



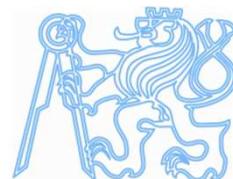
## COST Action TU0904 Integrated Fire Engineering and Response

TRAINING SCHOOL, March 12 - 15, 2013, Lulea  
Advanced Fire Engineering in Practice - Software Tools

# Charring of timber

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Faculty of Civil Engineering



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Timbre-fibre  
concrete  
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Fire tests of  
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## Timbre-fibre concrete structures

- Research is focused on **modelling of membrane action of timber-fibre concrete composite floors exposed to fire**
- The aim is the preparation of the **design prediction model** for the fire resistance of the timber-fibre concrete composite floors
  - Initialization and development of the plastic yield lines
  - Development and progress of membrane behaviour
  - Achievement of the ultimate limit state



Model will facilitate the increase of the fire resistance of the multi-storey building by optimal structural solution for reconstructions and new structures



**Background material for the update of the European structural fire safety standards**

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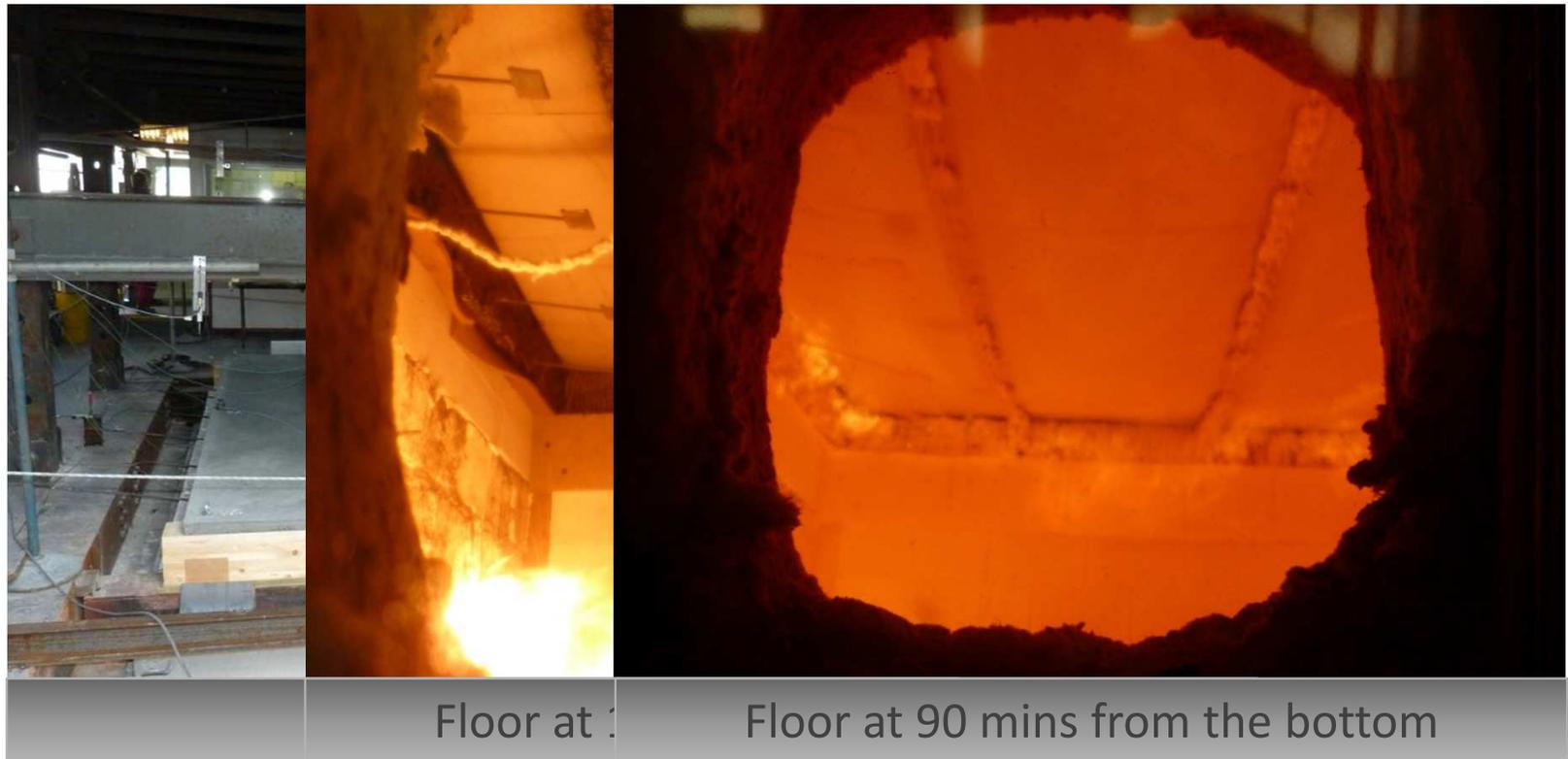
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## Fire tests of timber-fibre concrete floor slab

- Full-size floor specimens performed at the Fire testing laboratory
- Specimens were 4,5 m long and 3 m wide, consisting of two secondary beams with the cross section 120/160 mm and a 60 mm thick floor slab connected to glue laminated floor joists
- It was subjected the standard fire for 150 mins and for 60 mins



Floor at :

Floor at 90 mins from the bottom

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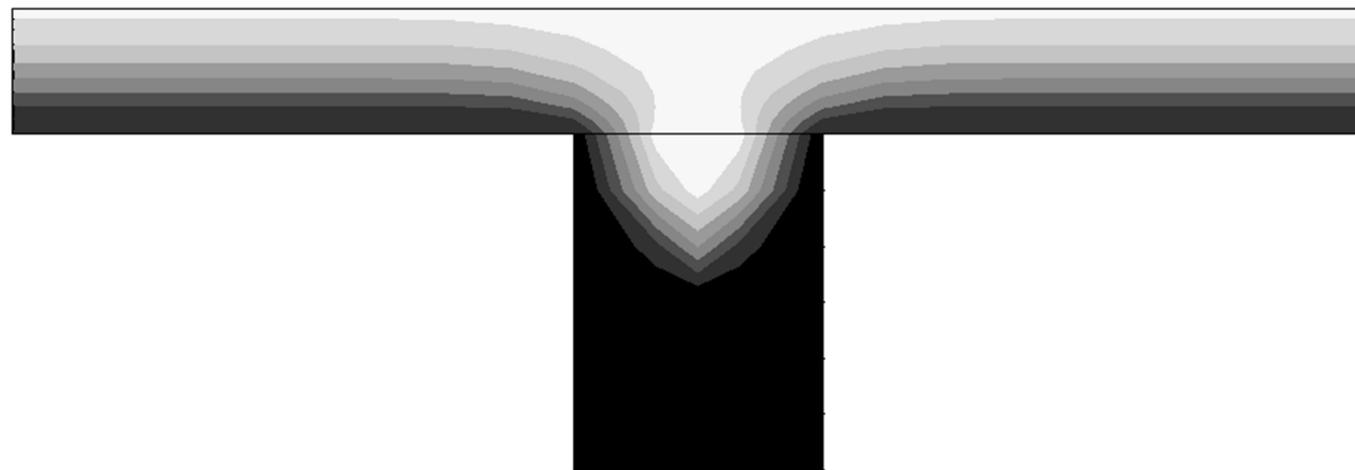
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# Numerical analysis

- To simulate the behaviour of composite timber-concrete beam according to the fire test of composite timber-concrete floor
- Transient **non-linear analysis** with an implicit Newmark's integration
- Temperature-dependent relationships for timber properties proposed by the European code
- Timber charring as a **reduction of the elastic moduli** and tensile strength due to temperature change



**ANSYS** PLOT NO. 1  
 NODAL SOLUTION  
 STEP=181  
 SUB =1  
 TIME=1800  
 TEMP (AVG)  
 RSYS=0  
 PowerGraphics  
 EFACET=1  
 AVRES=Mat  
 SMN =30.7731  
 SMX =854.336  
 30.7731  
 122.28  
 213.787  
 305.294  
 396.801  
 488.308  
 579.815  
 671.322  
 762.829  
 854.336

Temperature development at 60 mins

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## Benchmark studies

- **Test the validity** of currently accepted **charring rates** of glue laminated timber
- Description of the experimental and numerical **investigation into parameters** that influence charring rate

→ Find out by experiment of timber-fibre concrete floor slab under nominal fire conditions

→ 3D FE model to predict the mechanical behaviour



**Simple models** for representing the partially protected composite floors in fire

Model of fire unprotected timber structures, to be used for comparison when using or validating fire engineering software

- Prepared at the Polytech Clermont-Ferrand with **prof. Abdelhamid Bouchair**



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# THANK YOU FOR YOUR ATTENTION

URL: [www.ocel-drevo.fsv.cvut.cz](http://www.ocel-drevo.fsv.cvut.cz)

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