

FIRE DESIGN OF CONCRETE AND MASONRY STRUCTURES

Software Tools Developed at the Czech Technical University in Prague



This outcome has been achieved with the financial support of the Ministry of Education, Youth and Sports of the Czech Republic, project No. MSM6840770001 (the first and the second author) and project CIDEAS No. 1M0579 (the third author). Additional support from the grant No. SGS11/001/OHK1/1T/11 (the first and the third author) provided by the Grant Agency of the CTU in Prague is greatly acknowledged.

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INTRODUCTION

Software tools to fire design of concrete and masonry structures developed at the Czech Technical University in Prague are presented in this poster. These tools have been developed in MATLAB environment. They are available for free on:

<http://concrete.fsv.cvut.cz/~stefan/research.htm>

TempAnalysis

Computer program for thermal analysis of rectangular cross-sections exposed to fire (Štefan, Procházka, 2009)

- ▶ One-dimensional or two-dimensional problem.
- ▶ Spatial discretization using a Finite Element Method.
- ▶ Time discr. using a semi-implicit difference scheme.
- ▶ A two-dimensional problem can be solved either using a simplified approach proposed by Hertz (2006) (based on two separate 1D solutions) or with the use of 2D FEM.
- ▶ Arbitrary material (material with constant material properties, material with time-dependent material properties, concrete according to EN 1992-1-2 (2004)).
- ▶ An analysed cross-section can be protected by insulation on the fire-exposed sides.
- ▶ A design fire scenario is represented either by the standard fire curve or by the parametric curve according to EN 1991-1-2 (2002).
- ▶ One-, two-, three- or four- sided fire exposure.
- ▶ Outputs: temperature of any point of the analysed cross-section, temperature profile, temperature field

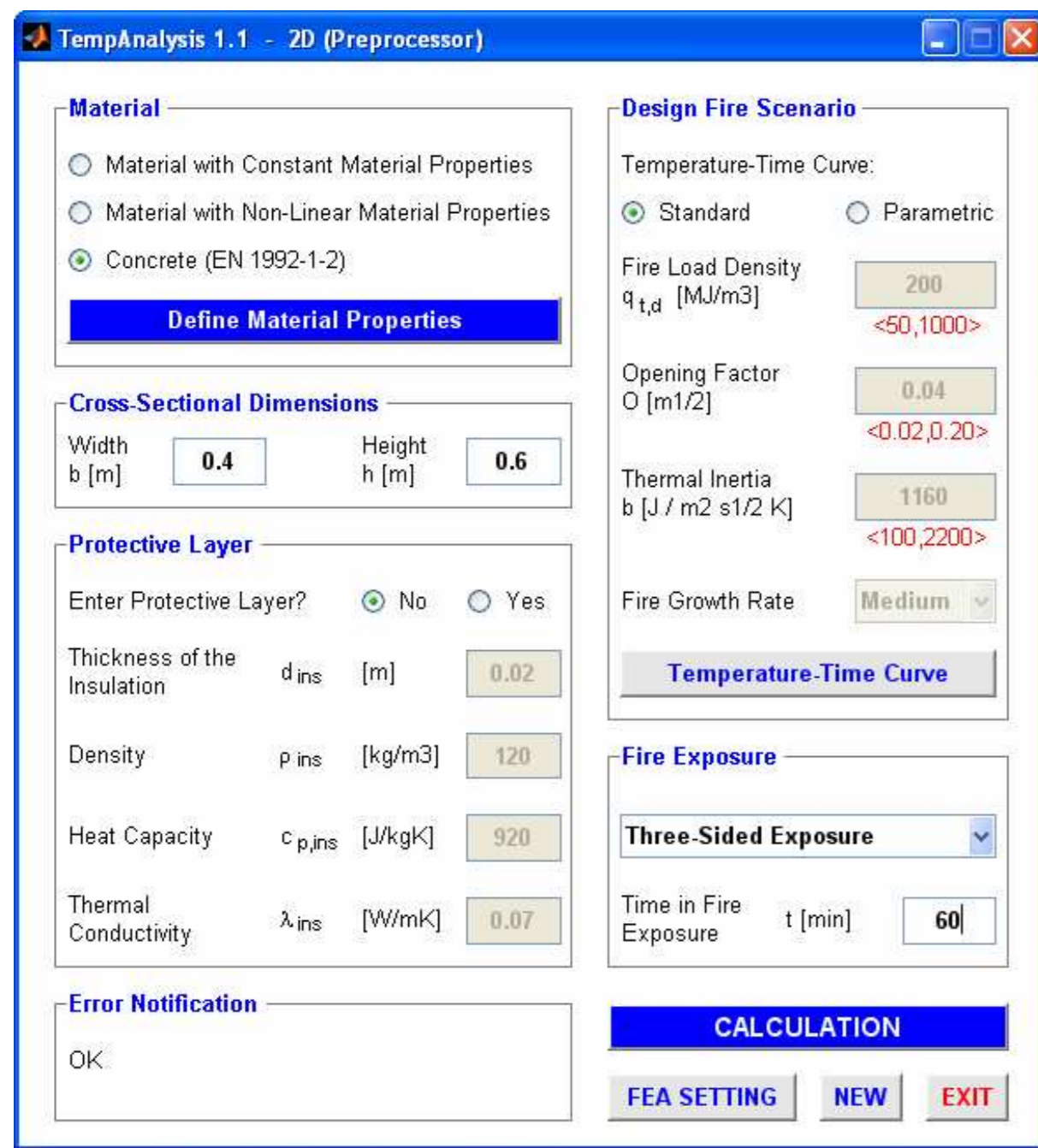


Fig. 1 TempAnalysis pre-processor dialog window

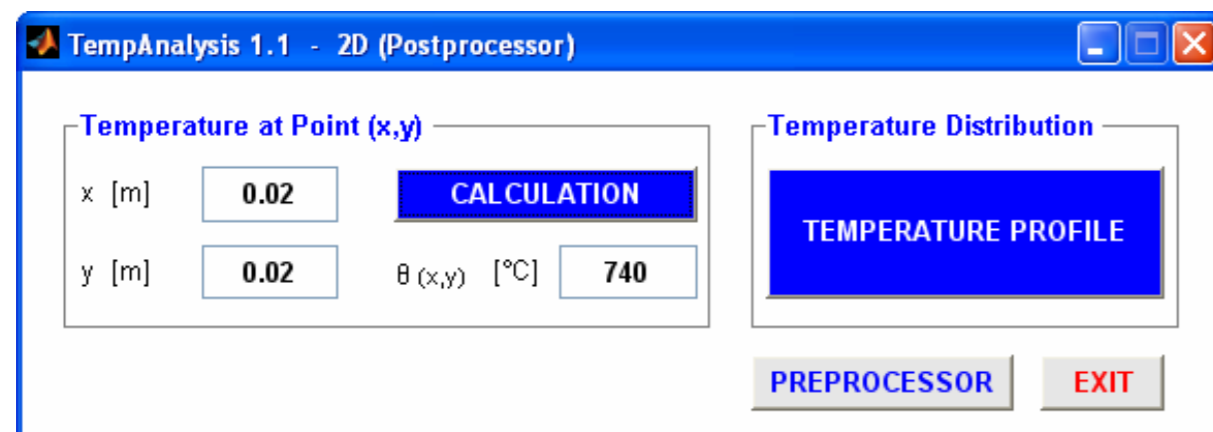


Fig. 2 TempAnalysis post-processor dialog window

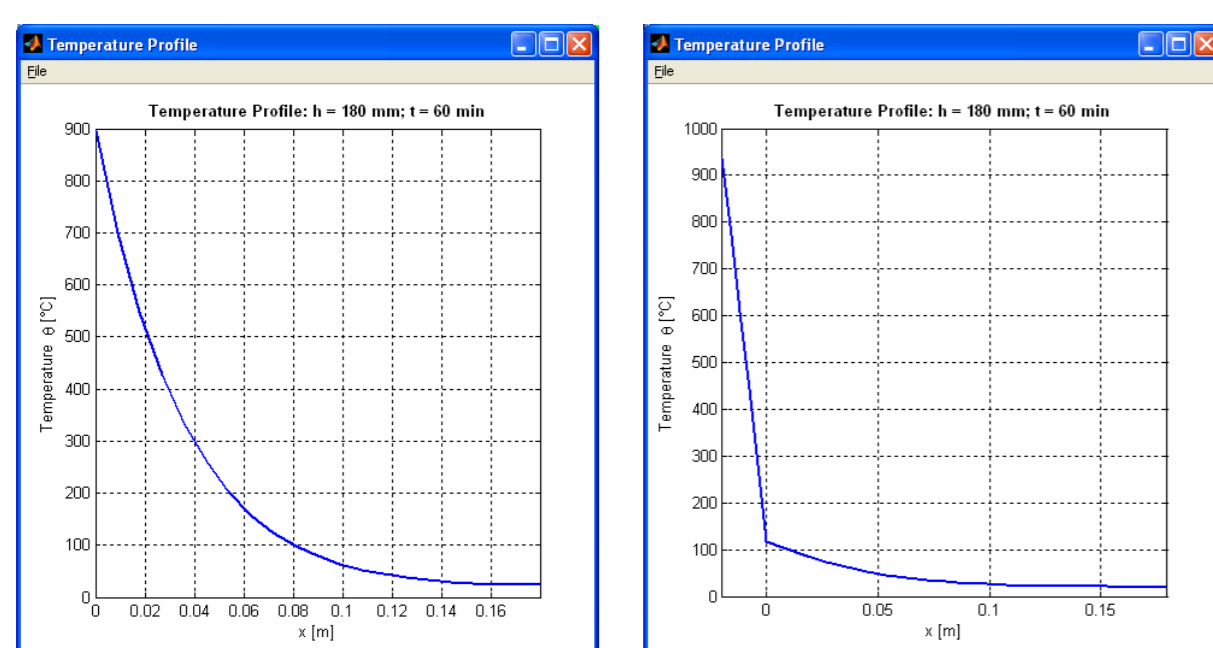


Fig. 3 TempAnalysis - 1D temperature profiles

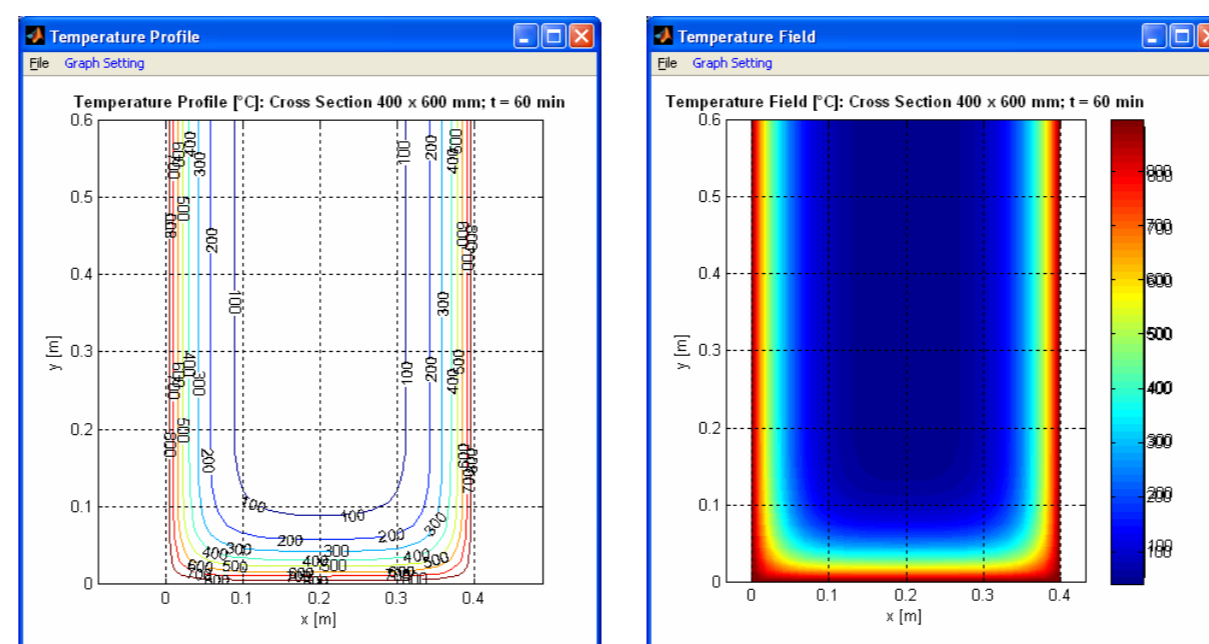


Fig. 4 TempAnalysis - 2D temperature profile/field

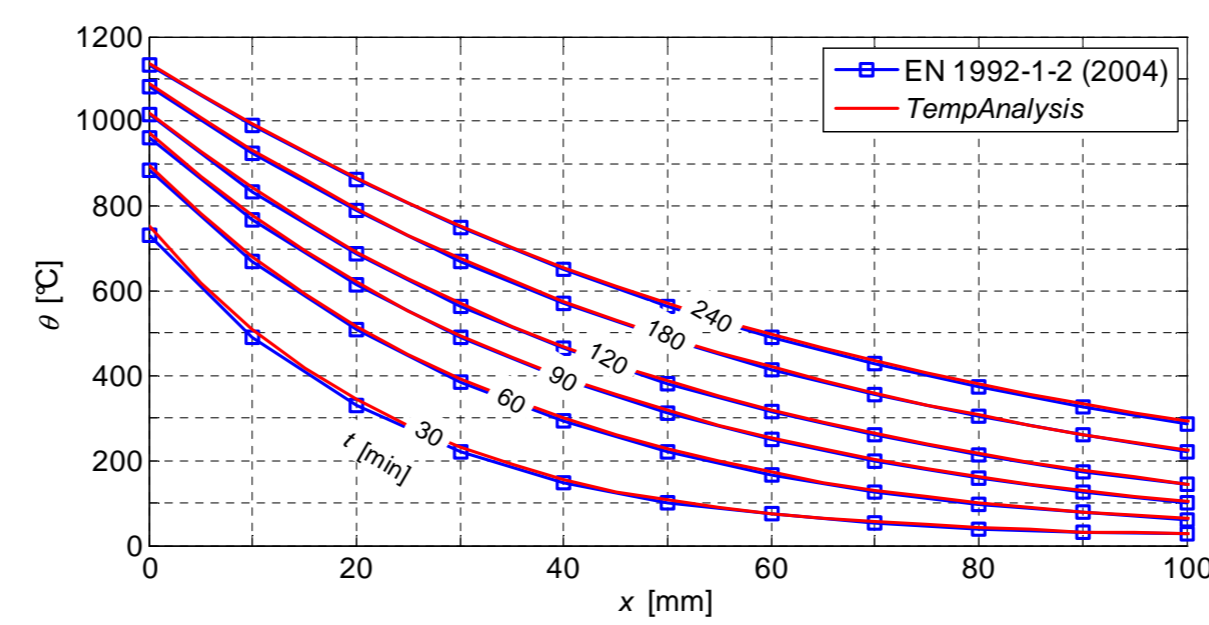


Fig. 5 Results comparison - 1D

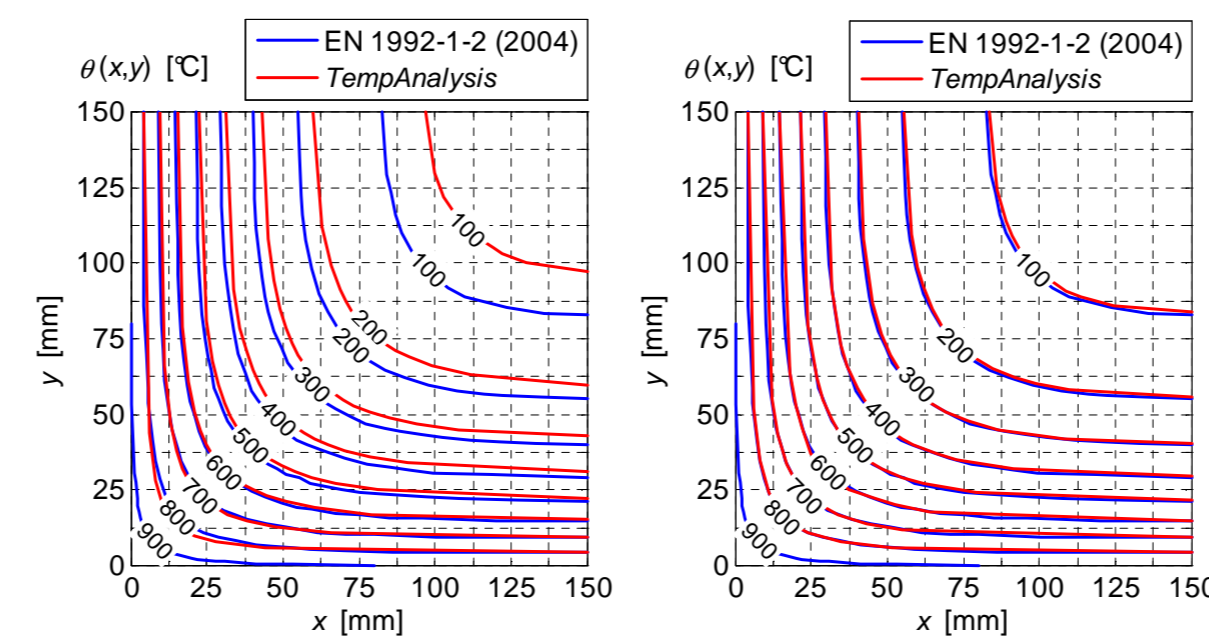


Fig. 6 Results comparison - 2D (left: simplified algorithm; right: 2D FEM)

HygroThermAnalysis

Computer program for hygro-thermal analysis of concrete rectangular cross-sections exposed to fire (Štefan, Beneš, 2010)

- ▶ Based on Bažant-Thonguthai (1978) model for hygro-thermal behaviour of concrete at high temperatures.
- ▶ One-dimensional or two-dimensional problem.
- ▶ Spatial discretization using a Finite Element Method.
- ▶ Time discr. using a semi-implicit difference scheme.
- ▶ Prediction of spalling-damage using a heuristic engineering criterion (see Beneš et al., 2011).
- ▶ Outputs: (i) temperature, water content and pore pressure of any point of the analysed cross-section; (ii) graphical expression of a temperature, water content and pore pressure distribution; (iii) graphical expression of a spalling damage spatial distribution.
- ▶ In the current version of this software, mechanical load is neglected (spalling is assumed to be caused only due to the pore pressure), however, the more complex thermo-hygro-mechanical model is currently being included in this software.

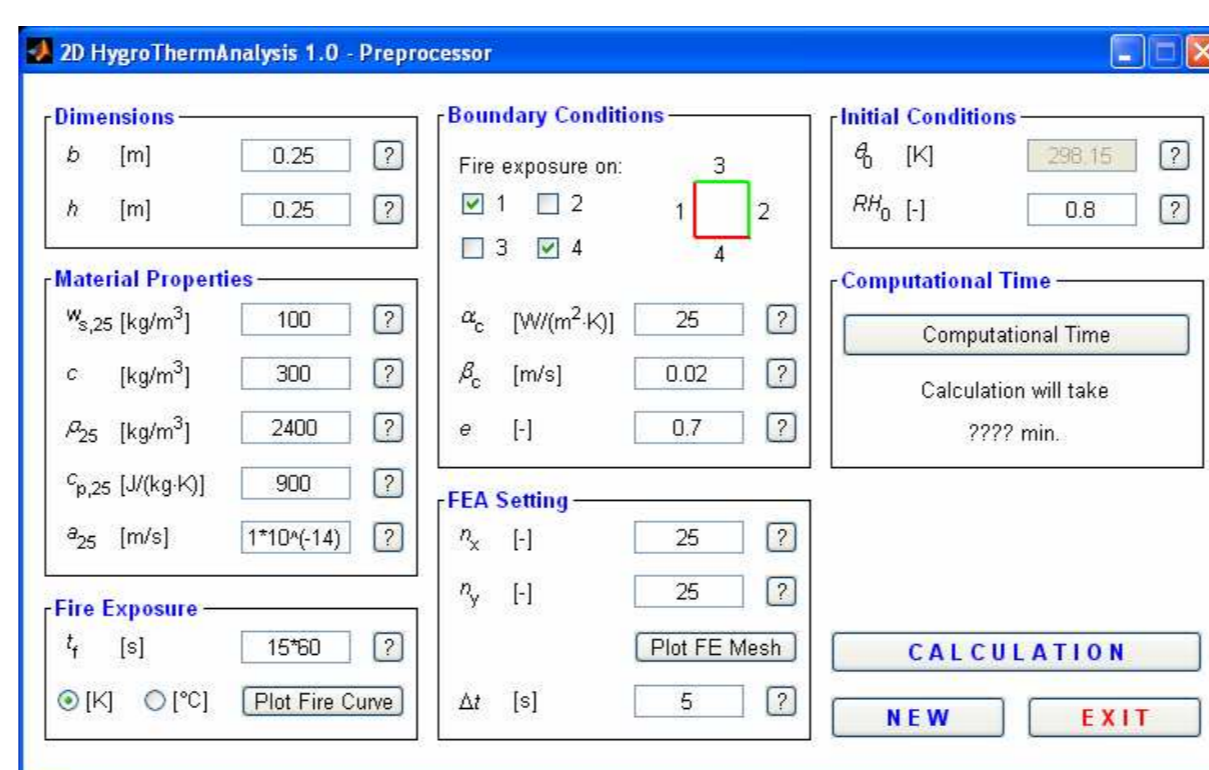


Fig. 7 HygroThermAnalysis pre-processor dialog window

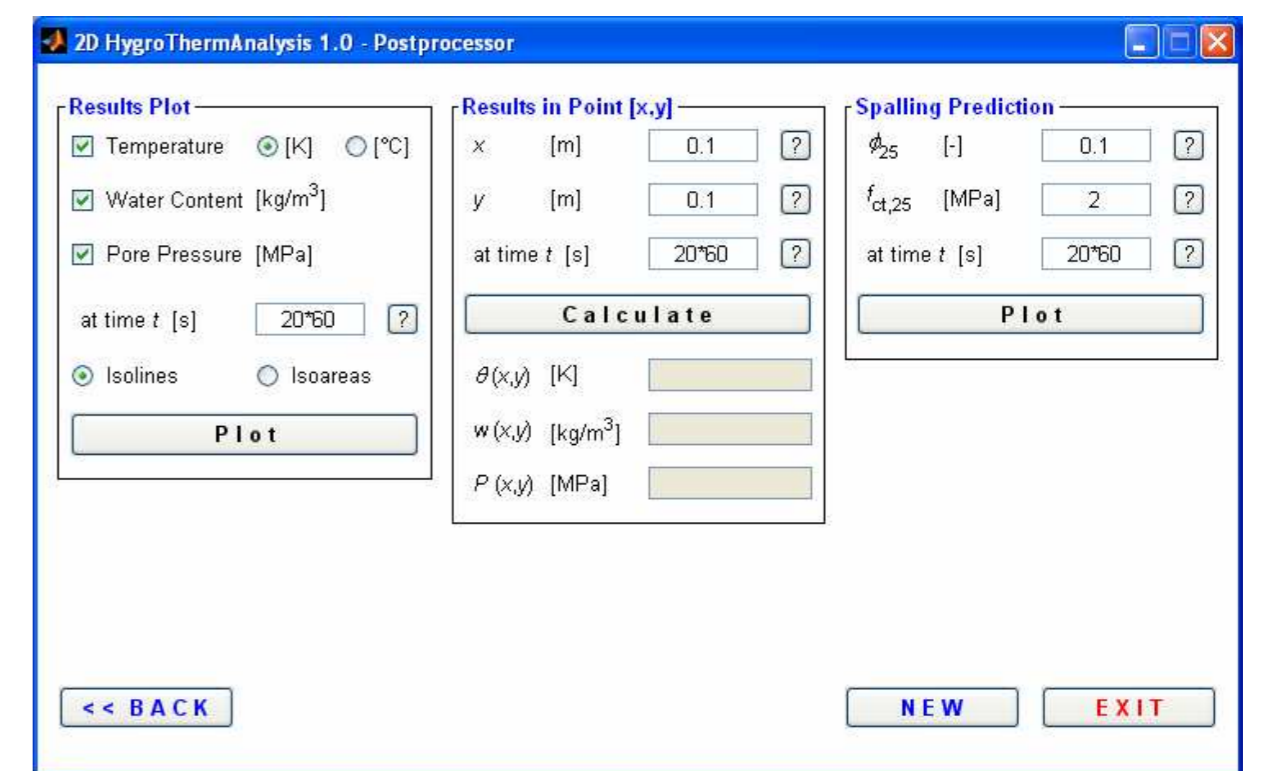


Fig. 8 HygroThermAnalysis post-processor dialog window

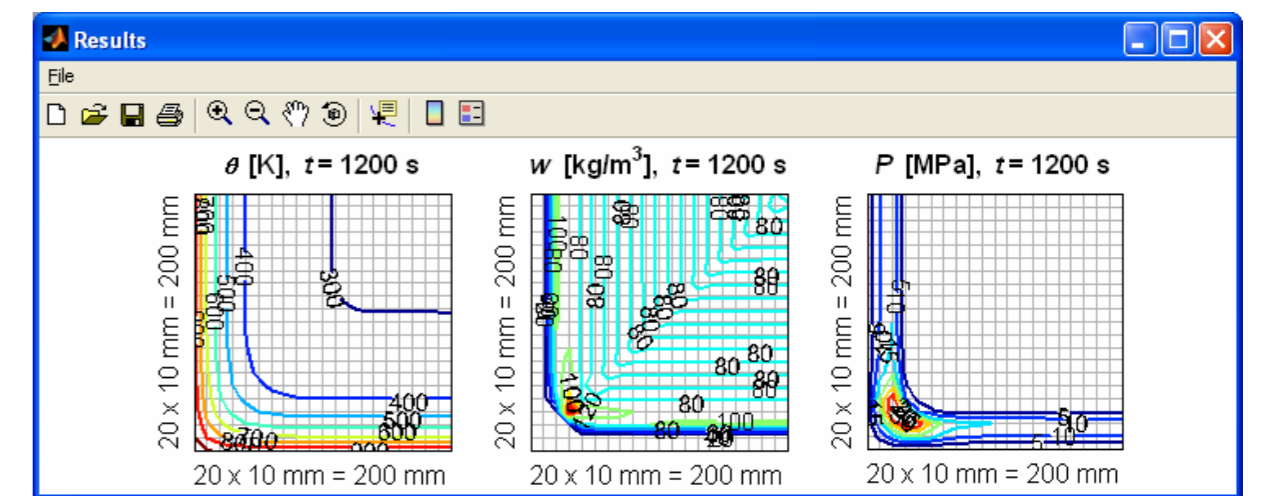


Fig. 9 HygroThermAnalysis - distribution of θ , w , P

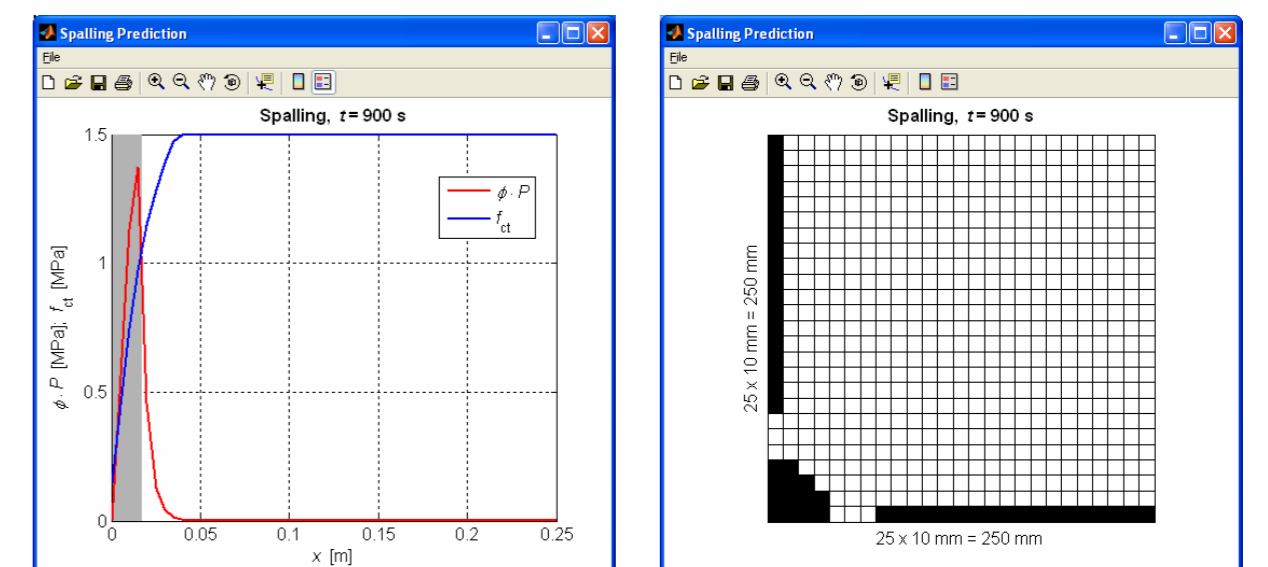


Fig. 10 HygroThermAnalysis - spalling prediction (1D; 2D)

FiDeS (Fire Design Software)

Software package to fire design of concrete and masonry structures according to Eurocodes (Štefan, 2010)

- ▶ Consists of five computer programs.
- ▶ Under development (in the actual version, the user interface is only in Czech).

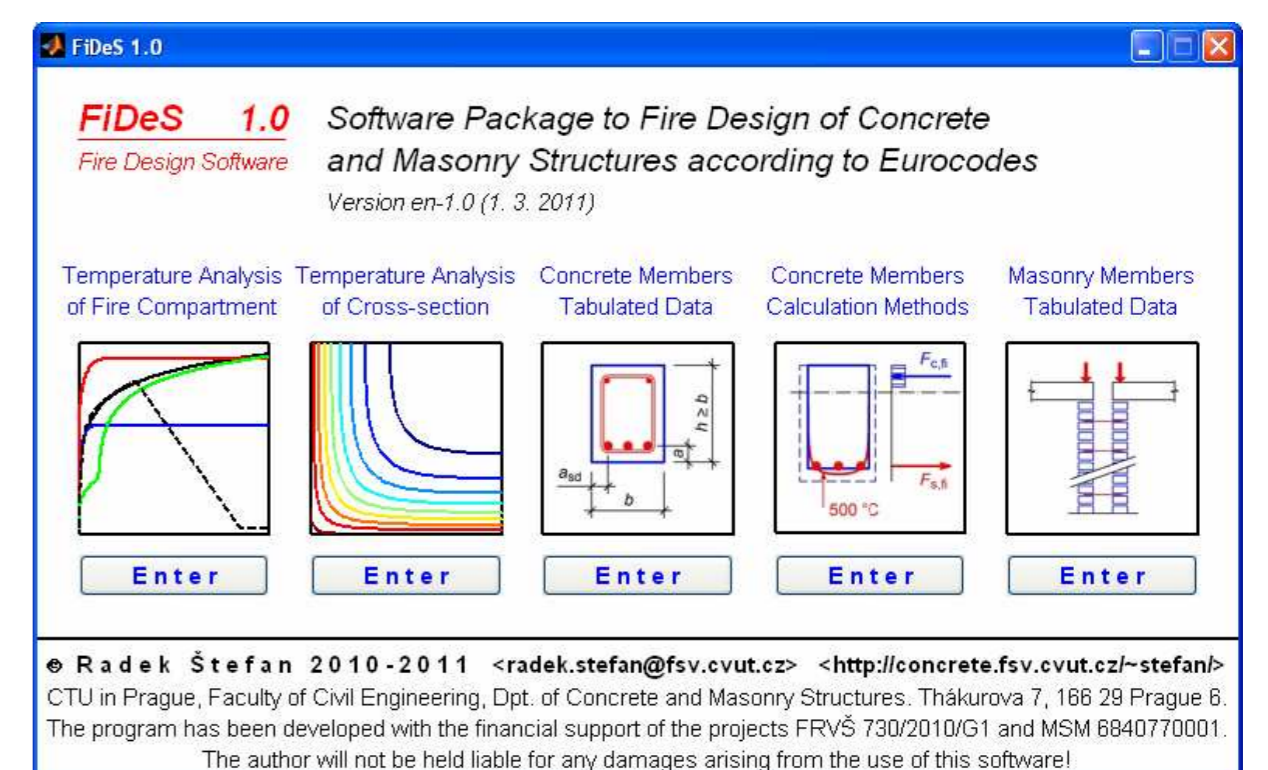


Fig. 11 FiDeS dialog window

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