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IS 3063 (1994): Fasteners - Single coil rectangular section spring lock washers [PGD 31: Bolts, Nuts and Fasteners Accessories]



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भारतीय मानक

बंधक — एक कुण्डली वाले आयताकार सेक्शन स्प्रिंग
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(दूसरा पुनरीक्षण)

Indian Standard

FASTENERS— SINGLE COIL RECTANGULAR
SECTION SPRING LOCK WASHERS—
SPECIFICATION

(*Second Revision*)

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BUREAU OF INDIAN STANDARDS
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NEW DELHI 110002

FOREWORD

This Indian Standard (Second Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Bolts, Nuts and Fasteners Accessories Sectional Committee had been approved by the Light Mechanical Engineering Division Council.

The rectangular section spring lock washers are suitable for use with bolt/nut assemblies of property class 5·8 or less. For higher property classes other sections such as waveform, conical, etc, are generally used.

Steel spring lock washers serve to counteract the loss in inherent tension caused by setting or creep of a bolt/nut assembly provided that they are sufficiently resilient to increase the overall resilience of the assembly and that their inherent springiness can compensate for any loss in tension so that the clamping force required to ensure the reliability of the assembly is maintained.

There may be a relative movement between bolt and nut if the friction between the clamped components is overcome by transverse forces. If this does occur, loosening of the assembly cannot be prevented by spring lock washers.

Thus, when using these components, it should be checked whether the spring lock washers may usefully be applied as the elements maintaining the clamping force.

This standard was originally published in 1965 and revised in 1972. In the present revision following major changes have been made:

- a) The title and scope have been modified.
- b) Permanent set test has been modified and aligned with DIN 127 : 1987.
- c) Permanent load test has been incorporated in line with DIN 127 : 1987.
- d) Free height of spring lock washers has been incorporated in the table of dimensions.
- e) Non-preferred sizes have been covered under separate table.
- f) Spring force test has been incorporated in Annex A for information.

In preparation of this standard assistance has been derived from:

DIN 127-1987 'Spring lock washers with square ends or tang ends'.

DIN 267 (Part 26) : 1987 'Fasteners — Technical supply conditions — Steels spring washer for bolt/nut assemblies'.

Indian Standard

FASTENERS — SINGLE COIL RECTANGULAR SECTION SPRING LOCK WASHERS — SPECIFICATION

(Second Revision)

1 SCOPE

This standard covers requirements for single coil rectangular section spring lock washers suitable for use with bolt/nut assemblies involving fasteners of property class 5·8 or less in the size range 2 to 100 mm.

2 REFERENCES

The following Indian Standards are necessary adjuncts to this standard:

| IS No. | Title |
|---------------------------|--|
| 1501 (Part 1) : 1984 | Method for vickers hardness test for metallic materials: Part 1 HV 5 to HV 100 (second revision) |
| 4072 : 1975 | Steel for spring washers (first revision) |
| 6821 : 1973 | Methods for sampling non-threaded fasteners |

3 TYPES

The spring lock washers shall be of following two types:

Type A — Spring lock washers with bent (deflected or tang) ends.

Type B — Spring lock washers with flat (square) ends.

4 DIMENSIONS

The dimensions of the spring lock washers shall be as given in Tables 1A and 1B.

5 MATERIAL

The spring lock washers shall be made from suitable steel according to IS 4072 : 1975 to meet the requirements specified.

6 HEAT TREATMENT

The spring lock washers after coiling shall be suitably heat treated to a hardness of HV 430 to 530.

7 FINISH

Spring lock washers shall be supplied in natural finish unless otherwise specified by the purchaser. At the request of the purchaser washers may be phosphate coated, nickel plated, tinned, electrogalvanized, copper plated or cadmium plated. The functional properties of the spring lock washers shall not be impaired as a result of the protective coatings. These coated washers shall be subjected to appropriate treatment as given in the relevant electroplating standard to avoid hydrogen embrittlement.

NOTE — The use of hot dip galvanized spring lock washers is not recommended as it entails the loss of physical properties during the process of galvanizing.

8 DESIGNATION

The spring lock washers shall be designated by the nomenclature, type, nominal size, the number of this standard and the surface protection, if any.

Example:

A spring lock washer of nominal size 10 mm, Type A and with phosphate coating shall be designated as follows:

Spring Lock Washer A10 — IS 3063
Phosphate coated

8.1 In case the spring washer is intended for use with LH thread, the designation shall be modified as follows:

Spring Lock Washer LH-A 10 IS 3063
Phosphate coated

9 GENERAL REQUIREMENTS

9.1 The flat faces of washers and the inner and outer peripheries shall be smooth and free from knurling, serrations, die-marks, deep scratches, etc, although slight feed roll marks shall be permissible.

9.2 Washers shall also be free from burrs, rust, pit marks, loose scale and defects that might affect their serviceability.

9.3 The clearances and angles of the cut ends shall be in such degree so that the washers do not cause lapping when they are completely compressed and shall not be liable to tangle or link together when in the free condition.

10 SAMPLING AND ACCEPTANCE

The sampling and acceptance criteria shall be in accordance with IS 6821 : 1973.

11 TESTS

11.1 Hardness Test

The hardness shall be tested in accordance with IS 1501 (Part 1) : 1984. For checking hardness, the washers shall be lightly ground to assure the removal of a decarburized or plated surface. The values shall be measured, where possible, in the middle of the washer surface at the point of contact with the supporting surface.

11.2 Permanent Set Test

The spring lock washer shall be compressed between hardened, flat ground washers (with a hardness of not less than 60 HRC) for two minutes using the compression loads specified in Tables 2A and 2B.

The free height of the washers after release of load shall not be less than the values specified in Tables 2A and 2B.

11.3 Permanent Load Test

Ten spring lock washers, threaded on a bolt and separated from one another by parallel-faced washers (hardened to minimum 500 HV) shall not crack or fracture after 48 hours conditioning at ambient temperature under the compression loads specified in Tables 2A and 2B.

11.4 Twist Test

A portion of the washer shall be gripped in vice jaws and then equal portion shall be gripped in wrench jaws as shown in Fig. 1. Edges of the wrench jaws shall be sharp and parallel to the vice jaws. The wrench shall then be rotated in a direction that increases the free height of the spring lock washer till the washer is twisted through an angle of 90°. The washer shall show no sign of fracture.

12 PACKING

Unless otherwise specified, spring lock washers shall be packed in cartons of 100, 500 or 1 000. Each carton shall contain spring lock washers of one size only.

13 MARKING

13.1 Each carton containing the spring lock washers shall be marked with the following:

- a) Indication of source of manufacture,
- b) Nominal size,
- c) Type, and
- d) Quantity.

13.2 BIS Certification Marking

The product may also be marked with Standard Mark.

13.2.1 The use of the Standard Mark is governed by the provisions of Bureau of Indian Standards Act, 1986 and the Rules and Regulations made thereunder. The details of conditions under which the licence for the use of Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

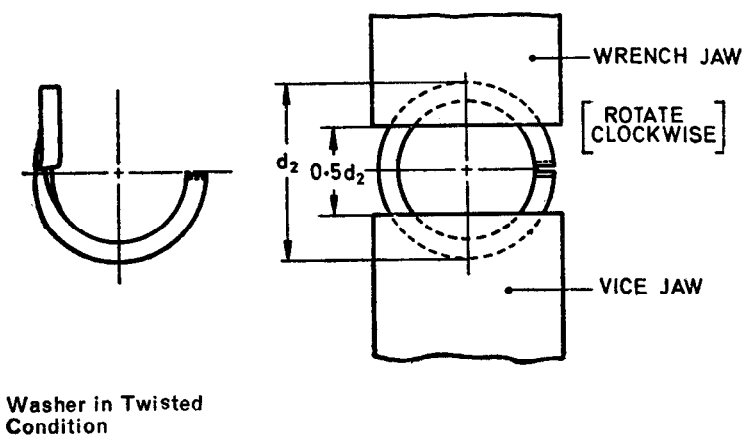
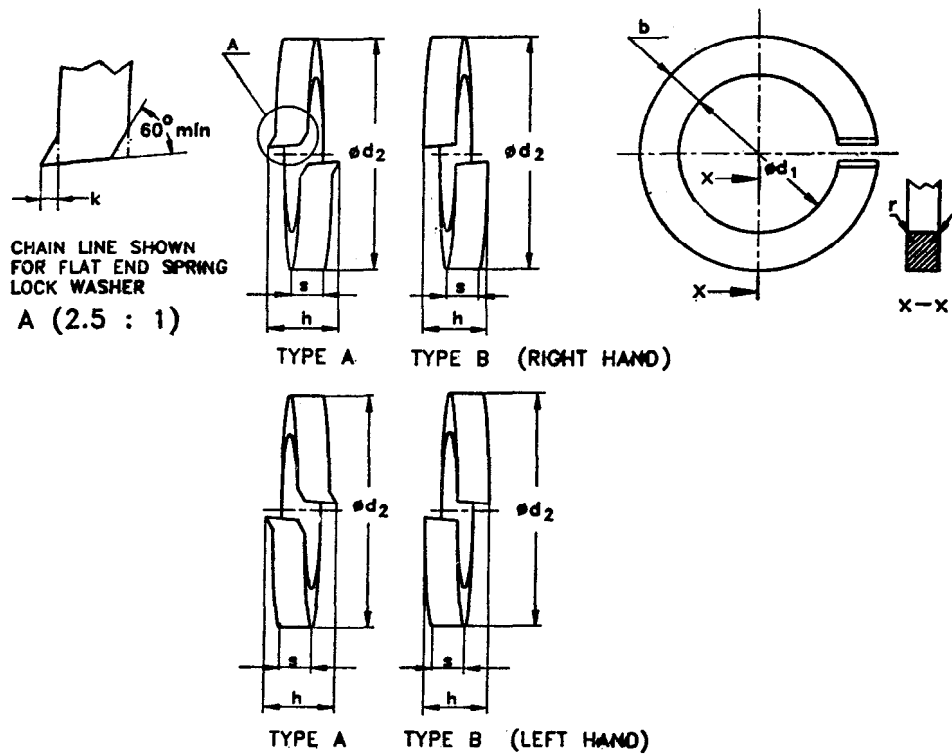


FIG. 1 TWIST TEST

Table 1A Dimensions for Spring Washers
(Clause 4)

All dimensions in millimetres.



| Nom Size | d_1 | | d_2 Max | b | | s | | r Nom | k^* | Weight Approx (7.85 kg/dm ³) kg/1 000 pcs | For Bolt, Nut or Screw Size | h | | | |
|----------------------|-------|----------|--------------|-------|----------|-------|----------|------------|-------|--|---|--------|------|--------|------|
| | Basic | Tol + | | Basic | Tol ± | Basic | Tol ± | | | | | Type A | | Type B | |
| | | | | | | | | | | | | Min | Max | Min | Max |
| 2 ¹⁾ | 2.1 | 0.3 | 4.4 | 0.9 | 0.1 | 0.5 | 0.1 | 0.1 | — | 0.033 | 2 | — | — | 1 | 1.2 |
| 2.2 ^{1) 2)} | 2.3 | 0.3 | 4.8 | 1 | 0.1 | 0.6 | 0.1 | 0.1 | — | 0.050 | 2.2 | — | — | 1.2 | 1.4 |
| 2.5 ¹⁾ | 2.6 | 0.3 | 5.1 | 1 | 0.1 | 0.6 | 0.1 | 0.1 | — | 0.053 | 2.5 | — | — | 1.2 | 1.4 |
| 3 ¹⁾ | 3.1 | 0.3 | 6.2 | 1.3 | 0.1 | 0.8 | 0.1 | 0.2 | 0.15 | 0.11 | 3 | 1.9 | 2.1 | 1.6 | 1.9 |
| 4 | 4.1 | 0.3 | 7.6 | 1.5 | 0.1 | 0.9 | 0.1 | 0.2 | 0.15 | 0.18 | 4 | 2.1 | 2.5 | 1.8 | 2.1 |
| 5 | 5.1 | 0.3 | 9.2 | 1.8 | 0.1 | 1.2 | 0.1 | 0.2 | 0.15 | 0.36 | 5 | 2.7 | 3.2 | 2.4 | 2.8 |
| 6 | 6.1 | 0.4 | 11.8 | 2.5 | 0.15 | 1.6 | 0.1 | 0.3 | 0.2 | 0.83 | 6 | 3.6 | 4.2 | 3.2 | 3.8 |
| 8 | 8.1 | 0.4 | 14.8 | 3 | 0.15 | 2 | 0.1 | 0.5 | 0.3 | 1.60 | 8 | 4.6 | 5.4 | 4 | 4.7 |
| 10 | 10.2 | 0.5 | 18.1 | 3.5 | 0.2 | 2.2 | 0.15 | 0.5 | 0.3 | 2.53 | 10 | 5 | 5.9 | 4.4 | 5.2 |
| 12 | 12.2 | 0.5 | 21.1 | 4 | 0.2 | 2.5 | 0.15 | 1.0 | 0.4 | 3.82 | 12 | 5.8 | 6.8 | 5 | 5.9 |
| 16 | 16.2 | 0.8 | 27.4 | 5 | 0.2 | 3.5 | 0.2 | 1.0 | 0.4 | 8.91 | 16 | 7.8 | 9.2 | 7 | 8.3 |
| 20 | 20.2 | 1 | 33.6 | 6 | 0.2 | 4 | 0.2 | 1.0 | 0.4 | 15.2 | 20 | 8.8 | 10.4 | 8 | 9.4 |
| 24 | 24.5 | 1 | 40 | 7 | 0.25 | 5 | 0.2 | 1.6 | 0.5 | 26.2 | 24 | 11 | 13 | 10 | 11.8 |
| 30 | 30.5 | 1.2 | 48.2 | 8 | 0.25 | 6 | 0.2 | 1.6 | 0.8 | 44.3 | 30 | 13.6 | 16.1 | 12 | 14.2 |
| 36 | 36.5 | 1.2 | 58.2 | 10 | 0.25 | 6 | 0.2 | 1.6 | 0.8 | 67.3 | 36 | 13.6 | 16.1 | 12 | 14.2 |
| 42 ^{1) 2)} | 42.5 | 1.2 | 68.2 | 12 | 0.25 | 7 | 0.25 | 2 | 0.8 | 111 | 42 | 15.6 | 18.4 | 14 | 16.5 |
| 48 ^{1) 2)} | 49 | 1.5 | 75 | 12 | 0.25 | 7 | 0.25 | 2 | 0.8 | 123 | 48 | 15.6 | 18.4 | 14 | 16.5 |
| 52 ^{1) 2)} | 53 | 1.5 | 83 | 14 | 0.25 | 8 | 0.25 | 2 | 1 | 182 | 52 | 18 | 21.2 | 16 | 18.9 |
| 56 ^{1) 2)} | 57 | 1.5 | 87 | 14 | 0.25 | 8 | 0.25 | 2 | 1 | 193 | 56 | 18 | 21.2 | 16 | 18.9 |
| 60 ^{1) 2)} | 61 | 1.5 | 91 | 14 | 0.25 | 8 | 0.25 | 2 | 1 | 203 | 60 | 18 | 21.2 | 16 | 18.9 |
| 64 ^{1) 2)} | 65 | 1.5 | 95 | 14 | 0.25 | 8 | 0.25 | 2 | 1 | 218 | 64 | 18 | 21.2 | 16 | 18.9 |
| 68 ^{1) 2)} | 69 | 1.5 | 99 | 14 | 0.25 | 8 | 0.25 | 2 | 1 | 228 | 68 | 18 | 21.2 | 16 | 18.9 |
| 72 ^{1) 2)} | 73 | 1.5 | 103 | 14 | 0.25 | 8 | 0.25 | 2 | 1 | 240 | 72 | 18 | 21.2 | 16 | 18.9 |
| 80 ^{1) 2)} | 81 | 1.5 | 111 | 14 | 0.25 | 8 | 0.25 | 2 | 1 | 262 | 80 | 18 | 21.2 | 16 | 18.9 |
| 90 ^{1) 2)} | 91 | 1.5 | 121 | 14 | 0.25 | 8 | 0.25 | 2 | 1 | 290 | 90 | 18 | 21.2 | 16 | 18.9 |
| 100 ^{1) 2)} | 101 | 1.5 | 131 | 14 | 0.25 | 8 | 0.25 | 2 | 1 | 318 | 100 | 18 | 21.2 | 16 | 18.9 |

¹⁾ Test values for the spring force test as described in Annex A have not as yet been specified for these nominal sizes.

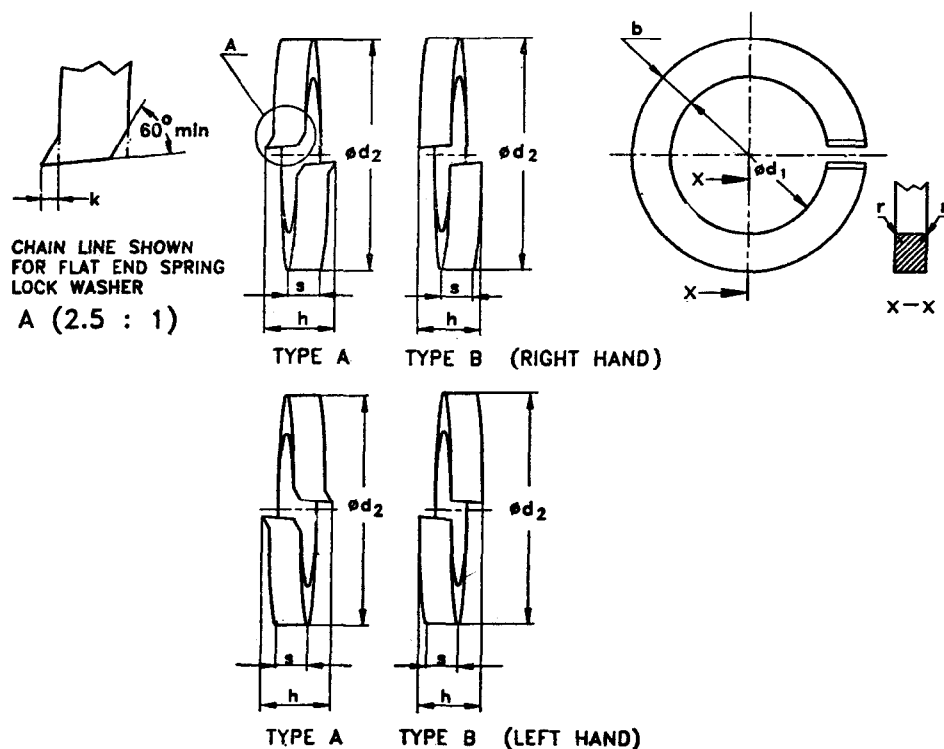
²⁾ Test values for the permanent set test have not as yet been specified for these nominal sizes.

NOTE — Dimensions specified apply before coating.

*The bend k shall be made on the last tenth of the washer circumference without any sharp angle.

Table 1B Dimensions for Spring Washers of Non-preferred Sizes
(Clause 4)

All dimensions in millimetres.



| Nom Size | d_1 | | d_2 Max | b | | s | | r Nom | k^* | Weight Approx (7.85 kg/dm ³) kg/1 000 pcs | For Bolt, Nut or Screw Size | h | | | |
|---------------------|-------|----------|--------------|-------|----------|-------|----------|------------|-------|--|---|--------|------|--------|------|
| | Basic | Tol + | | Basic | Tol ± | Basic | Tol ± | | | | | Type A | | Type B | |
| | | | | | | | | | | | | Min | Max | Min | Max |
| 3.5 ¹⁾ | 3.6 | 0.3 | 6.7 | 1.3 | 0.1 | 0.8 | 0.1 | 0.2 | 0.15 | 0.12 | 3.5 | 1.9 | 2.2 | 1.6 | 1.9 |
| 7 ¹⁾ | 7.1 | 0.4 | 12.8 | 2.5 | 0.15 | 1.6 | 0.1 | 0.3 | 0.2 | 0.93 | 7 | 3.6 | 4.2 | 3.2 | 3.8 |
| 14 | 14.2 | 0.5 | 24.1 | 4.5 | 0.2 | 3 | 0.15 | 1.0 | 0.4 | 6.01 | 14 | 6.8 | 8 | 6 | 7.1 |
| 18 | 18.2 | 0.8 | 29.4 | 5 | 0.2 | 3.5 | 0.2 | 1.0 | 0.4 | 9.73 | 18 | 7.8 | 9.2 | 7 | 8.3 |
| 22 | 22.5 | 1 | 35.9 | 6 | 0.2 | 4 | 0.2 | 1.0 | 0.4 | 16.5 | 22 | 8.8 | 10.4 | 8 | 9.4 |
| 27 | 27.5 | 1 | 43 | 7 | 0.25 | 5 | 0.2 | 1.6 | 0.5 | 28.7 | 27 | 11 | 13 | 10 | 11.8 |
| 33 | 33.5 | 1.2 | 55.2 | 10 | 0.25 | 6 | 0.2 | 1.6 | 0.8 | 63.0 | 33 | 13.6 | 16.1 | 12 | 14.2 |
| 39 ^{1) 2)} | 39.5 | 1.2 | 61.2 | 10 | 0.25 | 6 | 0.2 | 1.6 | 0.8 | 71.7 | 39 | 13.6 | 16.1 | 12 | 14.2 |
| 45 ^{1) 2)} | 45.5 | 1.2 | 71.2 | 12 | 0.25 | 7 | 0.25 | 2 | 0.8 | 117 | 45 | 15.6 | 18.4 | 14 | 16.5 |

¹⁾ Test values for the spring force test as described in Annex A have not yet been specified for these nominal sizes.

²⁾ Test values for the permanent set test have not as yet been specified for these nominal sizes.

NOTE — Dimensions specified apply before coating.

*The bend k shall be made on the last tenth of the washer circumference without any sharp angle.

Table 2A Compression Load and Free Height of Washers After Compression
(Clauses 11.2 and 11.3)

| Nominal Size | Compression Load | Minimum Free Height |
|--------------|------------------|---------------------|
| mm | N | mm |
| 2 | 700 | 0.8 |
| 2.5 | 1 160 | 1 |
| 3 | 1 760 | 1.3 |
| 4 | 3 050 | 1.4 |
| 5 | 5 050 | 1.9 |
| 6 | 7 050 | 2.6 |
| 8 | 12 900 | 3.2 |
| 10 | 20 600 | 3.5 |
| 12 | 30 000 | 4 |
| 16 | 56 300 | 5.6 |
| 20 | 88 000 | 6.4 |
| 24 | 127 000 | 8 |
| 30 | 204 000 | 9.6 |
| 36 | 298 000 | 9.6 |

Table 2B Compression Load and Free Height of Washers of Non-Preferred Sizes After Compression
(Clauses 11.2 and 11.3)

| Nominal Size | Compression Load | Minimum Free Height |
|--------------|------------------|---------------------|
| mm | N | mm |
| 7 | 9 000 | 2.6 |
| 14 | 41 300 | 4.8 |
| 18 | 69 000 | 5.6 |
| 22 | 110 000 | 6.4 |
| 27 | 167 000 | 8 |
| 33 | 255 000 | 9.6 |

ANNEX A

(Foreword and Tables 1A and 1B)

SPRING FORCE TEST

A-1 SPRING FORCE TEST

A spring force test may be carried out in order to assess the springiness of spring washers, this test permitting the residual spring force to be determined.

Place the washer to be tested in a test device and apply the compression load specified in Tables 4A and 4B the test device being designed to permit as uniform an application of the load as possible. The pressure platen shall have a surface hardness of at least 60 HRC. After two minutes, the load applied to the spring washer shall be slowly and steadily released through a travel of 20 μm , which shall be measured using a precision measuring device (see A-2).

The residual spring force shall reach the values specified in Tables 4A and 4B due allowance being made for any deformation of the test device.

The Explanatory Notes describe a suitable test device and include examples of spring characteristics.

The residual spring force values represent provisional specifications, with which experience has to be gained. Table 3 summarizes the residual spring forces required.

Table 3 Residual Spring Force
(Clause A-1)

| Type of Washer | Compression Load Corresponding to the Proof Load for Property Class | Residual Spring Force After Release Through Travel of 20 μm as a Percentage of the Compression Load |
|--|---|---|
| Spring lock washer as specified in IS 3063 | 6.8 ¹⁾ | 20% for nominal sizes 4 to 5 30% for nominal sizes 6 to 12 40% for nominal sizes 14 to 20 50% for nominal sizes above 20 |

¹⁾ Spring lock washers which are only intended for bolt/nut assemblies involving fasteners of a property class less than 6.8 are also to be tested at compression loads corresponding to property class 6.8 proof loads.

A-2 EXPLANATORY NOTES TO SPRING FORCE TEST

The residual spring forces specified are based on tests and the relevant technical literature, but are not as yet sufficiently substantiated for them to be made mandatory for acceptance inspection at present. Before mandatory data

can be specified, further experience and test results are needed to obtain a statistically substantiated evaluation.

The same compression loads used for the permanent set and permanent load tests apply as for the spring force test.

When determining the spring characteristic of spring lock washers as part of the spring force test, the effect of the elastic deformation of the test device is to be allowed for by deducting the spring travel originating in the test device from the overall travel (i.e. that of spring washer and test device). The relief characteristic for the test device is to be determined as follows.

Place a plain washer instead of a spring washer in the test device (see Fig. 2 for example), the plain washer being lapped on both sides and having a tolerance on parallelism not exceeding 1 μ m and a hardness of not less than 700 HV. The washer dimensions (inside diameter, outside diameter and thickness) shall be identical to those of the spring washer to be tested. Plot the relief characteristic of the test device starting at the compressions loads specified in Tables 4A and 4B. It is essential that parallel faced washers having the same dimensions as the spring lock washers to be tested be used when recording the relief characteristic of the test device, as different-sized washers will give different characteristics.

In Fig. 3, the continuous line represents the total relief characteristic of spring lock washer plus test device for a IS 3063 — A12 — Steel spring lock washer measured under a compression load of 30 kN, and the dashed line, the relief characteristic of device only. A segment of the relief characteristic of the spring lock washer obtained by subtraction of the two curves is plotted as a chain line.

To avoid any reversibility error of the force measuring device and the travel gauge, the values of compression load specified in Tables 2A and 2B may be exceeded by 5% when applying the load. The starting point for measuring the 20 μ m travel shall however, be the compression load specified (see Fig. 4).

Although the 20 μ m travel is in most cases larger than the probable amount of setting of a bolt/nut assembly due to surface roughness and coatings, this travel can be reproduced in the test with relatively greater accuracy than a 5 μ m or 10 μ m travel.

Thus, the residual spring forces given in Tables 4A and 4B represent lower limit values for the clamping forces of bolt/nut assemblies exhibiting an exceptionally high degree of setting at parting lines. The free height of spring lock washers after removal of the proof load, which

Table 4A Compression Loads and Minimum Residual Spring Force
(Clauses A-1 and A-2)

| Nominal Size | Compression Load ¹⁾ | Minimum Residual Spring Force |
|--------------|--------------------------------|-------------------------------|
| mm | N | N |
| 4 | 3 050 | 600 |
| 5 | 5 050 | 1 000 |
| 6 | 7 050 | 2 100 |
| 8 | 12 900 | 3 900 |
| 10 | 20 600 | 6 200 |
| 12 | 30 000 | 9 000 |
| 16 | 56 300 | 22 500 |
| 20 | 88 000 | 35 200 |
| 24 | 127 000 | 63 000 |
| 30 | 204 000 | 102 000 |
| 36 | 298 000 | 149 000 |

¹⁾ Corresponding to property class 6'8.

Table 4B Compression Loads and Minimum Residual Spring Force of Washers of Non-Preferred Sizes
(Clauses A-1 and A-2)

| Nominal Size | Compression Load | Minimum Residual Spring Force |
|--------------|------------------|-------------------------------|
| mm | N | N |
| 14 | 41 300 | 16 500 |
| 18 | 69 000 | 27 600 |
| 22 | 110 000 | 55 000 |
| 27 | 167 000 | 83 000 |
| 33 | 255 000 | 127 000 |

was previously the sole spring characteristic specified, gives only little indication of the ability of a spring lock washer to counteract the loosening of a bolt/nut assembly, as the greatest relief travels are in the very flat segment of the characteristic where the forces are very small. The curve plotted in Fig. 3, which covers a relief travel of 0.2 mm does not reach zero force until after a total relief travel of approximately 3.5 mm.

This shows that, though basically simple, the test device must satisfy a number of requirements if valid, reproducible and repeatable results are to be obtained. Figure 2 illustrates a test device suitable for both electrical and mechanical measurements of travel. For component(s) of the test device the following specifications apply:

- 1) Low resilience and, if possible, only (elastic) compressive deformation without flexural deformation of the complete test device, in particular in the zone where the force is transmitted from the pressure platen to the bearing plate and the upper part of the pedestal.

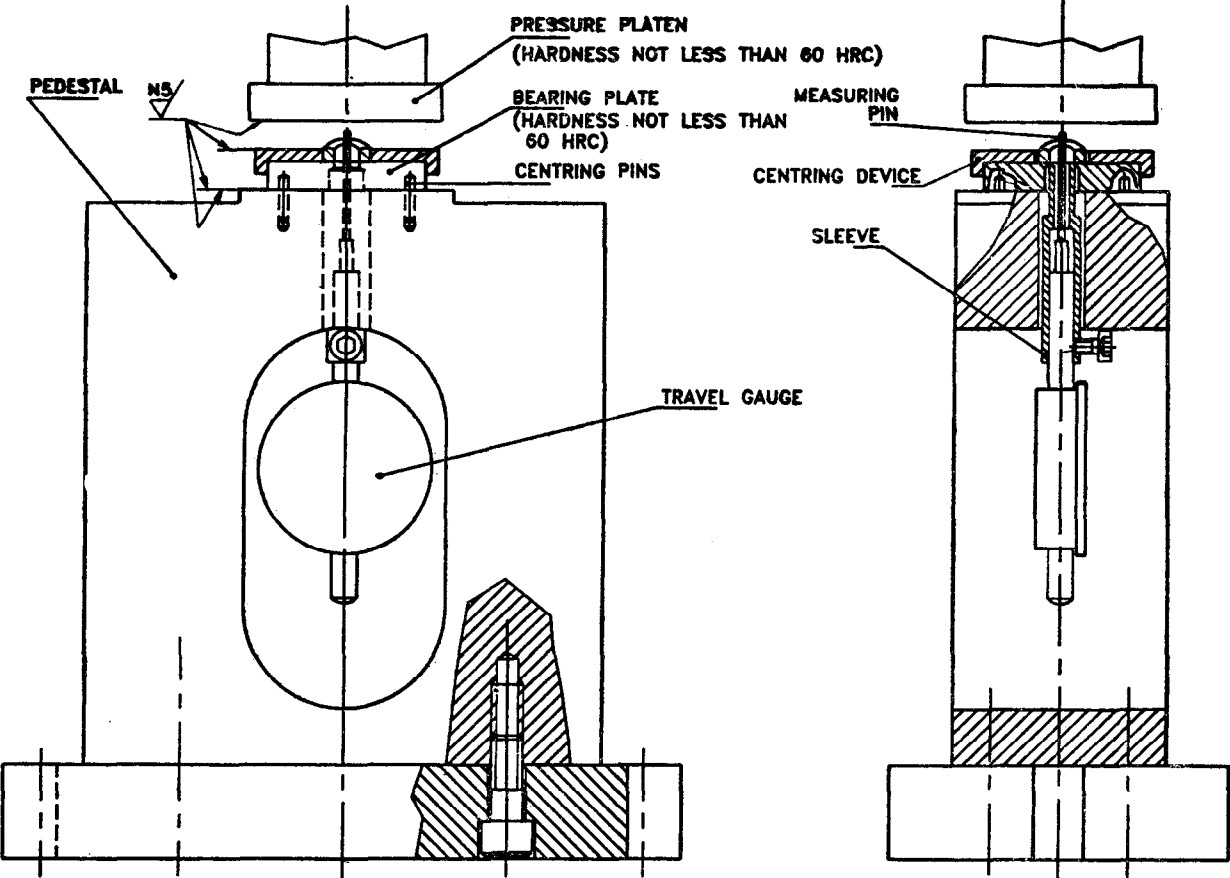


FIG. 2 EXAMPLE OF TEST DEVICE

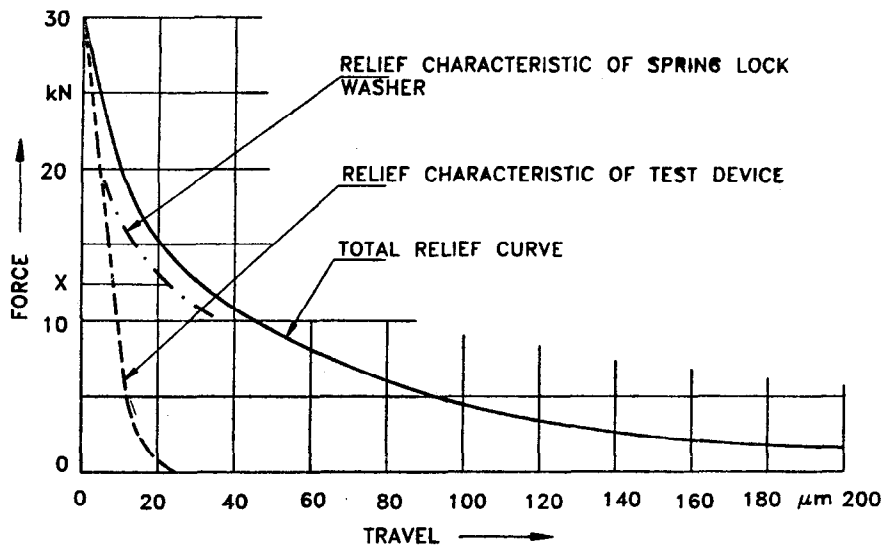


FIG. 3 DETERMINATION OF SPRING CHARACTERISTIC (RELIEF CHARACTERISTIC)
FOR A SPRING LOCK WASHER A12 — IS 3063 STEEL
(USING A COMPRESSION LOAD OF 30 kN)

- 2) Centric bore in the pedestal permitting the passage of the measuring pin of the travel gauge and that of the sleeve specified under item 3.

3) Fastening of travel gauge using a sleeve exactly at the same height as the upper face of the bearing plate so as to ensure that the error resulting from the inherent formation of the gauge is as small as possible.

4) Bearing plate and sleeve removable, so that bearing plates for different washer diameters can be used.

5) All surfaces via which the force is applied and the deformations of which are included in the travel measurements shall have a roughness, R_a , not exceeding 0.4 (corresponding to R_z not exceeding 1.6).

6) The bearing plate and the pressure platen shall have a hardness of not less than 60 HRC.
- 7) The pressure platen shall be guided so as to be parallel to the bearing plate, a useful feature being a play of some tenths of a millimetre in the plane of the bearing plate to compensate for small elastic forces (this is generally provided for in universal testing machines).

8) The compression load shall be adjustable to within 2% and it shall be possible to read the residual spring force to within 2%.

9) The dial indicator, the inductive travel gauge or any other travel gauge used may only have a relative repeatability error and reversibility error not exceeding $1\text{ }\mu\text{m}$ for any partial measuring range of $40\text{ }\mu\text{m}$, the direction of movement of the measuring pin being away from the gauge.

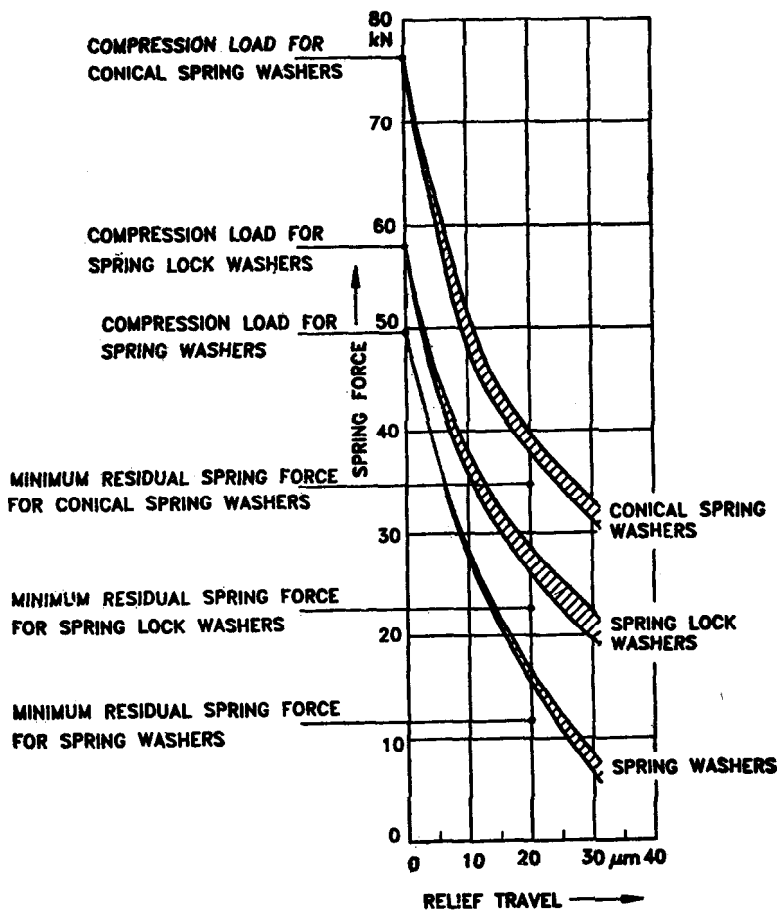


FIG. 4 GRAPHS REPRESENTING RELIEF TRAVELS AND RESIDUAL SPRING FORCES FOR VARIOUS SPRING WASHER (NOMINAL SIZE 16)

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Amendments Issued Since Publication

| Amend No. | Date of Issue | Text Affected |
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Telephones: 323 01 31, 323 33 75, 323 94 02

Telegrams: Manaksanstha
(Common to all offices)

Regional Offices:

Telephone

Central : Manak Bhavan, 9 Bahadur Shah Zafar Marg
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323 76 17, 323 38 41

Eastern : 1/14 C.I.T. Scheme VII M, V.I.P. Road, Maniktola
CALCUTTA 700054

{ 337 84 99, 337 85 61
337 86 26, 337 91 20

Northern : SCO 335-336, Sector 34-A, CHANDIGARH 160022

{ 60 38 43
60 20 25

Southern : C.I.T. Campus, IV Cross Road, CHENNAI 600113

{ 235 02 16, 235 04 42
235 15 19, 235 23 15

Western : Manakalaya, E9 MIDC, Marol, Andheri (East)
MUMBAI 400093

{ 832 92 95, 832 78 58
832 78 91, 832 78 92

Branches : AHMADABAD. BANGALORE. BHOPAL. BHUBANESHWAR.
COIMBATORE. FARIDABAD. GHAZIABAD. GUWAHATI.
HYDERABAD. JAIPUR. KANPUR. LUCKNOW. NAGPUR.
PATNA. PUNE. THIRUVANANTHAPURAM.