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(JRMA/JSA)

**Elastomeric seismic-protection
isolators for buildings—
Part 1: Specifications**

ICS 83.140.99;91.120.25

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Foreword

This translation has been made based on the original Japanese Industrial Standard established by the Minister of Economy, Trade and Industry through deliberations at the Japanese Industrial Standards Committee according to the proposal for establishment of Japanese Industrial Standard submitted by The Japan Rubber Manufacturers Association (JRMA)/Japanese Standards Association (JSA) with the draft being attached, based on the provision of Article 12 Clause 1 of the Industrial Standardization Law.

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JIS K 6410 series consists of the following 2 parts under the general title “*Elastomeric seismic-protection isolators for buildings*”:

Part 1: Specifications

Part 2: Test methods

Elastomeric seismic-protection isolators for buildings—Part 1: Specifications

Introduction

This Japanese Industrial Standard has been prepared based on the second edition of **ISO 22762-3** published in 2010 with some modifications of the technical contents.

The portions given continuous 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 JE.

1 Scope

This Standard specifies the elastomeric seismic isolators used to provide buildings with protection from earthquake damage.

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

ISO 22762-3:2010 *Elastomeric seismic-protection isolators—Part 3: Applications for buildings—Specifications* (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**.

Warning: Persons using this Standard should be familiar with normal procedures related to testing of elastomeric isolators and rubber materials. This Standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user to establish appropriate safety and health practices.

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 0417 *Permissible deviation in dimensions without tolerance indication for gas cut steel plates*

JIS G 3101 *Rolled steels for general structure*

JIS G 3106 *Rolled steels for welded structure*

NOTE : Corresponding International Standard: ISO 630 *Structural steels—Plates, wide flats, bars, sections and profiles* (MOD)

JIS G 3136 *Rolled steels for building structure*

JIS H 2105 *Pig lead*

JIS K 6410-2 *Elastomeric seismic-protection isolators for buildings—Part 2: Test methods*

NOTE : Corresponding International Standard: ISO 22762-1 *Elastomeric seismic-protection isolators—Part 1: Test Methods* (MOD)

JIS Z 9015-0 *Sampling procedures for inspection by attributes—Part 0: Introduction to the JIS Z 9015 attribute sampling system*

JIS Z 9015-1 *Sampling procedures for inspection by attributes—Part 1: Sampling schemes indexed by acceptance quality limit (AQL) for lot-by-lot inspection*

3 Terms and definitions

For the purpose of this Standard, the following terms and definitions apply.

3.1 elastomeric isolator

rubber bearing which consists of rubber sheets and steel sheets alternately stacked together and vulcanized, with flanges connected to both of the outermost layers

There are isolators which support buildings horizontally with flexibility, and reduce the seismic force by extending the period of vibration of the buildings and those having, in addition to the said function, the damping properties to reduce the transmission of the seismic energy.

3.2 natural rubber bearing, NRB

elastomeric isolator with approximately linear shear force-deflection characteristics, fabricated using natural rubber

3.3 high-damping rubber bearing, HDR

elastomeric isolator of which the inner rubber has relatively high damping properties

3.4 lead rubber bearing, LRB

elastomeric isolator whose inner rubber with a lead plug or lead plugs press-fitted into a hole or holes of the isolator body to achieve damping properties

3.5 inner rubber

rubber between reinforcing steel plates and upper and lower joining steel plates of an elastomeric isolator

NOTE : Inner rubber is a determinative factor for compressive stiffness, shear stiffness, equivalent damping factor, deformation performance and durability.

3.6 cover rubber

rubber wrapped around the outside of inner rubber, reinforcing steel plates and upper and lower joining steel plates for protection purposes

NOTE : Cover rubbers are intended for protecting the inner rubber from deterioration due to oxygen, ozone, ultraviolet rays, rain water, etc. and for protecting the reinforcing steel plates from corrosion. They are applied before or after curing of isolators, some formed together with the inner rubber, and others applied after curing of the inner rubber.

3.7 reinforcing steel plates

steel plates stacked together with inner rubbers in an elastomeric isolator

They are also referred to as inner steel plates.

NOTE : They restrain the swell-out of rubber caused by the compressive load exerted on the isolator and enhance the compressive stiffness or vertical bearing capacity.

3.8 effective loaded area

area of the inner rubber plane excluding the holes for lead plugs

3.9 free surface area

side surface area of one inner rubber layer whose deformation is not restrained by compression

3.10 first shape factor, S_1

ratio of effectively loaded area to free deformation area of one inner rubber layer between steel plates

3.11 second shape factor, S_2

for circular elastomeric isolator, ratio of the diameter of the inner rubber to the total thickness of the inner rubber

for rectangular or square elastomeric isolator, ratio of the effective width of the inner rubber to the total thickness of the inner rubber

3.12 compressive properties of elastomeric isolators

characteristics indicating the performance of elastomeric isolators against compressive force

The characteristics are compressive stiffness and compressive displacement.

3.13 shear properties of elastomeric isolators

characteristics indicating the horizontal properties of elastomeric isolator

The characteristics are shear stiffness, equivalent damping ratio, post-yield stiffness, characteristic strength, etc.

3.14 ultimate properties

properties at either buckling or breaking of an isolator under compression load, tension load or large shear deformation

NOTE : Diagram expressing the ultimate properties by the interaction curve of compressive stress and shear strain of an elastomeric isolator is referred to as the ultimate properties diagram.

3.15 breaking

rupture of elastomeric isolator due to compression or tension shear loading

The state of sudden decrease of shear force on shear force-shear displacement curve (hysteresis loop) caused by the rupture of rubber layer and/or adhesive plane.

3.16 buckling

state of loss of stability of elastomeric isolators, such as loss of restoring force that generates a negative slope in the shear force-shear displacement curve (hysteresis loop) before breaking

3.17 axial stress

stress calculated by dividing the compressive force that the elastomeric isolator supports by the effective area of the elastomeric isolator

3.18 nominal compressive stress

compressive stress value to be used as reference in type inspection of the products

NOTE : The nominal compressive stress is calculated by the manufacturer based on the agreement between the purchaser and the manufacturer.

3.19 nominal shear strain

shear strain value to be used as reference in type inspection of the products

NOTE : The nominal shear strain is calculated by the manufacturer based on the agreement between the purchaser and the manufacturer.

3.20 ultimate shear strain

shear strain generating either buckling, breaking, or roll-out of an elastomeric isolator at the nominal compressive stress

3.21 ultimate compressive stress

compressive stress at which the elastomeric isolator is capable of safely supporting the compressive force without buckling or breaking, including the state of shear deformation

3.22 full-scale isolator

test piece of which the material, shape and dimensions are identical with the elastomeric isolators used for actual buildings

3.23 scaled-model isolator

test piece of which the first shape factor and second shape factor are equivalent to, but which is a similarity reduction of, elastomeric isolators used for actual buildings

3.24 shear-block test piece

specimen for shear test with rubber adhered between the layers of steel plates

4 Symbols

For the purpose of this Standard, the following symbols apply.

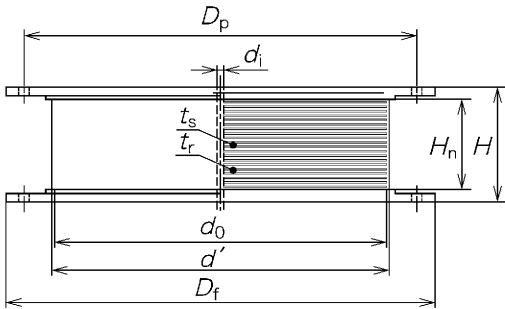
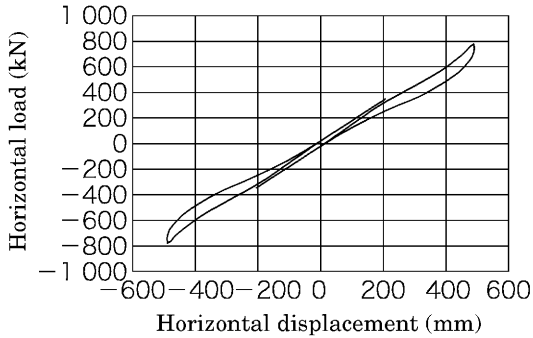
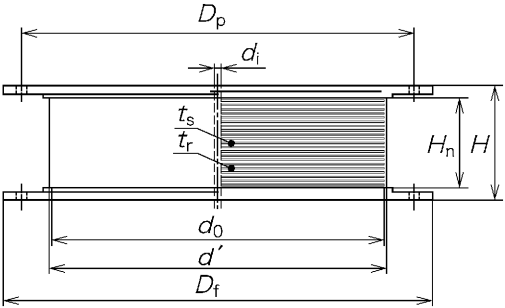
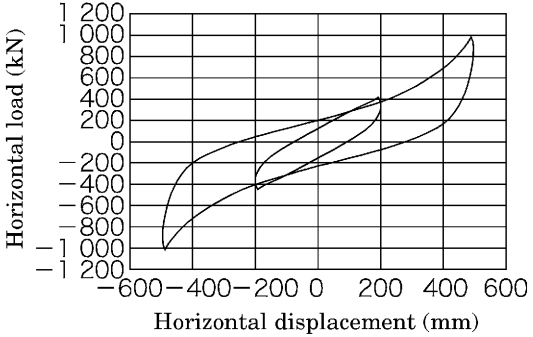
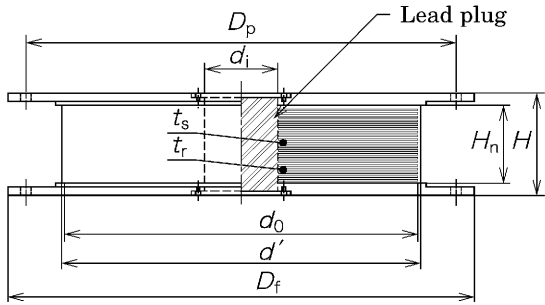
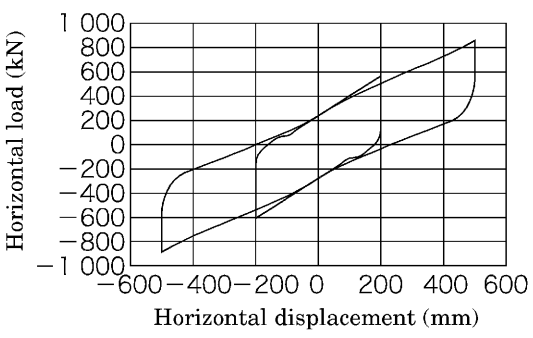
Symbol	Unit	Description
A	mm^2	effective plan area: plan area of elastomeric isolator, excluding cover rubber portion
A_{free}	mm^2	free surface area: side area per a rubber layer including the central hole
a	mm	side length of inner rubber of square isolator, or length of inner rubber in longitudinal direction of rectangular isolator
a'	mm	length in longitudinal direction of the rectangular isolator (including cover rubber thickness)
D_f	mm	outer diameter of flange
D_p	mm	centre-to-centre distance of bolt holes that are opposite to each other with respect to the centre (circular) or the symmetrical axis (square) of the flange
d_i	mm	inner diameter of inner rubber of elastomeric isolator
d_o	mm	outer diameter of inner rubber of elastomeric isolator
d'	mm	outer diameter of elastomeric isolator (including cover rubber thickness)
E_c	N/mm^2	apparent Young's modulus corrected by allowing compressibility
E_∞	N/mm^2	bulk modulus of rubber
E_0	N/mm^2	Young's modulus of rubber
F_{ly}	N	tensile stress at yield of elastomeric isolator
G	N/mm^2	shear modulus
G_{eq}	N/mm^2	equivalent linear shear modulus at shear strain
H	mm	height of elastomeric isolator, including mounting flange
H_n	mm	height of elastomeric isolator, excluding mounting flange
h	mm	total thickness of inner rubber
h_{cq}	—	equivalent damping ratio
K_d	N/mm	post-yield stiffness
K_h	N/mm	shear stiffness
K_v	N/mm	compressive stiffness
L_f	mm	length of one side of a rectangular flange
n	—	number of inner rubber layers
P	N	compressive force
P_{ly}	N	tensile stress at yield
Q	N	shear force
Q_d	N	characteristic strength
S_1	—	first shape factor
S_2	—	second shape factor
t_r	mm	thickness of one inner rubber layer
t_s	mm	thickness of one reinforcing steel plate

W_d	$N \cdot mm^2$	energy dissipated per cycle
X	mm	shear displacement
Y	mm	compressive displacement
α	N/mm^2	apparent shear modulus of lead plug
γ	—	shear strain
γ_{max}	—	maximum design shear strain during earthquake
γ_{nom}	—	nominal shear strain
γ_u	—	ultimate shear strain
δ_H	mm	horizontal offset of isolator
δ_V	mm	difference in isolator height measured between two points at opposite extremes of the isolator
ε_c	—	compressive strain of elastomeric isolator
κ	—	correction factor for apparent Young's modulus according to rubber hardness
σ	N/mm^2	compressive stress
σ_{cr}	N/mm^2	critical compressive stress in elastomeric isolator
σ_{max}	N/mm^2	maximum design compressive stress
σ_{min}	N/mm^2	minimum design compressive stress (including tensile stress)
σ_{nom}	N/mm^2	nominal compressive stress
σ_s	N/mm^2	maximum stress in reinforcing steel plates
σ_{sa}	N/mm^2	allowable tensile stress in reinforcing steel plates
σ_l	N/mm^2	tensile stress at yield of elastomeric isolator divided by the effective area of the isolator
τ_p	N/mm^2	shear stress at yield of lead plug
ξ	—	factor for computation of critical stress
ψ	—	flatness

5 Classification

The elastomeric isolators are categorized into natural rubber elastomeric isolators (hereafter referred as “NRBs”), high-damping rubber elastomeric isolators (hereafter referred as “HDRs”) and lead plugged elastomeric isolators (hereafter referred to as “LRBs”), as shown in table 1. The isolators have either circular or square cross-section. The flange connection types are shown in Annex JA.

Table 1 Classification of elastomeric isolators

Type	Abbreviation	Rubber material used
Natural rubber elastomeric isolator	NRB	Natural rubber base rubber
 Example of construction (circular)		 Example of shear property
High-damping rubber elastomeric isolator	HDR	High-damping rubber
 Example of construction (circular)		 Example of shear property
Lead plugged elastomeric isolator	LRB	Natural rubber base rubber and lead plug
 Example of construction (circular)		 Example of shear property

6 Requirements

6.1 Performance requirements for rubber materials

Elastomeric isolators shall satisfy the performance requirements in table 2. For 100 % modulus of the tensile property and rubber hardness given in table 2, which are to be specified depending on the performance required for the isolator, only the tolerance values are given in the table, and the reference values shall be agreed upon between the purchaser and the supplier prior to testing.

Table 2 Performance requirements of rubber materials

Property	Item of requirement		Required value	Test method
Tensile properties	Tensile strength MPa		8.0 min.	5.3 of JIS K 6410-2
	Elongation at break %		500 min.	
	100 % modulus	Tolerance on reference value %	±30	
Heat ageing property	Tensile strength	Change rate with respect to initial value %	−30 min.	5.4 of JIS K 6410-2
	Elongation at break	Change rate with respect to initial value %	−50 min.	
Hardness	Rubber hardness	Tolerance on reference value	±5	5.5 of JIS K 6410-2
Adhesion property	90° peel strength N/mm		6.0 min.	5.6 of JIS K 6410-2
Brittleness point ^{a)}	Brittleness temperature °C		−40 max.	5.7 of JIS K 6410-2
Ozone resistance	Observation of cracks		No generation of cracks.	5.8 of JIS K 6410-2
Note ^{a)} The test is required for products used at ambient temperatures 0 °C or under.				

6.2 Materials for flanges, joining steel plates and reinforcing steel plates

Materials for flanges, joining steel plates and reinforcing steel plates shall be as shown in table 3.

Table 3 Materials for flanges, joining steel plates and reinforcing steel plates

Material	Applicable JIS	Material symbol
Flanges and joining steel plates	JIS G 3101	SS400
	JIS G 3106	SM490
	JIS G 3136	SN400 or SN490
Reinforcing steel plates	JIS G 3101	SS400

6.3 Material used for lead plugs

The material of lead plugs used for LRB shall be of “special grade” as given in table 1 of clause 3 of JIS H 2105.

6.4 Performance requirements for elastomeric isolators

6.4.1 Performance items for which reference values are to be determined

Performance items for which reference values for elastomeric isolators are to be determined are shown in table 4. Reference values shall be determined by referring to Annex A, Annex B and Annex JC. Other reference values than these shall be as agreed between the purchaser and the manufacturer. Representative examples of reference values are shown in table JB.2, table JB.3 and table JB.4.

Table 4 Performance items for which reference values for elastomeric isolators are to be determined

Performance item		Type		
		NRB	HDR	LRB
Compressive property	Compressive stiffness K_v	○	○	○
Shear properties	Shear stiffness K_h	○	○	—
	Equivalent damping ratio h_{eq}	—	○	—
	Post-yield stiffness K_d	—	—	○
	Characteristic strength Q_d	—	—	○
○: Applicable —: Not applicable				

6.4.2 Performance requirements

The performance requirements for elastomeric isolators shall be as given in table 5.

Table 5 Performance requirements for elastomeric isolator

Performance item	Property		NRB	HDR	LRB	Test method
Compressive property	Compressive stiffness K_v	Tolerance on reference value %	-30 min.			6.2.1 of JIS K 6410-2
Shear property ^{a)}	—	Tolerance on reference value %	±20			6.2.2 of JIS K 6410-2
Dependency of shear properties ^{a)}	Compressive stress dependency ^{b)}	Change rate with respect to nominal compressive stress %	±30	K_h : ±30 h_{eq} : -30 to +60	K_d : -40 to +20 Q_d : ±15	6.3.2 of JIS K 6410-2
	Repeated loading dependency ^{c)}	Change rate with respect to the value of the third cycle %	-10 min.	K_h : -30 min. h_{eq} : -20 min.	K_d : -10 min. Q_d : -30 min.	6.3.4 of JIS K 6410-2
	Temperature dependency ^{d)}	Change rate with respect to the value at 23 °C %	±20	K_h : -20 min. (40 °C) +50 max. (0 °C) h_{eq} : ±20	K_d : ±20 Q_d : ±40	6.3.5 of JIS K 6410-2 Annex JB of JIS K 6410-2
	Shear strain dependency ^{a)} %		Value dependent on shear strain			6.3.1 of JIS K 6410-2
	Vibration frequency dependency %		—			6.3.3 of JIS K 6410-2
Durability	Shear property	Change rate with respect to initial value %	+20 max.	K_h : +20 max. h_{eq} : -20 min.	K_d : +20 max. Q_d : ±5	6.6.1 of JIS K 6410-2
	Ultimate shear strain	Change rate with respect to initial value %	-20 min.			
	Creep %		10 max.			6.6.2 of JIS K 6410-2
Tensile property	Tensile stress at yield MPa		Value dependent on shear strain			6.5 of JIS K 6410-2
Ultimate property	Ultimate compressive stress ^{b)} MPa		Value dependent on shear strain			6.4 of JIS K 6410-2
Notes ^{a)} Performance items of shear properties are K_h for NRB, K_h and h_{eq} for HDR and K_d and Q_d for LRB (see table 4).						
^{b)} Judgement of compressive stress shall be made based on the values 0.5 σ_{nom} and 2.0 σ_{nom} .						
^{c)} Judgement shall be made based on the value of 50th cycle.						
^{d)} Judgement shall be made based on the values at 0 °C and 40 °C.						

6.5 Dimensions and tolerances

Dimensions of elastomeric isolators shall be determined by agreement between the purchaser and the supplier within the range of shape and dimensions given in table JB.1. Tolerances on dimensions of respective parts of elastomeric isolators shall be as follows.

6.5.1 Plan dimensions

Tolerances on outer diameter d' and length of one side a' of elastomeric isolators, when they are tested in accordance with 7.3 of **JIS K 6410-2**, shall be as specified in table 6.

Table 6 Tolerances on plan dimensions of elastomeric isolators

Plan dimensions d' and a' of elastomeric isolator mm		Tolerance
Above	Maximum	
—	500	± 5 mm
500	1 500	± 1 %
1 500	—	± 15 mm

6.5.2 Height

Tolerances on height of elastomeric isolator H or H_n , when it is tested in accordance with 7.4 of **JIS K 6410-2**, shall be ± 1.5 % or ± 6.0 mm, whichever is smaller.

6.5.3 Flatness

Tolerances on flatness of elastomeric isolator Ψ , when it is tested in accordance with 7.5 of **JIS K 6410-2**, shall be as follows.

$$\Psi \leq 0.25 \text{ \%} \quad \text{and} \quad |\delta_v| \leq 3.0 \text{ (mm)}$$

6.5.4 Horizontal offset

Tolerances on horizontal offset of elastomeric isolator δ_H , when it is tested in accordance with 7.6 of **JIS K 6410-2**, shall be as follows.

$$\delta_H \leq 5.0 \text{ (mm)}$$

6.5.5 Plan dimensions of flanges

Tolerances on plan dimensions of flanges, when they are tested in accordance with 7.7 of **JIS K 6410-2**, shall be in accordance with “Grade B” given in table 1 of **JIS B 0417**, and as specified in table 7.