions for threaded steel fasteners: Part 3 Mechanical properties and test methods for bolts, screws and studs with full loadability (second revision)'. The test is applicable only to fasteners of lengths equal to twice the diameter ($2d$) or longer.

When carrying out the test, a free threaded length at least equal to one diameter (d) shall be subjected to the tensile load.

The measured tensile strength value shall be at least equal to the values given in Tables 3 and 4, irrespective of the location of the point of fracture between the bearing face of the bolt head and the end of the adapter.

8.3 Determination of Stress at 0.2 Percent Permanent Strain ($R_{p0.2}$) — Tests for determination of stress at 0.2 percent permanent strain shall be carried out only on complete bolts and screws in the finished condition. This test is applicable only to fasteners of lengths equal to twice the diameter ($2d$) or longer.

The test shall be carried out by measuring the extension of the bolt or screw when subjected to axial tensile loading (see Fig. 3).

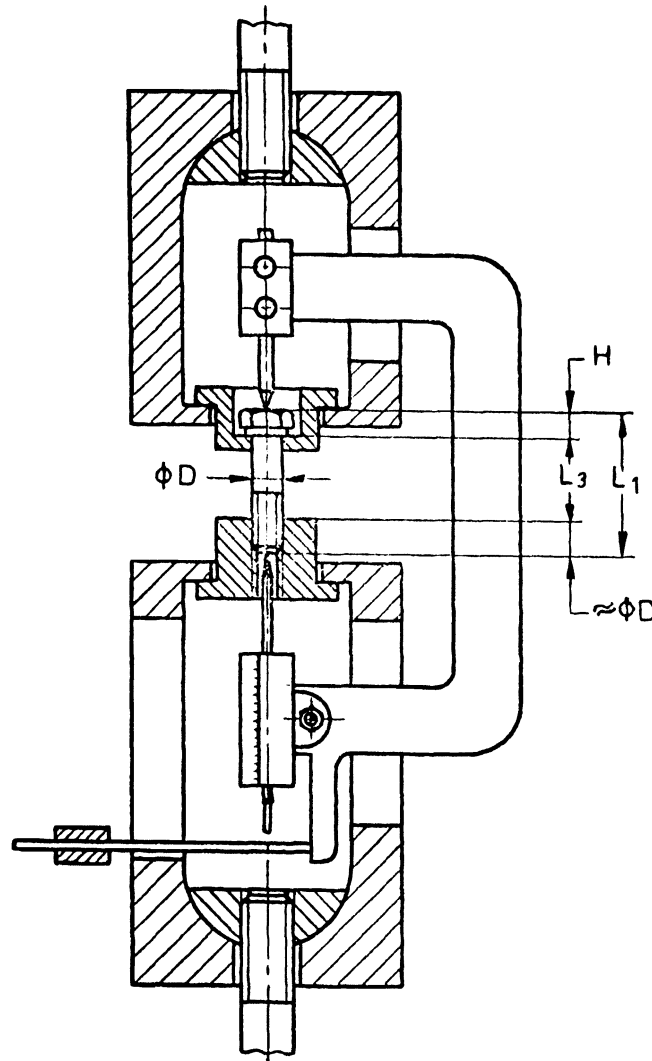


FIG. 3 BOLT EXTENSOMETER WITH SELF-ALIGNING GRIPS

A curve of load against extension shall be plotted as shown in Fig. 4.

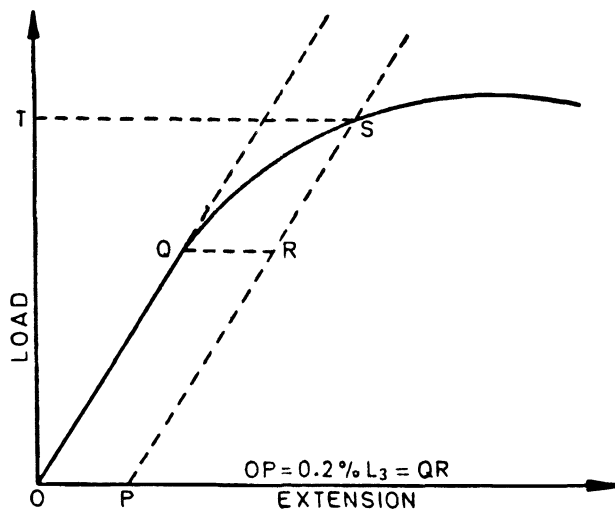


FIG. 4 LOAD-EXTENSION CURVE FOR STRESS AT 0.2 PERCENT PERMANENT STRAIN ($R_{p0.2}$)

The clamping length from which $R_{p0.2}$ is calculated is taken as the distance L_3 between the under-side of the head and the threaded adapter (see Fig. 3). A value equal to 0.2 percent of L_3 is then applied to the horizontal (strain) axis of the load extension curve, OP , and the same value is plotted horizontally from the straight line portion of the curve as QR . A line is then drawn through P and R and the intersection, S , of this line with the load-extension curve corresponds to a load at point T on the vertical axis. The load, when divided by the thread tensile stress area (see Appendix A), gives the stress at 0.2 percent permanent strain ($R_{p0.2}$).

The component under test shall be screwed into a hardened threaded adapter to a depth of one diameter (see Fig. 3).

The value of extension is determined between the bearing face of the bolt head and the end of the adapter.

8.4 Determination of Total Extension at Fracture (A_L) — The extension test shall be carried out on bolts, screws and studs in the finished condition. It is applicable only to fasteners with lengths equal to three times the diameter ($3d$) or longer.

The component under test shall be screwed into the threaded adapter to a depth of one diameter (see Fig. 3). After the bolt or screw has been fractured in accordance with the tensile testing procedure, the two broken pieces shall be fitted closely together and the overall length (L_2) measured again (see Fig. 5).

The total extension at fracture shall then be calculated using the formula:

$$A_L = L_2 - L_1$$

The value obtained shall exceed the minimum values of the appropriate property value tables.

If this test is required on machined samples, the test values should be specially agreed.

8.5 Determination of Breaking Torque (T_m) — The screws shall be tested in a clamping device as shown in Fig. 6. At failure under the applied torque, the minimum torque given in Table 5 shall be exceeded.

The shanks of the screw shall be clamped in a mating split blindhole die in order that at least two full threads project above the clamping device, and a length equivalent to one nominal diameter, exclusive of the point, shall be held within the clamping device.

For this breaking torque test, a calibrated torque-measuring instrument shall be used with a measuring range not exceeding five times the specified minimum value.

The accuracy of the torque-measuring device shall not be worse than ± 7 percent of the minimum specification value for the screw diameter to be tested.

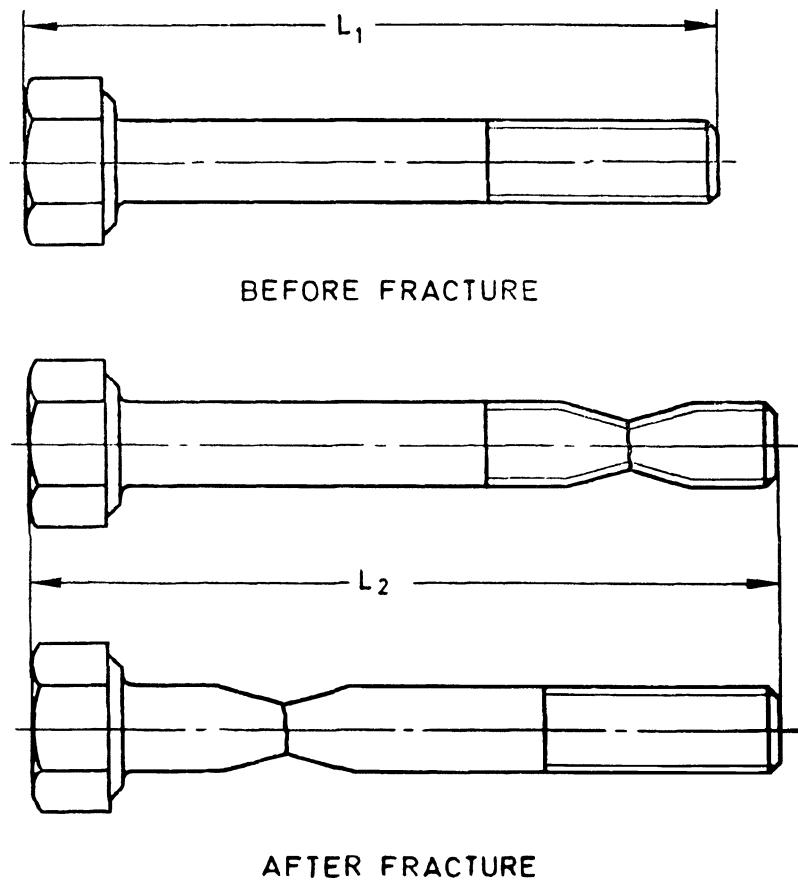


FIG. 5 DETERMINATION OF TOTAL EXTENSION AT FRACTURE (A_L)

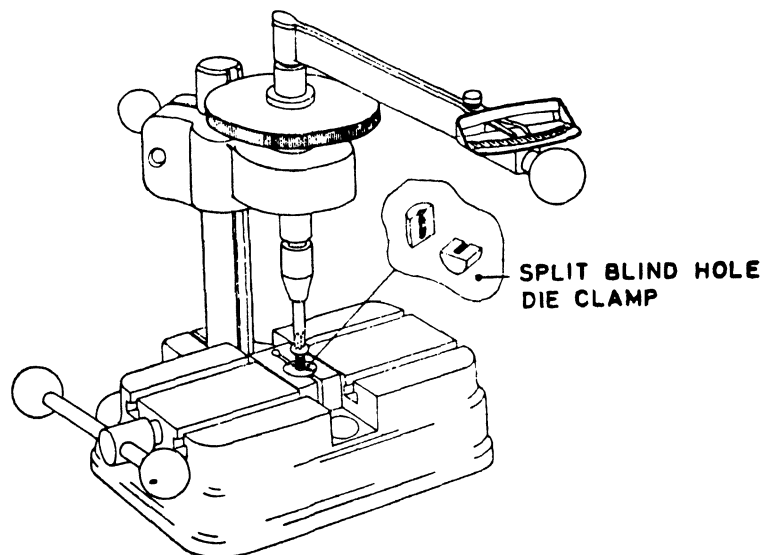


FIG. 6 APPARATUS FOR DETERMINATION OF BREAKING TORQUE (T_m)

8.6 Proof Load Test for Nuts — The test procedure shall be in accordance with IS : 1367 (Part 6) - 1980 'Technical supply conditions for threaded steel fasteners: Part 6 Mechanical properties and test methods for nuts with specified proof loads (*second revision*)'.

The nuts shall be assembled on a threaded mandrel and the specified load according to the thread size, steel grade and property class applied. The nut shall be capable of being fully loaded up to the proof load (specified minimum tensile strength of bolts of the same steel grade and property class) of the appropriate property class without thread stripping occurring.

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8.7 Hardness Test — Hardness tests shall be carried out in accordance with IS : 1500 - 1968 Method for Brinell hardness test for steel (*first revision*), IS : 1586 - 1968 Methods for Rockwell hardness test (B and C scales) for steel (*first revision*) or IS : 1501 - 1968 Method for Vickers hardness test for steel (*first revision*).

The hardness tests on bolts shall be made at the end of the bolt, midway between the centre and the circumference.

The hardness test on nuts shall be made on the bearing face midway between the corner and the thread chamfer.

APPENDIX A

(Tables 3 and 4; and Clause 8.3)

SCREW THREAD — TENSILE STRESS AREAS

$$A_s = \frac{\pi}{4} \left[\frac{d_2 + d_3}{2} \right]^2$$

where

A_s is the stress area,

d_2 is the pitch diameter of the thread, and

d_3 is the minor diameter of the thread.

Thread Size (Coarse Series)	Stress Area A_s mm ²
M1.6	1.3
M2	2.1
M2.5	3.4
M3	5.0
M4	8.8
M5	14.2
M6	20.1
M8	36.6
M10	58.0
M12	84.3
(M14)	115
M16	157
(M18)	192
M20	245
(M22)	303
M24	353
(M27)	459
M30	561
(M33)	694
M36	817
(M39)	976

Note — Diameters shown in brackets are non-preferred sizes.

APPENDIX B

(Tables 3 and 4; and Clause 8.4)

TOTAL EXTENSION AT FRACTURE (A_L)

Nominal Diameter d mm	Extension ($L_2 - L_1$) mm			
	$0.6d$	$0.4d$	$0.3d$	$0.2d$
5	3.0	2.0	1.5	1.0
6	3.6	2.4	1.8	1.2
8	4.8	3.2	2.4	1.6
10	6.0	4.0	3.0	2.0
12	7.2	4.8	3.6	2.4
(14)	8.4	5.6	4.2	2.8
16	9.6	6.4	4.8	3.2
(18)	10.8	7.2	5.4	3.6
20	12.0	8.0	6.0	4.0
(22)	13.2	8.8	6.6	4.4
24	14.4	9.6	7.2	4.8
(27)	16.2	10.8	8.1	5.4
30	18.0	12.0	9.0	6.0
(33)	19.8	13.2	9.9	6.6
36	21.6	14.4	10.8	7.2
(39)	23.4	15.6	11.7	7.8

Note — Diameters shown in brackets are non-preferred sizes.

EXPLANATORY NOTE

This standard was first published in 1961 and subsequently revised in 1967. As a result of International agreements arising from the work of ISO/TC 2, the ISO Committee on fasteners, extensive alterations have come about, which have necessitated a thorough revision with substantial additions to the 1967 edition. For technical and drafting reasons the standard has been split up into various parts. The different parts are listed in Part 1.

This part covers the requirements of stainless steel threaded fasteners and is in conformity with ISO 3506 - 1979 'Corrosion-resistant stainless steel fasteners — Specifications' issued by the International Organization for Standardization.

This edition 3.1 incorporates Amendment No. 1 (May 1991). Side bar indicates modification of the text as the result of incorporation of the amendment.