IS 6735 (1994): Fasteners - Spring lock washers for screws with cylindrical heads [PGD 31: Bolts, Nuts and Fasteners Accessories]

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भारतीय मानक

बंधक – बेलनाकार सिरे वाले पेंच के लिए स्प्रिंग लॉक वाशर – विशिष्टि

(पहला पुनरीक्षण)

Indian Standard

FASTENERS — SPRING LOCK WASHERS FOR SCREWS WITH CYLINDRICAL HEADS — SPECIFICATION

(First Revision)

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FOREWORD

This Indian Standard (First 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.

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

a) Title and scope have been modified.

b) Permanent set test has been modified and aligned with DIN 267 (Part 26) : 1987.

c) Permanent load test has been incorporated in line with DIN 267 (Part 26) : 1987.

d) Free height of spring lock washer has been incorporated.

e) Non-preferred sizes have been covered under seperate table.

f) Spring force test has been incorporated in the Annex A for information.

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.

In the preparation of this revision assistance has been derived from:

DIN 7980 : 1987 'Spring lock washers with square ends for cheese head screws'

DIN 267 (Part 26) : 1987 'Fasteners — Technical delivery conditions — Steel spring washers for bolt/nut assemblies'.

Indian Standard

FASTENERS — SPRING LOCK WASHERS FOR SCREWS WITH CYLINDRICAL HEADS — SPECIFICATION

(First Revision)

1 SCOPE

This standard covers requirements for spring lock washers suitable for use with bolt/nut assemblies involving fasteners of property classes less than 8·8 in the size range 2 to 48 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 DIMENSIONS

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

4 MATERIAL

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

5 HEAT TREATMENT

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

6 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.

7 DESIGNATION

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

Example:

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

Spring Lock Washer 10 — IS 6735 Phosphate coated.

7.1 The designation for LH spring lock washers shall be modified as follows:

Spring Lock Washer LH — 10 IS 6735 Phosphate coated.

8 GENERAL REQUIREMENTS

8.1 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.

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

8.3 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.

9 SAMPLING AND ACCEPTANCE

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

10 TESTS

10.1 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.

10.2 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.

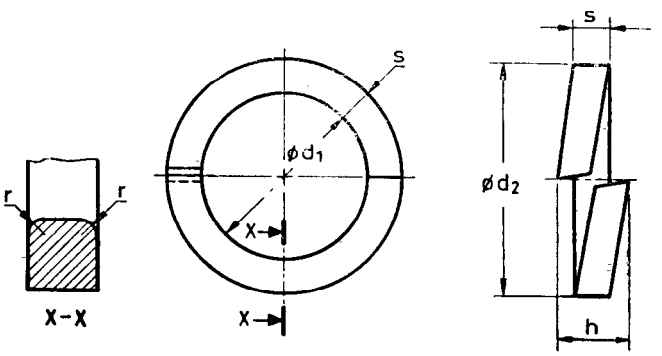
The free height of the washers after release of load shall not be less than the values specified in Tables 2A and 2B.

10.3 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.

Table 1A Dimensions for Spring Lock Washers for Screws with Cylindrical Heads

(*Clause* 3)



All dimensions in millimetres.

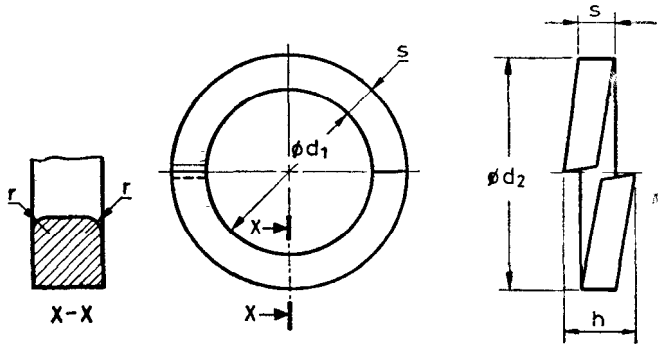
Nominal Size	d_1		d_2	s		h		r	Mass (7·85 kg/dm³) per 1000 units in kg ≈	For Thread Size
	Min	*Max*	*Max*	Basic	Limit Deviations	*Mir*	*Max*			
3[1]	3·1	3·4	5·6	1	±0·1	2	2·36	0·2	0·105	3
4	4·1	4·4	7	1·2	±0·1	2·4	2·83	0·2	0·195	4
5	5·1	5·4	8·8	1·6	±0·1	3·2	3·78	0·2	0·37	5
6	6·1	6·5	9·9	1.6	±0·1	3·2	3·78	0·3	0·425	6
8	8·1	8·5	12·7	2	±0·1	4	4·72	0·5	1·05	8
10	10·2	10·7	16	2·5	±0·1	5	5·9	0·8	1·96	10
12	12·2	12·7	18	2·5	±0·15	5	5·9	0·8	2·28	12
16	16·2	17	24·4	3·5	±0·2	7	8·25	1	5·94	16
20	20·2	21·2	30·6	4·5	±0·2	9	10·6	1	12·3	20
24	24·5	25·5	35·9	5	±0·2	10	11·8	1·6	18·1	24
30	30·5	31·7	44·1	6	±0·2	12	14·2	1·6	32	30
36	36·5	37·7	52.2	7	±0·25	14	16·5	1·6	52·5	36
42[1) 2)]	42·5	43·7	60·2	8	±0·25	16	18·9	2	80	42
48[1) 2)]	49	50·5	67	8	±0·25	16	18·9	2	90	48

[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 test for permanent set as described in Annex A have not as yet been specified for these nominal sizes.

Table 1B Dimensions for Spring Lock Washers for Screws with Cylindrical Heads of Non-preferred Sizes

(*Clause* 3)



All dimensions in millimeters.

Nominal Size	d_1		d_2	s		h		r	Mass (7·85 kg/dm³) per 1000 units in kg ≈	For Thread Size
	Min	*Max*	*Max*	Basic	Limit Deviation	*Min*	*Max*			
3·5[1)]	3·6	3·9	6·1	1	±0·1	2	2·36	0·2	0·114	3·5
14	14·2	14·7	21·1	3	±0·2	6	7·1	1	3·8	14
18	18·2	19	26·4	3·5	±0·2	7	8·25	1	6·6	18
22	22·5	23·5	32·9	4·5	±0·2	9	10·6	1	13·6	22
27	27·5	28·5	38·9	5	±0·2	10	11·8	1.6	20·6	27
33	33·5	34·7	47·1	6	±0·2	12	14·2	1·6	35	33

[1)] Test values for the spring force test as described in Annex A have not as yet been specified for this nominal size.

Table 2A Compression Load and Free Height of Washers After Compression

(*Clause* 10.2 *and* 10.3)

Nominal Size mm	Compression Load N	Minimum Free Height mm
3	1 760	1·6
4	3 050	1·9
5	5 050	2·5
6	7 050	2·6
8	12 900	3·2
10	20 600	4
12	30 000	4
16	56 300	5·6
20	88 000	7·2
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

(*Clause* 10.2 *and* 10.3)

Nominal Size mm	Compression Load N	Minimum Free Height mm
3·5	2 370	2·6
14	41 300	4·8
18	69 000	5·8
22	110 000	7·2
27	167 000	8
33	255 000	9·6

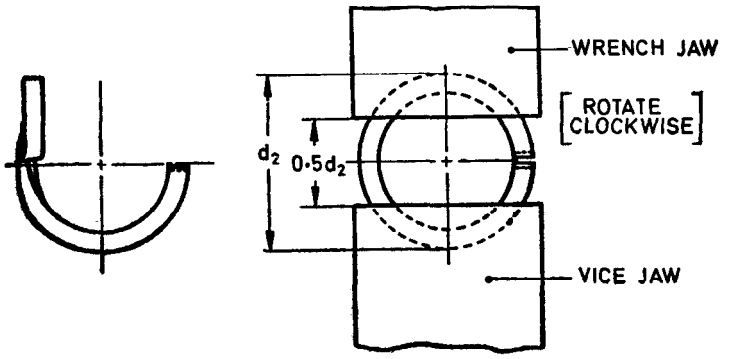


FIG. 1 TWIST TEST

10.4 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 washer till the washer is twisted through an angle of 90°. The washer shall show no sign of fracture.

11 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.

12 MARKING

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

a) Indication of source of manufacture,

b) Nominal size, and

c) Quantity.

12.2 BIS Certification Marking

The product may also be marked with Standard Mark.

12.2.1 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.

ANNEX A

(*Foreword,* Tables 1A *and* 1B)

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.

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.

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 to IS 6735	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.

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

Nominal Size	Compression Load [1)] N	Minimum Residual Spring Force 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 Load and Minimum Residual Spring Force of Washers of Non-preferred Sizes
(*Clauses* A-1 *and* A-2)

Nominal Size	Compression Load [1)] N	Minimum Residual Spring Force 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

[1)] Corresponding to property class 6.8.

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 μm 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 sping 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.

As an example, 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 μm travel shall however, be the compression load specified (*see* Fig. 4).

Although the 20 μm 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 μm or 10 μm 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 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,

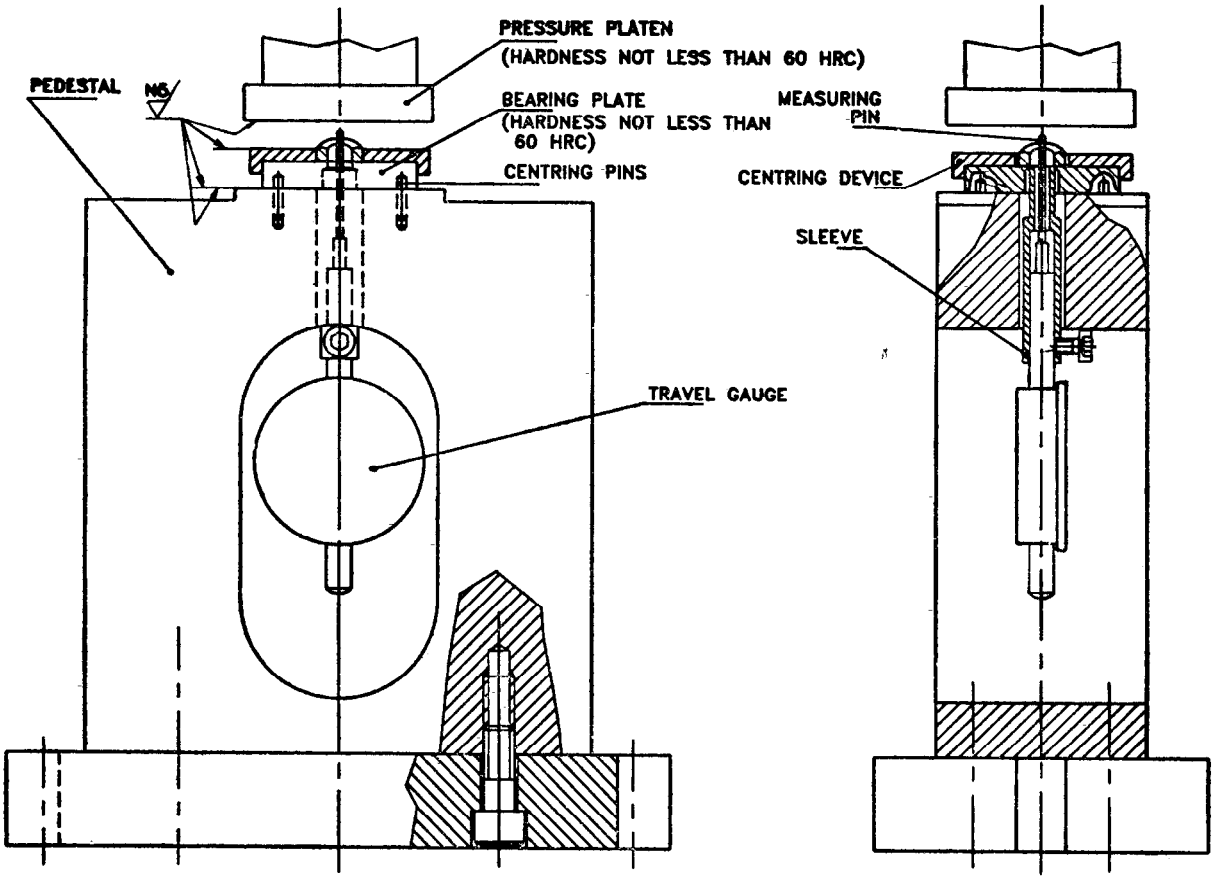


FIG. 2 EXAMPLE OF TEST DEVICE

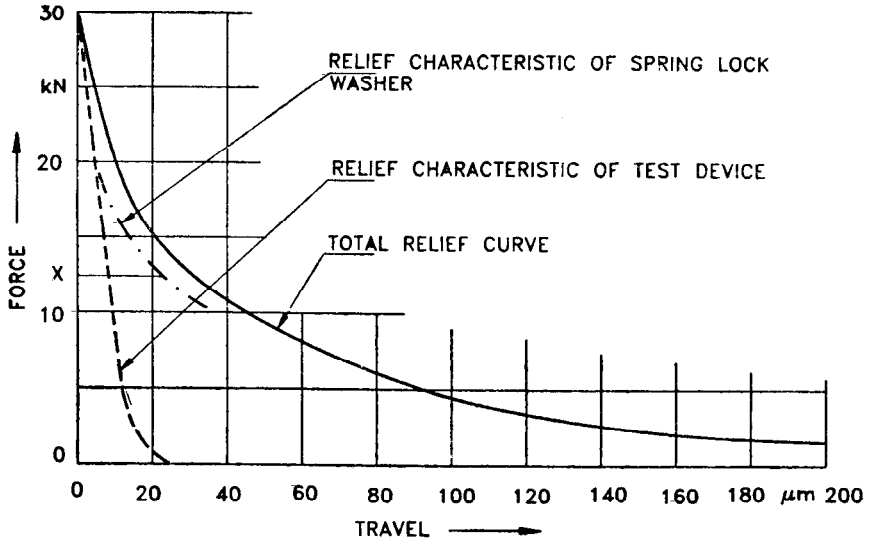


FIG. 3 DETERMINATION OF SPRING CHARACTERISTIC (RELIEF CHARACTERISTIC) FOR A SPRING LOCK WASHER A12 — IS 3063 STEEL (USING A COMPRESSION LOAD OF 30 kN)

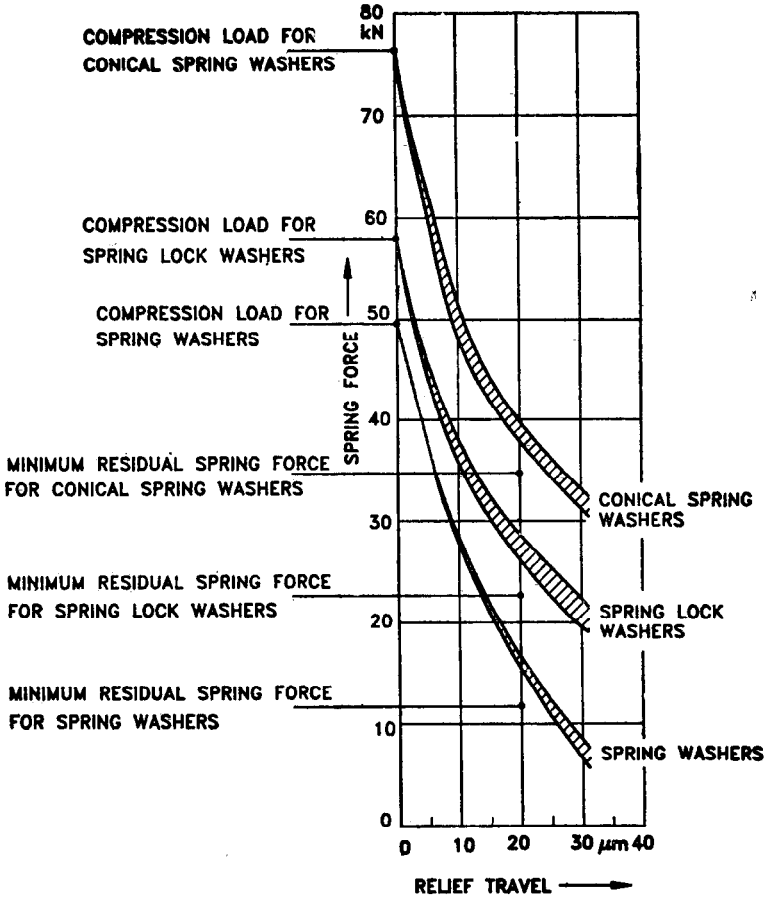


FIG. 4 GRAPHS REPRESENTING RELIEF TRAVELS AND RESIDUAL SPRING FORCES FOR VARIOUS SPRING WASHER (NOMINAL SIZE 16)

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.

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 μm for any partial measuring range of 40 μm, the direction of movement of the measuring pin being away from the gauge.

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