ASSIGNMENT – FIRE MODULE

"OpenSees, the Open System for Earthquake Engineering Simulation, is an **object-oriented**, **open-source** software **framework**. It allows users to create both serial and parallel finite element computer applications for **simulating** the response of structural and geotechnical **systems** subjected to **earthquakes and other hazards**."

https://opensees.berkeley.edu/wiki/index.php/Main_Page

OpenSees is a collection of objects for structural analysis. Similar to a Matlab toolbox, or a Python package.

OpenSeesPy

Source: https://openseespydoc.readthedocs.io/en/latest/src/thermal.html

14.5.1. Restrained beam under thermal expansion

1. The original model can be found here.
2. The Pypton source code is shown below, which can be downloaded here.
3. Make sure the numpy and matplotlib packages are installed in your Python distribution.
4. Run the source code in your favorate Python program and should see

OpenSees for Fire

Free download: https://openseesforfire.github.io/

OPENSEES FOR FIRE

View the Project on GitHub
OpenSees@GitHub

View People
OpenSees for Fire Group

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ResearchGate

OpenSees

SFPE Hong Kong Student Chapter

This project is maintained by JIANG Liming

About

The OpenSees development for modelling 'structures in fire' was first started at University of Edinburgh in 2009. A number of students and researchers worked on this long-term project with their own contributions which enable OpenSees to perform analyses for 'structure in fire' including heat transfer ,thermo-mechanical analyses, and integrated analyses. [See it on Researchgate Project] [OpSees for fire Roadmap]

Check our specific topics of OpenSees for fire:
Heat Transfer -|- **Hybrid Fire Testing** -|- **OpenFire**

Users (command|examples)

A number of web pages are constructed to offer the users a detailed guidance to the recently added capabilities within OpenSees

Workshops

The onoging and the past Workshops of OpenSees for fire introducing the latest development and features

Developers

A detailed description of all the new or modified classes developed for enabling thermomehcanical analyses in OpenSees.

General steps in pre-processing

1. Clear objects
2. Define dimensions and DOFs
3. Materials
4. Nodes
5. Boundary conditions
6. Nodal masses
7. Elements
8. Define special output
9. Apply gravity load
10. Apply fire demand (structural temperature-time history)

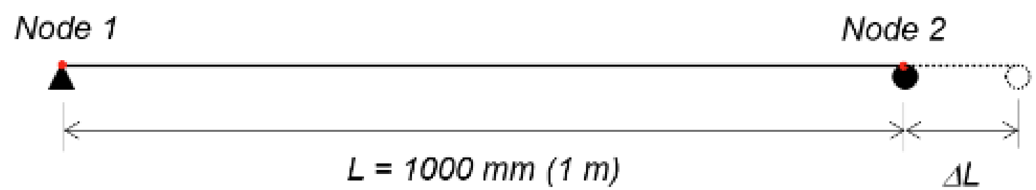
NSF NHERI SimCenter

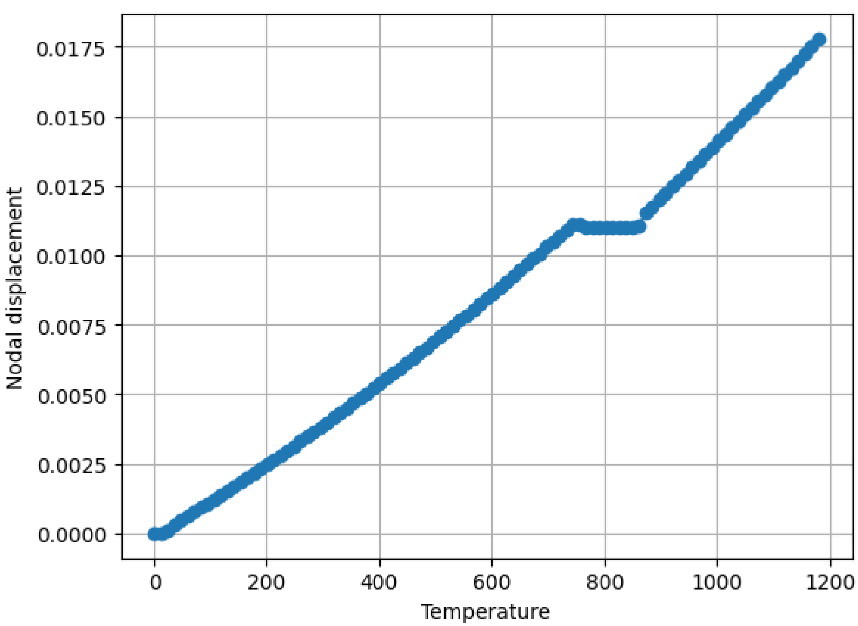
Differences in commands in structural analysis:

- Material library: Steel01Thermal, Concrete01Thermal
- Section: FiberThermal
- Element type: dispBeamColumnThermal
- Element fire loading pattern:
    - eleLoad('-ele', i, '-type', '-beamThermal', 500.0, -0.165, 30.0, 0.165)

Validation: Thermal Expansion

A steel beam (IPE 330 section) is heated to 1180 ° C. Horizontal displacement of right end (Node 2) is monitored. This displacement is normalized against the original length and plotted against the beam temperature. The calculated thermal expansion is compared against Eurocode 3, Part 1-2 steel temperature-dependent thermal expansion .





Eurocode 3, part 1-2

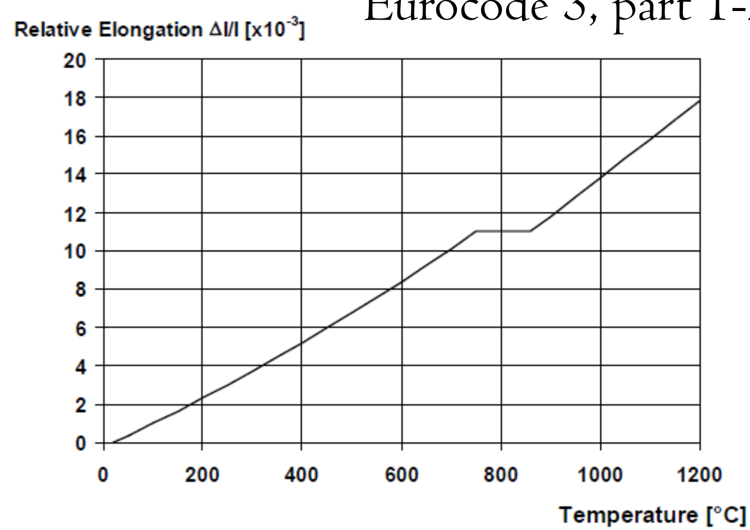
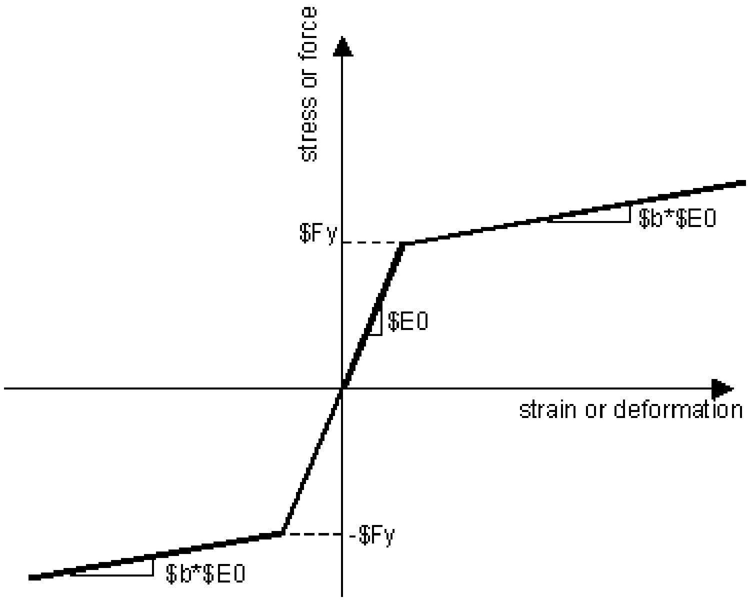
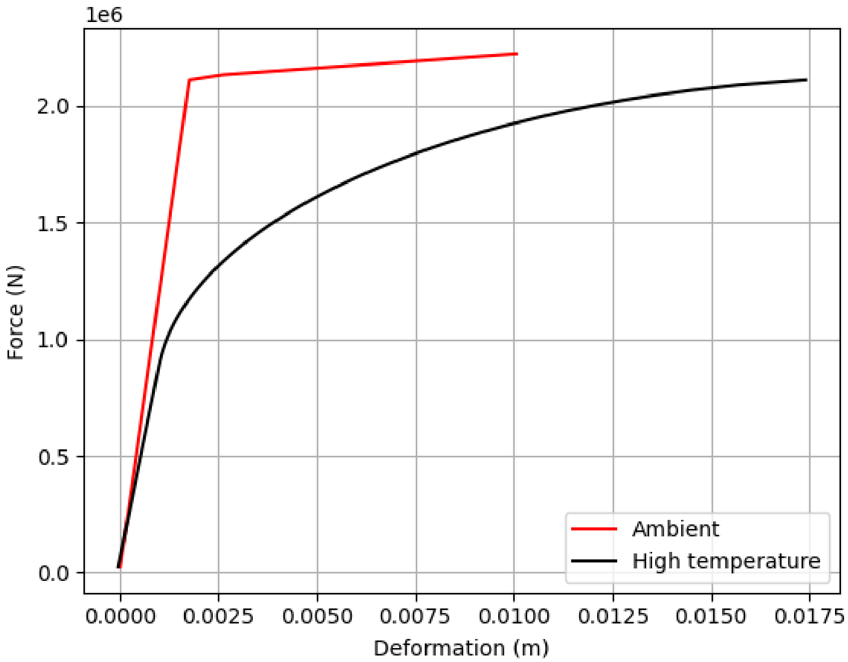


Figure 3.3: Relative thermal elongation of carbon steel as a function of the temperature

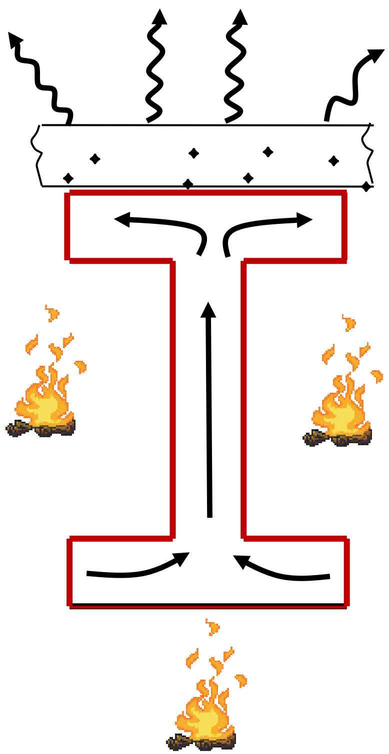
Validation: Material Degradation

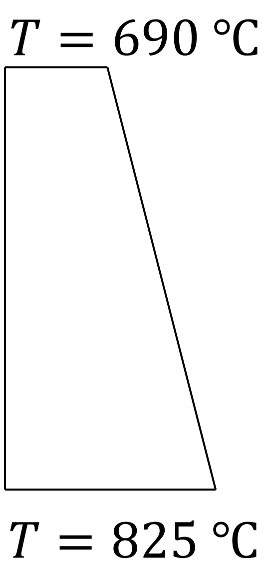
In Scenario A, IPE 330 steel beam at room temperature is first subjected (incrementally) to its axial yield load $\boldsymbol{P_y}$ at Node 2 as shown. The load-deformation of Node 2 is compared to Steel01Thermal material behavior. Young's modulus and yield stress of steel are $E = 200\ GPa$ and $\sigma_Y = 355\ MPa$, respectively. In Scenario B, the beam is first heated to $400\ °C$ and then subjected to the same load $\boldsymbol{P_y}$. Two cases are compared to each other.



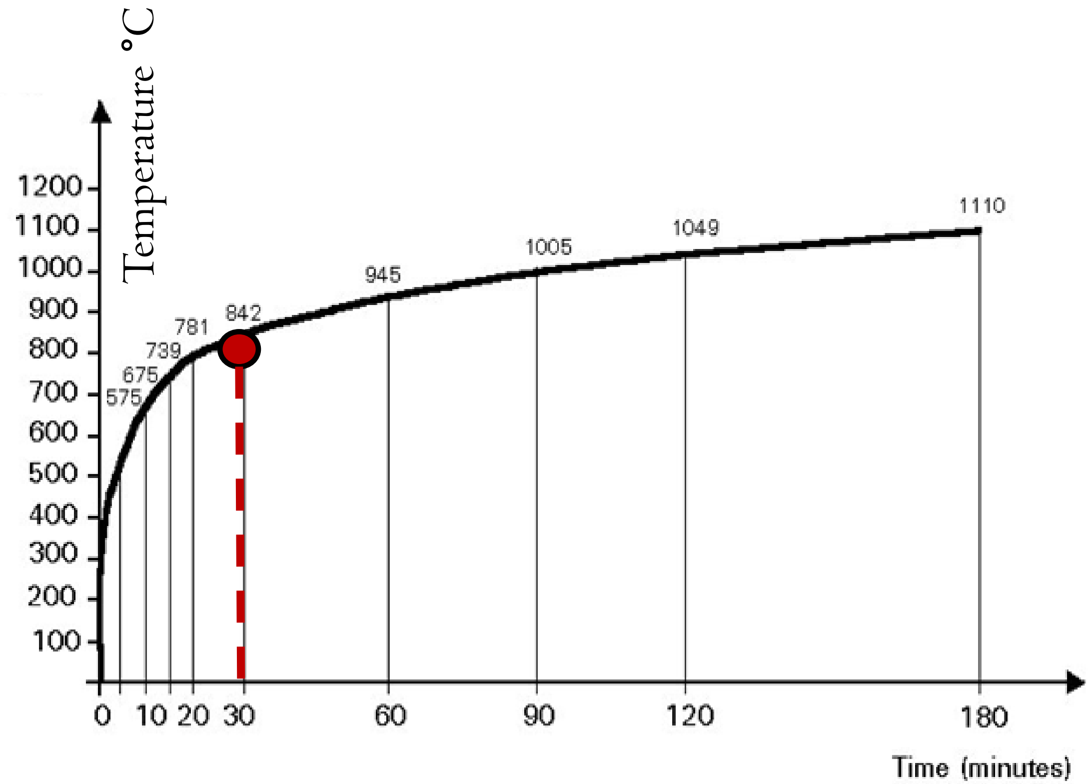


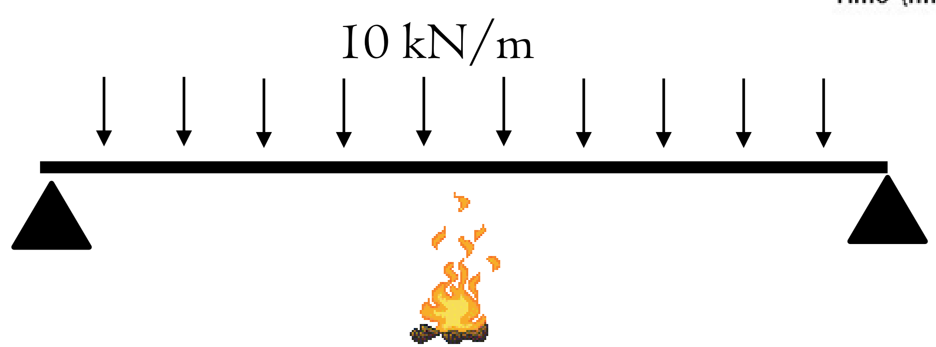
Assignment: Beam under Fire





IPE 330





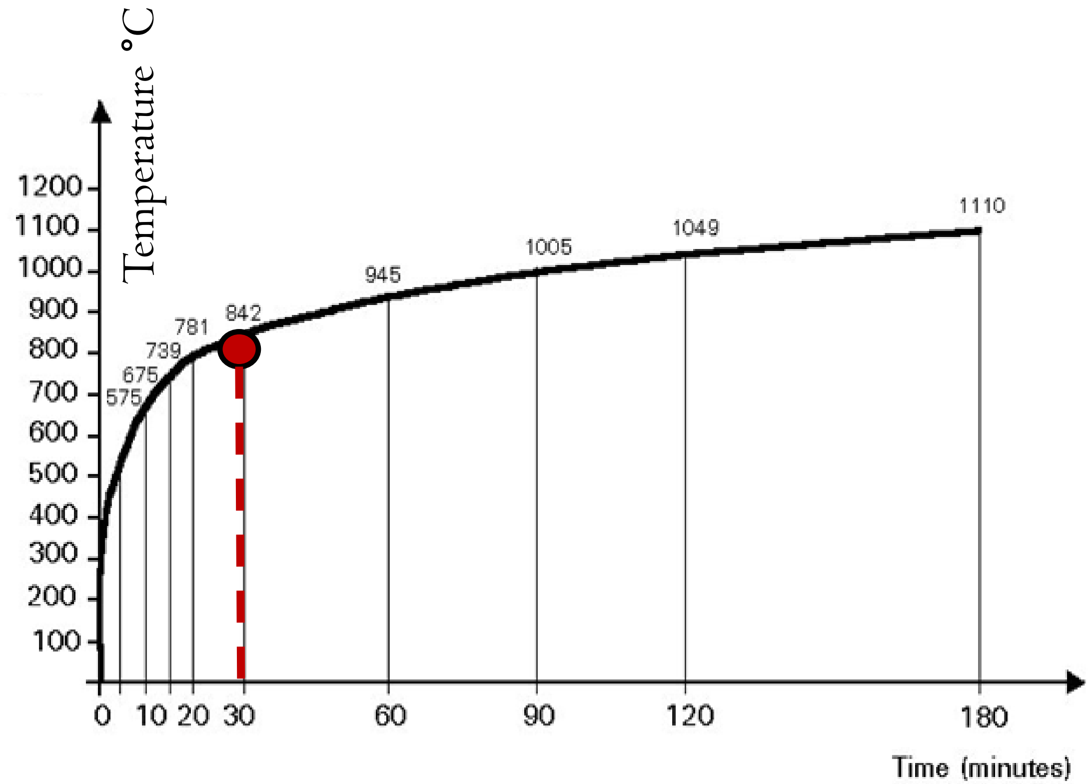
Assignment: Beam under Fire

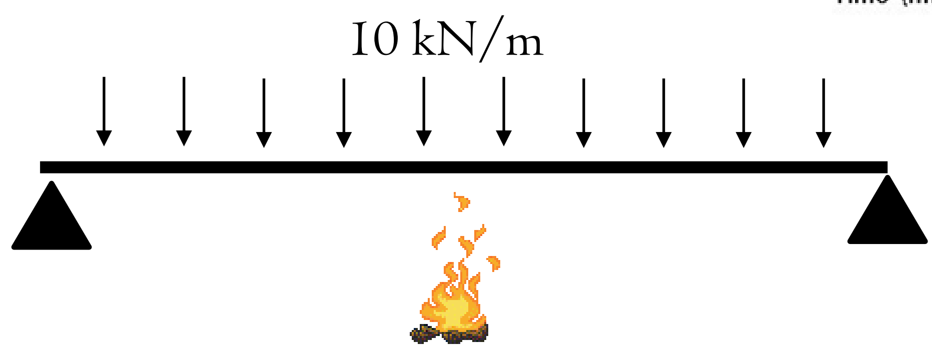
Effect of boundary conditions

- Pin-roller
- Pin-pin
- Fix-fix

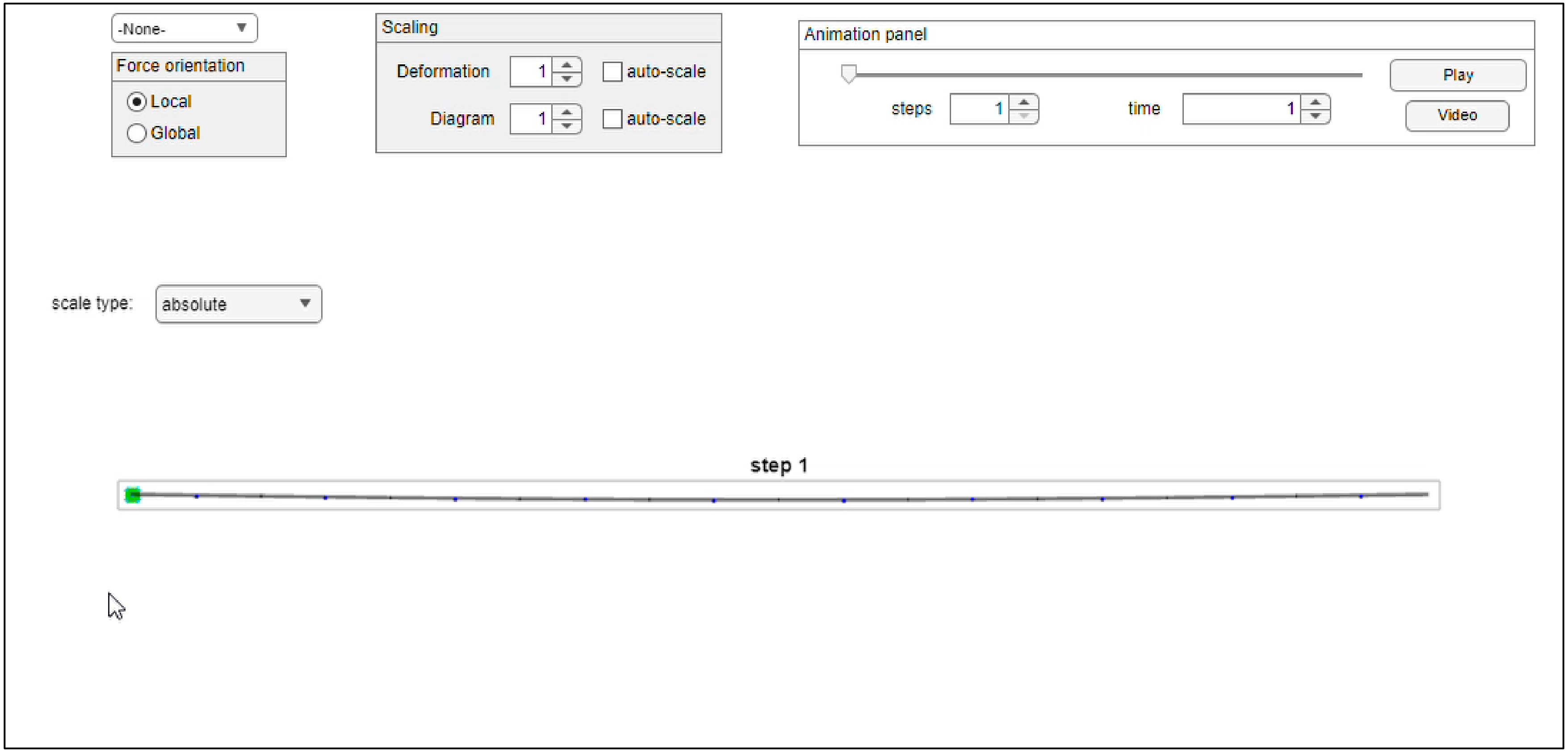
Initial utilization ratio ($@\ t = 0$)

- Low load
- High load

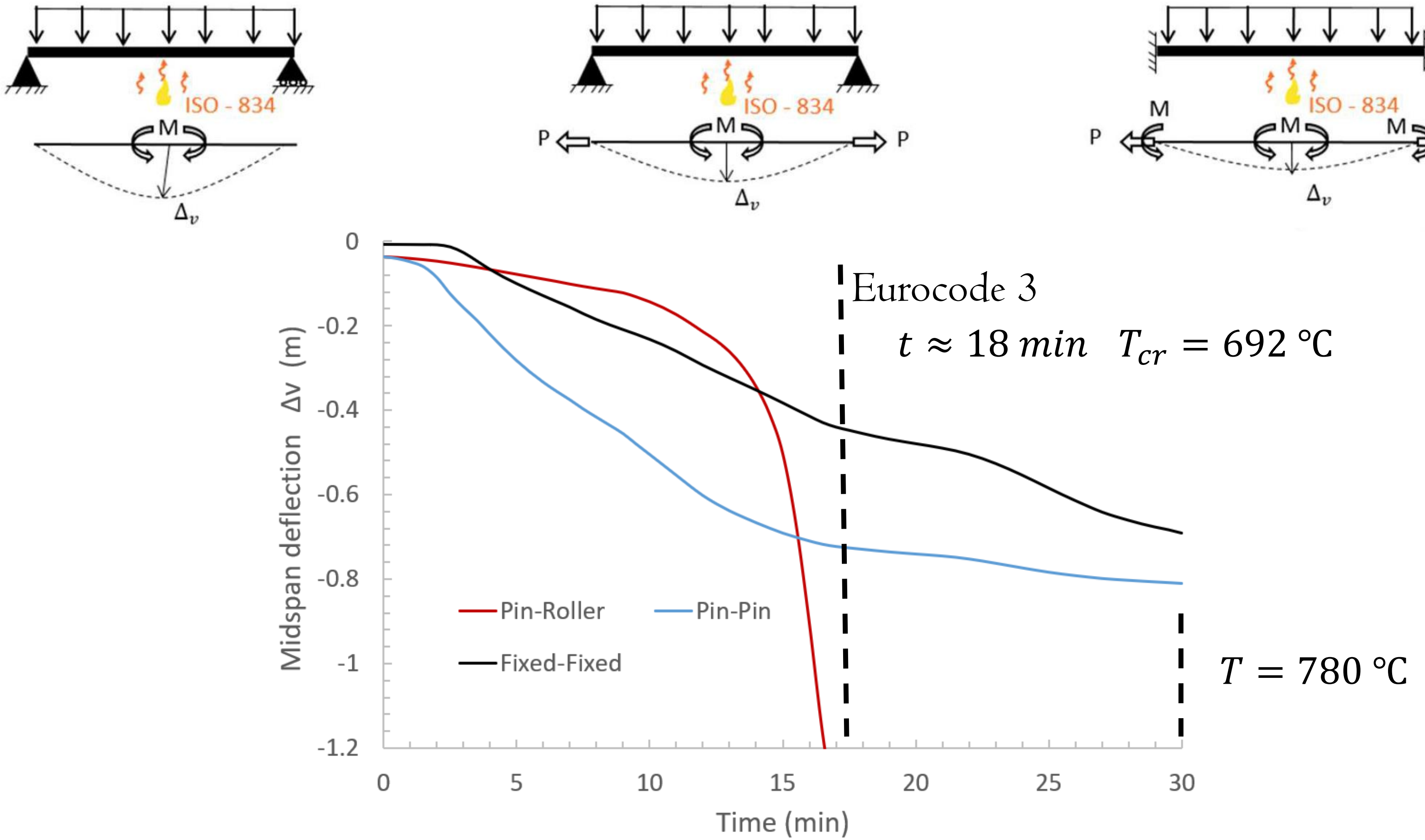




Structural Fire Behavior



Importance of restraints



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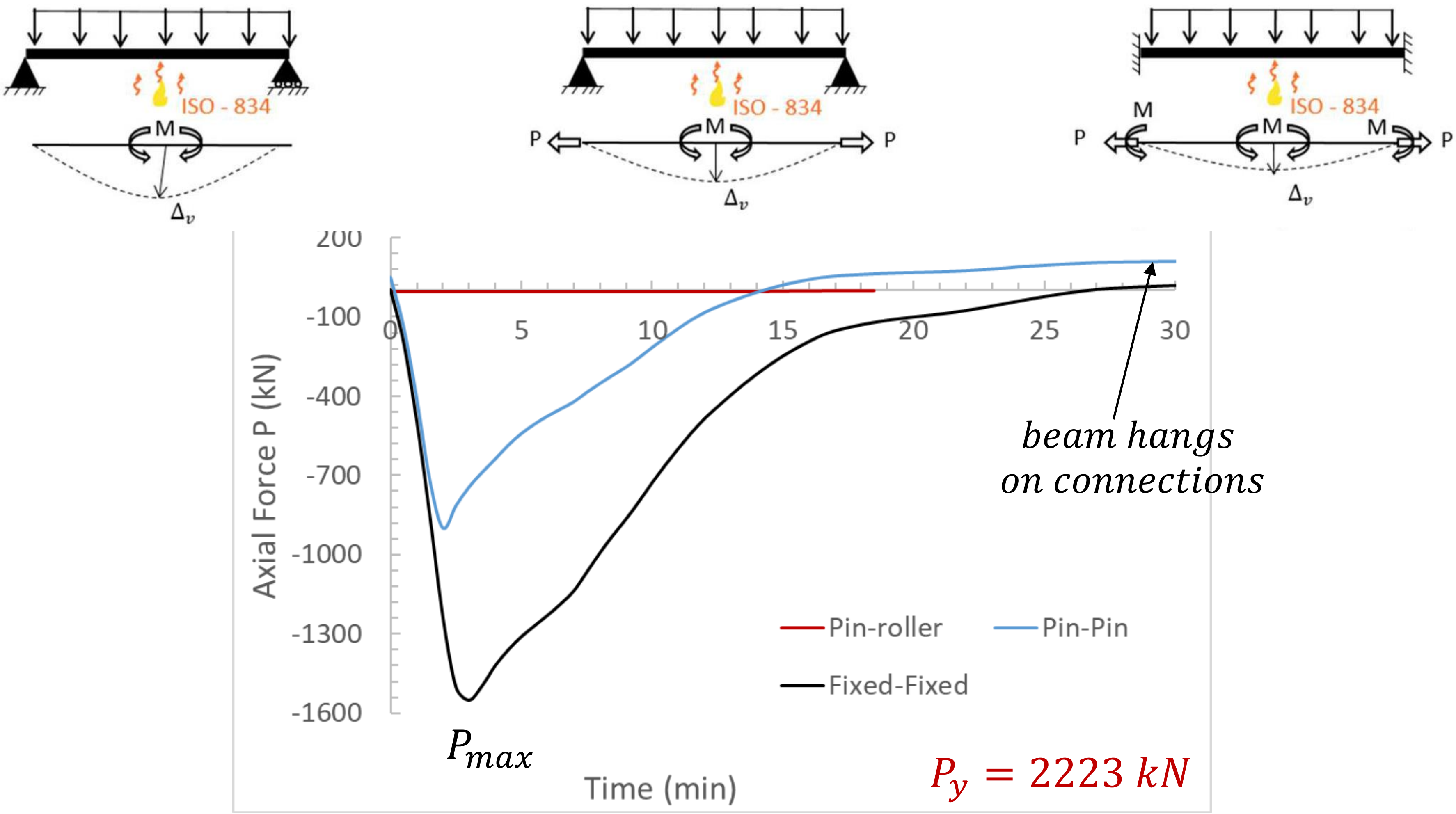

Importance of restraints