2.6 Concrete explosive spalling of reinforced and prestressed units during fire (short version)

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Concrete Explosive Spalling of Reinforced and Prestressed Units during Fire

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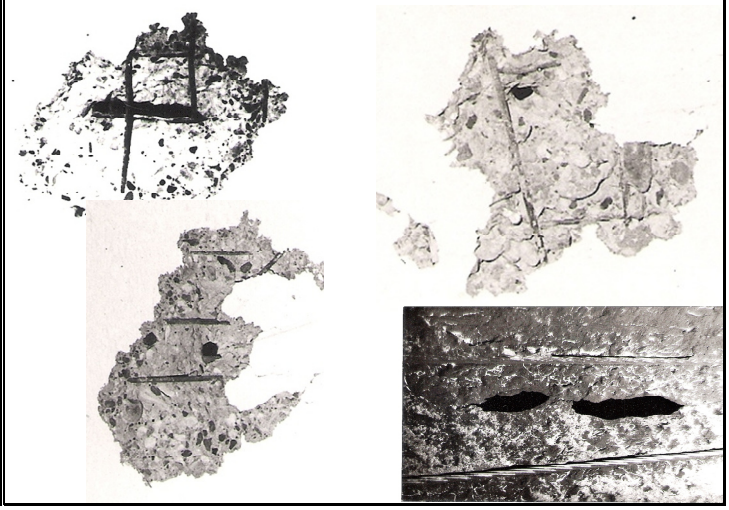
Explosive spallings of concrete



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SYSTEMATICAL OCCURRENCE OF EXPLOSIVE SPALLING ON CONCRETE SURFACE

- systematic occurrence of explosive spalling in time, always between the 10th and the 30th minute in both standard fire and actual (effective) fires
- "gun" noise with explosive spalling in the shape of a disc
- large crater on the concrete surface, always about 25 cm in diameter, but only 2 – 3 cm in depth
- systematic occurrence in the geometry of the unit: always on the end of the span of a beam (or similar units), never in the middle of the span, never in the maximum bending moment zone
- always in the middle of the height of the web
- if in a thin web, thinner than 7 cm, spalling is always pierced, and a hole remains in place; often the thin web disappears along a certain length; in case of a presstressed unit, a few seconds after the spalling, the high resistance wires break with a muffled sound and after 2-3 seconds the whole loaded structural unit collapses
- no correlation between concrete spalling and moisture content

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Explosive spalling in a monolith structure in actual fire

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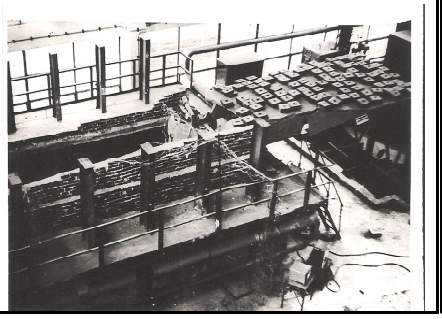
⊤⊤ unit 12 m span, before and after fire test (explosive spalling in 20 min)



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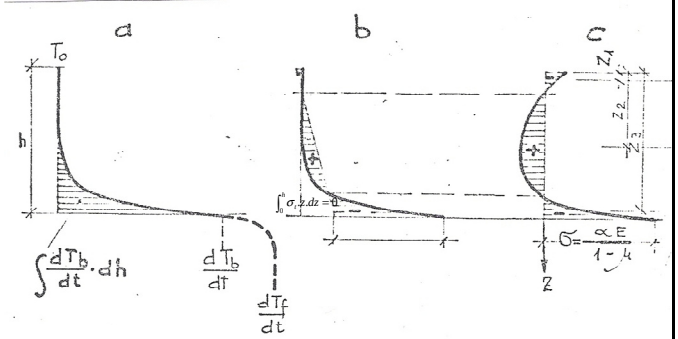
Temperatures and stresses in the cross section of an unloaded slab exposed to fire



$$\int_0^h \sigma_t.dz = 0 \qquad \int_0^h \sigma_t.z.dz = 0$$

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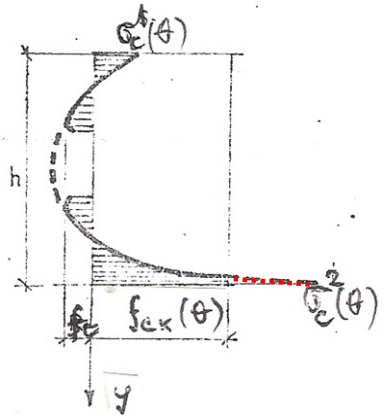
Relationship between stresses and strengths in the explosive concrete spalling situation



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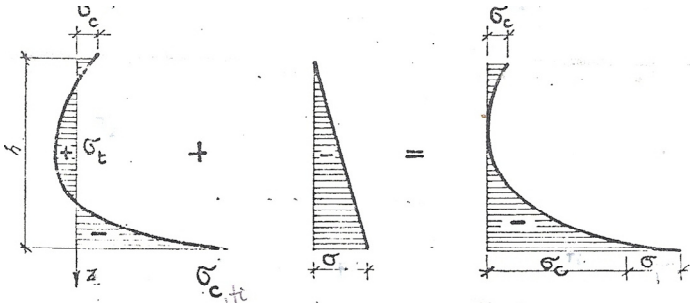
Stresses in the superficial layer of an unloaded prestressed element



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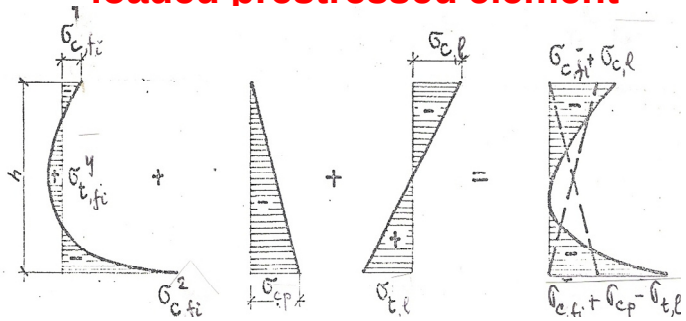
Stresses in the superficial layer of a loaded prestressed element



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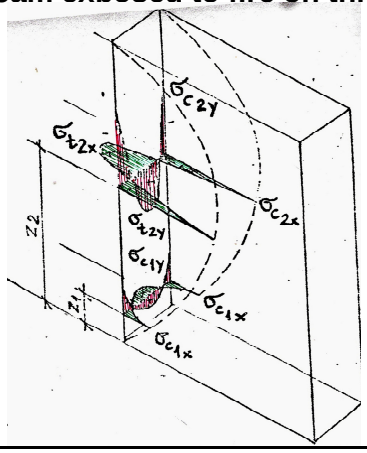
Thermal stresses distribution in the height of a beam exposed to fire on three sides



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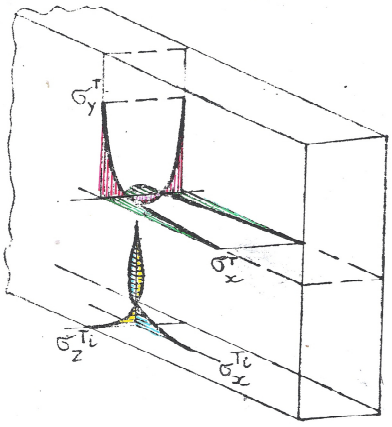
Thermal stresses distribution taking into account the lower side of the beam



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Additional conclusions

1. Straight linear units are more exposed to explosive spalling than curved elements and than elements with variable cross section.
2. These conclusions permitted the fire conformation of the typified prestressed industrial elements in Romania
3. Eurocode 2 (EN 1992-1-2) should be revised in section 4.5.1.

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