

Analysis and design of steel structures for buildings  
according to Eurocode 0, 1 and 3

Steel Design 1

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# Structural basics

# Colophon

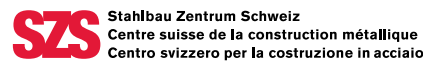
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The text is based on the (English) EN version of the Eurocodes using default and/or recommended values. Where a country can make a national choice – or when non-contradictory complementary information may be used – this is indicated by the following symbol: **NA**. Separate annexes contain the national choices for Belgium, Germany, Luxembourg, The Netherlands and Switzerland. These annexes can be downloaded free of charge from the websites of the (national) organisations as well as any errata, corrections and additions to this textbook.

# Illustrations

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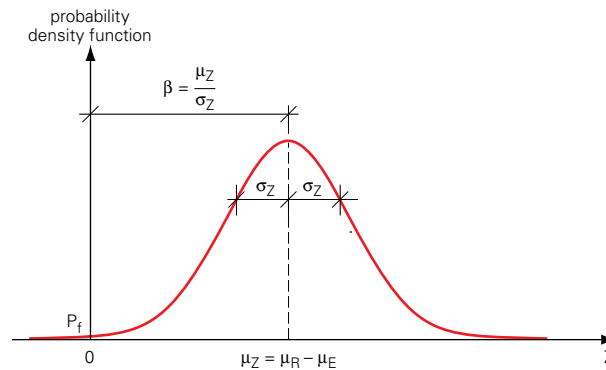


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2.4 The reliability index  $\beta$  is a measure for the probability of failure.



and the consequences for the environment, see *Structural basics 1* (Structural safety), table 1.11. Depending on the consequences of its failure, a (part of a) structure is classified into a consequence class with corresponding reliability class, with a coupled reliability index  $\beta$ , see *Structural basics 1*, table 1.12. The reliability index (a number) can be regarded as a 'measure' of the level of safety that is required during the period of use of

a structure. The reliability index depends on the reference period, which corresponds with the design working life.

In figure 2.4, the safety  $Z$  is expressed as the difference between the resistance  $R$ , and the effect of actions  $E$ :

$$Z = R - E \quad (2.8)$$

The reliability index  $\beta$  is the ratio between the average safety  $\mu_Z$  and its standard deviation  $\sigma_Z$ . The probability of failure  $P_f$  is a measure of the area below the curve for which  $Z < 0$  is valid; this is where failure occurs.

The required value for the reliability index is a minimum value which always needs to be satisfied. A greater value may be chosen for certain structures, perhaps to meet client requirements or additional legal requirements. Examples would be nuclear power plants, or for a crucial part of a structure. In such cases there will be a smaller probability of failure, so a larger value for the reliability index, see *Structural basics 1*, table 1.5. For most buildings, a probability of failure of  $P_f \approx 10^{-4}$  is acceptable: this matches a reliability of  $\beta = 3,8$ .

### 2.2.3 Partial factors for actions

EN 1990, Annex A1 provides recommended values for the partial factors for actions for buildings.

- a **NA** Six different limit states are distinguished, depending on the design situation (table 2.5). Values for the partial factors for permanent loads  $G$  ( $\gamma_G$ ), variable actions  $Q$  ( $\gamma_Q$ ) and accidental actions  $A$  ( $\gamma_A$ ) are also provided, see table 2.6. For the ultimate limit state STR/GEO (set B), the partial factors depend on the reliability class (RC1, RC2 or RC3) and are derived from the reliability index  $\beta$ . In table 2.6, for the ultimate limit state STR/GEO (set B), either equation (6.10) of cl. 6.4.3.2(3) has to be used or the set of equations (6.10a) and (6.10b). The choice is made in the National Annexes of the different countries. To obtain the partial factor for permanent loads in equation (6.10b), the recommended  $\xi$  value of 0,85 was used. This value may be specified differently in the National Annexes of the different countries.
- b **NA**
- c **NA**