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Probabilistic optimization of a frame

M. SÝKORA

Klokner Institute, CTU in Prague
Šolinova 7, 166 08 Prague 6
Czech Republic
sykora@klok.cvut.cz

The poster describes a design procedure based on probabilistic methods and optimization that should provide structures having an acceptable reliability level and the optimum cost. A steel frame has been originally designed using recommendations provided in EN documents. Actions due to dead load, snow and wind are taken into account. Considering the latest versions of the EN documents, lateral-torsional buckling of a beam yields the most critical criterion. Proposed reliability analysis is based on the limit state function derived from the criterion for lateral-torsional buckling. Theoretical models of stochastic variables are determined taking into account recommendations given by the Joint Committee for Structural Safety. Reliability of the frame is verified by time-invariant analysis. Time-variant snow and wind actions are, therefore, approximated by their appropriate extremes in accordance with Turkstra's rule. The reliability analysis indicates that the original design using the EN documents leads to a satisfactory reliability level. Submitted probabilistic optimization based on minimization of the total cost is then applied in order to find the most economical design. A simplified objective function expressed as a sum of initial, structural, and expected malfunction cost is considered. It is assumed that the decisive parameter is the sectional area A. The initial cost C_0 is independent of the parameter and failure probability P_f. The structural cost is a product of the marginal cost per unit sectional area C_0, and the sectional area A. The expected malfunction cost is a product of the failure probability P_f, and the malfunction cost C_f due to failure. The paper shows that the probabilistic optimization technique may become an effective tool of structural design. Assuming a given cost ratio C_f/C_0, the proposed technique enables to specify optimum structural parameters leading to the minimum total cost. However, one of the most

important and difficult tasks remains the assessment of the cost values of C_0 and C_f.

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