2.19 Behaviour of RC elements in case of fire

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Behavior of RC elements in case of fire

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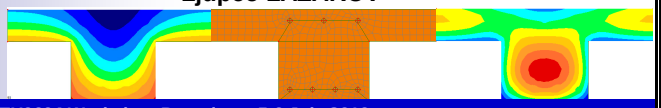

COST TU0604 Workshop Barcelona, 5-6 July 2010

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Complex nonlinear behavior

- Nonlinear temperature distribution
- Temperature dependent material properties
  - Thermal properties
    - Thermal conductivity, heat capacity, thermal expansion
  - Mechanical properties
    - Stress-strain relationship, modulus of elasticity, Compressive/tensile strength, Poisson's ratio
- Strength capacity

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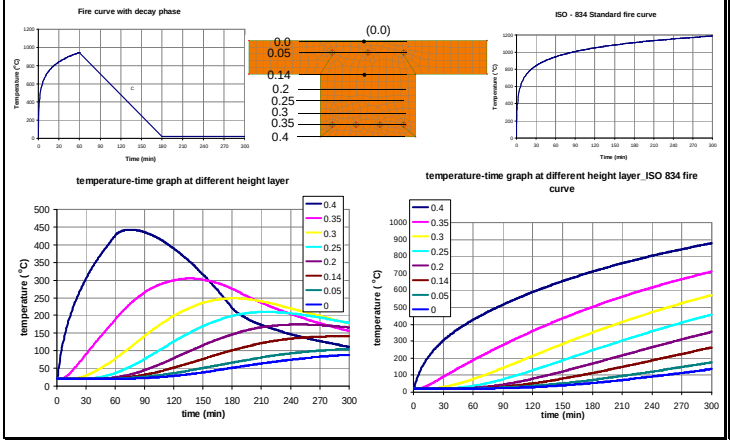
Thermal analysis



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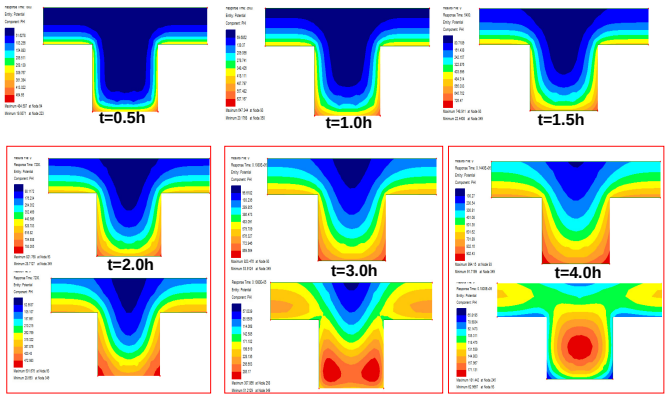
Thermal analysis



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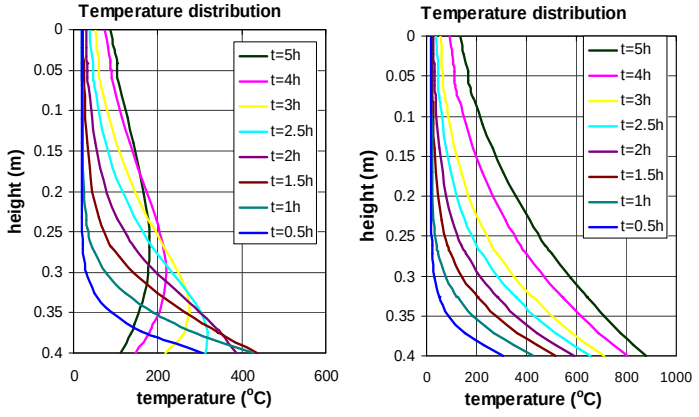
Thermal analysis



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Coupled Thermal - Stress analysis

- **FIRE program (Cvetkovska, 2002)**
  - **FIRE – T (**nonlinear transient heat flow analysis**)**
  - **FIRE – S (**nonlinear stress-strain response associated with fire)
- **FIRE – S accounts for:**
  - **dimensional changes caused by temperature differences,**
  - **changes in mechanical properties of materials with changes in temperature,**
  - **degradation of sections by cracking and/or crushing and**
  - **acceleration of shrinkage and creep with an increase of temperature**

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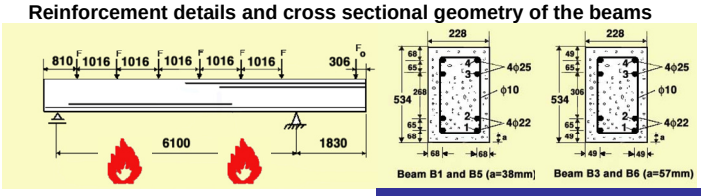
Test example to verified the computer program “FIRE”

Experimental investigation by B.ELLINGWOOD & T.D.LIN

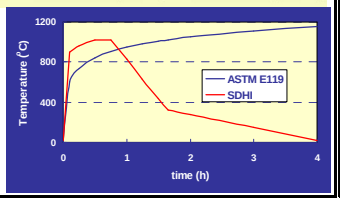
Reinforcement details and cross sectional geometry of the beams



FIRE EXPOSURE OF THE BEAMS

Beams B1 and B3: ASTM E 199

Beams B5 and B6: SDHI



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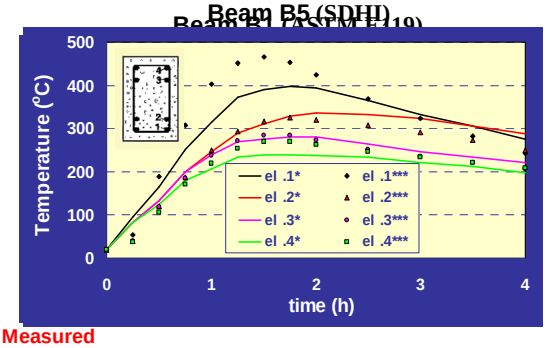
Test example to verified the computer program “FIRE”

Comparison of reinforcement temperatures



* Measured

*** Predicted by program FIRE

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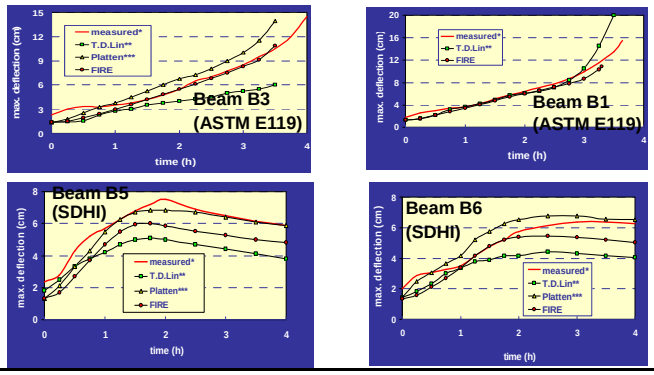
Test example to verified the computer program “FIRE”

Comparison of measured maximum deflections predicted by different computer programs



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CONCLUSION

- The approach used in FIRE provides better agreement between the calculated and experimentally achieved deflections in case when ASTM fire model is used, but that is not a case during the cooling phase, when beams are subjected to SDHI fire model.
- The effect of creep at elevated temperatures in the program FIRE is involved by the temperature dependent stress-strain relationships for concrete and steel, recommended in EC2. They are defined while specimens are subjected to ASTM E119 (or ISO 834) fire model, so they are not adequate for SDHI fire model.
- The model proposed is capable of predicting the fire resistance of reinforced concrete structural elements with a satisfactory accuracy.

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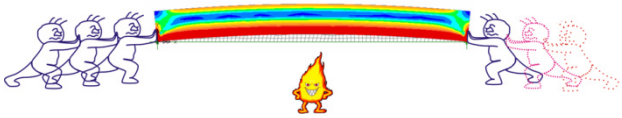
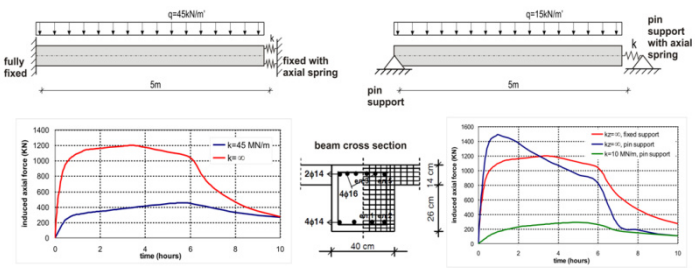
AXIAL RESTRAIN EFFECTS ON FIRE RESISTANCE OF RC BEAMS



COUPLED THERMAL-STRESS ANALYSIS



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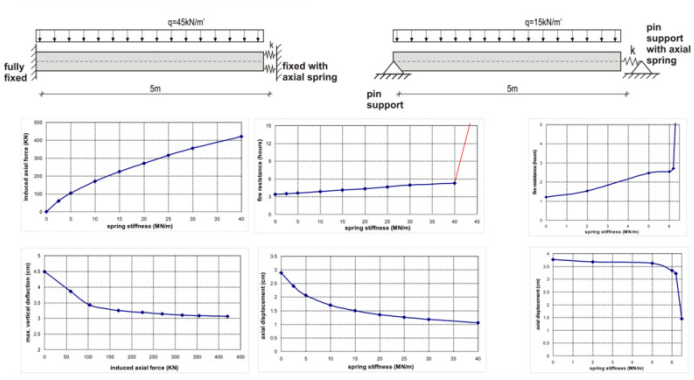
AXIAL RESTRAIN EFFECTS ON FIRE RESISTANCE OF RC BEAMS

COUPLED THERMAL-STRESS ANALYSIS



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