


1.11 Temperature of external column at fire test in Mokrsko (short version)

Sokol Z., Czech Republic

TEMPERATURE OF EXTERNAL COLUMN AT FIRE TEST IN MOKRSKO

Zdeněk Sokol, Milan Pultar




Czech Technical University in Prague
Department of Steel and Timber Structures

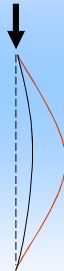
Barcelona
5 and 6 July 2010


1

EXTERNAL COLUMN



Non-uniform temperature along the height
Thermal gradient (shadow effect)
Deformation caused by thermal gradient
Buckling resistance






Czech Technical University in Prague
Department of Steel and Timber Structures

Barcelona
5 and 6 July 2010

2

COLUMN TEMPERATURE

Gas temperatures next to column
Temperature of exposed flange
Temperature of unexposed flange




Czech Technical University in Prague
Department of Steel and Timber Structures

Barcelona
5 and 6 July 2010

3

GAS TEMPERATURES NEXT TO COLUMN




Czech Technical University in Prague
Department of Steel and Timber Structures

Barcelona
5 and 6 July 2010

4

GAS TEMPERATURE IN THE WINDOW



Czech Technical University in Prague
Department of Steel and Timber Structures

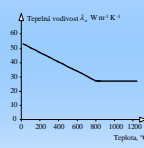
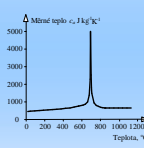
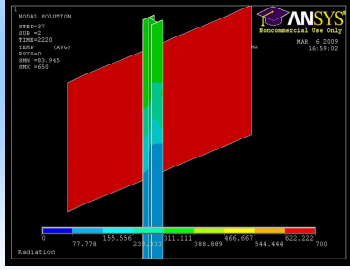
Barcelona
5 and 6 July 2010


5

FE MODEL - ANSYS

Heat transfer – convection nad radiation
Heat conduction in the column
Column: Solid 70, 3D element, 8 nodes
Window: Shell 57

Non-linear material properties

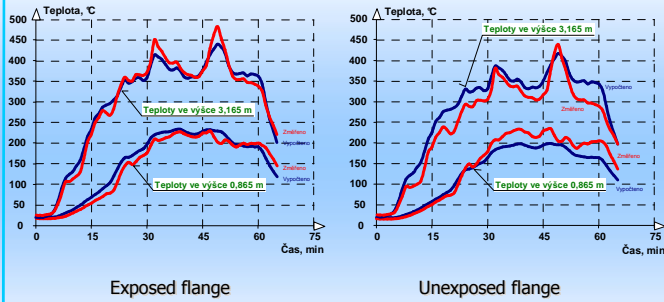


Czech Technical University in Prague
Department of Steel and Timber Structures

Barcelona
5 and 6 July 2010

6

PREDICTED TEMPERATURE

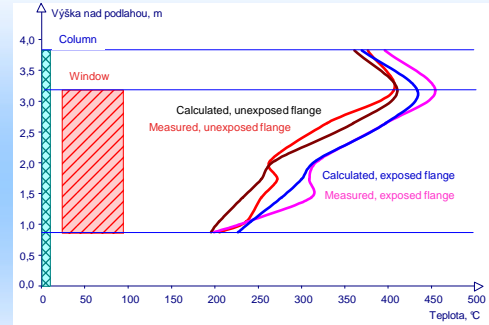


Czech Technical University in Prague
Department of Steel and Timber Structures

Barcelona
5 and 6 July 2010

7

TEMPERATURE ALONG THE HEIGHT



Czech Technical University in Prague
Department of Steel and Timber Structures

Barcelona
5 and 6 July 2010

8

SIMPLIFIED MODEL

Heat transfer according to Stefan-Boltzmann principle
2D calculation
Temperature of each element is given by formula

$$c(T)\rho S \int_{x_1}^{x_2} \frac{\partial T}{\partial t} dx - a S \left(\frac{\partial T}{\partial x}(x_2) - \frac{\partial T}{\partial x}(x_1) \right) - b r (x_2 - x_1) \frac{\partial T}{\partial n} \\ = \sigma w \int_{x_1}^{x_2} (\varphi T_f^4(x) - \varepsilon_1 \varphi(x) T^4(x)) dx \\ + \varepsilon_2 \varphi \int_{x_1}^{x_2} (w(1 - \varphi(x)) + q) (T_c^4 - T^4(x)) dx + \alpha (w + q) \int_{x_1}^{x_2} (T_c - T) dx$$

Numerical solution using finite difference method
Non-linear equations caused by fourth power of the temperature
Equations are solved by Newton method
Software can be downloaded from <http://mat.fsv.cvut.cz/cideas>

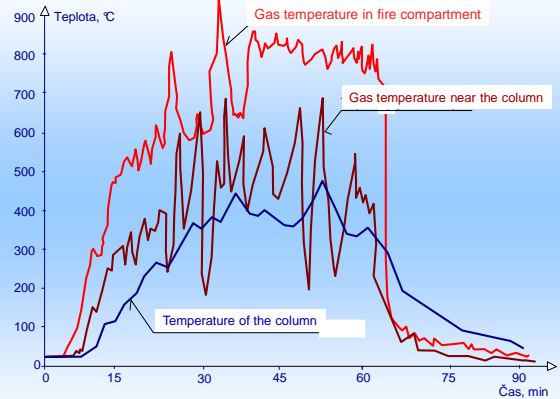


Czech Technical University in Prague
Department of Steel and Timber Structures

Barcelona
5 and 6 July 2010

9

PREDICTED COLUMN TEMPERATURE

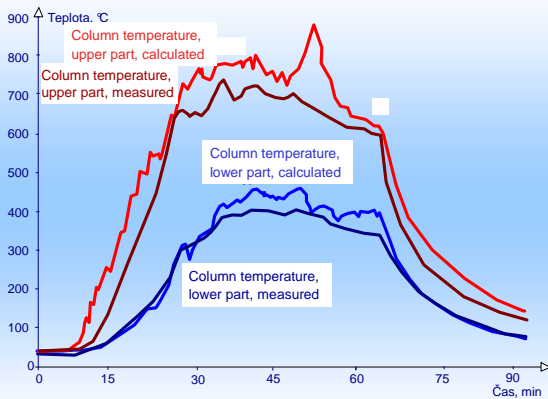


Czech Technical University in Prague
Department of Steel and Timber Structures

Barcelona
5 and 6 July 2010

10

COMPARISON OF TEMPERATURES



Czech Technical University in Prague
Department of Steel and Timber Structures

Barcelona
5 and 6 July 2010

11

CONCLUSION

Two methods for temperature prediction
Compared to fire test in Mokrsko
Software is available for download at <http://mat.fsv.cvut.cz/cideas>.



Czech Technical University in Prague
Department of Steel and Timber Structures

Barcelona
5 and 6 July 2010

12