INTERNATIONAL STANDARD

ISO 22762-1

First edition
2005-07-15

Elastomeric seismic-protection isolators —

Part 1:
Test methods

Appareils d'appuis structuraux en élastomère pour protection sismique —

Partie 1: Méthodes d'essai

Reference number
ISO 22762-1:2005(E)

Contents

Page

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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.

ISO 22762-1 was prepared by Technical Committee ISO/TC 45, *Rubber and rubber products*, Subcommittee SC 4, *Products (other than hoses)*.

ISO 22762 consists of the following parts, under the general title *Elastomeric seismic-protection isolators*:

- *Part 1: Test methods*
- *Part 2: Applications for bridges — Specifications*
- *Part 3: Applications for buildings — Specifications*

Introduction

This International Standard contains two parts related to specifications for isolators — one for bridges and the other for buildings — since the requirements for isolators for bridges and for buildings are quite different, although the basic concept of the two products is similar. Therefore, when this International Standard is applied to the design of bridge isolators, Part 2 and the relevant clauses in Part 1 are used and, when it is applied to building isolators, Part 3 and the relevant clauses in Part 1 are used.

The main differences to be noted between isolators for bridges and isolators for buildings are as below:

a) Isolators for bridges are mainly rectangular in shape and those for buildings 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 that are neither buildings nor bridges (e.g. tanks), the structural engineer may use either Part 2 or Part 3 of this International Standard, depending on the requirements of the structure.

Elastomeric seismic-protection isolators —

Part 1:
Test methods

1 Scope

ISO 22762 applies to elastomeric seismic isolators used to provide buildings or bridges with protection from earthquake damage. The isolators covered consist of alternate rubber layers and reinforcing steel plates. They 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.

This part of ISO 22762 specifies the test methods for determination of the characteristics of elastomeric seismic isolators and for measurement of the properties of the rubber material used in their manufacture.

The specifications cover testing for all properties required in the elastomeric isolators, such as compression and shear properties, the durability of the isolators and the physical properties of the materials used in isolators.

Annex E may be used to review those requirements needing confirmation prior to the test programme.

2 Normative references

The following referenced documents are indispensable for the application 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 37, *Rubber, vulcanized or thermoplastic — Determination of tensile stress-strain properties*

ISO 48, *Rubber, vulcanized or thermoplastic — Determination of hardness (hardness between 10 IRHD and 100 IRHD)*

ISO 188, *Rubber, vulcanized or thermoplastic — Accelerated ageing and heat resistance tests*

ISO 812, *Rubber, vulcanized — Determination of low-temperature brittleness*

ISO 813, *Rubber, vulcanized or thermoplastic — Determination of adhesion to a rigid substrate — 90° peel method*

ISO 815, *Rubber, vulcanized or thermoplastic — Determination of compression set at ambient, elevated or low temperatures*

ISO 1431-1, *Rubber, vulcanized or thermoplastic — Resistance to ozone cracking — Part 1: Static and dynamic strain testing*

ISO 1827, *Rubber, vulcanized or thermoplastic — Determination of modulus in shear or adhesion to rigid plates — Quadruple shear method*

ISO 3387, *Rubber — Determination of crystallization effects by hardness measurements*

ISO 4664-1, *Rubber, vulcanized or thermoplastic — Determination of dynamic properties — Part 1: General considerations*

ISO 7500-1:2004, *Metallic materials — Verification of static uniaxial testing machines — Part 1: Tension/compression testing machines — Verification and calibration of the force-measuring system*

ISO 7619-2, *Rubber, vulcanized or thermoplastic — Determination of indentation hardness — Part 2: IRHD pocket meter method*

ISO 11346:2004, *Rubber, vulcanized or thermoplastic — Estimation of life-time and maximum temperature of use*

ISO 22762-2, *Elastomeric seismic-protection isolators — Part 2: Applications for bridges — Specifications*

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

ISO 23529, *Rubber — General procedures for preparing and conditioning test pieces for physical test methods*

3 Terms and definitions

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

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

3.2
buckling
state when elastomeric isolators lose their stability under compression-shear loading

3.3
compressive properties of elastomeric isolator
compressive stiffness (K_{v}) for all types of rubber bearings

3.4
compressive-shear testing machine
machine used to test elastomeric isolators, which has the capability of shear loading under constant compressive load

3.5
cover rubber
rubber wrapped around the outside of inner rubber and reinforcing steel plates before or after curing of elastomeric isolators for the purpose of protecting the inner rubber from deterioration due to oxygen, ultraviolet rays and other natural elements and protecting the reinforcing plates from corrosion

3.6
design compressive stress
long term compressive force on the elastomeric isolator imposed by the structure

3.7
effective loaded area
area sustaining vertical load in elastomeric isolators, which corresponds to the area of reinforcing steel plates

3.8
effective width
⟨rectangular elastomeric isolator⟩ the smaller of the two side lengths of inner rubber to which direction shear displacement is not restricted

3.9
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

NOTE Types of such isolators include high-damping rubber bearings, linear natural rubber bearings and lead rubber bearings.

3.10
first shape factor
ratio of effectively loaded area to free deformation area of one inner rubber layer between steel plates

3.11
high-damping rubber bearing
HDR
elastomeric isolator with relatively high damping properties obtained by special compounding of the rubber and the use of additives

3.12
inner rubber
rubber between multi-layered steel plates inside an elastomeric isolator

3.13
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

3.14
linear natural rubber bearing
LNR
elastomeric isolator with linear shear force-deflection characteristics and relatively low damping properties and fabricated using natural rubber

NOTE Any bearing with relatively low damping may be treated as an LNR bearing for the purposes of isolator testing.

3.15
maximum compressive stress
maximum compressive stress acting briefly on elastomeric isolators during an earthquake

3.16
nominal compressive stress
long-term compressive stress recommended by the manufacturer for the isolator, including the safety margin

3.17
roll-out
instability of an isolator with either dowelled or recessed connection under shear displacement

3.18
routine test
a test for quality control of the production isolators during and after manufacturing

3.19
second shape factor
⟨circular elastomeric isolator⟩ ratio of the diameter of the inner rubber to the total thickness of the inner rubber

⟨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
a 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 of structure for base-isolated bridges or buildings and is responsible for specifying the requirements for elastomeric isolators

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

3.24
ultimate property diagram
UPD
diagram giving the interaction curve of compressive stress and buckling strain or breaking strain of an elastomeric isolator

4 Symbols and abbreviated terms

For the purposes of all three parts of ISO 22762, the symbols given in Table 1 apply.

Table 1 — Symbols and definitions

Symbol	Definition
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 sheared under non-seismic displacement
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
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_{o}	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
$E_{\mathrm{c}}^{\mathrm{s}}$	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
$G_{\mathrm{eq}}(\gamma)$	equivalent linear shear modulus at shear strain γ
H	height of elastomeric isolator including mounting flange
H_{n}	height of elastomeric isolator excluding mounting flange
h_{eq}	equivalent damping ratio
$h_{\mathrm{eq}}(\gamma)$	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 square 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

P_{max} maximum design compressive force

P_{min} minimum design compressive force

Q shear force

Q_b shear force at break

Q_{buk} shear force at buckling

Q_d characteristic strength

S_1 first shape factor

S_2 second shape factor

T 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_o 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 design shear displacement

X_d shear displacement due to dynamic shear movement

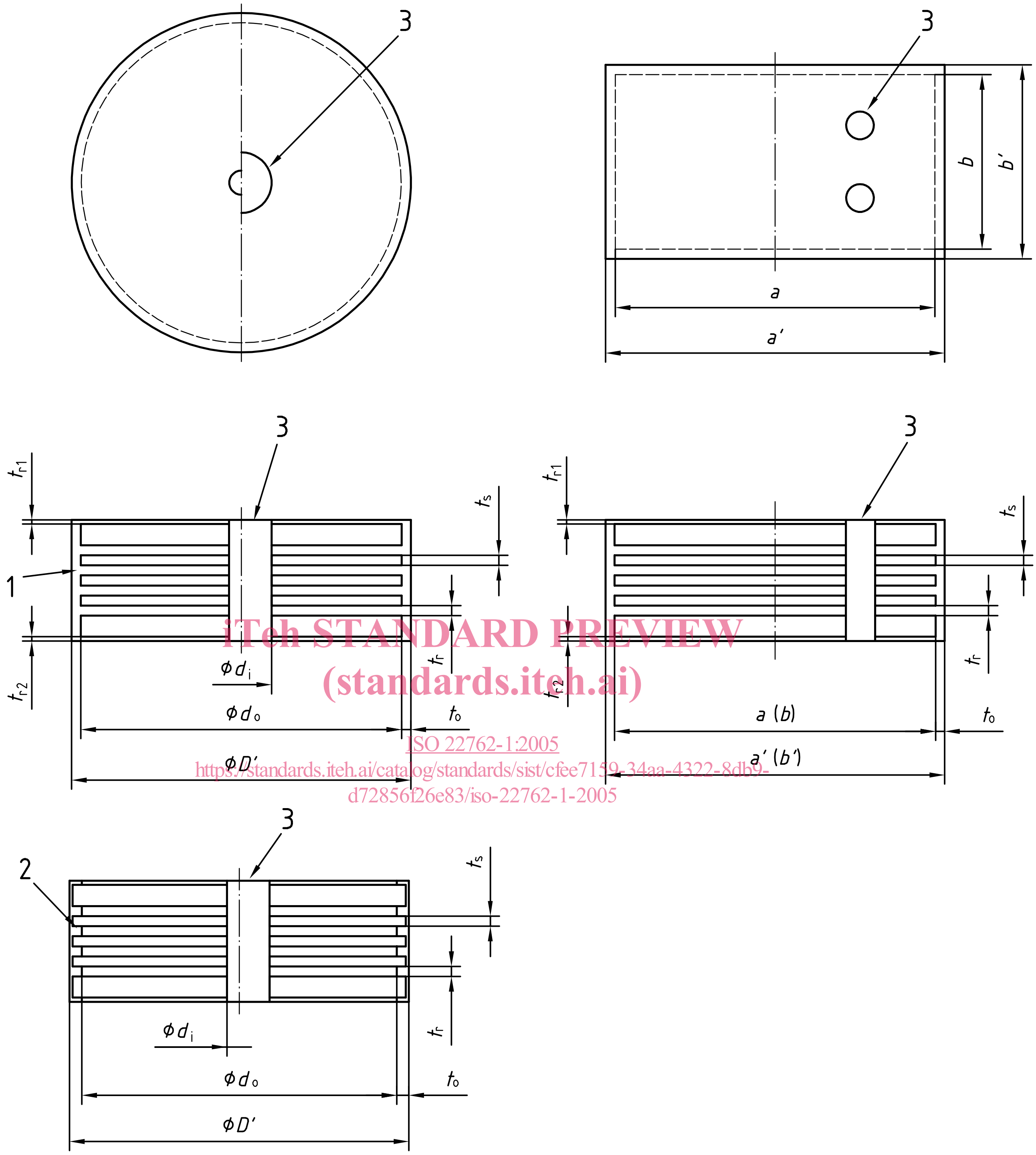
Y compressive displacement

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 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 isolator
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 rubber height to total height of rubber and steel layers
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 long term 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
σ_{yi}	yield stress in steel plate
τ_B	shear stress in bolt
τ_f	allowable shear stress in steel
ϕ	factor for computation of buckling stability
ψ	factor for computation of buckling check
ξ	factor for computation of critical stress



a) Circular type
(lhs of drawings shows LNR and HDR, rhs shows LRB)

b) Rectangular type
(lhs of drawings shows LNR and HDR, rhs shows LRB)

Key

1 cover rubber cured with insulator

2 cover rubber added after isolator cured

3 lead plug

Figure 1 — Cross-section of isolator