Comparison of Safety Factor Evaluation Methods for Flexural Buckling of HSS Welded Box Section Columns

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Comparison of safety factor evaluation methods for flexural buckling of HSS welded box section columns

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Abstract

The statistical evaluation of the experimental and numerical results is an essential task in case of resistance model development for civil engineering structures. If a design model is developed which has analytical or empirical background its safety level has to be confirmed and it should be proved that the developed design method fits the safety requirements of the EN 1990 [1]. However, in the EN 1990 and also in the international literature there are several different safety factor evaluation methods that can be used to check the necessary safety level of the analyzed design method (e.g.: 5% quantile level, 2.3% quantile level, 1‰ quantile level, γ_M partial safety factor, γ_M^* partial safety factor, β reliability index). In the international literature different calculation methods can be found even for the calculation of the same partial safety factor as well. In the present study the flexural buckling resistance of high strength steel (HSS) welded box sections are analyzed and the application of different safety approaches are demonstrated and compared. The authors investigated the buckling resistance of the analyzed columns by laboratory tests and by numerical simulations and the necessary partial safety factors are determined by different approaches. Based on the comparison tendencies are identified and the differences between the statistical evaluation methods are demonstrated.

Keywords: flexural buckling, high strength steel, partial safety factor, statistical evaluation.

List of notations

α_E FORM (First Order Reliability Method) sensitivity factor for effects of actions
α_R FORM (First Order Reliability Method) sensitivity factor for resistance
β reliability index
γ_M^* partial safety factor applicable for design
γ_M theoretical partial safety factor
γ_{M1} partial safety factor applied for stability failure modes in Eurocode
$\gamma_{M,2.3}$ theoretical partial safety factor calculated from deterministic numerical resistances
$\gamma_{M,MCS,i}$ theoretical partial safety factor calculated from an individual Monte Carlo simulation
$\gamma_{M,St}$ theoretical partial safety factor calculated from mean values of stochastic numerical resistances
$\gamma_{M,St,2.3}$ theoretical partial safety factor calculated from characteristic values of stochastic numerical resistances
δ error term
Δk modification factor for calculation of the partial safety factor
$\Delta k_{2.3}$ modification factor for calculation of the partial safety factor based on deterministic numerical resistances
$\Delta k_{MCS,i}$ modification factor for calculation of the partial safety factor based on an individual Monte Carlo simulation