University
of Ljubljana

Faculty
of civil and
geodetic engineering

BENCHMARK STUDIES OF
AXIALLY LOADED RC COLUMNS

COST Action TU0904

Advanced Fire Engineering in Practice

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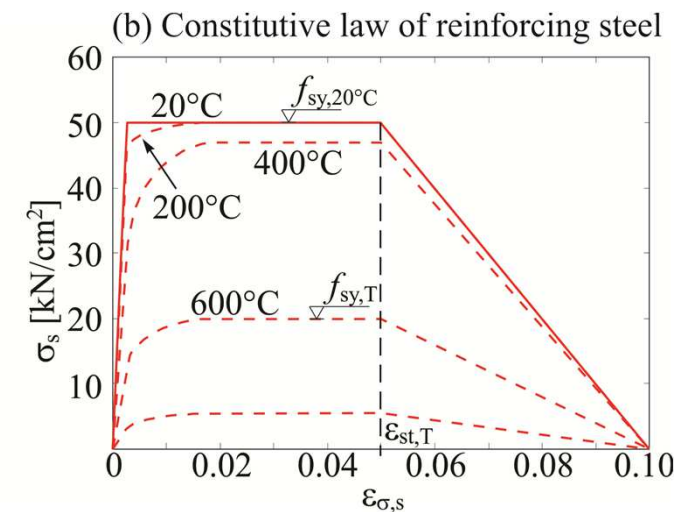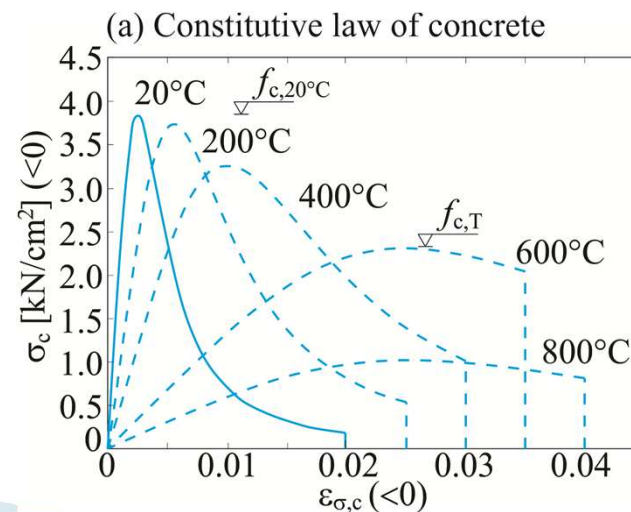# Outline of the presentation

- Mathematical model (thermal analysis and mechanical analysis, material models)

- Example: Simply supported reinforced concrete column
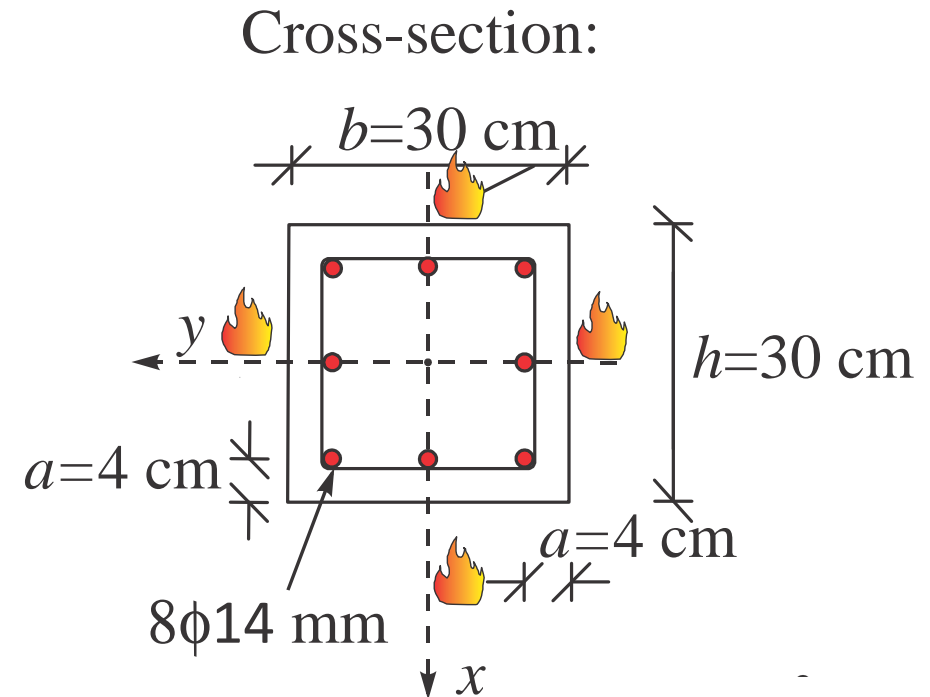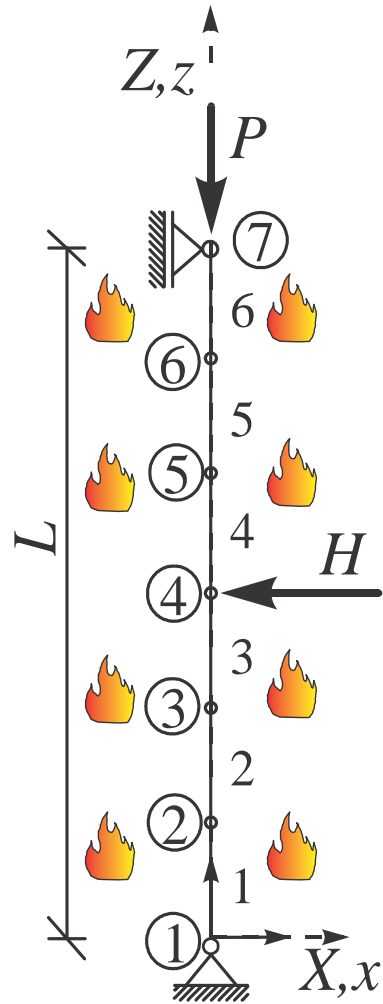
- Results

- Summary

Mathematical model

- Fire analysis is devided in **three mathematicaly independent phases**:
  - ❖ **1. phase**: Determination of time developement of temperatures of fire compartment (**ISO 834 fire curve**)
  - ❖ **2. phase**: Determination of tempeature field of the column
    (**hygro-thermal analysis** – proposed by Davie et al. (2006))
  - ❖ **3. phase**: Determination of critical buckling time – influence of slenderness, load level ration and creep of concrete (**mechanical analysis – software NFIRA**)

Material models

- EN 1992-1-2 (2004)

(a) Constitutive law of concrete — σ_c [kN/cm²] (<0) vs $\varepsilon_{\sigma,c}$ (<0); curves for 20°C, 200°C, 400°C, 600°C, 800°C; $f_{c,20°C}$, $f_{c,T}$

(b) Constitutive law of reinforcing steel — σ_s [kN/cm²] vs $\varepsilon_{\sigma,s}$; curves for 20°C, 200°C, 400°C, 600°C; $f_{sy,20°C}$, $f_{sy,T}$, $\varepsilon_{st,T}$

Simply supported concrete columns

Cross-section:

$b=30$ cm

$h=30$ cm

$a=4$ cm

$a=4$ cm

$8\phi14$ mm

③ node number

3 element number

Results – (Node 4)

X - displacement (Node 4)
Load level μ = 0.5

- - - - 0.5 Nrd,20 no creep
——— 0.5 Nrd,20 creep

Results – (Node 7)

Z - displacement (Node 7)
Load level μ = 0.5

- - - 0.5 Nrd,20 no creep
—— 0.5 Nrd,20 creep
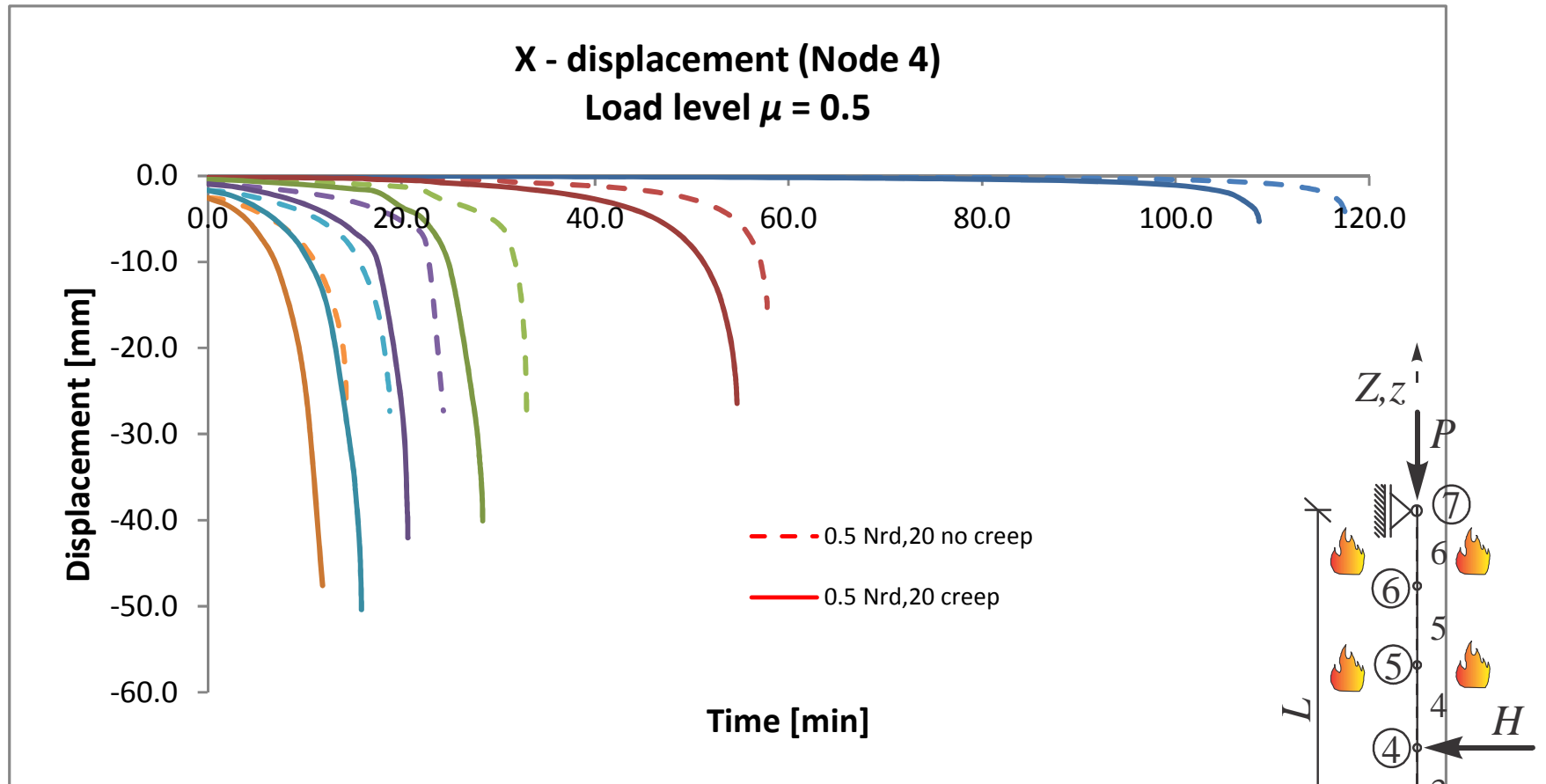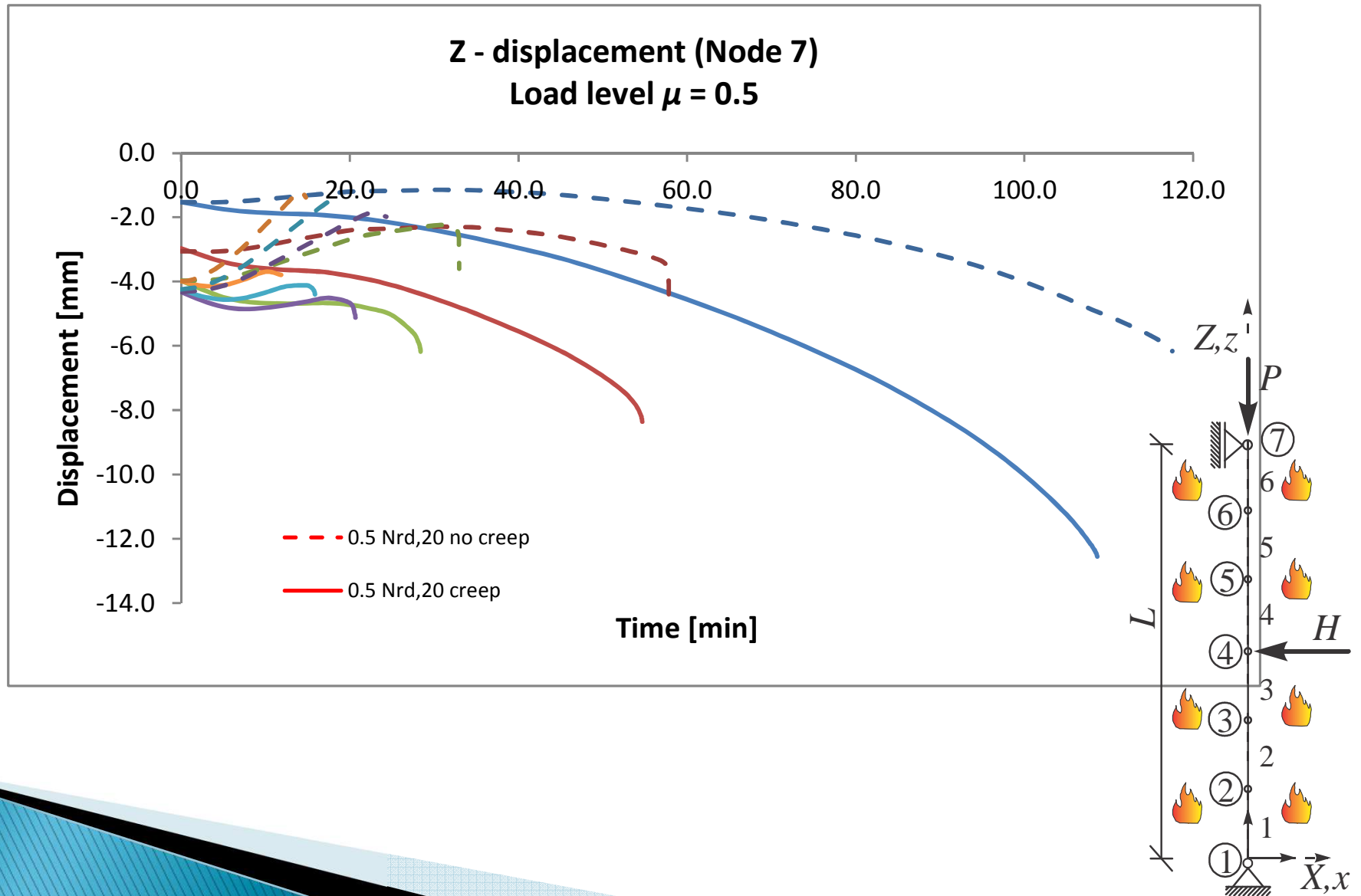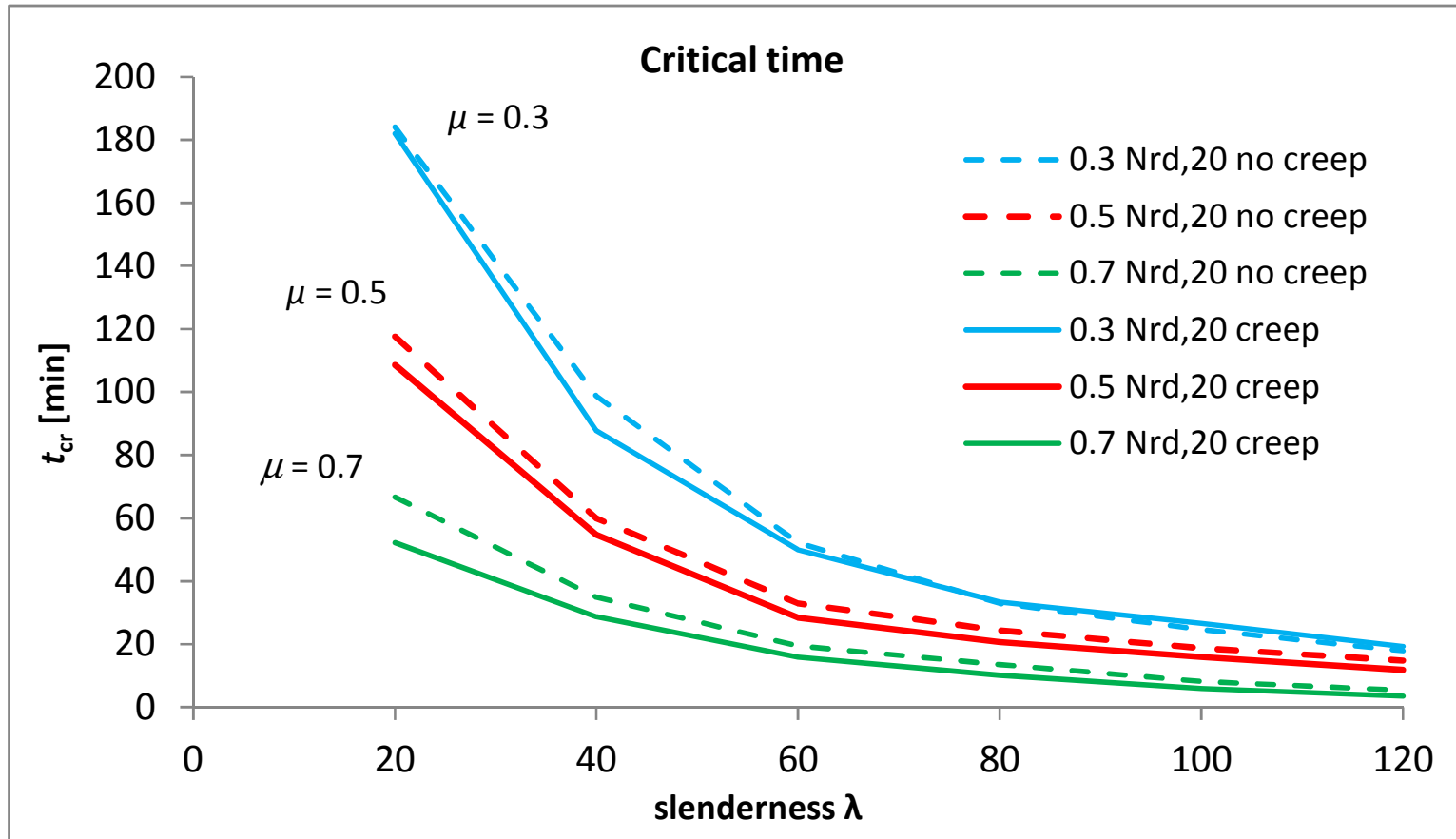
Results

Summary

- This report summarises the results of a benchmark study of simply supported concrete columns.

- The results are presented for various loads levels and various column slendernesses.

- In accordance within present analysis, we use the temperature dependent constitutive laws of concrete and reinforcing steel as suggested in EN 1992-1-2 (2004).

- Aim of the study was to present the influence of creep of concrete and transient strains at elevated temperatures.

- Therefore two sets of analyses were performed. Results show that **critical time is reduced for cases if creep of concrete and transient strains are taken into account.**

Thank you for your attention

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