SLOVENSKI STANDARD
SIST EN 15129:2010

01-januar-2010

Naprave za zagotavljanje potresne varnosti konstrukcij

Anti-seismic devices

Erdbebenvorrichtungen

Dispositifs anti-sismiques

Ta slovenski standard je istoveten z: EN 15129:2009

ICS:

91.120.25	Zaġ ita pred potresi in vibracijami	Seismic and vibration protection

SIST EN 15129:2010 en

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 15129

November 2009

ICS 91.120.25

English Version

Anti-seismic devices

Dispositifs anti-sismiques

Erdbebenvorrichtungen

This European Standard was approved by CEN on 19 September 2009.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Management Centre: Avenue Marnix 17, B-1000 Brussels

Ref. No. EN 15129:2009: E

Contents

Page

Foreword

This document (EN 15129:2009) has been prepared by Technical Committee CEN/TC 340 “Anti-seismic devices”, the secretariat of which is held by UNI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by May 2010, and conflicting national standards shall be withdrawn at the latest by August 2011.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

For relationship with EU Directive(s), see informative Annex ZA, which is an integral part of this document.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

1 Scope

This European Standard covers the design of devices that are provided in structures, with the aim of modifying their response to the seismic action. It specifies functional requirements and general design rules for the seismic situation, material characteristics, manufacturing and testing requirements, as well as evaluation of conformity, installation and maintenance requirements. This European Standard covers the types of devices and combinations thereof as defined in 3.4.

NOTE Additional information concerning the scope of this European Standard is given in Annex A.

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.

EN 1090-2, *Execution of steel structures and aluminium structures – Part 2: Technical requirements for steel structures*

EN 1337 (all parts), *Structural bearings*

EN 1990:2002, *Eurocode – Basis of structural design*

EN 1998 (all parts), *Eurocode 8: Design of structures for earthquake resistance*

EN 10025 (all parts), *Hot rolled products of structural steels*

EN 10083 (all parts), *Steels for quenching and tempering*

EN 10088 (all parts), *Stainless steels*

EN 10204:2004, *Metallic products – Types of inspection documents*

EN ISO 4287, *Geometrical product specifications (GPS) – Surface texture: Profile method – Terms, definitions and surface texture parameters (ISO 4287:1997)*

EN ISO 4526, *Metallic coatings – Electroplated coating of nickel for engineering purposes (ISO 4526:2004)*

EN ISO 6158, *Metallica coatings – Electrodeposited coatings of chromium for engineering purposes (ISO 6158:2004)*

ISO 34 (all parts), *Rubber, vulcanized or thermoplastic – Determination of tear strength*

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 815 (all parts), *Rubber, vulcanized or thermoplastic – Determination of compression set*

ISO 898 (all parts), *Mechanical properties of fasteners*

ISO 1083, *Spheroidal graphite cast irons – Classification*

ISO 3755, *Cast carbon steels for general engineering purposes*

ISO 4664 (all parts), *Rubber, vulcanized or thermoplastic – Determination of dynamic properties*

3 Terms, definitions, symbols and abbreviations

3.1 Terms and definitions

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

NOTE In this European Standard, compressive forces, stresses and strains are positive.

3.1.1
activation velocity
velocity at which a Shock Transmission Unit (STU) reacts with its design force

3.1.2
axial force N_{Ed} acting on a device under the design seismic action
maximum value during the action is denoted $N_{Ed,max}$ and the minimum value $N_{Ed,min}$. The minimum value acting on a device may be tensile

3.1.3
core element
component of a Linear Device (LD) or of a Non Linear Device (NLD) on which the mechanism characterising the device's behaviour is based

NOTE Core elements of a LD or of a NLD are the device's components that provide it with the flexibility and, eventually, with the energy dissipation and/or re-centring capacity or any other mechanical characteristic compatible with the requirements of a LD or of a NLD. Examples of core elements are steel plates or bars, shape memory alloy wires or bars, rubber elements.

3.1.4
design displacement d_{bd} (of a device)
total displacement (due to both translation and rotation about the vertical axis of the isolation system) that a device will undergo when the structural system is subjected to the design seismic action alone according to EN 1998-1

3.1.5
design displacement of an isolation system in a principal direction d_{cd}
horizontal displacement at the effective stiffness centre, occurring under the design seismic action alone

3.1.6
(maximum) displacement of a device in a principal direction d_{Ed}
for an anti-seismic device in a bridge d_{Ed} equals d_{max}, the maximum total horizontal displacement at the location of the device including all actions effects and the application of the reliability factor to d_{bd}, according to EN 1998-2:2005, 7.6.2 (2)P

For devices in other structures d_{Ed} equals $\gamma_x\, d_{bd}$, the design displacement increased by the reliability factor.

3.1.7
design force V_{bd} (of a device)
force (or moment) corresponding to d_{bd}

3.1.8
devices
elements which contribute to modify the seismic response of a structure by isolating it, by dissipating energy or by creating permanent or temporary restraints via rigid connections. The devices considered are described in the various clauses of this European Standard

3.1.9
ductility demand (of a device)
displacement ductility demand referred to the theoretical bilinear cycle, and is evaluated as d_{bd}/d_1 (see 3.1.4 and 3.1.44)

NOTE The ductility demand is a useful parameter to evaluate the plastic demand of an EDD based on material hysteresis (see 3.1.17).

3.1.10
effective damping (of a device) ξ_{effb}
value of the effective viscous damping, corresponding to the energy dissipated by the device during cyclic response at the total design displacement:

$$\xi_{effb} = W(d_{bd}) / (2\pi\, V_{Ebd}\, d_{bd}) \tag{1}$$

where

$W(d_{bd})$ = energy actually dissipated by a device during the 3rd load cycle, with maximum displacement equal to d_{bd}.

NOTE ξ_{effb} is introduced for a simple characterisation of the behaviour of any device. It cannot be used in the analytical calculations of the response of the structural system, unless they can be carried out by linear analysis and all the devices have the same damping and stiffness in the given direction. Where different devices are used, reference is made to the overall effective damping of the isolation system.

3.1.11
effective period T_{eff}
in the case of seismic isolation, is the period of a single degree of freedom system moving in the direction considered, having the mass of the superstructure and the stiffness equal to the effective stiffness of the isolation system

3.1.12
effective stiffness of a device in a principal direction K_{effb}
ratio between the value of the total horizontal force transferred through the device and the component of the total design displacement in the same direction, divided by the absolute value of the total design displacement (secant stiffness)

$$K_{effb} = V_{Ebd} / d_{bd} \tag{2}$$

NOTE K_{effb} is introduced for a simple characterisation of the behaviour of a device. It cannot be used in the analytical calculations of the response of the structural system, unless they can be carried out by linear analysis and all the devices have the same damping and stiffness in the given direction. Where different devices are used, reference is made to the overall effective stiffness of the isolation system.

3.1.13
effective stiffness of an isolation system in a principal direction K_{eff}
sum of the effective stiffness of the devices located at the isolation interface

3.1.14
effective stiffness centre
stiffness centre of an isolation system, accounting for the effective stiffness of the devices

3.1.15
energy dissipation design
design approach in which mechanical elements are introduced at certain locations of the structure to dissipate the energy which is introduced into the structure by an earthquake

3.1.16
energy dissipation capacity
ability of a device to dissipate energy during the load-displacement cycles

3.1.17
energy dissipating device (EDD)
device which has a large energy dissipation capacity, i.e. which dissipates a large amount of the energy stored during the loading phase. After unloading it normally shows a large residual displacement. A device is classified as EDD if the equivalent viscous damping ξ is greater than 15 %

3.1.18
first branch stiffness K_1 of a NLD
initial stiffness of a NLD is defined as the secant stiffness between the points corresponding to the forces $V_{Ebd}/10$ and $V_{Ebd}/5$:

$$K_1 = (V_{Ebd}/5 - V_{Ebd}/10) / [d(V_{Ebd}/5) - d(V_{Ebd}/10)] \qquad (3)$$

NOTE K_1 is referred to as initial or elastic stiffness when dealing with softening devices.

3.1.19
Fluid Viscous Damper (FVD)
anti-seismic device whose output is an axial force that depends on the imposed velocity only; its principle of functioning consists of exploiting the reaction force of a viscous fluid forced to flow through an orifice and/or valve system

3.1.20
Fluid Spring Damper (FSD)
anti-seismic device whose output is an axial force that depends on both imposed velocity and stroke; its principle of functioning consists of exploiting the reaction force of a viscous fluid forced to flow through an orifice and valve system and at the same time is subjected to progressive compression

3.1.21
Hardening Device (HD)
NLD whose effective stiffness K_{effb} and second branch stiffness K_2 are greater than the first branch stiffness K_1

3.1.22
Hydraulic Fuse Restraint (HFR)
Hydraulic Fuse Restraints are SRs whose behaviour is hydraulic in nature and depends upon the opening of relief valves

3.1.23
stiffness K_1 of a LD
stiffness of a LD is defined as the secant stiffness between the points corresponding to the forces $V_{Ebd}/10$ and $V_{Ebd}/5$:

$$K_1 = (0{,}2 \cdot V_{bd} - 0{,}1 \cdot V_{bd})/[d_{(0,2Vbd)} - d_{(0,1Vbd)}] \qquad (4)$$

NOTE The evaluation of K_1 as secant stiffness is justified by the difficulty of tracing the tangent to a curve at the origin in an experimentally drawn diagram.

3.1.24
isolation system
collection of devices used for providing seismic isolation

3.1.25
isolation interface
in the case of seismic isolation, the surface which separates the substructure and the superstructure and where the isolation system is located

3.1.26
isolator
device possessing the characteristics needed for seismic isolation, namely, ability to support gravity load of superstructure, and ability to accommodate lateral displacements. Isolators may also provide energy dissipation, and contribute to the isolation system's recentring capability

NOTE In EN 1998-2, isolator may also designate the devices belonging to an isolation system, whether they support gravity loads or not.

3.1.27
linear device (LD)
anti-seismic device which is characterised by a linear or almost linear load-displacement relationship up to the displacement d_{bd}, with a stable behaviour under a large number of cycles and substantial independence from velocity. After unloading, it does not show a residual displacement. Even when some energy dissipation occurs in the device, residual displacements shall be negligible, and in any case less than 2 % of the maximum displacement

NOTE For visco-elastic devices, residual displacements can be partially or totally recovered after some hours. In this case, the final residual displacement should be referred to.

3.1.28
Mechanical Fuse Restraint (MFR)
SR whose behaviour is determined by the break-away of sacrificial components

3.1.29
Non Linear Device (NLD)
anti-seismic device which is characterised by a non linear load-displacement relationship, with a stable behaviour under the required number of cycles and substantial independence from velocity. A device is classified as non linear if either ξ_{effb} is greater than 15 % or the ratio $|K_{effb} - K_1|/K_1$ is greater than 20 %, where ξ_{effb} and K_{effb} are evaluated at the 3rd cycle with maximum displacement equal to d_{bd}

3.1.30
Non linear Elastic Devices (NLED)
NLD which normally dissipates a negligible amount of the energy stored during the loading phase. The static residual displacement after unloading shall be negligible. A device is classified as NLED if ξ_{effb} is less than 15 % while the ratio $|K_{effb} - K_1|/K_1$ is greater than 20 %

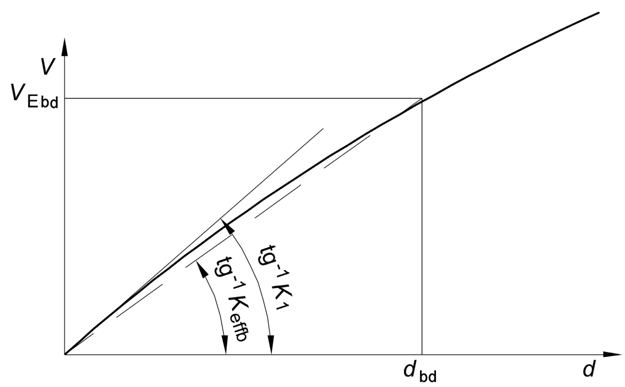

Figure 1 — Initial and effective stiffness of a linear device

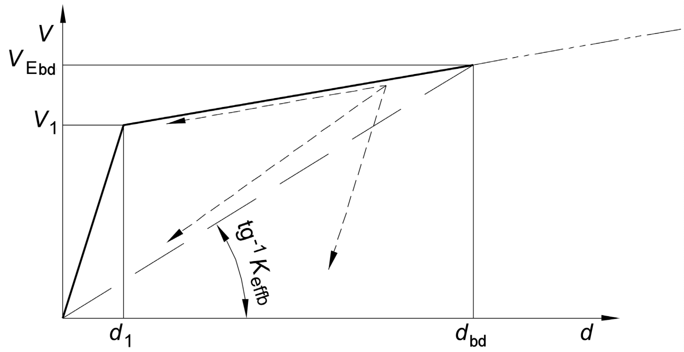

Figure 2 — Effective stiffness of a non linear device

3.1.31
Permanent Connection Device (PCD)
device which provides steady restraint in one or two horizontal directions, accommodates rotations and vertical displacements, i.e. does not transmit bending moments and vertical loads; the device which restrains the movements in one horizontal direction only is referred to as Moveable Connection Device, while the device which restrains the movements in two horizontal directions is defined as Fixed Connection Device

NOTE In certain circumstances, the above devices may be required to operate in a plane inclined to the horizontal. In such case, the terms "vertical" and "horizontal" take on the appropriate significance.

3.1.32
Rigid Connection Device (RCD)
device which links two structural elements without transmitting bending moments and vertical loads; this category of devices includes Permanent Connection Devices (see 5.1), Fuse Restraints (see 5.2) and Temporary Connection Devices (see 5.3)

3.1.33
Fuse Restraint (FR)
device that, below a certain pre-established force threshold (break-away force), prevents any relative movement between connected parts, whilst it permits movement after the aforesaid threshold has been exceeded

3.1.34
second branch stiffness K_2
parameter referred to the theoretical bilinear cycle and defined as (see Figure 2):

$$K_2 = [V_{Ebd} - V_{(0,5 \cdot dbd)}] / (0,5 \cdot d_{bd}) \quad (5)$$

where

$V_{(0,5 \cdot dbd)}$ is the force corresponding to $(0,5 \cdot d_{bd})$ at the 3rd cycle of the test

NOTE 1 The formula is obtained by evaluating the second branch stiffness as a secant stiffness referred to displacements $0,5 \cdot d_{bd}$ and d_{bd}.

NOTE 2 K_2 is often referred to as post-elastic stiffness when dealing with softening devices.

3.1.35
seismic isolation
design approach in which appropriate mechanisms (isolation systems) are provided at a certain level of the structure to decouple the part of the structure located above this level, therefore modifying the seismic response of the structure and its contents

3.1.36
service life of a device
period over which a device is expected to perform within its specified parameters. The value is taken as that given in Technical Specifications of the Project, based on declarations made by manufacturers

NOTE Additional information concerning the service life is given in informative Annex B.

3.1.37
Shock-Transmission Unit (STU)
device whose output is an axial force that depends on the imposed velocity; its principle of functioning consists of exploiting the reaction force of a viscous fluid forced to flow through an orifice in order to provide a very stiff dynamic connection whilst for low velocity applied loads the reaction is negligible

3.1.38
Softening Device (SD)
NLD whose secant stiffness K_{effb} and second branch stiffness K_2 are smaller than the first branch stiffness K_1

3.1.39
Statically Re-centring Device (StRD)
Energy Dissipating Device whose force-displacement cyclic curve at the 3rd cycle passes through or very near the origin of the axes, at a distance not greater than 0,1 d_{bd}

3.1.40
substructure
in the case of seismic isolation, the part of the structure which is located under the isolation interface and is anchored to the foundations

3.1.41
superstructure
in the case of seismic isolation, the part of the structure which is isolated and is located above the isolation interface

3.1.42
Supplemental Re-centring Device (SRCD)
device whose force-displacement cyclic curve at the 3rd cycle passes through or very near the origin of the axes and, for small displacement at unloading (0,1 d_{bd}), provides a force which is at least 0,1 V_{Ebd}

NOTE The supplemental force > 0,1 V_{Ebd} is meant to counteract the effect of parasitic non-conservative forces (e.g. friction in other devices, yielding in structural elements, etc.) or other energy dissipating non re-centring devices, in order to provide the entire structural system with an overall Re-centring capability. The supplemental force is calibrated according to the re-centring requirements of the structural system.

3.1.43
Temporary Connecting Device (TCD)
anti-seismic device whose output is a force that depends on the imposed velocity; its principle of functioning consists of a system providing for the required reaction force when dynamically activated whilst for slow applied movements it does provide a minor reaction

3.1.44
theoretical bilinear cycle of a NLD
it is conventionally defined to identify the main mechanical characteristics of a non linear device through the first and second branch stiffness values and by the following parameters:

d_1 = abscissa of the intersection point of the straight line starting at the origin with stiffness K_1 and the straight line passing through (d_{bd}, V_{Ebd}) with stiffness K_2 in the experimental 3rd load cycle of a quasi static test;

V_1 = ordinate of the intersection point of the straight line starting at the origin with stiffness K_1 and the straight line passing through (d_{bd}, V_{Ebd}) with stiffness K_2 in the experimental 3rd load cycle of a quasi static test;