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Elastomeric seismic-protection isolators —

Part 2: Applications for bridges — Specifications

Appareils d'appui structuraux en élastomère pour protection sismique —

Partie 2: Applications pour ponts — Spécifications

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 45, *Rubber and rubber products*, Subcommittee SC 4, *Products (other than hoses)*.

This third edition cancels and replaces the second edition (ISO 22762-2:2010), which has been technically revised.

The main changes compared to the previous edition are as follows:

— the definitions of some symbols in Clause 4 have been changed.

A list of all parts in the ISO 22762 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

ISO 22762 series includes two parts related to specifications for isolators, i.e. ISO 22762-2 for bridges and ISO 22762-3 for buildings. This is because the isolator requirements for bridges and buildings are quite different, although the basic concept of the two products is similar. Therefore, ISO 22762-2 and the relevant clauses in ISO 22762-1 are used when ISO 22762 (all parts) is applied to the design of bridge isolators whereas ISO 22762-3 and the relevant clauses of ISO 22762-1 are used when it is applied to building isolators.

The main differences to be noted between isolators for bridges and isolators for buildings are the following.

a) Isolators for bridges are mainly rectangular in shape and those for buildings are circular in shape.

b) Isolators for bridges are designed to be used for both rotation and horizontal displacement, while isolators for buildings are designed for horizontal displacement only.

c) Isolators for bridges are designed to perform on a daily basis to accommodate length changes of bridges caused by temperature changes as well as during earthquakes, while isolators for buildings are designed to perform only during earthquakes.

d) Isolators for bridges are designed to withstand dynamic loads caused by vehicles on a daily basis as well as earthquakes, while isolators for buildings are mainly designed to withstand dynamic loads caused by earthquakes only.

For structures other than buildings and bridges (e.g. tanks), the structural engineer uses either ISO 22762-2 or ISO 22762-3, depending on the requirements of the structure.

Elastomeric seismic-protection isolators —

Part 2:
Applications for bridges — Specifications

1 Scope

This document specifies minimum requirements and test methods for elastomeric seismic isolators used for bridges, as well as rubber material used in the manufacture of such isolators.

It is applicable to elastomeric seismic isolators used to provide bridges with protection from earthquake damage. The isolators covered consist of alternate elastomeric layers and reinforcing steel plates, which are placed between a superstructure and its substructure to provide both flexibility for decoupling structural systems from ground motion and damping capability to reduce displacement at the isolation interface and the transmission of energy from the ground into the structure at the isolation frequency.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 630 (all parts), *Structural steels*

ISO 22762-1:2018, *Elastomeric seismic-protection isolators — Part 1: Test methods*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
breaking
rupture of *elastomeric isolator* (3.9) due to compression- (or tension-) shear loading

3.2
buckling
state when *elastomeric isolators* (3.9) lose their stability under compression-shear loading

3.3
compressive stiffness
K_V
compressive stiffness for all types of rubber bearings

3.4
cover rubber
rubber wrapped around the outside of inner rubber and reinforcing steel plates before or after curing of *elastomeric isolators* (3.8) for the purposes of protecting the inner rubber from deterioration due to oxygen, ozone and other natural elements and protecting the reinforcing plates from corrosion

3.5
design compressive stress
long-term compressive force on the *elastomeric isolators* (3.8) imposed by the structure

3.6
effective loaded area
area sustaining vertical load in *elastomeric isolators* (3.8), which corresponds to the area of reinforcing steel plates

3.7
effective width
<rectangular elastomeric isolator> the smaller of the two side lengths of inner rubber to which direction shear displacement is not restricted

3.8
elastomeric isolator
rubber bearing, for seismic isolation of buildings, bridges and other structures, which consists of multi-layered vulcanized rubber sheets and reinforcing steel plates

EXAMPLE High-damping rubber bearings, linear natural rubber bearings and lead rubber bearings.

3.9
first shape factor
ratio of effectively loaded area to free deformation area of one inner rubber layer between steel plates

3.10
high-damping rubber bearing
HDR
elastomeric isolator (3.8) with relatively high damping properties obtained by special compounding of the rubber and the use of additives

3.11
inner rubber
rubber between multi-layered steel plates inside an *elastomeric isolator* (3.8)

3.12
lead rubber bearing
LRB
elastomeric isolator (3.8) whose *inner rubber* (3.11) with a lead plug or lead plugs press fitted into a hole or holes of the isolator body to achieve damping properties

3.13
linear natural rubber bearing
LNR
elastomeric isolator (3.8) with linear shear force-deflection characteristics and relatively low damping properties, fabricated using natural rubber

Note 1 to entry: Any bearing with relatively low damping can be treated as an LNR bearing for the purposes of isolator testing.

3.14
maximum compressive stress
peak stress acting briefly on *elastomeric isolators* (3.8) in compressive direction during an earthquake

3.15
nominal compressive stress
long-term stress acting on *elastomeric isolators* (3.8) in compressive direction as recommended by the manufacturer for the isolator, including the safety margin

3.16
roll-out
instability of an isolator with either dowelled or recessed connection under shear displacement

3.17
routine test
test for quality control of the production isolators during and after manufacturing

3.18
second shape factor
<circular elastomeric isolator> ratio of the diameter of the inner rubber to the total thickness of the inner rubber

3.19
second shape factor
<rectangular or square elastomeric isolator> ratio of the effective width of the inner rubber to the total thickness of the inner rubber

3.20
shear properties of elastomeric isolators
comprehensive term that covers characteristics determined from isolator tests:

— shear stiffness, K_h, for LNR;

— shear stiffness, K_h, and equivalent damping ratio, h_{eq}, for HDR and LRB;

— post-yield stiffness, K_d, and characteristic strength, Q_d, for LRB

3.21
structural engineer
engineer who is in charge of designing the structure for base-isolated bridges or buildings and is responsible for specifying the requirements for *elastomeric isolators* (3.8)

3.22
type test
test for verification either of material properties and isolator performances during development of the product or that project design parameters are achieved

3.23
ultimate properties
properties at either buckling, breaking, or roll-out of an isolator under compression-shear loading (see Annex D).

4 Symbols

For the purposes of this document, the symbols given in Table 1 apply.

Table 1 — Symbols and descriptions

Symbol	Description
A	effective plan area; plan area of elastomeric isolator, excluding cover rubber portion
A_b	effective area of bolt
A_e	overlap area between the top and bottom elastomer area of isolator
A_{free}	load-free area of isolator
A_{load}	loaded area of isolator
A_p	area of the lead plug for a lead rubber bearing
a	side length of square elastomeric isolator, excluding cover rubber thickness, or length in longitudinal direction of rectangular isolator, excluding cover rubber thickness

Table 1 *(continued)*

Symbol	Description
a_e	length of the shorter side of the rectangular isolator, including cover rubber thickness
a'	length in longitudinal direction of the rectangular isolator, including cover rubber thickness
B	effective width for bending of flange
b	length in transverse direction of the rectangular isolator, excluding cover rubber thickness
b'	length in transverse direction of the rectangular isolator, including cover rubber thickness
c	distance from centre of bolt hole to effective flange section
D'	outer diameter of circular isolator, including cover rubber
D_f	diameter of flange
d_i	inner diameter of reinforcing steel plate
d_k	diameter of bolt hole
d_0	outer diameter of reinforcing steel plate
E_{ap}	apparent Young's modulus of bonded rubber layer
E_c	apparent Young's modulus corrected, if necessary, by allowing for compressibility
$E_c{}^s$	apparent Young's modulus corrected for bulk compressibility depending on its shape factor (S_1)
E_∞	bulk modulus of rubber
E_0	Young's modulus of rubber
F_u	tensile force on isolator by uplift
G	shear modulus
$G_{eq}(\gamma)$	equivalent linear shear modulus at shear strain
H	height of elastomeric isolator, including mounting flange
H_n	height of elastomeric isolator, excluding mounting flange
h_{eq}	equivalent damping ratio
$h_{eq}(\gamma)$	equivalent damping ratio as a function of shear strain
K_d	post-yield stiffness (tangential stiffness after yielding of lead plug) of lead rubber bearing
K_h	shear stiffness
K_i	initial shear stiffness
K_p	shear stiffness of lead plug inserted in lead rubber bearing
K_r	shear stiffness of lead rubber bearing before inserting lead plug
K_t	tangential shear stiffness
K_v	compressive stiffness
L_f	length of one side of a rectangular flange
M	resistance to rotation
M_f	moment acting on bolt
M_r	moment acting on isolator
n	number of rubber layers
n_b	number of fixing bolts
P	compressive force
P_0	design compressive force in absence of seismic action effects
P_{max}	maximum compressive force including seismic action effects
P_{min}	minimum compressive force including seismic actions effects (the minimum may be negative; ie the minimum force may be tensile)
Q	shear force
Q_b	shear force at break
Q_{buk}	shear force at buckling

Table 1 *(continued)*

Symbol	Description
Q_d	characteristic strength
S_1	first shape factor
S_2	second shape factor
T	temperature
T_0	standard temperature, 23 °C or 27 °C; where specified tolerance is ±2 °C, T_0 is standard laboratory temperature
T_r	total rubber thickness, given by $T_r = n \times t_r$
t_r	thickness of one rubber layer
t_{r1}, t_{r2}	thickness of rubber layer laminated on each side of plate
t_s	thickness of one reinforcing steel plate
t_0	thickness of outside cover rubber
$U(\gamma)$	function giving ratio of characteristic strength to maximum shear force of a loop
V	uplift force
v	loading velocity
W_d	energy dissipated per cycle
X	shear displacement
X_0	design shear displacement
X_b	shear displacement at break
X_{buk}	shear displacement at buckling
X_s	shear displacement due to quasi-static shear movement
X_{max}	maximum shear displacement
X_d	shear displacement due to dynamic shear movement
Y	compressive displacement
Z	section modulus of flange
α	coefficient of linear thermal expansion
γ	shear strain
γ_0	design shear strain
γ_a	upper limit of the total of design strains on elastomeric isolators
γ_b	shear strain at break
γ_c	local shear strain due to compressive force
γ_d	shear strain due to dynamic shear movement
γ_{max}	maximum design shear strain during earthquake
γ_r	local shear strain due to rotation
γ_s	shear strain due to quasi-static shear movement
γ_u	ultimate shear strain
δ_H	horizontal offset of isolator
δ_v	difference in isolator height measured between two points at opposite extremes of the isolator
ε	compressive strain of rubber
ε_{cr}	creep strain
ε_T	tensile strain of isolator
ε_{Tb}	tensile-break strain of isolator
ε_{Ty}	tensile-yield strain of isolator
ζ	ratio of total height of rubber and steel layers to total rubber height

Table 1 *(continued)*

Symbol	Description
θ	rotation angle of isolator about the diameter of a circular bearing or about an axis through a rectangular bearing
θ_a	rotation angle of isolator in the longitudinal direction (a)
θ_b	rotation angle of isolator in the transverse direction (b)
λ	correction factor for calculation of stress in reinforcing steel plates
η	correction factor for calculation of critical stress
κ	correction factor for apparent Young's modulus according to hardness
$\Sigma\gamma$	total local shear strain
σ	compressive stress in isolator
σ_0	design compressive stress
σ_B	tensile stress in bolt
σ_b	bending stress in flange
σ_{bf}	allowable bending stress in steel
σ_{cr}	critical stress in isolator
σ_f	allowable tensile stress in steel
σ_{max}	maximum design compressive stress
σ_{min}	minimum design compressive stress
σ_{nom}	for building: nominal compressive stress recommended by manufacturer
σ_s	tensile stress in reinforcing steel plate
σ_{sa}	allowable tensile stress in steel plate
σ_{sy}	yield stress of steel for flanges and reinforcing steel plates
σ_{su}	tensile strength of steel for flanges and reinforcing steel plates
σ_t	tensile stress
σ_{te}	allowable tensile stress in isolator
τ_B	shear stress in bolt
τ_f	allowable shear stress in steel
ϕ	factor for computation of buckling stability
ξ	factor for computation of critical stress

5 Classification

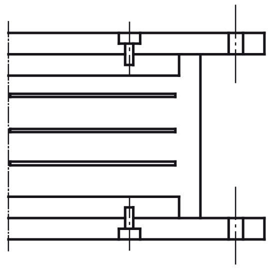
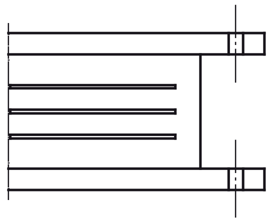
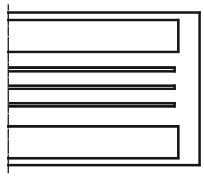
5.1 General

Elastomeric isolators are classified by construction, their ultimate properties and tolerances on their performance.

5.2 Classification by construction

Elastomeric isolators are classified by construction, as shown in Table 2. The structural engineer shall specify which construction is to be used.

Table 2 — Classification by construction

Type	Construction	Illustration
Type I	Mounting flanges are bolted to connecting flanges, which are bonded to the laminated rubber.	
Type II	Mounting flanges are directly bonded to the laminated rubber.	
Type III	Isolators without mounting flanges	

5.3 Classification by tolerances on shear stiffness

Elastomeric isolators may be classified by their tolerance on shear stiffness, as shown in Table 3. The structural engineer shall specify the tolerance required.

Table 3 — Classification by tolerance on shear stiffness

Class	Tolerance %
S-A	±10
S-B	±20

6 Requirements

6.1 General

Elastomeric isolators for bridges and the materials used in their manufacture shall meet the requirements specified in this clause. For test items (see Table 4) that have no specific required values, the manufacturer shall define the values and inform the purchaser prior to production.

The standard temperature for determining the properties of elastomeric isolators is 23 °C or 27 °C in accordance with prevailing International Standards. However, it is advisable to establish a range of working temperatures, taking into consideration actual environmental temperatures and possible changes in temperature at the work site where the elastomeric isolators are installed.

6.2 Type tests and routine tests

6.2.1 Testing to be carried out on elastomeric isolators is classified into

a) type tests, and

b) routine tests.

6.2.2 Type tests shall be conducted either to ensure that project design parameters have been achieved (in which case the test results shall be submitted to the structural engineer for review prior to production) or to verify isolator performance and material properties during development of an isolator. The test piece for each type test shall be full-scale or one of the options specified in Table 4. The test piece shall not have been subjected to any previous test programme. The tests shall be performed on test pieces not subjected to any scragging, unless the production isolators are to be supplied after scragging. In that case, the test pieces shall be subjected to the same scragging procedure as the production isolators

6.2.3 Previous type test results may be substituted, provided the following conditions are met.

a) Isolators are fabricated in a similar manner and from the same compound and adhesive.

b) All corresponding external and internal dimensions are within 10 % of each other.

c) The second shape factors are within ±10 %.

d) The test conditions such as maximum and minimum vertical load applied in the ultimate property test, as described in 6.5.7, are more severe.

