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Euro_Codes an essential tool for structural engineers!

But can they be improved?

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Symposium Eurocodes

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Eurocodes

The complete set of Eurocodes, as available since 2004, can be used for structural design of buildings and civil works. It is consistent in:

- starting point of structural design

$$E_d \leq R_d \quad \Leftrightarrow \quad \gamma_F E_k \leq \frac{R_k}{\gamma_M}$$

- safety approach based on probabilistic theory
- determination of loads
- load combinations to be considered
- content of material related Eurocodes

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Problems in the Codes

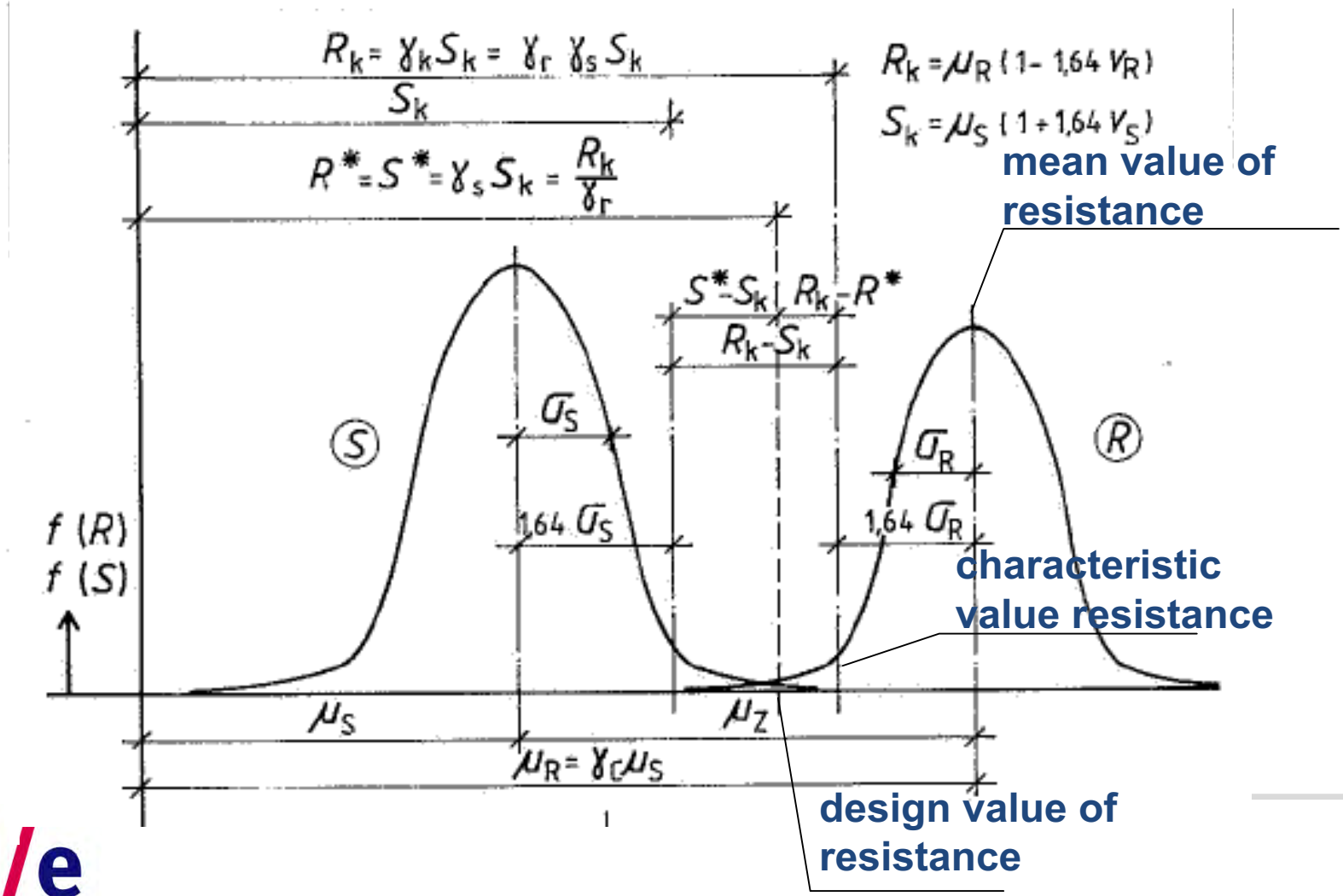
- The tradition of codes and tasks of codes vary from country to country
  - law or referred to in contracts
  - shall or should
- Harmonization of design rules and traditional practice in the several countries
  - Concrete strength (B25 => C20/25 => C20??)
  - Rules for shear resistance
- The size of the package of Eurocodes
  - Evaluation process takes to long

    the work on Eurocode 2 started in 2012 and the code will be published for use in....
  - Organisation within the package

    Create a situation where it should be possible to revise relevant documents on itself

Ease of use

Probabilistic approach



Ease of use

From experience based on several cases of forensic engineering it is learned that failure of structures seldom are due to

Effect of load as should considered according to the code

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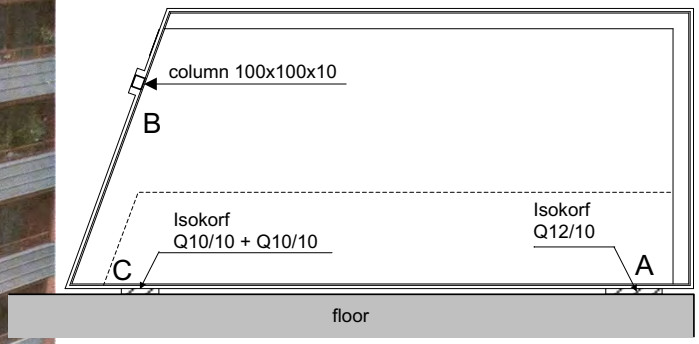
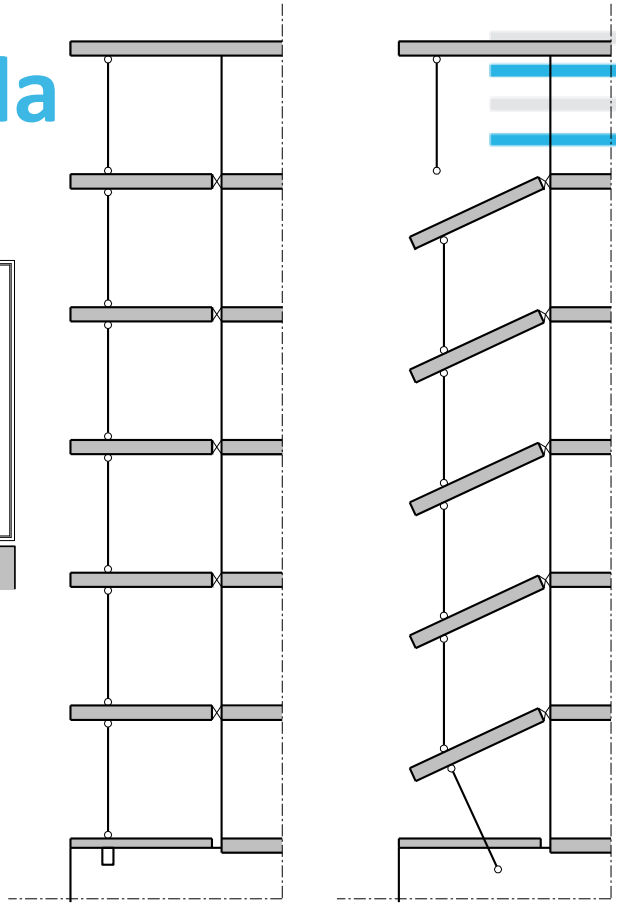
Resistance of the structure as it should be according to the code

Failure and damage to structure occur due to human error(s)

Balcony Structure Patio Sevilla





Ponding of steel roof structures

Snow November 2005

Over 100 structures were damaged when the characteristic snow load was present in the eastern part of the Netherlands

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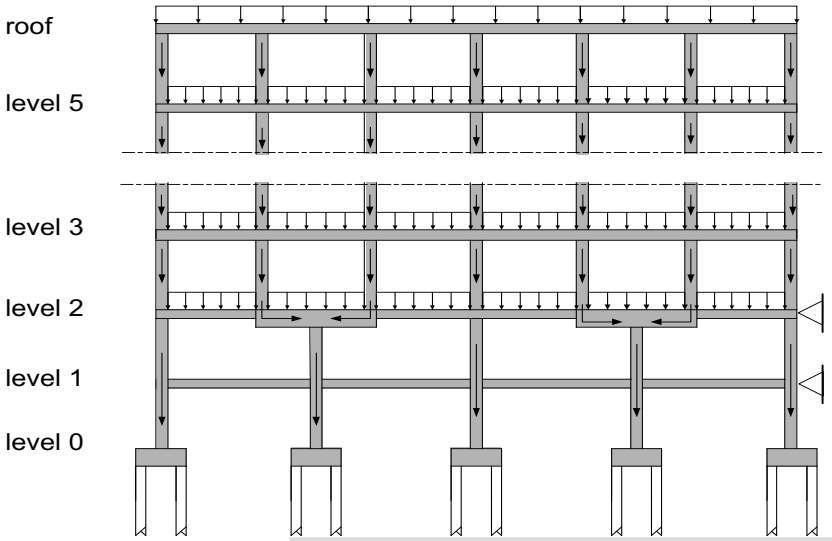
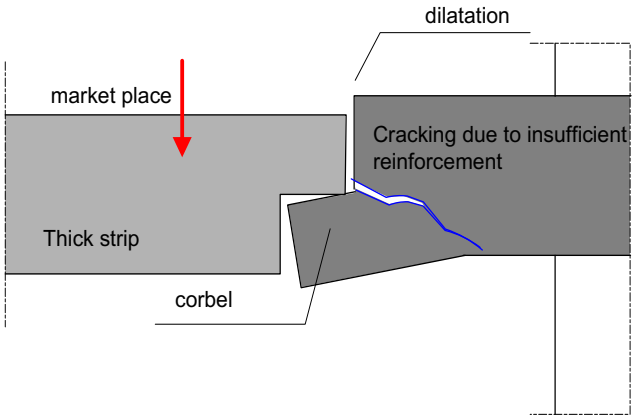
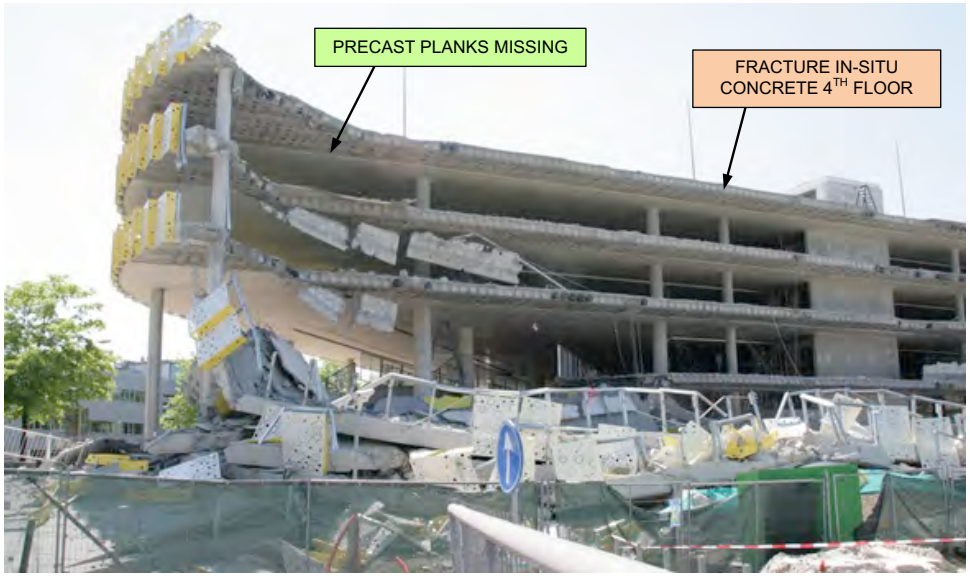
Bos en Lommerplein complex

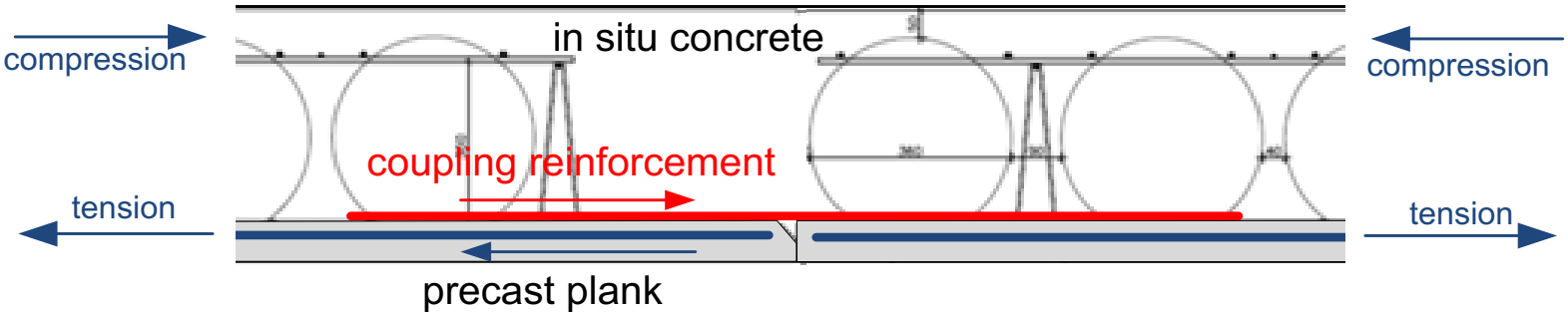




Failure of silo supporting steel structure

Parking garage Eindhoven Airport





Parking garage Wormerveer

A structure consisting of hollow core slabs and a steel beam

Ease of Use

The structural reliability is better ensured by codes:

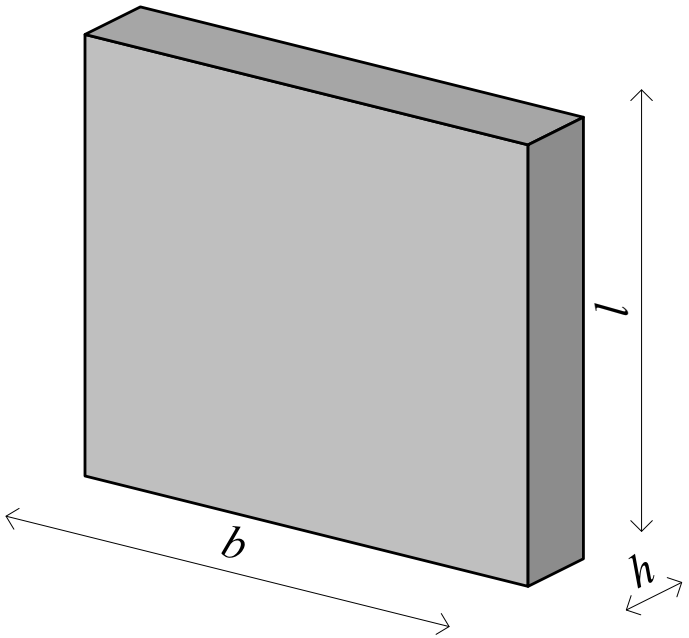
- which are easy to use
- which are consistent in its use
- which are not more complex then required for the job
  - NEN 6702 versus EN 1990 and EN 1991

instead of changing one or two decimals in the partial factors!

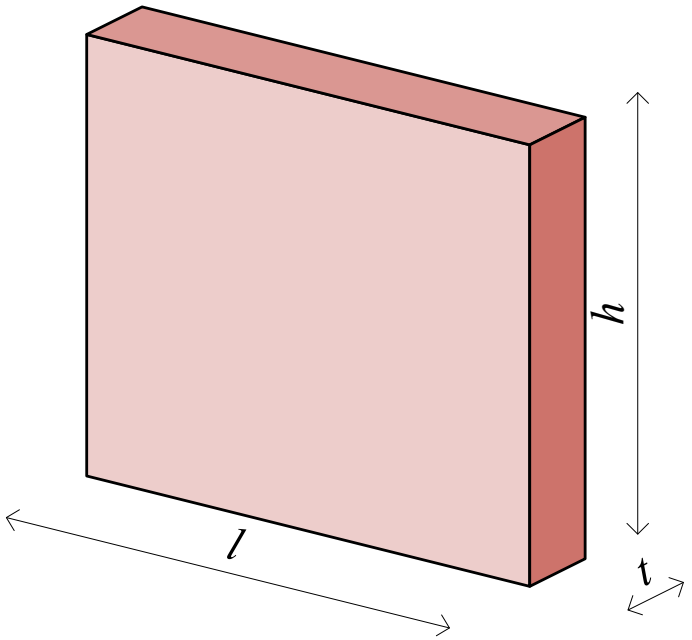
Ease of use

Consist use of symbols and expressions

Concrete wall



Masonry wall



Ease of use

Consist use of symbols and expressions:

Slenderness:

EC2	Concrete columns and walls:	$\lambda = l_{buc}/i$
EC6	Masonry for walls:	$\lambda = h_{ef}/t_{ef}$

Rotational stiffness or restrained:

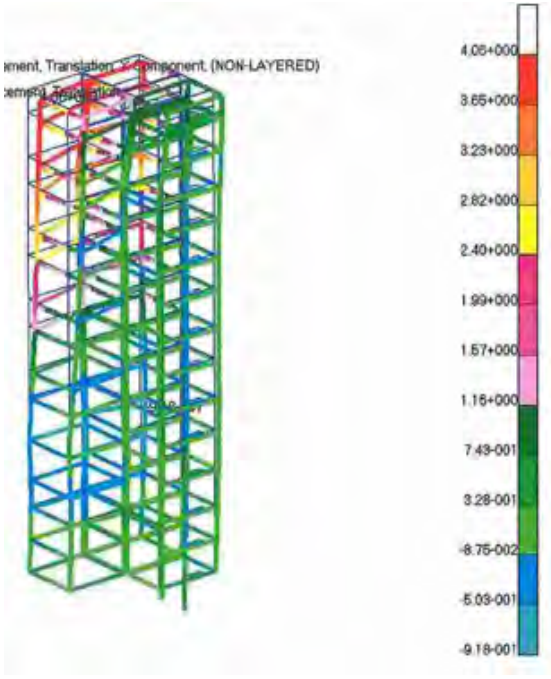
EC2	the relative flexibility of rotational restraint	$k = \theta/M \times EI/l$
EC3	the rotational stiffness	C
EC6	the rotational stiffness	$k_r = \theta/M$

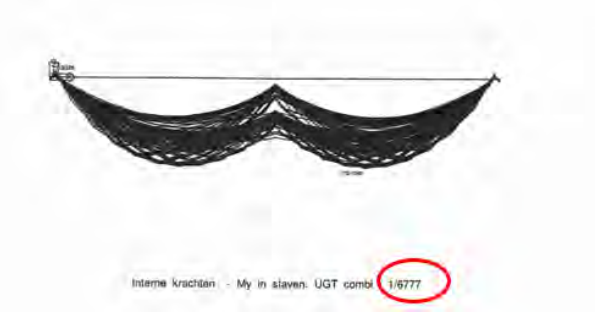
Ease of use

Structural analysis

The determination of the internal forces is more and more work, like that of an financial accountant. The number of load combination is increasing every time:

- the goal is to optimize the extreme internal forces;
- only envelops with the minimum and maximum internal forces are considered;
- this makes a check of the result of the analysis ‘impossible’





Product Standards

Product Standards are also part of the Euro_Codes

- their content is dominated by the manufactures;
  - Dutch mirror committee TC250/SC6 – TC125;
- a CE-marking is not sufficient to guarantee the structural quality;
  - a wall tie can have a CE marking when it is able to resist 1 Newton
  - specification of structural products becomes more extensive
- product standards are essential for the specification of structural materials and products;
- marking is essential for the structural reliability;
  - EN 10080 - Steel for the reinforcement of concrete

Summary

The evolution of the Eurocodes is useful and required

- it should be remembered that Eurocodes are a tool for structural engineers and not a scientific publication
- ease of use is more relevant for structural reliability than changes of partial factors

Proposal:

- Write a code of practice for each Eurocode, that can be used for the structural design of 90% of the structures that will be built