EN 81-77
Lifts subject to seismic conditions

Ing. Paolo Tattoli
• **EN 81-77:2013**

• Safety rules for the construction and installations of lifts. Particular applications for passenger and goods passenger lifts. Lifts subject to seismic conditions

<table>
<thead>
<tr>
<th>Publication Date</th>
<th>30 November 2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>Withdrawn Date</td>
<td>29 November 2018</td>
</tr>
</tbody>
</table>
• **EN 81-77:2018**

• Safety rules for the construction and installations of lifts. Particular applications for passenger and goods passenger lifts. Lifts subject to seismic conditions

**Publication Date**

29 November 2018
What is the content of the standard?

- The document specifies the special provisions and safety rules for passenger and goods passenger lifts where these lifts are permanently installed in buildings that are in compliance with EN 1998-1 (Eurocode 8).
- The document defines additional requirements to EN 81-20 and 50.
- It applies to new passenger lifts and goods passenger lifts. But can be used as a basis to improve the safety of existing lifts.
- The document does not introduce any additional special provisions and safety rules for lifts which are in Seismic lift category 0 as defined in Annex A, Table A.1.
- The document does not address other risks due to seismic events (e.g. fire, flood, explosion).
Today’s presentation

- 1) Historical background on the work done to date
- 2) Information regarding the contents of the first and second edition of the standard
- 3) Questions? Please leave all questions for the end of the presentation
The first step on the road to preparation of the standard was the decision made by TC10 during the plenary meeting at the end of 2006

CEN/TC10 Plenary Meeting

RESOLUTION – BRUSSELS 007/2006 - LIFTS SUBJECT TO SEISMIC CONDITIONS

• CEN/TC 10 agreed WG 1 to investigate and develop a harmonised standard specific for lifts subject to seismic conditions
• This future standard will be part of the particular applications for passenger and goods passenger lifts (family 7X as defined in CEN/TR 81-10)
Subject

Title

• EN 81-77 Safety rules for the construction and installation of lifts – Particular applications for passenger and goods passenger lifts – Part 77: Lifts subject to seismic conditions

Actual Scope

• The European Standard specifies the special provisions and safety rules for passenger and goods passenger lifts where these lifts are permanently installed in buildings complying with EN 1998 (Eurocode8). [Note: Complying intends new buildings or seismic-retrofitted old buildings]
Road Map

- CEN/TC10/WG1 decisions made in 2007:
  - to develop the standard
  - to nominate WT Convenor: PAOLO TATTOLI (IT)
  - to “call for experts” [ask CEN members to nominate participants to new WT]
Road Map

• **Project initiation (WT kick off):**
  – immediately after the WT5 was formed
    ▪ Early 2008

• **First Draft of the standard:**
  – ready within 21-24 months (end of 2009 – beginning of 2010)
Work in progress

- WT5 carried out a specific risk assessment taking into account:

1) information coming from research on the topic (damages on lifts, frequency, other important parameters, etc.)

2) existing documents (A17 std, Japanese guide, New Zealand std, etc.) already available

3) expert’s experience and professionalism
Example of seismic damage

- Entrance (landing doors)
- Traction Machine Movement
- Control Panel Falling
- Car derailing
- Counterweight or balancing weight derailing
- Counterweight or balancing weight block fall
- Rope (traveling cable) entwinement
- Governor rope breaking
- Landing switch breakage (well deformation)
Bibliography [ed. 2018]

- ISO 14798, *Lifts (elevators), escalators and moving walks — Risk assessment and reduction methodology*
- ISO/TR 25741, Lifts and escalators subject to seismic conditions - Compilation report
- ASME A17.1, Safety code for elevators and escalators
- Japan Guide for Earthquake Resistant Design & Construction of Vertical Transportation
- NZS 4332, Non-domestic passenger and goods lifts
**Preparing and updating the Risk assessment permitted us to prepare the draft contents**

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Hazard (Hazardous Situation)</th>
<th>Harmful event (cause)</th>
<th>Harmful event (effect)</th>
<th>Estimation of risk elements</th>
<th>Protective measures (risk reduction measure)</th>
<th>After protective measures</th>
<th>Residual risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>Persons in the car during earthquake and car is running at nominal speed and car above the position of the counterweight</td>
<td>Weight block of the counterweight come out from the counterweight frame</td>
<td>Block fall down in pit and/or the situated above accessible area</td>
<td>The counterweight must be designed in such a way that the movement of the weight block outside the frame is totally prevented</td>
<td></td>
<td>1 F</td>
<td></td>
</tr>
</tbody>
</table>

Comment: In this case we have mechanical damage of the equipment and damage of the user. The block could damage the governor tension sheave and let the safety gear not able to work. This with the leaving of the friction could be very dangerous. The car could fall down except if the safety gear works (see case number 10)

**Risk estimation and evaluation table**

<table>
<thead>
<tr>
<th>Severity level</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>P</td>
<td>L</td>
<td>P</td>
<td>L</td>
</tr>
<tr>
<td>B</td>
<td>P</td>
<td>L</td>
<td>P</td>
<td>L</td>
</tr>
<tr>
<td>C</td>
<td>P</td>
<td>L</td>
<td>P</td>
<td>L</td>
</tr>
<tr>
<td>D</td>
<td>P</td>
<td>L</td>
<td>P</td>
<td>L</td>
</tr>
<tr>
<td>E</td>
<td>P</td>
<td>L</td>
<td>P</td>
<td>L</td>
</tr>
<tr>
<td>F</td>
<td>P</td>
<td>L</td>
<td>P</td>
<td>L</td>
</tr>
</tbody>
</table>
The aim of the standard is to:

- avoid loss of life and reduce the extent of injury
- avoid people trapped in the lift
- avoid equipment damage
- avoid environmental problems
- reduce the number of lifts out of service
The draft of the standard

• The aspects of the standard can be summarized in two areas:
  – design of systems and components
  – behaviour of lifts in case of earthquake (that is how they have to react during and after an earthquake)
Safety requirements and/or protective measures

• Lifts within the scope of EN81-77 shall comply with the relevant safety requirements and/or protective measures of the standard when the lifts are subject to seismic conditions
Design acceleration $a_d$

- For the purpose of the standard lifts have been divided into categories, taking into account the design acceleration ($a_d$)
- $a_d$ is the horizontal acceleration to be used for calculation of forces – moments acting on lift systems and arisen from seismic events
Subdivision of the lifts in categories considering the design acceleration

- $a_d$ is a function of peak ground acceleration and other factors (type of soil, importance building factor, the natural vibration period of the building, and all the other parameters stated in EN 1998 – Eurocode8)
- This value has normally to be provided by the owner of the building
- The next table shows the seismic lift categories
## Lifts categories

<table>
<thead>
<tr>
<th>Design Acceleration (m/s²)</th>
<th>Effect on Buildings</th>
<th>Seismic lift cat.</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>$a_d \leq 1$</td>
<td>No building damage</td>
<td>0</td>
<td>The requirements of EN81-1 and EN81-2 [new EN 81-20 and EN 81-50] are adequate therefore <strong>no additional action is required</strong></td>
</tr>
<tr>
<td>$1 &lt; a_d \leq 2.5$</td>
<td>Minor building damage</td>
<td>1</td>
<td><strong>Minor corrective actions required</strong></td>
</tr>
<tr>
<td>$2.5 &lt; a_d \leq 4$</td>
<td>Substantial building damage</td>
<td>2</td>
<td><strong>Medium corrective actions required</strong></td>
</tr>
<tr>
<td>$a_d &gt; 4$</td>
<td>High building damage</td>
<td>3</td>
<td><strong>Substantial corrective actions required</strong> [in comparison to Cat. 2]</td>
</tr>
</tbody>
</table>
Loads and forces

• The car structure and retaining devices shall withstand the loads and forces imposed on them including forces generated by the design acceleration ($a_d$)

• For passenger lifts shall be taken into account the mass of the car plus 40% of the rated load evenly distributed

• For goods passenger lifts shall be taken into account the mass of the car plus 80% of the rated load evenly distributed
Example of damage:

**Car, cwt, bwt derailing**

- Car, counterweight, balancing weight move out from guide rails

P. 1 e 2 from: *Terremoto in Umbria, gli effetti sugli ascensori; Elevatori, March-April 1998*
Example of damage:

**Car, cwt, bwt derailing**

- Car, counterweight, balancing weight goes out from guide rails

P. 1, 2, 3: Electric lifts installed in L’Aquila
Guide rail system

• The guide rail stiffness must be increased
• The guide rails, their joints and attachments shall comply with requirements of EN 81-1 and EN 81-2 [new EN 81-20:2014, 5.7] and they shall also withstand the loads and forces generated by the design acceleration ($a_d$)
• Where retaining devices are provided, car and counterweight retaining devices shall be used as frame supporting points in guide rails verification
Retaining devices

- For lift categories 2 and 3 as protection measure for car and counterweight (or balancing weight) shall be provided retaining devices able to hold the frame on its guide rails.
Retaining devices

• The retaining devices shall be placed in such a way to distribute loads in a similar way as the guide shoes

• The retaining devices shall either be integrated or mounted close to the guide shoes
Example of damage:

**Cwt or bwt blocks fall**

- Weight blocks of the counterweight or balancing weight coming out from the frame


P. 2 from: *From the Wenchuan Seism: Statistics & Analysis of Elevator Damages in Xi’an*; Elevator World, November 2008
Counterweight and balancing weight

- If the counterweight or the balancing weight incorporates filler weights, necessary measures shall be taken to prevent their movement outside the frame (see EN 81-1, 8.18)
Example of damage: **Machinery damage**

- Machinery and main equipment in the machinery space overturns and/or is displaced as a result of seismic forces.
Example of damage:

Machinery damage

- Machinery and main equipments in the machine space overturns and/or is displaced as a result of seismic forces

P. 1 from: *Terremoto in Umbria, gli effetti sugli ascensori: Elevatori, Marzo-Aprile 1998*

P. 2: Electric lift installed in L’Aquila
Machinery

• All machinery [including control cabinet(s) and drive system, lift machine, main switch(es), and means for emergency operations, cylinder and ram, pulleys and associated overhead beams and supports, rope attachments, overspeed governor, tension pulleys and compensation rope tension devices] shall be designed and anchored to prevent overturning and displacement as a result of the forces imposed on them including forces generated by the design acceleration ($a_d$)
Example of damage: **Hydraulic lifts**

- Hydraulic machine overturns and hoses are displaced as a result of seismic forces.
Hydraulic lifts

- Hydraulic lifts shall preferably use flexible pipe work but where the use of rigid pipe is essential it shall use flexible pipe at the end of each rigid length
Example of damage

**Ropes/chains snagging**

- Ropes/chains swaying in the shaft and becoming snagged on fixed devices in the shaft as for example the guide fixing or ramps

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P.2 from: *From the Wenchuan Seism: Statistics & Analysis of Elevator Damages in Xi'an*; Elevator World, November 2008
Protection of snag points

• Is not possible to make general valid calculations or models for sway clearances of flexible elements

• As consequence of this, the proposal is to avoid all snag points created by brackets, sills, detection devices and other equipment mounted in the lift well
Protection of snag points

• After a long discussion, WG1 agreed to introduce a mixed approach for this argument:
  – Jea guide approach for the height of the well
  – ASME A17 approach (revised) for the horizontal distances between snag points
Protection of snag points

• In order to prevent that suspension ropes, governor ropes, travelling cables, compensation ropes and chains, swaying in the well, get entangled with fixed equipment, snag points created by brackets, sills, devices and other equipment mounted in the well shall be protected according to the following Table
<table>
<thead>
<tr>
<th>Height of the well</th>
<th>Horizontal distance between snag points and lift parts</th>
<th>Lift parts</th>
<th>Protective Measures</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 20 m</td>
<td></td>
<td></td>
<td>Not necessary</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>[due to very small shake (displacement) of buildings]</td>
<td></td>
</tr>
<tr>
<td>&gt; 20 m ≤ 60 m</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 900 mm</td>
<td>Travelling cables</td>
<td></td>
<td>Install protection measure for example a protection wire in the corner of the rail bracket or other snag points near the travelling cables</td>
<td>Required if any portion of the loop is smaller than 900 mm from a snag point</td>
</tr>
<tr>
<td>&lt; 750 mm</td>
<td>Compensating Chain(s), Compensating rope(s), Counterweight overspeed governor rope</td>
<td></td>
<td>Install protection measure for example a protection wire in the corner of the rail bracket or other snag points</td>
<td>Full travel</td>
</tr>
<tr>
<td>&lt; 500 mm</td>
<td>Car overspeed governor rope</td>
<td></td>
<td>Install protection measures for example a protection wire in the corner of the rail bracket or other snag points</td>
<td>Full travel</td>
</tr>
<tr>
<td>&lt; 300 mm</td>
<td>Suspension ropes</td>
<td></td>
<td>Install protection measures for example a protection wire in the corner of the rail bracket or other snag points</td>
<td>Full travel</td>
</tr>
<tr>
<td>&gt; 60 m</td>
<td>Protect all snag points independently from horizontal distance</td>
<td>Travelling cables, Compensating Chain(s), Compensating rope(s), Counterweight overspeed governor rope, Car overspeed Governor rope, Suspension ropes</td>
<td>Install protection measures for example a protection wire in the corner of the rail bracket or other snag points</td>
<td>Full travel</td>
</tr>
</tbody>
</table>
Example of damage:

**Building displacement**

- The different parts of the building move apart and the devices of the lift are subject to displacement.
Machinery and pulley spaces

- Where buildings are designed with expansion joints subdividing the structure into dynamically independent units, the machinery and the well of electric lifts shall be located on the same side of an expansion joint.
Example of damage: Ropes/chains dislodgement

- Ropes/chains (including governor rope and compensation ropes) come out from traction sheave or diverting pulley
Suspension, compensation and overspeed protection

- The devices for preventing the ropes from leaving the grooves of traction sheaves and pulleys shall include one retainer no more than 15° from the points where the ropes enter and leave the grooves and at least one intermediate retainer every 90° of the angle of wrap.

- The strength and stiffness of the retainers and their distance to the traction sheaves and pulleys compared to the diameter of the ropes shall be such that they are effective.
Suspension, compensation and overspeed protection

• The devices for preventing the chains from leaving the sprockets shall include one retainer at the points where the chains enter and leave the sprockets

• Compensation chains or similar means shall be guided in the pit in order to limit them from swaying and reaching snag points
Example of damage:

Environmental damage

Prescription for Hydraulic lifts

• Hydraulic lifts shall be provided with a rupture valve in compliance with 12.5.5 of EN 81-2 [EN 81-20:2014, 5.6.3]

• The space in which the hydraulic power unit is situated and the pit shall be designed in such a way that it is impervious, so that all the fluid contained in the machinery placed in these areas will be retained if it leaks out or escapes
Electric installations and appliances
Example of damage: **Equipment damage**

- Landing switch devices or final limit switches break as a result of car moving and devices fixed on the car enter in contact with vane and ramps fixed in the shaft.
Electric Installation in lift shaft

• The fixing of landing switch devices or final limit switches, vanes or similar devices fixed in the shaft shall be designed to withstand the loads and forces imposed on them including forces generated by design acceleration (\(a_d\))

• In addition the devices mentioned above shall be protected by guards from swaying ropes and cables in the shaft
Example of damage: **Trapping of people**

- The behaviour of lifts in case of earthquake has to reduce the risk for passengers being trapped in a car in the event of earthquake in a building
Behaviour of the lift:

• in case of failure of the mains power supply
• in seismic mode (special mode in which the lift performs after detection of seismic trigger level)
Behaviour of the lift in case of failure of the mains power supply

- In case of seismic events, for **seismic lift category 2 and 3**, in order to avoid people to be trapped in the car **in case of failure of the mains power supply**, the lift has to be able to move **automatically** the car to the next landing in up or down direction
Behaviour of the lift in case of failure of the mains power supply

• At landing the lift shall operate as described in the standard taking into account:
  – lifts with automatic power operated doors,
  – lifts with manually operated doors

• The behaviour of the lift in case of failure of the normal power supply shall not override any of the following:
  — the electric safety devices;
  — the inspection operation (EN 81-20:2014, 5.12.1.5)
  — the emergency electric. oper. (EN 81-20:2014, 5.12.1.6)
  — the firefighters lift switch (EN 81-72:2015, 5.8.1)
Seismic mode =
Seismic Detection System

- A seismic detection system [for s-waves] shall be provided for lifts with counterweight or balancing weight in seismic lift category 3
- Where the seismic detection system is used exclusively to control the lift it may be placed in the pit of the lowest lift in the building
- In case of expected interference with other vibration sources, alternative locations of the seismic detection system are allowed (see assumption in the Introduction)
Seismic Detection System

- The seismic detection system shall comply to the following specifications:
  - detection of tri-axial acceleration
  - seismic trigger level $\leq 1.00 \text{ m/s}^2$ in any direction including vectors
  - frequency response between 0.5 – 10 Hz
  - system reaction time $\leq 3$ sec
  - automatic system test $\leq 24$ hours
  - emergency power supply back-up system for $\geq 24$ hours
  - manual reset of alarm trigger
### Availability and diagnostics

- The standard provides a lot of technical specifications for the seismic detection system
- For example:
  - The seismic detection function shall be tested every 24 hours
  - **The system reaction time shall not exceed 3 seconds**
  - The operation of the s.d.s. shall not be impeded or lost even in case of electrical power supply switching or mains power supply failure
  - Emergency electrical power supply used to provide at least 24 hours of power supply
  - The resetting and return of the lift to normal operation made by operation of **manual reset devices**
- **Visually indicated** (see EN 81-72)
Behaviour of the lift in Seismic mode

• After activation of the seismic detection system, the lift shall perform as described below:

• 1) all registered car and landing calls shall be cancelled. New calls shall be ignored;

• 2) a lift in motion shall reduce the speed or stop and proceed to the next possible landing away from the counterweight or balancing weight with maximum 0,3 m/s car speed;

• 3) …
Behaviour of the lift in Seismic mode

• ...

3) when lift is at landing
   – a) a lift with automatic power operated doors shall open the doors, remove the lift from service and keep the doors open
   – b) a lift with manually operated or non-automatic power operated doors shall remain in this condition and be removed from service with the doors unlocked
   – c) in case of a firefighters lift under phase 2 operation, the automatic power operated door shall function as defined in EN 81-72

See other provisions in the standard
Behaviour of the lift in Seismic mode

• The seismic mode shall not override any of the following:
  – the electric safety devices,
  – the inspection operation (EN 81-1 and EN 81-2, 14.2.1.3) [new (EN 81-20:2014, 5.12.1.5)],
  – the emergency electrical operation (EN 81-1, 14.2.1.4) [new (EN 81-20:2014, 5.12.1.6)]
  – the firefighters lift switch phase 2 operation (EN 81-72)
About Notices, markings and operating instructions

- Maintenance instruction to be provided by the installer to the client shall take into account the information for maintenance personnel to
  - properly make periodical checks of the lift operation
  - safely check the lift after an earthquake
About Notices, markings and operating instructions

- Instructions have to be passed to the building owner in the instruction handbook (owner documentation) of the lift describing the behaviour of the lift in the event of earthquake and the need to maintain and to periodically test that the seismic equipment is in working order.

- $a_d$ shall be documented in the information for the owner provided by the installer.
P-wave and S-wave

**primary waves**

- types of elastic waves produced by earthquakes. Earthquake advance warning is possible by detecting the non-destructive primary waves that travel more quickly through the Earth's crust than do the destructive secondary waves. The amount of advance warning depends on the delay between the arrival of the primary wave and other destructive waves, generally in the order of seconds for distant, large quakes.

**secondary waves**

- waves produced by earthquakes; they are also named shear waves because they move through the body of an object, unlike surface waves. The secondary wave moves as a shear or transverse wave, so motion is perpendicular to the direction of wave propagation. The secondary waves are destructive and arrive later than primary waves.
Primary wave detection system (Annex C – Informative)

- Subject to negotiation, provided from the owner of the building (part of the building), in addition to the seismic detection system, in seismic lift category 3, a primary wave detection system may be provided complying with the following specifications:
  - primary wave trigger level ≤ 0.10 m/s²
  - sensing direction: vertical
  - frequency response: 1 – 10 Hz

Technical specifications
To summarize:

- Detection of seismic waves will activate control management of the car movement in order to:
  - put the car in safety status attending the expected seismic event
  - restart the car in the case of no seismic event in order to optimize safety of users and units and minimize loss of time in job activities in the building
EN 115-1:2017
Safety of escalators and moving walks - Part 1: Construction and installation

Seismic conditions

Ing. Paolo Tattoli
For escalators and moving walks, the subject “Seismic Condition” is included in EN 115-1:2017, Annex M (Normative)
EN 115-1:2017
Annex M (normative)

Escalators and moving walks subject to seismic conditions

• The annex specifies the special provisions and safety rules for escalators and moving walks permanently installed in buildings that are in compliance with EN 1998-1:2004 (Eurocode 8)
EN 115-1:2017
Annex M (normative)

Escalators and moving walks subject to seismic conditions

Structural requirements
Design requirements
Machinery

Calculation procedure according to EN 1998-1:2004

Table M.1

Figure M.1
Escalators and moving walks within the scope of this standard shall comply with the relevant safety requirements and/or protective measures of this annex when they are subject to seismic conditions.

Structural requirements

- Escalators and moving walks subject to seismic conditions within the scope of this standard shall comply with the relevant safety requirements and/or protective measures of this annex when they are subject to seismic conditions.
EN 115-1:2017
Annex M (normative)

Escalators and moving walks subject to seismic conditions

Structural requirements

• EN 115 don’t use the “table” of “lift categories” introduced in EN 81-77 but introduce 4 categories taking into account $a_{gR}$ peak ground acceleration

• Very low seismicity $a_{gR} \leq 0.5 \, \text{m/s}^2$
• Low seismicity $0.5 \, \text{m/s}^2 < a_{gR} < 1.0 \, \text{m/s}^2$
• Medium seismicity $1.0 \, \text{m/s}^2 < a_{gR} < 4.8 \, \text{m/s}^2$
• High seismicity $a_{gR} = 4.8 \, \text{m/s}^2$
It is assumed that negotiations have been made for each contract between the customer and the supplier/installer about the peak ground acceleration $a_{gR}$ to be considered (see also Introduction). The building designer or owner shall provide the design acceleration which will be documented in the information. The owner shall agree on one common acceleration value $a_{gR}$. The acceleration value $a_{gR}$ needs to be communicated between all participants of the contract.
Machinery shall be designed and anchored to prevent displacement as a result of the forces imposed on them including forces generated by the design acceleration ($a_{gR}$).

Example
• **Electrical installation and other equipment** In case the building is equipped with a seismic detector/sensor the electrical system of the escalator or moving walk shall provide an interface for the connection to this detector/sensor and shall stop the escalator or moving walk in case of seismic activity

• This function shall be of manual reset type
Figure M.1 — Calculation procedure according to EN 1998-1:2004

Classification into seismic zones acc. to the national specifications concerning EN 1998-1

Determination of the ground acceleration and ground type
\( a_{gr} = xx \text{ m/s}^2 \), ground class type A

Determination of the importance class \( \gamma_i = 0,85 \)

Very Low Seismicity
\( a_{gr} \leq 0,5 \text{ m/s}^2 \) or \( 0,05 \times g \)

Rules of EN 1998-1 need not to be applied

Low Seismicity
\( 0,5 \text{ m/s}^2 < a_{gr} < 1 \text{ m/s}^2 \)

Low dissipative structures design concept (DCL)

Medium Seismicity
\( 1 \text{ m/s}^2 < a_{gr} < 4,8 \text{ m/s}^2 \)

Behavior coefficient \( q \leq 2 \)

High Seismicity
\( a_{gr} = 4,8 \text{ m/s}^2 \) or \( 0,5 \times g \)

Dissipative structures design concept (DCM / DCH)

Behavior coefficient \( 2 < q < 8 \)

Check of regularity criteria default: regular

Calculation method for torsional effects

Superposition of seismic forces and moments due to dead and live loads

Plastic mechanism-design of capacity \( \gamma_c = 1,25 \)

Rules of EN 1998-1 for dissipative structures

Design and verifications according to EN 1993
• Thanks you for your attention

• Any questions?

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