ON THE USE OF THE BUCKLING LENGTH CONCEPT IN THE DESIGN OR SAFETY CHECKING OF STEEL PLANE FRAMES

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The concept of "buckling length" (BL), also termed "effective length", was introduced by Jasinsky in 1893 (Timoshenko, 1953) to quantify the boundary conditions influence on the elastic critical load of uniform columns, i.e., prismatic columns under uniform compression (since Jasinsky only looked at columns with restrained ends, the original designation was "reduced length"). In this context, the BL is physically interpreted as the distance between adjacent points of contraflexure in the column buckling mode shape (eventually "extended"). Later, the simplicity and appeal of the BL concept led to its extension to compression members belonging to frames and incorporation in design/safety checking procedures still prescribed by the existing codes. In the case of Eurocode 3 (EC3, 1992), the design/safety checking of steel plane frames with respect to in-plane buckling phenomena may or must use the BL concept (i) to evaluate elastic critical loads, (ii) to define the member geometrical imperfections and (iii) to verify the resistance of compressed frame members.

Unfortunately, however, using the BL concept to solve problems other than isolated uniform columns (e.g., frames) may (i) lack a physical meaning and (ii) lead to unsafe/uneconomical designs, due to inappropriate interpretations. It is, therefore, important (i) to identify such problems and (ii) to discuss the advantages/drawbacks of using the BL concept. The objective of this paper consists of drawing attention to several limitations and ambiguities related to the common use of the BL concept, mainly in the context of the design/safety checking of plane frames with respect to in-plane buckling phenomena, and providing a contribution to shed some light on the issues involved. For this purpose, a number of simple illustrative examples are presented and discussed. On the basis of these examples, a few guidelines, concerning the convenience/validity of the BL concept and the definition of alternative approaches, are suggested and commented. The paper deals first with the use of the BL concept to perform linear stability analyses (determine critical loads), after which procedures related to the verification of a compressed member resistance are addressed (including the definition of the initial geometrical imperfections).