

## NUMERICAL ANALYSIS OF LATERAL TORSIONAL BUCKLING OF STEEL I-BEAMS WITH AND WITHOUT WEB-OPENINGS UNDER FIRE

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### 1. INTRODUCTION

During the last decade, there has been great concern about fire applied loading effect on structural steel frames and their elements, especially when instability phenomenon arises due to high temperatures [1]. The objective of this paper is to study the fire behaviour of I-beam steel simply supported members with and without web openings under lateral torsional buckling accounting geometric imperfection and residual stress.

A nonlinear geometric and material analysis, with the Newton-Raphson time step solution, was done using finite element software ANSYS. The analysis investigates the overall displacement and the LTB moment capacity of hot rolled steel section for parent solid beams and their corresponding cellular beams. .

The first part of the numerical simulation results are confronted with those obtained by Peter et al. [2]. In the second part where both imperfections are computed for lateral torsional buckling analysis, comparison is made with those calculated according to Eurocode EN 1993-1-2 [3] for solid beam and with analytical formulation from Panedpojaman, P. et al. for cellular beam [4].

### 2. MODEL DESCRIPTION AND INPUT PARAMETERS

The studied floor steel beams are simply supported made from 610UB101 hot rolled profile freed laterally to undergo lateral torsional buckling as considered by Peter et al. [2].

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The openings in the cellular beam are arranged at regular intervals while respecting the following conditions  $a_0 / h = 0.8$ ,  $H_f/h = 1.3$  and  $w / a_0 = 0.3$  [3] where  $h$  is the initial height of the cross section and  $H_f$  the final height,  $a_0$  the opening diameter, and  $w$  is the web post width.

The beams are subjected to a uniformly distributed load varying with time,  $q = 100$  t, and constant temperature. The element steel grade is S430 ( $f_y = 430$  [MPa]) with a typical value of modulus of elasticity of 210 [GPa], and Poisson's ratio of 0.3.

The shape of the initial imperfections at the mid-span of beams was introduced in the numerical model considering the first Eigen buckling mode with a maximum value of  $L/1000$  [5]. Maximum compressive and tensile residual stresses are applied directly on both web and flange according to the existing literature.

### 3. ANALYSIS AND RESULTS

Figure 1 presents the numerical analysis results, in terms of buckling moment versus temperature, carried out with and without imperfections for solid and cellular beams.

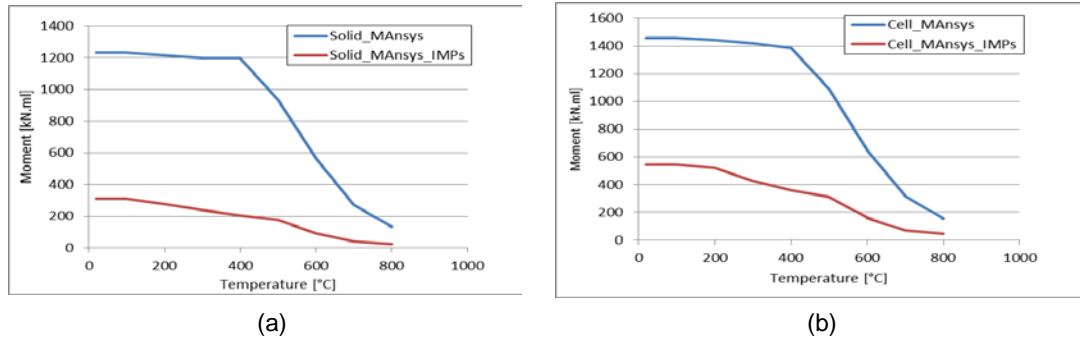


Figure 1: Comparison of FEM results for parent solid (a) and cellular (b) beams with and without imperfections.

A parametric study for LTB analysis, different solid and cellular beams, where geometric data,  $L$ ,  $a_0/h$ ,  $w/a_0$ ,  $H_f/h$  and load types are varied.

### 4. REFERENCES

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