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The influence of joint modeling on fire behaviour of steel frame structure



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Summary

- Analyses of steel frame structure in case of fire, carried out through 1D Finite Element Model, are sufficient to simulate the global behaviour, but it does not allow to take into account the joint behaviour.

1D Finite Element Model (SAFIR2011)
 pin-pin joints on beam

B-B
 350x350x8
 (S235)

3D Finite Element Model (STRAUS7)

pin-pin joints on beam

3D FEM including bolted joint modeling (STRAUS7)

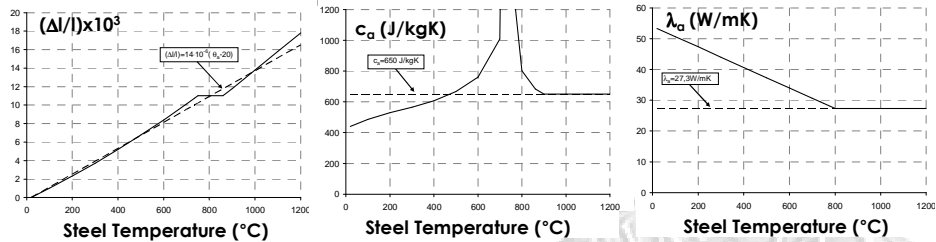
3D Finite Element Model, that includes the joint model, is capable to simulate the global structural behaviour taking into account the influence of the joint on stiffness and resistance.

A-A
 IPE300 (S235)

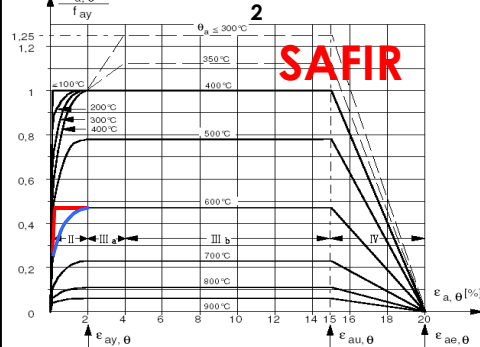
- The comparisons between the analyses results of steel frame structure exposed to fire, carried out through 1D and 3D Finite Element Model, including or less joints model, are shown in order to evaluate the influence of joint behaviour on the analysis results.

Comparison between thermo-mechanical properties

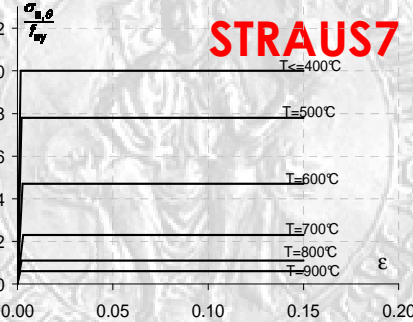
Steel thermal properties in accordance with EC3-1-2



Steel constitutive law in accordance with EC3-1-2

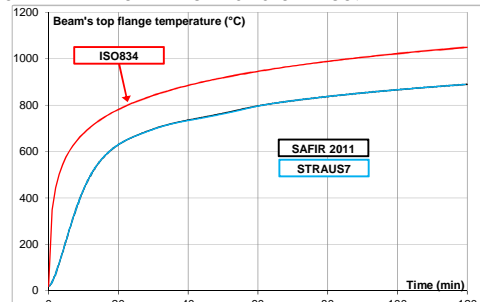
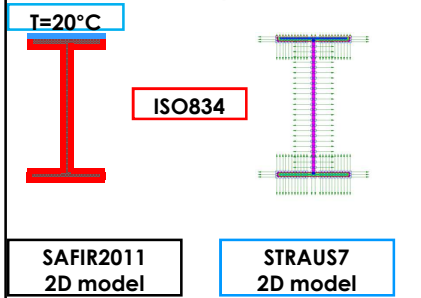


Simplified (elasto-plastic) constitutive law for steel at high temperatures

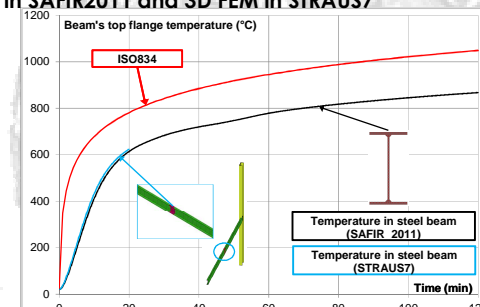
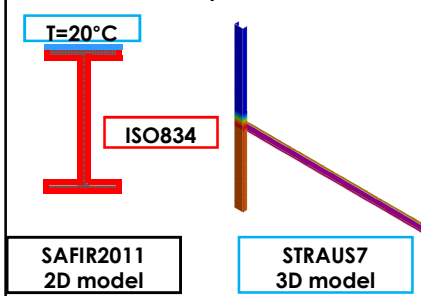


Thermal analyses results

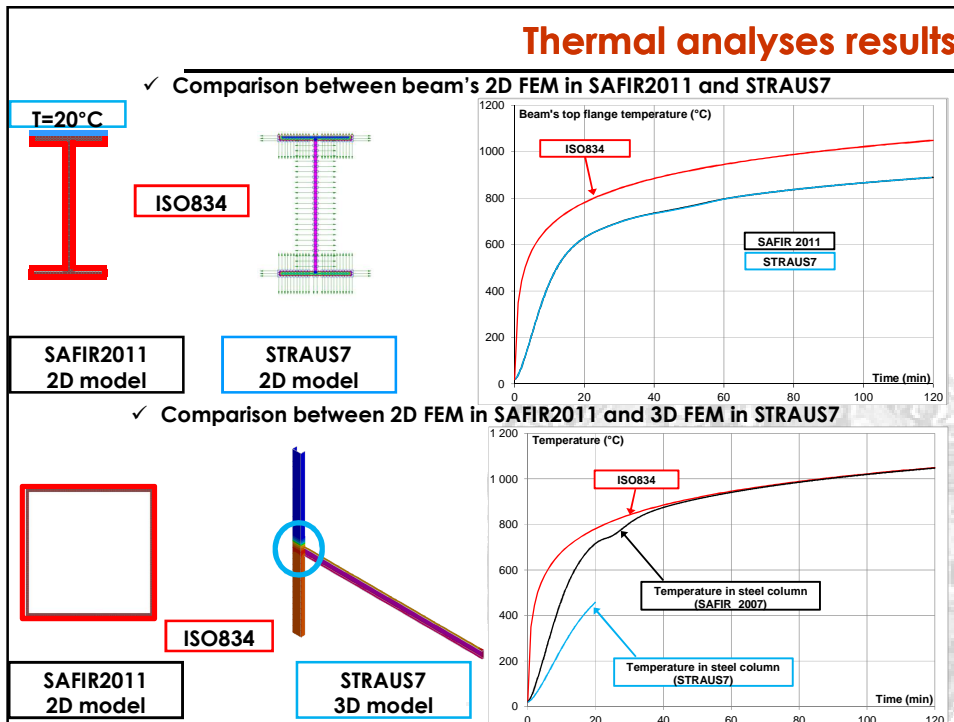
Comparison between beam's 2D FEM in SAFIR2011 and STRAUS7



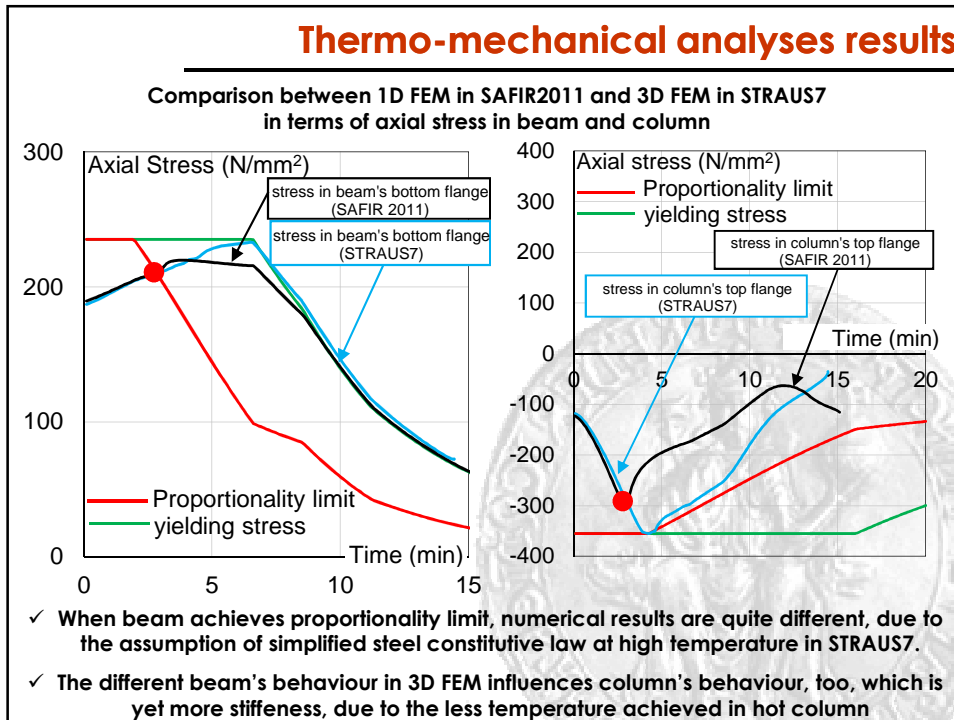
Comparison between 2D FEM in SAFIR2011 and 3D FEM in STRAUS7



Thermal analyses results

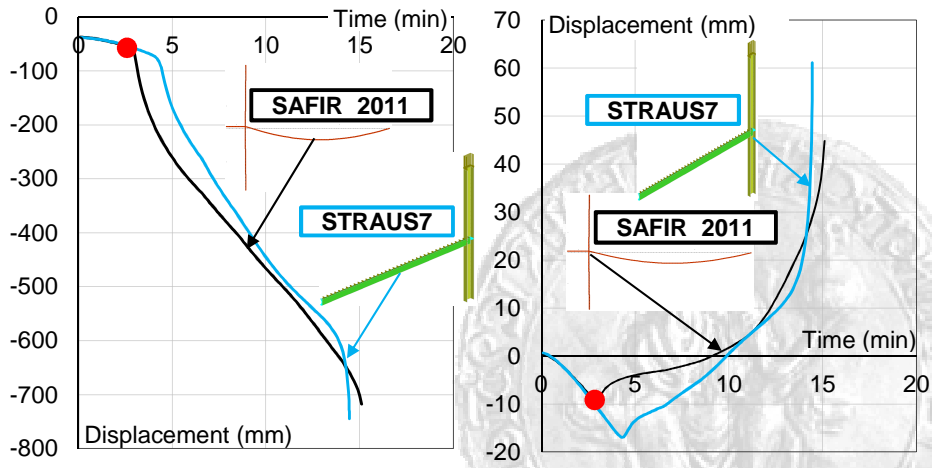


Thermo-mechanical analyses results



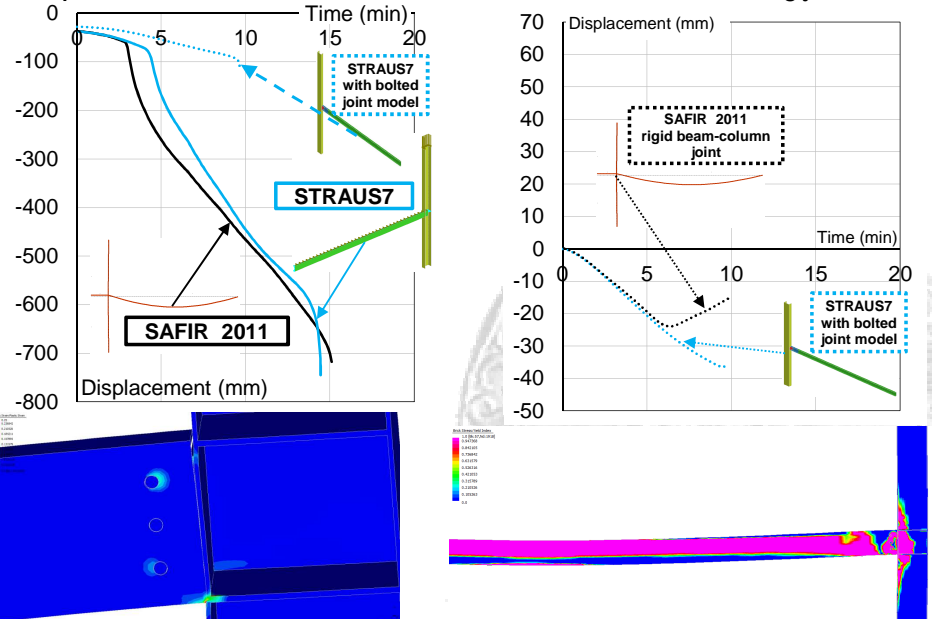
Thermo-mechanical analyses results

Comparison between 1D FEM in SAFIR2011 and 3D FEM in STRAU7
in terms of beam and column's displacement



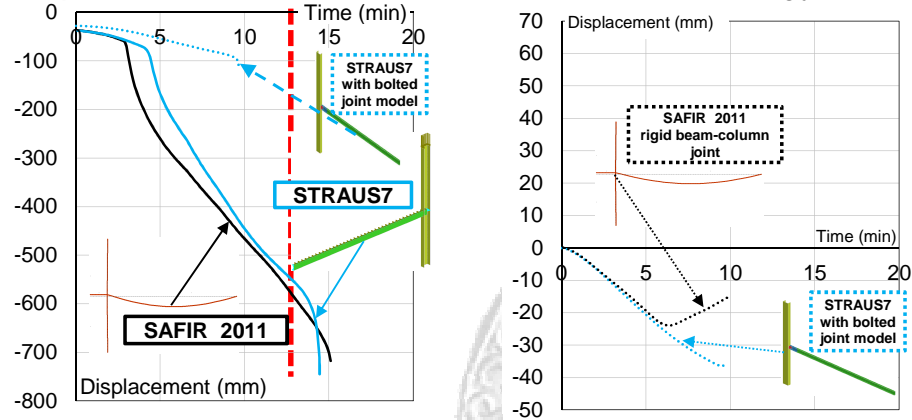
Thermo-mechanical analyses results

Comparison between 1D FEM in SAFIR2011 and 3D FEM in STRAU7, including joint model



Thermo-mechanical analyses results

Comparison between 1D FEM in SAFIR2011 and 3D FEM in STRAUS7, including joint model



Simplified check of joint
(EC3-1-2)

Conclusions

- ✓ The comparison in terms of thermal analyses results of beam's 2D and 3D FEM shows the complete agreement between the SAFIR 2011 and STRAUS7 model
- ✓ The comparison in terms of thermal analyses results of column's 2D and 3D FEM shows quite differences, due to longitudinal column's heat transfer, that it can't be take into account in 2D FEM.
- ✓ In terms of thermo-mechanical results, when structural elements achieve proportionality limit, numerical results become quite different, due to the assumption of simplified steel constitutive law at high temperature implemented in STRAUS7
- ✓ 3D FEM, including joint model, exhibits behaviour quite similar to SAFIR 1D FEM, with beam-column rigid joint
- ✓ Nevertheless, 1D and 3D FEM show the same failure time

Thanks for your attention

