SAFETY APPROACH IN RELATION TO LIFESPAN

Regarding the concept of lifespan, several aspects appear to be confused here. We distinguish the following terms:

- **Economic lifespan**: The period during which future revenues exceed future costs.
- **Functional lifespan**: The period during which the building meets all the requirements and wishes of the user.
- **Aesthetic lifespan**: The period during which the aesthetic value of the building meets the requirements and wishes of the user.
- **Technical lifespan**: The period during which a facade or applied product can reliably continue to fulfill the desired functions. A facade construction consists of different elements, each of which has a different technical lifespan. Therefore, the technical lifespan of components varies. The concept of technical lifespan is not unambiguous!
  Table 2.1 of EN 1990:2002 Eurocodes requires that for a product, the lifespan during which its performance is maintained at a level that enables well-designed and executed works, in the case of replaceable structures and/or components, should adhere to the 'design life category: 2' and 'working life category: normal,' with a reference period of 25 years. Adhesion has been demonstrably proven based on nearly 40 years of experience.
- **Design lifespan**: As per the Eurocode for new construction, EN 1990. The design lifespan refers to the current safety philosophy, which is a theoretical static approach where, in the present structural verification for structural safety, calculation values (load and material factors) for loads and material strength are added based on a reference period.
  Thus, through static calculations, using the applicable consequence and reliability class for the reference period of 50 years, the desired safety level of a (part of a) structure can theoretically be assessed in terms of its probability of failure over a relevant period.

The Eurocode has adopted a safety approach in structural design based on partial load and strength factors, known as the LRFD concept (Load and Resistance Factor Design). First, characteristic values for the design parameters are derived, which are 5% lower or 95% upper bound estimates for strength and load parameters, respectively. Instead of using characteristic values, so-called representative values are sometimes used. These are safely estimated values by non-statistical methods, which are assumed to result in at least the same level of safety in design as characteristic values.
For this reason, we recommend using the representative or usage value of 1 MPa in static verifications.

The characteristic strength parameters are then divided by partial safety factors for strength (material factors). The characteristic load parameters are multiplied by load factors. This way, design values (also called calculation values) for strength and loads are obtained.
The criterion for the safety of a design is that the calculated strength of the structure, based on the calculation values for strength parameters, must be greater than or equal to the calculated load effects based on the calculation values for loads.

In this regard, a so-called reference period has been introduced for structural safety, based on which the calculation values for loads and strength must be determined. Thus, through static calculations, the safety level of a (part of a) structure can theoretically be defined in terms of the probability of failure over a relevant period.

This practical method for determining the desired safety level is based on the correct selection of the following (calibrated) parameters:

- Consequence class in which the structure falls;
- The prescribed characteristic loads.
- The prescribed load factors γf and combination factors ψ.
- The standardized calculation rules and material properties.
- The prescribed material factor γm.

The load and material factors are, in principle, chosen such that the safety level, expressed as βn, is achieved, which corresponds to the relevant consequence class. For new construction, the Eurocode, NEN-EN 1990, Table B2, provides the values for βn, as listed in the second-to-last column of Table 1 below. The National Annex to EN 1990, Appendix C, indicates that for situations where wind load is dominant, a lower value better aligns with reality. These values are included in the last column.

Table 1: Reliability Index for New Construction for Design Lifespan

Consequence Class	Consequences of Failure	Wind Load Not Governing	Wind Load Governing
1	Negligible/small	Small	βn = 3.3
2	Significant	Significant	βn = 3.8
3	Very large	Very large	βn = 4.3

The values in the table are based on a design lifespan of 50 years. For consequence class 1 in new construction, this criterion is never decisive.

For consequence classes 2 and 3, it can be decisive for wind (last column of the table).

TWEHA 2022