NUMERICAL ANALYSIS OF INSTABILITY FAILURE MODES OF CELLULAR STEEL BEAMS IN FIRE CONDITIONS

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Abstract: Beams with long spans are increasingly used in the steel building constructions and usually are used with openings for technical equipment and ventilations systems cut in their web. These elements are structural steel beams that are deeper than normal rolled sections, with distributed circular openings, or other like squared or hexagonal, that are produced by cutting and welding hot rolled steel sections (Westok method). The split halves are then offset and welded together to form a deeper beam with full circular or hexagonal shaped web openings. This method reduces the floor height and therefore the overall height of building.

In fire conditions, a cellular beam at a design degree of utilisation, web post failure may occur before the section reaches the critical temperature obtained members in bending. This fact is mainly due to web height, and slenderness, and because the temperature of the web-post in a cellular beam increases at a faster rate compared to its equivalent (similar web size) solid beam. Beam failure may occur by local buckling instability of the web-post between the openings or by Vierendeel bending at the openings.

This behaviour is analysed and evaluated by a numerical method, using the finite element method, considering geometrically and material nonlinear simulations. A parametric analysis is performed for different cellular beams, considering the variation of: i) different cross sections; ii) web post widths; iii) hole diameter to the section height ratios and (iv) distance between holes.

The numerical simulations should clearly define the cellular beams failure mode, either from the buckling of the web post, the Vierendeel bending or the flange compression at the hole section. A comparison of results is presented for the studied cases at ambient and elevated temperatures.

Keywords: Cellular Beams, Fire conditions, Numerical Analysis, Global Buckling, Local Buckling, Lateral Torsional Buckling

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