STRESS-STRAIN RELATIONSHIP OF REINFORCING STEEL
Subjected to Tension and High Temperature

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The paper could be find in the conference proceedings, book 1, page 134.

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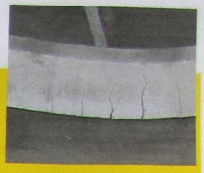
Introduction



- Calculations of load bearing capacity of RC elements subjected to fire will be required more and more often
- In these calculations an appropriate prediction of stress-strain relationship of reinforcing steel plays a crucial role
- When separated structural elements are analysed
  bars elongation ▶ cross-section LBC calculation
- When a part of a structure is analysed or when a global structural analysis is performed
  bars elongation ▶ cross-sections stiffness decrease calculation
  ▶ prediction of internal forces redistribution
  ▶ secondary static scheme prediction

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Tests in high temperature

Test in **room temperature** ▶ **2** coordinates: stress-strain σ-ε
Test in **high temperature** ▶ **3** coordinates: stress-strain-temperature σ-ε-θ

Two ways of testing:
- ▶ at constant temperature (steady temperature state)
- ▶ at variable (increasing) temperature

The total elongation of reinforcing bar heated up to high temperature ▶

$$\varepsilon_{tot} = \varepsilon_0 + \varepsilon_\sigma + \varepsilon_{cr}$$

At constant temperature

$$\varepsilon_{tot} = \varepsilon_0 + \varepsilon_\sigma + \varepsilon_{cr}$$

At variable temperature

$$\varepsilon_{tot} = \varepsilon_0 + \varepsilon_\sigma + \varepsilon_{cr}$$

≈ fire !!!!!

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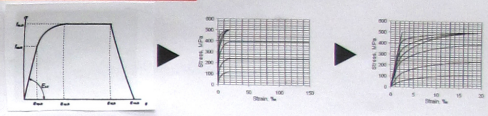
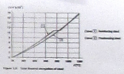
Eurocode 1992-1-2 model

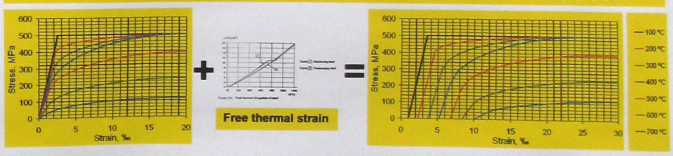
Stress-strain relationship



Free thermal strain



For RC elements LBC calculation in fire situation



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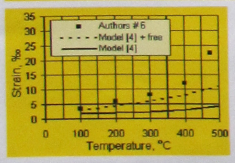
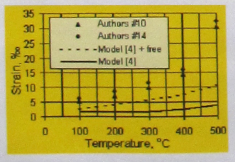
RC elements elongation

Obtained experimentally >> Calculated according to EC 2-1-2





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Conclusions

- The stress-strain relationship recommended in EN 1992-1-2 is based on the test results performed in steady temperature state conditions. This type of testing does not simulate the conditions to which the real RC structural elements are subjected during fire.
- Reinforcing bars of RC structural elements are stressed before the fire starts and during the fire the bars are heated up while stressed. The real fire conditions can be simulated by the tests performed under constant load and increasing temperature. In these tests the sum of the free thermal steel strain and the elongation appearing due to load action is measured.
- When the stiffness decrease of bent RC structural elements in fire is going to be considered the reinforcement elongation should be calculated as the sum of the elongation estimated on the base of stress-strain relationship and free thermal steel elongation.

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