



# EN 12845-3

## Guidance for earthquake bracing



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# Today's presentation

- Driving factors of seismic damage
- Achieve proper seismic protection
- Guidance: CEN/TS 17551 (EN 12845-3)



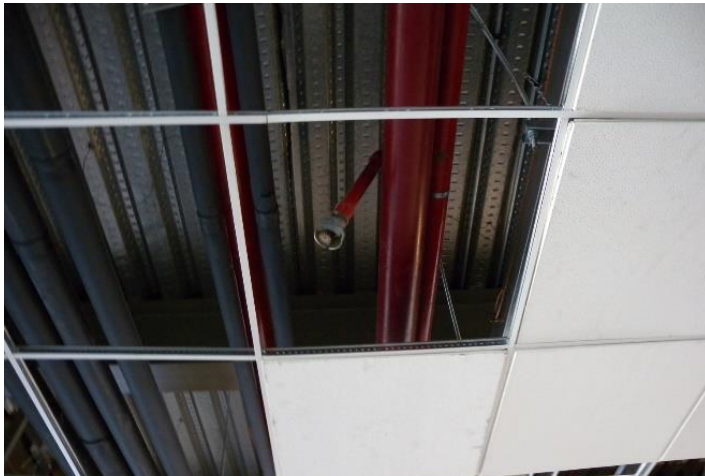
# Sprinkler system earthquake damage



**Excessive relative movements/rotations between pipes**



**Interaction with structural elements**



**Interaction with non-structural elements**

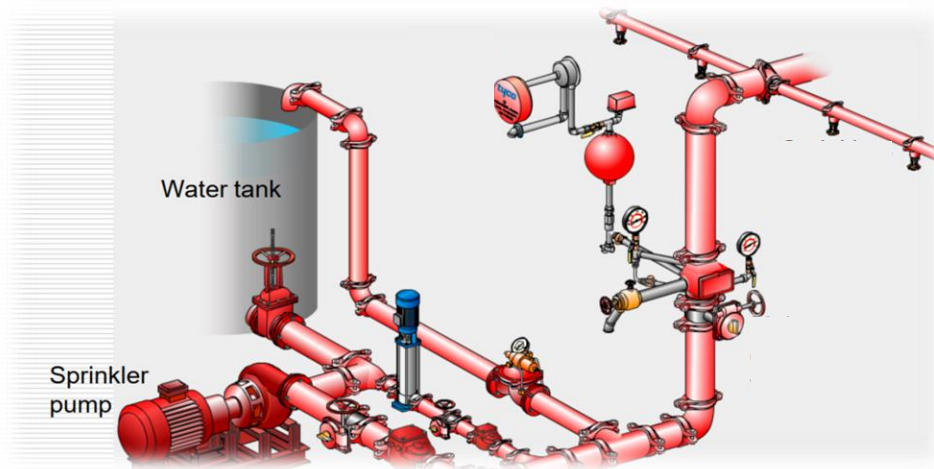




# The driving factors behind the damage

- Lack of **proper** bracing
- Lack of **proper** flexibility
- Lack of **proper** clearance

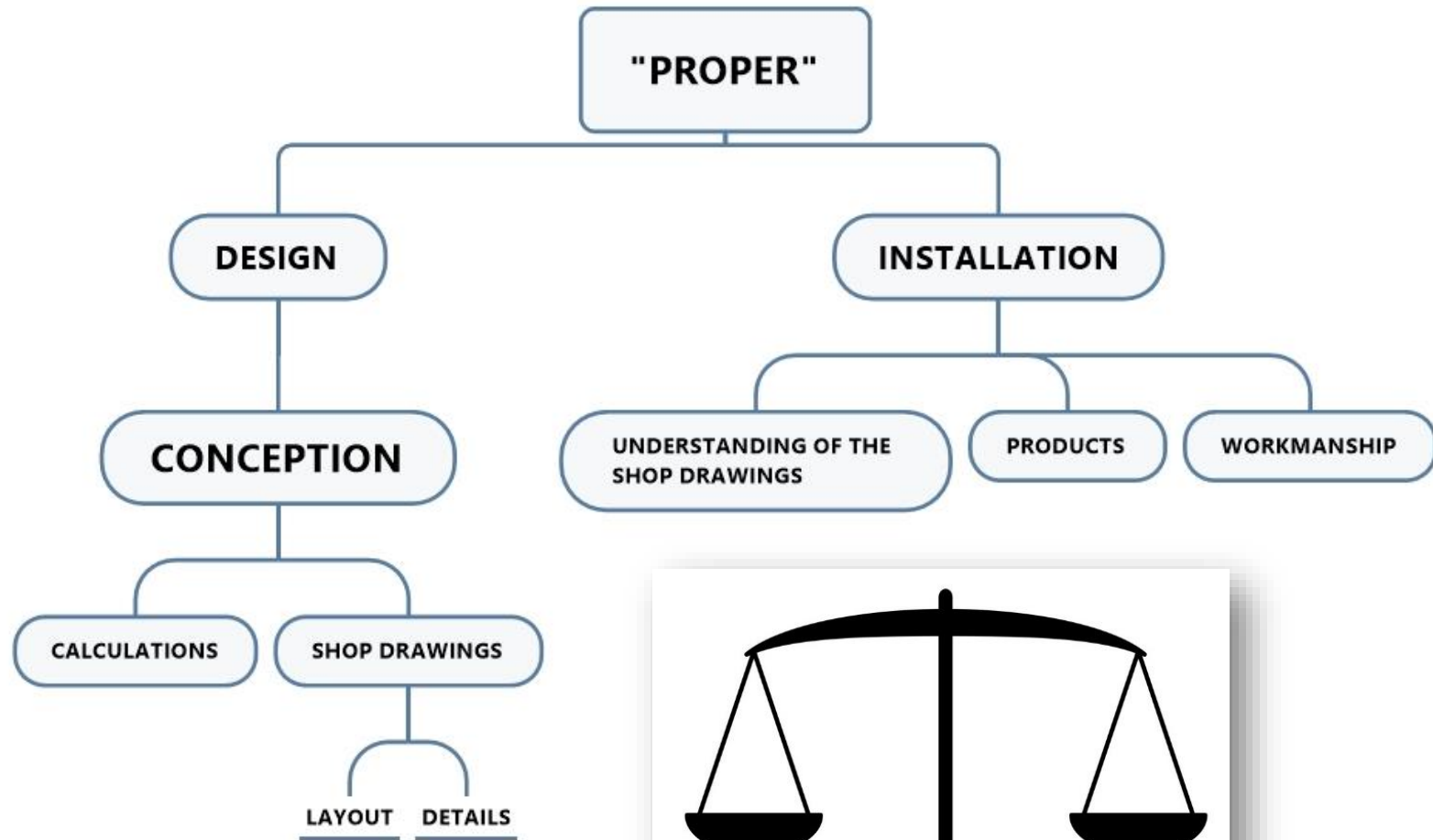
Lack of  
**PROPER  
CONCEPTION OF  
THE SYSTEM**



We need to consider **the whole system** from the water supply to the branch lines

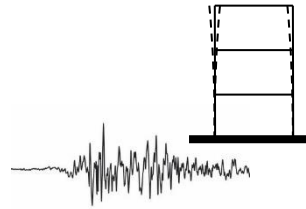


# Achieving proper seismic protection





# Design conception



Seismic action

## STRATEGY

**ANALYSIS OF THE CRITICAL ISSUES**

**VULNERABILITY**



**RESPONSES TO THE CRITICAL ISSUES**

— SYSTEM LAYOUT

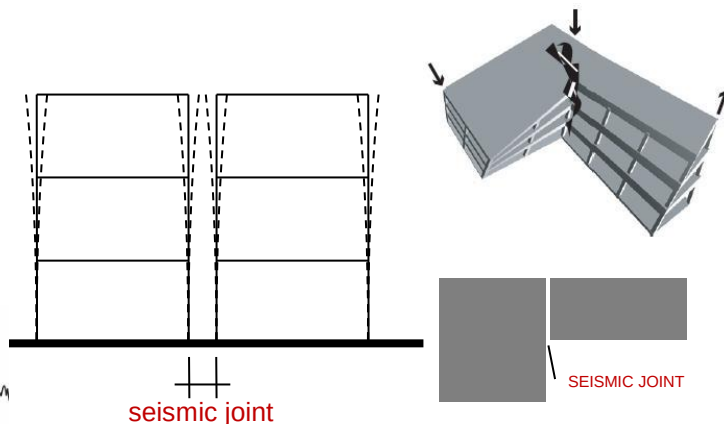
— RESPONSE OF THE SYSTEM  
COMPONENTS

— INTERACTIONS WITH OTHER  
STRUCTURAL OR  
NON-STRUCTURAL ELEMENTS



# Design conception: system layout

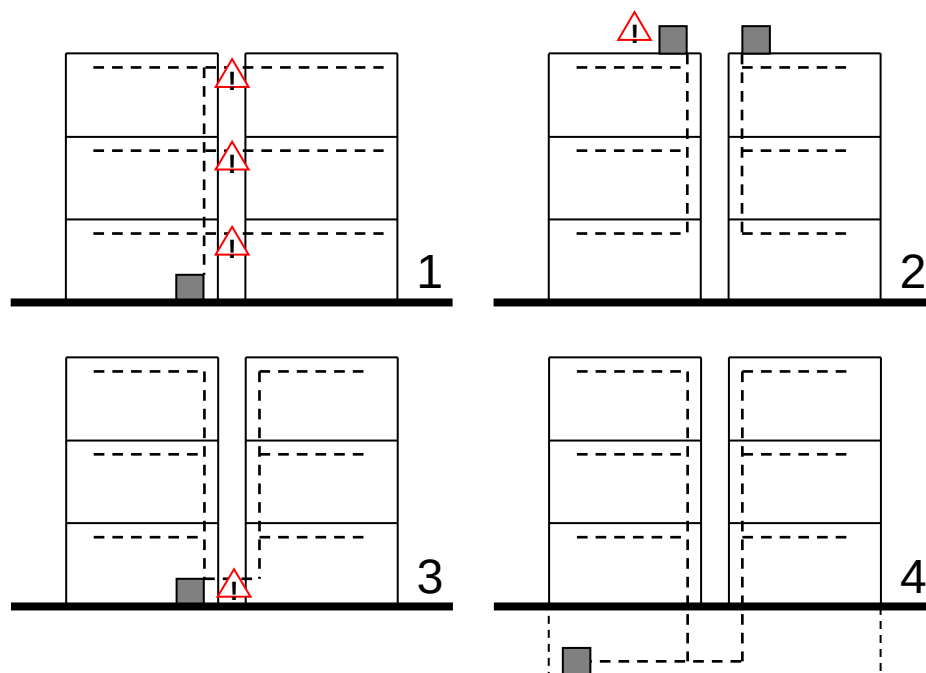
Seismic action



## STRUCTURAL DESIGN

TO ELIMINATE OR REDUCE THE CONFIGURATION-RELATED PROBLEMS/WEAKNESSES

- REGULARIZATION
- INTRODUCTION OF SEISMIC JOINTS



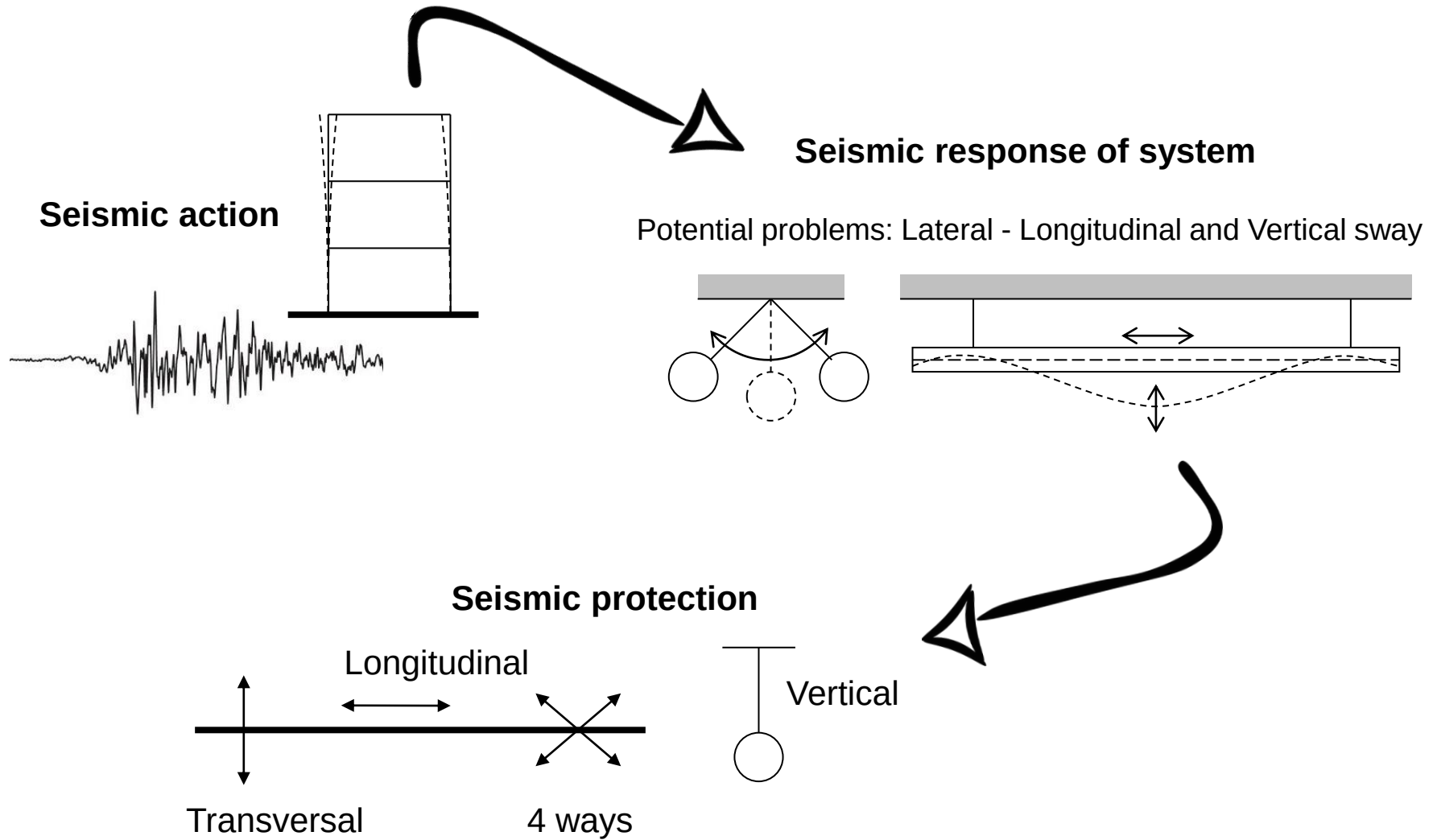
## SYSTEMS DESIGN

ELIMINATE OR REDUCE THE CONFIGURATION-RELATED PROBLEMS/WEAKNESSES

- REDUCTION OF THE NUMBER OF JOINT CROSSINGS  
(1 → 2, 3 or 4)
- CROSSINGS AT LOWER/EST LEVEL  
(1 and 2 → 3 or 4)



# Design conception: response of the components

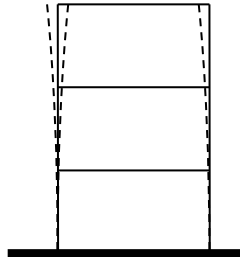






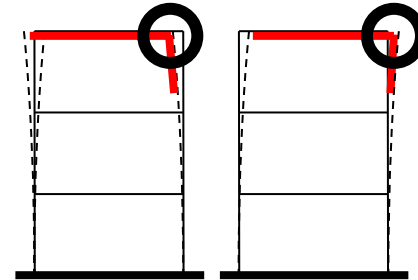
# Design conception: response of the components

## Seismic action



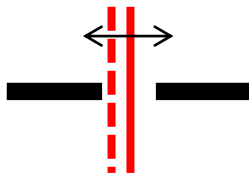
## Seismic response of system

Potential problems:  
relative movements and interactions between pipe  
runs and other elements / rotations between pipe runs

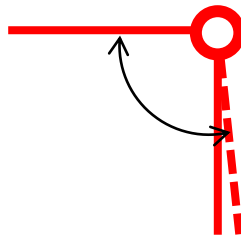


## Seismic protection

### Clearance



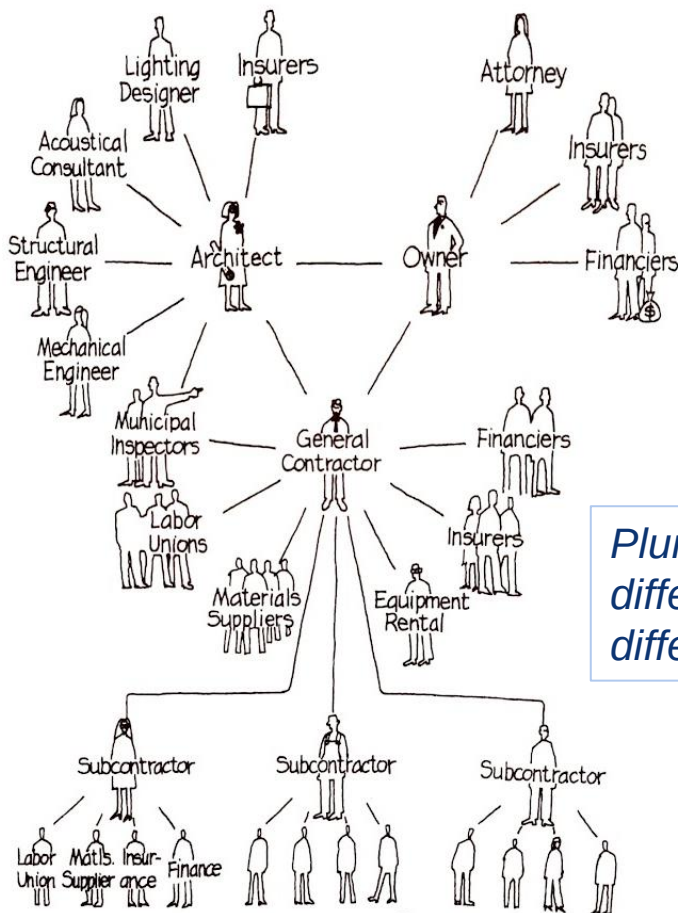
### Flexible joints





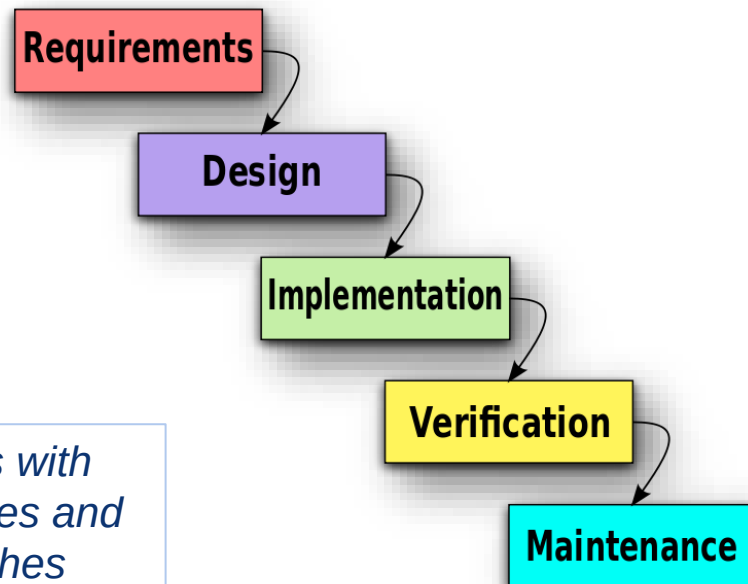
# Achieving proper seismic protection

## Plurality of ACTORS



*Plurality of actors with different languages and different approaches*

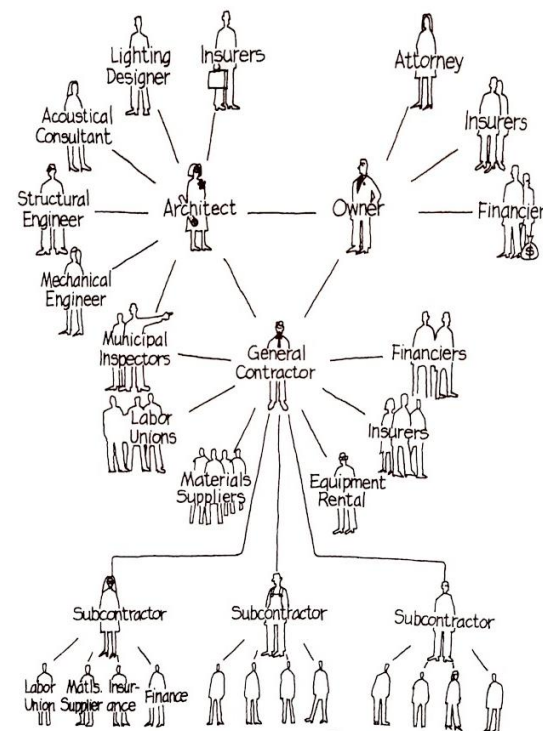
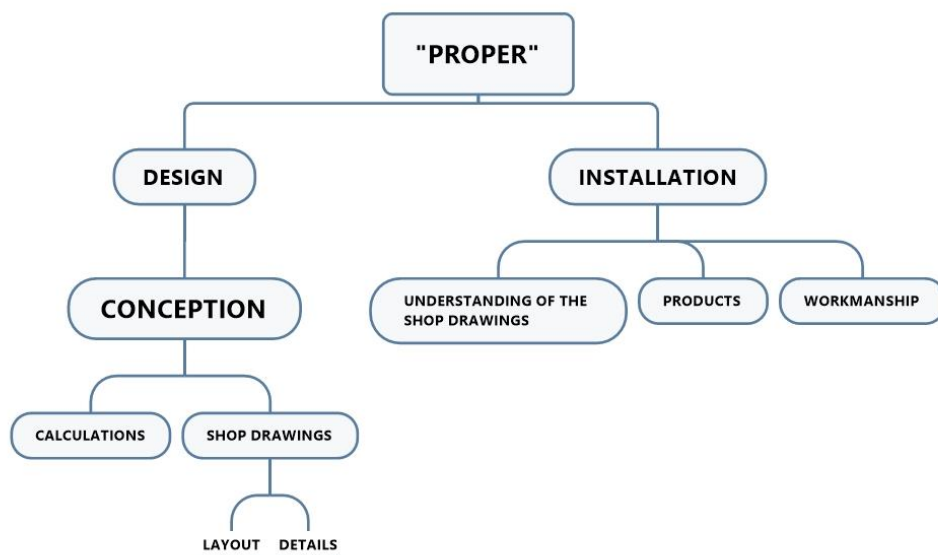
## Plurality of ACTIONS



... It is not (only) a problem of seismic actions



# Achieving proper seismic protection



**NEED FOR GUIDANCE**  
A common reference  
could play an important role





# Need for guidance



Applicable with caution in EU:

- Different definition of the seismic hazard
- Different design method



# Need for guidance



## TECHNICAL SPECIFICATION SPÉCIFICATION TECHNIQUE TECHNISCHE SPEZIFIKATION

CEN/TS 17551

March 2021

ICS 13.220.20

English Version

### Fixed firefighting systems - Automatic sprinkler systems - Guidance for earthquake bracing

Installations fixes de lutte contre l'incendie - Systèmes  
d'extinction automatiques du type sprinkleur -  
Recommandation pour le contreventement sismique

Ortsfeste Brandbekämpfungsanlage - Automatische  
Sprinkleranlagen - Leitfaden für Erdbbensicherungen

This Technical Specification (CEN/TS) was approved by CEN on 4 January 2021 for provisional application.

The period of validity of this CEN/TS is limited initially to three years. After two years the members of CEN will be requested to submit their comments, particularly on the question whether the CEN/TS can be converted into a European Standard.

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Ref. No. CEN/TS 17551:2021 E

Version 2 of this document will (soon) become **EN 12845-3**

## EN 12845-3 GUIDANCE FOR EARTHQUAKE BRACING

prof. Stefano Grimaz – SPRINT-Lab - Università degli Studi di Udine  
ing Andrea Dusso – Safexpertise, SPRINT-Lab - Università degli Studi di Udine



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# Need for guidance

TECHNICAL SPECIFICATION  
SPÉCIFICATION TECHNIQUE

CEN/TS 17551

## Introduction

This document specifies requirements for earthquake protection of automatic sprinkler systems in accordance with EN 12845 and fire hose piping systems. **Requirements made herein are intended to greatly improve the likelihood that the fire protection systems will remain in working condition during earthquake and minimize or prevent any potential water damage from fixed firefighting systems leakage due to an earthquake.**

## 1 Scope

This document specifies **requirements for earthquake protection of automatic sprinkler systems in accordance with EN 12845**. This document **applies only to locations in earthquake zones in accordance to EN 1998-1:2004, 3.2.1<sup>1</sup> and for area subject to peak ground acceleration above 9 % of g.**

This document does not cover all legislative requirements. In certain countries specific national regulations apply and take precedence over this document. Users of this document are advised to inform themselves of the applicability or non-applicability for this document by their national responsible authorities.

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Ref. No. CEN/TS 17551:2021 E

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# CEN/TS 17551 – Overview

## CEN/TS 17551

|                                                                                                                                                                                                                                                                                                                                                                                                           |                            |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|
| TECHNICAL SPECIFICATION<br>SPÉCIFICATION TECHNIQUE<br>TECHNISCHE SPEZIFIKATION                                                                                                                                                                                                                                                                                                                            | CEN/TS 17551<br>March 2021 |
| ICS 13.228.20                                                                                                                                                                                                                                                                                                                                                                                             |                            |
| English Version                                                                                                                                                                                                                                                                                                                                                                                           |                            |
| Fixed firefighting systems - Automatic sprinkler systems -<br>Guidance for earthquake bracing                                                                                                                                                                                                                                                                                                             |                            |
| Installations fixes de lutte contre l'incendie - Systèmes<br>d'extinction automatiques du type sprinkleur -<br>Recommandation pour le contreventement sismique                                                                                                                                                                                                                                            |                            |
| Ordnende Brandbekämpfungsanlage - Automatische<br>Sprinkleranlagen - Leitfaden für Erdbebensicherungen                                                                                                                                                                                                                                                                                                    |                            |
| This Technical Specification (CEN/TS) was approved by CEN on 4 January 2021 for provisional application.                                                                                                                                                                                                                                                                                                  |                            |
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### "General"

- 1 Scope
- 2 Normative references
- 3 Terms and definitions
- 4 Design principles

### "Technical"

#### 5 Sway bracing and sprinkler pipe support

- 5.1 General
- 5.2 Sway brace design
- 5.3 Anchorage for in rack sprinklers
- 5.4 Type, attachment and locations of hangers

#### 6 Flexibility

- 6.1 General
- 6.2 Flexible Couplings
- 6.3 Seismic separation assemblies

#### 7 Clearance

- 7.1 Clearance around piping through walls or floors
- 7.2 Clearance at sprinklers

#### 8 Other provisions

- 8.1 Suspended ceilings
- 8.2 Water supply

## 4 Design principles

Requirements given in this document fall into the following seven principles:

- brace sprinkler piping and equipment to minimize uncontrolled differential movement between these installations and the attached structure; and
- provide flexibility on piping systems and on equipment where differential movement between portions of those piping systems or equipment is expected; and
- provide clearance between sprinkler piping and structural members, walls, floors or other objects so that potential damage from impact is minimized; and
- provide anchorage or restraint to minimize potential sliding and/or overturning of equipment such as the booster pump, jockey pump, tanks, controller, battery package and diesel tank; and
- use types of pipe hangers and sway bracing in accordance to EN 12845 to minimize the potential for pull-out, properly locate them and attach them to structural members only; and
- use types of pipe joining methods in accordance to this document to minimize potential pipe breaks; and
- provide fire protection system plans and calculations with proper verification of design and proper verification that the completed installation is in accordance with this document and installed in accordance with EN 12845.





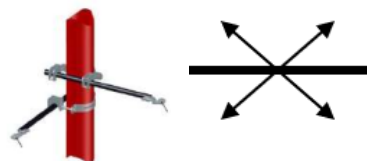
## **Four steps to properly design sway bracing**

- Step 1 Define sway bracing **locations with respect to the sprinkler piping and to the structural members** to which the bracing will be attached
- Step 2 **Calculate the seismic design load** requirements for each sway bracing location
- Step 3 Select the **proper sway bracing shape, angle of attachment, size and maximum length** based on the horizontal design load requirement
- Step 4 Select the **proper method to attach the sway bracing to the structure and to the piping**



# Guidance for sway bracing design

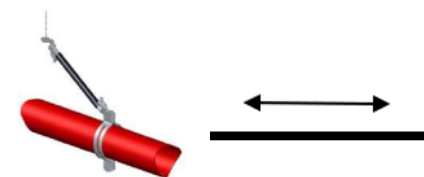
Step 1: Define sway bracing locations with respect to the sprinkler piping and to the structural members to which the bracing will be attached.



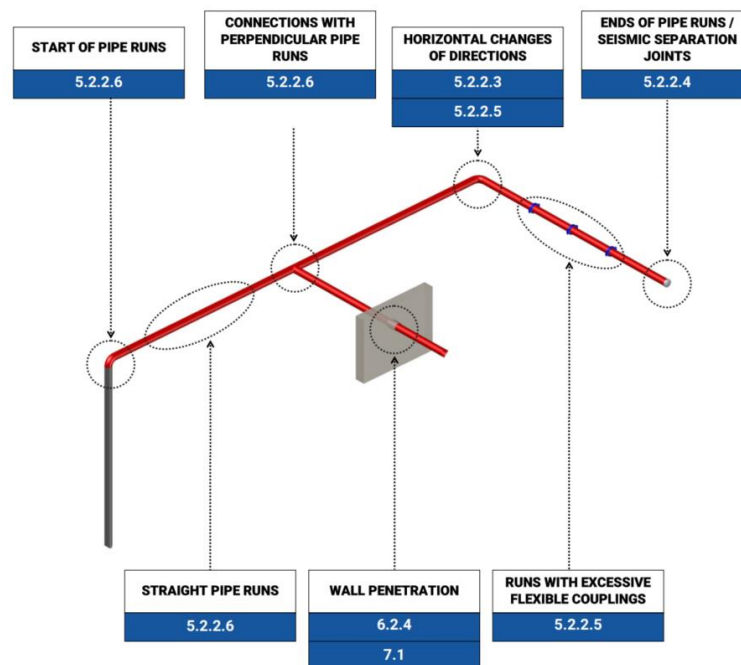
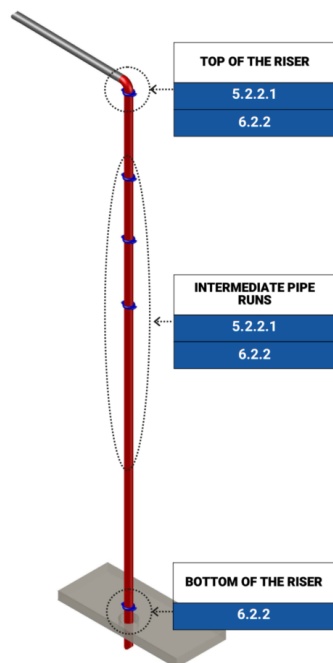
Four-way brace



Lateral brace



Longitudinal brace





# Guidance for sway bracing design

Step 2: Calculate the **seismic design load** requirements for each sway bracing location.

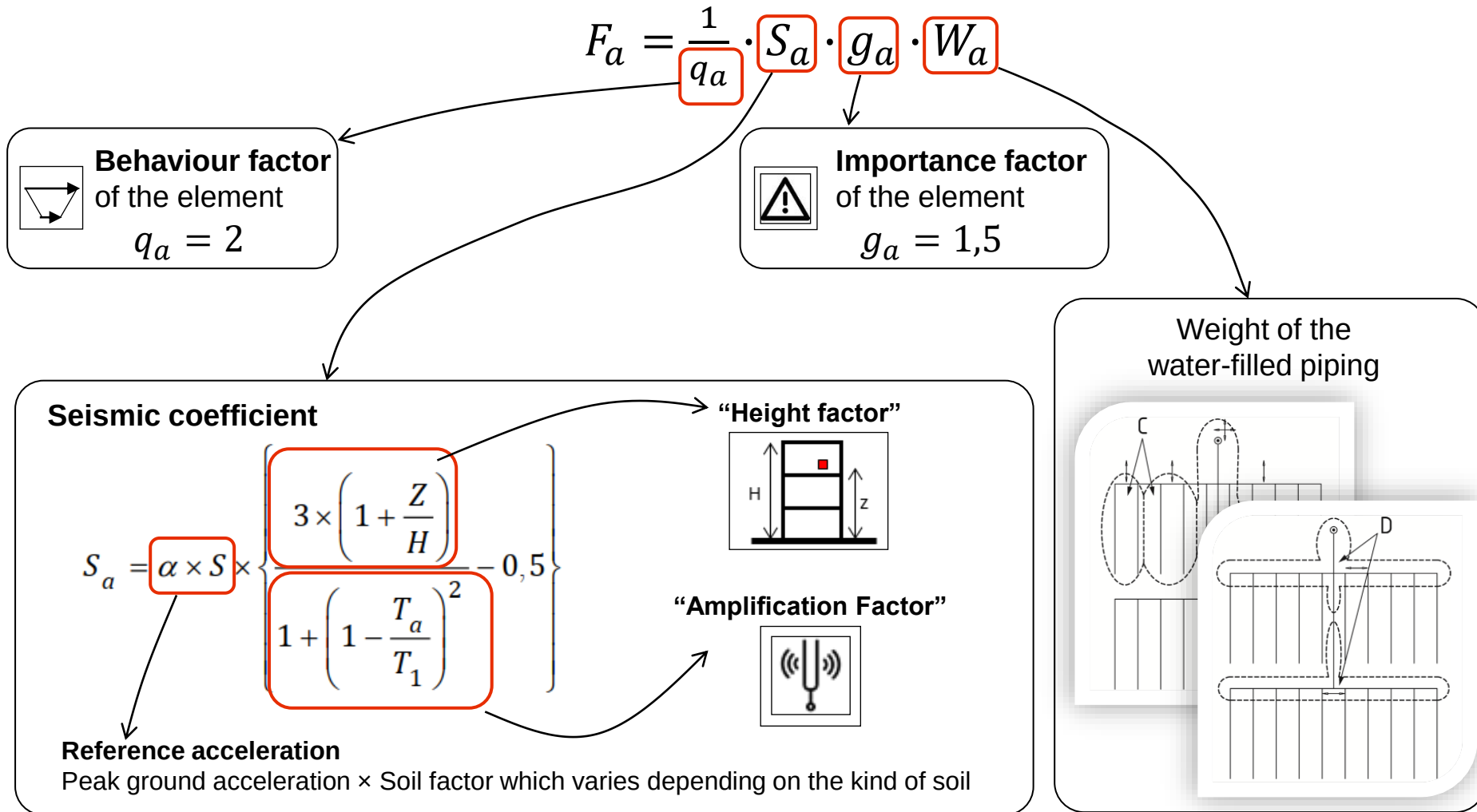
**Two alternative methods** to calculate the horizontal force caused by the seismic actions on the pipes:

- ☐ Eurocode method
- ☐ Simplified method



# Guidance for sway bracing design

## □ Eurocode method:





# Guidance for sway bracing design

## □ Simplified method:

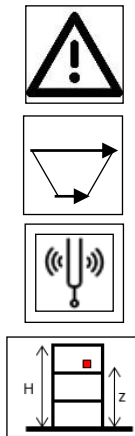
$$F_a = \alpha \cdot S \cdot 5,5 \cdot W_a$$

It gives conservative results compared to “Eurocode method”

### Reference acceleration

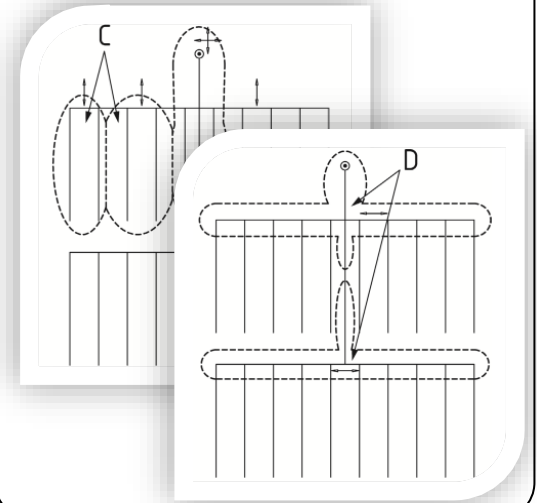
Peak ground acceleration × Soil factor,

The soil factor **S** is assumed always equal to **1,15** when using the Simplified Method



~~“Importance factor”~~  
~~“Behavior factor”~~  
~~“Amplification factor”~~  
~~“Height factor”~~

Weight of the water-filled piping

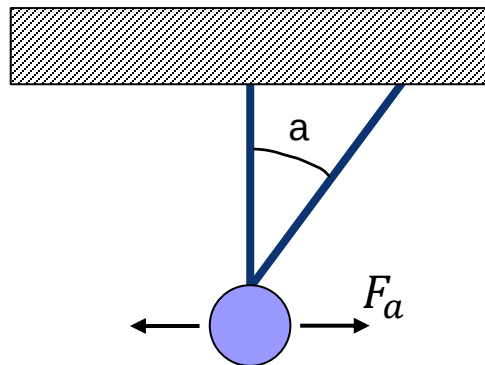




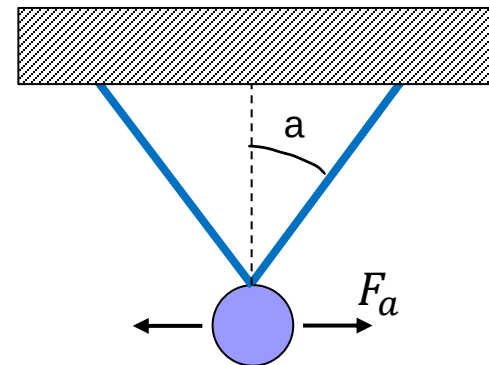
# Guidance for sway bracing design

Step 3: Select the **proper sway bracing shape, angle of attachment, size and maximum length** based on the horizontal design load requirement.

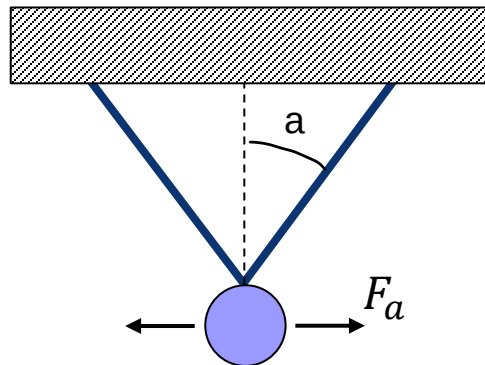
- One vertical and one diagonal brace



- Tension only sway bracing



- Two opposing diagonal braces



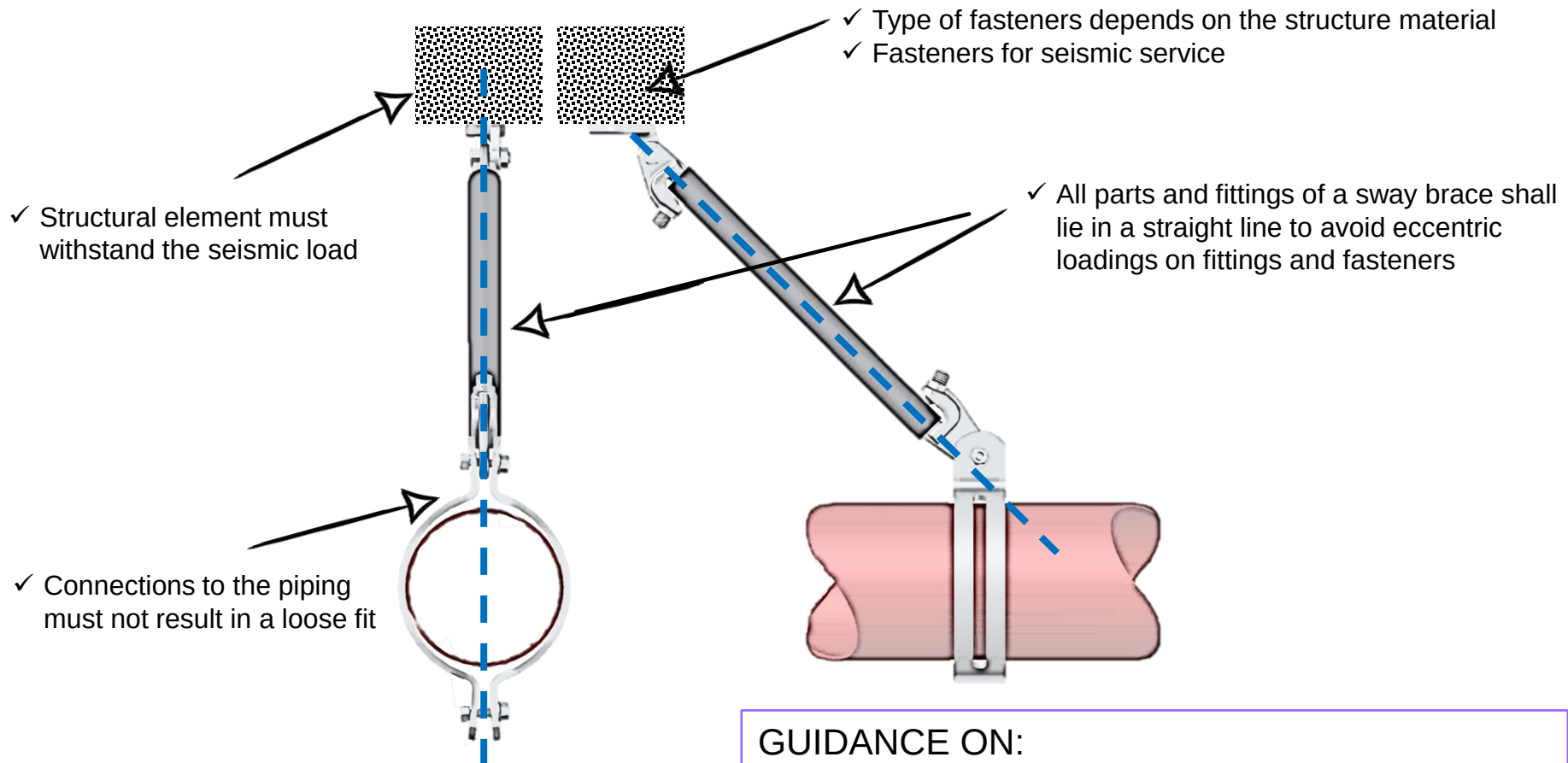
## GUIDANCE ON:

- ✓ Actions to size each brace member
- ✓ Limits to angle “a” (at least 30° from the vertical)
- ✓ Limits to the slenderness ratio for compression members (length/least radius of gyration  $\leq 200$ )



# Guidance for sway bracing design

Step 4: Select the proper method to attach the sway bracing to the structure and to the piping.



## GUIDANCE ON:

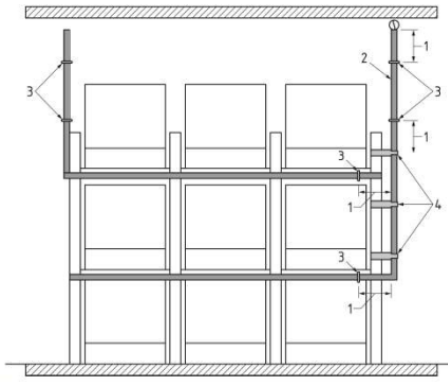
- ✓ Actions to be considered for fastener sizing based on the sway bracing shape



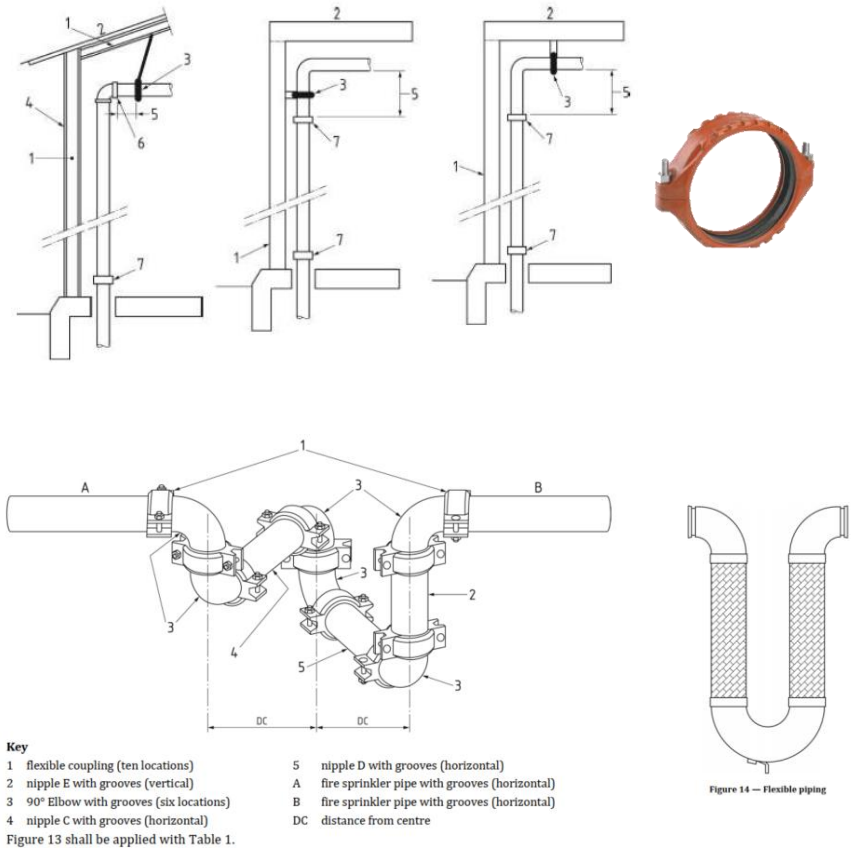


# Further guidance

- ✓ Protection for in-rack sprinkler piping



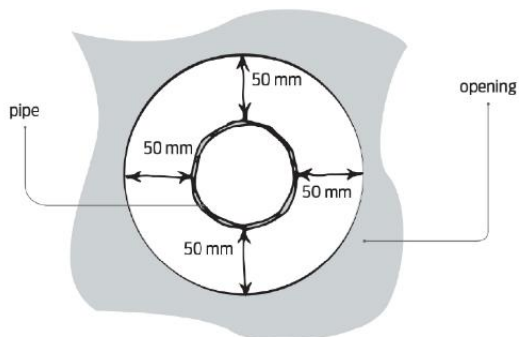
- ✓ Flexibility and seismic separation joints





# Further guidance

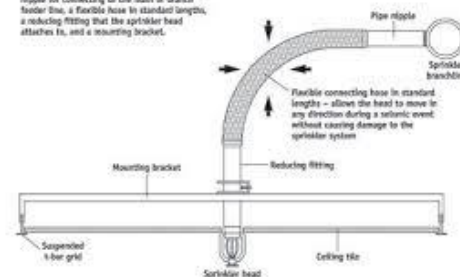
- ✓ **Clearance** around piping through rigid structures



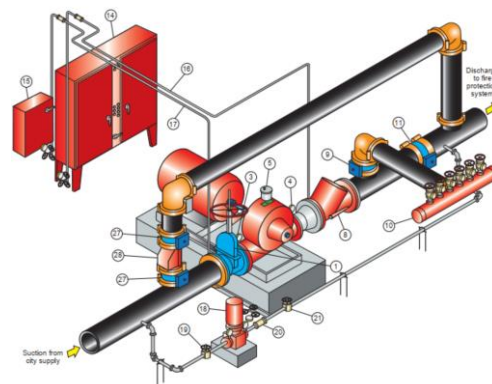
- ✓ **Other provisions**
  - **Suspended ceilings**

Typical Flexible Sprinkler Connection

Typically, each unit consists of a threaded pipe nipple for connecting to the main or branch feeder line, a flexible hose in standard lengths, a reducing fitting that the sprinkler head attaches to, and a mounting bracket.



- **Water supply**





# Conclusions

## The driving factors behind the damage

- Lack of **proper** bracing
- Lack of **proper** flexibility
- Lack of **proper** clearance



Lack of  
**PROPER  
CONCEPTION  
OF THE SYSTEM**

We need to consider the whole system from the water supply to the branch lines

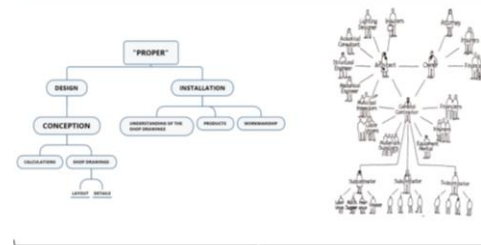
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## Achieving proper seismic protection



**NEED FOR GUIDANCE**  
A common reference  
could play an important role



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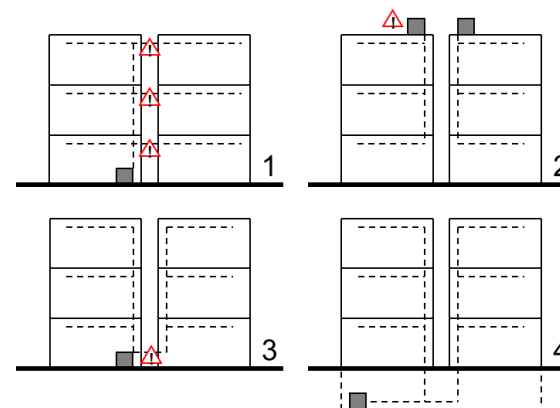
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## Common technical reference



## Conception of the system



## Earthquake Protection for Sprinkler Systems

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ing Andrea Dusso – Safexpertise, SPRINT-Lab - Università degli Studi di Udine



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**THANKS FOR YOUR  
ATTENTION!**

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**ing. Andrea Dusso – [andrea.dusso@safexpertise.com](mailto:andrea.dusso@safexpertise.com)**