Probabilistic analysis of concrete beams during fire

Ir. R. Van Coile, dr. Ir.-arch. E. Annerel, dr. Ir. R. Caspeele, prof. dr. Ir. L.Taerwe

Magnel Laboratory for Concrete Research – Department of Structural Engineering

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Background of the research

Structural response of concrete elements exposed to fire

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Design methods of EN 1992-1-2

- structural fire resistance time t_R
- $M_{Rd,fi,t_R} = M_{Ed,fi,t_R} = M_{Ed,fi}$
- limit state function not available in a closed form

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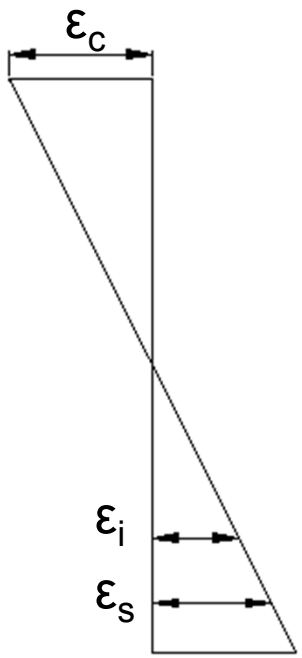
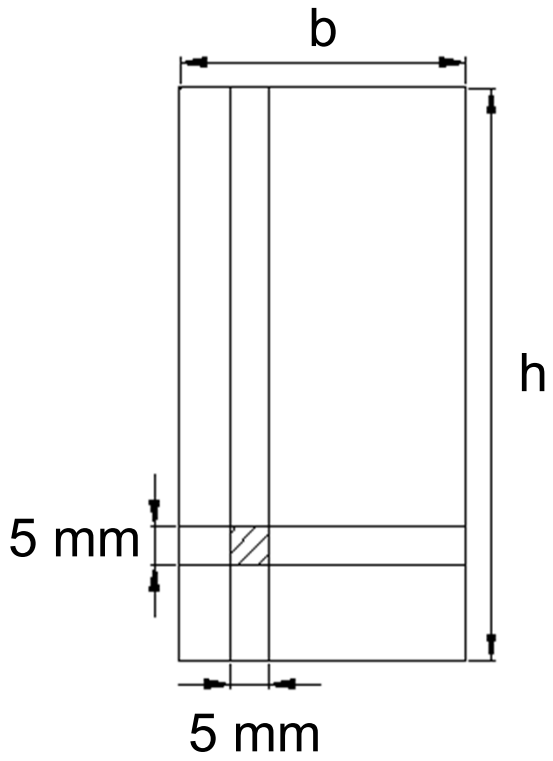
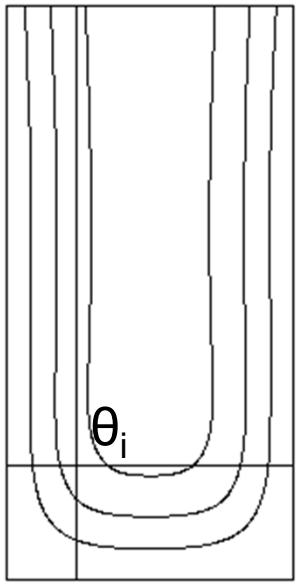
Analyzing structural safety of concrete elements during fire through the development of a probabilistic model

Time dependent deterministic model with beam parameters as stochastic variables







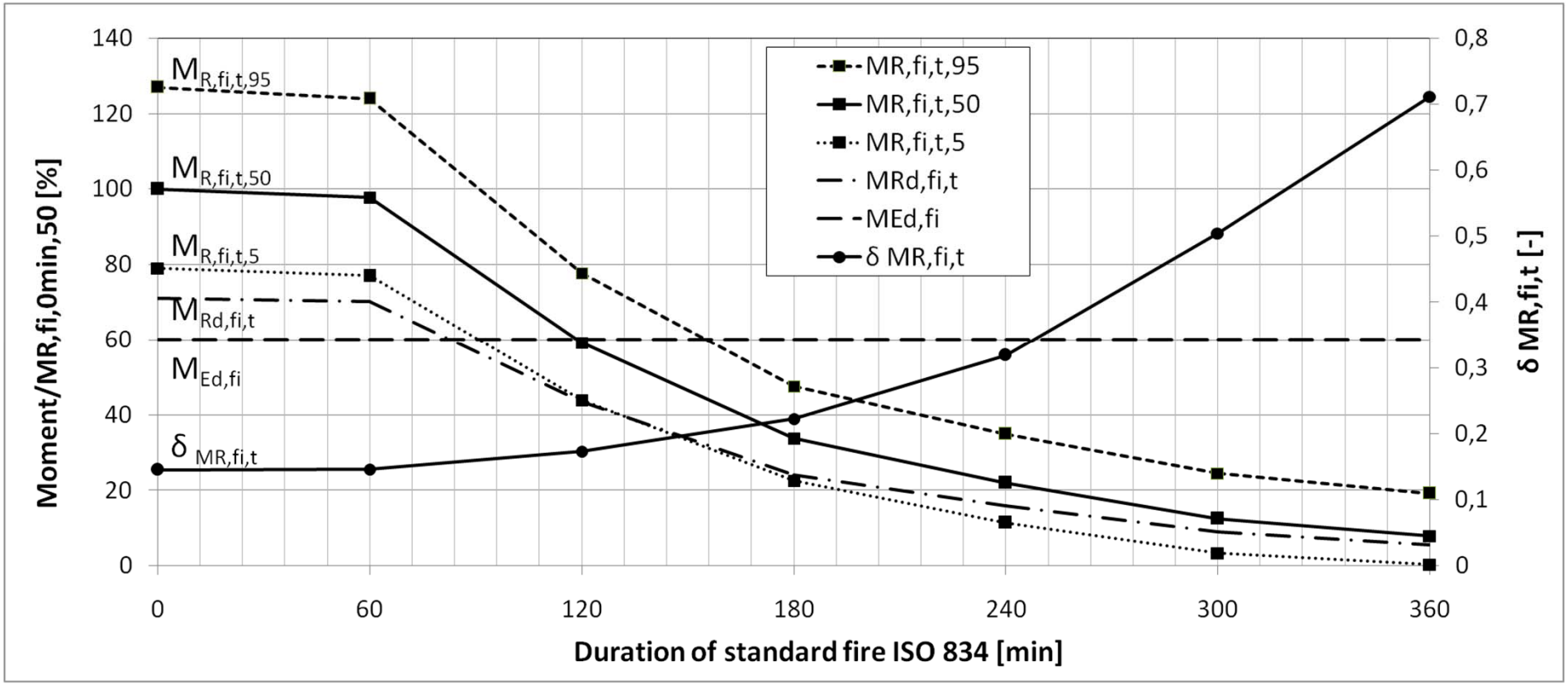
Temperature profile calculated by finite element Diana

Analysis of $M_{R,fi,t}$

- 10.000 Monte Carlo simulations
- probabilistic analysis of the simulation results

Probabilistic analysis of the simulation results

Example beam: R90 (table method EN 1992-1-2)

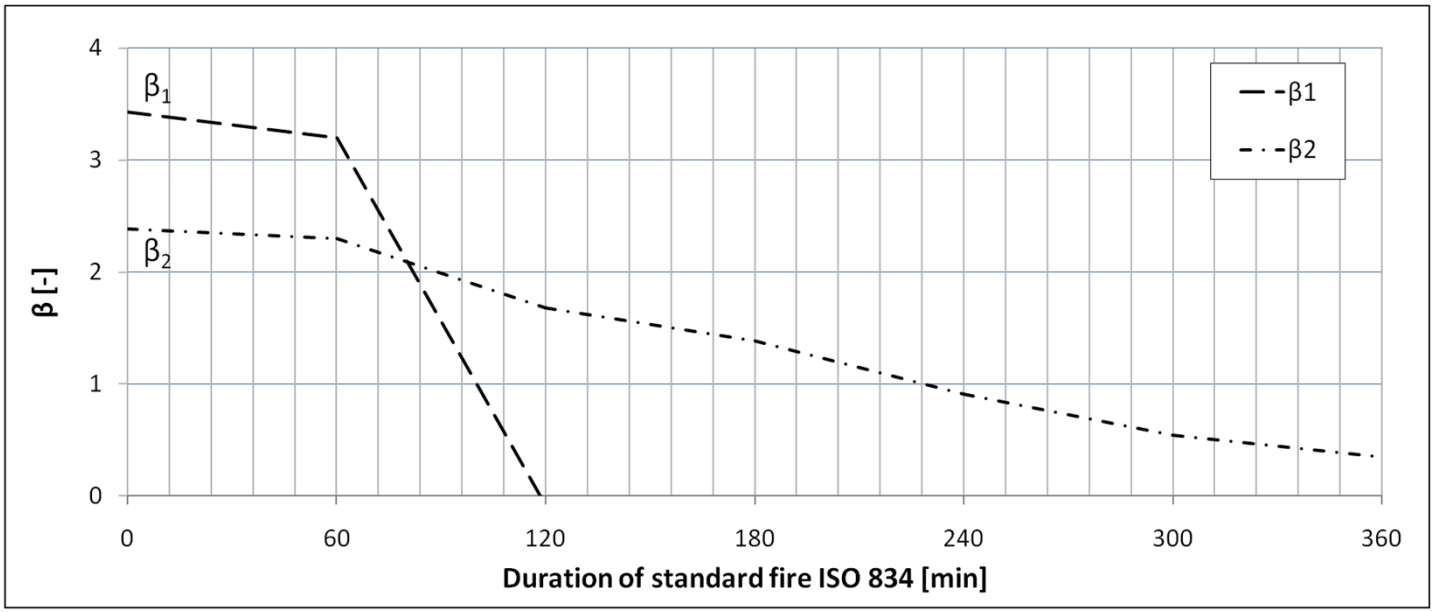


- t_R is defined by the intersection of $M_{Rd,fi,t}$ and $M_{Ed,fi}$ (EN 1992-1-2)
- model calculations indicate t_R = 83 min

Evaluation of safety level and its evolution

$$P_{f,1} = P\left[M_{R,fi,t} < M_{Ed,fi}\right] = \Phi\left(-\beta_1\right) \qquad P_{f,2} = P\left[M_{R,fi,t} < M_{Rd,fi,t}\right] = \Phi\left(-\alpha_R\beta_2\right) = \Phi\left(-\beta_2\right)$$

- β_1 ~ structural safety during fire
- depends on design load
- β_2 ~ intrinsic safety of design value $M_{Rd,fi,t}$
- α_R = 1, based on EN 1990



Decrease β_2 ⇨ { increasing probability of $M_{Rd,fi,t}$ overestimating $M_{R,fi,t}$
$M_{Rd,fi,t}$ corresponds with less extreme fractile of $M_{R,fi,t}$

~ uncertainty reduction factors for mechanical properties and temperature of reinforcement

⇨ Not explicitly taken into account by EN 1992-1-2

Thank you