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ISO-/TC-45/SC-4~~/WG 9~~

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Elastomeric seismic-protection isolators —

—Part-7:
Relationship of the ISO 22762 series to the design and testing

# of seismic isolation systems

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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~~document 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).

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

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

~~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~~

~~— Part 4: Guidance on the application of ISO 22762-3~~

~~— Part 5: Sliding seismic-protection isolators for buildings~~

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— Part 6: High-durability and high-performance specifications and test methods

— Part 7: Relationship of the ISO 22762 series to the design and testing of seismic isolation systems

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.htmlwww.iso.org/members.html.

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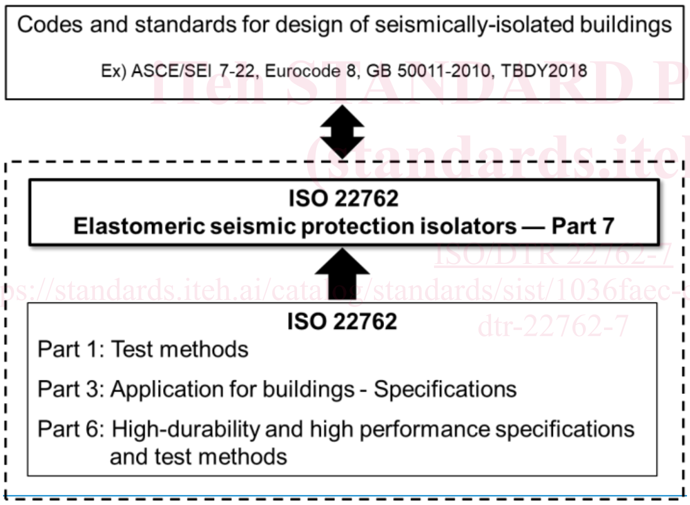
Introduction

Elastomeric isolators are one of the most popular types of seismic isolation systems for buildings worldwide. Structural engineers must comply with national building code requirements, or guidelines if detailed code provisions for isolation do not exist, and generally that means designing in accordance with a standard, such as ASCE/SEI 7-22. In these codes and guidelines, the requirements for isolators must satisfy design demands determined by structural seismic response analysis. The ISO 22762 series ~~provide~~provides detailed requirements for testing and design of elastomeric isolators and gives different requirements (grades) according to the target performance level for the isolation system. This new document is intended to explain the relationship between the requirements in national seismic codes with ASCE/SEI 7-22 used by way of example throughout, and ISO 22762 series, with the goal of allowing structural engineers to more effectively, and more widely, make use of ISO 22762 series when designing seismically-isolated buildings. ASCE/SEI 7-22 is used throughout ~~Part 7~~this document as an example building code for seismically-isolated buildings, and any reference to “seismic code” may be understood to refer to that document. The concept of ~~the ISO 22762 -Part7~~this document is given in ~~Figure 1.~~Figure 1.



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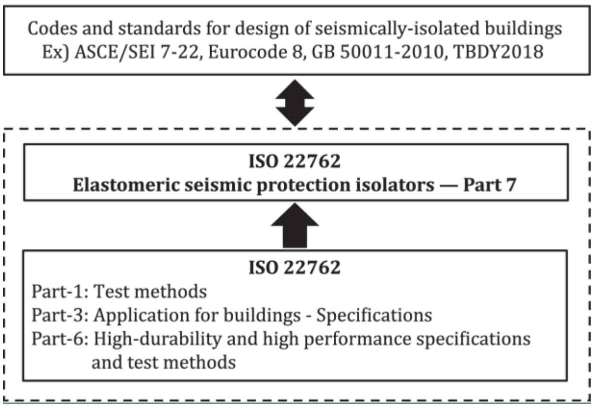

Figure 1 — Conceptual diagram showing the role of ISO/TR 22762~~- Part -~~7

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Elastomeric seismic-protection isolators — —

Part 7: Relationship of the ISO 22762 series to the design and testing of seismic isolation systems

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1 1Scope

This document explains the relationship of the ISO 22762 series to the design and testing of seismic isolation systems, including the relationship to national seismic codes..

2 2Normative references

There are no normative references in this document..

3 3Terms and definitions

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

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

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

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

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3.1
breaking
rupture of *elastomeric isolator* (3.6)(3.6) due to compression- (or tension-) shear loading

3.2
buckling
state when *elastomeric isolators* (3.6)(3.6) lose their stability under compression-shear loading.

3.3
compressive properties of elastomeric isolator
K_v
compressive stiffness for all types of rubber bearings

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3.4
design compressive stress
long-term compressive force on the *elastomeric isolator* (3.6)(3.6) imposed by the structure.

3.5
design shear strain
shear strain of elastomeric isolator at design shear displacement

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3.6
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.

3.7
first shape factor
ratio of effectively loaded area to free deformation area of one inner rubber layer between steel plates

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

3.9
inner rubber
rubber between multi-layered steel plates inside an *elastomeric isolator* (3.6)(3.6)

3.10
lead rubber bearing
LRB
elastomeric isolator (3.6)(3.6) whose *inner rubber* (3.8)(3.8) with a lead plug or lead plugs press fitted into a hole or holes of the isolator body to achieve damping properties.

3.11
linear natural rubber bearing
LNR
elastomeric isolator (3.6)(3.6) 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.

3.12
maximum compressive stress
peak stress acting briefly on *elastomeric isolators* (3.6)(3.6) in compressive direction during an earthquake.

3.13
maximum shear strain
shear strain of elastomeric isolator at maximum shear displacement

3.14
property modification factor
a factor to account for a variation in physical property from a standard value, due to effects such as temperature, rate of loading, manufacturing variations, ageing and environmental exposure.

3.15
compressive stress
nominal compressive stress
long-term stress acting on *elastomeric isolators* ~~(3.6)~~(3.6) in compressive direction as recommended by the manufacturer for the isolator, including the safety margin

3.16
production test
project specific test to verify that the isolator manufactured has the required performance prior to shipping~~.~~

3.17
prototype test
project specific test to verify that the designed isolator has the required performance~~.~~

3.18
qualification test
test to demonstrate the isolator performance in various test items, which is conducted by manufacturer and whose data is submitted for approval of structural engineer as one of bidding documents~~.~~

3.19
routine test
test for quality control of the production isolators during and after manufacturing

3.20
second shape factor
<circular elastomeric isolator> ratio of the diameter of the *inner rubber* ~~(3.8)~~(3.8) to the total thickness of the inner rubber
<rectangular or square elastomeric isolator> ratio of the effective width of the *inner rubber* ~~(3.8)~~(3.8) to the total thickness of the inner rubber

3.21
seismic code
building code that defines regulatory requirements for the earthquake design of buildings, and which may include provisions for seismic isolation

3.22
shear properties
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

3.23
standard value
value of isolator property defined by manufacturer based on the results of type test~~.~~

3.24
structural engineer
engineer responsible for the design of the seismically-isolated building and for specifying the requirements for *elastomeric isolators* ~~(3.6).~~ (3.6)

3.25
type test
test for verification of either material properties and isolator performances during development of the product or that project design parameters are achieved~~.~~

3.26
ultimate ~~properties~~property
property~~properties~~ at either buckling, breaking, or roll-out of an isolator under compression-shear loading

4 4Symbols

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

Table ~~A~~1 — Symbols and descriptions

Symbol	Description
D_L	dead load of building-superstructure
D_D	displacement at the ~~center~~centre of stiffness of the isolation system under the Design Earthquake[a] (from seismic code)
D_M	maximum displacement at the center of stiffness of the isolation system under the Maximum Earthquake[a] (from seismic code)
D_{TM}	maximum displacement of an element of the isolation system under the Maximum Earthquake[a], including torsional effects (from seismic code)
E_L	load of building-superstructure in vertical direction generated during earthquake
h_{eq}	equivalent damping ratio
K_d	post-yield stiffness (tangential stiffness after yielding of lead plug) of lead rubber bearing
K_{eff}	effective stiffness of an isolator unit in the horizontal direction at either the Design Earthquake or the Maximum Earthquake level (from seismic code)
K_h	shear stiffness
L_L	live load of building-superstructure
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
$Q_1(X_1)$	shear force at maximum positive shear displacement
$Q_2(X_2)$	shear force at minimum negative shear displacement
Q_d	characteristic strength
S_1	first shape factor
S_2	second shape factor
T_r	total rubber thickness, given by $T_r = n \times t_r$

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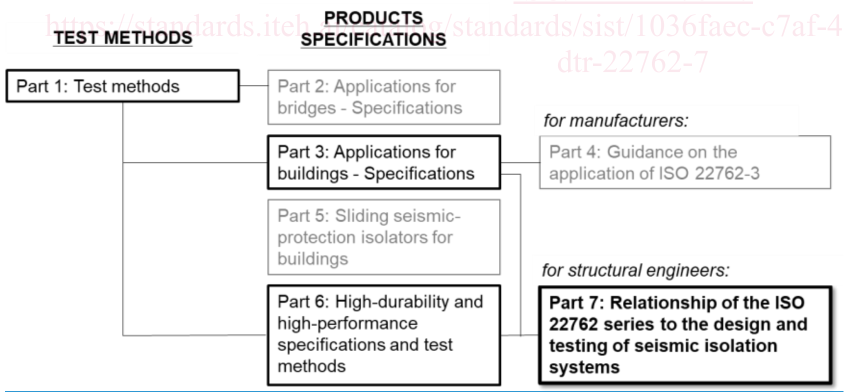
Symbol	Description
X_0	design shear displacement
X_1	maximum positive shear displacement
X_2	minimum negative shear displacement
β_{eff}	effective damping (equivalent viscous damping ratio) of an isolator unit in the horizontal direction at either the Design Earthquake or the Maximum Earthquake level (from seismic code)
γ_0	design shear strain
γ_{max}	maximum design shear strain during earthquake
γ_u	ultimate shear strain under horizontal uniaxial loading
σ_0	design compressive stress
σ_{max}	maximum compressive stress
σ_{min}	minimum compressive stress
[a] The terms “Design Earthquake” and “Maximum Earthquake” are used for simplicity herein to facilitate explanation of concepts and relationships for two earthquake hazard levels. It is recognized that these terms are not directly used by ASCE 7-22 or other building codes. The test parameters presented in subsequent tables (give table numbers) assume that the Design Earthquake demand is 2/3 of the Maximum Earthquake Demand.	

5 ~~5~~Structure of ISO 22762 from perspective of relationship with ~~Part 7~~this document

The relationship between the different parts of ISO 22762 is shown schematically in ~~Figure 2. Part 7~~Figure 2. This document intends to help structural engineers whereas ~~Part~~ ISO 22762-4 ~~to help~~helps manufacturers of elastomeric isolators for buildings.



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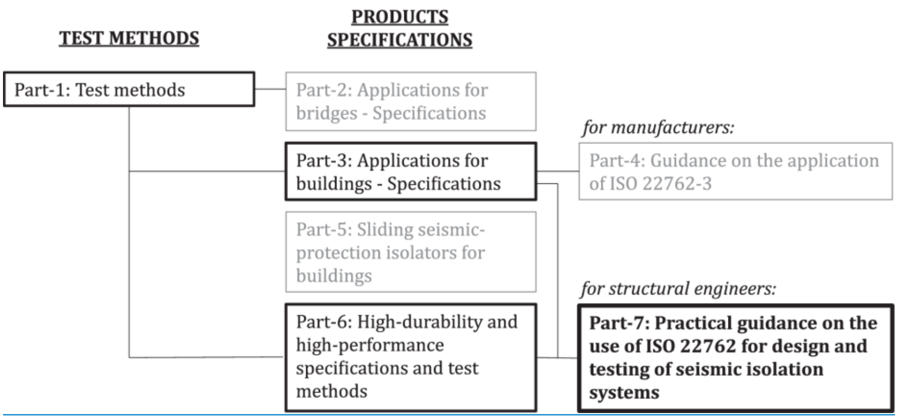

Figure 2 — Relationship of ~~Part 7~~this document and other parts of the ISO 22762 series

6 Application of ISO 22762 to the testing and design requirements of elastomeric isolators given in building codes

6.1 General

When applying the ISO 22762 series for the design of elastomeric seismic isolation bearings it is necessary for the user to relate various design terms and symbols in the seismic code or guideline being followed with the applicable terms and symbols in ISO 22762 series. It is expected that the main users of ISO 22762 series will be structural engineers and that their primary interest will be the testing requirements for the seismic isolators. The types of tests typically required are qualification tests, prototype tests and production tests.

6.2 Correspondence between seismic codes and ISO 22762: ~~key~~Key design terms and definitions

The correspondence between key design terms and definitions commonly used in seismic codes and those used in ISO 22762 series is shown in ~~Table 2.~~Table 2.

Table 2 — Correspondence between seismic codes and ISO 22762: ~~key~~Key design terms and definitions

Seismic code term	ISO 22762 term	Remarks
Qualification test	Type test	All tests and requirements specified in ~~Part3~~ISO 22762-3 or ~~Part6~~ISO 22762-6 are applicable.
Prototype test	Type test	There are minor differences in some definitions of isolator properties between seismic codes and ISO 22762. In such case, similar definition in ISO 22762 is applied.
Production test	Routine test	Some minor differences exist in definition of the properties. In such

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