Horizontal projections as alternative to spandrels for protection against external fire spread

Markus Nilsson, Division of Fire Safety Engineering, Lund University

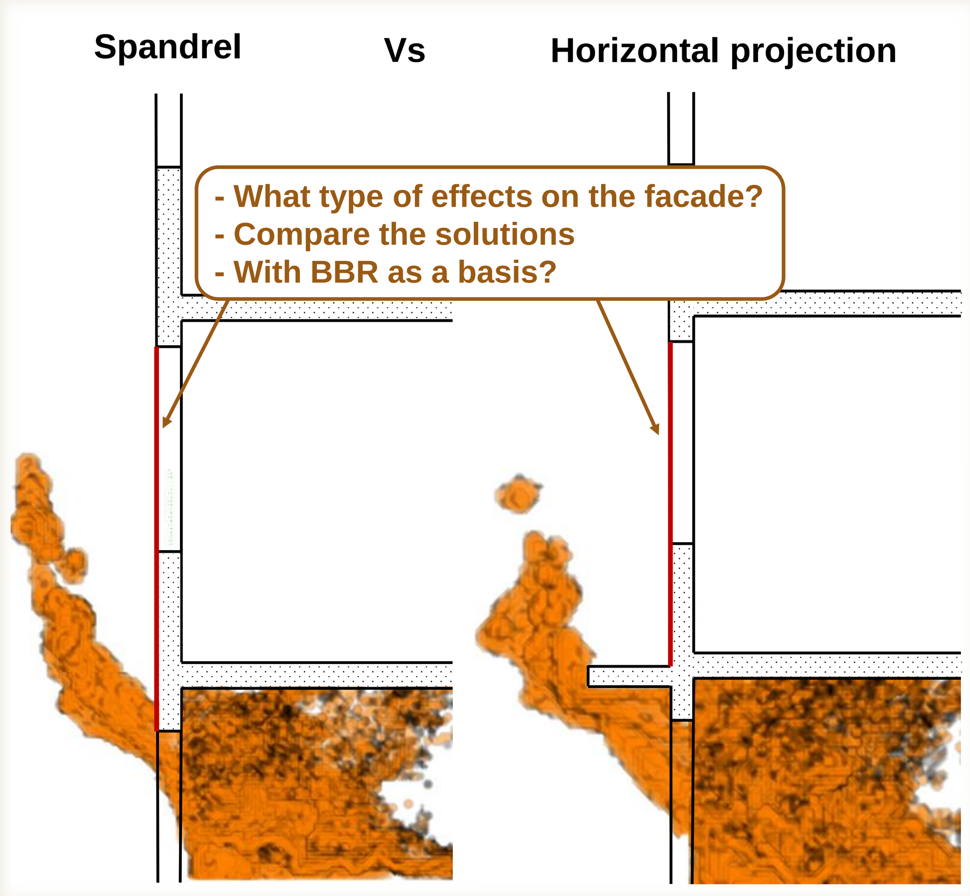
Introduction

External vertical fire spread between compartments is a risk that has been studied for decades. In Sweden, a prescriptive spandrel configuration of at least 1.2 meters between windows in the facade is given in the building code. However, the spandrel and/or horizontal projection configurations differ significantly between countries and a conclusion drawn from a review of different building codes is that the level of protection differs.

In the Swedish building regulation (BBR) no horizontal projection alternative is given. However, the regulation is performance-based and the spandrel configuration is given as general recommendation (i.e. a "deemed to satisfy" solution). This means that the designer can deviate from this recommendation if she/he can show that (1) the functional requirement is reached, i.e. fire will not spread between different compartments along the building facade, or (2) that an equal level of safety as stated in the general recommendation is given by the solution. Since no quantitative target level is given by the functional requirement it is implied that the accepted safety level can be derived from the spandrel height of 1.2 meters mentioned above.

The fact that no horizontal projection alternative is given in the regulation poses a problem when designing buildings with balconies, both of French and regular type. Because of the lack of guidance it is not clear how a balcony needs to be designed to fulfil the requirement without the given spandrel height. Because of these "design uncertainties", a study was initiated by Brandskyddslaget AB in cooperation with Lund University.

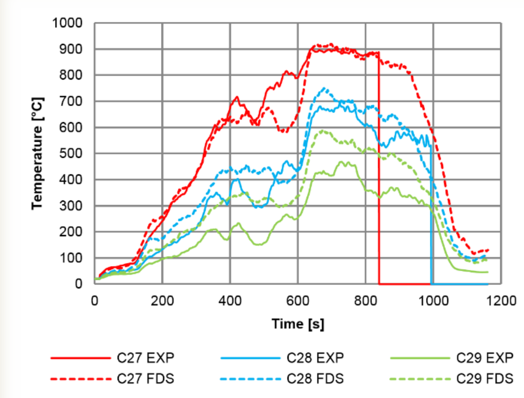
Purpose and aim



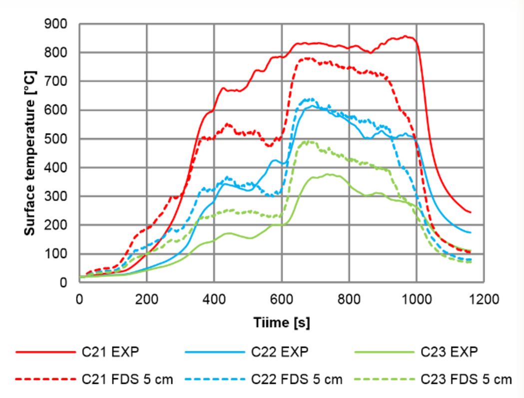
Can external fires be modelled in a credible way?

In order to obtain credible results in the study, it was first necessary to evaluate a calculation tool for modelling external fire spread. This was done by performing a validation study of FDS version 6.2.0 against a large-scale fire test on a SP FIRE 105 test rig in Borås, Sweden.

Altogether, FDS version 6.2.0 was deemed well suited as a calculation tool for modelling external fire spread (example results below). The conclusions drawn from the validation study were then taken into consideration when performing the simulations in the comparative analysis.

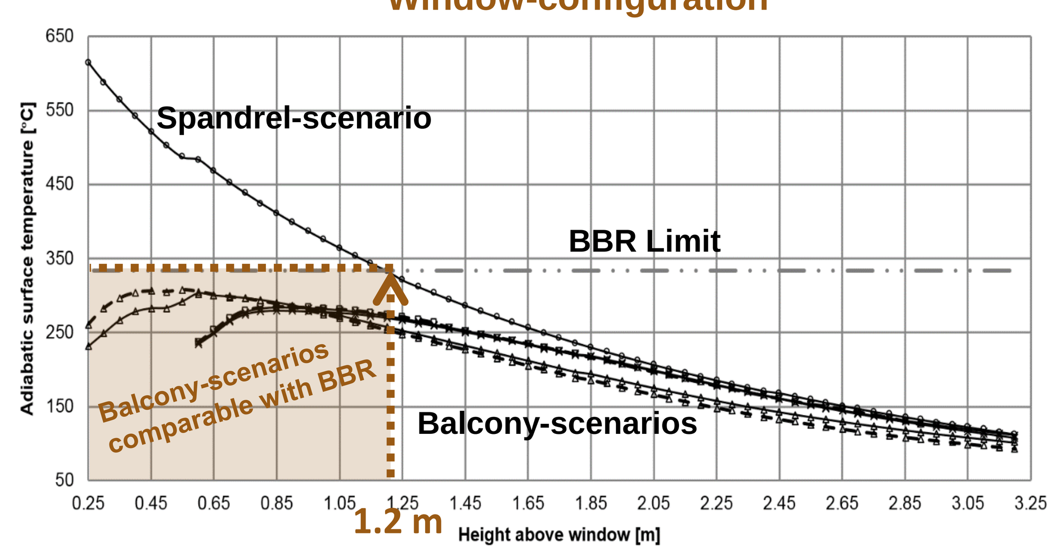


Thermocouple temperature

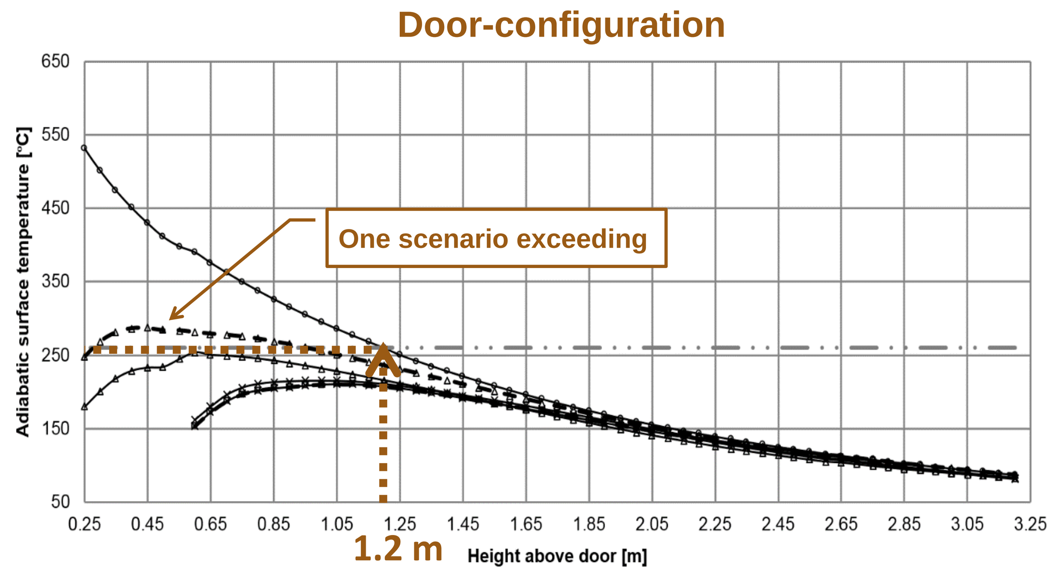


Adiabatic surface temperature

Window-configuration



Door-configuration



Performing a comparative analysis

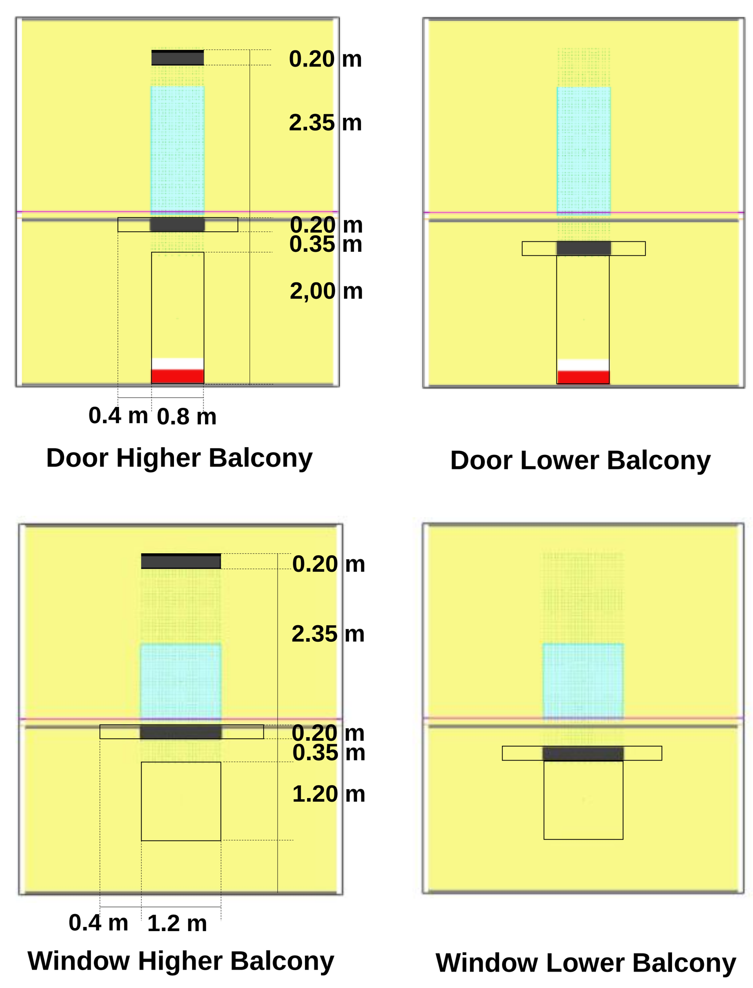
In a comparative analysis a smaller apartment was built up in FDS with two opening configurations in the building facade: a door or a window (general setup seen from the front in the right picture). By studying the adiabatic surface temperature at different heights along the facade, the consequence of the external flames was compared between scenarios built up by spandrel configurations and scenarios with horizontal projections between openings as the only difference.

By comparing the output data from these scenarios, the impact of horizontal projections on external fire spread was shown at different heights above the underlying opening by observing the difference in the output data in different graphs. Two examples of such diagrams presented in the studies are shown to the left.

The results in the left diagrams refer to different scenarios within the window- and door configuration and to the various horizontal projections as per the illustration to the right and the spandrel configuration. Balcony-scenarios resulting in consistently lower values than the Spandrel-case at each height mean that the existence of these balconies results in lesser consequences at the facade on all heights compared with the Spandrel-case.

Furthermore, if these values are below the grey horizontal line (BBR Limit), these balconies are considered to result in lesser consequences on the facade at all heights compared with the accepted level in the prescriptive part of the BBR. The latter since the BBR Limit highlights the consequence at 1.2 m above the opening in the spandrel case.

Geometries tested

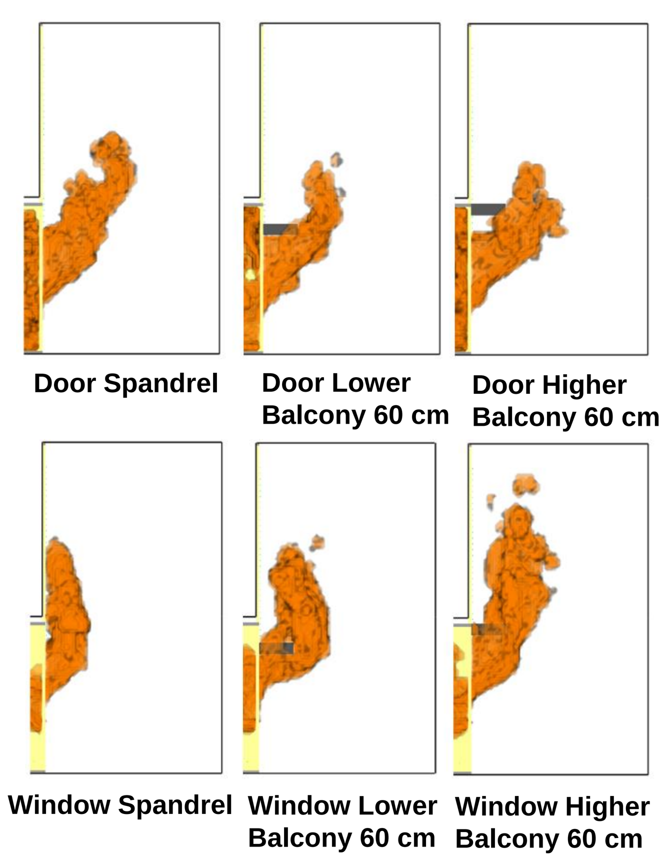


Real examples out there

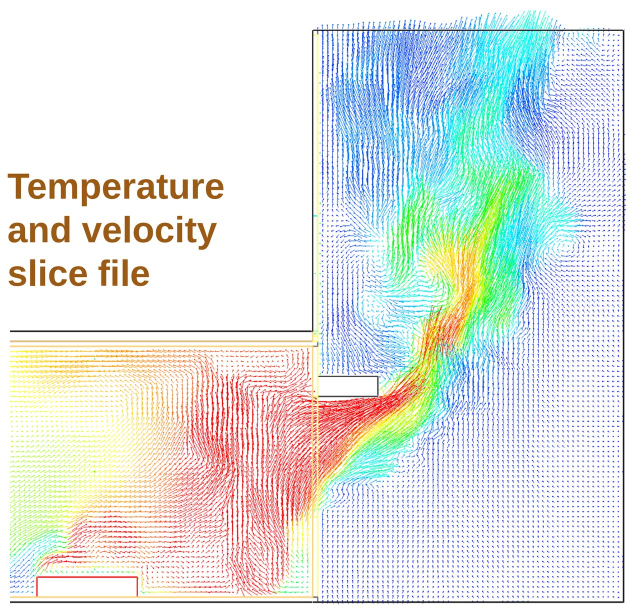
The outcome of a fire on ground floor of a residential building in Berlin. In this case the use of horizontal projections (right) resulted in less consequences on the facade compared to a vertical safety distance (left), as seen on the smoke damage and broken windows.

Rendering in FDS

External flames



Temperature and velocity slice file



Conclusions

- The use of horizontal projections result in less severe fire exposure at the facade compared with scenarios built up by different spandrel heights.
- The results suggests that the use of 60 cm deep horizontal projections in most cases result in less severe fire exposure at the facade compared with the accepted level in the prescriptive part of BBR.
- This means that in many cases, a spandrel height of at least 1.2 m as stated by the BBR can be replaced by a 60 cm deep horizontal projection positioned at any height above the underlying opening.
- The results also shows that horizontal projections with a depth less than 60 cm may offer the same protection as the 1.2 m spandrel height requirement in BBR for specific configurations.
- Also, combinations of a specific vertical safety distance and a less deep horizontal projection prove to offer the same protection as the protection given by the 1.2 m spandrel. This means that it is possible in many cases to adapt the design to suit a project's specific preferences as far as possible, by using the verification method presented in the study.

Future recommendations

A future recommendation is to further investigate the possibilities of using horizontal projections as a protection in order to improve the prescriptive requirements in BBR, similar to the design of the New Zealand building regulations. The New Zealand building codes offers combinations of spandrels and horizontal projections in the prescriptive requirements as an alternative to only stating a vertical safety distance. A similar system is also seen in France. This would lead to flexible protection methods in BBR, still resulting in the same level of protection compared to today's spandrel height requirement of 1.2 m.

Moreover, similar levels could then be expected in various buildings including the application of horizontal projections as compensation for the spandrel requirement. This is not the case in fire safety engineering today as the application of horizontal projections is done in a relatively arbitrary manner. The design of such advice may advantageously be developed using the comparative methodology presented in the studies (see further reading below).

Further reading

Nilsson, M. (2016). *The impact of horizontal projections on external fire spread - a numerical comparative study,* Report nr. 5510, Lund University, Division of Fire Safety Engineering, Lund, 2016.

Nilsson, M., Mossberg, A., Husted, B., & Anderson, J. (2016). *Protection against external fire spread - Horizontal projections or spandrels?* Paper presented at 14th International Fire Science & Engineering Conference, Vol. 2, pp. 1163-1174, Royal Holloway College, University of London, UK.

Nilsson, M., Nilsen, J., & Mossberg, A. (2016). *Validating FDS against a large-scale fire test for facade systems.* Paper presented at the 3rd Fire and Evacuation Modelling Technical Conference (FEMTC), Meliá Costa del Sol in Torremolinos, Spain.

Nilsson, M., & Mossberg, A. (2016). *A comparison of horizontal projections and spandrels as protection methods against external fire spread.* SFPE Europe Magazine, Issue nr 4.

Nilsson, M., & Mossberg, A. (2016). *Skydd mot brandspridning via fönster i fasaden - Balkongplattor eller skyddsavstånd?* Bygg & Teknik, nr 6.

Contact: Markus Nilsson | Brandskyddslaget AB | Sweden Box 9196, SE-10273 | markus.nilsson@brandskyddslaget.se