Numerical study of composite column subframe assembly in fire

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Fire Engineering research: key issues for the future

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Outline

- Introduction
- Aim of the Research
- Description of the finite element model
- Results

Introduction

- COMPFIRE
  - “The objective of the project is to develop a comprehensive component based design methodology for composite joints in fire, particularly joints between steel beams and composite columns such as concrete filled tubes and partially encased open sections”

Introduction

- Fire testing has been carried out at different levels of structural details such as:
  - Composite joint components
  - Isolated composite joints
  - Composite structural sub assemblies
  - Demonstration structures

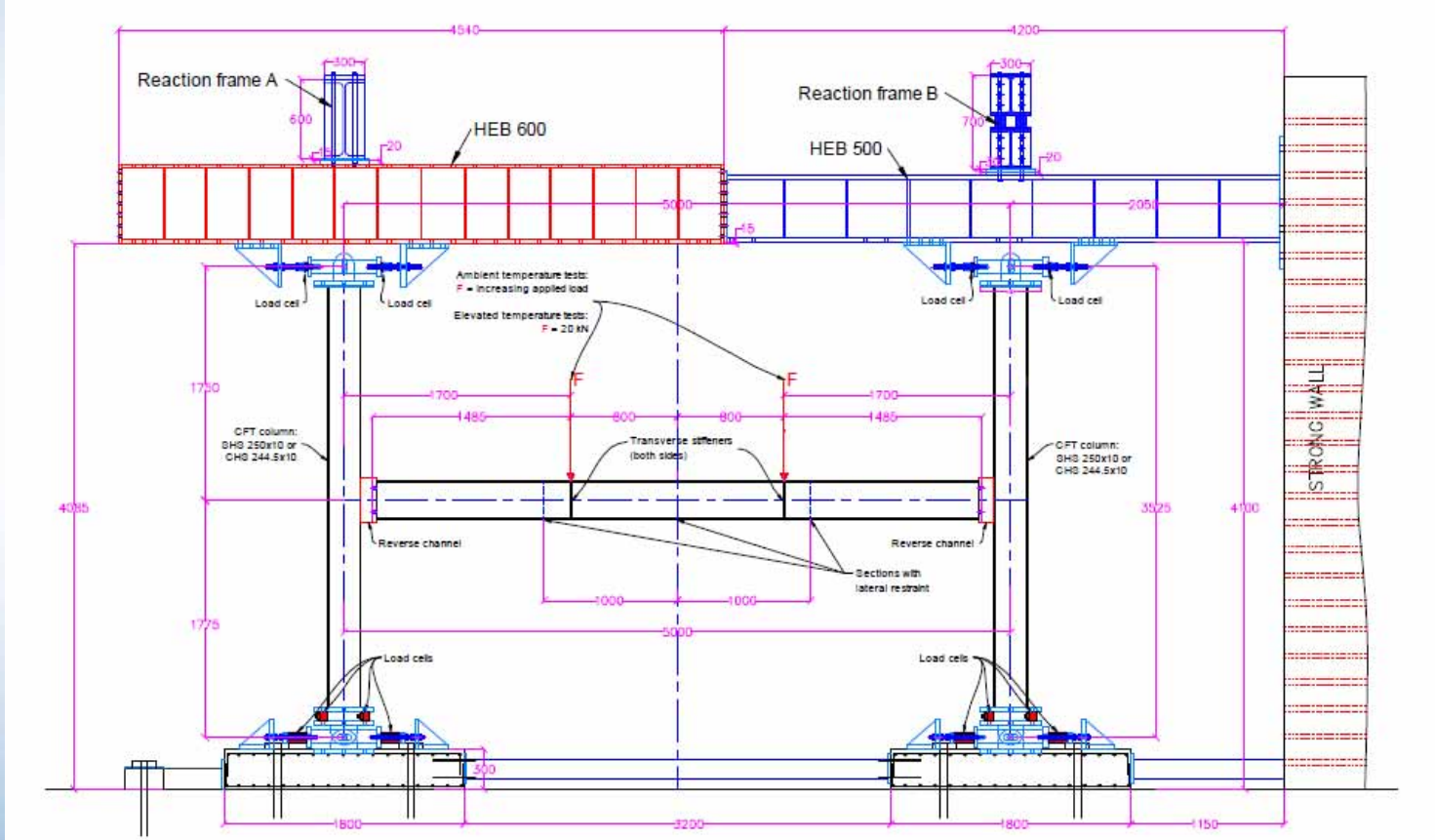
Aim of the Research

- This research is part of the COMPFIRE project as the work package which deals with finite element modeling of subframe assemblies
- Objectives
  - Results from the furnace tests on subframe assemblies are used to validate the numerical models and to demonstrate the robustness of composite structures in fire by improved joint detailing
  - These models will then be used to carry further parametric studies to determine the interaction between composite joints and structural members

Aim of the Research

- Objectives…
  - Improvement of the composite joint detailing robustness
  - Developing a methodology for realistic prediction of the progressive degradation of a composite structure under fire

Test Setup



a) Elevation view

Test Program

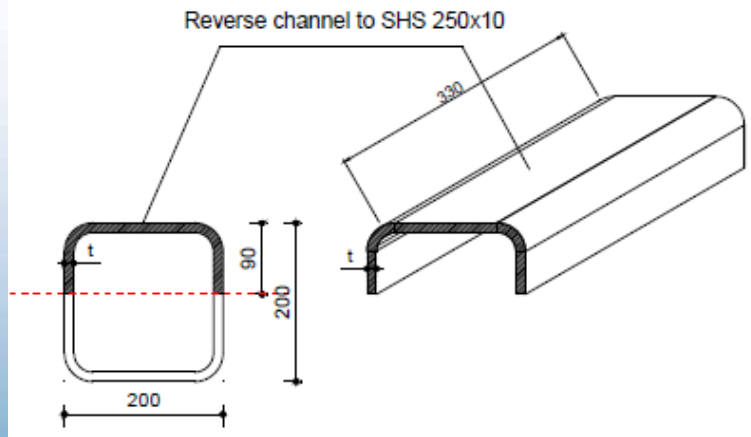
Table 2: Distribution of experimental tests

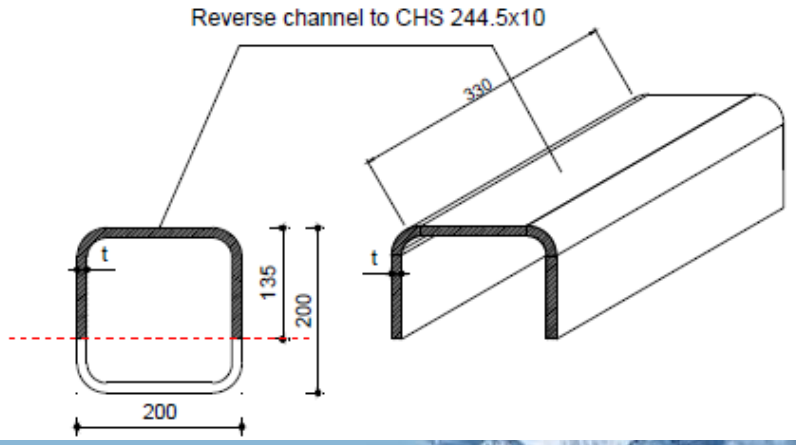
Test nº	Temperature	Column section	Reverse channel joint	Reason
1	Ambient	CHS 244.5x10	C1	Reference test at 20ºC
2	Ambient	SHS 250x10	S1	Reference test at 20ºC
3	Ambient	SHS 250x10	S2	Reference test at 20ºC
4	Natural fire 1 + cooling	SHS 250x10	S1	Joint behaviour under natural fire 1
5	Natural fire 2 + cooling	SHS 250x10	S1	Joint behaviour under natural fire 2
6	Natural fire 2 + cooling	SHS 250x10	S2	Joint behaviour under natural fire 2
7	Natural fire 2 + cooling	SHS 250x10	S3	Joint behaviour under natural fire 2

Test Program

Table 3: Reverse channel joints

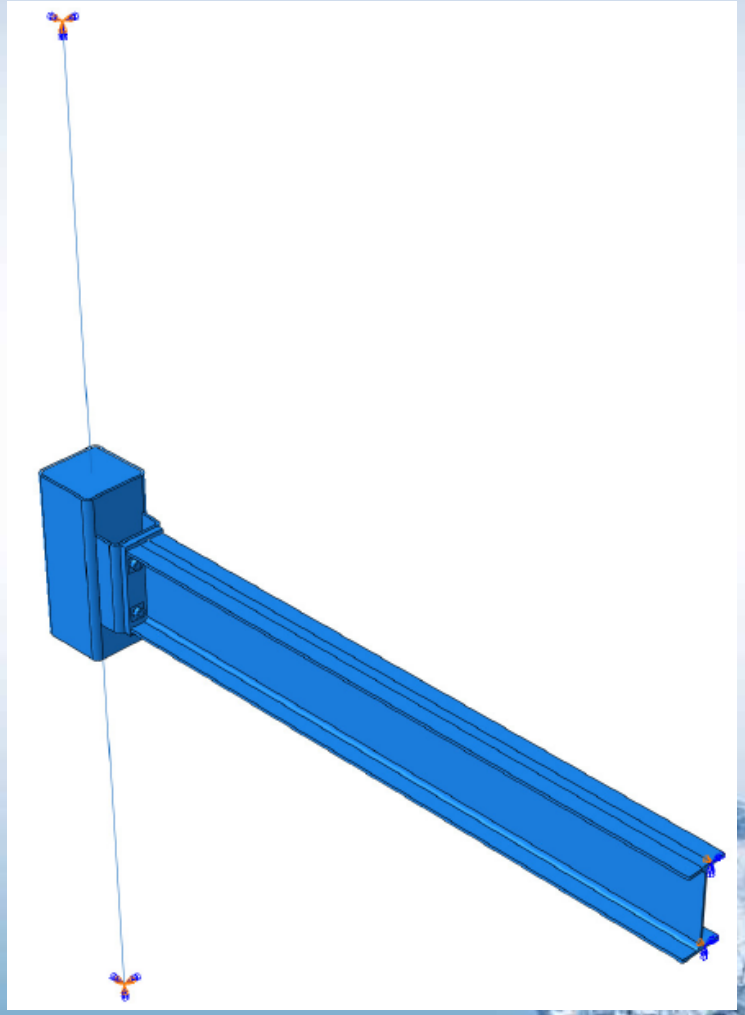
Test nº	Column section	Reverse channel joint	Reverse channel section
1	CHS 244.5x10	C1	U 200x135x8
2	SHS 250x10	S1	U 200x90x8
3	SHS 250x10	S2	U 200x90x10
4	SHS 250x10	S2	U 200x90x10
5	SHS 250x10	S1	U 200x90x8
6	SHS 250x10	S2	U 200x90x10
7	SHS 250x10	S3	U 200x90x12





Finite element model

- Utilizing the symmetry of the model



Finite element model

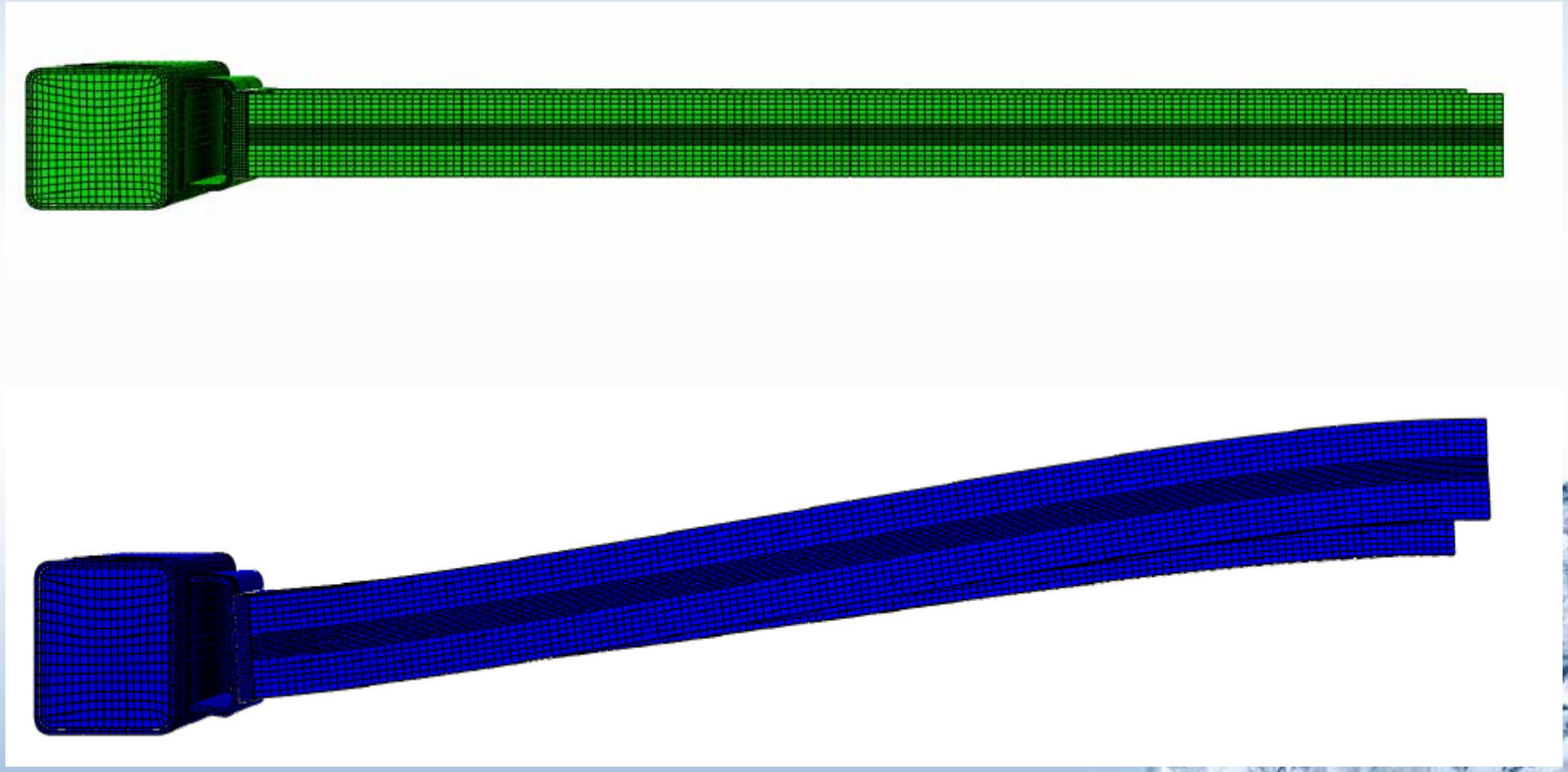
- Solid C3D8 elements for the steel beam connection components and part of the column
- Beam elements for Part of the columns away from the connection
- Temperature dependent non-linear material properties both for steel and concrete
- Surface to surface contact with friction coefficent 0.25 in tangential direction and ‘hard contact’ in the normal direction
- Tie constraint used at all welds
- Constant temperature applied

Finite Element model

General procedure:

- Initial step
  - Ambient temperature (20 ºC) application (predefined field)
- First step
  - Small pre-tensioning of bolts
    - Initialise contact
- Second step
  - Applying the loading
- Third step
  - Applying temperature as a predefined field

Finite Element model



Tasks to perform

- Validate the model using experimental data
- Perform parametric studies
- Improve understanding of the interaction between composite joint and the surrounding structure


Thank you for
your attention!
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