STRUCTURAL FIRE ENGINEERING IN BUILDING RENOVATION

Application of Natural Fire and Heat transfer Models to guarantee Fire Safety

StuBeCo
Studiebureel voor berekening van constructies

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Design considerations

Existing regulations

- Belgian standards for school building IBN/BIN 1982
- Belgian regulations for low buil

Scientific possibilities

- ISO834 + design following NBN-EN's = conservative
- Natural fire + interrogation commission = delay (5 months)

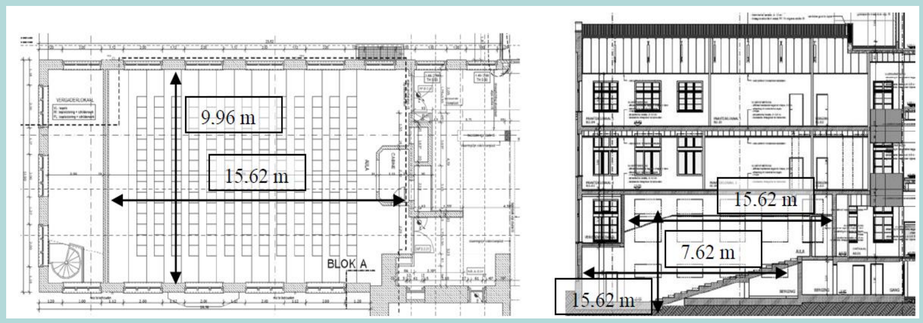
Approach

- Existing building constructed from 1881 till 1937 < 1982
- Transformation without building permit request
- Natural fire without interrogation

Only to fulfill conscience problem of local school authority, because of leak in regulations for existing buildings

Description of case study

Geometry



photo

Material properties

Material	ρ [kg/m³]	ΔL/L [mm/mK]	λ [W/mK]	c [J/kgK]
Masonry	1600	5	0,70	840
Concrete	2300	10*	1,60*	1000*
Steel	7850	12*	14,6*	450*

* At 20°C, temperature dependent following EN's

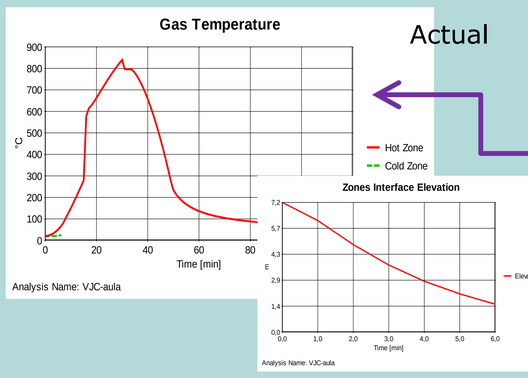
Fire load = 2-zone model

Fire load due to EN 1991-1-2 = 347 MJ/m² for school building raised till 511 MJ/m² for wooden false ceiling in audience.

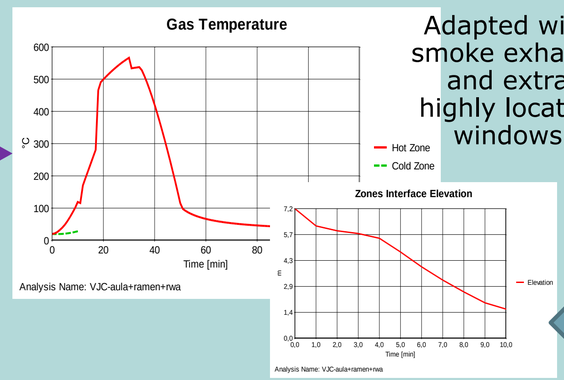
Fire growth = medium, RHR = 250 kW/m², modification factors of 1; 0,87; 0,78 and 1,43 (danger of activation; heat detection; off site fire brigade and surface)

Combustion efficiency factor = 0,80 and a constant ratio of at least 2% openings in relation to the vertical surfaces

Audience



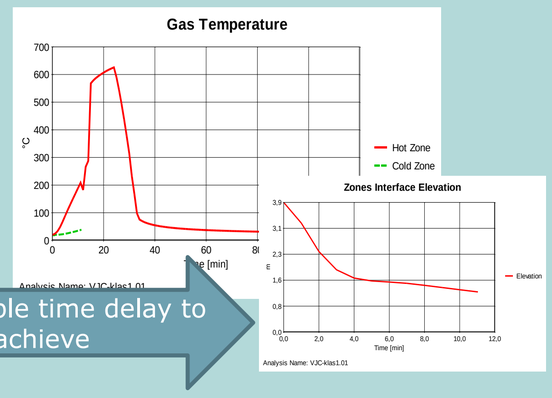
Actual



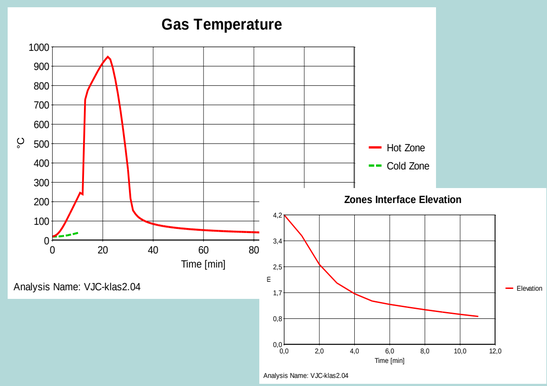
Adapted with smoke exhaust and extra highly located windows

Comparable time delay to achieve

Class room @ 1st level

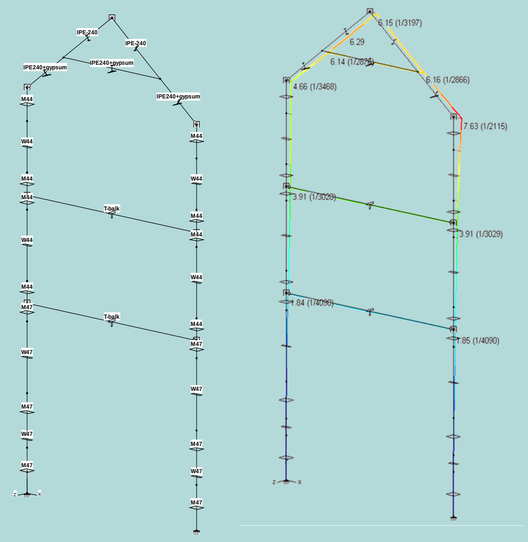


Class room @ 2nd level

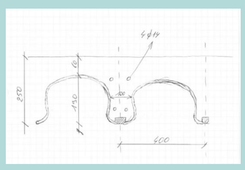


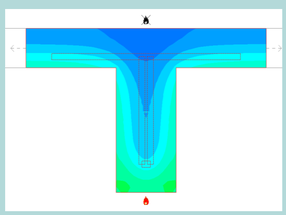
Mechanical response of the structure

Thermo elastic behavior of a slice model (one rib) from the building + rotational springs at the junction between vertical and horizontal elements. The width of the masonry incorporates the reduced stiffness according to the presence of windows.
Temperature profiles calculated by Powerframe (finite difference method)



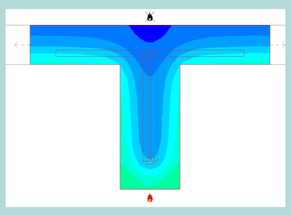
Audience





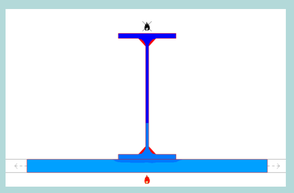
$T_{reinf,max}$ = 226°C @ 43'

Class room @ 1st level



$T_{reinf,max}$ = 162°C @ 31'

Class room @ 2nd level



$T_{reinf,max}$ = 45°C @ 51'

Conclusions

With the aid of easy to use 2-zone models and a thermo elastic stability check we were in the possibility to build up a tailor made solution for this particular problem.
Some extra costs were needed but otherwise we could realise also some efforts for the steel construction. The proposed solution is withhold by the school authority and executed without delay in execution time.

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