Load Carrying Capacity of Composite Castellated Beams

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Abstract

Due to unique geometry of castellated steel beams and existence of the web holes, estimation of shear load carrying capacity of these beams is rather different from traditional beams with solid webs. Shear capacity estimation of castellated beams becomes even more complicated when these beams are used in composite floor systems due to contribution of the concrete slab. Herein, a numerical study is performed to assess the shear capacity of composite castellated beams by using nonlinear finite element (FE) method. A benchmark parametric FE model is created and validated comparing the test results. This comparison showed a good accuracy for the model. This model is used in the parametric study of shear response of composite castellated beams. Different FE models of these beams are analyzed and the obtained results show that the floor slab can have a considerable contribution in shear capacity of composite castellated beams.

Keywords: Castellated steel beams, composite beams, shear capacity, nonlinear finite element.

Introduction

Because of their economy and aesthetic, castellated I-shaped steel beams have a vast application in steel building construction in the form of subsidiary beams (joists) or simply supported main gravity girders. However, the castellation process causes different potential modes of failure such as web-post instabilities, developing Vierendeel mechanism and rupture of the welded joints [1]. Numerous numerical and experimental studies have been conducted on the structural response of these beams focusing on the global instabilities [2-6] or local yielding/buckling mechanisms [7-10]. Zaarour and Redwood [8] investigated web-post buckling failure mode of simply supported castellated beams. Their study showed that web-post buckling is a potential mode of failure and should be considered in design of castellated beams. Redwood and Demirdjian [9] tested four simply supported castellated beams under a concentrated load at the mid span. The tests showed that the web-post buckling depends on the restraining effects of the beam flanges. Web-post buckling capacity is numerically assessed by Golizadeh *et al.* [10] and an empirical relation is proposed for