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Lateral–torsional buckling resistance of coped beams

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Abstract

The lateral–torsional buckling resistance of beams depends on the support conditions. In floor structures for buildings coped beams are often used. A numerical model was developed to investigate the influence of copes on the lateral buckling resistance. This model is described in a companion paper [Maljaars J, Stark JWB, Steenbergen HMGM, Abspoel R. Development and validation of a numerical model for buckling of coped beams. Journal of Constructional Steel Research 2005;61(11):1576–93]. In this paper results of a parameter study carried out with the numerical model are presented. Based on these results recommendations for design rules are given. The study is restricted to (coped) beams with end plates.

Keywords: Lateral–torsional buckling; Design of buildings; Cope; Endplate; Connection

1. Introduction

The well-known equation for the elastic critical buckling load for lateral–torsional buckling (M_{cr}) of a beam loaded with a uniform bending moment was published in 1960

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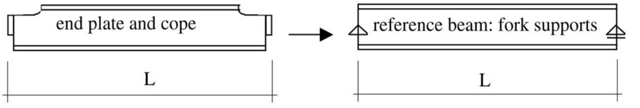


Fig. 1. Comparison between coped beam and beam with fork supports.

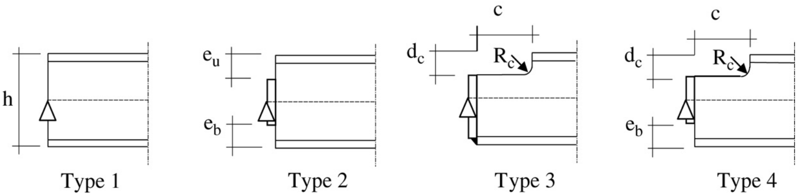
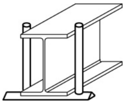


Fig. 2. Studied connections.

by Timoshenko and Gere (Eq. (1)). The equation was analytically derived for a simply supported beam with fork supports, i.e. the rotation about the longitudinal axis and vertical and lateral deflections are restrained, while rotations about the strong and weak axes are free. In addition, the beam ends are assumed free to warp, but no other distortion of the beam end is allowed.

$$M_{\mathrm{cr}} = \frac{\pi}{L}\sqrt{EI_z\left(GI_t + \frac{\pi^2}{L^2}EI_{\mathrm{wa}}\right)} \qquad (1)$$



Conditions for fork supports are not always fulfilled in connections applied in practice. When copes are used, local web deformation in the coped part or lateral–torsional buckling of the coped part of the section may reduce the elastic critical buckling load of the entire section [4,3]. Local web deformation may also occur if endplates are not welded to the full height of the section end.

In order to quantify the influence of copes and partial end plates on the elastic critical buckling load and on the buckling resistance, a parameter study was carried out with the numerical models, described in [1].

Buckling of coped beams of various sizes supported by two types of end plates and with various dimensions of copes were compared with buckling of a reference beam with equal properties, but with a uniform cross-section and with fork supports, see Fig. 1.

The influence of the support conditions on the elastic critical buckling load is expressed by a reduction factor on the elastic critical buckling load of the reference beam (Eq. (1)). The equations for these reduction factors were based on curve fitting of the numerically obtained results. For the determination of the ultimate buckling resistance from the elastic critical buckling load, appropriate buckling curves are proposed.

2. Parameter field

Four different types of end condition as shown in Fig. 2 were considered:

1. Beam with uniform cross-section and fork supports. This is the reference beam;
2. Beam with uniform cross-section and end plates;