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The Behaviour of Fin Plate Steel Connections in Fire

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The Behaviour of Fin Plate Steel Connections in Fire

- Introduction to **Fin Plate steel connection.**
- The aims of this research.
- Creating the FEM and the evaluation at ambient temperature.
- FEM at elevated temperature and the evaluation.
- Conclusion



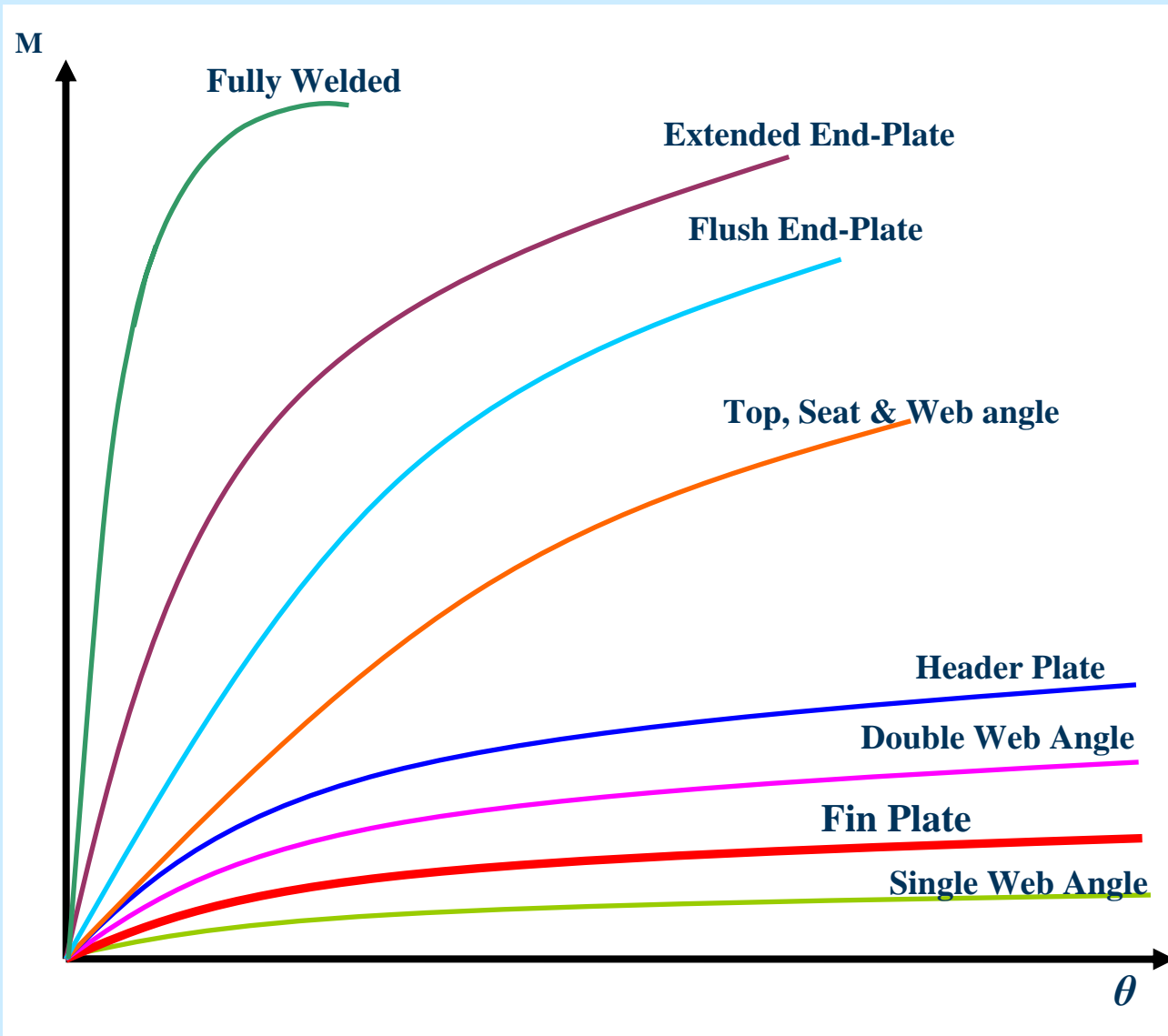
Fin Plate Configuration

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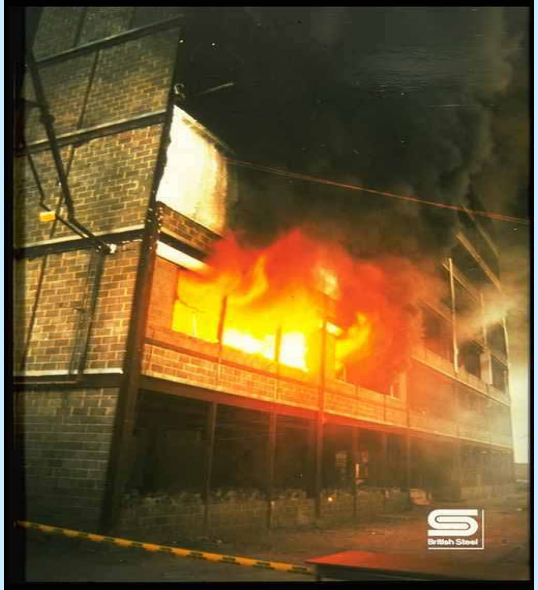
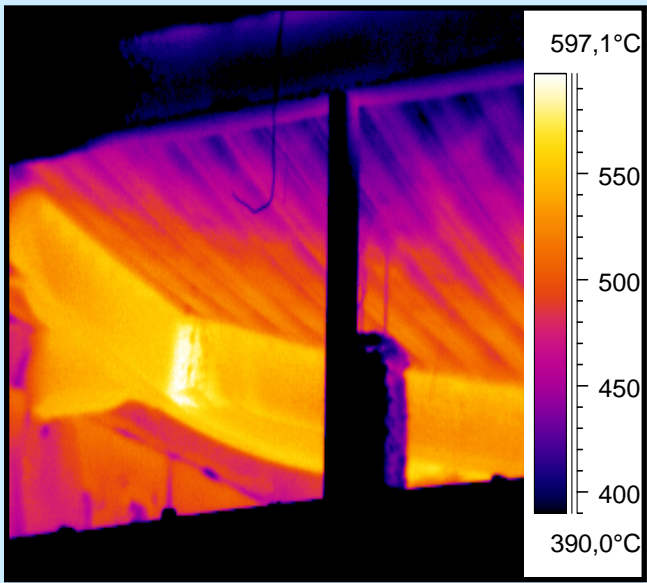
Connection behaviour





Fin Plate Connection in Fire and the Catenary Action

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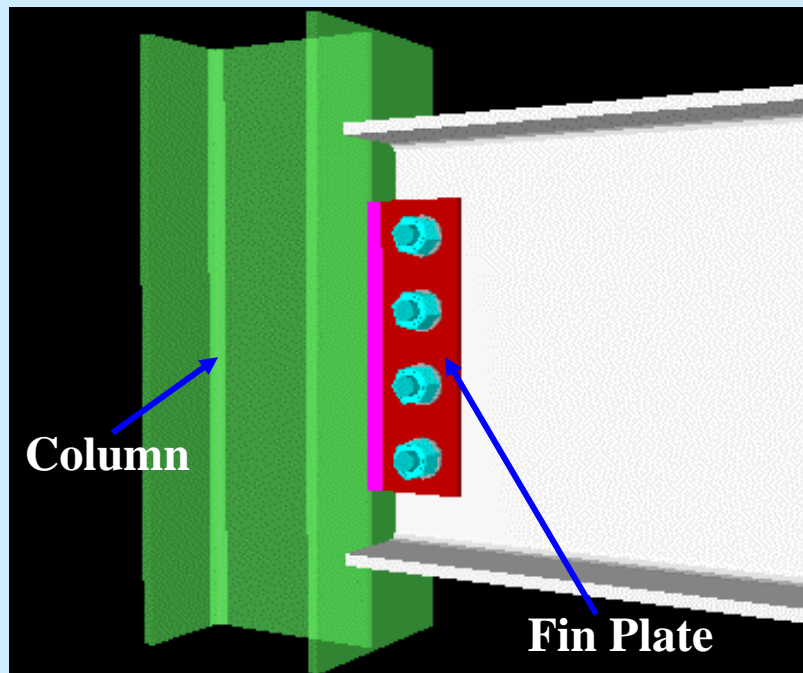


The Research Aims

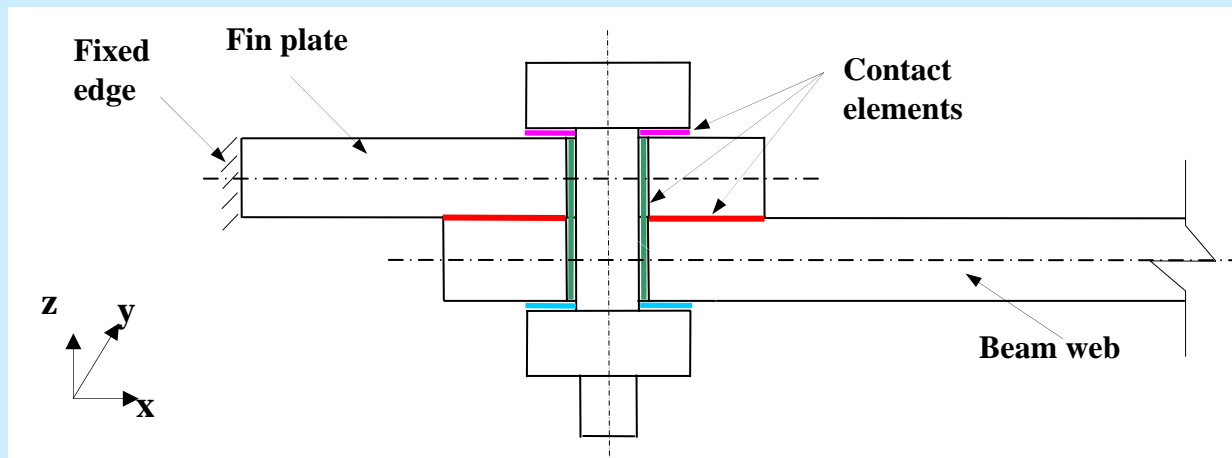
- **Understand the behaviour of fin plates in fire.**
- **Examine the ability to resist tying force as part of the Robustness requirement.**
- **Evaluate their performance across a range of size.**
- **Provide design guidance.**



Modelling the connection

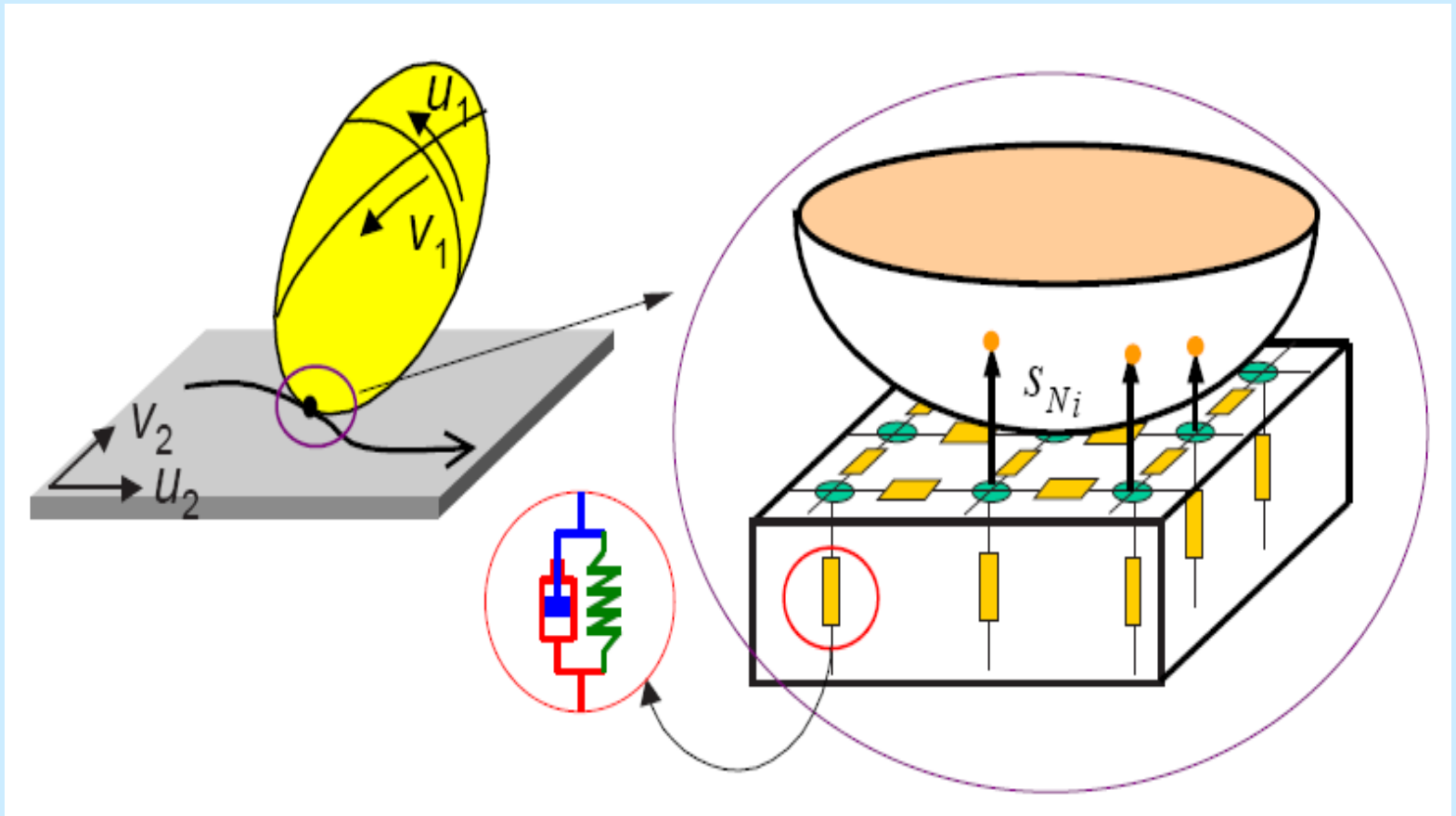


- Bolt shank-to-bolt holes
- Beam web-to-fin plate.
- Bolt head-to-beam web
- Nut-to-fin plate.



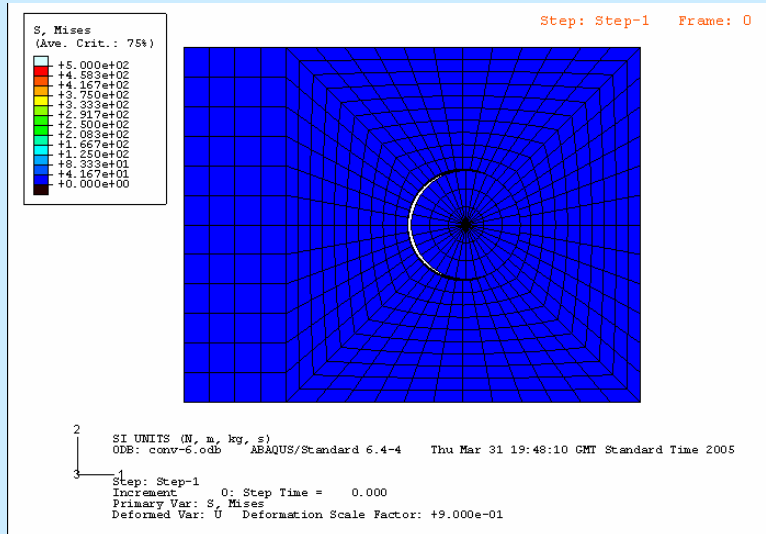
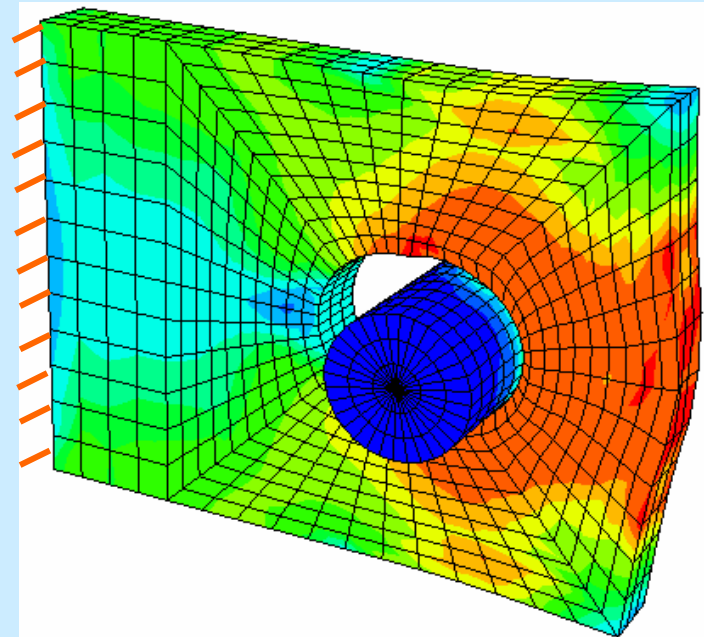
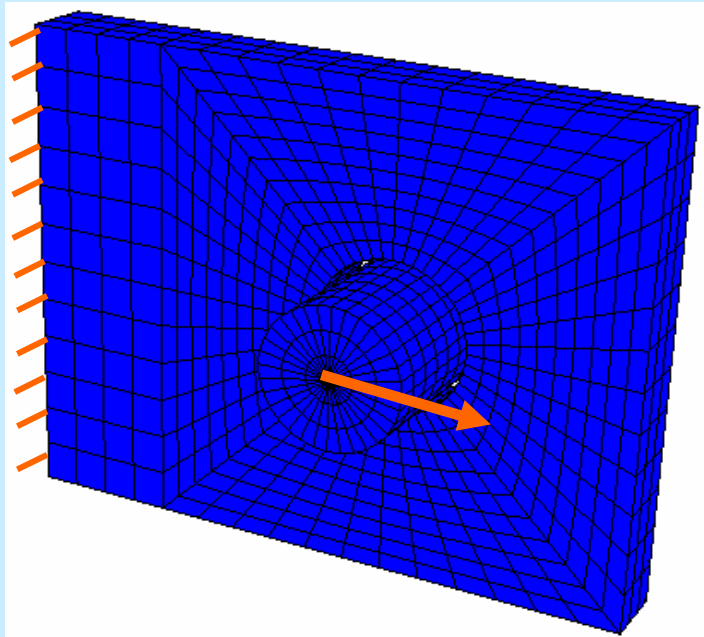


Contact Methodology





The Finite Element Model



**Brick element
C3D8I**

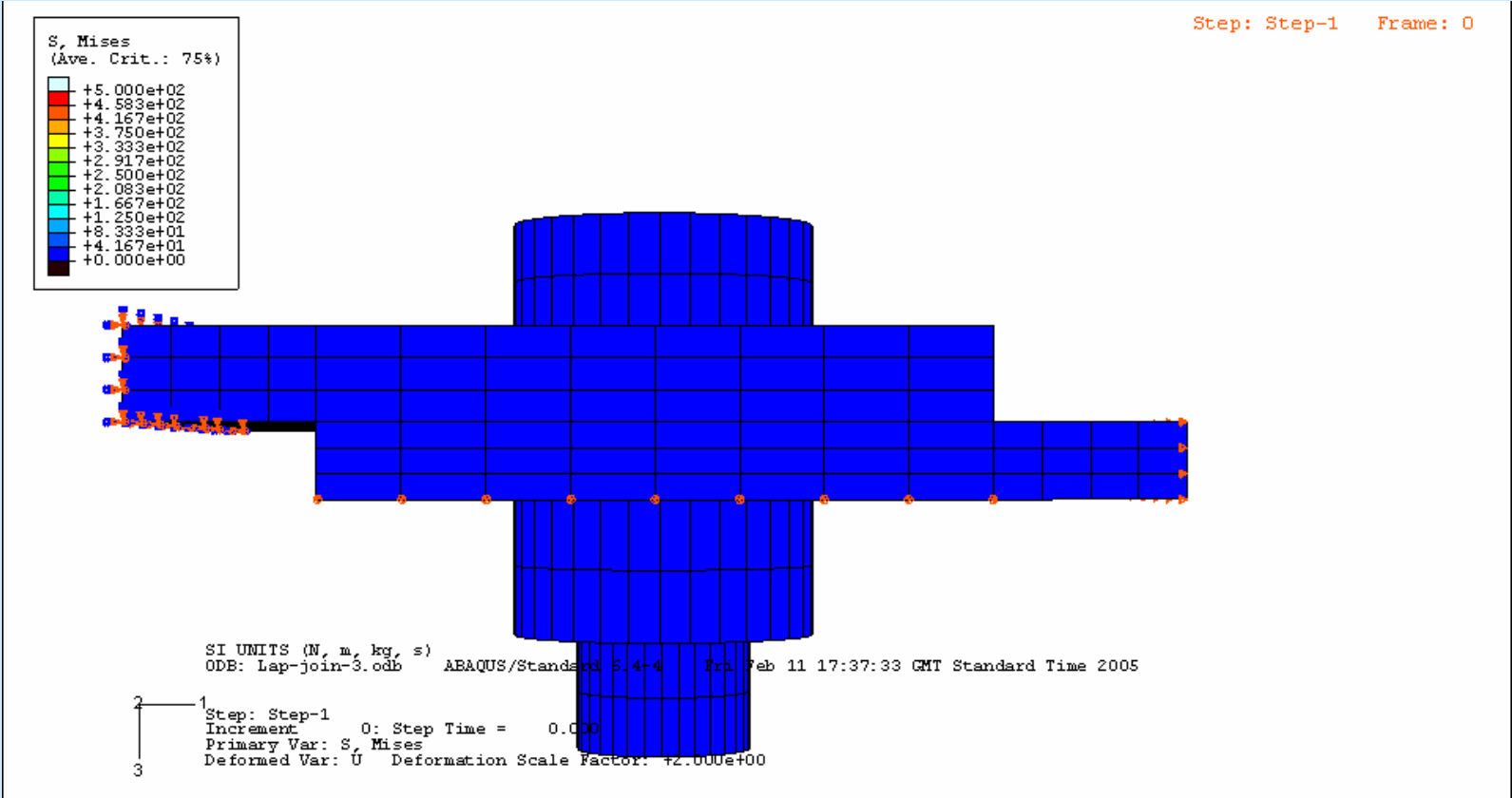
**Surface-to-surface
contact element**



The Finite Element Model

Lap joint

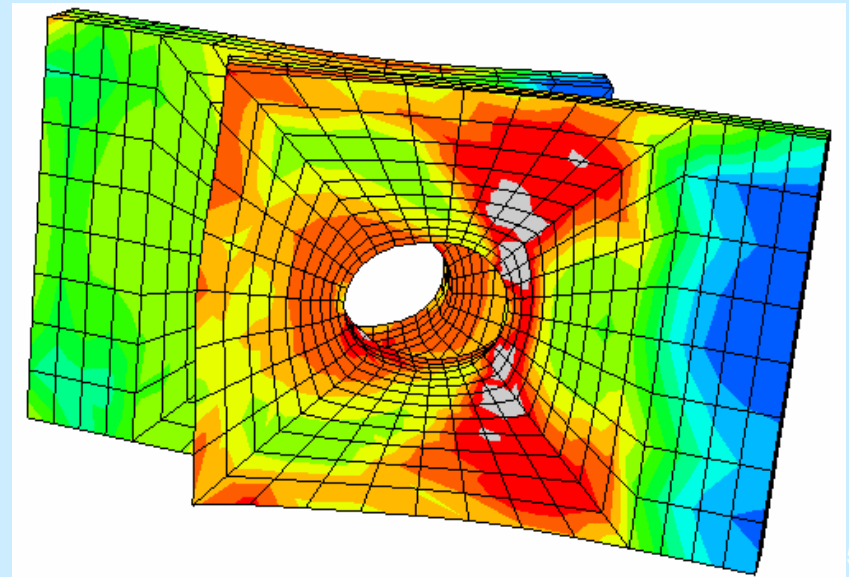
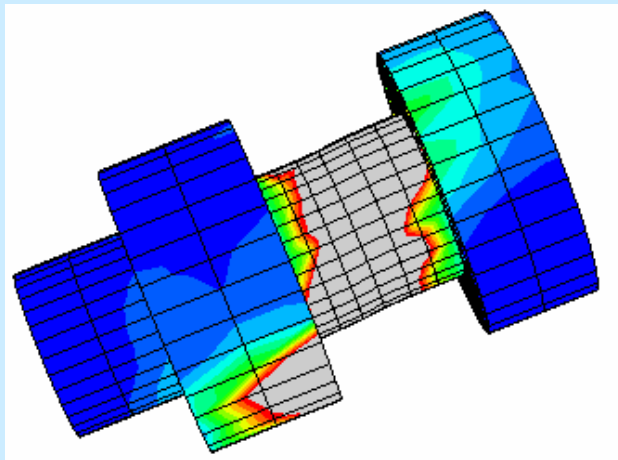
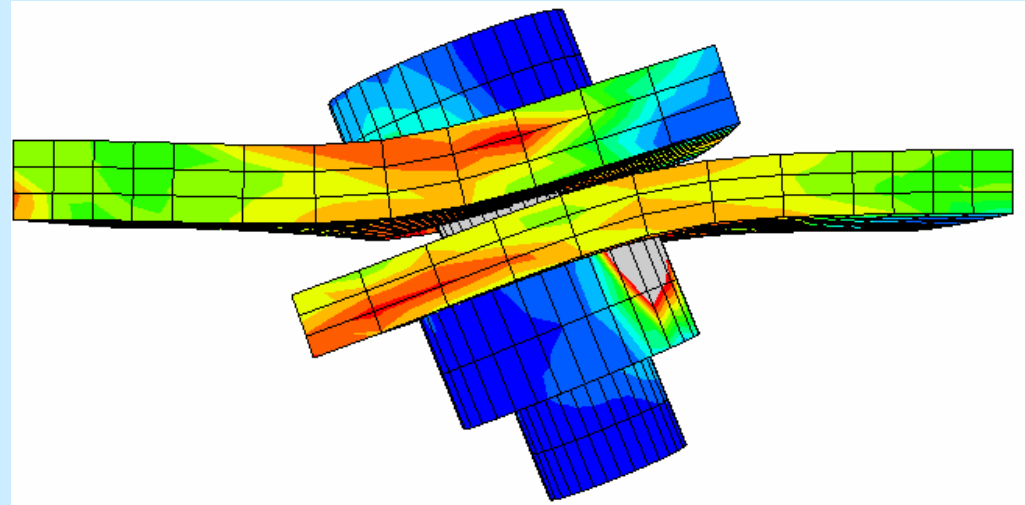
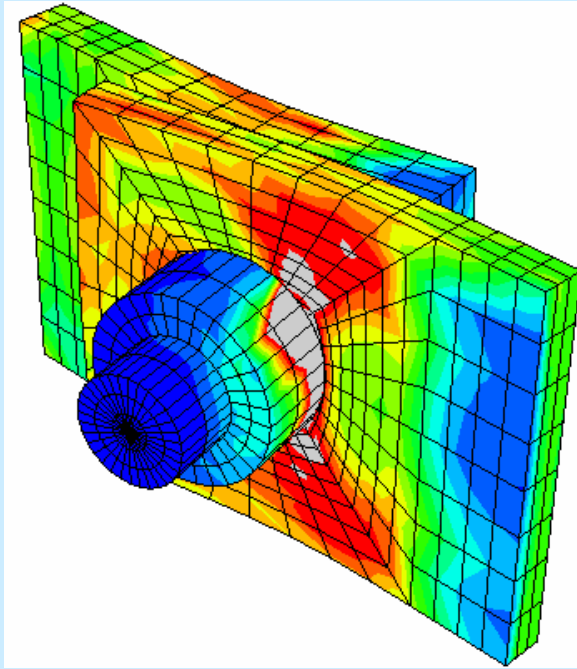
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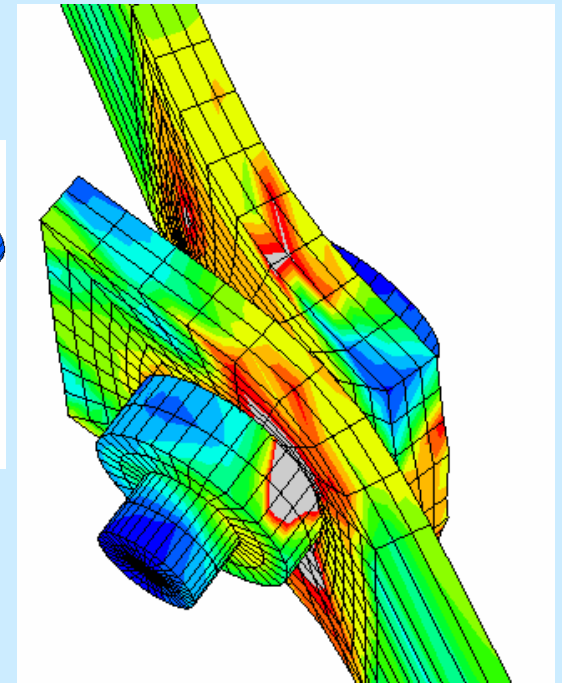
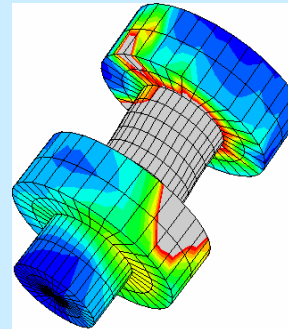
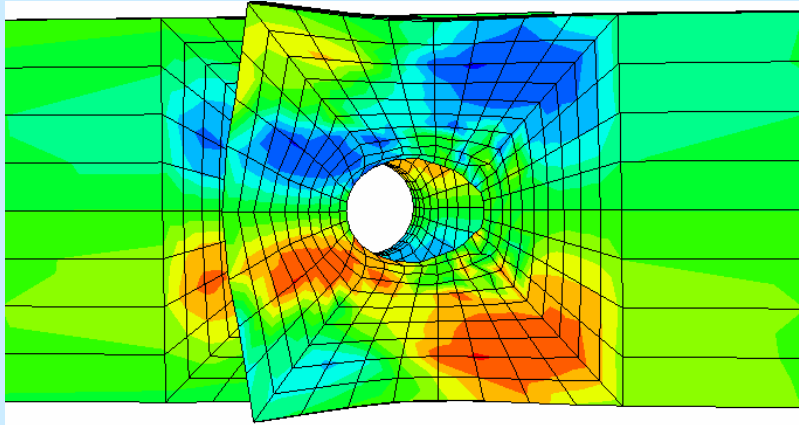
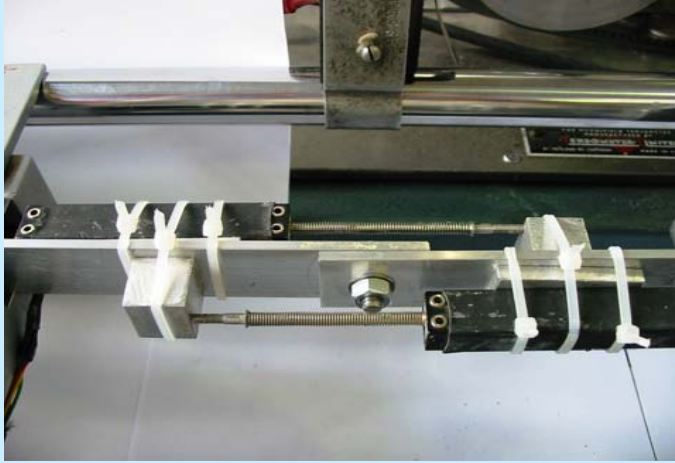
The Finite Element Model

Lap joint



FEM Evaluation at Ambient Temperature

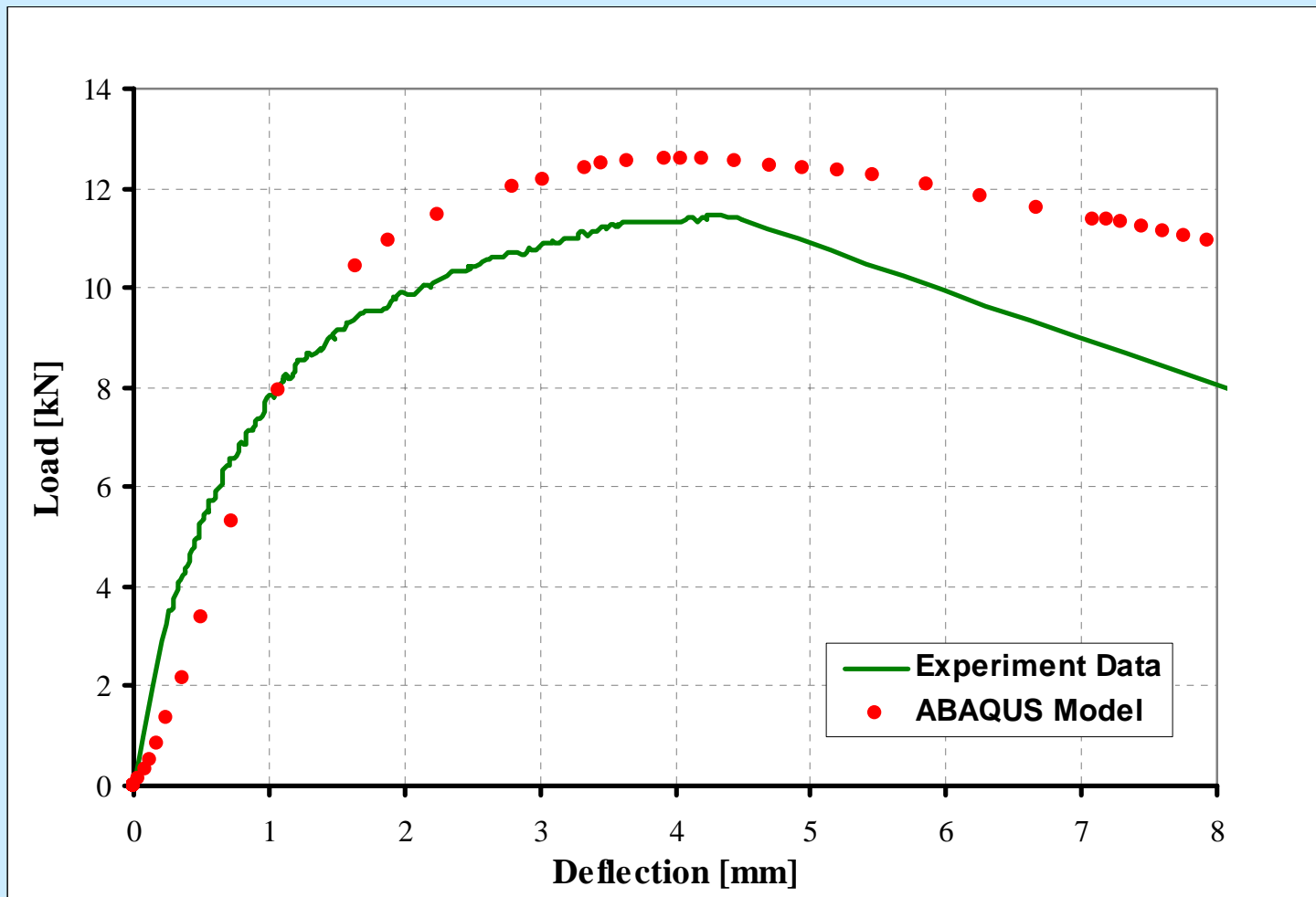
Aluminium Lap joint test





FEM Evaluation at Ambient Temperature

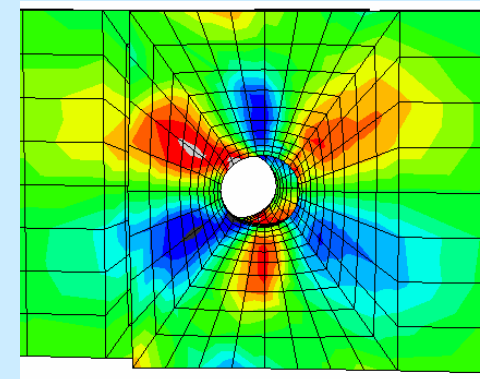
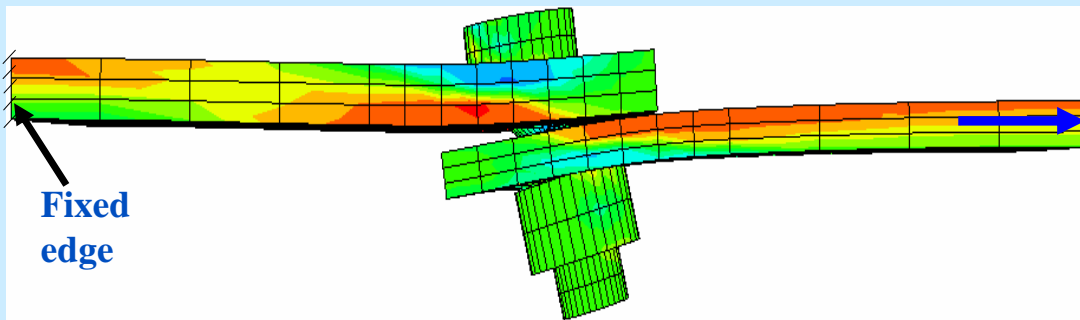
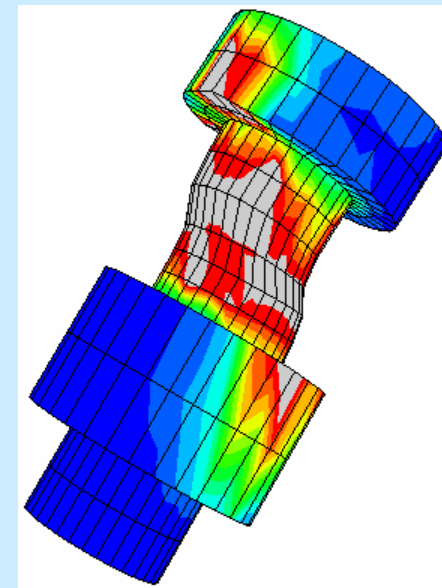
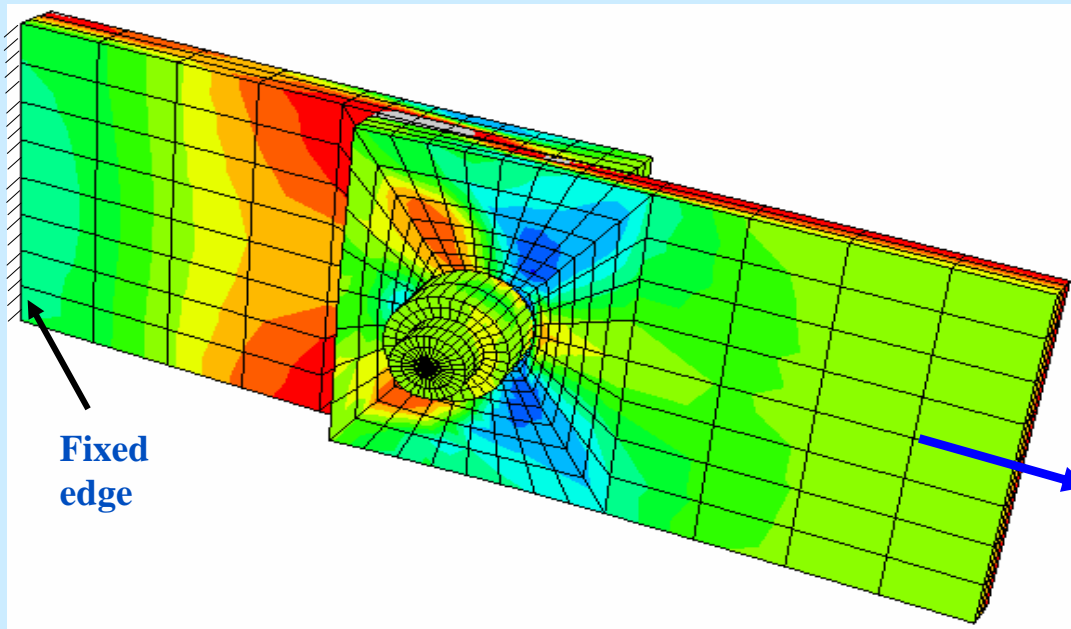
Aluminium Lap joint test





FEM Evaluation at Ambient Temperature

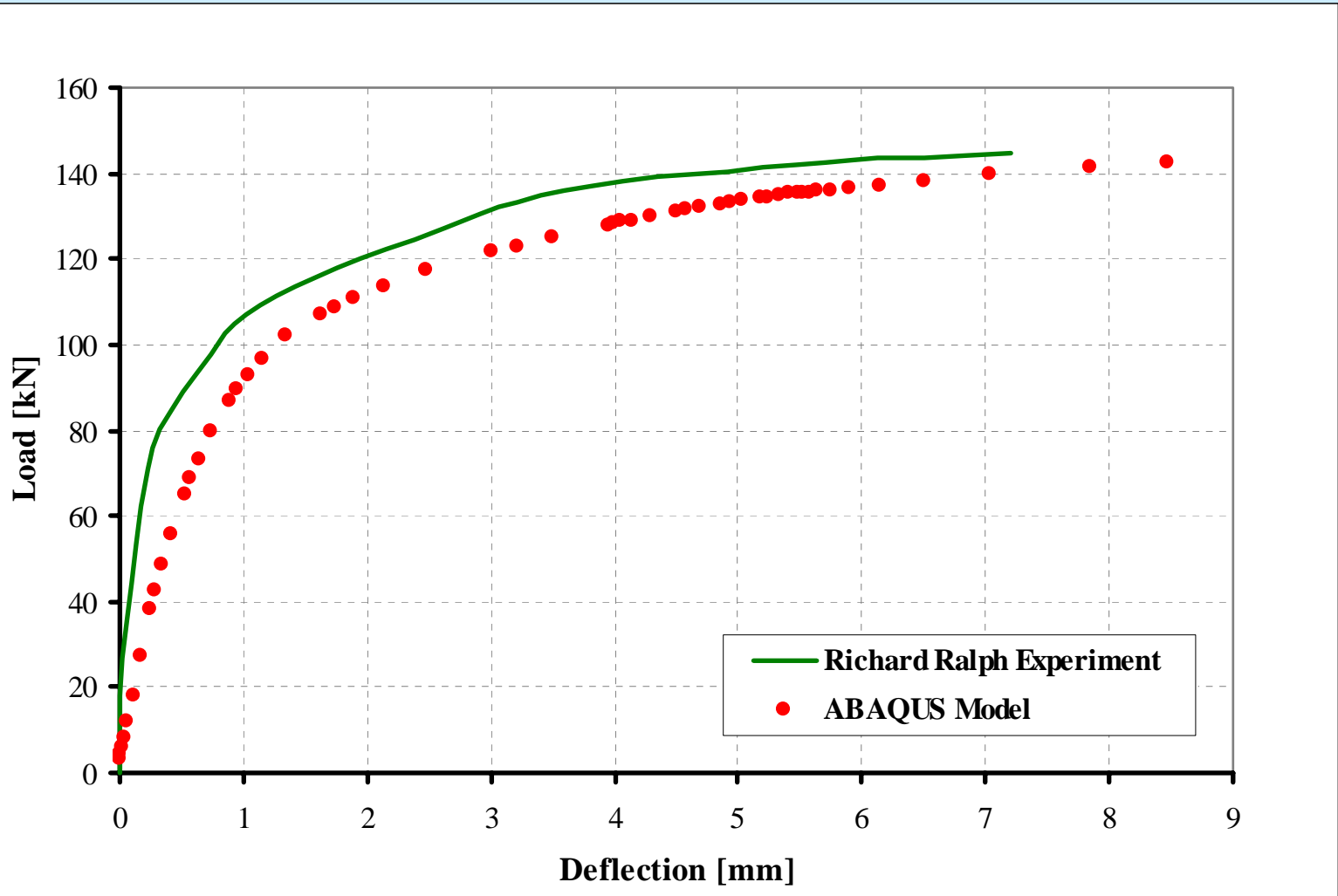
Richard Ralph experiment





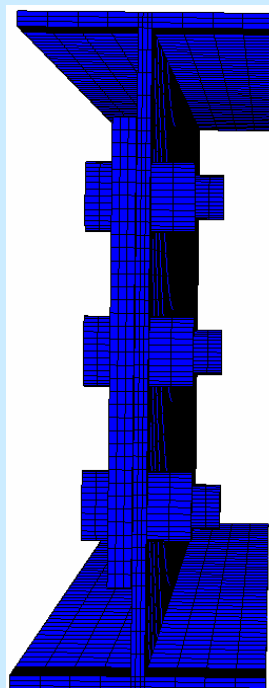
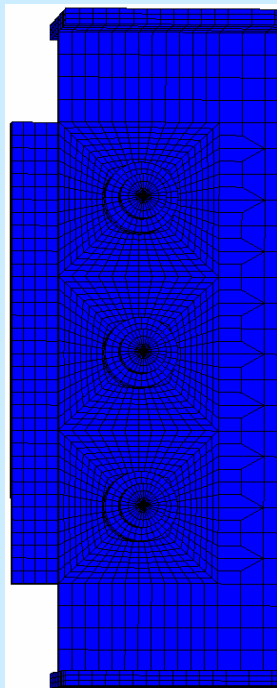
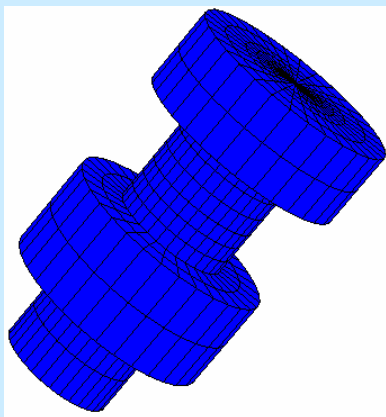
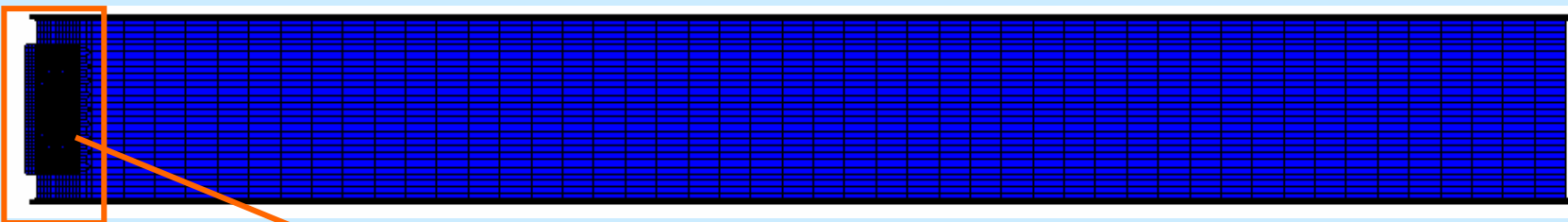
FEM Evaluation at Ambient Temperature

Richard Ralph experiment

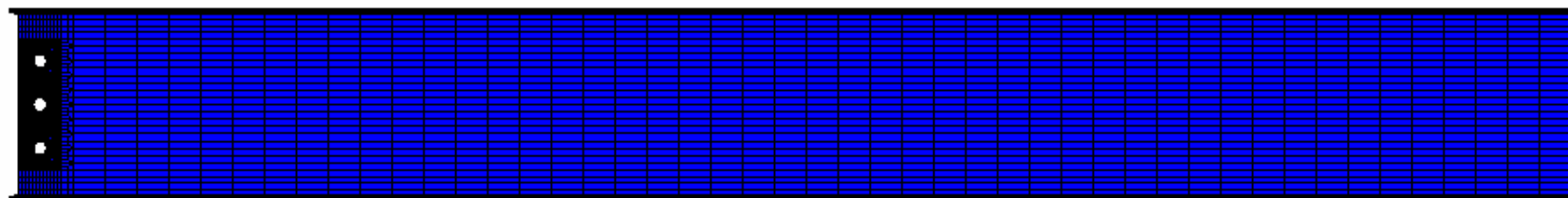




The Finite Element Model



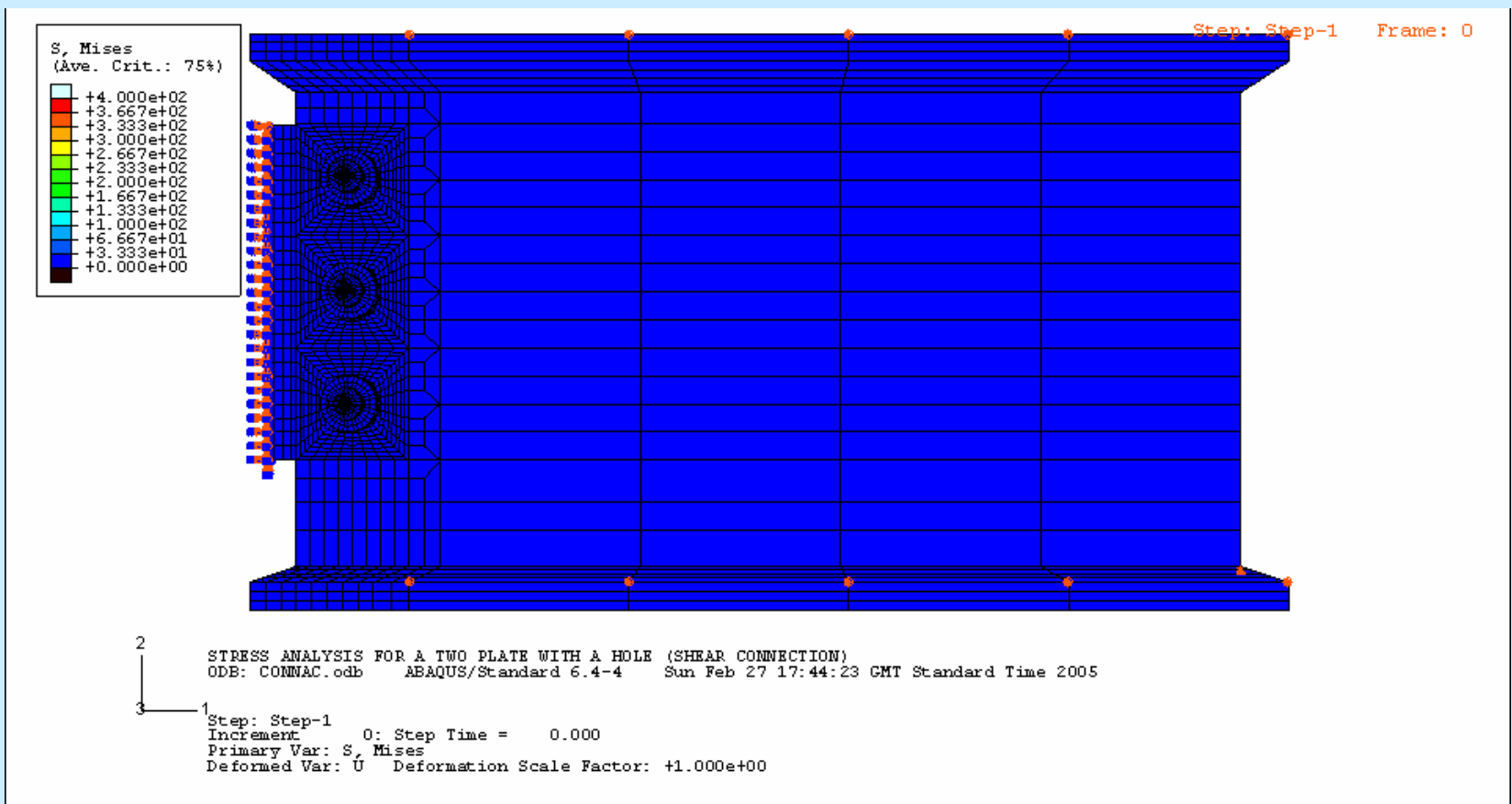
- **Brick element C3D8I**
- **Surface-to-surface contact element**
- **Non-linear material**





FEM Evaluation at Ambient Temperature

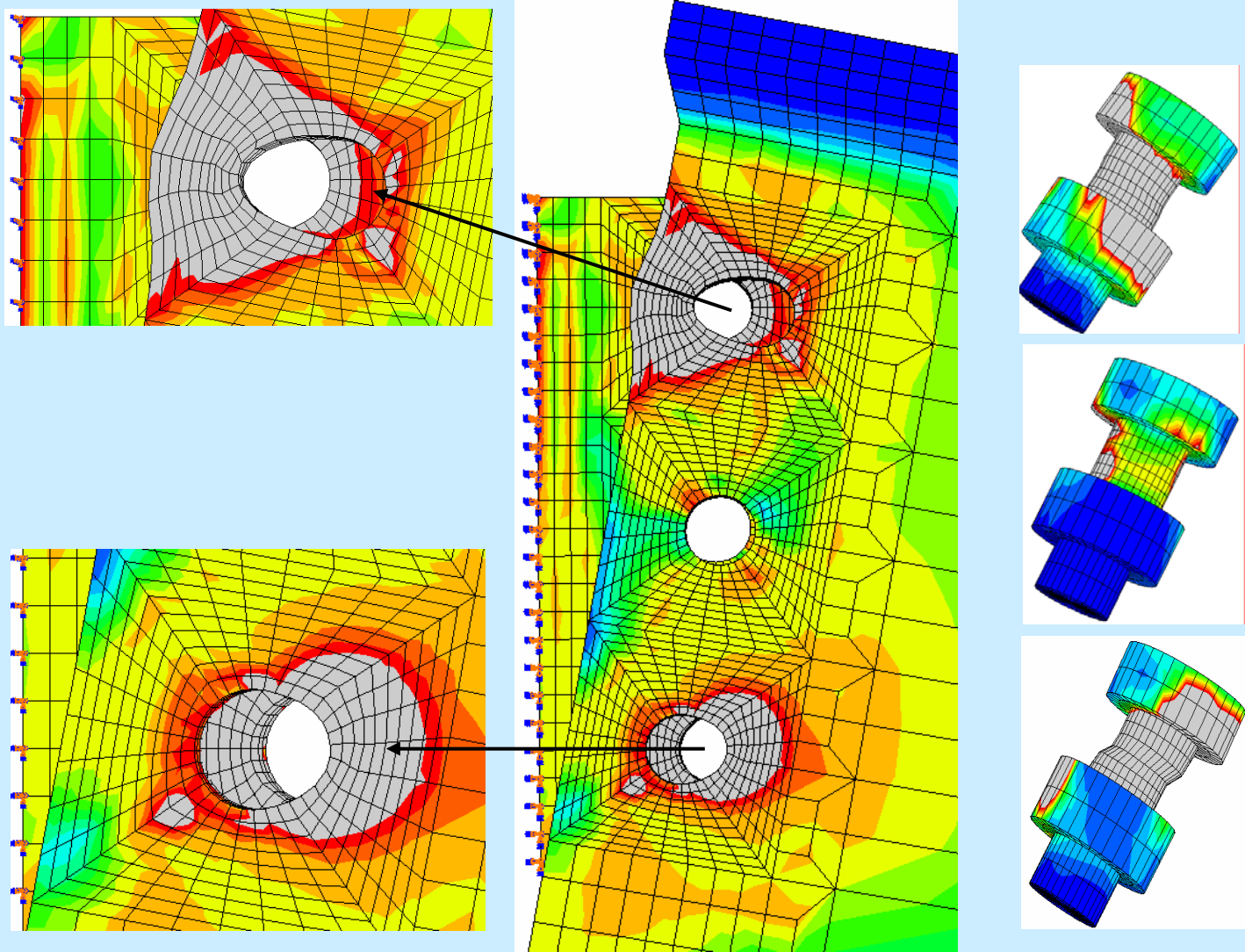
Moment Rotation of Richard Ralph experiment





FEM Evaluation at Ambient Temperature

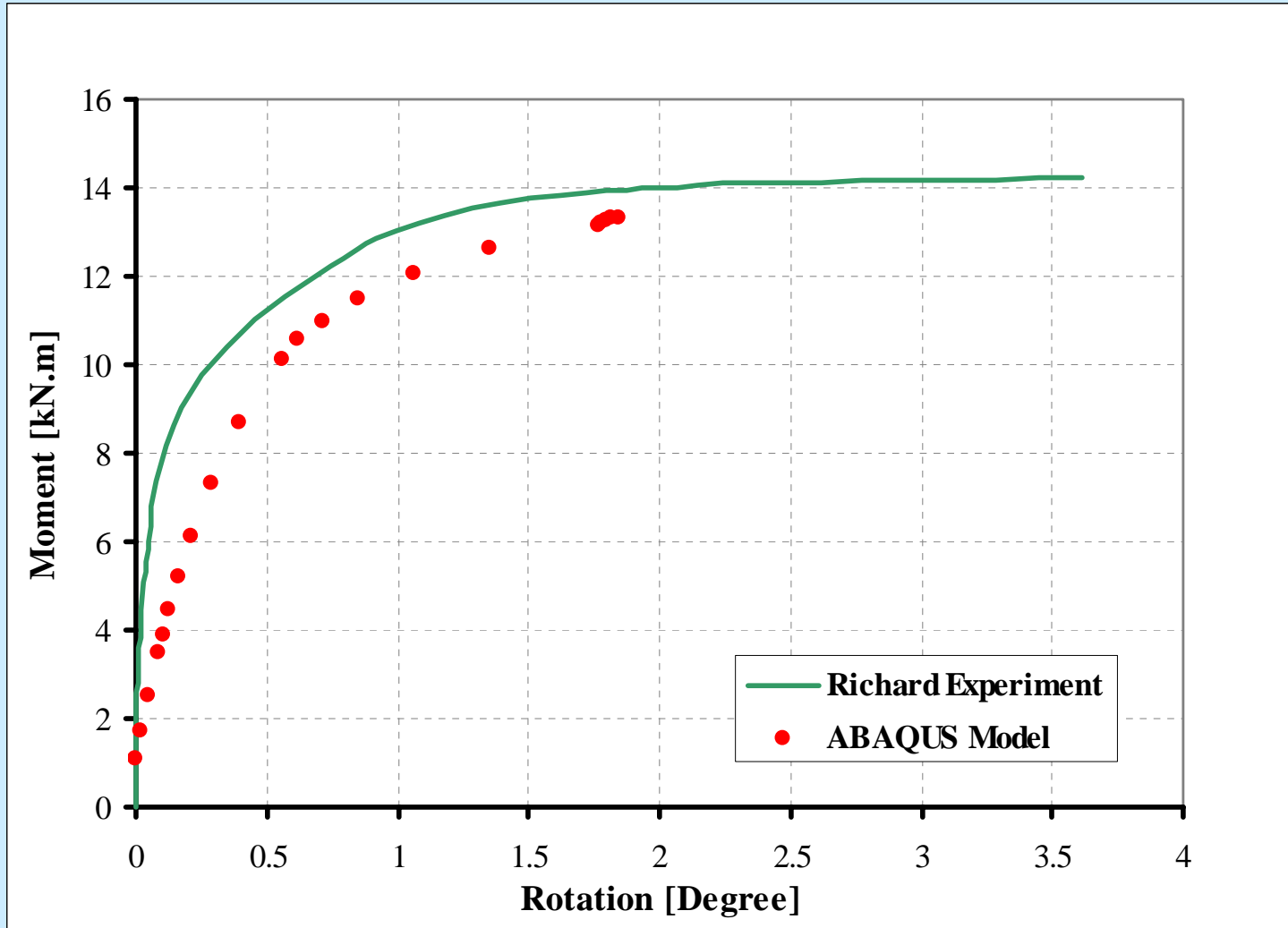
Moment Rotation of Richard Ralph experiment





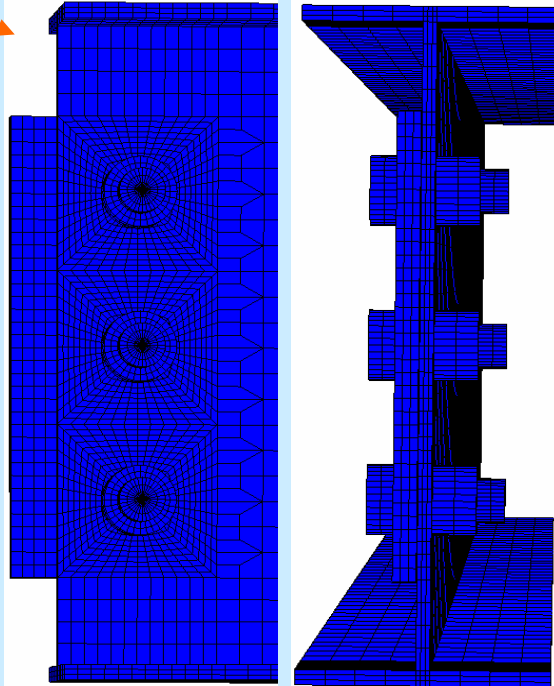
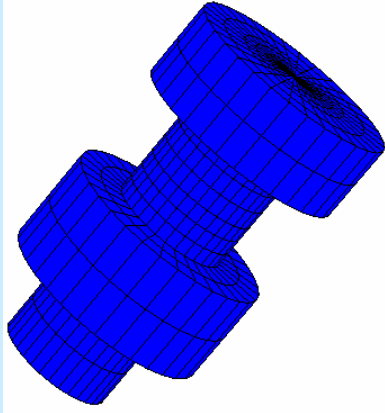
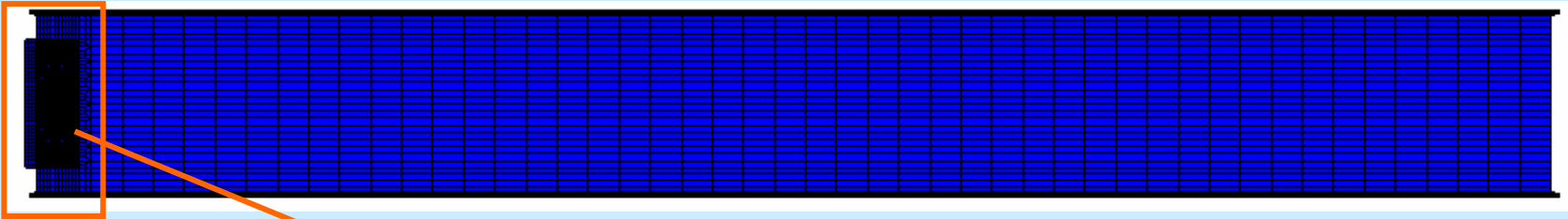
FEM Evaluation at Ambient Temperature

Moment Rotation of Richard Ralph experiment

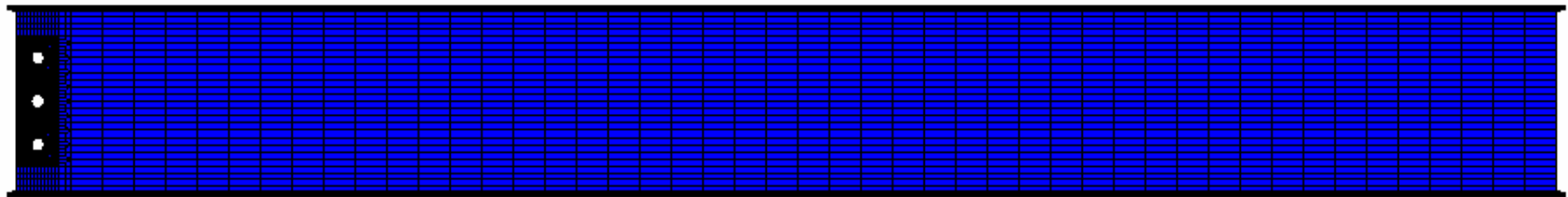




FEM at Elevated Temperature



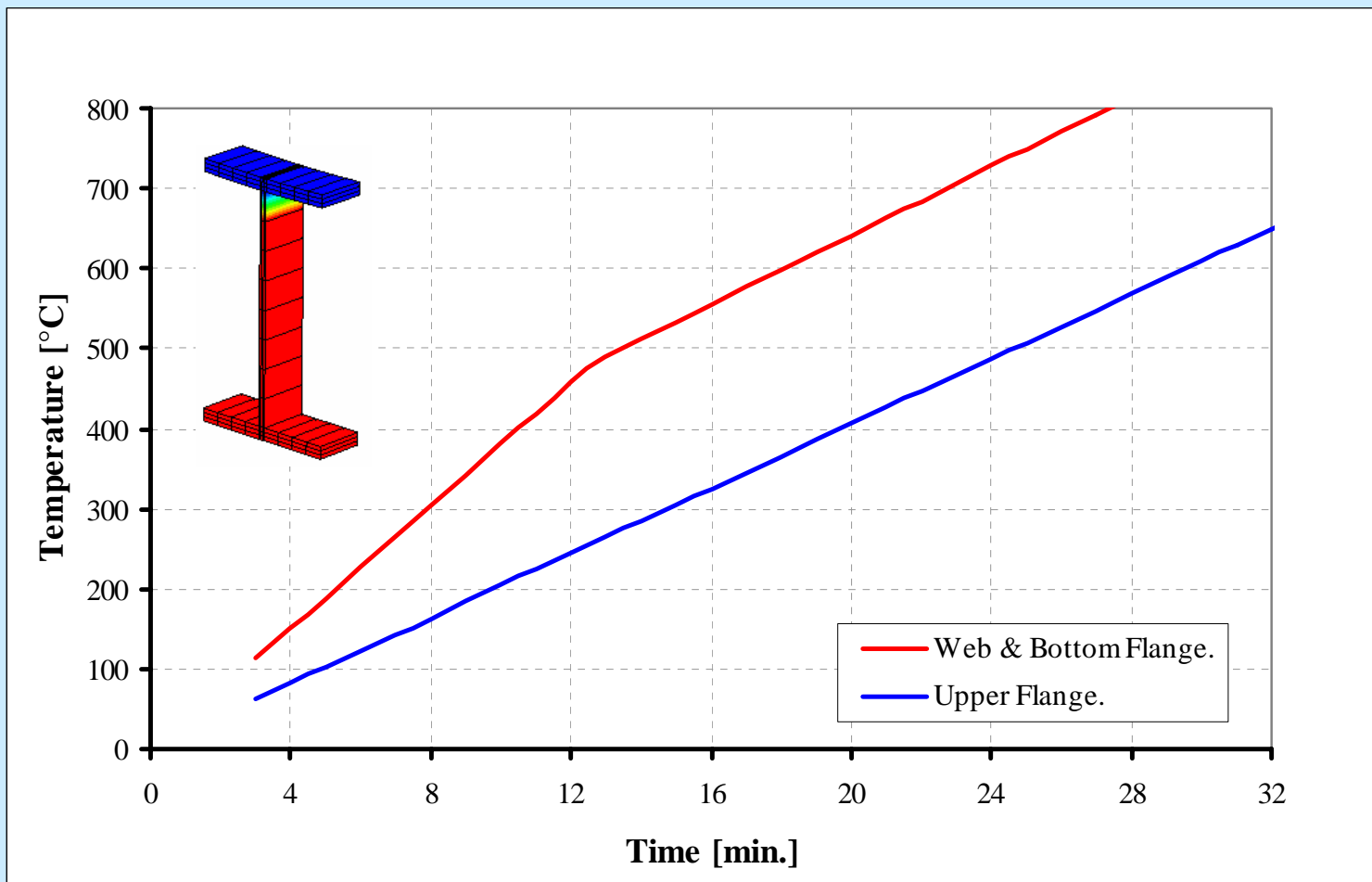
- **Brick element C3D8T**
Coupled Temperature-Displacement analysis
- **Non-linear material temperature dependent**
- **Geometric non-linearity**





FEM Evaluation at Elevated Temperature

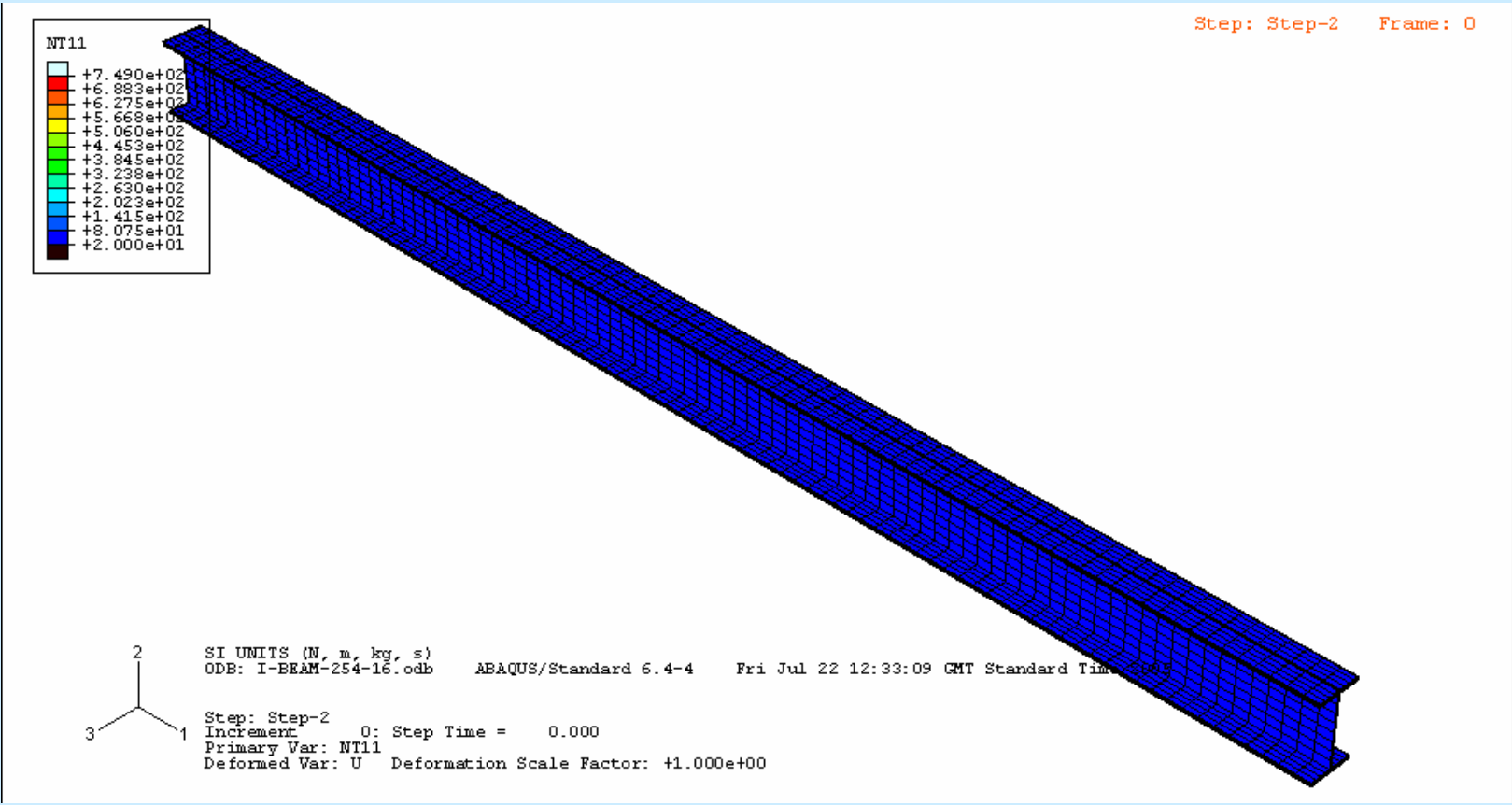
Comparison to the results of El-Rimawi, Test data and VULCAN





FEM Evaluation at Elevated Temperature

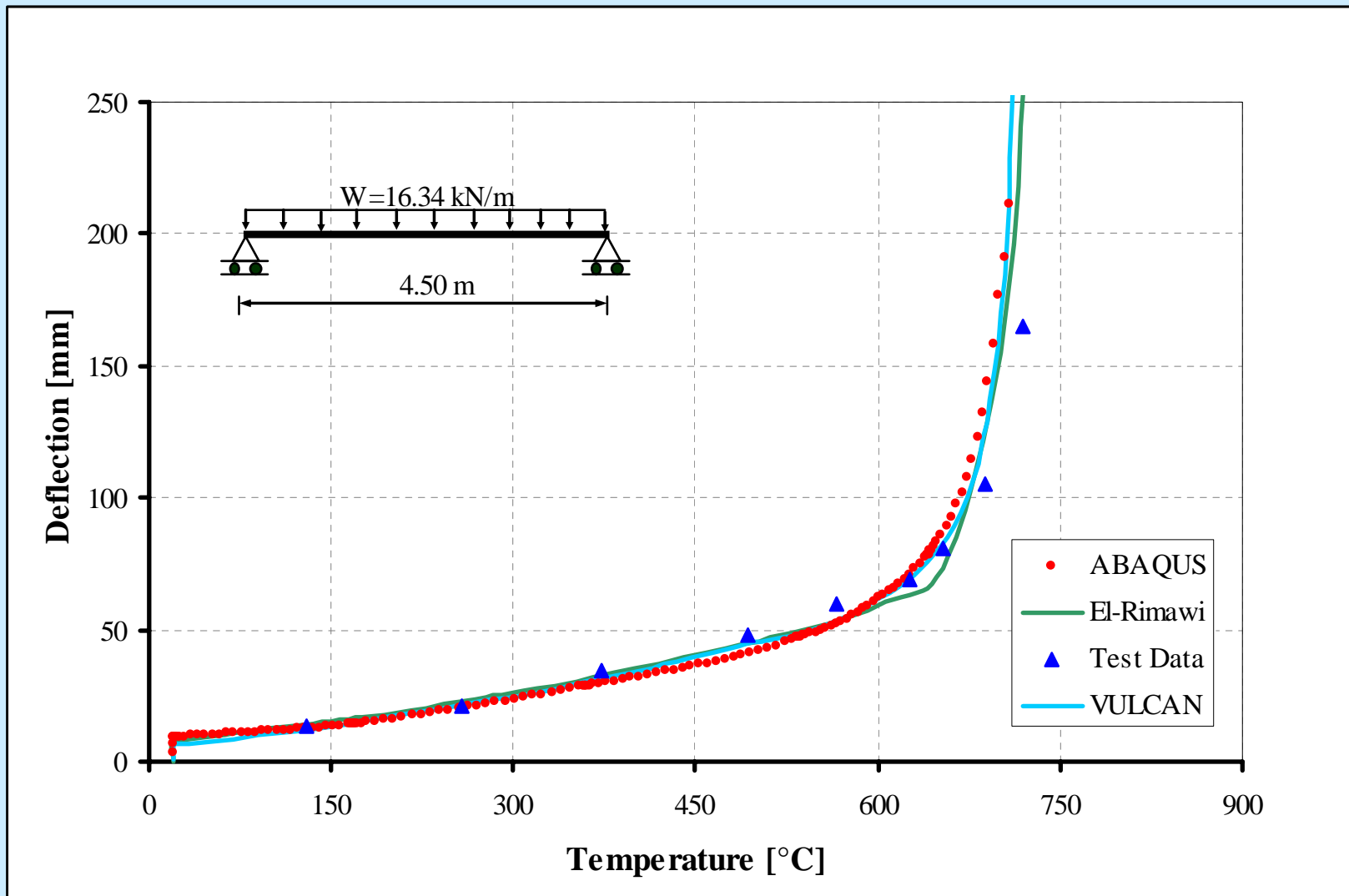
Comparison to the results of El-Rimawi, Test data and VULCAN





FEM Evaluation at Elevated Temperature

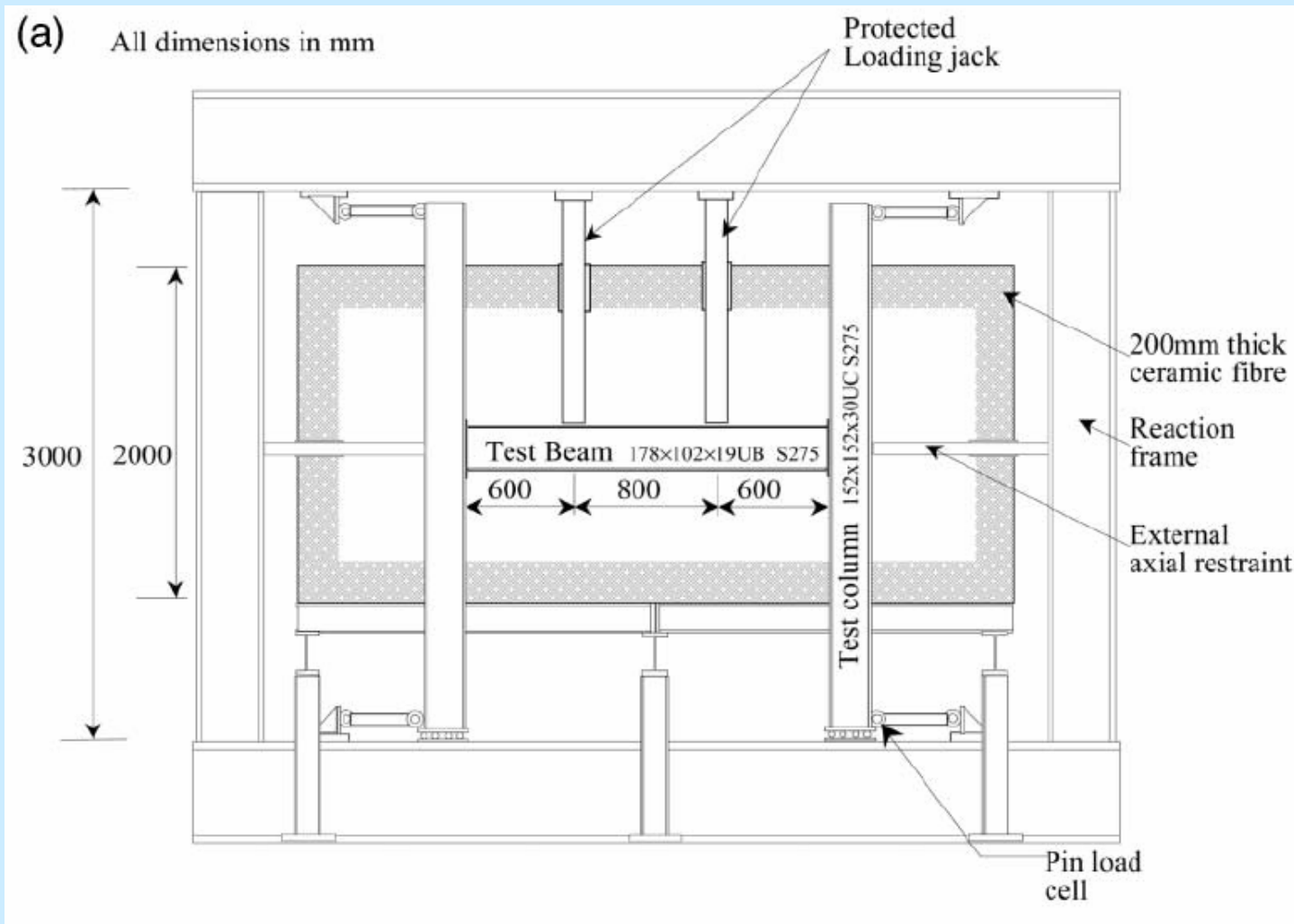
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FEM Evaluation at Elevated Temperature

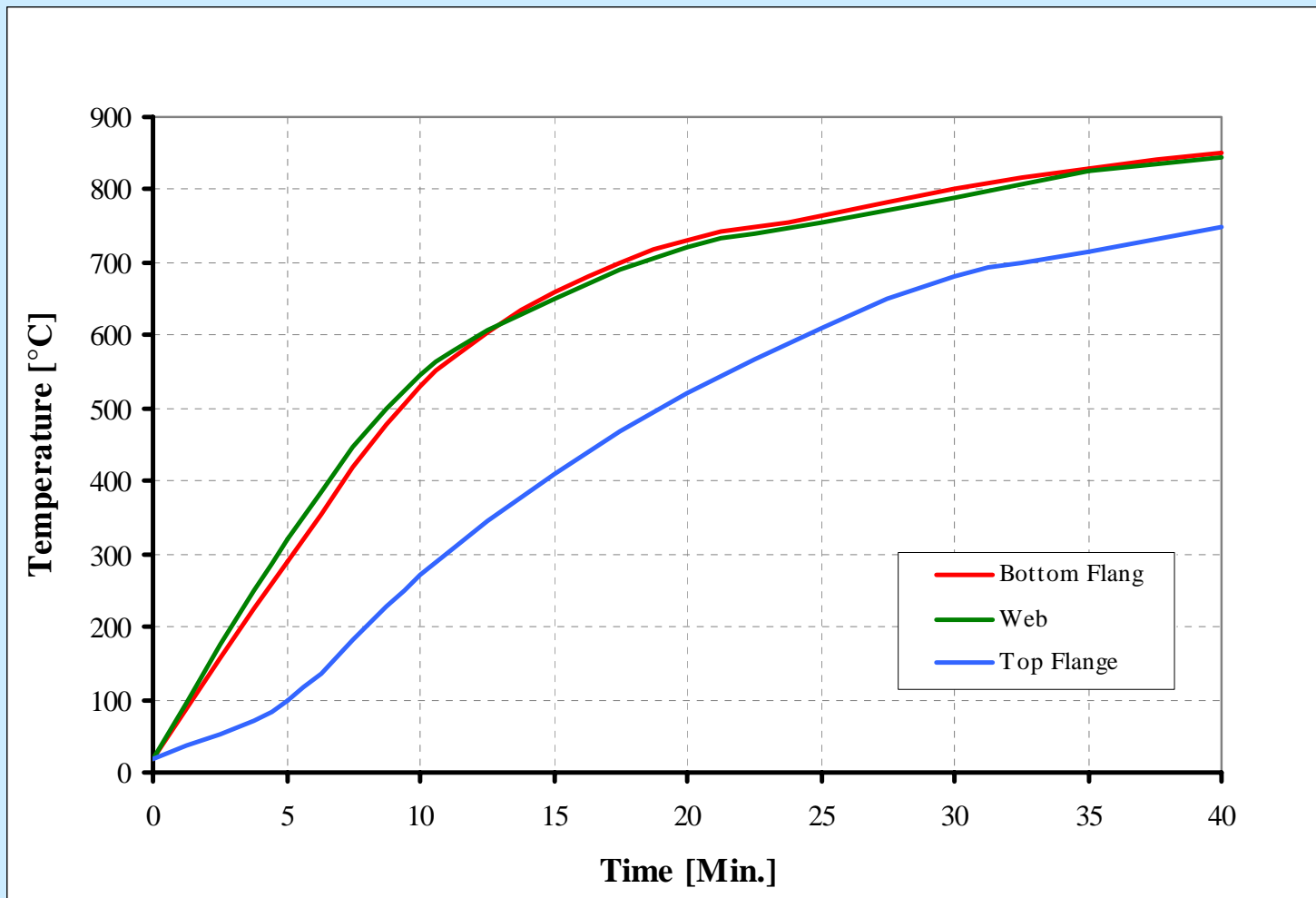
Comparison to the results of T. C. H. Liu and VULCAN





FEM Evaluation at Elevated Temperature

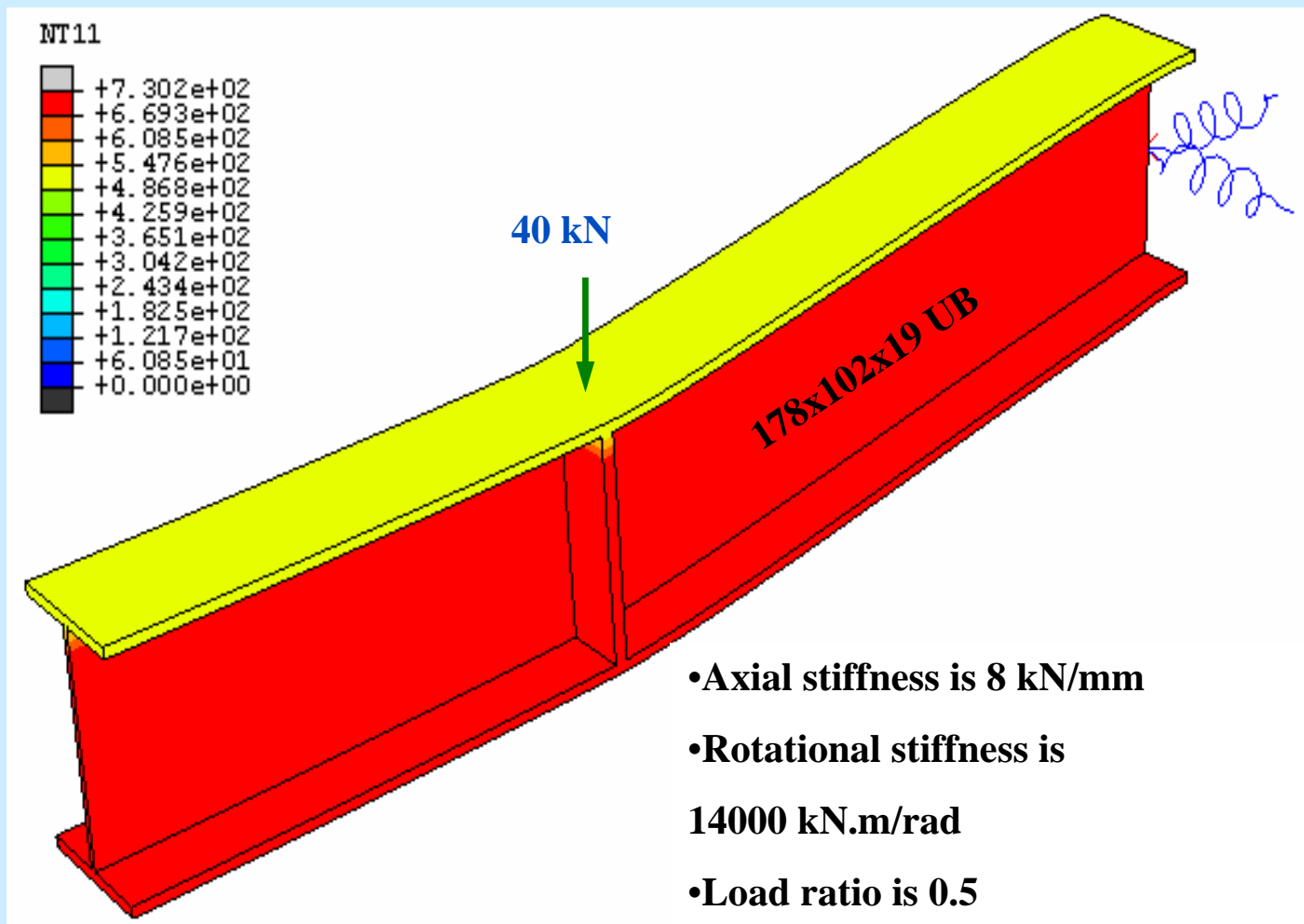
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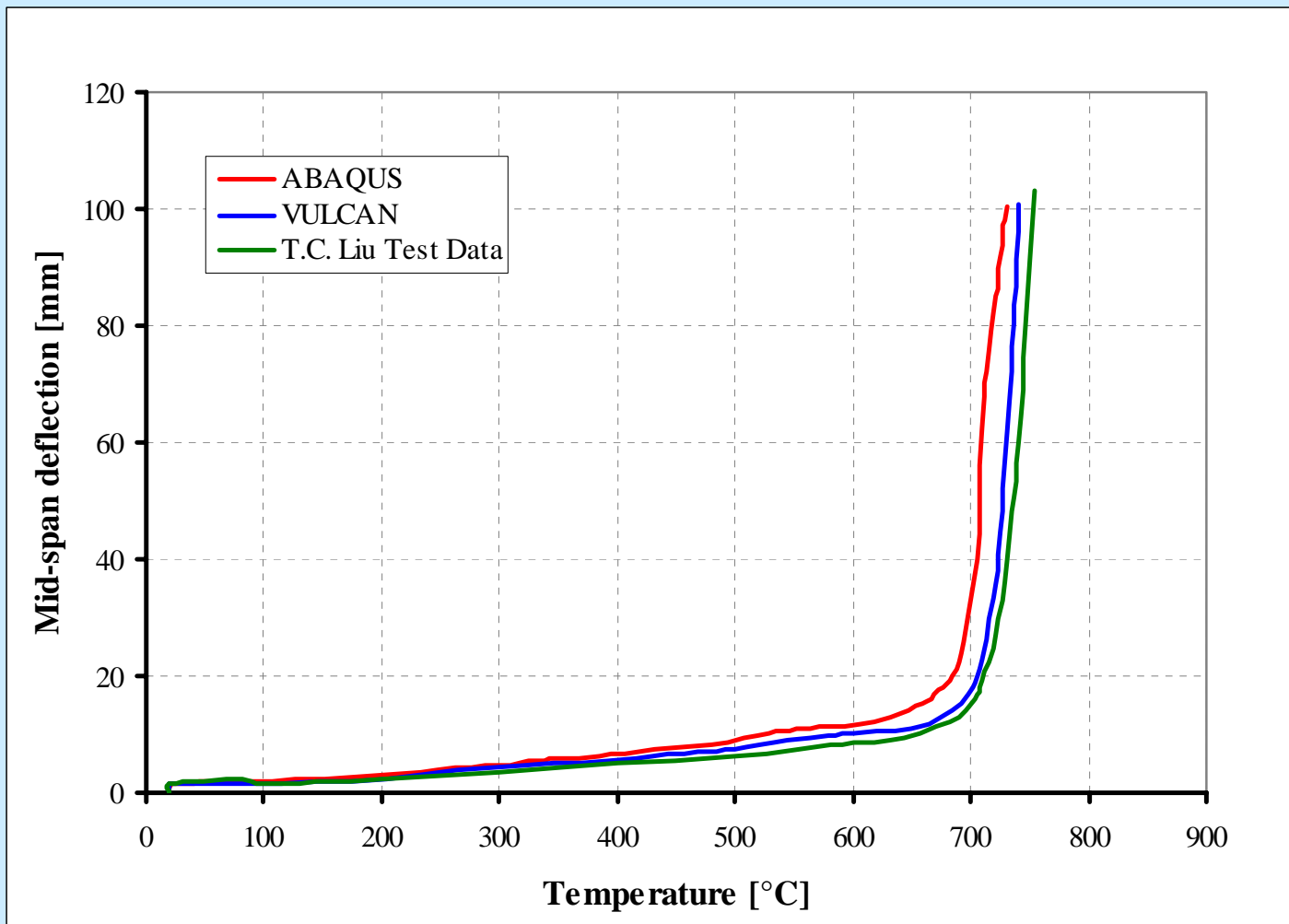
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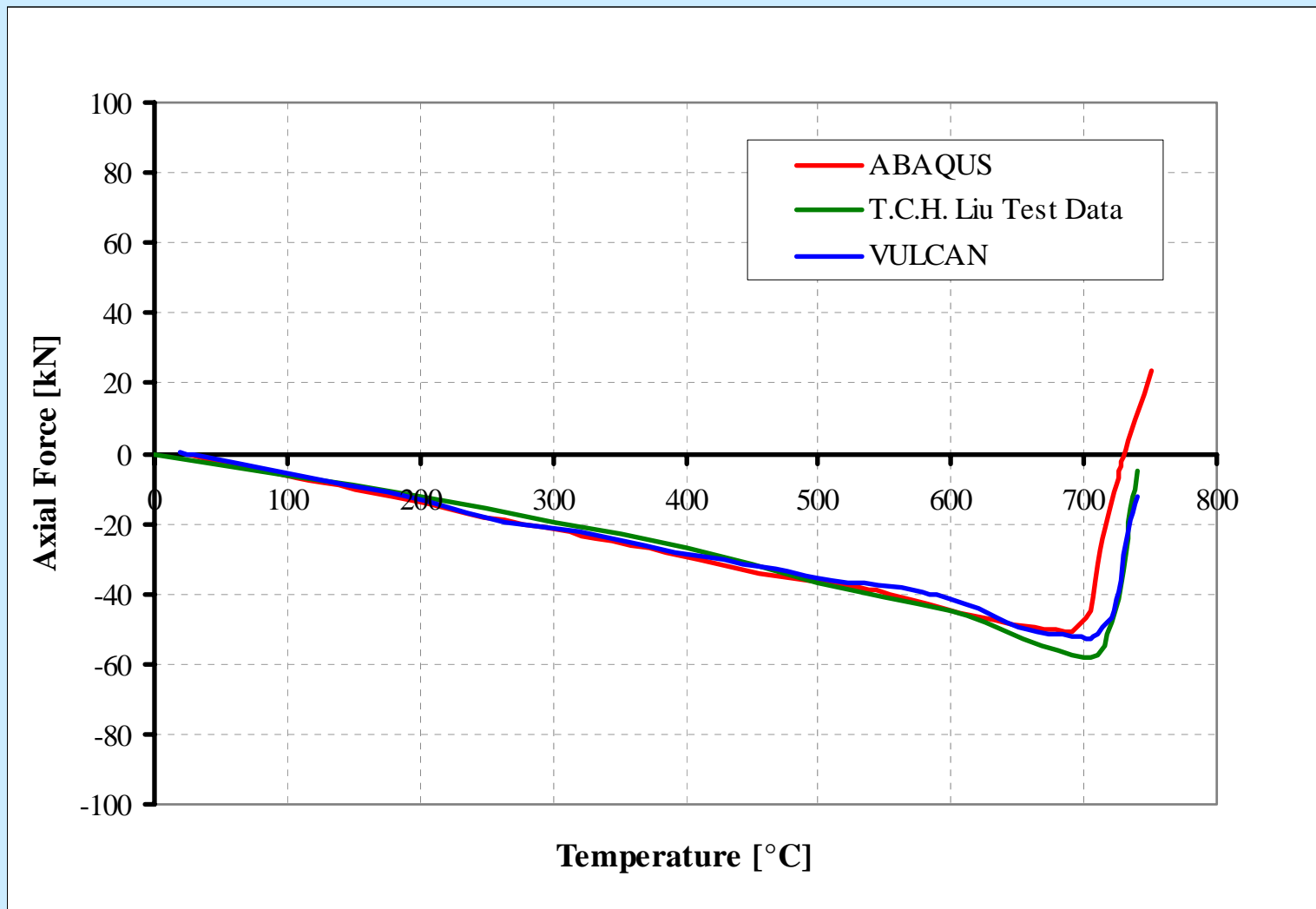
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FEM Evaluation at Elevated Temperature

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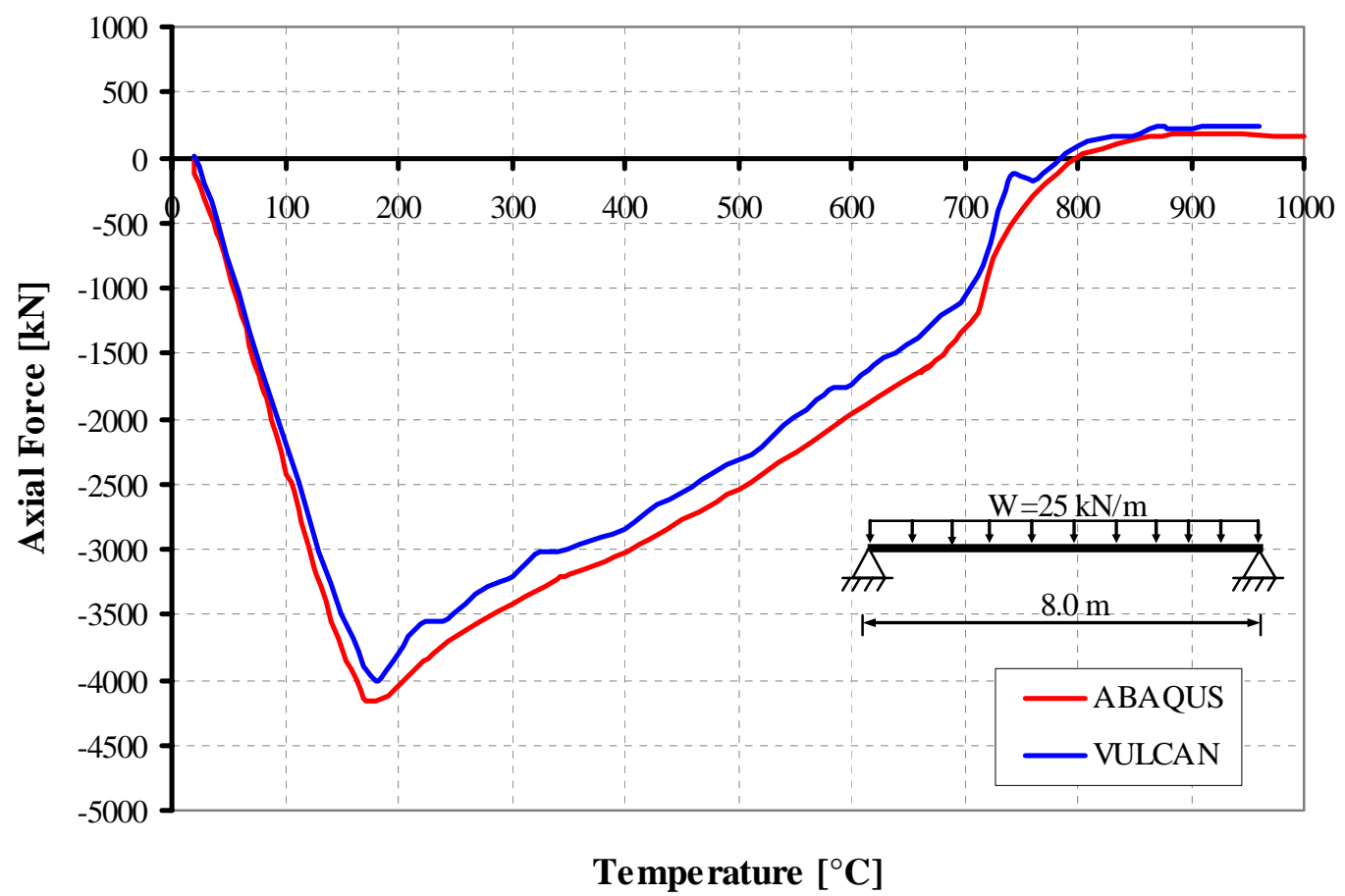




FEM Evaluation at Elevated Temperature

Comparison between the results of ABAQUS simulation and VULCAN for the pin ended beam (fully axially restrained)

Linear Time-Temperature 10°C/min. was used for this model

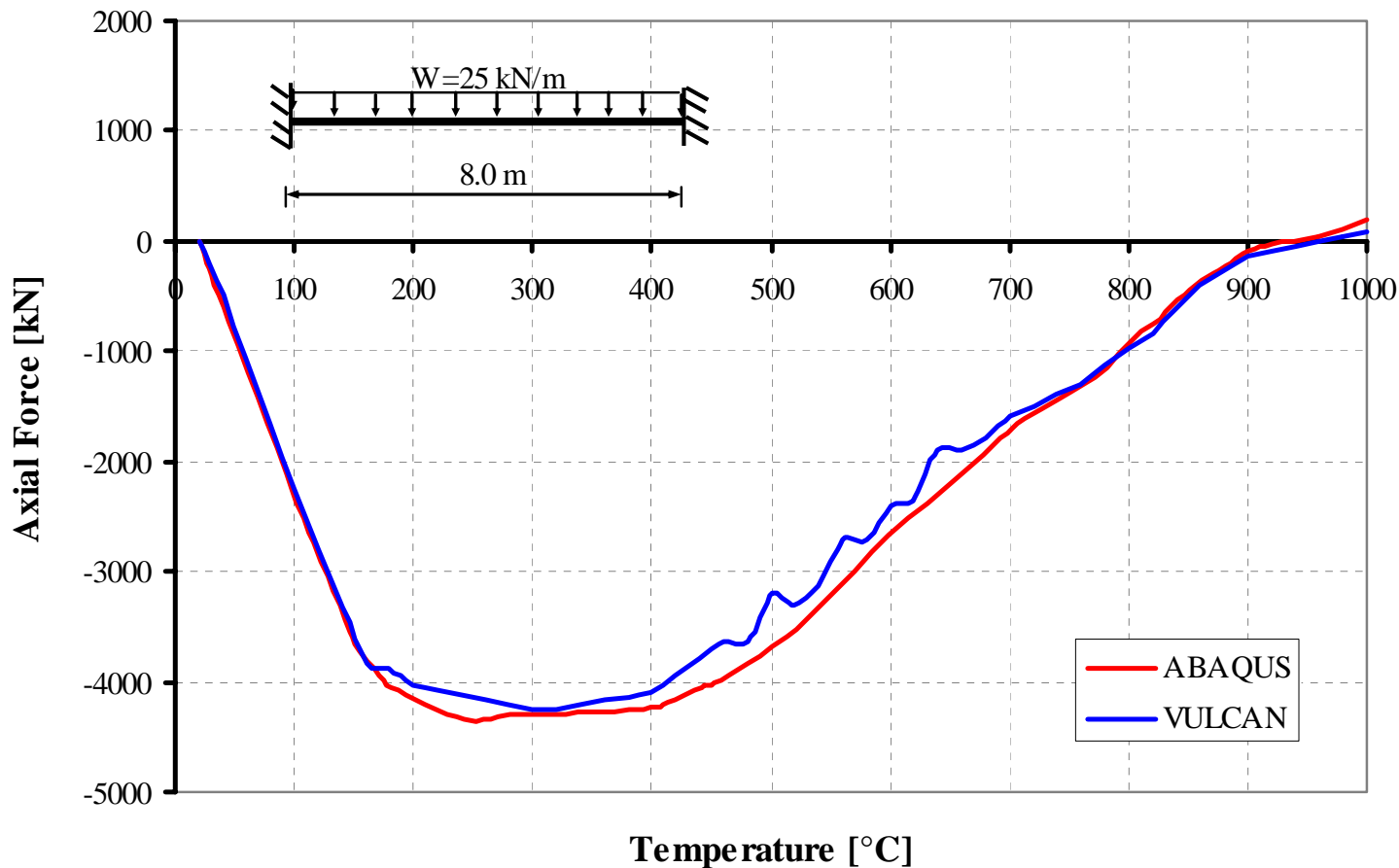




FEM Evaluation at Elevated Temperature

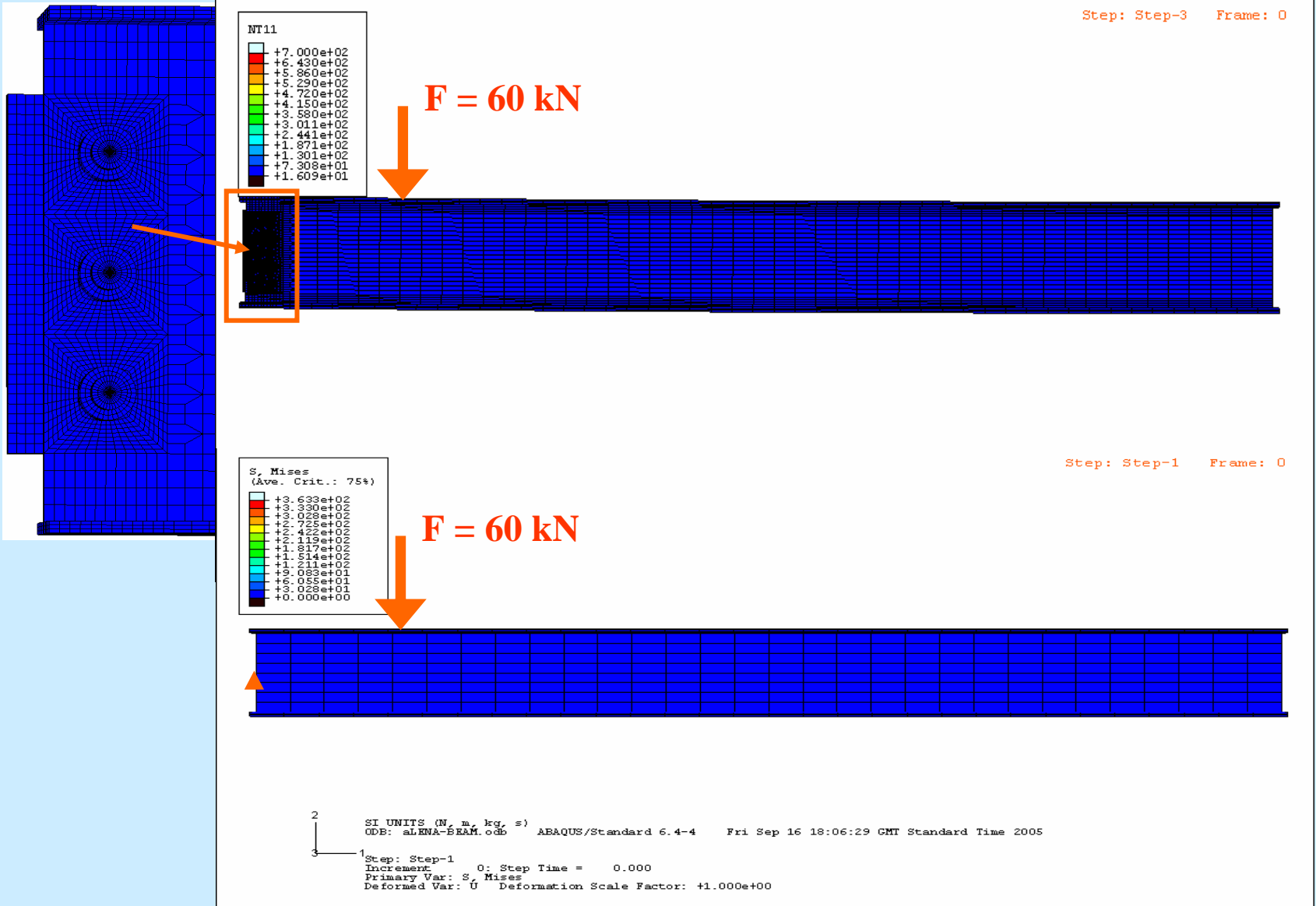
Comparison between the results of ABAQUS simulation and VULCAN for the fixed ended beam (rotationally and axially fully restrained)

Linear Time-Temperature 10°C/min. was used for this model



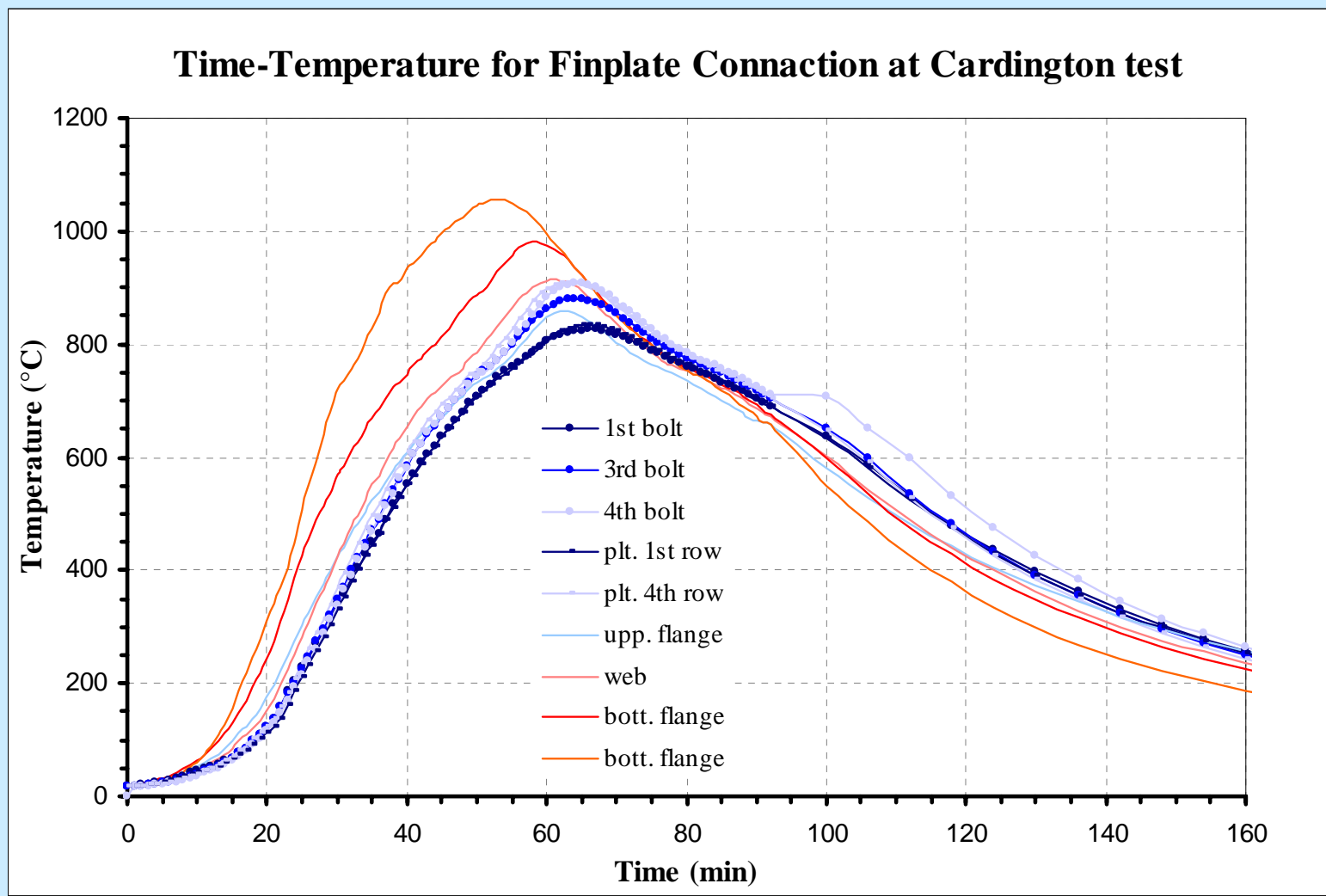


FEM of Beam-connection at Elevated Temperature



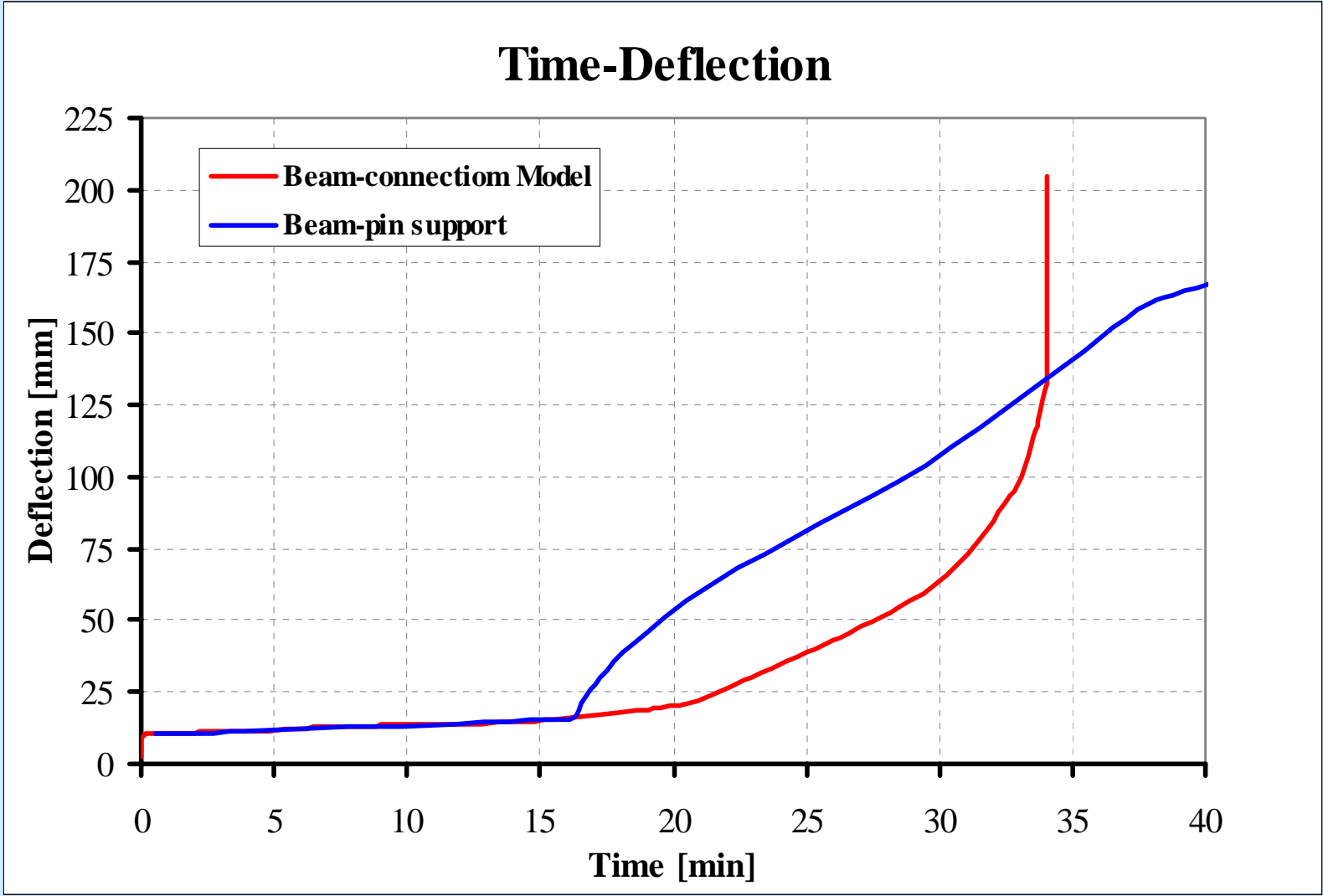


FEM Evaluation at Elevated Temperature





FEM of Beam-connection at Elevated Temperature





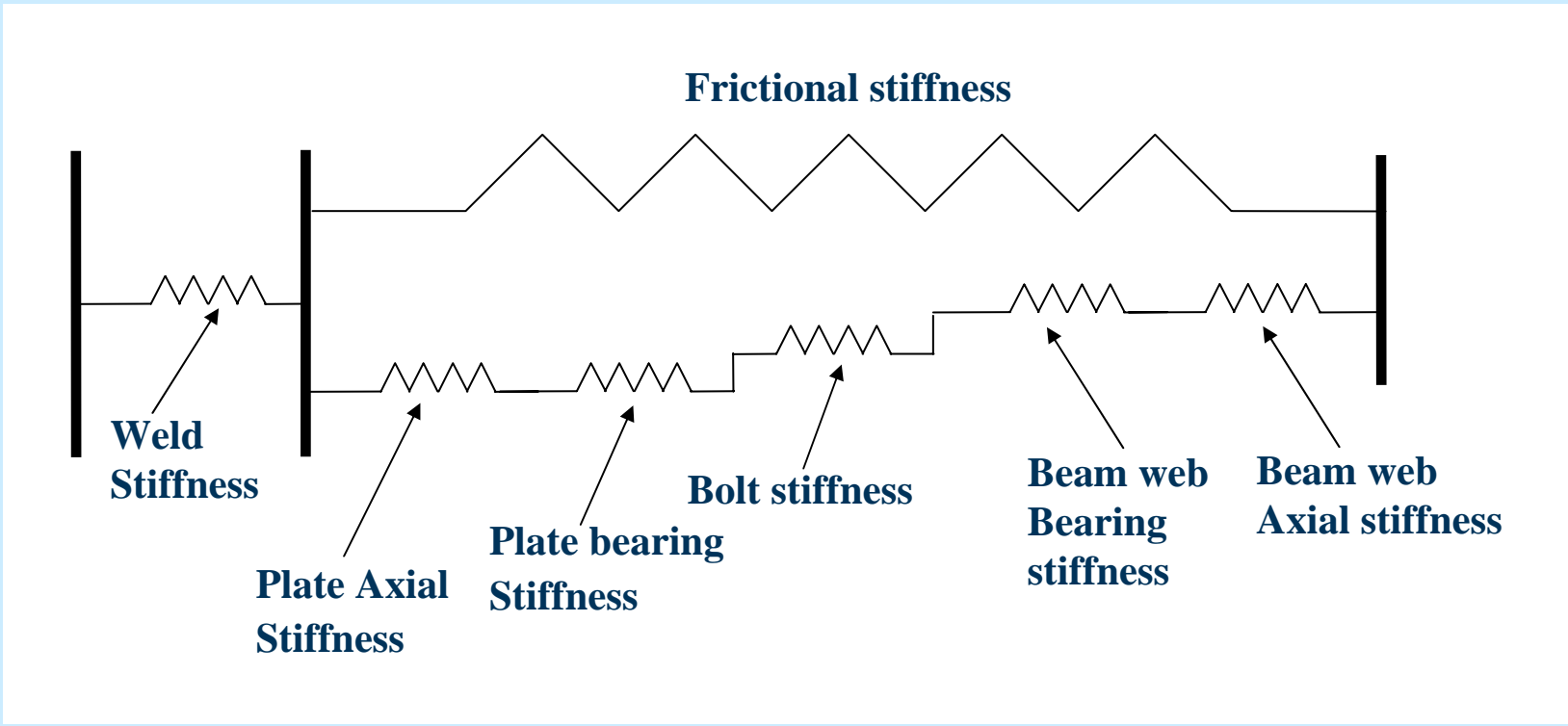
Conclusion

- **Creating a FEM of Fin Plate.**
- **Introduces contact element.**
- **Validated against test data.**
- **Account for temperature.**
- **Successfully modelled axially restrained beams and validated.**
- **Create a connection-beam model suitable for parametric study.**



What is next ?

Using the FE model to develop a simplified component model.





THANK YOU

For Your Attention

&

Welcome any Questions

or

Comments