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Translation

O

Technical specification for the supply of parallel leaf springs for vehicles

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Technische Lieferbedingungen für Fahrzeug-Blattfedern

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5th edition, July 1985	with its 3 Amendments dated 1.7.86, 1.7.91 and 1.7.92
6th edition, November 2003	Retyped in FrameMaker and up-date of references to ISO standards following changes made between 1985 and 2003: - ISO 82:1974: Steel. Tensile testing (standard withdrawn on 1.7.1984) is mentioned in the 5th edition of UIC Leaflet 821 dated 1.7.1985. CTR SC03 suggests ISO Standard 6892:1998 as a replacement standard. - ISO 85:1959: Bend test for steel (standard withdrawn on 1.7.1985) is mentioned in the 5th edition of UIC Leaflet 821 dated 1.7.1985. The ISO has officially replaced this standard by ISO Standard 7438:1985.

The person responsible for this leaflet is named in the UIC Code

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Summary

This technical specification governs the supply of parallel leaf springs with constant thickness or with a parabolic profile, intended for use in the suspension gear for tractive or hauled stock.

It also applies to all springs which are comparable to the above types in terms of their functional or dimensional characteristics.

1 - Purpose

1.1 - Scope

This technical specification governs the supply of parallel leaf springs with constant thickness or with a parabolic profile, intended for use in the suspension gear for tractive or hauled stock.

It also applies to all springs which are comparable to the above types in terms of their functional or dimensional characteristics.

1.2 - Definitions

The term "parallel leaf spring" describes the complete unit formed by the following components:

- leaves, including the leaf fitted with devices connecting the spring to the underframe or another spring (eyes, small grippers, drill holes) and termed "the main leaf",
- buckle,
- insert(s) and buckle key(s) if required,

either hot or cold-assembled using a buckle.

Progressive flexibility springs consist of leaves at two different stages: the stage comprising the main leaf is termed "primary stage", the other "secondary stage". These stages may consist individually of one or several leaves.

Springs incorporating leaves with thicknesses varying according to a parabolic profile are termed "parabolic springs".

Springs incorporating constant-thickness leaves are termed "trapezoidal springs".

1.3 - Classification

Springs shall be classified into two categories (Category 1 and Category 2) with decreasing characteristics. Categories shall be determined by the engineering and design departments and indicated on drawings.

Parabolic springs shall be classified in Category 1.

All particulars relevant to contract implementation, and more especially those concerning observance of the following points in this specification:

2.1.1 - page 4, 2.1.3, 2.1.4 - page 5, 2.2.1 - page 6, 2.2.2, 2.2.3 - page 7, 2.2.4 - page 8,
3.2.2 - page 10, 3.2.3.2 - page 11,
4.3.2 - page 13, 4.3.4 - page 19,

shall be specified in the order or its appended documents.

The drawings of springs or component parts shall stipulate:

- the steel grade and the reference of the document governing supply of the material,
- the category,
- the characteristics,
- the method of assembly (hot or cold),
- the reference to this specification.

1.4 - List of reference documents

Reference is made in this technical specification to documents other than UIC leaflets, as follows:

ISO standards: *ISO 83 - ISO 630 - ISO 683/14 - ISO 6506-1, ISO 6892, ISO 7438* (see Bibliography - page 33).

2 - Characteristics

2.1 - Component parts

2.1.1 - Component materials

2.1.1.1 - Leaves

Leaves shall be manufactured from steel bars supplied under the terms specified in *UIC Leaflet 820* (see Bibliography - page 33).

The steel grade used for leaves shall be that specified in the order or its appended documents.

2.1.1.2 - Buckles

Buckles shall be manufactured from the steel grade specified in the drawing. Unless otherwise stipulated, use shall be made of Fe 360-C or Fe 510-C steel defined in *ISO Standard 630*.

2.1.1.3 - Other parts

The characteristics of other component parts such as inserts, wedges and buckle keys must be consistent with the indications given in the order or its appended documents.

2.1.2 - Physical characteristics

2.1.2.1 - Leaves

Leaves must be free of any flaw likely to prevent the springs from performing efficiently under service conditions.

Leaves must not be entirely decarburized, and the depth of partial decarburization must be less than the values indicated in Table 1 overleaf:

Table 1 :

Leaf thickness in mm	Decarburization depth in mm
< 7	0,20
≥ 7 < 15	0,30
≥ 15 < 25	0,40
≥ 25 < 35	0,55
≥ 35 ≤ 80	0,80

If stipulated in the order or its appended documents, main leaves of Category 1 trapezoidal springs and all the leaves of parabolic springs shall undergo a magnetic crack detection test in accordance with the procedure and conditions set out in Appendix B - page 31. They must show no untoward effect either on the surface under stress under normal operating conditions or at the edges.

Leaves with random spectra measuring less than 5 mm in length on the surface under compression in normal operating conditions shall be accepted, provided:

- these are over 150 mm apart,

- the corresponding defect is eliminated by slight longitudinal grinding, without heating:

  - to a depth of 0,2 mm at the maximum,
  - with gradual levelling of the surface.

After removal of defect, leaves shall undergo a further magnetic crack detection test in accordance with the conditions in Appendix B - page 31.

2.1.2.2 - Other parts

The other component parts must not show any flaws likely to impair their use.

2.1.3 - Geometrical characteristics

2.1.3.1 - Leaves

The shape and dimensions of leaves shall be those stipulated in the order or its appended documents. Main leaf eyes shall be cylindrical and the ends shall not come into contact with the leaf.

2.1.3.2 - Other component parts

The geometrical characteristics of the other component parts must be consistent with the indications given in the standards or in the drawings.

2.1.4 - Mechanical characteristics

2.1.4.1 - Category 1 spring leaves

Unless otherwise stipulated in the order or its appended documents, category 1 spring leaves shall be manufactured from steel grade 13 or 14, as defined in *ISO Standard 683-14*.

Leaves must be shot-peened in such a way that the deflection in the Almen A2 test piece used under the conditions defined in Appendix A - page 28 is 0,5 mm for the surface under stress.

The shot-peened area shall represent at least 95% of the surface. This value shall be assumed to have been reached as soon as the impressions are seen during visual examination when magnified to the power of 10 to cover the whole surface.

After heat treatment, the test pieces taken under the conditions stipulated in point 4.3.3 - page 17 shall have the following characteristics:

Tensile strength:

$1\,450\ N/mm^2 \leq Rm \leq 1\,600\ N/mm^2$

$Rp\ 0,2 \geq 1\,320\ N/mm^2$

$A\% > 8$

KU resilience at 20°C ≥ 13 J (mean value of results obtained on 3 test pieces; no individual result may have a value < 75% of the minimum mean value).

Hardness should be between 420 and 465 HBW

Differences in hardness on the same leaf or on the leaves of the same batch must not exceed 30 HBW.

2.1.4.2 - Category 2 spring leaves

These spring leaves shall be manufactured from steel grades 4 or 7 defined in *ISO Standard 683-14*, or from any other grade approved by the purchasing Railway.

The HBW hardness must lie between 380 and 430 for grades 4 or 7.

2.1.4.3 - Buckles

Buckles shall have the characteristics of the steel grade stipulated in the order or its appended documents.

Buckles must show no crack or fracture after the expanding test carried out under the conditions stipulated in point 4.3.4.11 - page 21.

Test pieces taken from one of the lateral surfaces of the buckle, and bent until the gap between the two ends is half the thickness of the test piece, must show no crack or fracture.

The buckle's HBS hardness must be between 100 and 130, or within the limits stipulated by the purchasing Railway.

2.1.4.4 - Other parts

The characteristics of other parts must be consistent with the stipulations contained in the order or its appended documents.

2.2 - Springs

2.2.1 - Geometrical characteristics

The shapes and dimensions of the springs when finished must correspond to those stipulated in the order or its appended documents.

The axial plane of the buckle, its surfaces and the centres of the assembly holes must either be parallel or perpendicular to one another as applicable, and correspond to the conditions or tolerances specified in these documents.

The centre planes (lateral and longitudinal) of the spring shall form its planes of symmetry.

On the assembled spring, the lateral surfaces formed by the edges of leaves must be such that no edge deviates from the plane tangent to the other edges by more than 1,5 mm.

When the spring is not under load, the ends of the leaves may be separated by a slight gap, but under Load F1 (see points 4.3.4.12 - page 21 and 4.3.4.13 - page 22), this gap must disappear for constant-flexibility springs or the primary stage of progressive-flexibility springs.

2.2.2 - Mechanical characteristics

2.2.2.1 - Deflection test

It must be possible for the springs to withstand two successive test loads applied under the conditions laid down in point 4.3.4.12 - page 21.

After the deflection test, the height differences must be within the tolerances indicated on the drawing.

2.2.2.2 - Flexibility

The flexibility as measured under the conditions laid down in points 4.3.4.13 or 4.3.4.14 - page 23, according to whether the spring is of constant or progressive flexibility, must be consistent with the values indicated on the drawing.

Unless otherwise stipulated, the flexibility tolerance shall be ± 8% for trapezoidal springs and ± 7% for parabolic springs.

2.2.2.3 - Resistance of leaves to slippage

When spring leaves at least 90 mm wide are clamped in a buckle and the leaves are fastened together by interlocking centre nibs and keying with an insert, the strength of the assembly shall be such that no displacement of the component parts occurs when a load is exerted either on a central leaf of the spring, or on the insert, in accordance with the test conditions stipulated in point 4.3.4.15 - page 24.

The value of the load must be 75 kN for buckles made of Fe 360 C steel.

2.2.3 - Marking

Each spring must bear the following marks, either hot or cold stamped on the buckle:

- the manufacturer's mark,
- the owner's mark,
- the "interchangeable part" mark,
- the deflection under test load of 20 kN measured on each spring, and if so stipulated in the order or in its appended documents,
- the last two figures of the year of manufacture,
- the maximum axle load of the vehicle on which this spring is to be fitted, if this load is in excess of 200 kN,
- the category.

If the spring type has to be indicated, relevant particulars may be painted on leaves.

No hot or cold stamped mark should be made on the surface under stresses in normal conditions of use or on edges.

2.2.4 - Protection against rust

Unless otherwise stipulated in the order or its appended documents:

1. Category 1 springs shall be protected against rust by a coat of paint approved by the purchasing Railway;

2. Category 2 springs shall be protected against rust as follows:

   - on non-machined parts: a coating of grease or a similar product the composition of which has been approved by the purchasing Railway,
   - on machined parts: an anti-rust coating approved by the purchasing Railway;

3. separately-ordered buckles for cold assembly shall at least be given the same primary protective coat of paint as that stipulated for buckles of assembled springs;

4. each parabolic spring leaf shall be given a coat of paint with a high zinc content , approved by the purchasing Railway, before assembly of the spring.

   The thickness of the coat of paint, when dry, shall be between 30 μm and 50 μm.

   After assembly, the spring shall be given a coat of paint approved by the purchasing Railway. The minimum thickness of the coat of paint, when dry, must be 20 μm.

3 - Manufacture

The manufacture of springs covered by this technical specification shall be entrusted solely to works approved beforehand by the purchasing Railway.

Category 1 springs must officially be approved by the purchasing Railway prior to mass production.

Official approval shall be given if the tests carried out in the purchasing Railway's laboratory on six springs supplied free of charge are satisfactory. The tests to be performed shall be specified by the purchasing Railway but shall mandatorily comprise a leaf slippage test carried out after the test spring has been subject to dynamic stresses.

3.1 - Component materials

Flat steel bars used for springs shall be manufactured in accordance with the technical specifications of *UIC Leaflet 820*.

3.2 - Springs

3.2.1 - Leaves

All necessary precautions must be taken during manufacture of the leaves to avoid changing the steel properties and the development of defects (cracks, fissures, stress cracks, etc.) which may be prejudicial to their use.

In particular, leaves shall be heated in such a way that no overheating and no significant scale formation occur.

Shaping of parabolic leaves by rolling must be carried out in such a way that it does not give rise to formation of scales or other defects which may be prejudicial to their use.

In the case of leaves with rivet holes, these holes shall be hot-punched before heat treatment, or cold-drilled. Any other method of making holes must first be referred to the purchasing Railway for approval. Any burrs arising from the manufacturing process must be carefully removed.

Leaves shall be subject to heat treatment which must obligatorily include quenching and tempering. Heat treatment procedures shall be approved by the purchasing Railway.

Bending and quenching of leaves shall be carried out on a device keeping the leaf in shape throughout the quenching process, without impeding the action of the cooling liquid.

The heating temperature before quenching as well as the tempering temperature must be measured by means of calibrated recording apparatus. Temperature records must be kept at the disposal of the purchasing Railway's representative.

In order to ensure that the leaves are heat-treated under optimum conditions, it is recommended that the quenching and tempering temperatures be stipulated beforehand according to the actual chemical composition of the steel used.

When so stipulated, shot-peening must be carried out as evenly as possible.

It is forbidden to make use of shot containing sharp-edged particles.

3.2.2 - Buckles

Buckles shall be manufactured to the dimensions and tolerances shown on the drawings by forging, with or without welding.

If welding is not explicitly stipulated on the drawing, it may only be carried out with the purchasing Railway's agreement.

Forging operations shall be carried out in such a way as to avoid causing folds in the metal, cracks or fissures, or any other defect prejudicial to its use.

Welding shall be carried out in such a manner as to avoid any transformation of the properties of the metal prejudicial to its use in the welding zone.

Normalisation heat treatment shall be obligatory after welding in the case of buckles intended for cold assembly. Such treatment shall be carried out, if so stipulated in the order or its appended documents, on buckles intended for hot assembly.

Any machining that may be required shall be performed in such a manner as to ensure that the quality of the surface is consistent with the conditions stipulated on the order or its appended documents.

3.2.3 - Fitting the spring

3.2.3.1 - Assembly of the leaves

Unless otherwise stipulated in the order or its appended documents, leaves of trapezoidal springs must be lubricated before assembly.

Before assembly, the leaves of parabolic springs must be given an anti-rust coating, as stipulated in point 2.2.4 - page 8.

When the assembly of leaves of non-parabolic springs requires, before fitting, a gap to be allowed between the surfaces of two consecutive leaves, the shape of each leaf must be such that the value of this gap between the various spring leaves, before clamping the leaves in the buckle:

- is maximum in the centre plane of the spring,
- is proportional to the length of the leaf,
- decreases regularly, from the centre plane to the ends, and from the first to the last leaf.

Gaps between parabolic spring leaves must comply with the stipulations of the order or its appended documents.

3.2.3.2 - Fitting the buckle

The buckle must be hot or cold assembled, depending on the stipulations contained in the drawings, and taking account of the tolerances allowed. The thickness of inserts must be determined in relation to the actual height of the stack of leaves where any proportional gap which may have been adopted during adjustment of the leaves, has been eliminated.

Hot assembly

The buckle must be heated in such a way as to permit positioning and clamping without causing abnormal stresses, folds in the metal, or distortion of the band when the buckle has one.

The clamping force shall first be applied to the lateral surfaces; whilst maintaining this force, sufficient pressure shall then be applied on the other two surfaces to ensure that the assembly is strongly pressed together. As a general rule, the force must not exceed 500 kN, and must be maintained on all four faces until the buckle is no longer red at any point.

After assembly in the buckle, the spring shall be placed on dry ground and sheltered from draughts, to allow normal cooling of the buckle. Cooling by spraying with or plunging into water shall be forbidden.

Once the spring has cooled to ambient temperature, no adjustment by displacement of the leaves shall be made.

Cold assembly

This operation must be carried out under progressively increasing force, so as to cause regular elongation of the vertical sides of the buckle.

No further adjustment by displacement of the leaves must be carried out subsequently. At the time when the key is securely welded on the buckle, precautions shall be taken to avoid damaging the leaves.

4 - Inspection

The materials for use in the manufacture of springs, and also the finished springs, shall be checked by the purchasing Railway's representative, both as regards the manufacturing process and the characteristics of the materials used.

4.1 - Inspection of the manufacturing process

It shall be possible for the purchasing Railway's representative to carry out all the checks required to ensure that the conditions specified in the order or its appended documents for the manufacture of the materials and springs are properly observed.

In particular, recording pyrometer charts shall be placed at his disposal to enable him to check the temperatures of heat treatment furnaces and also, if he so wishes, shot-peening efficiency and regularity, whenever this is specified.

4.2 - Quality control of the methods involved

Quality controls shall be carried out on the characteristics of all materials used for the manufacture of leaf springs. Steel bars shall be tested in accordance with the provisions of *UIC Leaflet 820*, and other miscellaneous parts, in accordance with the specific conditions stipulated in the relevant documents.

4.3 - Inspection of the characteristics of parts

4.3.1 - Submission

4.3.1.1 - Condition of parts on submission

Component parts and springs ordered with anti-corrosion protective coating shall be submitted to the purchasing Railway's representative before and after application of the coating.

4.3.1.2 - Batching

Parts shall be submitted in batches.

4.3.1.2.1 - Leaves

Each batch shall consist exclusively of leaves of identical type, shape and dimensions, manufactured from steel bars from the same cast and subjected to the same heat treatment.

4.3.1.2.2 - Other component parts

Each batch shall consist exclusively of identical parts subjected if at all to the same heat treatment.

4.3.1.2.3 - Springs

Each batch shall consist exclusively of springs of the same type.

4.3.1.3 - Advice of submission

The purchasing Railway's representative shall be advised of the date of submission in a written statement signed by the works manager or his authorised representative. Opposite the description of the material, this statement shall show the number of component parts or springs submitted in each batch, and the references of the corresponding order.

When the material is submitted for inspection, a certificate shall be supplied to the purchasing Railway's representative confirming that the manufacturing conditions specified have indeed been observed, and giving the findings from the tests that the manufacturer is required to carry out under his own responsibility

4.3.2 - Nature and extent of checks and tests

The purchasing Railway shall also reserve the right to dismantle some of the springs to detect any assembly defects, or any damage to leaves and buckles caused by the assembly process.

Table 2 :

Nature of checks and tests	Number of parts to be checked or tested for batches of:							
	1 to 25	26 to 50	51 to 90	91 to 150	151 to 280	281 to 500	501 to 1 200	1201 to 3 200
Category 1 springs								
Main leaf of trapezoidal and parabolic springs and first leaf of the secondary stage of parabolic springs								
Tensile test Resilience test Chemical analysis Checking decarburization Hardness A (see figures 1 - page 17, 2 and 3 - page 18 and point 4.3.4.2 - page 19)	1	1	1	1	1	1	2	3
Batch homogeneity - Hardness B (see figures 1, 2 and 3 and point 4.3.4.2)	See sampling schedule in Table 3 - page 15 for AQL = 0,4							
Main leaf of trapezoidal springs and all leaves of parabolic springs								
Magnetic crack detection test	If so stipulated in the order or its appended documents							
Leaves other than main leaves of trapezoidal and parabolic springs and than the first leaf of the secondary stage of parabolic springs								
Hardness B (see figures 1, 2 et 3 and point 4.3.4.2)	See sampling schedule in Table 3 for AQL = 1							
Leaves for which shot-peening is stipulated:								
Checking shot-peening efficiency	To be determined by the purchasing Railway, in agreement with the manufacturer, depending on the conditions under which shot-peening takes place							

Table 2 :

Nature of checks and tests	Number of parts to be checked or tested for batches of:							
	1 to 25	26 to 50	51 to 90	91 to 150	151 to 280	281 to 500	501 to 1 200	1201 to 3 200
Assembled springs:								
Bending strength under test load Deflection depth under load F1	100%							
Flexibility measurement	2	3	4	4	5	5	10	14
Leaf slippage test	At the discretion of the purchasing Railway's representative							
Category 2 springs								
Leaves								
Hardness B (see figures 1 - page 17, 2 and 3 - page 18 and point 4.3.4.2 - page 19)	See sampling schedule in Table 3 for AQL = 4							
Leaves for which shot-peening is stipulated:								
Checking shot-peening efficiency	To be determined by the purchasing Railway, in agreement with the manufacturer, depending on the conditions under which shot-peening takes place							
Assembled springs								
Bending strength under test load[a] Height check[b] Flexibility measurement	2	3	4	4	5	5	10	14
Buckles[c]								
Expanding test[d]	1	1	1	1	1	1	2	3
Hardness test	See sampling schedule in Table 3 for AQL = 4							
All parts								
Appearance and dimensions (in particular, shape of main leaf eye)[e]	At the discretion of the purchasing Railway's representative							

a. Before submission and under the manufacturer's responsibility, each part must have undergone this test satisfactorily.
b. If individual marking of the spring height is requested (see point 2.2.3), this should be an individual test.
c. Where welded buckles are concerned, specific tests may be stipulated to check welding soundness.
d. Subject to the purchasing Railway's approval, the bending test may replace the expanding test.
e. Before submission and under the manufacturer's responsibility, each part must have undergone these tests satisfactorily, if they are stipulated.

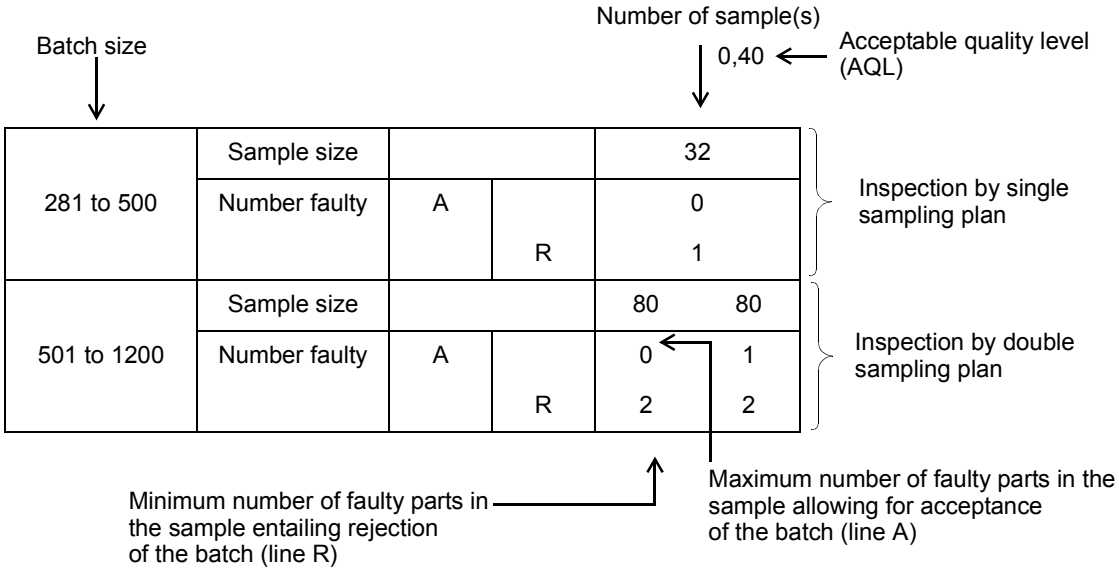
Table 3 :

Number of parts of the batch to be checked for acceptance				AQL					
				0,40		1		4	
1 to 25	Sample size			100%		13		3	
	Number faulty	A		0		0		0	
			R	1		1		1	
26 to 50	Sample size			100% or 32		13		8	8
	Number faulty	A		0		0		0	1
			R	1		1		2	2
51 to 90	Sample size			32		13		8	8
	Number faulty	A		0		0		0	1
			R	1		1		2	2
91 to 150	Sample size			32		13		13	13
	Number faulty	A		0		0		0	3
			R	1		1		2	4
151 to 280	Sample size			32		32	32	20	20
	Number faulty	A		0		0	1	1	4
			R	1		2	2	4	5
281 to 500	Sample size			32		32	32	32	32
	Number faulty	A		0		0	1	2	6
			R	1		2	2	5	7
501 to 1200	Sample size			80	80	50	50	50	50
	Number faulty	A		0	1	0	3	3	8
			R	2	2	3	4	7	9
1 201 to 3 200				80	80	80	80	80	80
		A		0	1	1	4	5	12
			R	2	2	4	5	9	13

Comments on the use of Table 3

Table 3 - page 15 has been compiled in accordance with the instructions of *ISO Standard 2859*, Part 0 to 4 "Sampling procedures for inspection by attributes".

A - Table layout



B - Example of use

1. Given a batch of 300 parts to be inspected with an AQL of 0,40. The batch comprises between 281 and 500 parts. Inspection is carried out according to the single sampling plan. The acceptance inspector takes a sample of 32 parts.

   On completion of this inspection, he counts the number of faulty parts:

   - 1st case: 0 faulty parts, the batch is accepted,
   - 2nd case: 1 or more faulty parts, the batch is rejected.

2. Given a batch of 508 parts to be inspected with an AQL of 0,40. The batch comprises between 201 and 1 200 parts. Inspection is carried out according to the double sampling plan. The acceptance inspector takes a sample of 80 parts

   On completion of this inspection, he counts the number of faulty parts:

   - 1st case: 0 faulty parts, the batch is accepted,
   - 2nd case: 2 or more faulty parts, the batch is rejected.
   - 3rd case: 1 faulty part. The acceptance inspector takes a further sample of 80 parts and checks them. He then counts the number of faulty parts from both sets of samples:

     - 1st case: 1 faulty part, the batch is accepted,
     - 2nd case: 2 or more faulty parts, the batch is rejected.

4.3.3 - Sampling and preparation of test pieces

4.3.3.1 - Sampling

The purchasing Railway's representative shall take random samples from each batch submitted for testing, and shall mark them in a permanent manner.

The samples and test pieces must retain the stamp of the purchasing Railway's representative.

4.3.3.2 - Preparation of test pieces

4.3.3.2.1 - Checking shot-peening efficiency

The test pieces and the material required for checking shot-peening efficiency must conform to the indications on the drawing. If the inspection conditions have not been clearly defined, the test pieces and material necessary for this inspection must conform to the indications in Appendix A - page 28.

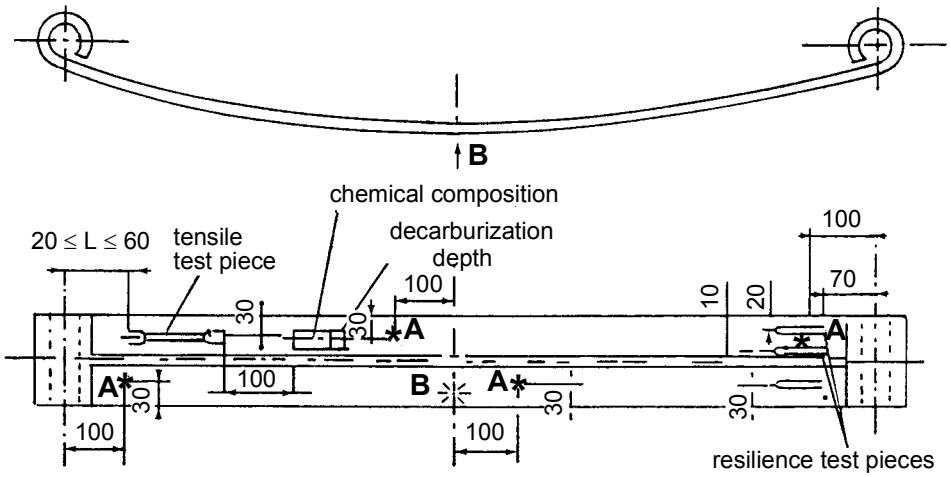
4.3.3.2.2 - Hardness test - Magnetic crack detection test - Appearance - Dimensional test - Expanding test - Test under test load and flexibility test

The test piece shall consist of the leaf, buckle or spring itself.

4.3.3.2.3 - Tensile test

The tensile test piece shall be taken at the place indicated on figure 1 for main leaves of trapezoidal springs, and on figures 2 and 3 - page 18 for main and secondary leaves of parabolic springs.

The test piece shall be prepared in accordance with the instructions in *ISO Standard 6892*. In the case of a test piece with a circular cross-section, the latter shall have a diameter of 10 mm or of nearly 10 mm if the leaf thickness makes it impossible to take a 10 mm-diameter test piece; the length between marker points shall be 5 d.



* places where hardness tests are to be performed

Fig. 1 - Main leaf of trapezoidal springs

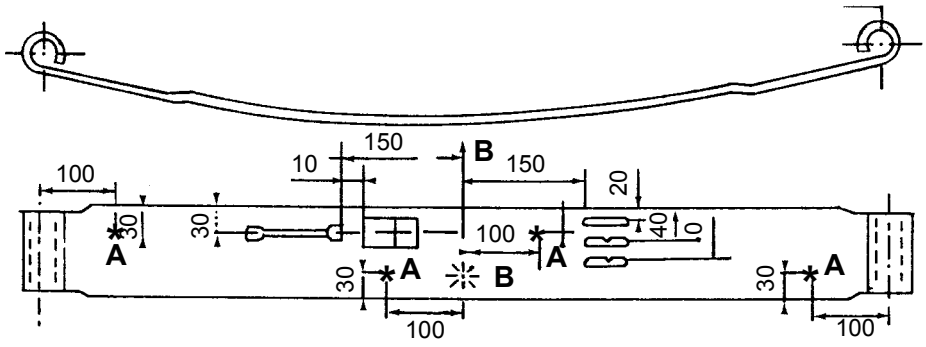
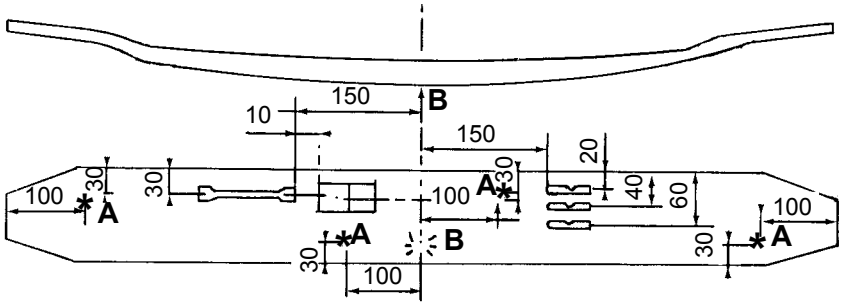


Fig. 2 - Main leaf of parabolic springs



* places where hardness tests are to be performed

Fig. 3 - Secondary leaf of parabolic springs

Other leaves

The hardness test stipulated shall be performed at point B corresponding to the spot marked on the above figures on the surface under compression, under normal conditions of use.

4.3.3.2.4 - U-notch resilience test

Three test pieces shall be taken at the spots indicated on Figures 1 - page 17, 2 and 3.

The test pieces shall be prepared in accordance with the indications of *ISO Standard 83*. The centreline of the cylinder forming the bottom of the U-notch shall be perpendicular to the leaf surfaces. Test pieces shall be taken as near as possible to the surface under stress, under normal conditions of use.

4.3.3.2.5 - Checking chemical composition

A test piece of at least 50 g shall be removed at a point situated at a quarter of the leaf width.

4.3.3.2.6 - Checking decarburization depth

A test piece measuring 20 x 20 mm x e (leaf thickness) shall be taken at the place indicated on Figures 1, 2 and 3. The surface perpendicular to the longitudinal centreline of the leaf shall be polished and then etched using a nital solution (2 to 4% of nitric acid in alcohol) for micrographic examination.

4.3.3.2.7 - Buckle bending test

The test shall be carried out on a test piece taken lengthwise along the centreline of one of the buckle surfaces. Unless otherwise stipulated in the order or its appended documents, the test piece shall be of the same thickness as that of the buckle surface. In the case of buckles obtained by welding, the test piece shall, whenever possible, be taken and machined in such a way that its centre part contains the line of welding perpendicular to its longest centre-line.

The test piece shall be prepared in accordance with the provisions of *ISO Standard 7438*.

4.3.4 - Organisation of checks and tests

4.3.4.1 - Checking shot-peening efficiency

Unless otherwise stipulated in the order or its appended documents, the check shall be carried out in accordance with the indications contained in Appendix A - page 28.

4.3.4.2 - Hardness test

The hardness test must be carried out in accordance with the indications contained in *ISO Standard 6506*.

4.3.4.2.1 - Leaves

The hardness test shall be carried out on leaves in accordance with the indications in Figures 1 - page 17, 2 and 3 - page 18 and the extent of checks and tests given in point 4.3.2 - page 13.

For checking the heat treatment homogeneity of leaves (Hardness A), the test shall be performed at 4 points on the surface under stress.

For checking the heat treatment homogeneity of the batch (Hardness B), the test shall be carried out at 1 point on the surface in compression.

4.3.4.2.2 - Buckles

The hardness test on buckles shall be performed on a slightly ground surface.

4.3.4.3 - Tensile test

The tensile test shall be carried out in accordance with the indications contained in *ISO Standard 6892*.

4.3.4.4 - U-notch resilience test

The resilience test shall be carried out in accordance with the indications contained in *ISO Standard 83*.

4.3.4.5 - Checking chemical composition

The chemical composition shall be checked in accordance with the methods defined by the corresponding ISO Recommendations or Standards or, except in the case of a dispute, with any other method approved by the purchasing Railway.

4.3.4.6 - Checking decarburization depth

The texture shall be examined when magnified to the power of 100.

4.3.4.7 - Magnetic crack detection test

Magnetic crack testing of leaves for Category 1 springs shall be carried out under the conditions defined in Appendix B - page 31.

4.3.4.8 - Checking appearance and dimensions

This shall be carried out by any appropriate means provided by the manufacturer and previously approved by the purchasing Railway.

4.3.4.9 - Checking the shape of the eye

The shape of the eye shall be checked using a gauge (C) approved by the purchasing Railway. This gauge shall be placed, as indicated in Figure 4, successively along the 4 generating lines located 5 mm from the edge of the leaf at each extremity.

The gap between gauge and leaf must be less than 0,6 mm over the length indicated on Figure 5 - page 21.

Unless otherwise specified in the order or its appended documents, the clearance (j) must be 6 ± 2 mm.

Different criteria may be imposed when the main leaf is connected to the underframe by a specially designed link.

4.3.4.10 - Buckle bending test

The buckle bending test shall be carried out in accordance with the indications given in *ISO Standard 7438*. It shall be conducted in such a manner that the forging skin forms the outside surface of the bend and, if possible, when the buckle is welded, in such a manner that bending occurs in the welded zone.

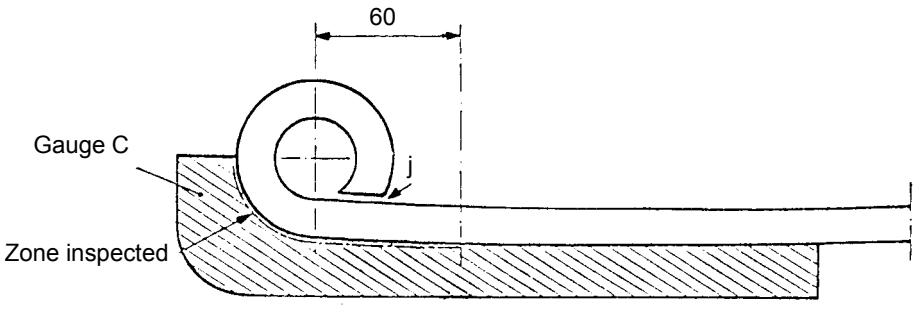


Fig. 4 -

4.3.4.11 - Buckle expanding test

The buckle shall rest by its edges on supports that do not obstruct in any way the central opening where the leaves are held.

An expander with a 9° maximum phase angle shall be inserted in this opening, and sufficient pressure applied to drive it right through, at a speed of 2 mm/s, and cause a gradual increase, in the interior height h, of:

- 20% for buckles made from Fe 360 C steel,
- 13% for buckles made from Fe 510 C steel.

The thinning of the buckle side-walls must be regular.

4.3.4.12 - Deflection test under test load

The spring shall be placed under the test apparatus in accordance with conditions indicated in Figure 5.

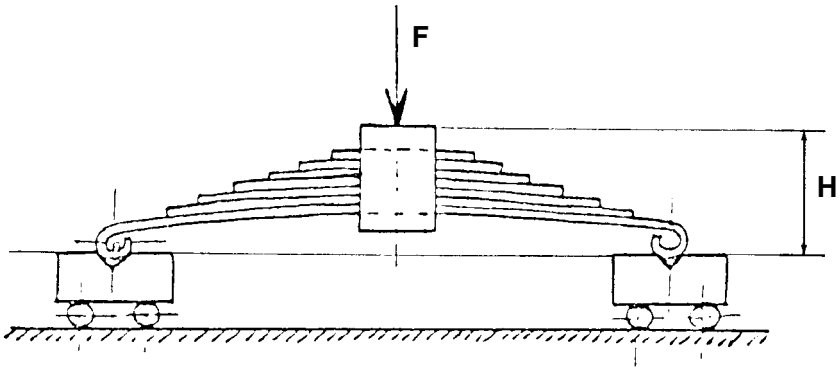


Fig. 5 -

Its two ends shall rest on rolling supports which enable it freely to undergo the deflection caused by the test load.

The following loads shall be exerted:

(See Figure 6 - page 22 for constant flexibility springs and Figure 7 - page 23 for progressive flexibility springs).

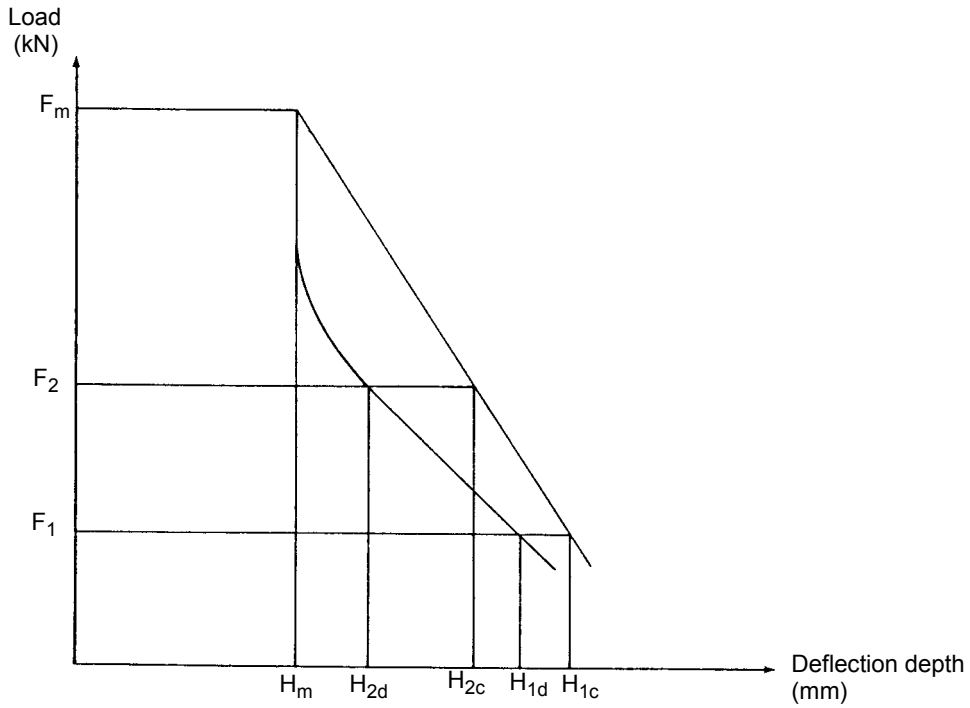


Fig. 6 -

a) Loading of the spring to maximum load F_m indicated in the drawing

b) Release to 0

c) Loading of the spring to F_m

d) Release to F_1 and recording the deflection obtained H_{1d}

e) Loading of the spring to F_m

f) Release to F_1 and recording the deflection obtained H_{1d}

g) Release to 0

The load F_1 shall be indicated in the drawing; otherwise, a value of 20 kN shall be taken.

4.3.4.13 - Measurement of the flexibility of constant flexibility springs

After the deflection test under test load, the spring remaining under the test conditions indicated in Figure 5 - page 21, the flexibility shall be determined by exerting the following loads (see Figure 6).

a) Loading of the spring to F_1 and recording the deflection obtained H_{1c}

b) Increasing loading from F_1 to F_2 and recording the deflection obtained H_{2c}

c) Increasing loading from F_2 to F_m

d) Decreasing loading from F_m to F_2 and recording the deflection obtained H_{2d}

e) Decreasing loading from F_2 to F_1 and recording the deflection obtained H_{1d}

f) Release of the spring

The flexibility Ca shall be equal to:

$$Ca\ (mm/kN) = \frac{(H_{1c} + H_{1d}) - (H_{2c} + H_{2d})}{2(F_2 - F_1)}$$

The load F_2 shall be indicated in the drawing; otherwise, a value of 90 kN shall be taken.

When so specified in the order, the inner friction $\frac{H_{2c} - H_{2d}}{H_{2c} + H_{2d}}$ shall be recorded.

4.3.4.14 - Measurement of the flexibility of progressive flexibility springs

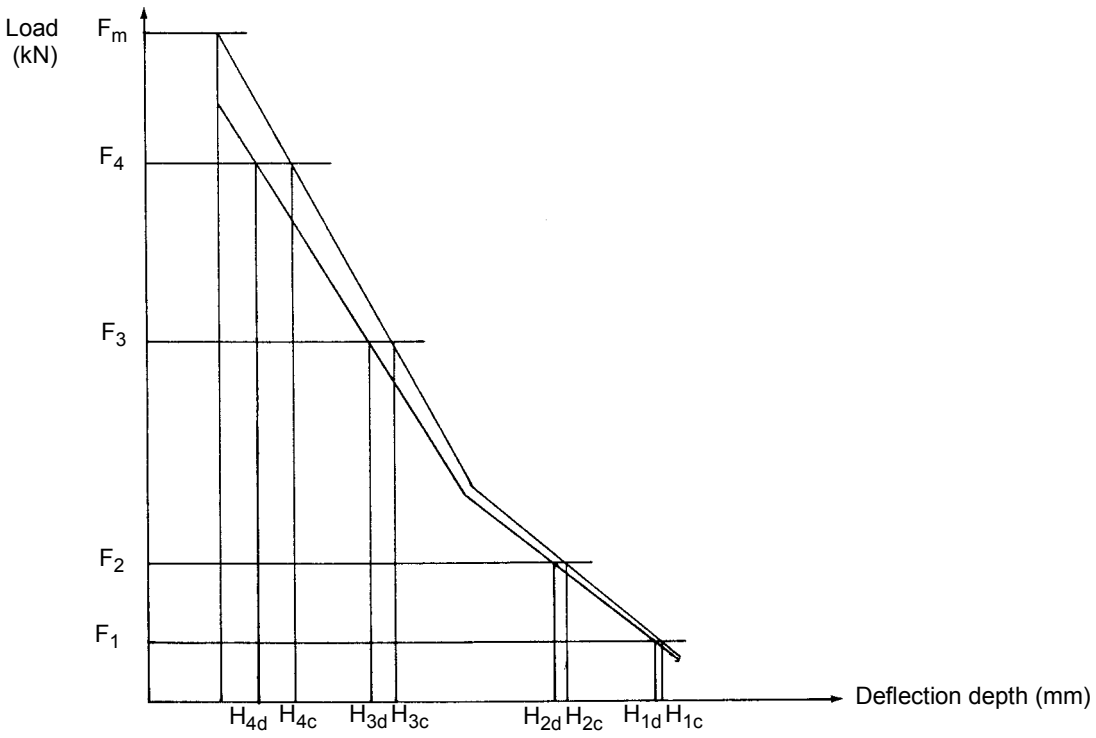


Fig. 7 -

After the deflection test under test load, the spring shall remain in the test conditions indicated in Figure 5 - page 21 and the flexibility shall be determined by exerting the following loads (see Figure 7).

a) Loading of the spring to F_1 and recording the deflection depth H_{1c}

b) Increasing loading from F_1 to F_2 and recording the deflection depth H_{2c}

c) Increasing loading from F_2 to F_3 and recording the deflection depth H_{3c}

d) Increasing loading from F_3 to F_4 and recording the deflection depth H_{4c}

e) Increasing loading from F_4 to F_m

f) Decreasing loading from F_m to F_4 and recording the deflection depth H_{4d}

g) Decreasing loading from F_4 to F_3 and recording the deflection depth H_{3d}

h) Decreasing loading from F_3 to F_2 and recording the deflection depth H_{2d}

i) Decreasing loading from F_2 to F_1 and recording the deflection depth H_{1d}

j) Release of the spring

The flexibility Ca_1 shall be equal to:

$$Ca_1 \text{ (mm/kN)} = \frac{(H_{1c} + H_{1d}) - (H_{2c} + H_{2d})}{2(F_2 - F_1)}$$

The flexibility Ca_2 shall be equal to:

$$Ca_2 \text{ (mm/kN)} = \frac{(H_{3c} + H_{3d}) - (H_{4c} + H_{4d})}{2(F_4 - F_3)}$$

Loads F_1, F_2, F_3 and F_4 shall be indicated in the drawing. When this is not the case, the following values shall be applied: F_1 = 10 kN, F_2 = 30 kN, F_3 = 80 kN, F_4 = 120 kN.

When so specified in the order, the inner friction $\frac{H_{2c} - H_{2d}}{H_{2c} + H_{2d}}$ shall be recorded.

4.3.4.15 - Test for checking the resistance of spring leaves to slippage

This test shall be carried out using apparatus officially approved by the purchasing Railway beforehand.

4.3.4.15.1 - The test for checking the resistance of spring leaves to slippage shall be performed, at the time of official approval, as follows:

The spring(s) selected for checking the mechanical characteristics shall be sawn throughout its/their thickness at a distance of 30 mm on either side of the buckle.

A compressive load shall be exerted at End A of the main leaf section, as shown in Figure 8.

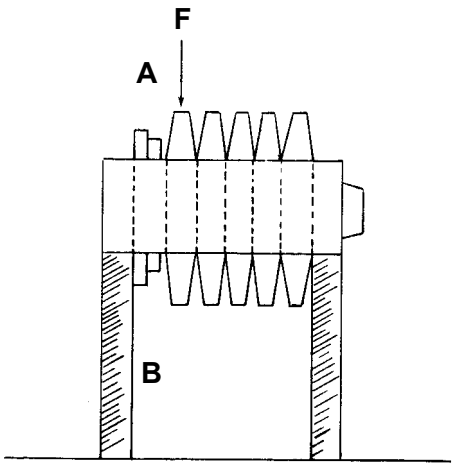


Fig. 8 -

The "load/spring leaf slippage" curve shall be recorded. The spring leaf slippage corresponds to the slope changeover point of this curve.

The test piece shall be turned upside-down and the load shall be exerted at End B of the main leaf section.

The leaf slippage loads recorded during both tests must exceed or equal the values stipulated in point 2.2.2.3 - page 7.

After being approved by the purchasing Railway, at the time when acceptance tests are carried out, the method stipulated in point 4.3.4.15.2 can be used. Should a conflict arise, however, the findings from the test defined above shall, alone, prevail.

4.3.4.15.2 - The test shall be performed before welding the insert on to the buckle. Load F shall be exerted on the upper insert on the thinnest side in order to ensure movement away from the buckle, care being taken to push neither on the buckle nor on the lower insert.

Load F is provided by a jack fitted with an insert of the same cross section as the end of the upper insert.

The oil circuit shall involve a pressure gauge for calculating the value of Load F.

A dial gauge forming an integral part of the buckle shall measure any insert slippage.

The test shall be stopped when the value of the load equals that stipulated in point 2.2.2.3.

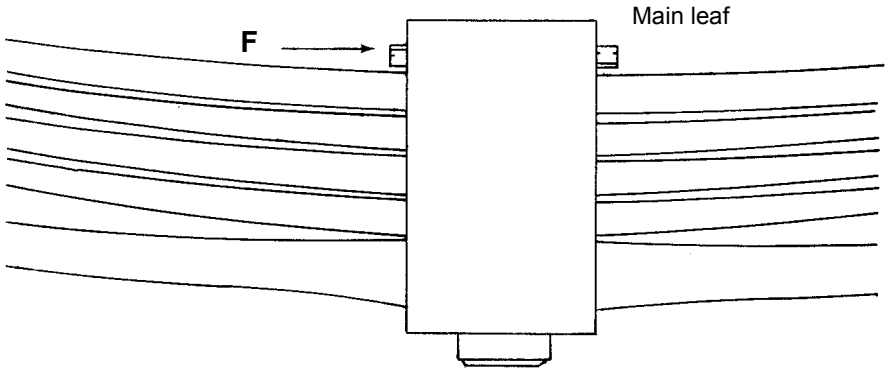


Fig. 9 -

4.3.4.16 - Determination of the deflection depth under Load F_1

The deflection depth under Load F_1 marked on the spring shall be determined as follows:

$$H_1 = \frac{H_{1c} + H_{1d}}{2}$$

4.4 - Conclusion of the checks and tests

Any defect in appearance or dimension shall entail rejection of the particular part concerned.

Any physical or mechanical characteristic which does not meet the conditions laid down shall entail rejection of the batch concerned.

Further tests or checks, with or without treatment to reduce defects, may only be carried out at the manufacturer's request if the purchasing Railway is in agreement.

5 - Guarantee

The springs shall be guaranteed for a period of one year against any defect ascribable to manufacture. This period shall run from the end of the year of manufacture.

If the springs are to be fitted to new stock, the delivery date of the vehicles to which they are fitted shall be regarded as the date of commencement of the guarantee period, provided however such springs are used within a period not exceeding two years.

Springs which, during the guarantee period, show defects making them either unfit for service or reducing their period of service shall be rejected.

Before being finally rejected, defective springs may however be subjected to a counter inspection carried out jointly by the purchasing Railway and the manufacturer, at the latter's request.

If the counter inspection confirms that the defects are indeed ascribable to manufacture, the defective springs shall finally be rejected.

Should the findings from the counter inspection fail to produce agreement between the purchasing Railway and the manufacturer, experts approved by both parties shall be called in to settle the dispute. The costs shall then be borne by the party found to be responsible.

If more than 5% of springs from the same delivery show defects leading to rejection, the purchasing Railway may reject the entire delivery.

Rejected springs shall be made available to the manufacturer with a view to their replacement, or reimbursement at their value in new condition at the time of withdrawal.

Appendix A - Checking shot-peening efficiency by the ALMEN method

A.1 - Purpose and scope

The ALMEN method described below is applied when the order or its appended documents require shot-peening of the leaves without specifying the methods of checking its efficiency.

A.2 - Principle of the method

If a steel strip held in a holder is shot peened on one of its surfaces only, this strip will be curved when removed from the holder, the convex surface being the shot-peened side. The magnitude of the deflection depends on the effective intensity of shot blasting.

The test piece held in this way is exposed to the same shot-peening cycle as the leaves observing the following parameters:

- speed of movement of the leaves in the shot-peening machine,
- velocity of shot blasting,
- nature and dimensions of the shot.

A.3 - Equipment and installations

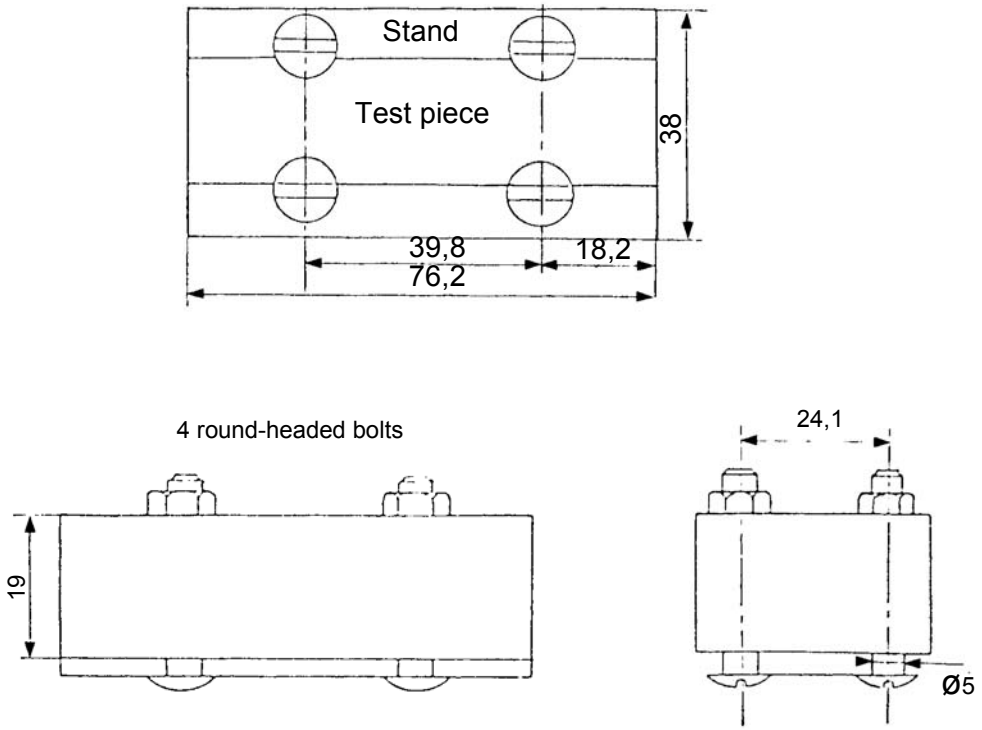
A.3.1 - ALMEN A2 test piece

(applicable for arc heights of less than 0,609 mm).

Characteristics			
Steel:	cold rolled with the following chemical composition:		
	$0,65 < C \leq 0,73$	$0,40 \leq Mn \leq 0,70$	
	$0,15 < Si \leq 0,35$	$P \leq 0,035$	$S \leq 0,035$
Hardness:	44 - 50 HR_c		
Length:	76,2 mm $\pm$ 0,4		
Width:	19 $mm^{+0,05}_{-0,10}$		
Thickness:	1, 30 $mm^{+0,02}_{-0,03}$		
Flatness:	Surface between 2 parallel planes 0,04 mm apart.		

A.3.2 - Test piece holder

The standardised test piece holder is shown in the following drawing:

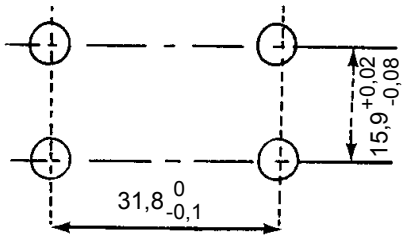


Steel hardness of the steel strip holder: 62 - 65 HR_C.

This test piece holder is fixed to a suitable assembly so that the test piece is exposed to shot peening under the same conditions as the leaves.

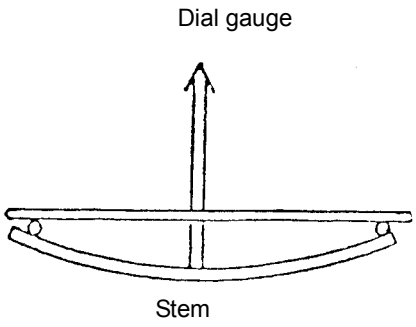
A.3.3 - ALMEN indicator

The indicator is used to determine the curvature of the test piece. It consists of a dial gauge (graduated in 1/100 mm) mounted on a plate with four hardened steel balls forming the corners of a rectangle (see drawing below) and situated in the same plane to ± 0,05 mm. The dial gauge stem is perpendicular to the centre of this rectangle.



The movement of the stem makes a measurement which depends on the transverse and longitudinal curvature of the test piece.

The measurement of deflection is made on the smooth concave side to eliminate any variation due to roughness of the shot peened surface.



Appendix B - Inspection of leaves by the magnetic crack detection method

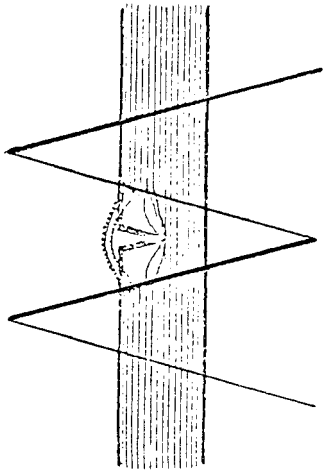
B.1 - Purpose

Inspection by the magnetic crack detection method as defined in this leaflet is intended to detect superficial defects that may impair the performance of the springs in use.

B.2 - Detection method

B.2.1 - Principle

A longitudinal magnetic induction is created in the leaves by placing them in the magnetic field obtained inside a solenoid through which alternating current flows.



"Leakage fields" created at the level of gaps are characterised by heaps of magnetic powder - SPECTRA - spread over the surfaces to be examined by means of a liquid moistening agent (magnetic solution).

The tangential magnetic induction, measured with a HALL probe, shall at least be 4 mT at any point of the surfaces to be examined.

This fine-grained magnetic powder is fluorescent, thereby providing sufficient contrast for the defects to be identified under ultra-violet lighting, so that lighting exceeds 1 500 $\mu W/cm^2$ at a distance of 40 cm from the light source.

B.2.2 - Operating procedure

Preparation

Inspection by magnetic crack detection shall take place after shot-peening of leaves. The surface under compression must have the same appearance as the shot-peened surface so that defects can easily be identified.

These leaves must be absolutely clean (free from scale, paint, grease or other impurities). Their surfaces must not show any unevenness (rough spots, holes) likely to affect the distribution of the powder.

Inspection

Magnetisation can be obtained:

- either by a rigid solenoid surrounding the entire spring leaf (Figure 1),
- or by rigid coils moving from one end to the other end of the leaf (Figure 2).

Inspections should be carried out by suitably qualified staff using equipment approved by the purchasing Railway's representative.

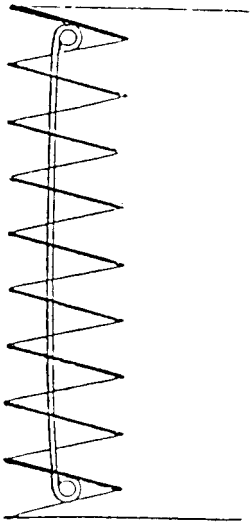


Fig. 1 -

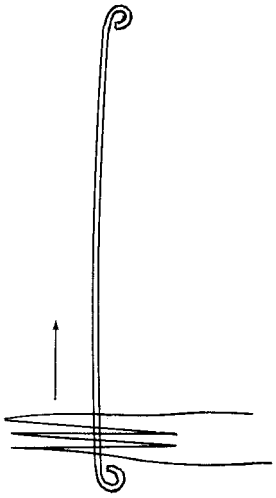


Fig. 2 -

Demagnetisation

Considerable residual magnetism may persist after magnetisation. The leaf must consequently be demagnetised after inspection.

Performance check

In addition to permanent monitoring of the magnetising intensity, the magnetic solution must be checked regularly (at least before each working session) using a magnetic crack detection reference sample or a calibration leaf approved by the purchasing Railway.

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Warning

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