LABORATÓRIO NACIONAL
DE ENGENHARIA CIVIL

albrasci
associação luso-brasileira
para a segurança contra incêndio

5.as JORNINC
Jornadas de Segurança aos **Incêndios Urbanos**

LISBOA • LNEC • 1 e 2 de junho de 2016

LIVRO DE RESUMOS

EDITORES
João Viegas; Carlos Pina dos Santos; José Pedro Lopes
Luís Laím; Nuno Lopes; Paulo Piloto

LABORATÓRIO NACIONAL
DE ENGENHARIA CIVIL

albrasci
associação luso-brasileira
para a segurança contra incêndio

5.as JORNINC
Jornadas de Segurança aos **Incêndios Urbanos**

LIVRO DE RESUMOS

LISBOA • LNEC
1 e 2 de junho de 2016

EDITORES
João Viegas
Carlos Pina dos Santos
José Pedro Lopes
Luís Laím
Nuno Lopes
Paulo Piloto

LOAD CARRYING CAPACITY OF PARTIALLY ENCASED COLUMNS FOR DIFFERENT FIRE RATINGS

Abdelkadir Fellouh
Student
UHBC - Algeria
IPB - Portugal

Nourredine Benlakehal
Professor
UHBC - Algeria

Paulo Piloto *
Professor
IPB - Portugal

Ana Ramos
Professor
USAL - Spain

Luís Mesquita
Professor
IPB - Portugal

ABSTRACT
Partially encased columns have significant fire resistant. However, it is not possible to assess the fire resistance of such members simply by considering the temperature of the steel. The presence of concrete increases the mass and thermal inertia of the member and the variation of temperatures within the cross section, in both the steel and concrete components. The annex G of EN1994-1-2 [1] allows to calculate the load carrying capacity of partially encased columns, for a specific fire rating time, considering the balanced summation method. New formulas will be used to calculate the plastic resistance to axial compression and the effective flexural stiffness. These two parameters are used to calculate the buckling resistance, assuming the most appropriate buckling curve of EN1993-1-1 [2]. The finite element method is used to determine which curve best fits the buckling resistance for different fire ratings of 30, 60, 90 and 120 minutes.

KEY WORDS: Fire; Partially encased columns; Balanced summation method; Buckling; Numerical simulation.

1. INTRODUCTION

Partially encased columns are usually made of hot rolled steel profiles, reinforced with concrete between the flanges. The composite section is responsible for increasing the torsional and bending stiffness when compared to the same section of the steel profile. In addition to these advantages, the reinforced concrete is responsible for increasing the fire resistance. Two

---

*Autor correspondente – Instituto Politécnico de Bragança, Campus Santa Apolónia, apartado 134, 5301-857 Bragança, Portugal
email: ppiloto@ipb.pt http://www.ipb.pt

methods are used to compare the member buckling resistance: the simple calculation method and the advanced calculation method. Two types of cross section were selected to study the effect of fire: IPE ranging from 200 to 500 and HEB ranging from 160 to 500. The columns were tested under ISO834 fire, using two column lengths and three buckling lengths.

2. MATERIAL AND METHODS

The design method, proposed by EN 1994 1-2 in annexe G, considers contours of temperature within the cross section after 30, 60, 90 and 120 minutes of fire exposure. The cross section is divided into components in which the mechanical property of the material changes with the average temperature and part of the material is also neglected. The load carrying capacity is then calculated. The design method considers the buckling curve "c" of EN1993-1-1 [2] to calculate the reduction factor for the relevant buckling mode. A parametric analysis was developed for different fire ratings, based on a three dimensional finite element model. Different types of simulations were developed (thermal analysis, elastic buckling analysis and incremental nonlinear analysis).

3. RESULTS AND CONCLUSIONS

Figure 1 represents an example of the numerical results used to determine the axial buckling load after 30 minutes of fire exposure, for a partially encased column built with HEA160. The numerical results help to verify the most adequate buckling curve to be used in the balanced summation method.

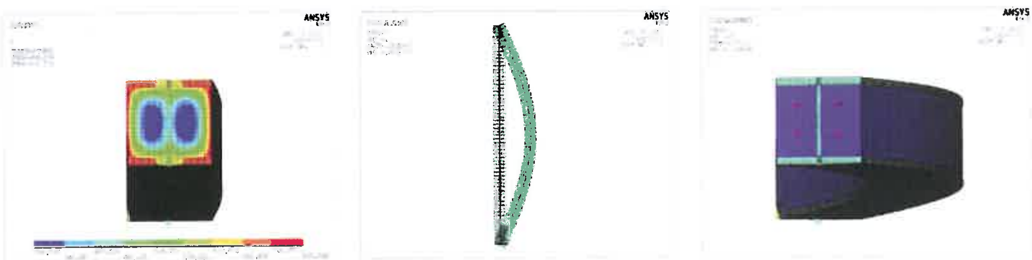

Figure 1: Numerical simulations of PEC: a) Temperature field for R30, b) Elastic buckling mode for R30, c) Buckling resistance for R30.

REFERENCES

[1] CEN, EN 1994-1-2 - Eurocode 4: Design of Composite Steel and Concrete Structures - Part 1–2: General Rules—Structural Fire Design. 2005: Brussels. p. 225.

[2] CEN, EN 1993-1-1 - Eurocode 3: Design of steel structures - Part 1-1: General rules and rules for buildings. 2005: Brussels. p. 91.