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A Logical System for Partial Safety Factors

Un système logique de coefficients partiels de sécurité

Ein logisches System für Teilsicherheitsfaktoren

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It is now generally accepted that a system of partial safety factors proves to be practical in structural design. These factors cover a wide spectrum of various influences which are due to the properties of loads or to the properties of structures. The character of the influences is very heterogeneous and thus the methods of establishing the values of partial safety factors are still discussed and not yet settled in general. In spite of this fact systems of partial safety factors were recently proposed by several international organizations, particularly by the European Concrete Committee, CEB /1/, International Building Council, CIB /2/, and International Standard Organization, ISO /3/.

However, all these systems have some of the following drawbacks:

a) they are not universal, i.e. they are often developed from the point of view of a particular type of structures;

b) they do not strictly separate factors according to the individual influences (e.g. factors attributed to loads and load-effects depend upon the material properties, methods of construction, etc.);

c) they are not flexible enough to enable continuous developments of design codes;

d) factors are distributed unevenly, i.e. some influences are stressed too much, others are disregarded at all.

Table 1. The Proposed System of Partial Safety Factors.

Origin of the influence	Character of the influence					
	Random		Non - random			
	Occurrence of unfavourable random events	Simultaneous occurrence of random events	Exactness of analysis, basic assumptions, etc.	Mode of occurrence of unfavourable events	Apparently noh-random properties	Consequence of occurrence of unfavourable events
Structure	γ_{S1}	γ_{S2}	γ_{S3}	γ_{S4}	γ_{S5}	γ_{S6}
Load	γ_{L1}	γ_{L2}	γ_{L3}	γ_{L4}	γ_{L5}	γ_{L6}

The above drawbacks cause difficulties in communication among different national and international organizations preparing design codes. To avoid this, a system can be developed, with a two-way classification of partial safety factors: according to the origin of influences they should cover (loads, structures), and, secondly, according ot the character of the influences (random, non-random, etc.). The proposed system is shown in Table 1, where each factor must be considered as a symbol for a group of factors covering influences of the same origin and character. A more detailed explanation of factors in Table 1 will clear the idea:

Factors γ_{S1} cover random behaviour of separate:

- material properties (strength, moduli of elasticity, etc.),
- dimensions,

artificial stress states (prestressing force),

or, integrally, random behaviour of the structural resistances (ultimate load, cracking load), or other important quantities (width of cracks, deflection, etc.).

The main aim of factors γ_{S1} is to ensure a low probability of occurence of unfavourable events.

Similarly, factors γ_{L1} express random behaviour of separate loads, or load-effects.

Factors γ_{S2} take into account low probability of simultaneous occurrence of two or more unfavourable random events, e.g. occurrence of minimum strength of concrete and steel, minimum ultimate bending moments in a statically indeterminate structure, etc.

Factors γ_{L2} have the analogous meaning for loads.

Factors γ_{S3} and γ_{L3} cover

- intentional or unintentional approximations accepted in the analysis, simplifications of hypotheses, etc.,
- uncertainties in basic assumptions.

Factors γ_{S4} take into account the mode of occurence of unfavourable events in the structure (e.g.brittle fracture).

Factors γ_{L4} cover unfavourable modes of load action: impact, repeated loads, etc.

Factors γ_{S5} and γ_{L5} should cover all deviations from some average behaviour which cannot be treated statistically at the present time, e.g. corrosion, emergency loads.

Factors γ_{S6} and γ_{L6} take into account consequences of structural failure (in a wider sense of word). If the damages concern the structure (its serviceability and durability) factors γ_{S6} would apply, whereas γ_{L6} would be used if objects carried or protected by the structure are endangered (goods, people). Since the border between the two domains of application may be arbitrary in many cases, both groups of factors, γ_{S6} and γ_{L6}, might be unified into one.

The proposed system of partial safety factors can be used for any type of structures, structural materials and loads. The quantitative meaning of particular factors may be different in separate but the qualitative meaning will not change.

R e f e r e n c e s

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SUMMARY

In order to enable the communication between different national and international bodies working in the domain of design standardization, as well as between designers on the whole, a simple universal system of partial safety factors is proposed and discussed. The system is based on a two-way classification of origins and characters of influences occurring in the structural design.

RESUME

Pour simplifier la communication entre les différentes organisations nationales et internationales dans le domaine du calcul des constructions et aussi entre les ingénieurs de projet eux-mêmes, un système universel de coefficients partiels de sécurité est proposé. Le système est basé sur une classification bi-dimensionelle.

ZUSAMMENFASSUNG

Um die Verständigung zwischen verschiedenen nationalen und internationalen Organisationen auf dem Gebiete der Bemessung der Baukonstruktionen zu verbessern, ist ein einfaches allgemeines System der Teilsicherheitsfaktoren entworfen worden. Das System nützt eine zweidimensionale Klassifizierung der Einflüsse auf die Sicherheit aus.

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