Thermal actions for structural analysis of an office building with large open-space

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SUMMARY

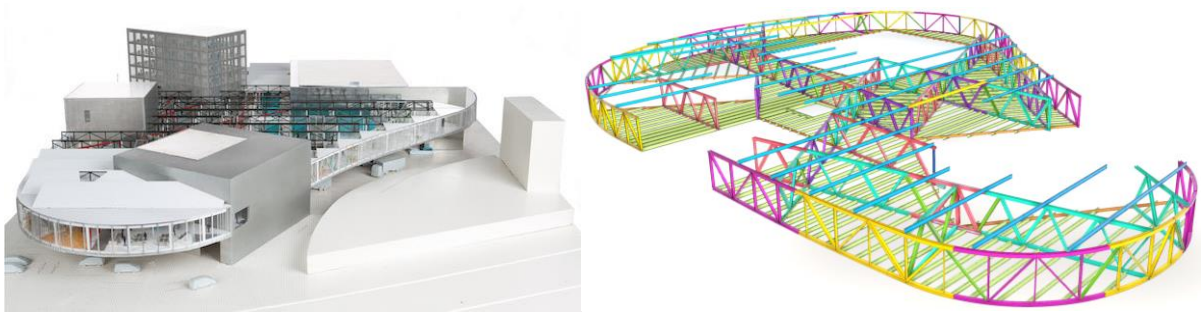
Fire design of new structures is an everyday challenge for fire safety engineers, where savings are often possible. To respond to these subjects (verification of structural strength, reduction or optimization of passive protection costs), engineering studies are increasingly using performance-based methods. This article describes a study carried out for a new office building with large open-space located in Lausanne in which an advanced method was used to assess the structural behaviour of the steel structure in case of fire.

ABSTRACT

To determine the resistance of structural members or plates in case of fire many options are available for the structural engineer: simplified methods, tabulated data, simple models (based on Eurocodes or ASTM for example) or advanced methods using finite elements calculations. Calculations are "quite obvious", well documented and widely accepted.

To achieve these calculations, we first need to heat the section of beams or shell elements. The simple and quick way to do it is achieved by considering the ISO fire curve. These analyses often show a lack of resistance thus involve the use of expensive (and maybe unnecessary) passive protective measures.

Standard curve analyses often over- or underestimate the real fire risk. In this case, performance-based design (PBD) should be used to analyse properly all the fire risk hazards and then decide the most effective technical and/or protection measures to use.



Office building with large open-space (left) and steel structure in the open-space (right)

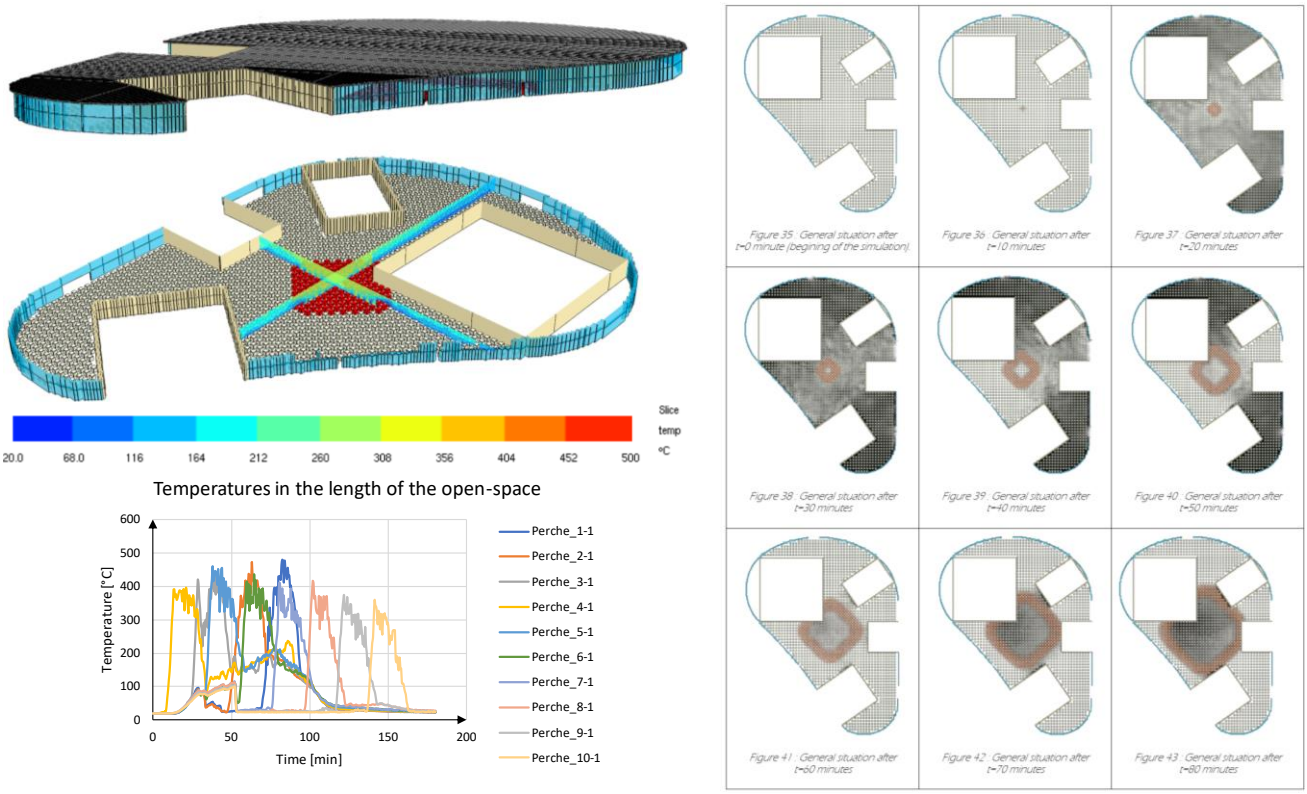
This study was carried out on several phases: natural fires approach with zones models (localized and compartment fires) and advanced methods analyses (Travelling fire with CFD model), with the following steps and findings:

1) <u>First round of analysis</u>

- Fire risk analysis to select real scenarios
- Natural fire approach with zones model gives quick results
- Sprinkler considered with a very simplified approach (no direct influence on the fire)
- Model unadapted to complex geometries
- Big compartment with large windows: compartment fire scenario not representative

2) Second round of analysis

- Complex geometry considered
- CFD model to study the fire spread risk in the case of an initial localized fire (Travelling fire)
- Analysis of the thermal stresses near the structure
- Reduction of the passive protection



Travelling fire with a CFD model.

With the presentation, we will show the full design process that helped the engineers to take the good decisions and give the correct and optimized advice to the client. We will see the benefits of a such approach too:

- Natural fire approach is often more favourable towards an optimization of the passive protection compared with the ISO fire scenario
- Performance-based methods give the opportunity to reduce cost in the project

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