Reliability differentiation in ULS checks according to EN1990

Pietro CROCE
Professor, PhD
Dept. of Civil Engineering, Structural Div. Univ. of Pisa, Italy
p.croce@ing.unipi.it

Pietro Croce, born 1957, is professor of Structural Mechanics and Design at the University of Pisa.

Paolo FORMICHI
Civil Engineer
Dept. of Civil Engineering, Structural Div. Univ. of Pisa, Italy
p.formichi@ing.unipi.it

Paolo Formichi, born 1970, received his civil engineering degree from the Univ. of Pisa in 1994.

Haig GULVANESSIAN
CBE
Visiting Professor
Imperial College
London, UK
gulvanessian@bre.co.uk

Haig Gulvanessian, born 1941, former Director of BRE, is visiting Professor at Imperial College, London.

Summary

In EN1990, action effects in persistent and transient design situations are to be derived according to appropriate combinations of actions. Three different sets can be chosen alternatively in the National annex: expression 6.10 or the most adverse between expressions 6.10a and 6.10b or the most adverse between expressions 6.10a modified and 6.10b. Since the three formulations are not equivalent in terms of structural reliability, a specific study has been performed to compare the reliability level associated with each of them, in some simple but very clear case studies. Results show that the target reliability level required in EN 1990 for ULS checks is commonly reached using expression 6.10, while expressions 6.10 a and 6.10b can lead to lower values, especially when the C.O.V. of the resistance is high.

Keywords: EN1990, Basis of design, Reliability, Load combinations, Reliability index.

1. Introduction

According to the partial factor method, the occurrence of any limit states is prevented checking that in the most critical hazard scenario it results

$E_d \leq R_d$ (1),

where R_d is the design value of the capacity and E_d is the design value of the action effect induced by the relevant load combination.

The verification of safety of structures through the partial factor method in persistent and transient design situations, which are in most cases the situations governing the design of structures, are treated in §6.4.3.2 of EN 1990 [1], where three different sets of combinations of actions are assigned for the evaluation of the action effects. The appropriate choice between the three alternative sets, given by expression 6.10 (2), by the most adverse between expressions 6.10a (3.a) and 6.10b (3.b), or by the most adverse between expressions 6.10a modified (4) and 6.10b (3.b):

$$\sum_{j\geq 1}\gamma_{G,j}G_{k,j}\text{"+"}\gamma_P P\text{"+"}\gamma_{Q,1}Q_{k,1}\text{"+"}\sum_{i>1}\gamma_{Q,i}\psi_{0,i}Q_{k,i} \qquad [6.10]\ \ (2),$$

$$\sum_{j\geq 1}\gamma_{G,j}G_{k,j}\text{"+"}\gamma_P P\text{"+"}\gamma_{Q,1}\psi_{0,1}Q_{k,1}\text{"+"}\sum_{i>1}\gamma_{Q,i}\psi_{0,i}Q_{k,i} \qquad [6.10a]\ \ (3.a),$$

$$\sum_{j\geq 1}\xi\gamma_{G,j}G_{k,j}\text{"+"}\gamma_P P\text{"+"}\gamma_{Q,1}Q_{k,1}\text{"+"}\sum_{i>1}\gamma_{Q,i}\psi_{0,i}Q_{k,i} \qquad [6.10b]\ \ (3.b),$$

$$\sum_{j\geq 1}\gamma_{G,j}G_{k,j}\text{"+"}\gamma_P P \qquad [6.10a\ modified]\ \ (4),$$

https://doi.org/10.2749/222137810796024880
Distributed by structurae