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Springs—Shot peening

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Foreword

This translation has been made based on the original Japanese Industrial Standard revised by the Minister of Economy, Trade and Industry through deliberations at the Japanese Industrial Standards Committee as the result of proposal for revision of Japanese Industrial Standard submitted by Japan Spring Manufacturers Association (JSMA)/Japanese Standards Association (JSA) with the draft being attached, based on the provision of Article 12 Clause 1 of the Industrial Standardization Law applicable to the case of revision by the provision of Article 14.

Consequently, **JIS B 2711:2005** is replaced with this Standard.

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Springs—Shot peening

Introduction

This Japanese Industrial Standard has been prepared based on the first edition of **ISO 26910-1** published in 2009 with some modifications of the technical contents in order to harmonize with the actual situation in Japan.

The portions given sidelines or dotted underlines are the matters in which the contents of the corresponding International Standard have been modified. A list of modifications with the explanations is given in Annex JC.

1 Scope

This Standard specifies the shot peening applied to springs in order to improve their resistance force to fatigue, stress corrosion cracking, delayed fracture, etc. mainly by introducing compressive residual stresses into their surface.

NOTE : The International Standard corresponding to this Standard and the symbol of degree of correspondence are as follows.

ISO 26910-1:2009 *Springs—Shot peening—Part 1: General procedures* (MOD)

In addition, symbols which denote the degree of correspondence in the contents between the relevant International Standard and **JIS** are IDT (identical), MOD (modified), and NEQ (not equivalent) according to **ISO/IEC Guide 21-1**.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this Standard. The most recent editions of the standards (including amendments) indicated below shall be applied.

JIS B 0021 *Geometrical product specifications (GPS)—Geometrical tolerancing—Tolerancing of form, orientation, location and run-out*

JIS B 0103 *Springs—Vocabulary*

JIS G 0202 *Glossary of terms used in iron and steel (Testing)*

JIS G 5121 *Corrosion-resistant cast steels for general applications*

JIS G 5904 *Testing method of cast shot and grit grain size*

JIS Z 0311 *Metallic blast-cleaning abrasives*

JIS Z 2244 *Vickers hardness test—Test method*

JIS Z 2245 *Rockwell hardness test—Test method*

JIS Z 8401 *Guide to the rounding of numbers*

NOTE : Corresponding International Standard: ISO 31-0 *Quantities and units—Part 0: General principles* (MOD)

JIS Z 8801-1 *Test sieves—Part 1: Test sieves of metal wire cloth*

3 Terms and definitions

For the purposes of this Standard, the terms and definitions given in JIS B 0103 and the following apply.

3.1 shot peening

cold work applied to the surface of a spring, to improve its fatigue strength and stress corrosion cracking resistance, by a stream of near-spherical hard particles at a high velocity that generates compressive residual stresses and work hardening in the surface layer

3.2 peening media

generally spherical or near-spherical hard particles, made of metals, glasses or ceramics, used for shot peening

3.3 Almen strip

rectangular metal strip used for evaluating the peening intensity by the magnitude of its bending deformation after shot peening on one surface

3.4 Almen arc height

magnitude of its bending deformation (height of the arched deformation) of an Almen strip measured on the basis of a fixed span after shot peening

NOTE : It is expressed in millimetres.

3.5 saturation time

minimum time for which the successive increase of Almen arc height is not more than 10 % for an additional exposure equal to t (minimum time for t where increase in $2 t$ is not more than 10 %)

3.6 peening intensity

intensity expressed in the kinetic energy of peening media acting on the unit surface area of the spring per unit time, and is practically evaluated by the Almen arc height for the saturation time

3.7 saturation curve

trend curve representing the change of Almen arc height with time until the Almen arc height saturates

3.8 coverage

area ratio of the dents formed by peening media impacts to the total area of the measuring surface

3.9 residual stress

internal stress of a spring remaining after the removal of external forces and heat applied on it

3.10 particle size distribution

size distribution of peening media

3.11 ordinary peening

shot peening using one type of peening media larger than 0.2 mm in nominal diameter

3.12 multi-stage peening

shot peening consisting of a series of peening at different conditions

NOTE 1 The name indicates the number of peening conditions combined, for example, “two-stage peening”.

NOTE 2 Two-stage peening is the one most practised. It usually consists of a first stage at an intensive peening condition with larger shot media at higher speeds, and a second stage at moderate or weak peening condition. The first peening stage generates higher compressive residual stresses deep under the surface of a spring. The second peening stage generates shallower residual compressive stresses. The sum of the two compressive stresses would give a good distribution pattern of compressive stresses from the surface to the required depth.

3.13 stress peening

shot peening applied under a static force corresponding to the working force of the spring during use

NOTE : Stress peening ensures that a spring will keep its intended compressive residual stresses under the applied tensile stresses at its working state. This is one of the frequently used techniques for laminated leaf springs, for example.

3.14 hot peening

shot peening applied at elevated temperatures from 150 °C to 350 °C for steel springs

NOTE : Hot peening is based on the ageing effect of steels. It is generally advantageous for achieving enhanced compressive residual stresses especially in hard steel springs.

3.15 fine peening

shot peening using peening media not exceeding 0.2 mm in nominal diameter

3.16 X-ray stress measurement

method for measuring internal stresses near the surface of polycrystalline springs based on X-ray diffraction techniques

3.17 angle of incidence, ψ

angle where the normal of diffraction atomic plane forms with the normal of measuring plane at the measurement point

3.18 diffraction angle, 2θ

angle where the direction of incident X-ray forms with the direction of diffraction X-ray

NOTE : Since the diffraction X-rays of practical metallic materials are diffracted in the shape of circular-cone whose axis is the axis of incident X-ray.

3.19 peak position, $2\theta_p$

diffraction angle which represents points of the maximum intensity of diffraction X-rays as it reflects the sample characteristics

3.20 intensity distribution curve

curve which indicates the intensity change of diffraction X-rays with respect to diffraction angle

3.21 half value breadth

width of diffraction angle with respect to the intensity of half the difference between the maximum value and the background in an intensity distribution curve (see figure JB.3)

3.22 ψ_0 fixed method

method for preparing the intensity distribution curve with the axis of incident X-ray fixed

NOTE : It is also called a θ fixed method in which the intensity distribution curve is prepared with the apparatus equipped with a film method and a one-dimensional or two-dimensional X-ray detector.

3.23 ψ fixed method

method for preparing a diffraction intensity curve by scanning the incident X-ray and the detector in the reverse direction to each other at an equiangular velocity under the condition where the bisector of an angle which the incident X-ray forms with the detector is fixed

NOTE : It is the method in which preparation can be performed only with the apparatus equipped with a special detector, and cannot be performed with the apparatus equipped with a film method and a one-dimensional or two-dimensional X-ray detector.

4 Operation method of shot peening

4.1 General

The mode, condition, category of peening machine, protection of non-peening surface, and pre-peening treatment and post-peening treatment shall be determined based on past experience and anticipated results.

4.2 Modes of shot peening

The modes of shot peening shall be as the following.

- a) Ordinary peening
- b) Multi-stage peening
- c) Stress peening
- d) Hot peening
- e) Fine peening

4.3 Conditions of shot peening

The conditions of shot peening shall be determined according to the following items.

- a) Type of peening media
- b) Class of Almen strip and desired Almen arc height (h)
- c) Coverage indicating location and area of measurement
- d) Period of shot peening [when the saturation time t is designated instead of the Almen arc height (h) upon the agreement between the purchaser and the supplier]

For multi-stage peening, the conditions of shot peening shall be designated for individual stages.

NOTE : Mechanical properties of peened material are not always directly proportional to the Almen arc height, since the effect would be variable depending on the size and shape of peening media and the hardness of material treated.

4.4 Category of shot peening machine

There are two main categories, centrifugal and air-blasting, according to the projection method of machines. The former is suitable for projecting larger amounts of peening media on wider areas treating several springs together, and the latter for smaller amounts, but at higher intensities on more focused areas.

The machine category shall be selected considering the design concepts of springs. Other specific details of the machine should be clarified, if necessary.

4.5 Protection of non-peening surface

Areas that do not require shot peening shall be clearly defined. Selected areas where the peening must not affect the springs surface shall be protected as required by appropriate means, such as masks, adhesive tapes, etc.

4.6 Pre-peening treatment and post-peening treatment

Conditions for pre-peening treatment and post-peening treatment are indicated as the following examples.

- a) **Pre-peening treatment** e.g., cleaning and degreasing
- b) **Post-peening treatment** e.g., rust protection, coating and wrapping

Care should be taken to prevent rusting, as it is generally easy for shot peened materials to start rusting.

5 Peening media

The classification of peening media shall be as given in table 1. The details thereof shall be according to Annex JA.

Table 1 Types and properties of peening media

Type name	Code	Material	Density ^{a)} g/cm ³	General shape	Nominal diameter mm	Hardness ^{b)} HV
Cast steel shot	SS	Cast steel	7.45 min.	Sphere	4 max.	200 to 850
Cut wire shot	CW	Steel	7.65 to 7.95	Cylinder	0.2 to 3	350 to 750
Conditioned cut wire shot	CCW	Steel	7.65 to 7.95	Rounded-corner cylinder	0.2 to 3	350 to 850
Glass beads	GB	Glass	2.30 min.	Sphere	1 max.	—
Ceramic beads	CB	Ceramic	3.60 to 3.95	Sphere	1 max.	500 to 800
Notes ^{a)} The density test of cut wire shot and conditioned cut wire shot shall be upon the agreement between the purchaser and the supplier.						
^{b)} According to JIS Z 2244 .						

6 Almen strip

An Almen strip shall be as follows.

- a) **Class of Almen strip** Almen strips shall be classified into three classes as given in table 2 whose shape and size shall be as given in figure 1.

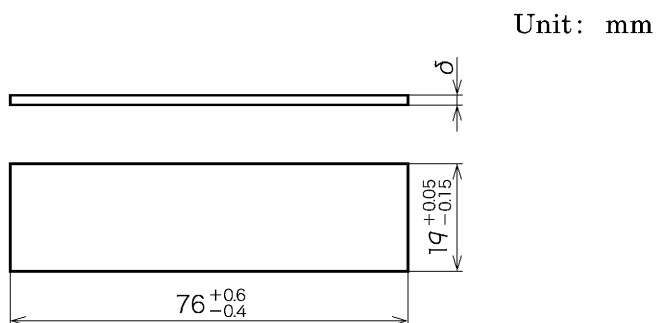


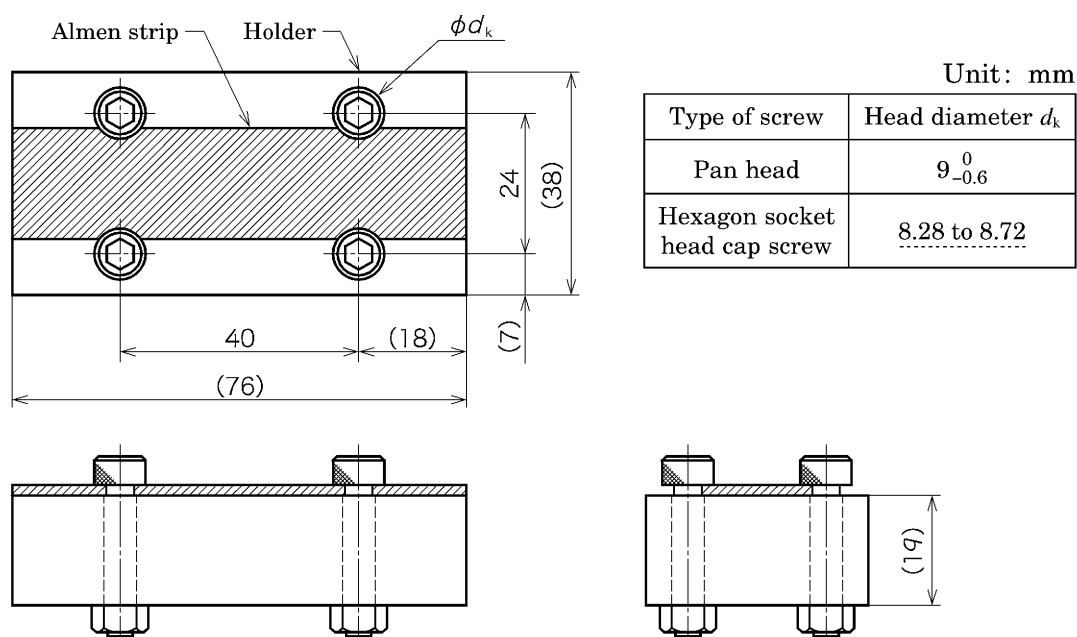
Figure 1 Shape and dimensions of Almen strip

Table 2 Class of Almen strip

Name	Nominal dimension mm	Thickness (δ) mm	Hardness ^{a) b)}	Flatness tolerance ^{c)} mm	Material
Strip N	0.8	0.76 to 0.81	72.5 HRA to 76 HRA	0.025	Carbon steel with 0.60 % to 0.90 % of carbon
Strip A	1.3	1.27 to 1.32	44 HRC to 50 HRC	0.025	
Strip C	2.4	2.36 to 2.41	44 HRC to 50 HRC	0.038	
Notes a) According to JIS G 0202 . b) According to JIS Z 2245 . c) According to JIS B 0021 .					

- b) **Application range according to class** An Almen strip of appropriate class shall be selected according to the intensity of shot peening. Strip A is for general use, and strip N is for lower range and strip C is for higher range, respectively. Almen strips should be used for Almen arc heights not greater than 0.6 mm.
- c) **Almen strip holder** An Almen strip shall be fixed on a steel holder as given in figure 2 to keep it flat in contact with the surface till the completion of peening.

The holder shall have a flat mounting surface with fastening screws to fix the Almen strip. Care should be taken so that the screw heads do not affect Almen arc height. The hardness of the holder should be at least 57 HRC to avoid early wear.



NOTE : Values in parentheses are for information only.

Figure 2 Shape and dimensions of Almen strip holder

7 Measurement of Almen arc height

Almen arc height shall be obtained as the height from the reference plane at the midpoint e with respect to the points on the same reference a, b, c, d as shown in figure 3 for the theoretical plane (reference plane) where shot peening is not performed of the shot-peened Almen strip. The numerical value of arc height shall be obtained to the nearest 0.01 mm with an Almen gauge (see Annex C).

Almen arc height are expressed with the class of test strip appended as in the following examples.

Example 1 0.35 mm A: Almen arc height of 0.35 mm by Almen strip A

Example 2 0.20 mm C: Almen arc height of 0.20 mm by Almen strip C

Unit: mm

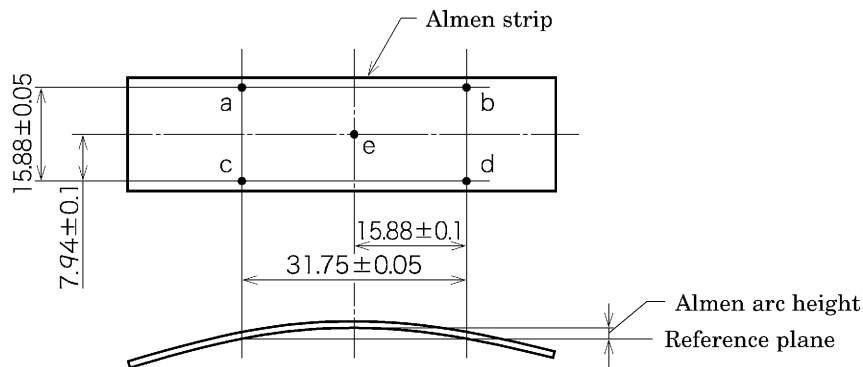


Figure 3 Definition of arc height

8 Evaluation of coverage

Coverage shall be evaluated on a surface of designated position of the product after treatment. The numerical value shall be rounded to the nearest 5 % step according to **JIS Z 8401**.

Coverage may be determined by comparing the peened surface with the standard photographs according to Annex A.

A supplemental Almen strip or coupon may be used to evaluate the coverage upon agreement between the purchaser and the supplier. It should have an equivalent hardness to the spring and be fixed on a holder similar to the test strip holder. Its surface is preferably polished with a buff for easy observation of dents by peening media.

When the length of time taken to reach 100 % coverage is regarded as a unit, the treatment time would then be expressed as 200 % coverage time for twice the unit time, and 300 % coverage time for three times the unit time, for example.

9 Shot peening machine

The shot-peening machine should be such that the incident angle of peening media to the surface of spring to be treated can be made at right angles and the projection can be performed uniformly and continuously at constant speed.

The shot-peening machine shall have the following functions.

- Regulation of the flow rate of peening media by means of orifice or gate valve
- Adjustment of the projection speed according to the variation of rotational speed of blade in the case of centrifugal machines
- Adjustment of the projection speed according to variation of the air pressure and/or the flow rate, in the case of air blasting machines

NOTE : See 4.4 for details of the shot peening machine.

10 Control of shot peening

The control of shot peening shall be carried out by the confirmation of the following items.