

SRI LANKA STANDARD 639 : 2007
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**SPECIFICATION FOR
LEAF SPRINGS FOR
AUTOMOBILE SUSPENSIONS
(FIRST REVISION)**

SRI LANKA STANDARDS INSTITUTION

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(FIRST REVISION)**

SLS 639 : 2007

Gr. 11

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SRI LANKA.**

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SPECIFICATION FOR LEAF SPRINGS FOR AUTOMOBILE SUSPENSIONS
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FOREWORD

This standard was approved by the Sectoral Committee on Materials, Mechanical Systems and Manufacturing Engineering and was authorized for adoption and publication as a Sri Lanka Standard by the Council of Sri Lanka Standards Institution on 2007-12-27.

This is the first revision of SLS 639. In this revision several changes were made to requirements for materials, dimensions and performance of Leaf Springs for Automobile Suspensions. Guideline for the determination of compliance of a lot with the requirements of this standard based on statistical sampling and inspection are given in Appendix **A** and Appendix **B**.

For the purpose of deciding whether a particular requirement of this standard is complied with the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with CS 102. The number of significant places retained in the rounded off value shall be the same as that of the specified value in this standard.

In the preparation of this specification, assistance derived from publications of the British Standards Institution, Bureau of Indian Standards, Singapore Institute of Standards and the Society of Automotive Engineers U.S.A is gratefully acknowledged.

1 SCOPE

This standard covers general requirements for leaf spring assemblies and individual spring leaves, for automobile suspensions.

2 REFERENCES

| | |
|------------|---|
| BSEN 10089 | Hot rolled steels for quenched and tempered springs – Technical delivery conditions |
| CS 102 | Presentation of numerical values |
| SLS 146 | Metallic materials – Brinell hardness test |
| SLS 428 | Random sampling methods |

3 DEFINITIONS

3.1 camber: The distance from the datum line to the point where the centre bolt or the cup centre intersects the surface of the main leaf. This may be either positive or negative.

3.2 centre bolt: The centre bolt is required to hold the spring leaves together, and the centre bolt head is used as a locating dowel during installation on the vehicle.

3.3 clamp length: Length of spring rendered inactive by the clamp located on the side opposite the spring seat. It is always less than the length in physical engagement with the clamp (see Figure 1, Figure 2 and Figure 3).

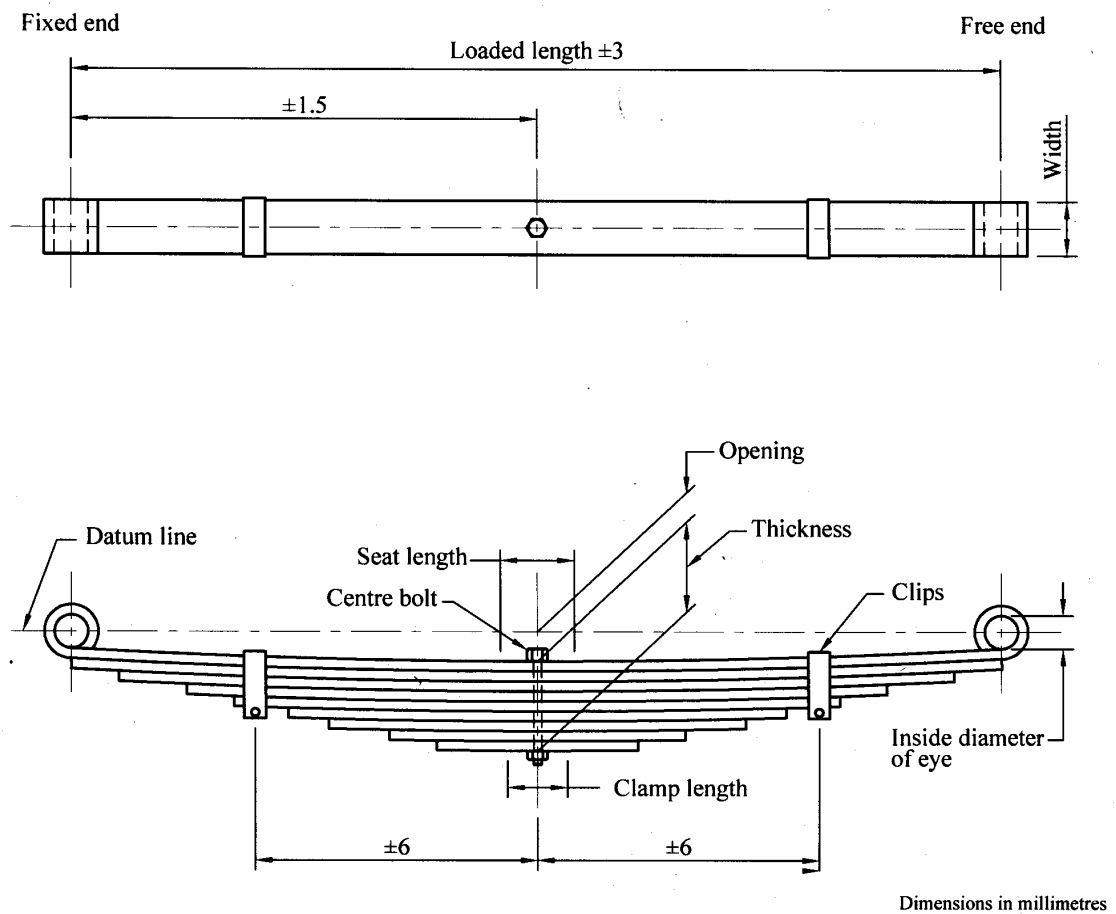
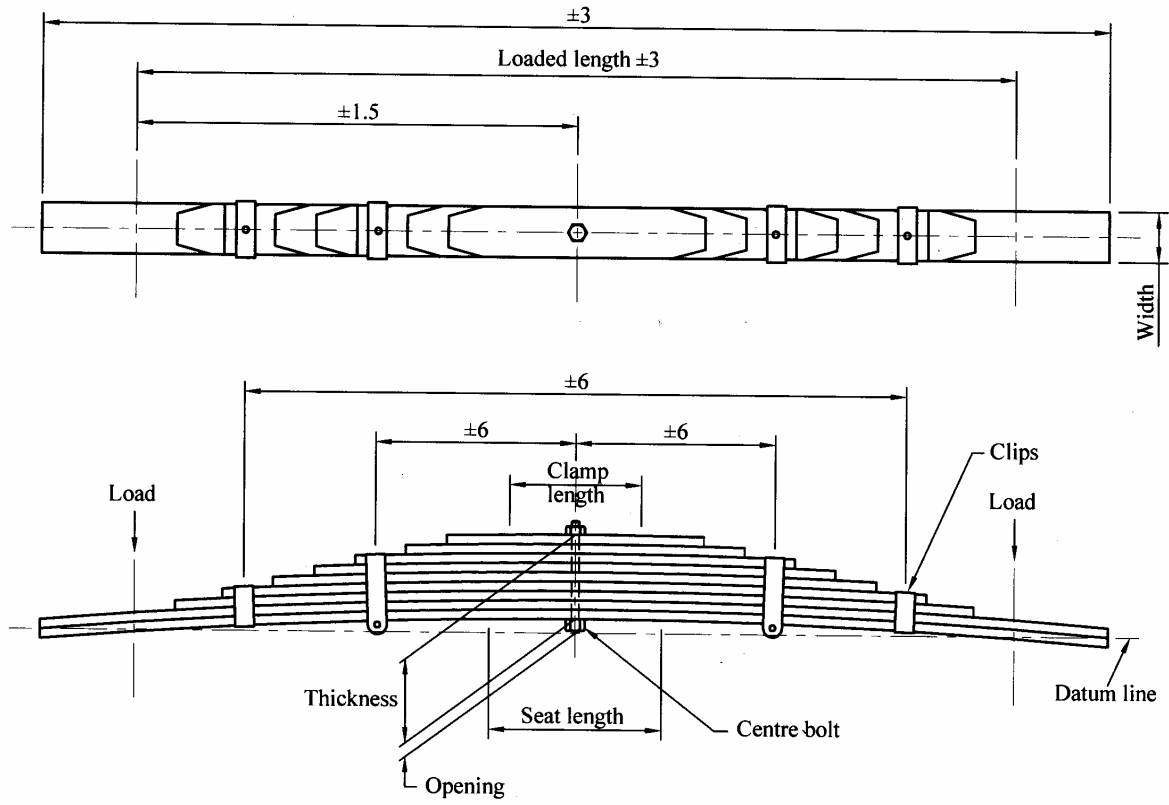


FIGURE 1 - Underslung spring



Dimensions in millimetres

FIGURE 2 - Spring with plain ends

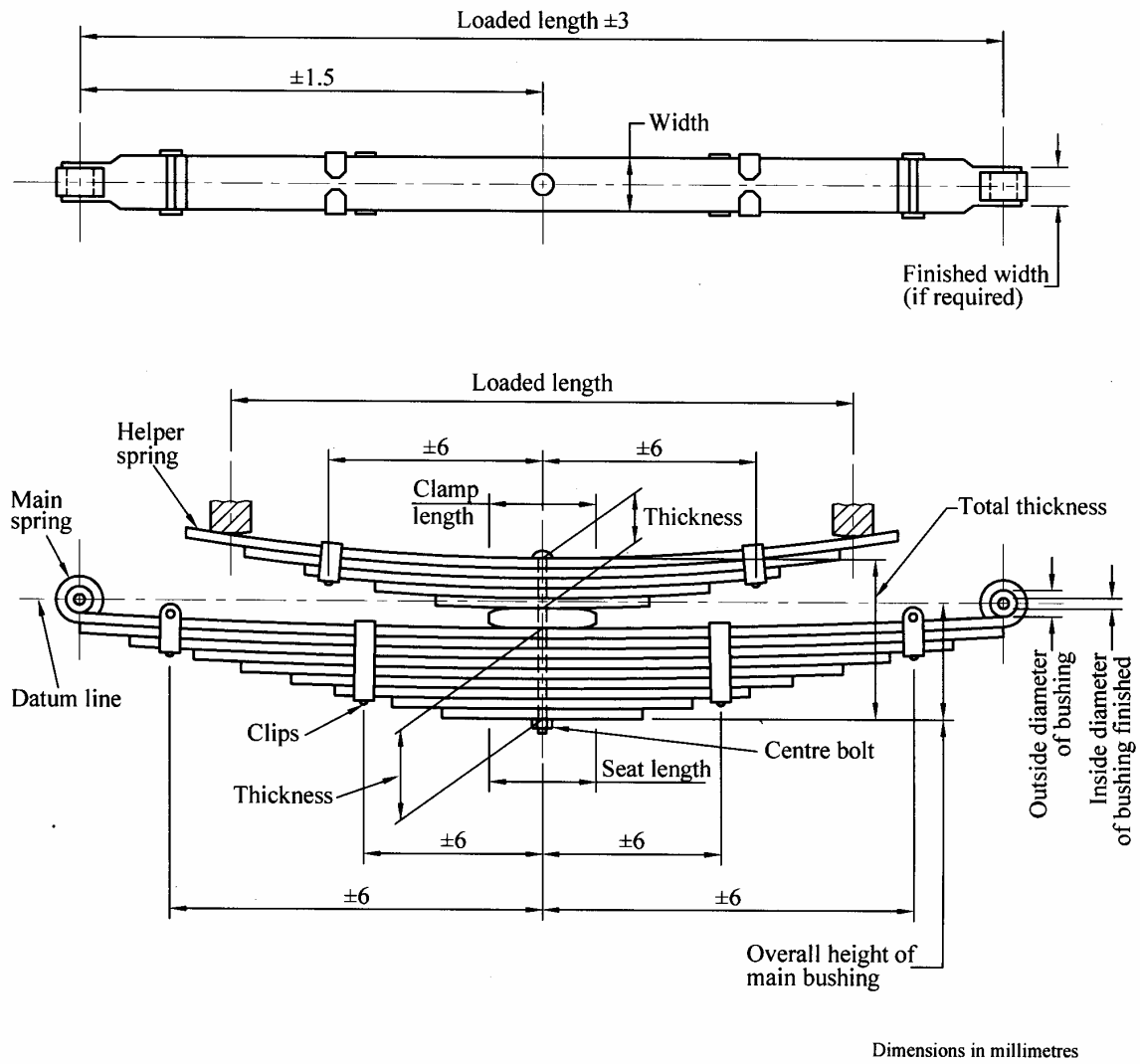


FIGURE 3 - Overslung springs

3.4 clearance : Difference in opening, or overall height, between the design load position and the extreme position (of maximum stress) to which the spring can be deflected on the vehicle.

3.5 clips : Most automotive leaf springs are fitted with clips of some form which serve primarily to prevent sidewise spread and vertical separation of the leaves.

3.6 cup centre : Cup centres are often used in heavy duty springs which may not safely depend alone on centre clamps and bolts to prevent a shifting of the spring on the axle seat due to driving and braking forces.

3.7 datum line : The line longitudinal to the length of the spring which passes through the centres of the eyes on springs having eyes. On other springs, it passes through the points where the load is applied near the ends of the spring. When load and rate are checked, the spring ends shall be free to move in the direction of the datum line.

3.8 finished width : Width to which the spring ends are finished, to bring about flat bearing surfaces on the edges.

3.9 free height (free camber) : The distance from the centre line of the eyes to the surface in contact with the seat, when the spring is not loaded.

3.10 leaf numbers : Leaves are designated by numbers, starting with the main leaf which is No. 1. The adjoining leaf is No. 2 and so on. If auxiliary or rebound leaves are used, the auxiliary leaf adjoining the main leaf is auxiliary leaf No. 1, the next one auxiliary leaf No. 2 and so on. (Auxiliary leaves are on that side of the main leaf on which load is applied to the spring ends, away from the side from which load is applied to the spring centre). Helper springs are considered as separate units (see Figure 3 and Figure 4).

3.11 leaf springs : Laminated steel spring usually of semi-elliptic type, finally heat-treated. The leaves are usually held together by a centre bolt and are prevented from lateral shifting by clips (see Figure 1, Figure 2 and Figure 3).

3.12 load : The force exerted by the spring at the specified opening or overall height. The total tolerance on load at the specified overall height or opening is usually expressed as load range (N) which is equivalent to a deflection (mm) at the nominal rate (N/mm).

3.12.1 This force is higher during compression of the spring (compression load) than during the release of the spring (release load). The load at any position will be the average of the compression load and the release load at that position.

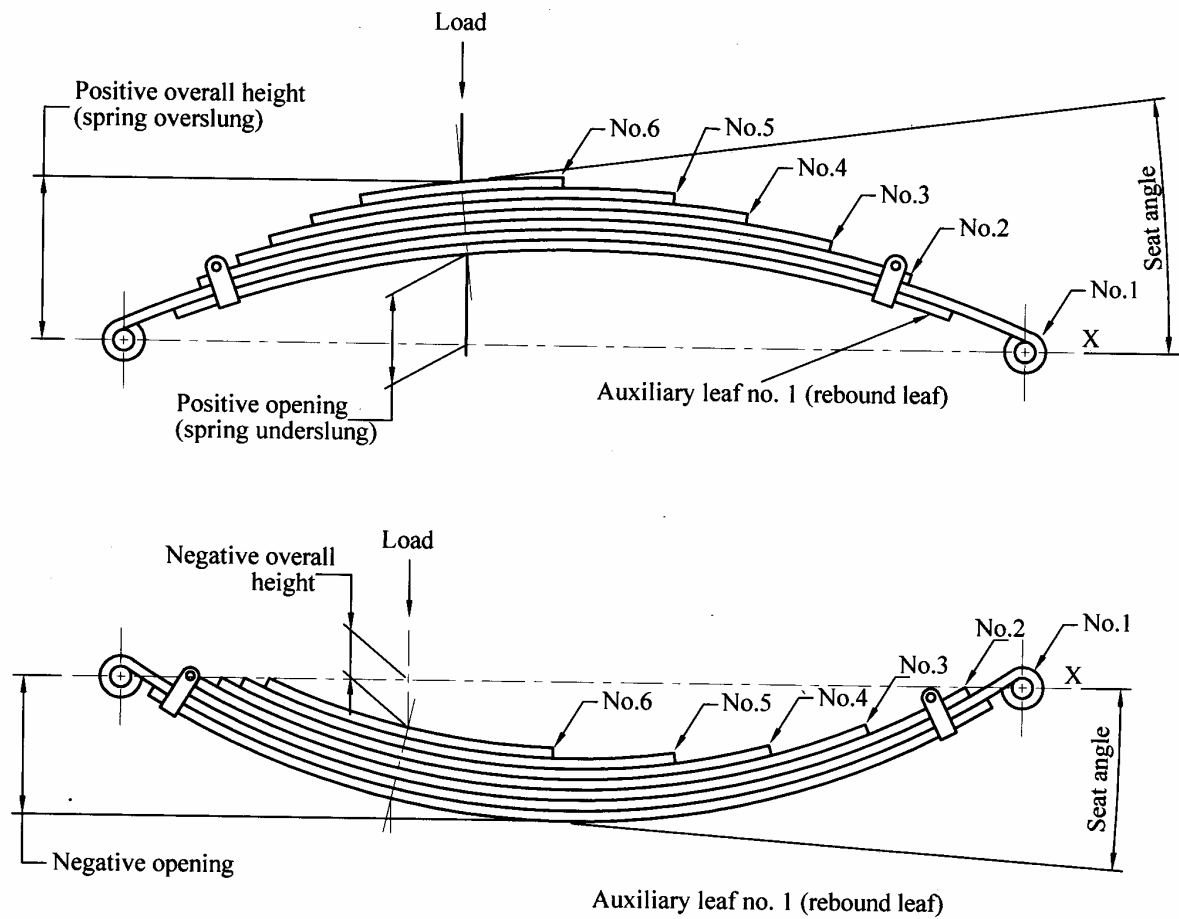


FIGURE 4 - Measurement of opening, overall height and seat angle

3.13 loaded fixed end length: Distance from the centre of the fixed eye to the projection on the datum line of the point where the centre line of the centre bolt intersects the spring surface in contact with the spring seat.

3.14 loaded height (loaded camber) : The distance from the centre line of the eyes to the surface in contact with the seat, when the spring is loaded.

3.15 loaded length : Distance between centres of the spring eyes when the spring is deflected to the specified load position. On springs without eyes, it is the distance between the lines along which the load is applied near the ends, measured under the specified loading conditions (see Figure 1, Figure 2 and Figure 3).

3.16 major defects : Failure to satisfy the specified requirements while subjecting any spring to the tests for reloaded height, rate and hardness.

3.17 minor defects : Each instance of lack of conformity to the specification while inspecting any spring for the requirements other than those of the tests for loaded height, rate and hardness.

3.18 ‘opening’ of ‘overall height’ : Distance from the datum line to the point where the centre bolt or cup centre intersects the surface of the spring that is in contact with the spring seat.

3.18.1 If the surface in contact with the seat is on the main leaf or an auxiliary leaf (which is characteristic of ‘underslung’ spring), this distance is called ‘opening’ (see Figure 1 and 2).

3.18.2 If the surface in contact with the seat is on the shortest leaf (which is characteristic of ‘overslung’ springs), this distance is called ‘overall height’ (see Figure 3).

3.18.3 ‘opening’ or overall height’ may be positive or negative (see Figure 4). They are fixed reference dimensions. Tolerance is expressed in terms of load (see ‘load’ 3.12).

3.19 rate : It is half the difference between the (average of compression and release loads) measured 25 mm above and 25 mm below the specified position.

3.20 seat angle: Angle between the tangent to the centre and to the spring seat and a line drawn through the terminal point of the active spring length at each eye taken along the tension surface of the main leaf (see Figure 4). When both ends of the spring have eyes of identical configuration and diameter (or have plain ends without eyes), the seat angle is the angle between the tangent at the centre of the spring seat and the datum line.

3.21 seat length : Length of spring that is in physical engagement with the spring seat when installed on a vehicle at design height. It is always greater than inactive or clamp length (see Figure 1, Figure 2 and Figure 3).

3.22 specified load : The load specified by the designer. All the spring dimensions are specified on the drawing at this load.

3.23 straight length : Distance between spring eye centres when the main leaf is flat.

3.24 thickness : Aggregate of the nominal thicknesses of the leaves at the centre of the spring assembly. The actual thickness may differ from this figure because of the rolling tolerances for the leaf sections.

4 REQUIEMENTS

4.1 Material

It is recommended that the material used for leaf springs shall be Si-Mn steel in accordance with BSEN 10089 : 2002.

4.2 Leaf sections

4.2.1 The section shall be of reasonably flat rolled steel. The surfaces may be slightly curved, but the curvature on the two sides shall be equal and concave. The edges shall be convex, rounded with radius of curvature approximately equal to the thickness of the flat.

4.2.2 The flats shall be substantially straight and free from lateral links, waves, twists or other surface imperfections, such as splits, seams, flakes and pits which render them unsatisfactory for leaf spring manufacturing purposes. These lateral deviations shall be less than 3 mm per 1 m length of material.

4.2.3 *Dimensions*

The recommended values for nominal width and nominal thickness of the leaf sections are as follows:

Nominal thickness (mm) – 3, 3.5, 4, 4.5, 5, 5.5, 6, 6.5, 7, 8 , 9, 10, 11, 12, 14, 16, 20

Nominal width (mm) - 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 90, 100, 125

4.2.4 *Rolling tolerances*

The rolling tolerances shall be in accordance with Table 1.

**TABLE 1 – Rolling tolerances for leaf sections
(All dimensions in millimeters)**

| Nominal width (1) | Tolerance on width (2) | Tolerance on thickness | | | Maximum concavity (6) | Maximum convexity (7) |
|----------------------------------|-------------------------------|-----------------------------|-------------------------------------|------------------------------|------------------------------|------------------------------|
| | | Thickness upto 8 (4) | Thickness over 8 upto 14 (4) | Thickness over 14 (5) | | |
| 40 and below | ± 0.30 | ± 0.15 | ± 0.15 | -- | 0.10 | 0.025 |
| Over 40 upto and including 70 | ± 0.50 | ± 0.15 | ± 0.15 | ± 0.25 | 0.15 | 0.050 |
| Over 70 upto and including 100 | ± 0.70 | ± 0.18 | ± 0.20 | ± 0.30 | 0.20 | 0.075 |
| Over 100 up to and including 125 | ± 1.00 | ± 0.20 | ± 0.25 | ± 0.40 | 0.25 | 0.100 |

4.3 Hardness

4.3.1 The heat-treated spring leaves when tested in accordance with **SLS 146** shall have a Brinell hardness value between 375 and 444.

4.3.2 The recommended points to be tested shall be taken as two(2) points within 100 mm distance from the centre and another two (2) points within 100 mm distance from each end of the leaf.

4.4 Eyes

4.4.1 General

It is recommended that eyes shall either be solid or rolled having a short scarf. The eye may be finished to accommodate a bushing where necessary (see Figure 3). It is preferable that the eyes shall project away from the second leaf.

If metallic bushes are used, they shall be made of steel or bi-metal.

4.4.2 Bore diameters

4.4.2.1 The recommended bore diameters are as follows:

18 mm, 20 mm, 22 mm, 23 mm, 25 mm, 28 mm, 30 mm, 31 mm, 32 mm, 33 mm, 34 mm, 35 mm, 36 mm, 37 mm, 38 mm, 40 mm, 42 mm, 45 mm, 48 mm, 50 mm, 55 mm, 60 mm, 65 mm.

4.4.2.2 The limits of tolerances(mm) on bore diameters shall be as follows:

- i) Bushed eyes - $\begin{matrix} +0.00 \\ -0.10 \end{matrix}$
- ii) Unbushed eyes - $\begin{matrix} +0.00 \\ -0.25 \end{matrix}$

4.4.2.3 Wall thickness of bushings

Unless otherwise specified, the minimum wall thickness of bushings shall be 3.2 mm.

4.4.2.4 The inner diameter of bushing shall be as specified by the purchaser.

4.4.3 Parallelism of spring eyes

Eyes of the main leaf shall be

- a) parallel to each other;
- b) parallel to the surface of the spring seat; and
- c) square to the centre line of the main leaf within the following tolerances (see also Figure 5 dimension A).
 - For passenger car springs, ± 2.5 mm in 500 mm and
 - For commercial vehicle springs, ± 5.0 mm in 500 mm

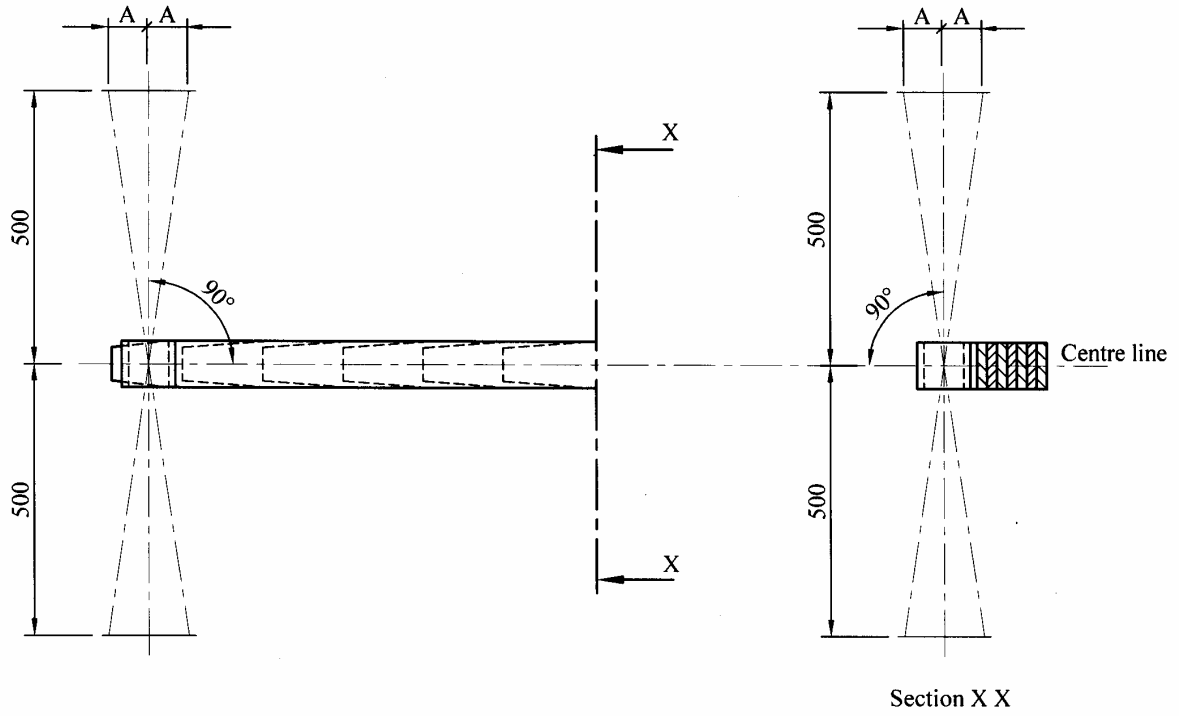
4.4.4 Tolerance on distance between spring

The distance between spring eye centres shall be correct within ± 3 mm. Half of this tolerance shall be allowed for each half of the spring (see Figure 6).

4.5 Leaf ends

4.5.1 *Shape*

The shape of the leaf ends shall be as agreed, to between the purchaser and the manufacturer. All edges are to be rounded or chamfered.



Dimensions in millimetres

FIGURE 5 - Parallelism of spring eyes

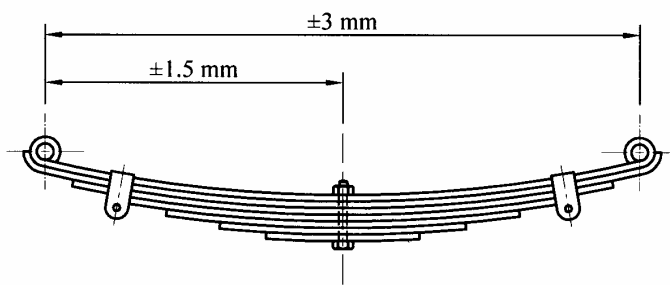


FIGURE 6 - Tolerance on spring eye centres

4.5.2 Finished width

Where the design calls for edge finishing of spring leaves, the finished width shall be equal to the nominal width of the leaf unless otherwise the finished width is specified by the purchaser.

4.5.2.1 Finished widths shall have the limits of tolerances(mm) as follows:

- i) Finished widths, up to and including 50 mm - $\begin{matrix} +0.0 \\ -0.5 \end{matrix}$
- ii) Finished widths, above 50 mm - $\begin{matrix} +0.0 \\ -1.0 \end{matrix}$

4.5.2.2 Ground or polished leaf ends

Subject to agreement between the manufacturer and the purchaser, the bearing axes of leaves may be ground or polished. The length to be ground shall be specified by the purchaser.

4.6 Centre bolts

4.6.1 The recommended dimensions of centre bolts are given in Table 2.

**TABLE 2 – Recommended dimensions for centre bolts
(All dimensions in millimeters)**

| Width of leaves (1) | Diameter of centre bolt (2) | Diameter of head (3) | Height of head (4) |
|---------------------------|--------------------------------|-------------------------|-----------------------|
| Up to and including 50 | 8 | 12 | 10 |
| 55 up to and including 70 | 10 | 15 | 11 |
| 75 up to and including 90 | 12 | 17 | 11 |
| 100 and above | 16 | 20 | 11 |

Where springs are mounted on rubber pads the size of the centre bolt head may be increased to suit.

4.6.2 For underslung springs the head should be adjacent to the main leaf; and for overslung springs, the head should be adjacent to the short leaf. The centre bolt should not be depended upon to prevent the shifting of leaves due to driving and breaking forces.

4.6.3 Centre bolts shall have cheese heads and thread according to the purchaser's requirements. In most cases centre bolts are highly stressed in the handling of the springs and in service. Therefore it is necessary to use heat treated bolts of high mechanical properties. The material for all centre bolts shall be steel with a tensile strength of 618 MPa to 775 MPa.

4.7 Centre holes, centre dimples and cup centres

4.7.1 *Centre holes*

The centre holes shall be punched or drilled to the diameter of the centre bolt within a tolerance of + 1 mm.

4.7.2 *Centre dimples*

The centre dimples shall be truncated cones with 45 ° sides. The dimensions of dimples, where provided, shall be as agreed upon between the manufacturer and the purchaser.

4.7.3 *Cup centres*

Cup centres may be used in heavy duty springs, where prevention of shifting of springs on the axle seat due to driving and breaking forces may not be depended safely on the centre bolt alone.

4.8 Clips

4.8.1 Rebound and alignment clips shall be provided on leaf springs. Where metal spring-covers are used, alignment clips may be omitted.

4.8.2 Clip sections, and size of rivets and bolts used with the clips shall be as given in Table 3 (see Figure 7).

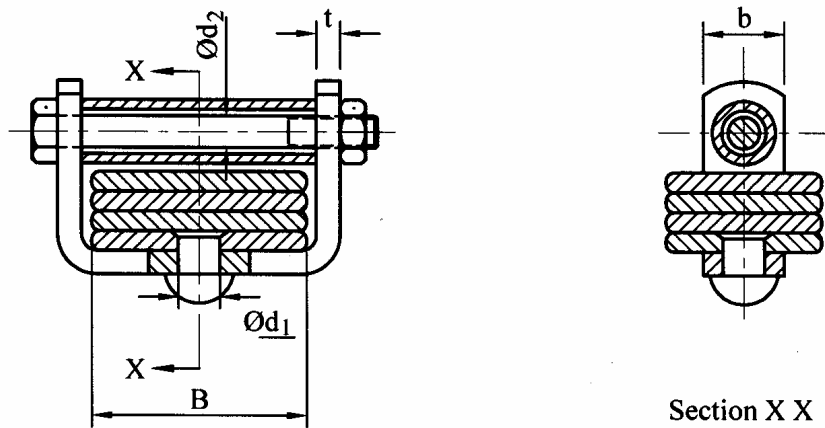


FIGURE 7 - Spring clip

TABLE 3 – recommended dimensions for clips
(All dimensions in millimeters)

| Spring width (B) (1) | Clip section (b x t) (2) | Diameter (d_1) of rivet (3) | Diameter of (d_2) bolts (4) |
|----------------------------|--------------------------------|---------------------------------------|---------------------------------------|
| Up to and including 40 | 20 x 4 | 6 | 6 |
| 45 and 50 | 20 x 4 | 8 | 6 |
| 55 and 60 | 25 x 5 | 10 | 8 |
| 65 to 75 | 25 x 5 | 10 | 10 |
| Above 75 | 32 x 6 | 10 (two) | 10 |
| | 32 x 10 | 10 (two) | 16 |

4.8.3 Clip bolts shall be made from mild steel. They shall be threaded as specified by the purchaser.

4.8.4 Clip bolts shall have hexagon heads and nuts, except where clearances are too small, in which case counter sunk bolts without nuts shall be used with tapped clips. Clips such as clinch type, shall be acceptable, subject to agreement between the purchaser and the manufacturer.

4.9 Tolerance on spring assemblies

4.9.1 In addition to the tolerances specified in Figure 1 to Figure 4, and under 4.5.2.1 the following tolerances shall be permitted on the spring assemblies.

Straight length ± 3 mm
Seat angle $\pm 0^{\circ} 30'$

4.10 Interleaf clearance

The maximum permissible interleaf clearance for heavy duty springs shall be 0.5 mm.

4.11 Surface finish and protective coatings

4.11.1 Leaf springs shall be supplied in the following finishes as specified by the purchaser.

4.11.1.1 Finish No. 1

Leaves left in the same condition as they come from the heat-treating process.

4.11.1.2 Finish No. 2

All burrs on the bearing sides removed.

4.11.1.3 Finish No. 3

The sheared and trimmed edges of the leaves chamfered on their bearing sides

4.11.1.4 Finish No. 4

All loose scales removed.

4.11.1.5 Finish No. 5

Shot-peened.

NOTE : *The depth of shot-peening, method of test of shot-peening and whether shot-peening is to be done on both sides or on tension side only shall be agreed to between the purchaser and the manufacturer.*

4.11.2 Combinations of these numbers may be used to indicate the desired finish completely.

4.11.3 Springs shall be lubricated at the time of assembly by applying a thin film of suitable lubricant to the tension surface of the leaves.

4.11.4 Springs shall be protected against corrosion by either oiling with rust inhibiting lubricant or by a painting system which will prevent corrosion.

The oxide coating produced during heat treatment also provides some protection against corrosion.

4.12 Average laden height

4.12.1 When laminated spring assemblies are load tested in accordance with **6.1** average laden height values shall be as follows:

| | | |
|------------------|---|---|
| Class 'A' limits | - | within ± 3 mm of the specified height |
| Class 'B' limits | - | within ± 6 mm of the specified height |

4.13 Average rate

4.13.1 When laminated spring assemblies are rate tested in accordance with **6.2** the average rate values shall be as follows:

| | | |
|------------------|---|---|
| Class 'A' limits | - | within ± 5 per cent of the specified rate |
| Class 'B' limits | - | within ± 7.5 per cent of the specified rate |

5 MARKING

5.1 The name and address or registered trade-mark of the manufacturer and the year of manufacture shall be legibly and indelibly marked on each spring leaf at a place not detrimental to the life and service of the spring. If required by the purchaser, type of finish and the code for the type of steel used shall also be marked.

6 METHODS OF TEST

6.1 Test for loaded height

Laminated spring assemblies shall be load tested as follows:

6.1.1 Apply a specified load W and measure the laden height H_1 from a given datum.

6.1.2 Deflect the assembly a further 25 mm by increasing the load and then reduce the load to W and measure the laden height H_2 .

6.1.3 Calculate the average laden height from $\frac{H_1 + H_2}{2}$ (See 4.12)

6.2 Test for rate

Laminated spring assemblies shall be rate tested as follows:

6.2.1 Deflect the spring to a point 25 mm above the height of the spring at the specified load and record the load W_1 .

6.2.2 Deflect the spring a further 50 mm and record the load W_2 .

6.2.3 Deflect the spring a further 25 mm then return 25 mm and record load W_3 .

6.2.4 Return further 50 mm and record load W_4 .

6.2.5 Calculate the average rate (kg/mm) from $\frac{W_2 - W_1}{100} + \frac{W_3 - W_4}{100}$ (see **4.13**)

7 TESTING AND INSPECTION FACILITIES

7.1 The supplier shall supply, free of cost, the required sample or samples, labour and available appliances for such testing as may be carried out by the purchaser or his authorized representative in accordance with this standard, at the premises of the supplier or at any other place mutually agreed upon.

APPENDIX A SAMPLING

A.1 LOT : In any consignment, all the springs of the same type and manufactured from the same material under essentially similar conditions of manufacture shall be grouped together to constitute a lot.

A.2 SCALE OF SAMPLING

A.2.1 For ascertaining the conformity of the lot to the requirements of this standard, tests shall be carried out for each lot separately.

A.2.2 The number of springs to be selected from the lot shall be in accordance with Table 4.

A.2.3 The springs shall be selected at random. In order to ensure randomness of selection random number tables as given in **SLS 428** shall be used.

TABLE 4 – Scale of sampling

| Number of springs in the log (1) | Number of springs to be selected (2) | Acceptance number for minor defects (3) | Acceptance number for major defects (4) |
|--|---|--|--|
| Up to 25 | 3 | 1 | 0 |
| 26 to 50 | 5 | 2 | 0 |
| 51 to 100 | 8 | 3 | 0 |
| 101 to 150 | 13 | 5 | 1 |
| 151 to 300 | 20 | 7 | 1 |
| 301 to 500 | 32 | 10 | 2 |
| 501 to 1 000 | 50 | 14 | 3 |
| 1 001 and above | 80 | 21 | 5 |

A.3 NUMBER OF TESTS

All the springs selected as in **A.2.2** and **A.2.3** shall be subjected to the following tests and measurements :

- | | |
|---|------------|
| a) Test for hardness | (see 4.3) |
| b) Dimensions of spring eyes | (see 4.4) |
| c) Spring eye centres distance | (see 4.4) |
| d) hole diameters and centre dimple | (see 4.7) |
| e) Straight length and seat angle | (see 4.9) |
| f) Maximum interleaf clearance for heavy duty springs | (see 4.10) |
| g) Surface finish and protective coatings | (see 4.11) |
| h) Protection against corrosion | (see 4.11) |
| j) Test for loaded height | (see 6.1) |
| k) Test for rate | (see 6.2) |

APPENDIX B
CONFORMITY TO STANDRD

B.1 The lot shall be declared as conforming to the requirements of this specification if the following conditions are satisfied.

B.1.1 The number of minor defects on springs tested as in **A.3** is less than or equal to the corresponding acceptance number given in Column 3 of Table **4**.

B.1.2 The number of major defects on springs tested as in **A.3** is less than or equal to the corresponding acceptance, number given in column 4 of Table **4**.

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Further particulars of the terms and conditions of the permit may be obtained from the Sri Lanka Standards Institution, 17, Victoria Place, Elvitigala Mawatha, Colombo 08.



SRI LANKA STANDARDS INSTITUTION

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