Alternative Forms Of Considering Shear Deformation In Axially Loaded Timoshenko Beams

Rodrigo B Burgos* and Luiz F. Martha†

* State University of Rio de Janeiro (UERJ)
Rua São Francisco Xavier, 20550-900, Rio de Janeiro, RJ, Brazil
rburgos@ig.com.br

† Pontifical Catholic University of Rio de Janeiro (PUC-Rio)
Rua Marquês de São Vicente, 521, 22453-900, Rio de Janeiro, RJ, Brazil
lfm@tecgraf.puc-rio.br

ABSTRACT

Buckling of beam-columns has been studied by many researchers since Euler derived an analytical expression for the limit bifurcation load of an axially loaded simply supported beam.

The mathematical model of Euler-Bernoulli for beams neglects shear deformation and, as a consequence, assumes that the derivative of transversal displacements is equal to the rotation of the beam's cross-section.

In Timoshenko's beam theory, shear deformation is usually considered as an additional cross-section rotation. Nonetheless, original texts of Timoshenko and Gere had already pointed out an alternative manner of considering shear deformation, although the great majority of literature articles neglect this fact. One reason for this could be that, usually, the alternative model does not lead to big differences in the results, although in some specific situations some discrepancies may be observed.

The objective of this paper is to discuss, in the context of a second-order geometric non-linear analysis, the differences in results considering the two alternatives for shear deformation. For the case of an axially loaded beam, the two alternatives lead to different values for critical loads. This is shown in numerical examples of known models, such as beam-columns with various end conditions. The analysis of Roorda's frame also presents very different results.

REFERENCES

[1] Areiza-Hurtado, M., Vega-Posada, C. and Aristizábal-Ochoa, D. (2005). Second-order stiffness matrix and loading vector of a beam-column with semi rigid connections on an elastic foundation. Journal of Engineering Mechanics, v. 131, n. 7, p. 752-762.

[2] Onu, G. (2008). Finite elements on generalized elastic foundation in Timoshenko beam theory. Journal of Engineering Mechanics, v. 134, n. 9, p. 763-776.

[3] Silvestre, N., Camotim, D. (2005). An asymptotic-numerical method to analyze the post-buckling behavior, imperfection sensitivity and mode interaction in frames. Journal of Engineering Mechanics, v. 131, n. 6, p. 617-632.

[4] Timoshenko, S. P., Gere, J. M. (1961). Theory of Elastic Stability. McGraw Hill, New York, USA.