Fire resistance of steel trusses in fire using OpenSees

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Background

Why *OpenSees*? OpenSource (free) and Object oriented framework, Multi-hazard

Total Lagrangian and *Co-rotational* element formulations have been implemented which account for phenomena experienced in a real fire:

- geometric nonlinearity caused by large displacements
- material nonlinearity due to the stiffness and strength reduction

Analysis of structures in fire is performed into two load steps

- The mechanical load applied and remains constant
- Thermal load

Usually Newton-Raphson method (load controlled)

Background

For each load step during the analysis an incremental displacement is found: $\{\Delta F\} = [K]\{\Delta u\}$

- ➢Cannot follow the equilibrium path beyond the limit points
- ➢For redundant structures local failure does not imply global failure
- ➢Dynamic procedure for tracing post buckling path

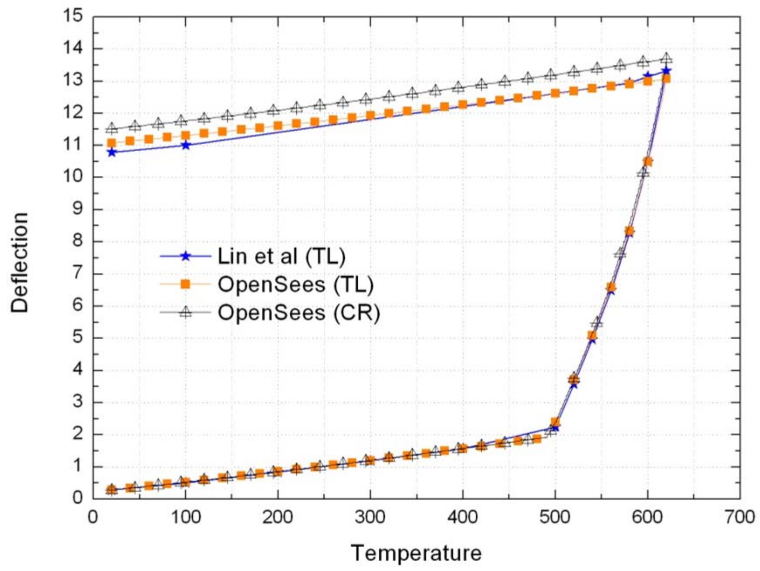
Material degradation: reduction of material properties like Young's modulus and Yield Stress

- ✓*Steel01Thermal*: Uniaxial bilinear steel material with kinematic hardening
- ✓*Steel02Thermal*: Uniaxial Giuffre-Menegotto-Pinto steel material with isotropic strain hardening.

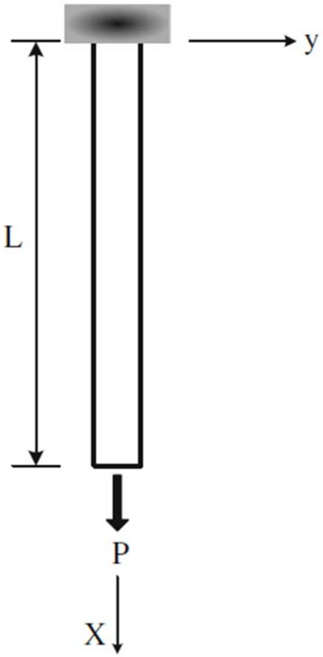
Numerical examples

One member truss

- ❑Solved by Lin et al.
- ❑Both TL and CR employed
- ❑DT= 1°C
- ❑Heating and cooling



Yielding occurs at around 500°C



- ➢ The comparison shows very good agreement
- ➢ Strain hardening does not have significant effect
- ➢ Both formulations present similar results

Two Member Truss

- ❑Lin et al (2010) using Generalised Displacement Control (GDC)
- ❑Loses stability through snap-through buckling
- ❑*Dynamic* procedure was followed

❖ Truss deflects upwards but when the members have yielded changes direction towards the other side

❖ Preloading plays a role in the behaviour of the truss