Structural applications of ferritic stainless steels

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About the project

- 60% funded by EC RFCS
- 40% funded by stainless steel industry

- 3 year project (July 2010 – July 2013)
- 8 European partners
  - Co-ordinated by SCI

Overview: today's discussion

- Background and objectives of the project
- Key findings to date
  - Material response
  - Member response
  - Connections
  - Corrosion
- What next?

A little about ferritics…

Compared to carbon steel

- Good corrosion-resistance

Compared to typical stainless steel

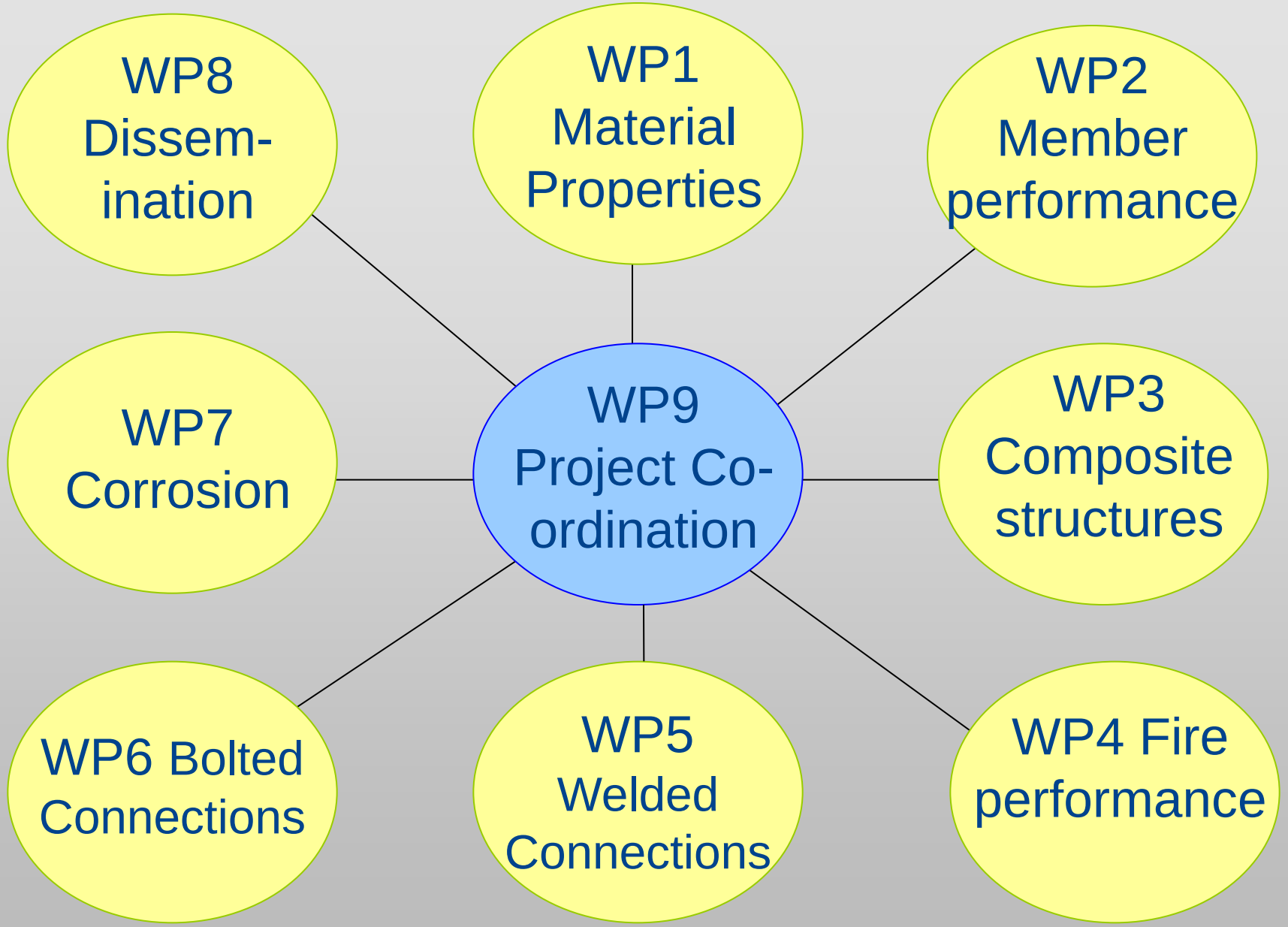
- Low-cost
- Price-stable (no nickel!)

As well as….

- Durable, strong, good impact-resistance

Objective of the project

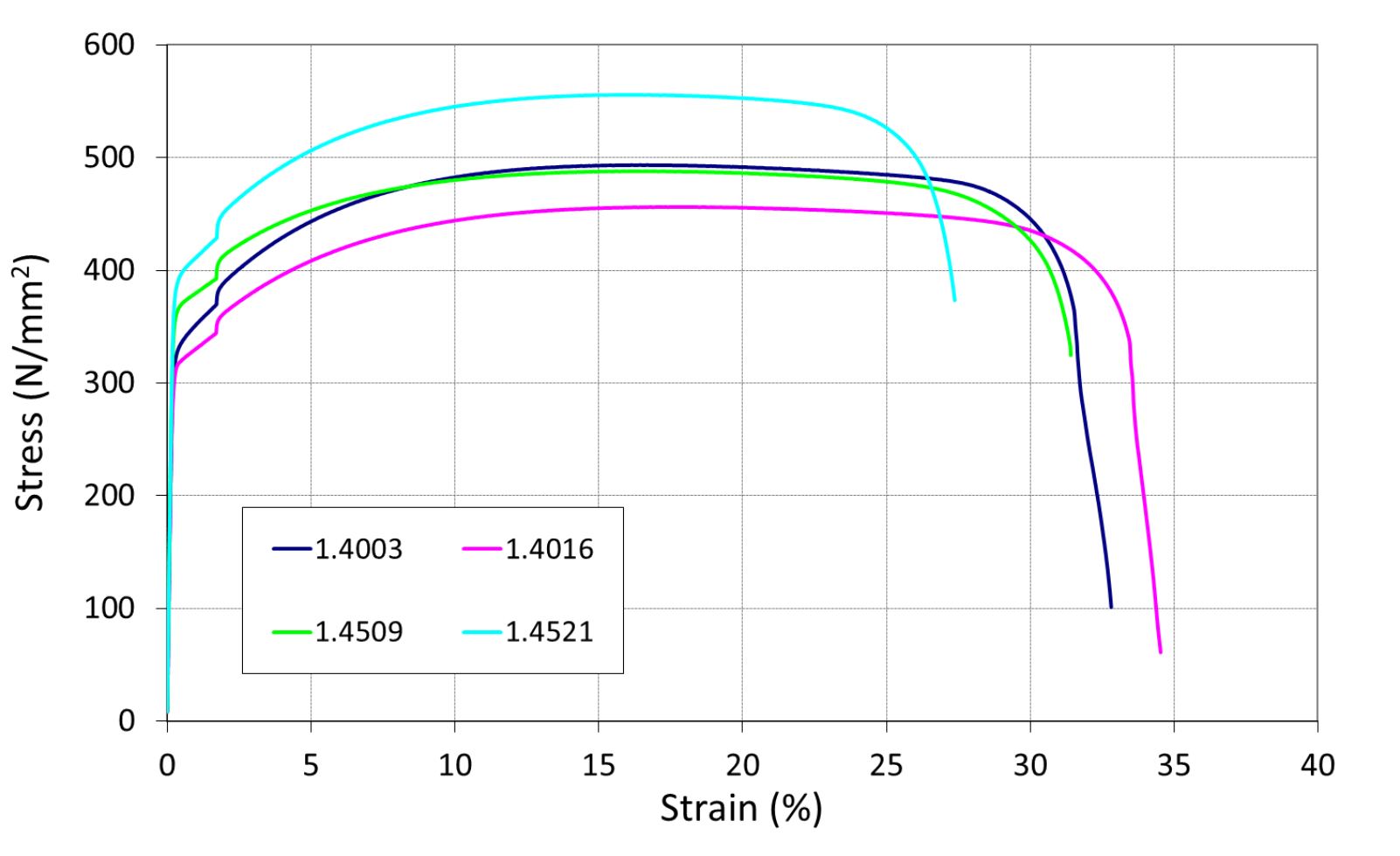
- Generate & provide technical information so ferritics can be specified in buildings
  - Structural performance
  - Fire resistance
  - Atmospheric corrosion resistance
  - Guidance on connections
- Investigate and highlight the advantages of this steel (economic, environmental…)


WP8 Dissem-ination
WP1 Material Properties
WP2 Member performance
WP7 Corrosion
WP9 Project Co-ordination
WP3 Composite structures
WP6 Bolted Connections
WP5 Welded Connections
WP4 Fire performance

WP1: End user requirements (Arup)

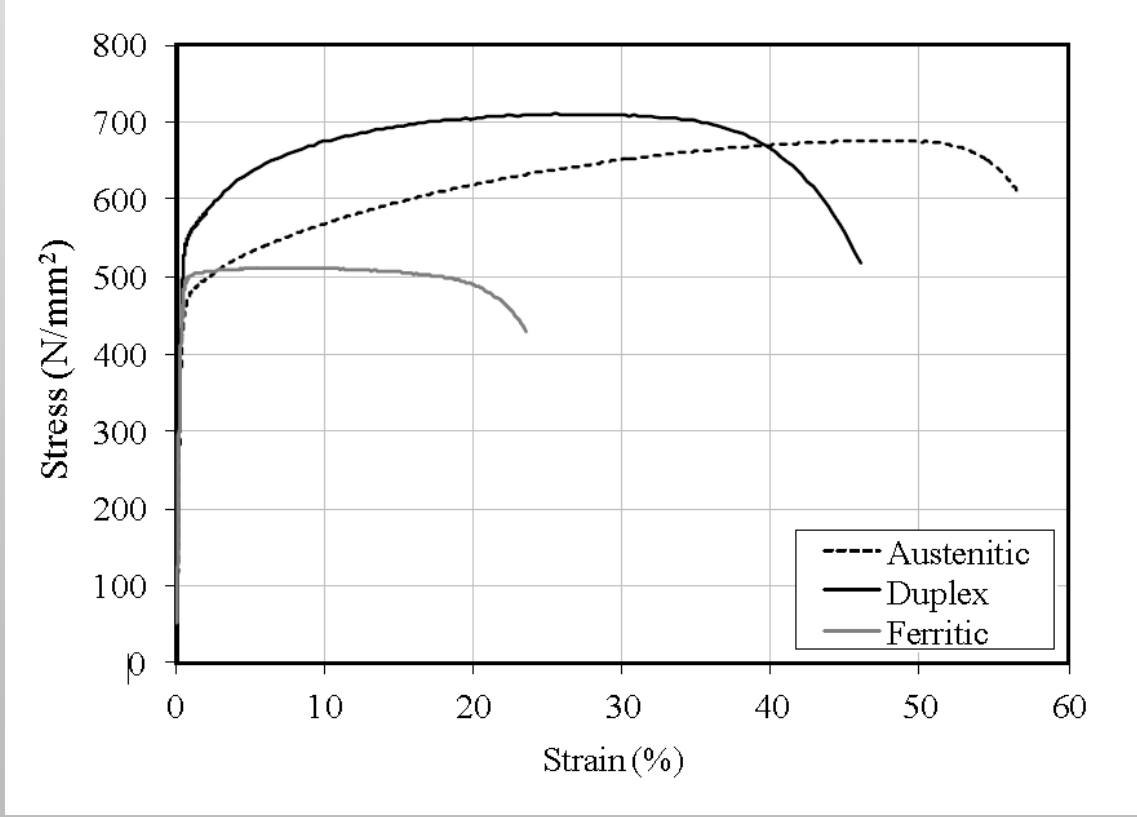
- Unknown in the construction industry
- Provide data on:
  - Corrosion and durability
  - Mechanical properties
  - Welding procedures and joining
  - Toughness
  - Grade selection

WP1: Material properties



WP1: Material properties

	Typical cold-rolled ferritic	Typical austenitic
f_y	350N/mm^2	280N/mm^2
f_u	500N/mm^2	650N/mm^2
ε_u (A80)	27%	55%



WP1: Material properties

- Relatively low f_u/f_y ratio (by SS standards)
- *n* value = under review
  - Look to be relatively high (like CS)
  - Annealed/cold formed
- E_s = under discussion
  - Around 200 N/mm^2

WP1: Toughness properties

1. Charpy tests
   - -40 to +20°C
   - Results: OK toughness for stabilised.
   - Need to do fracture toughness tests
2. Fracture toughness tests
   - Happening early 2013

WP2: Member performance

- Aim: to develop efficient design methods for ferritic thin-walled members
  - *Numerical analysis:* Based on GMNIA and use ABAQUS
  - *Experimental validation*: Thin walled top-hat and hollow sections
- Design expressions developed
- Recommendations for the use of DSM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Key findings (to date):

- Existing stainless steel buckling curve can be used in all cases
  - except cold-rolled hollow sections which should use carbon steel curves
- Higher “n” factor of ferritic steels can be taken into account for open sections

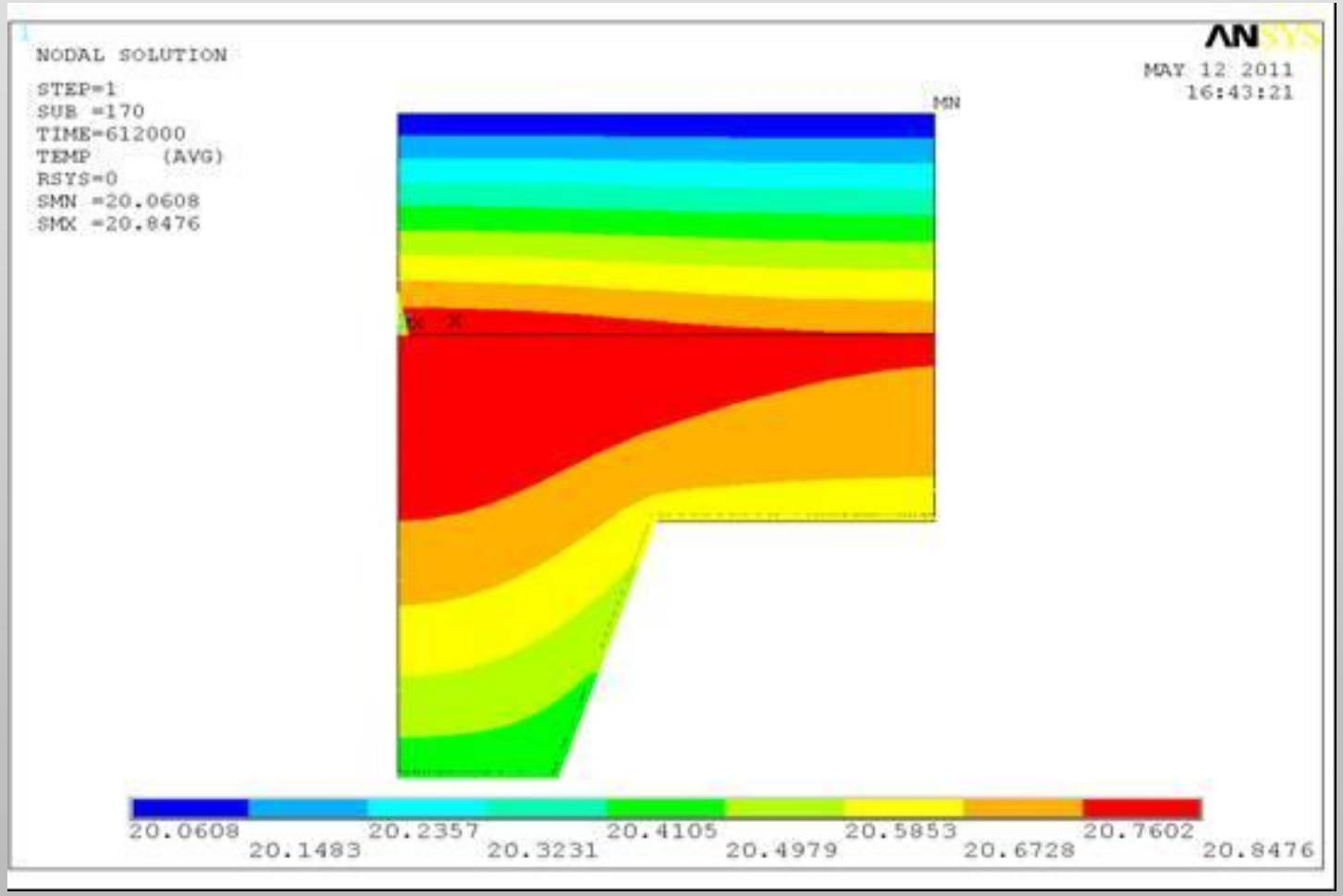
WP3: Composite performance

- Ferritic stainless steel decking
  - Decking tests (construction stage)
  - Composite slab tests
  - Stud welding trials
  - Push-out tests
  - Thermal performance
  - Fire performance

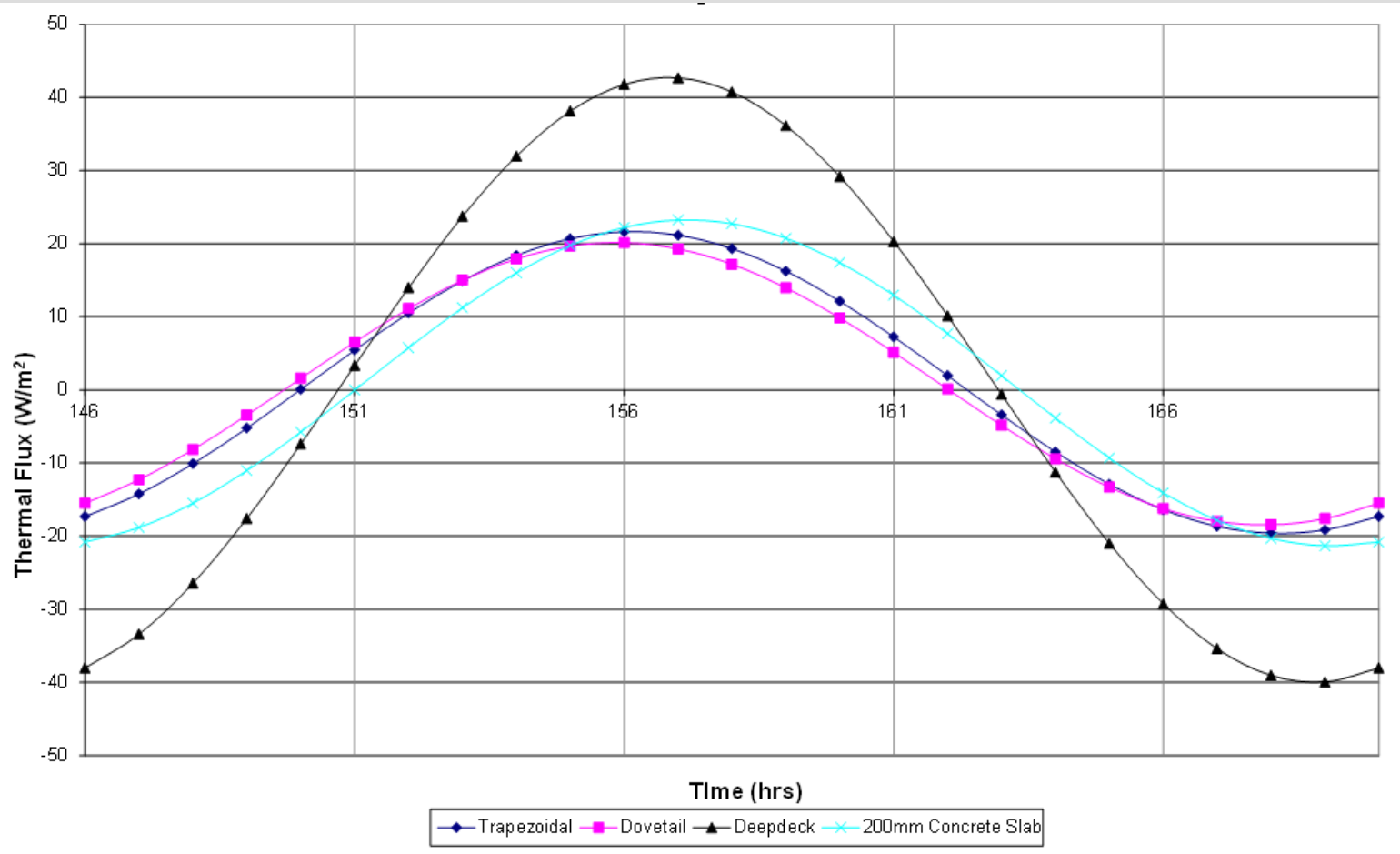
WP3: Thermal Modelling

- Utilisation of inherent thermal mass in comp. slab for efficient low-carbon solution
- Detailed FE analysis used to understand, quantify and compare behaviour

Temperature distribution (night)



Thermal flux for various profiles



WP4 Fire tests: Columns

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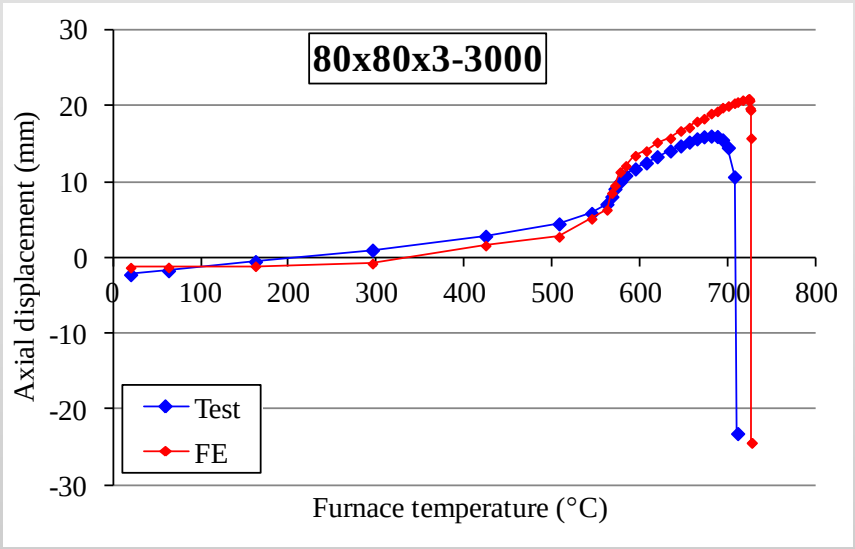
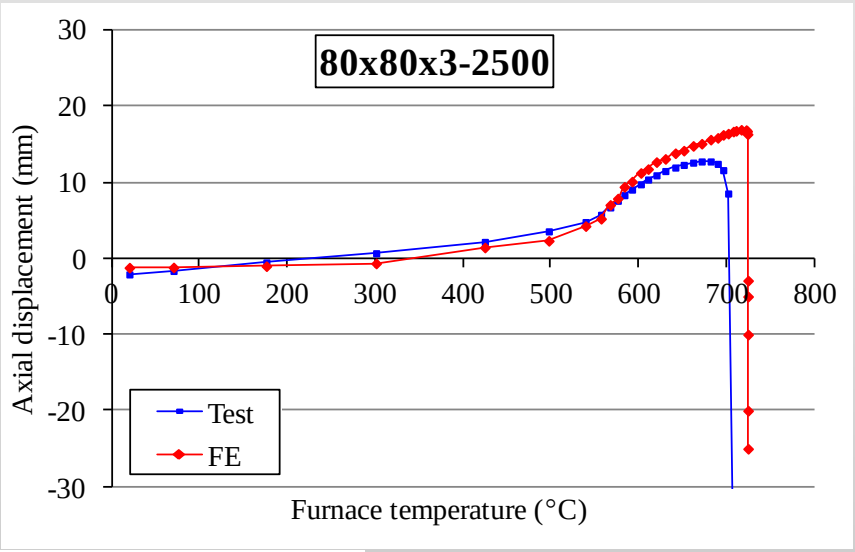
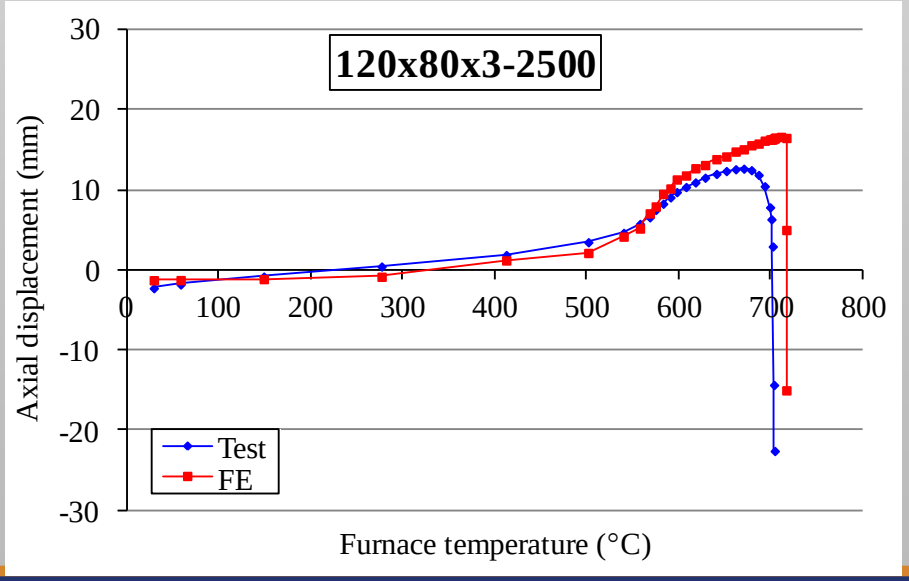
WP4: Column analysis







WP4 Fire tests: Beams

WP5: Welded joints

- Mechanical tests and metallographic examination of welds
- Design guidance

WP5: Key findings

- Cold-rolled materials have adequate toughness down to temperatures around 0°C.
- HAZ toughness is reasonable
- Susceptible to grain growth at temperatures above 950 °C - decreased toughness
- Welding heat input should be kept low
- Use austenitic welding consumables
- Stabilised ferritics are readily weldable

WP5: Design rules welded joints

- The strength rules in EN 1993-1-8 can be applied to stainless steels in conjunction with the rules in EN1993-1-3
- No experiments have been carried out on ferritic stainless steel tubular joints to date
- The level of design guidance that can be offered is limited

WP6: Bolted connections

WP7: Corrosion

- Develop a comprehensive understanding of the durability of the ferritic grades
- Base material + welded + bolted
- Exposure field tests, Accelerated tests, Electrochemical tests
- Design guidance
- Comparative study of the service life of building components

In conclusion

- Very successful consortium
- Results & findings are starting to emerge
- Toughness & durability are the key issues
- What next for ferritics?
  - Watch this space…

- Questions?

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