EC8-2G

Il nuovo standard europeo per la progettazione sismica

EUCENTRE FOR YOUR SAFETY.

reluis

Dispositivi antisismici

EN1998-1-2, EN1998-1-101

Strutture dotate di sistemi di isolamento/dissipazione e prestazioni dei dispositivi antisismici

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TC250-SC8, Liason TC340 «Antiseismic Devices»

Pavia - 5 Giugno 2025

EC8:2004 vs EC8:2024 : Scope

- **2004** EN1998:2004 section 10 to buildings where *all* devices sit on a single isolation interface and *explicitly excluded* "passive energy-dissipation systems … distributed over several storeys" .

- **2024** introduces § 6.8.1 which applies to **rigid connection, displacement-dependent, velocity-dependent devices and isolators – in any combination –** for fully or partially isolated structures as well as for ordinary buildings fitted with dampers.

- The definitions of EN15129:2009 "*Antiseismic Devices*" are recalled

- **Implication:** hybrid layouts (e.g. isolators plus viscous dampers, or storey-by-storey hysteretic links) are now codified rather than falling into a grey zone.

EC8:2004 vs EC8:2024 : Scope

Main innovation of EC8-2G in design of structures equiped with antiseismic devices

- Risk based definition of reliability factors
- Re-centering verification
- Modelling approaches
- Brand new section dedicated to supplemental dumping system
- Isolation dealt in EN1998-1-1, EN1998-1-2(Buildings), EN1998-2(Bridges), and other relevant parts

EC8:2004 vs EC8:2024 : Terminology & classification

From two definitions to a taxonomy

- 2004 defined only *isolation system* and *isolation interface*

- 2024 adds a formal glossary (3.1) that differentiates *displacement-dependent device*, *velocity-dependent device*, *isolator*, and retains *anti-seismic device* as an umbrella term

- Designers therefore reference an agreed typology and can link directly to the performance tests in **EN 15129** required by § 6.8.2.3

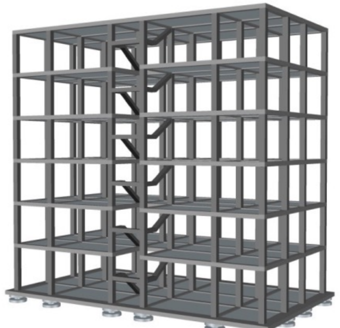
EC8 2G - Reliability framework

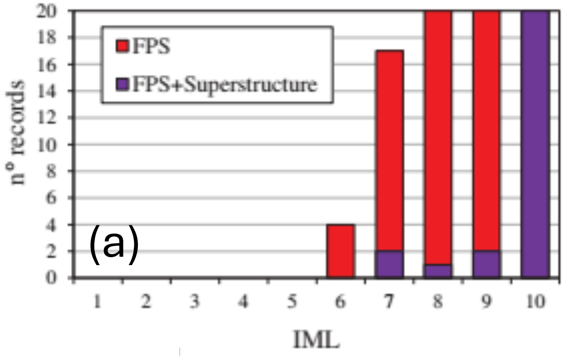
Key aspects

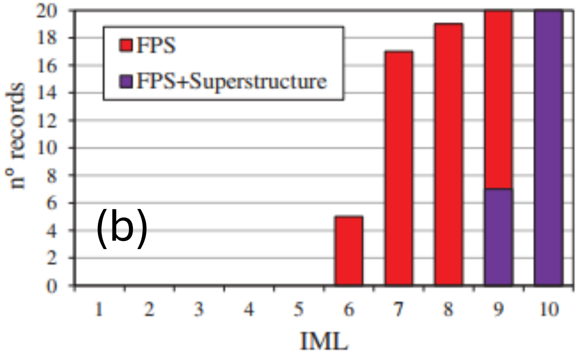
- **From hazard- to risk-based design** – Modern codes are shifting from simple hazard levels to explicit reliability targets. Europe's second-generation Eurocode 8 ties both seismic input and partial safety factors to target reliability — something missing from the first generation (EN1998-1-1: Annex F)
- **EC8:2004 required "increased reliability"** by multiplying isolation displacements by a $\boldsymbol{\gamma}_x$ factor not tied-in to limit states to be defined in National Annexes ($\boldsymbol{\gamma}_x$ =1.2 recommended for buildings, $\boldsymbol{\gamma}_x$ =1.5 for bridges).
- **Observed reliability gap** – Recent studies on Italian archetype buildings show that, under first-generation Eurocodes, isolated structures meet serviceability goals better than fixed-base ones yet exhibit **higher collapse risk** beyond the design intensity due to limited over-strength.
- **Implementation of a new approach** – Derive a risk-targeted amplification factor $\boldsymbol{\gamma}_x$ for device design that equalizes the reliability of isolated and fixed-base buildings in Eurocode 8-2G. The study:
  - γ_x factors were calibrated using the same reliability framework adopted for new displacement-based partial factors.
  - γ_x factors were validated via multiple-stripe nonlinear time-history analyses on different case-studies buildings equipped with experimentally calibrated LRB, HDRB and FPS models

EC8 2G - Reliability framework

The analysed building has six storeys and risk is calculated considering (a) record-to-record variability or (b) both record-to-record var. + model uncertainty (in particular, uncertainty on friction coefficient)







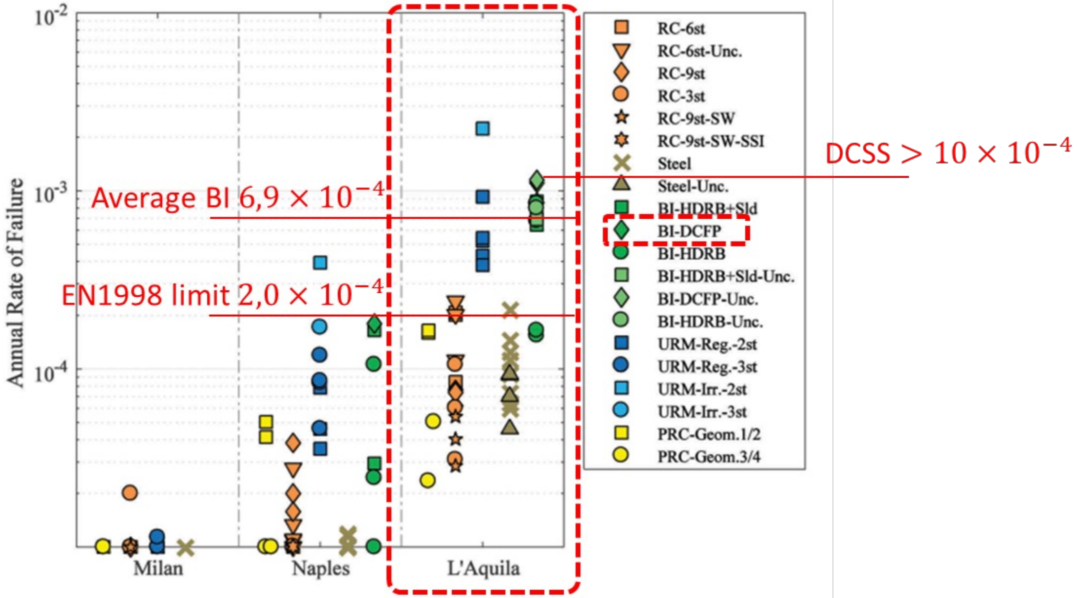


Figure 11. Global collapse failure rates (soil C-type).

The average annual probability of GC (>NC) isolated structures exceeds the threshold in EN1998-1-1, and that of DCSS is one order of magnitude larger

Table 3. Average global collapse failure rates per structural typology and per site.

	C-type			A-type		
	Milan	Naples	L'Aquila	Milan	Naples	L'Aquila
URM	1.02E−05	1.15E−04	8.41E−04	1.00E−05	9.33E−05	5.11E−04
PRC	1.00E−05	2.80E−05	9.98E−05	1.00E−05	3.03E−05	8.84E−05
RC	1.08E−05	1.38E−05	8.56E−05	–	–	8.02E−05
S	1.00E−05	1.05E−05	1.12E−04	1.00E−05	1.00E−05	4.50E−05
BI	–	8.59E−05	6.93E−04	–	–	–

EC8 2G - Reliability framework

Calibration of γ_x

- According to Eurocode 8 (both first and second generation), the isolation devices should be verified for the seismic action effect amplified by the value $\boldsymbol{\gamma}_x$.
- Since in the device verifications no resistance-side partial factor is used, the safety margins are lumped on the load-side, symmetrically to what is done in displacement-based verifications of structural members (presentation of prof. Paolo Franchin). The reliability factor for the isolation system is then obtained by combining the expression of $\boldsymbol{\gamma}_E$ and $\boldsymbol{\gamma}_R$

$$\gamma_E = \exp[(\alpha_E \beta_t - \kappa_E)\sigma_{\ln E}] = \exp(\beta_t \alpha_E^2 \sigma_{tot}) \exp(-\kappa_E \sigma_{\ln E})$$

$$\gamma_R = \exp(\alpha_R \beta_t \sigma_{\ln R}) = \exp(\beta_t \alpha_R^2 \sigma_{tot})$$

$$\gamma_x = \gamma_E \gamma_R = \exp[\beta_t \sigma_{tot} - \kappa_E \sigma_{\ln E}] = \exp[\beta_t \sigma_{tot} - \kappa_S b \sigma_{\ln S}]. \quad \Rightarrow \beta = \frac{\ln \gamma_x + \kappa_S(T_R) b \sigma_{\ln S}}{\sigma_{tot}}$$

To meet the target reliability for the NC-LS of 2×10^{-4}/year or β_t=2.33 (EC8 for Ordinary structures) one should use

T_r	γ_x	β
475	1.5	1.76
475	2.2	2.16
1600	1.5	2.28

γ_x EC8 1/2G vs other codes of practice

	EN1	IT	EN2	NZ	USA
γ_x	1.2	1.0	1.5	1.0	1.07
T_R	475	975	475	2500	2475
κ_S	1.282	1.645	1.282	2.058	2.054
β	1.42	1.46	1.76	1.83	1.93
$p_{f1}(\times 10^{-4})$	16	15	8	6.8	5.4

Record-to-record variability $\sigma \ln E/S=0.3$, (Franchin and Noto 2023a) $k=3$ value used before, and $b=1$ appropriate for displacement responses

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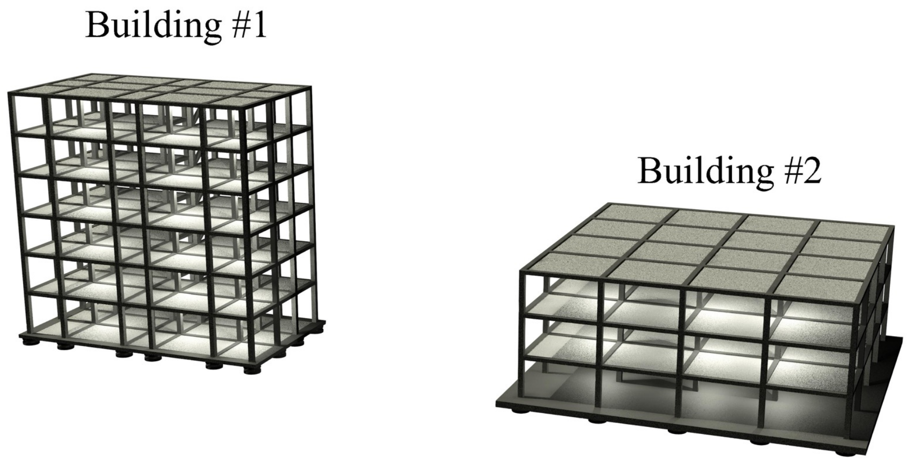
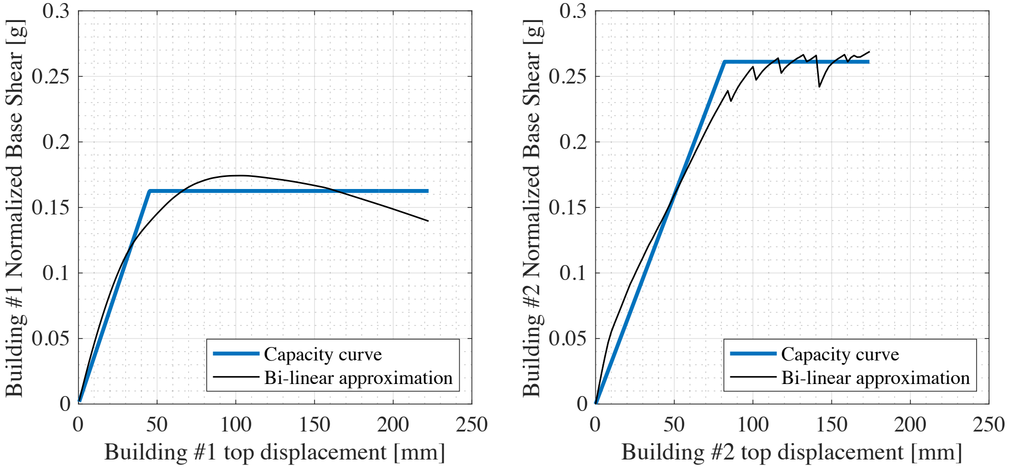
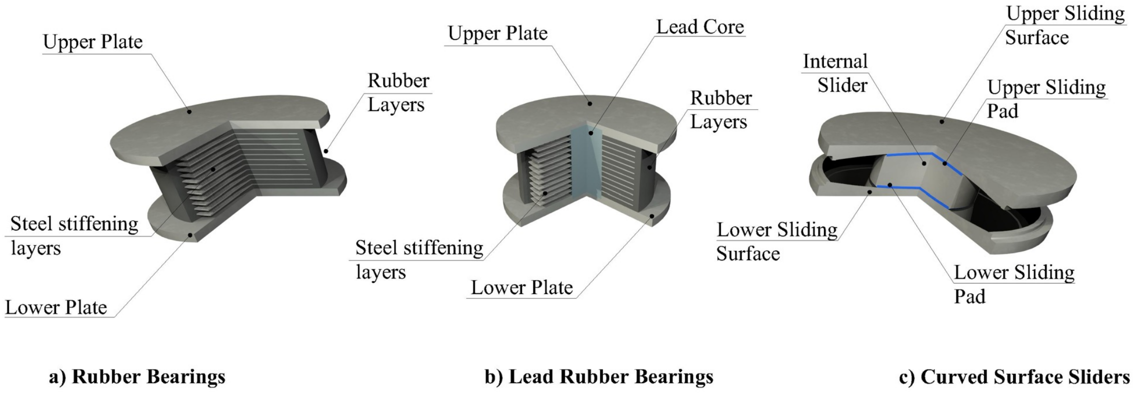
EC8 2G - Reliability framework

A refined numerical reliability analysis was carried out for two case studies employing IRHAs in a multiple-stripe framework (Jalayer and Cornell 2009)



Push-over curves



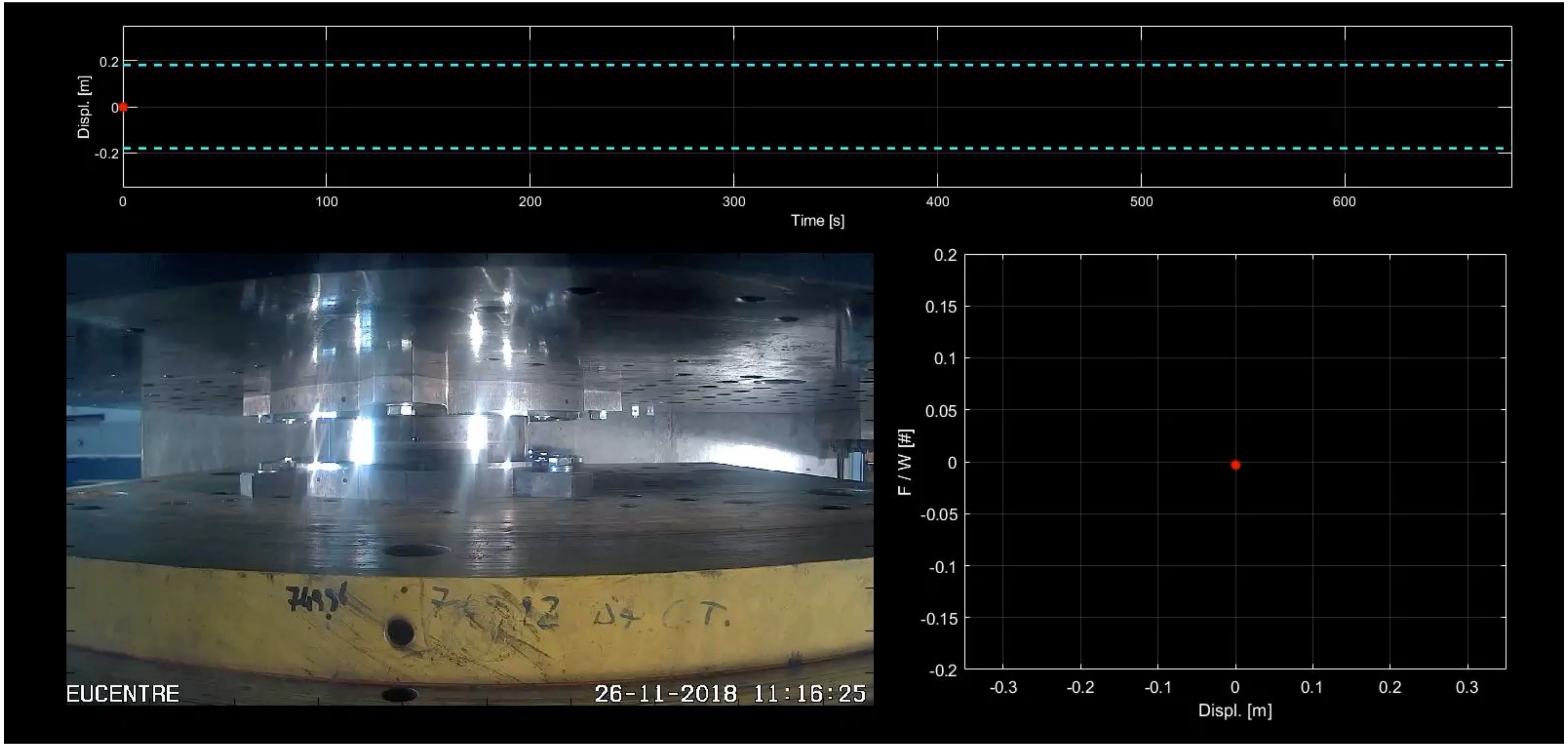


For all typologies, two different values of the design return period T_R have been considered,

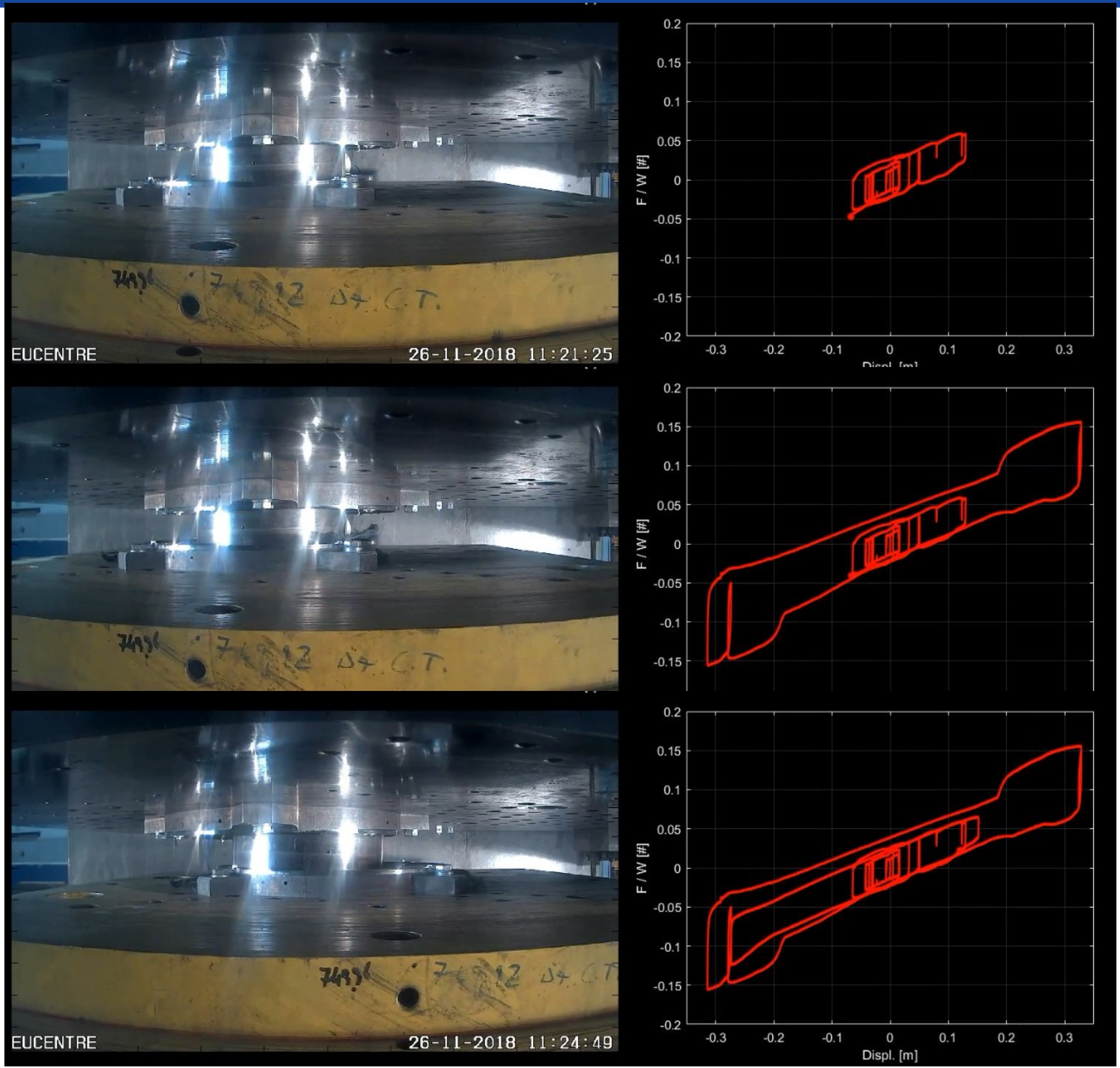
- 475 years (SD-LS)
- 1600 years (NC-LS)

Device response calibrated using experimental results

CSS Extra stroke cyclic response



EC8 2G - Reliability framework

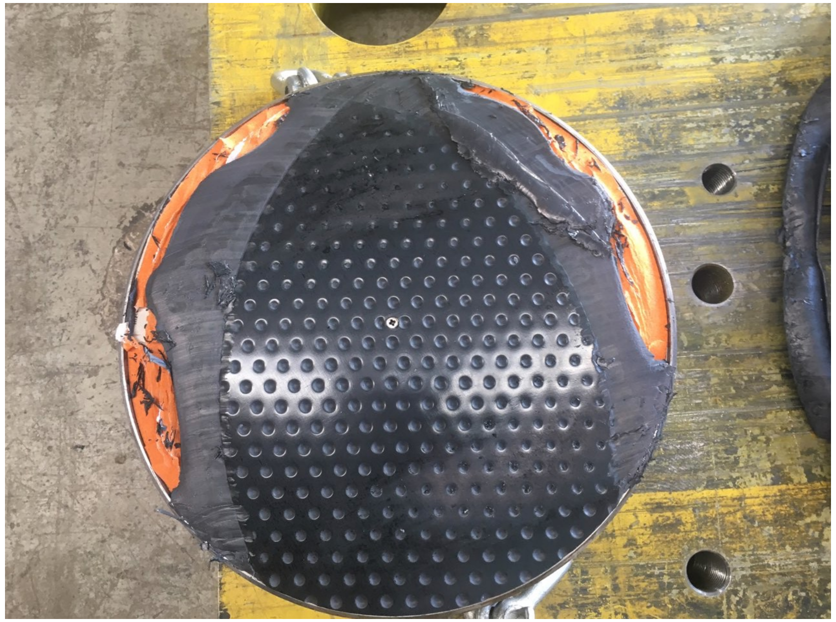


Device response calibrated using experimental results

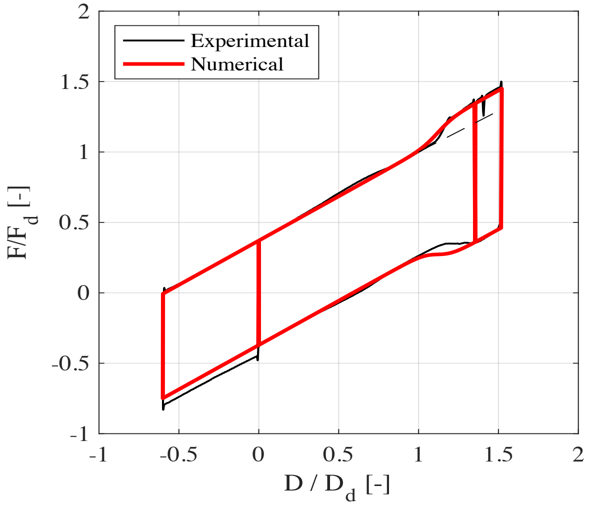
CSS Extra stroke cyclic response

The behavior of the device after the extra stroke is superimposable to that of the initial phase

EC8 2G - Reliability framework

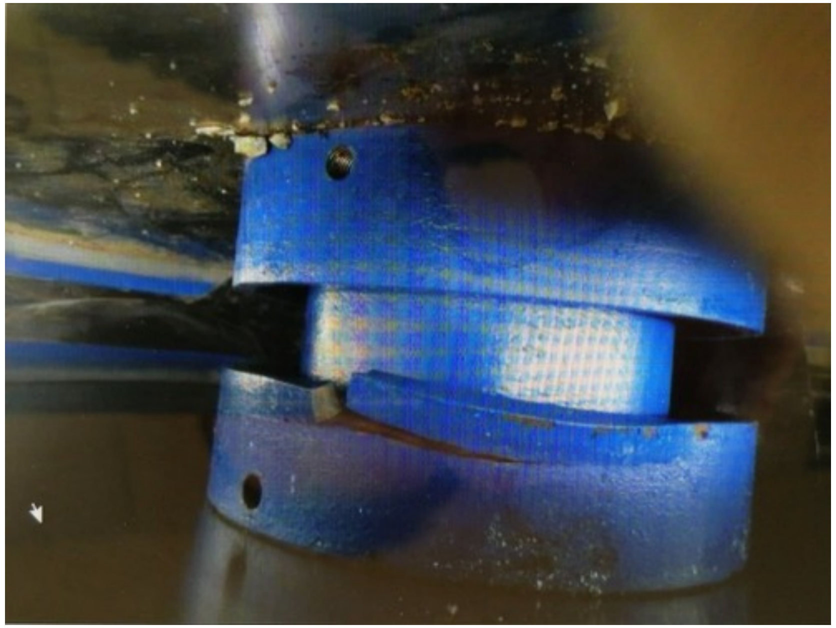


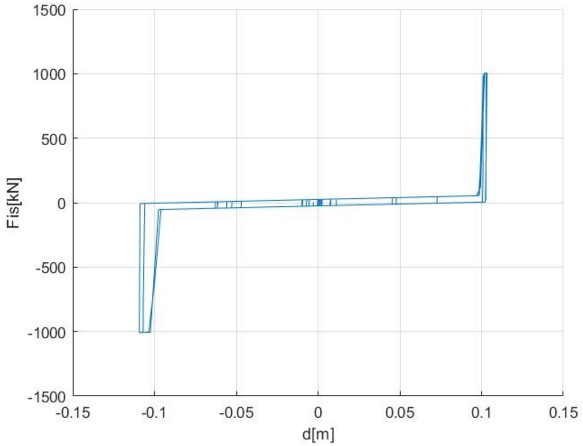
CSS design philosophies comparison



Cyclic model

Inner pad damage after extra stroke





External surrounding ring damage after inner pad impact

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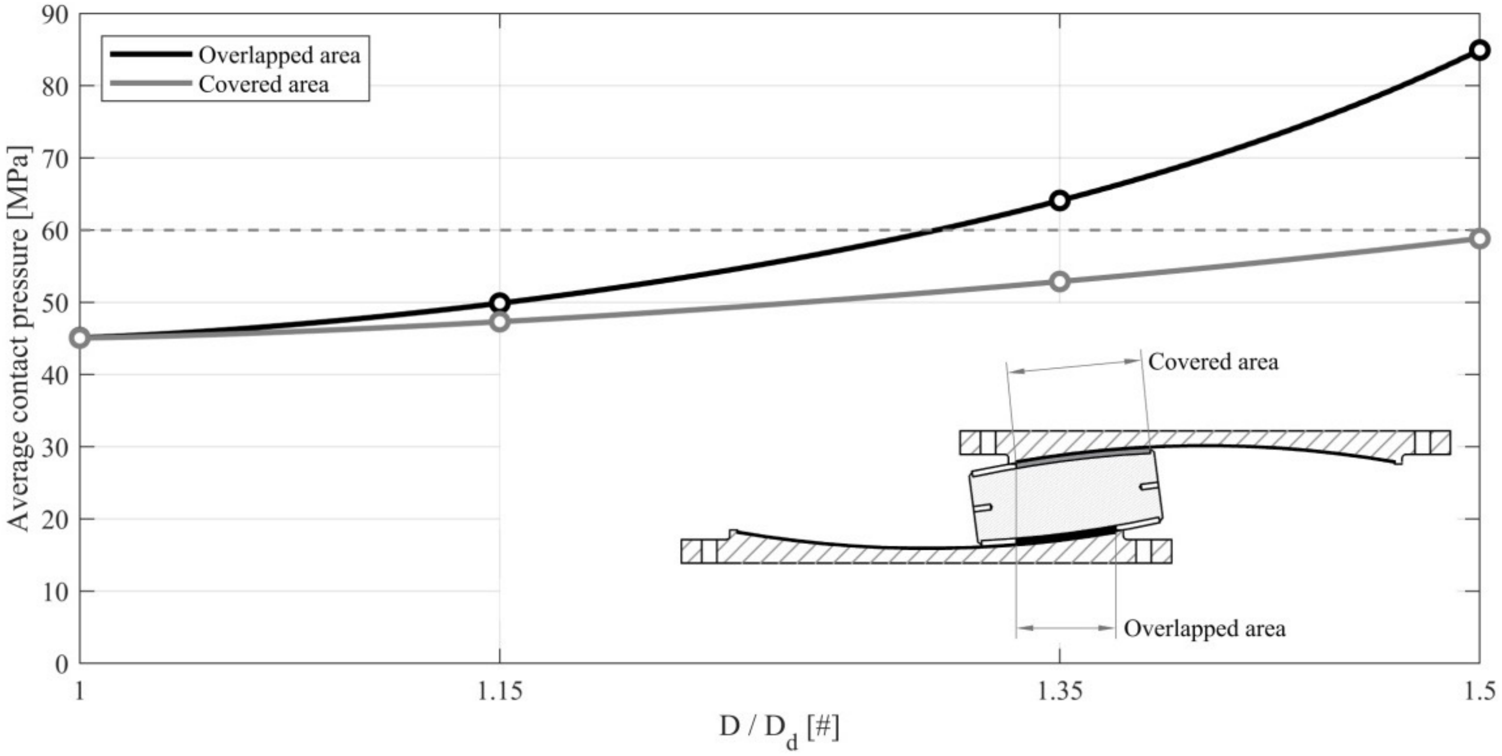
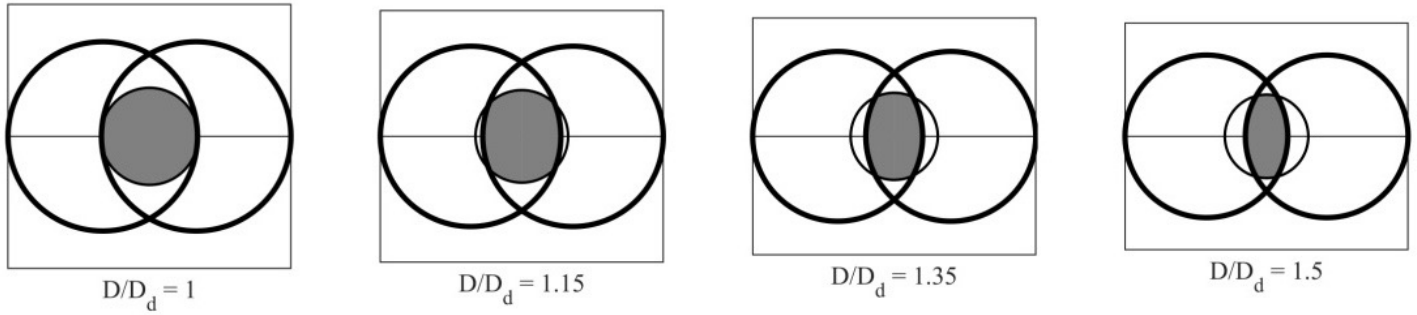
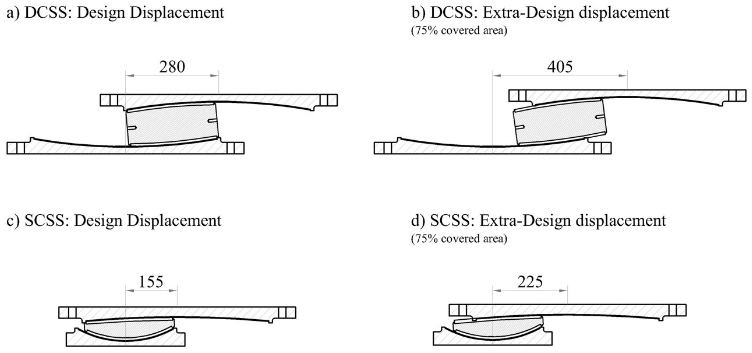
EC8 2G - Reliability framework

Trend of the vertical pressure distribution on the sliding surfaces.

Extra stroke must be compatible with device stability



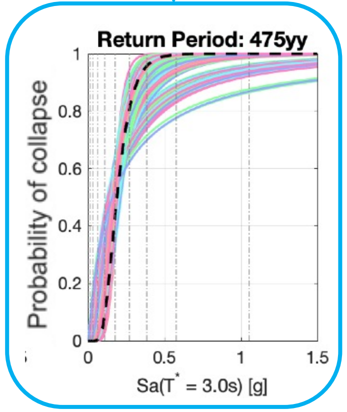


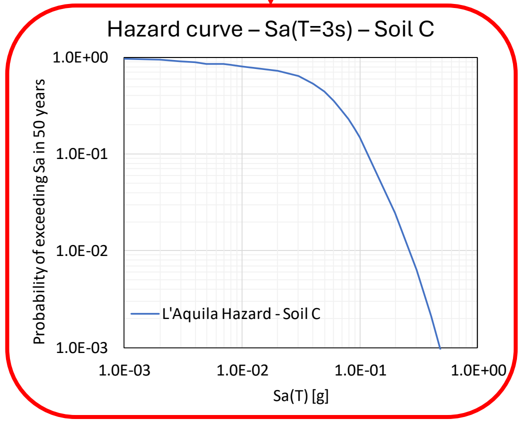


EC8 2G - Reliability framework

Risk analysis of Buildings 1 and 2
For each strip, analyses with 20 accelerograms were performed, for each accelerogram 1000 different random extractions of the properties of the devices were assumed. Considering 2 structures, 2 return periods, 3 different types of device, the total number of analyses carried out is 2400000

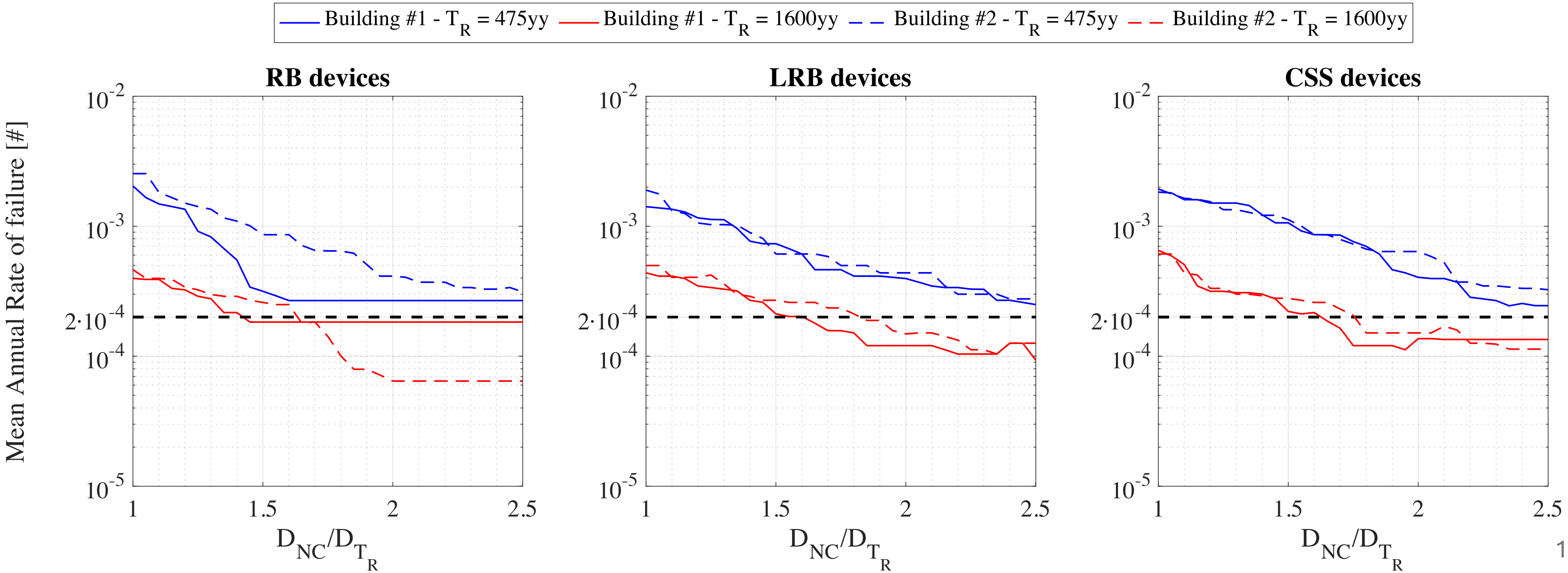
$$\lambda_f = \int_{IM} \boxed{P[f|IM = im]} \cdot \boxed{|d\lambda_{im}|}$$





IML [#]	1	2	3	4	5	6	7	8	9	10
T_R [years]	10	50	100	250	500	1'000	2'500	5'000	10'000	100'000
Sa(T*) [g]	0.0002	0.011	0.031	0.062	0.11	0.177	0.271	0.384	0.576	1.053

Annual rate of Failure vs normalized extra-stroke demand



D_{T_R}=design displacement capacity

D_{NC}=mean of max displacement from NL simulations

EC8 2G - Reliability framework

- The partial safety factor to be adopted in the design of the antiseismic devices values are derived from the reliability target of β_t=2.33 - reliability index in 50 years, corresponding to a probability in the same period of 1% or, equivalently, to an annual probability of 2×10^{-4} - set in the second-generation Eurocode 8 for the Near Collapse limit state of Ordinary structures.

- The study performed was shown that to meet the target, one should either use γ_x=1.5 applied in conjunction with T_R=1600 years (the intensity specified for NC) or T_R= 475 years specified for the Significant Damage limit state verification but use γ_x=1.85 . Considering that the first-generation Eurocode 8 used γ_x=1.2 in conjunction with T_R= 475 years, these values seem quite large, but these values are also confirmed by refined numerical assessment with experimentally-based models of the isolators, for all the considered device types (HDRB, LRB, DCSS) from European practice.

- For EC8-2G has been adopted the combination T_R= 475 and γ_x=1.85

EC8 2G - Reliability framework

(Main) Performance requirements (EN1998:2024 - 6.8.2.1)

- The anti-seismic devices and their connections to the structure shall be designed with increased reliability.
- The isolators used in isolation systems should be able to transmit vertical loads at NC limit state.
- NOTE The performance requirement for isolation devices at NC is to ensure safe transmission of vertical forces, even if sustaining some degree of damage. This implies that a sufficient support, in terms of geometry and resistance at ultimate, is maintained at NC. Behaviour at the attainment of the design displacement and beyond (extra-stroke displacement) depends on the isolator type. For example, curved surface sliders can provide the minimum required overlap area to transmit vertical forces with different extra-stroke displacement, depending on the slider diameter and the number of sliding surfaces.
- Dampers should provide stable energy dissipation at the NC limit state.

- NOTE Behaviour at the attainment of the design displacement and beyond (extra-stroke displacement) depends on the damper type. Dampers working in axial deformation can buckle beyond the design displacement and stop working, while dampers working in shear can provide dissipation beyond the design displacement.

EC8 2G - Reliability framework

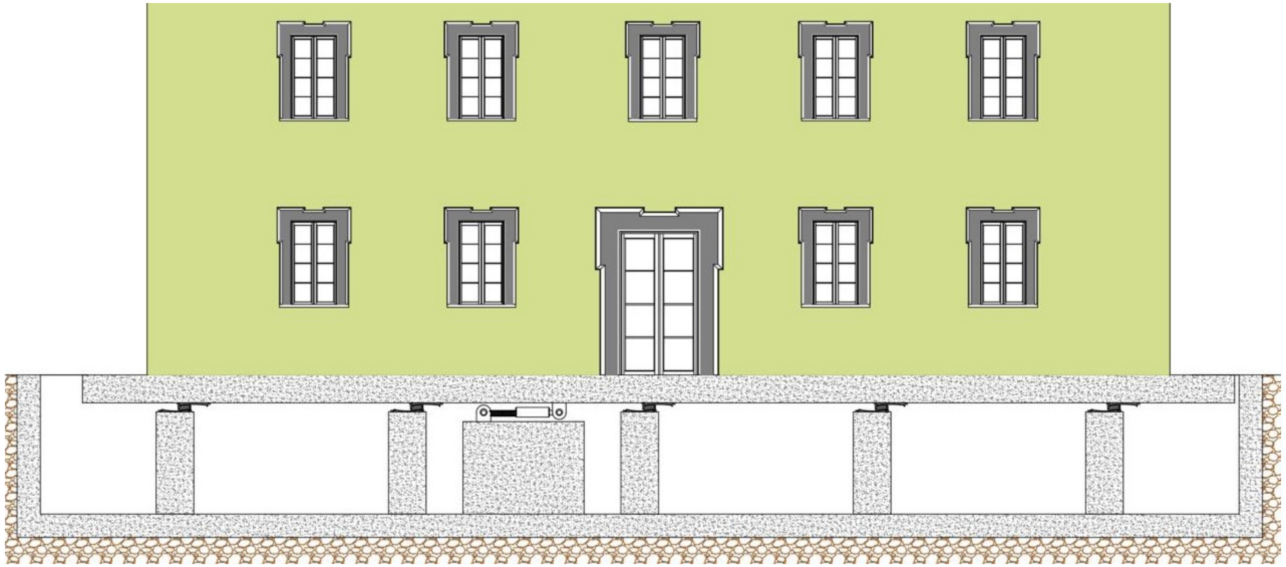
(Main) Compliance criteria for antiseismic devices (EN1998:2024 - 6.8.2.2)

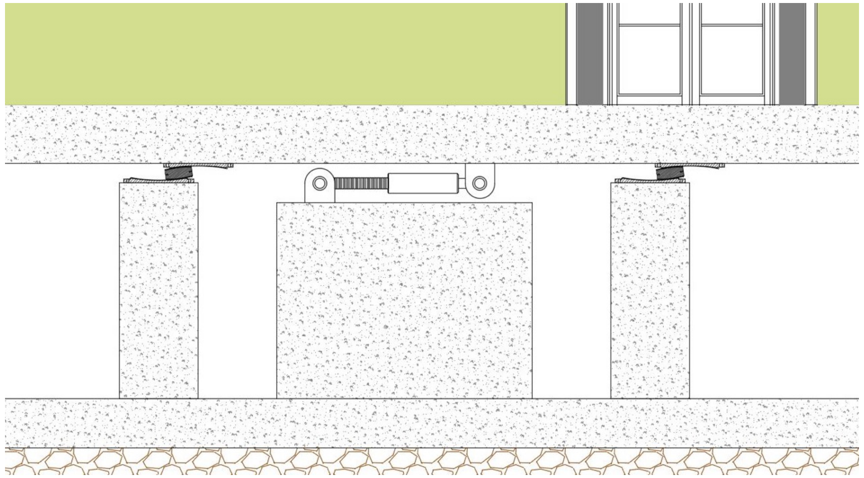
- The performance requirements may be considered satisfied if the anti-seismic devices and their connections to the substructure and the superstructure are designed for seismic displacements and velocities increased by an amplification factor γ_x.
- NOTE 1 The value of γ_x is given in the relevant part of Eurocode 8.
- NOTE 2 The amplification factor increases the action effects in the seismic design situation at SD limit state to cover for NC performance requirements and ensures approximate attainment of the values of target reliability suggested in Annex F.
- In fully isolated structures, the capacity design requirement may be considered satisfied if the superstructure and substructure are designed for amplified seismic action effects so that the total horizontal force in the isolation system in the direction under consideration corresponds to the displacements and/or velocities of the anti-seismic devices at SD, increased by an amplification factor equal to γ_x.
- If an isolator can displace beyond the design displacement while supporting the vertical loads without violating its mechanical stability, the amplification factor γ_x can be lowered by the ratio between the extra-stroke displacement and the displacement capacity. In the case of sliding devices, this condition can be considered satisfied if the ratio between the overlapping area and the area in the non-deformed configuration is not less than 0.80.
- If a damper can displace beyond the design displacement providing an equivalent viscous damping ratio not lower than 0,8 of that provided at the design displacement without incurring in stability problems, the amplification factor γ_x may be lowered by the ratio of the extra-stroke displacement and the displacement capacity.

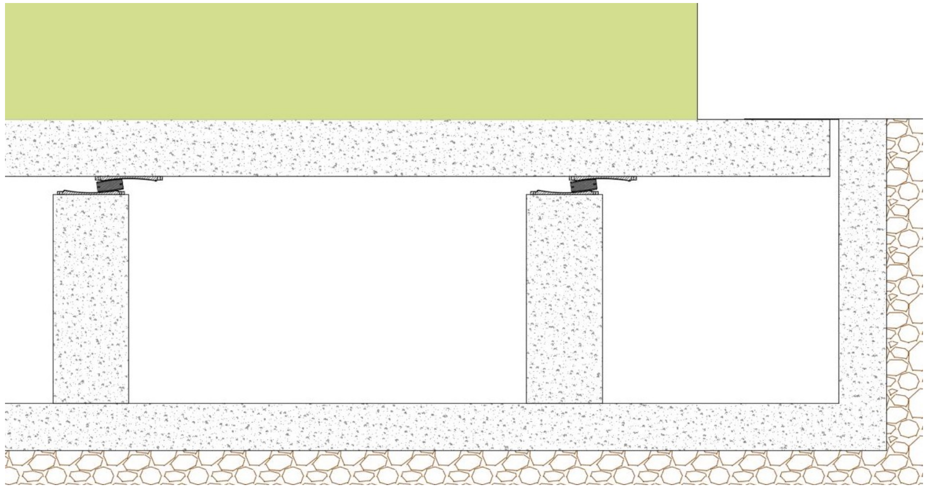
EC8 2G - Reliability framework

(Main) Compliance criteria for antiseismic devices (EN1998:2024 - 6.8.2.2)

- structure should be designed to accommodate without impacts the relative design displacement, considering the amplification factor specified in (4). Gas lines and other hazardous lifelines crossing these joints should be designed to accommodate safely these relative displacements.







From SDOF equivalent linear to four graded methods

The 2024 draft turns the single “equivalent-linear or time-history” choice of 2004 into a **four-tier hierarchy**.
Clause 6.8.5 of EN 1998-1-1:2024 lists the methods in increasing order of complexity

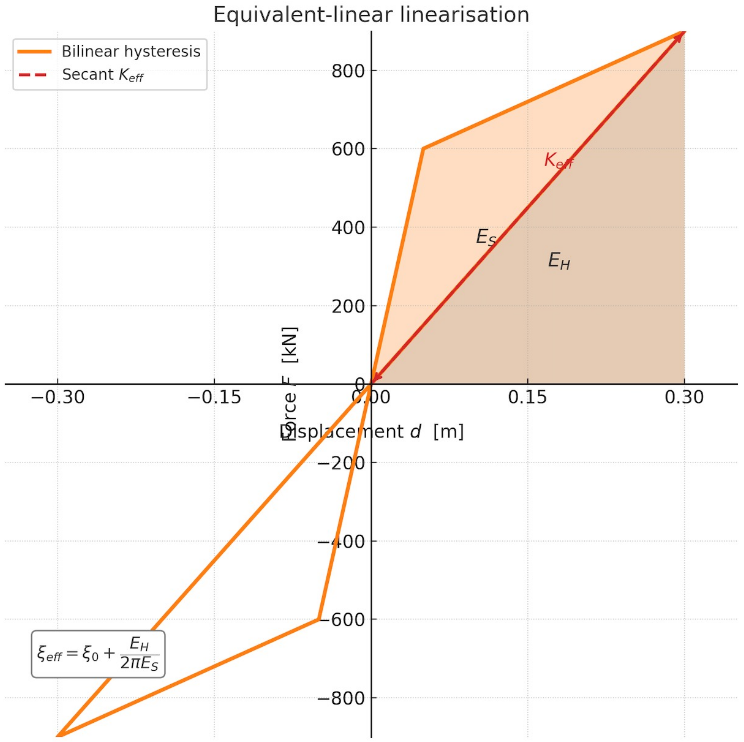
Level 1 - Predominant-mode

Linearization and Equivalent-linear Response-Spectrum

- Fully isolated structure modelled as SDOF per horizontal axis.
- Eligibility (all must hold):
- a) Isolation system equivalent-linear (6.8.5.2).
- b) Higher-mode mass ≤ 10 % (first-mode ≥ 90 %).
- c) T_{eff} ≥ 3 × period of non-isolated structure.
- d) ξ_{eff} ≤ 40 % (curved sliders) or ≤ 30 % (others).
- e) $\Delta F = F(d_{db}) - F(0.5 d_{db}) \geq 0.025 W_{build}$

Iterate when K_{eff} or ξ_{eff} depend on d_{db} until $|\Delta d_{db}| \leq 5\,\%$.

Include eccentricity between stiffness and mass centres.



Level 2 - Multi-mode Equivalent or Non-Linear Response-Spectrum Analysis

Extends the single-mode (§ 6.8.5.3) procedure to buildings where higher-mode mass or stiffness irregularities make one-mode modelling unsafe. All of the following must hold:

- Isolation/damper system can be linearised (secant K- ξ) per § 6.8.5.2.
- Sum of effective masses in the first two modes ≥ 90 % (so still "mode-dominant", but not single mode).
- $\xi_{eff} \leq 30$ % (40 % for curved sliders).
- Isolation mode period $T_{eff} \geq 3 \times$ period of fixed-base structure.
- No torsional irregularity beyond limits in § 5.2.

Step-by-step workflow

- Build the FEM model
  - Add one isolation DOF (or a 6-DOF deck).
  - Enter masses and stiffnesses of the super-structure with no behaviour factor *q*—the frame is kept fully elastic.
- Compute K_{eff} and ξ_{eff} at the target drift (DL, SD, NC).
- Run the modal analysis → extract modes 1…*n*.
- Apply the EC8 spectrum
  - Reduce ordinates with $\eta(\xi_{eff})$ only for the isolation mode; all upper modes use 5 % damping.
- Combine modes with CQC (mixed damping levels).
- Update the design drift d_{Ed}; if $|\Delta d| > 5$ % go back to Step 2.
- Amplify device forces/displacements by $\boldsymbol{\gamma}_x$.
- Verify the frame with elastic forces × $\gamma_{Ed} = 1.1$; size gaps and seats using $d_{db} = \boldsymbol{\gamma}_x d_{Ed}$.

Level 3 - Energy-balance analysis (Part 1-2 § 9.3.3, referenced by Part 1-1 § 6.8.5.4)

Concept

This method is to prove that the isolator + frame can absorb at least as much energy as the earthquake is expected to supply at the chosen limit state. If the balance closes at every limit state, peak forces/drifts computed in a single spectral run are considered reliable

Global balance $E_I \geq E_S + E_H(+E_V)$

$T_{\text{eff}} = 2\pi\sqrt{M/K_{\text{eff}}}$ using the secant stiffness of the isolation/damping system at the design drift d_{Ed}.

E_I pseudo energy input at the foundation level

Go to **Annex G** (or the national annex chart): locate the curve "$E_I(T, \xi = 5$" and read the ordinate corresponding to T_{eff}. That value is already an **upper-bound (≈95 % fractile) of input energy** derived from thousands of European accelerograms.

If your device system gives $\xi_{\text{eff}} \neq 5$, scale the 5 % ordinate by the same spectral reduction factor used for accelerations: $E_I(\xi) = E_I(5$

$E_S = \frac{1}{2} K_{eff} d_{Ed}^2 \pi$ Elastic energy

$E_S \geq 0.25 \cdot E_I$ (recentering check)

$E_H = \oint F dd$ hysteretic energy

Typical closed-form expressions

Bilinear isolator (LRB, metallic damper): $E_H = 4F_y(d_{Ed} - d_y)$.
Flat-slider friction damper: $E_H = 4F_s\, d_{Ed}$.
Pendulum slider: same as flat slider, but $F_s = \mu W$.

E_V Energy from viscous systems

Portion of seismic input energy that is **dissipated as "classical" viscous damping** (e.g., Rayleigh or modal damping in the frame, concrete cracking hysteresis modelled as an equivalent ξ = 5 %), **not** through the explicit hysteretic loop of the isolator/damper

In most isolated buildings **E_V is small (≈ 0–5 % of EI)** and the Note to § 6.8.5.4 allows it to be neglected.

- It becomes non-negligible only if the FEM model contains additional **viscous dashpots, oil dampers**, or unusually large Rayleigh damping in the super-structure

For a linear viscous dashpot with coefficient c $E_{v,i} = \int_0^t c\dot{d}_i^2 dt$ integrated over the cycle

Workflow

1. Compute K_{eff} & ξ_{eq} at target drift d_{Ed}.
2. Read pseudo-input energy E_I from spectrum (Annex G).
3. Run ONE response-spectrum analysis with ξ_eq → d_Ed, forces.
4. Calculate E_S (elastic) & E_H (hysteresis).
5. Check balance; if fail → update K_{eff}, ξ_{eq} and iterate.
6. Apply $\boldsymbol{\gamma}_x$ to d_{Ed} → design gap d_{db}.

Strengths: single spectral run; ties directly to dissipated energy; fast for retrofits.

Limits: requires devices on every storey + rigid diaphragms; no velocity-dependent dampers; vertical motion not covered.

From SDOF equivalent linear to four graded methods

The 2024 draft turns the single “equivalent-linear or time-history” choice of 2004 into a **four-tier hierarchy**.
Clause 6.8.5.4 of FprEN 1998-1-1:2024 lists the methods in increasing order of complexity

Level 4 - Non-linear response-history analysis

Mandatory when: velocity-dependent devices, ξ_{eff} cap exceeded, or other criteria unmet.

≥ 7 three-component records scaled to site; median of peaks governs design forces.

Model full F-v-d loops from EN 15129 tests (upper & lower bound).

Provides direct SD & NC verifications for both structure and devices.

Highest computational demand but captures phase & rate effects accurately

EC-2G : Re-centering capability

New mandatory check (6.8.2.4)

When an isolation or damping system yields or slides it dissipates seismic energy, but it also stores a fraction of that energy elastically.

- After strong shaking, only elastic restoring force pulls the building back toward zero drift.
- Too little restoring energy ⇒ permanent offsets, damaged stairs/pipes, delayed re-occupancy.
- Eurocode requires a minimum elastic-to-dissipated energy ratio to limit residual drift.

Excessive residual drifts:

- stress stair cores, façade joints,
- complicate inspection, repair and re-levelling,
- prevent immediate re-occupancy of hospitals, data centres, etc.
- Pipelines failure
- Reduced displacement capacity

EC8 2004 vs 2024: Re-centering capability

Two criteria are given to meet the code requirement

1) It should be verified that the condition $E_S \geq 0.25E_D$ is satisfied for a deformation from 0 up to the horizontal seismic displacement d_{Ed}

- E_S is the reversibly stored energy (elastic strain energy and potential energy) of the structure including the isolation system
- $E_D = \sum E_{Di}$ is the energy dissipated by the anti-seismic devices

2) For systems with bilinear behaviour in the horizontal direction the recentering check may be considered satisfied if the condition $\frac{d_{Ed}K_p}{F_o} \geq 0.5$ is satisfied.

- d_{Ed} is the seismic displacement of the isolation system in the considered direction;
- k_p is the post-elastic (tangent) stiffness;
- F_0 is the force at zero displacement of the isolation system under cyclic loading without including the contribution of velocity-dependent devices

This approach was adopted to transform the energy requirement into a purely geometric-mechanical formula that is easy to verify for devices with bilinear behavior (lead-rubber, metal dampers, etc.).

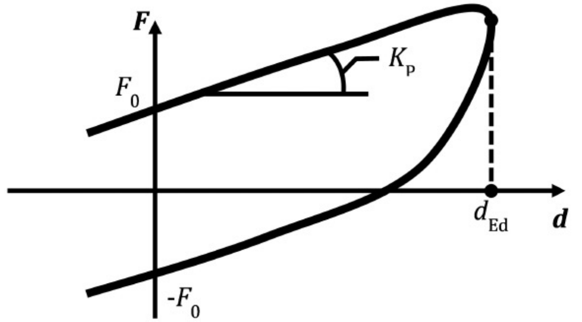
Energia elastica $E_s = \frac{1}{2}K_p d_{Ed}^2 \pi$

Energia isteretic $E_h \cong 4F_0 d_{Ed}$

$E_S \geq 0.25E_D \implies E_S \geq 0.25E_H$

$\frac{1}{2}K_p d_{Ed}^2 \pi \geq 0.25(4F_0 d_{Ed}) \implies \frac{K_p d_{Ed}}{F_0} = \frac{2}{\pi} \cong 0.64$

0.5



Comparison 2004-2024: Life-cycle obligations

IIM Plan and environmental protection

2004 advised “provide space for inspection” and “protect devices from fire” but left details to good practice

.

2024 turns those notes into direct requirements: devices shall conform to EN 15129 or EN 1337; an Installation–Inspection–Maintenance–Replacement Plan is compulsory; designers must allow access space and specify fire/chemical shields

.

Owners obtain a traceable maintenance schedule, and replacement becomes a designed-in activity rather than an afterthought

EC 2G - Energy-Dissipation Systems

Scope: applies to buildings that incorporate passive energy-dissipation devices.

Device classes covered:

– Displacement-dependent devices:

• Rigid-plastic behaviour (yield → constant force).

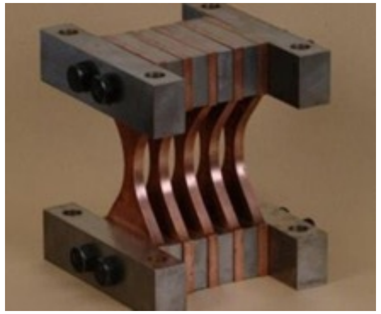
• Multilinear hysteresis (elastic k_e then softer plastic branches).

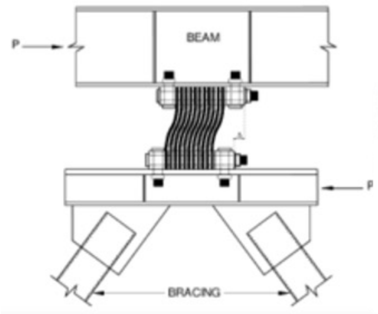
– Velocity-dependent devices:

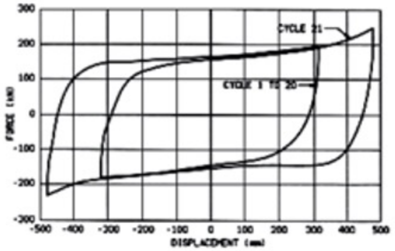
• Viscoelastic devices (solid/fluid).

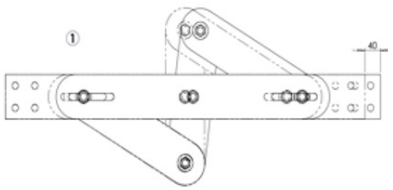
• Viscous fluid dampers.

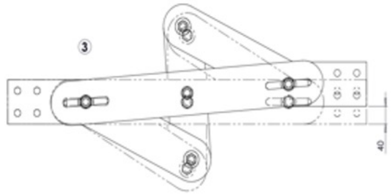
Hysteretic/Friction damper

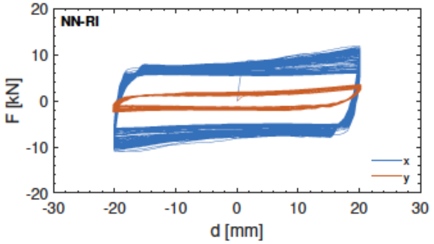




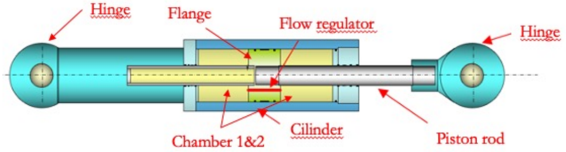


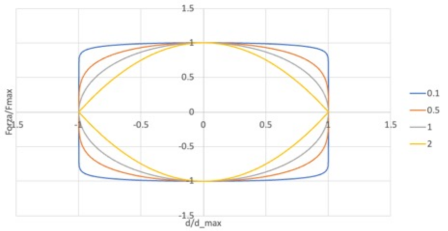


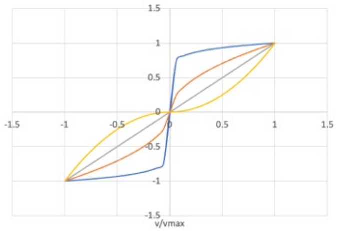


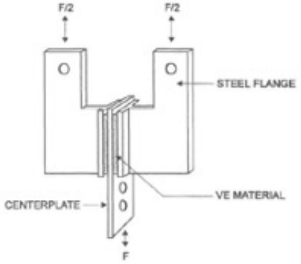


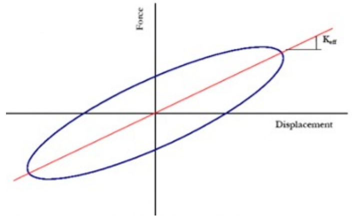
Viscous(elastic) damper











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Clause 9.2 – Design Philosophy

- Primary frame must remain elastic up to the Significant-Damage (SD) limit state. At Near-Collapse (NC) the frame may yield locally but stability must be preserved.
- Dampers shall dissipate ≥ 50 % of the total hysteretic energy at SD.
- Capacity-design hierarchy: the frame is detailed for "stronger than damper" condition (γ_{Ed} = 1.1 applied to frame actions, $\boldsymbol{\gamma}_x$ applied to damper actions).
- Serviceability (Damage-Limitation) drift limits of Table 7.1 remain unchanged, but may be checked using reduced forces if dampers are active at DL.

EC 2G - Limits

Compatibility

- • Yield displacement of every damper ≤ 0.4 × yield displacement of adjoining frame member.
- • Sum of design damper shears in a storey ≤ shear that would yield the weakest column or wall in that storey.
- • Added stiffness & damping eccentricity ≤ 0.15 B.
- • Vertical distribution rule: damper stiffness change between adjacent storeys ≤ 40 %.

Limit-State

- • Frame – verify elastic demand × γ_{Ed} (= 1.1) < elastic resistance of frame elements.
- • Dampers – verify force, displacement (and velocity for viscous types) amplified by $\boldsymbol{\gamma}_x$ against EN 15129 test bounds.
- • Interaction – damper anchorage and collector beams designed for amplified damper forces ($\boldsymbol{\gamma}_x$) combining with gravity effects.

Inspection & Maintenance

- Produce an Installation-Inspection-Maintenance-Replacement (IIMR) Plan as a contractual deliverable; include inspection intervals (≤ 5 years), test protocols, replacement procedure.
- Provide clear access gaps (≥ 300 mm) and removable covers; locate devices outside fire escape paths.
- Corrosion protection per EN 1993-1-1 Exposure Class; stainless pins mandatory for friction devices.

Fire Resistance & Robustness

- Devices inside fire compartments must retain ≥ 60 % design capacity after 30 min at 600 °C or be encapsulated in EI 60 enclosures.
- Frame must include continuous ties so that accidental removal of any single damper does not trigger collapse (alternate load path).
- Design accidental column removal with and without damper contribution to prove redundancy.

prEN 1998-1-101 - Characterisation and qualification

Loading sequence for antiseismic devices

(1) Tests of seismic isolation systems should be performed to define the main performance limits and requirements according to EN 15129 and EN 1998-1-2.

(2) The bearing capacity of a seismic isolation system should be assessed according to EN 1337.

(3) The primary response parameters should be investigated by using cyclic tests performed at differentdisplacement amplitude targets.

(4) The loading sequence should include the following steps:

1. Application of axial load in force control;
2. Displacement amplitudes applied in the transversal loading direction(s). At least three full cycles should be performed at each displacement amplitude to investigate the consistency in the hysteretic behaviour and stability of the seismic isolation system.

(5) The test results should be used to determine upper and lower bound of the range of variation by adopting the criteria defined in EN 15129 and EN 1998-1-1.

(6) Tests of displacement-dependent and velocity-dependent energy dissipation devices should be performed to define the main performance limits and requirements according to EN 15129 and EN 1998-1-2.

(7) In tests of displacement-dependent energy dissipation devices, at least two cyclic tests in displacement control with different incremental amplitudes should be performed up to the point where the restoring force exerted by the energy dissipation device under incrementally imposed displacements drops below the 20% of the peak force attained in previous loading cycles.

(8) Velocity-dependent parameters should be investigated by adopting loading cycles controlled in dynamic loading conditions. The velocity should be combined to displacement and axial force to define the response for all seismic loading conditions.

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Dispositivi antisismici

EN1998-1-2, EN1998-1-101

Strutture dotate di sistemi di isolamento/dissipazione e prestazioni dei dispositivi antisismici

Alberto Pavese, Università degli Studi di Pavia

TC250-SC8, Liason TC340 «Antiseismic Devices»

Pavia - 5 Giugno 2025