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Nicola Impollonia

Department of Civil Engineering and Architecture, University of Catania, 95123 Catania, Italy

Probabilitistic study of semi-rigid connections in steel framed structures

It is widely known that the behavior of steel frames is affected by the uncertainty of the beam-to-column connections. It is usually found that these connections are neither ideally pinned, nor perfectly rigid, but rather exhibit a semi-rigid behavior. Buildings codes such as the Euro code 3 introduce the concept of semi-rigid connections in terms of fixity factors or connection percentage. In particular, the limit values of the fixity factors for pinned and rigid joints in steel structures are 14% and 89%, respectively. Based on these values, and considering the largely scattered results observed in experiments, even when the same kind of connection is involved, in this contribution we perform an analytical, probabilistic study to characterize the stochastic structural response of semi-rigid connections in steel structures. The main goal is to assess to what extent the uncertainty of the semi-rigid connection propagates into the structural response. More specifically, the semi-rigid connection is idealized and modeled as a rotational spring at the beam end (representative of the initial stiffness of the joint) and the spring rotational stiffness is assumed as a uniformly distributed random variable. The two extremes of the uniform random variable are assumed equal to the aforementioned values indicated by the Euro code 3 for semi-rigid connections, namely 14% and 89%. The probability density function of a few response indicators, such as the mid-span deflection, the bending moment, and the element stiffness matrix terms, is computed. Misleading (and in some cases non-conservative) conclusions from a design viewpoint might be drawn unless the probabilistic nature of the structural response is properly accounted for, i.e., when resorting to a deterministic approach. This is evidenced by comparing the probability-based response with the deterministic response arising from an average value of the fixity factor being intermediate between the two extremes. The present analysis has been carried out for individual beams as well as for simple steel frames.

Biography

Nicola Impollonia is professor of Strength of Materials at the school of Architecture, University of Catania (Italy). He has published more than 30 papers in reputed journals and he is a member of the ECSS Buckling Workgroup at ESA.

nimpo@unict.it

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