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Lateral-torsional buckling steel beams with simultaneously tapered flanges and web

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Abstract. A procedure for critical buckling moment of a tapered beam is proposed with the application of potential energy calculations using Ritz method. Respective solution allows to obtain critical moments initiating lateral buckling of the simply supported, modestly tapered steel I-beams. In particular, lateral-torsional buckling of beams with simultaneously tapered flanges and the web are considered. Detailed, numerical, parametric analyses are carried out. Typical engineering, uniformly distributed design loads are considered for three cases of the load, applied to the top flange, shear centre, as well as to the bottom flange. In addition simply supported beam under gradient moments is investigated. The parametric analysis of simultaneously tapered beam flanges and the web, demonstrates that tapering of flanges influences much more the critical moments than tapering of the web.

Keywords: tapered I-beam; stability; lateral-torsional buckling; critical buckling moments

1. Introduction

Steel beams or columns tapered along their length or height are commonly applied in civil engineering because of their more optimal capabilities to carry on typical loads. This is particularly true when they are applied for middle size structures like industrial halls, trade malls, small bridges etc. That is why these type of steel structures are subjected of intensive research recently (see e.g., Marques *et al*. 2013, Benyamina *et al*. 2013, Yuan *et al*. 2013, Asgarian *et al*. 2013).

When properly designed against lateral torsional buckling, the steel beams are very economical in practical applications. However if these beams are not sufficiently resistant against flexural-torsional or lateral buckling their load capacity may substantially be reduced.

Stability of steel beams with linearly varying cross-sections along their length was analyzed by a relatively narrow group of specialists, though initial research on this problem started as early as in the fifties and sixties of the twentieth century. Butler (1966) presented the results of experimental I-section steel beams and channel sections with variable cross-section. Kitipornchai and Trahair (1972) gave approximate formulas for calculating the critical load initiating loss of stability of steel beams with tapered cross sections. The authors on the latter study also conducted an experiment on simply supported aluminium tapered I-beams. They found good agreement between their experimental results and the results of critical loads obtained from the analytical

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