SMART FAÇADE FROM THE POINT OF VIEW OF CZECH LEGISLATION WITH REGARD TO FIRE PROTECTION

Jiří Znebejánek*,[1]

*xcznebejanek@vutbr.cz
[1]Brno University of Technology, Veveří 331/95, 602 00 Brno

Abstract
The aim of this article is the research into whether the smart façade is or isn't an obstacle in the building permit issuing process in the Czech Republic from the point of view of fire protection technical standards. Due to the uncommonly complicated technical standard approval process, neither the engineers nor the authorities agree on a coordinated approach to fire safety issues of innovative solutions. The main aim of this study was the research review of the related articles in technical standards and evaluate them.

Keywords
Smart façade, fire protection, building permit issuing process, Czech technical standards

1 INTRODUCTION

Czech legislation and fire protection-based technical standards

There is quite a wide number of fire protection-based technical standards in the Czech Republic, some of them are mentioned in this paper, but all of them are listed in Decree No. 23/2008 Coll. The important thing about this decree is that technical standards specifically listed in it, are binding, and thus must be followed.

The history of fire protection-based standards lies in the 1980s. Each of them was written by a group of specialists, so-called standard-makers. Generally said, standards are written based on current needs, but mostly are released quite late. Not that they would be useless on the day they came up, but for example in the case of electromobility, technical standards are still in process of being written, when electro mobiles already park in the underground garages and neither engineers nor Fire Rescue Service of the Czech Republic (FRS CR) know how to face it.

Smart façade

Ventilated facades are nowadays already a well-known and commonly used way of realizing the building envelope. (…) Above all, they are used mainly for their advantages from the building physics point of view. For example, compared to the external thermal insulation composite system (ETICS), ventilated facades have a milder course in terms of the annual temperature balance inside the structure, and they drain moisture well from the perimeter shell. (…) A key component of ventilated facades is the ventilated gap. This is the area between the external cladding, which is in direct contact with the exterior, and the perimeter wall, or its thermal insulation located on the outside of the perimeter structure. This ventilated gap allows air to move freely. Air is sucked into the structure at the bottom of the façade through an entrance opening usually equipped with a grid to prevent animal entry, is driven along the length of the facade behind the external cladding and is then released to the exterior through an outlet opening in the upper part of the facade. The air movement itself is ensured by a phenomenon called natural convection. In the vertical gap, warmer air rises upwards due to its lower bulk density – the so-called chimney effect. Air flows naturally in most ventilated facade systems. Forced ventilation is used in the system of double facades [1], which by their own design are more space-intensive and create larger air gaps. (…)

The concept of a smart facade developed at the Institute of Building Services, Faculty of Civil Engineering, Brno University of Technology, consists in the ability to regulate the airflow in the gap using a system of forced ventilation and closing flaps on the side of the inlet and outlet opening depending on the changing boundary conditions. Fans with adequate input power and performance located in a smart facade can ensure greater airflow *to get rid of a greater heat load. Shut-off flaps ensure the movement or stopping of airflow to achieve the desired air temperature in the ventilated gap. They work in two modes: "open"; and "closed"* [2].

2 TECHNICAL STANDARDS ASSESSMENT

The paper contains the full text of the articles of the technical standards. The cited text on the relevant technical standard is followed by a written comment *(research author´s note* to clarify and explain the quoted paragraph in relation to the topic worked on by the author of the research and therefore is not part of the mentioned technical standards.

Article 5.4.8 of the ČSN 73 0810 technical standard

For double perimeter walls (internal, external), the requirements according to article 5.4.1 (perimeter wall fire resistance) apply to that part of the perimeter wall, that is in contact with the fire ceiling and fire walls, and which closes the fire section.
(This is not a requirement for fire belts, they have their own requirements. This article in fact says that if a building is situated in a fire hazard area of another building, the fire resistance must be met by the internal structure, which ensures the stability of the object, not the superimposed structure) [3].

Article 3.2.3. of the ČSN 73 0810 technical standard

Structural parts of type DP1 do not increase the fire intensity during the required fire resistance period (but at least for 15 minutes), i.e., the ignition temperature is not reached for any of the building materials used, and the essential components of structures consist of:

a) materials of reaction to fire class A1 or A2; or
b) from materials of reaction to fire class B to F located inside the structural part between products according to point a) (e.g., heat and sound insulation) in such a way the ignition temperature on the surface of listed materials contained in products does not occur during the required time of fire resistance; stability and load-bearing capacity of the structural part must not depend on these products; or
c) according to the compositions established in articles not important for this research.

Products of different classes of reaction to fire, which for any reason (e.g., for architectural reasons) are on the surface of structural parts of type DP1, without ensuring fire resistance, are not subjects to the assessment of the type of structures. If these materials release heat during a fire, they are included in the permanent fire load.

(A DP1 type of construction is required for buildings like hospitals, schools, dormitories etc. It is therefore possible to design a fire load in a ventilated gap (cables, flaps made of combustible material, servo drives), but only if the amount of heat released during a fire is determined and the insulation material is fire reaction class A1 or A2 – mineral wool) [4].

Article 3.2.3.1 of the ČSN 73 0810 technical standard

Perimeter walls of type DP1 (consisting of only non-flammable materials) with adequate fire resistance may have external parts (surfaces) also made of fire reaction class B products if all the following conditions are met: (…) any ventilated gaps in the surface layers, or other modifications, must not allow the spread of fire (hot gases, etc.) beyond the boundary of the fire section on the perimeter wall.

(In the standards of the ČSN 73 08xx series, the fire load in the ventilated air gap is not considered. The only case that, given the intended function of the façade, could be a problem is preventing to spread of fire in the air gap, especially when there are combustible materials such as wiring, actuators for control flaps and the materials of flaps themselves. In all cases, non-flammable materials can be used, including cables. However, this can make the eventual construction more expensive) [5].

Article 5.4.12 of the ČSN 73 0810 technical standard

If advertising banners etc. are placed in front of perimeter structures in buildings with a fire height over 12 m, these must be of fire reaction class at least B and must not produce extensive amounts of combustion gases, while they must not interfere with the fire-hazardous area of the fire sections of the same or neighbouring building and must not hinder the management of the intervention of a fire brigade.

DOI 10.13164/juniorstav.2024.24032

(As etc. I understand for example the use of photovoltaic panels as the outer shell of a ventilated façade, where reaction to fire class B is no longer a problem today, the use of photovoltaic panels as such can appear as a problem. As already mentioned above in the article, technical standards are delayed in the Czech Republic, which is why they are quite unfamiliar with something such as photovoltaic panels) [6], [7].

Article 7.2.8 of the ČSN 73 0802 technical standard

When determining the type of structures, surface treatments are considered if these treatments form part of the structural solution and affect the load-bearing capacity and integrity of the structure; this provision does not affect the requirements for limiting the spread of flame on the surface of building structures.

(This article says that the overhanging structure does not affect the classification of structural parts, so it can be used on all buildings without any restrictions while meeting other requirements such as limiting the spread of fire).

Article 8.4.1 of the ČSN 73 0802 technical standard

If a multi-layer perimeter wall is designed, the sealing of which is done only to the inner perimeter wall, the risk of the spread of fire and combustion products through the space between the inner and outer perimeter wall must be assessed separately.

(The risk can be avoided, for example, by designing fire partitions, consisting of flaps used to direct the airflow inside the smart façade. Another option to prevent the spread of fire through a ventilated gap is to design all components from non-combustible materials, as well as the ETICS) [8].

Article 8.4.8 of the ČSN 73 0802 technical standard

At the junction of the perimeter wall, a fire belt at least 900 mm wide must be created in the perimeter wall, while the width of the fire belt includes only those parts of the structure that demonstrably meet all requirements for fire belts, including fire resistance and type of construction. The fire belt must be in contact with the firewall over the entire thickness of the wall.

Article 8.4.10 of the ČSN 73 0802 technical standard

Fire belts are part of perimeter walls, they must be DP1 constructions without areas completely or partially open to fire and must have fire resistance determined according to the higher degree of fire safety of the adjustment fire sections of the building according to Table 12 ČSN 73 0802, and no flammable construction products may penetrate them.

(If a ventilated gap with external cladding is to be considered a fire belt, it must be a fire-enclosed area (resulting from clauses 8.4.5 and 8.4.7 ČSN 73 0802), be only of type DP1 construction (including dampers, actuators, cabling etc.) and fire durability refers only to the supporting structure, which is not concerned in here. This article is very important. Especially since the fire belts must be established on the building, the use of materials for the needs of a smart façade is limiting. In the width of 900 mm, where the fire belt is to be established, only non-combustible materials can be used) [9].

Article 8.4.12 of the ČSN 73 0802 technical standard

Perimeter wall external cladding made of products of reaction to fire classes C to E, including cornices, or projected structures in front of the external face of perimeter wall made of similar combustible products, must be assessed from the point of view of areas open to fire according to article 8.4.4 and 8.4.5 ČSN 73 0802. These facings or other overhanging structures for objects with a height exceeding 12 m can be used regardless of fire-hazardous areas of the fire sections of the same object.

If these modifications from combustible products are used for buildings with heights exceeding 12 m, the risk of fire spread to other fire sections of the same building must be assessed (e.g., through a continuous layer of combustible product or an air gap).

(This article describes a case where a combustible material is used for outer cladding. Up to a fire height of 12 m, only the separation distance is determined. From a fire height of 12 m above, the spread of fire through a ventilated gap is also assessed.) [10].

DOI 10.13164/juniorstav.2024.24032

3 DISCUSSION

From the articles of the Czech technical standards commented on above, it is clear there are only a few obstacles in the way of a smart façade. Only in rare cases are materials of fire reaction worse than class B used as external cladding.

If we take, for example, a smart façade with external cladding made of cetris boards or "green" segments with flowerpots, the only limiting factor is the fire height of the building. If the fire height of the object is more than 12 m, the spread of fire in a ventilated gap must be prevented at the boundaries of the fire sections. This can be achieved by using already installed flaps in the individual segments of the smart façade made of fire reaction class materials A1/A2 and using them to create fire partitions at the border of the fire sections.

If the fire height of the building is up to 12 m, only fire belts are being considered.

The smart façade system can be used in medical facilities, schools and dormitories, provided that all the above-mentioned requirements are respected, but nothing actually prevents its use.

The only real problem comes with the outer cladding of photovoltaic cells. Photovoltaic panels are perceived by fire protection authorities in the Czech Republic as a technological device from which separation distances must be established. This significantly limits the installation of photovoltaic panels in the entire area of the smart façade. The ratio of the area with and without photovoltaic panels is significantly limited by number of windows. It can in fact be said the PV panel can be as close to a window as 1.5 m from any side, but not an inch closer. Another problem is the cabling between the inverter and PV cells. Let's say a conventional PV plant has cabling between cells and inverter live all the time. This might be a trouble during a fire as the voltage can directly endanger the lives of firefighters. However, new systems offer a solution, where these live cables are shortened to a few decimetres.

We can therefore say that the future of the smart façades, at least as far as fire safety is concerned, is promising. Although the legislation does not know anything such as a smart façade, nor anything similar. And that might be a reason why.

4 CONCLUSIONS

As can be seen from the text above, a smart façade does not face many other limitations than a conventional ventilated façade. Non-standard smart solutions, such as the outer layer consisting of photovoltaic panels, can be an obstacle. Unfortunately, praxis shows us that there can often be a problem in these non-standard solutions. Although not intended, technical standards in the Czech Republic can be interpreted in multiple ways, and it always depends on the people who assess them.

Whether on the side of architects or officials, each of us can right now list several reasons why smart facades should not be implemented in terms of fire safety. However, our real task is to look for solutions, that are environmentally friendly and cost-effective. The real challenge is to look for solutions that are ecological, economical and at the same time safe to use.

Let´s hope the technical standards will be more specific in the future, and when researching similar systems like the smart façade, we will no longer have to think about what the firefighters would say about it and whether the money spent on research would be wasted.

Acknowledgement

The creation of this article has been supported by specific research called Experimental research of heat and mass transfer in systems of building services, marked FST-S-23-8176.

References

[1] ŠAGÁT, Erik. Ventilation of the building envelope. Brno, 2016. 130 p., 2 p. attachments. Doctoral thesis. Brno University of technology, Faculty of civil engineering, Institute of building structures. Supervisor doc. Ing. Libor Matějka, CSc., Ph.D., MBA

[2] SALAJKA, Radek, ZNEBEJÁNEK, Jiří and RUBINA, Aleš. (2023). Energy consumption of smart facade. MATEC Web of Conferences. 385. 10.1051/matecconf/202338501002. [online]

[3] OLESZKIEWICZ I.,. Fire Exposure to Exterior Walls and Flame Spread on Combustible Cladding. *Fire Technology*. 1990. 26(4), p. 357

[4] DUNGAR, Uğur and SELAMET, Serdar. (2022). Fire load and fire growth characteristics in modern high-rise buildings. Fire Safety Journal. 135. 103710. 10.1016/j.firesaf.2022.103710. [online]

[5] YAKOVCHUK, Roman, KAHITIN, O., LOIK, V., SYNELNIKOV, O., HALANCHENKO, R. and VOZNIAK, O.. (2022). Analysis of Factors Affecting the Spread of Fire by The Structure of Facade Thermal Insulation with Ventilated Air Layer. Bulletin of Lviv State University of Life Safety. 24. 57-65. 10.32447/20784643.24.2021.07

[6] IRINGOVÁ, Agnes. (2022). Location of Photovoltaic Panels in the Building Envelope in Terms of Fire Safety. Civil and Environmental Engineering. 18. 10.2478/cee-2022-0050

[7] European Committee for Standardization (CEN). EN 13501-1:2019-02 Fire Classification of Construction Products and Building Elements—Part 1: Classification Using Data from Reaction to Fire Tests; European Committee for Standardization (CEN): Brussels, Belgium, 2019

[8] FRANCO, José Tomás. Reaction And Fire Resistance: How Are Materials Classified In The Event Of A Fire? [Cómo se clasifican los materiales ante un incendio: reacción y resistencia al fuego] 01 May 2019. *ArchDaily* [online]. [Accessed 1 Nov 2023]. ISSN 0719-8884 Available at: https://www.archdaily.com/916062/reaction-and-fire-resistance-how-are-materials-classified-in-the-event-of-a-fire. [online]

[9] KLOPOVIC S., TURAN ÖF., 1998. Flames Venting Externally during Full-scale Flashover Fires: Two Sample Ventilation Cases, *Fire Safety Journal* 31(2), p. 117

[10] PENG, L., ZHAOPENG. Ni, and XIN H. Review on the fire safety of exterior wall claddings in high-rise buildings in China. The 9th Asia-Oceania Symposium on Fire Science and Technology, Procedia Engineering 62 (2013), pp. 663