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Gergő Érces, Sándor Rácz

SPATIAL FUNDAMENTALS OF THE PROTECTION AGAINST FIRE SPREAD RELATIONSHIP BETWEEN THE RISK UNIT AND THE FIRE SECTION IN HUNGARY

Abstract

The spatial characteristics of fire spread fundamentally determine the ways in which fire propagation protection is designed. According to the Hungarian regulations, the extent of the basic units of fire protection is currently determined by means of risk-based analysis. Taking into account the spatial effects of fire, the authors analyse the real spatial aspects of protection against the fire spread e in the paper. The relationships between risk units and fire sections are presented. Novel complex design methods are described for the analytical possibilities in building information modelling and in the context of fire sections studied by network research methods.

Keywords: risk unit, fire section, fire spread, BIM

A TŰZTERJEDÉS ELLENI VÉDELEM TÉRBELI ALAPVETÉSEI A KOCKÁZATI EGYSÉG ÉS TŰZSZAKASZ VISZONYA MAGYARORSZÁGON

Absztrakt

A tűz terjedésének térbeli jellemzői alapvetően határozzák meg a tűzterjedés elleni védelem kialakításának módozatait. A magyarországi szabályozás értelmében, napjainkban a kockázatelvű elemzés útján határozzák meg a tűzterjedés elleni védelem alapvető egységeinek mértékét. A tűz térbeli hatásainak figyelembevételével a szerzők a tűzterjedés elleni védelem valós térbeli aspektusait elemzik a publikációban. Bemutatják a kockázati egységek és tűzszakaszok összefüggéseit. Ismertetik az épületinformációs modellezésben és a hálózatkutatási módszerekkel vizsgált tűzszakaszok összefüggéseiben rejlő elemzési lehetőségeket újszerű komplex tervezési módszereket.

Kulcsszavak: kockázati egység, tűzszakasz, tűzterjedés, BIM

1. INTRODUCTION

Among other things, in order to create security and prevent danger, the human brain is able to map the space around us in three dimensions. We are also able to interpret and evaluate what we have seen, so we can make appropriate decisions for the survival. Albert Szent-Györgyi's idea defines one of the biological pillars of the preventive activities. Based on it, we can only achieve the necessary security created by regulation if we prevent the danger. The science of prevention has now become a widely accepted and priority discipline in all fields of safety (safety of life, health protection, environmental protection, climate protection, fire protection, etc.) [11] [12]. The importance of prevention has perhaps never been felt in recent decades as much as it is today due to the pandemic. As experts, scientists, doctors, etc. they are looking for preventive methods to prevent the spread of the virus, so the field of fire protection is constantly looking for elementary methods in its field of science that can be used to prevent the fire spread in accordance with the expected safety level [10]. The spatial system of protection against the fire spread is based on a system of risk units and fire sections.

2. FIRE PROTECTION OBJECTIVES AND PLANNING PRINCIPLES IN CASE OF PROTECTION AGAINST FIRE SPREAD

54/2014. (XII. 5.) decree of the Ministry of the Interior about the National Fire Safety Codes (hereinafter: OTSZ) distinguishes three basic protection objectives and sets them as a requirement to be solved:

1. safety of life objectives
2. value protection of community
3. value protection of owners

Of course, the priority is the protection of life, but in the field of protection against the fire spread, a set of solutions for preventing the fire spread must be validated on the basis of the properties of a given spatial system without ranking. It is our basic principle, that a fire generates in a single random space at any time, and anywhere. If we deal with this basic axiom as an evidence, we can say that there is a spatial unit in which, if a fire generates, it can be formed in a spatial sense protected against the fire spread. This smallest spatial unit with fire protection is the fire section. According to the OTSZ a fire section is a building, a specific part of the building, or a specified part of the outdoor storage area, which is designed to be protected against fire spread from the adjacent part of the structure and space. [7]

Thus, in terms of protection objectives, the unit of protection against the smallest elementary spatial fire spread is the fire section. According to the Thermodynamics II definition (Clausius definition): „Heat generally cannot flow spontaneously from a material at a lower temperature to a material at a higher temperature." So in case of fire, the fire spreads from the combustion process with the higher energy level to the spatial systems with the lower energy level. Today it is an evident phenomenon that we are able to correctly interpret and evaluate, but as a result of a very complex and complicated process in the field of technical solutions, we can only create appropriate technical solutions that provide the expected level of safety. In relation to the entropy Clausius stated that „In nature, spontaneous processes take place in which the entropy of the thermodynamic system increases." Entropy is a factor that expresses the degree of disorder. According to the definition above, we need to create a spatially connected system with zero entropy (or close to zero) in order to form a system that is adequately protected from fire spread in an ordered manner. [8]

However, its creation is no longer evident. The OTSZ defines the requirement system using a modern engineering approach and defines the basic requirement coherences. According to this, fire sections with a given maximum floor area must be created depending on the risk class of a specific risk unit. As long as we can design a single-storey building with a clear purpose as a single risk unit, meeting the requirement above is not a big challenge. However, the more directions, the more ways we move away from simple spatial design, the more complex the protection of a building against fire propagation, the more we find that the spatial units become more determinant. That is, the smaller is the degree of disorder (i.e., the entropy of the spatial system), the safer we can apply preventive fire protection methods, and the more accurately we can identify places and periods in which a fire is potentially more likely to generate. Although at any location, at any time, we assume the generation of fire in a building, but its probability in a well-constructed system whose entropy is small or close to zero can be well determined and predicted. To do this, we need to analyse the risks, taking into account the hazards and their extent. [1] [9]

3. RISK UNITS AND RISK CLASSIFICATION

Compared to the regulations from the previous decades, one of the best and one of the most optimal methods from the point of view of the current OTSZ is to determine the risk classes of risk units. From a methodological point of view, this together with the relevant Fire Protection Technical Directives (TvMI), provide designers with a set of tools and methodologies the expected safety level, which can be achieved and justified. The basis of the method is based on the spatial units of the buildings. In such a field the risk unit is therefore the structure or its part delimited from the point of view of the prevention of the fire spread. Within it, during the design, the circumstances determining the risk class must be taken into account to the same extent and in the same way. The risk unit as a spatial unit is very similar to the fire section in terms of fire prevention. The difference is given by the fire protection quality, that in addition to its spatiality, is coded into the concept as a fire protection property by a class definition. This risk class includes, in addition to the quantitative and destination criteria that a fire section has, the conditions that determine the fire protection situation. These must be taken into account during the design in accordance with the legal requirements. This characteristic value of fire protection properties is the risk class, which is defined as: the vulnerability in case of fire, the amount of damage and loss, classification reflecting the extent of additional hazards due to fire. [2]

Determining the fire protection characteristic by the risk classification method is the basic difference between the fire section and the risk unit. The fire section is a quantitative characteristic, an essential element of a spatial system of protection against the fire spread. In addition to these quantitative values, the risk class is a larger system with quality characteristics. Thus, in terms of design in the field of fire protection factors, the risk unit is clearly a larger set than the fire section. This means that while a risk unit can basically form a fire section, a fire section may not be able to form a separate risk unit. In addition to the risk classes of risk units, we define the so-called the concept of a standard risk class. This structure is a classification for the whole part of the building and is the strictest of the risk classes of the risk units. Its significance is related to the basic tool system of passive fire protection, the determination of the fire resistance performance of basic fire protection structures. In the sense that the minimum value of the fire resistance limit requirement depends on the relevant risk class for the whole structure.

Overall, it can be stated that a risk unit and its risk class are an essential spatial characteristic of the degree of safety expected, which is the sum of fire and fire protection quality characteristics. On the other hand, the fire section, is a spatial unit without a fire protection quality value, which can be interpreted as part of the risk unit as a factor against the fire spread. Therefore, its extent depends on the risk class and purpose of the risk unit. Thus, the fire section is a floor area criterion in this system of relations, depending on the risk class and purpose of the risk unit, the maximum value of which is defined by the OTSZ. Built-in automatic fire extinguishers can be considered as a factor influencing the floor area. [3]

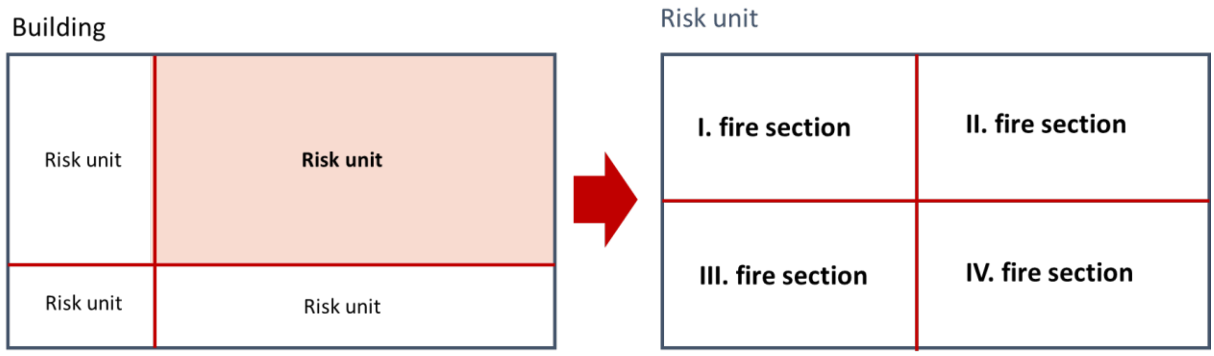

Figure 1 - Building - Risk unit (made by the authors)

Based on the above, we can observe special extremes in relation to risk units and fire sections. These are often used by designers, in many cases to oversimplify the risk and spatial fire design required to design to the optimum, which can provide the expected safety level in a long-term sustainable way. One special extreme value is case of 1 building = 1 risk unit = 1 fire section. In case of small, simple buildings, the right structure handles the problems of a possible small but complex building or a functionally diverse structure very superficially. The other extreme value is 1 building = n risk units = n fire sections, i.e. so many risk units so many fire sections. This solution, which is also a popular solution, is a suitable structure for risk units and clearly separable purposes that form a simple spatial unit, but in its context it does not address the long-term sustainable fire protection characteristics of the building as a unit. In case of complex, large buildings, this extreme value is offered as an option. However, this technical solution fragments the building, which becomes a negative factor in the field of fire protection. There is no exact solution formula, but there is a method to create the middle ground, which is 1 building = n risk units = n + x fire sections. [3]

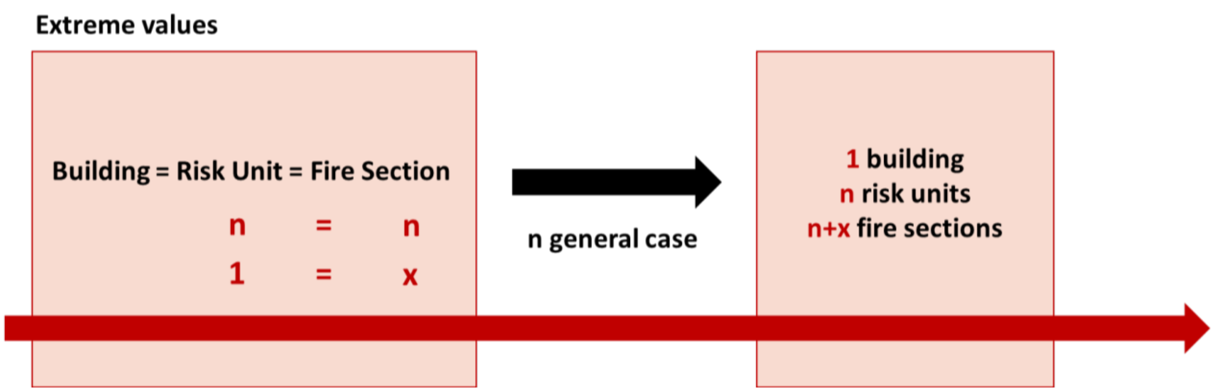

Figure 2 - Extreme values in fire sections (made by the authors).

4. SPATIAL SYSTEM OF THE PREVENTION OF FIRE SPREAD

The human brain maps the world in three dimensions. Reflecting on it, we create extensive structures in 3 dimensions, in which the fire also spreads in 3 dimensions. Accordingly, we must also establish the protection against the fire spread in three dimensions. Nowadays, buildings are designed in two dimensions. The architectural thinking and creative methodology have been moving more and more dynamically to 3D imaging for almost two decades. Even the creation of 3D building models with computer software and architectural documentation is still usually done in 2D. Nowadays, architectural fire design is still implemented with a small extent by analysing 3D models. Practically, 2D architectural documentation is the basis in case of design. In a good case, already in the early phase of the design, even nowadays there is a tendency to prepare fire protection plan chapters, which are followed by the architectural plan.

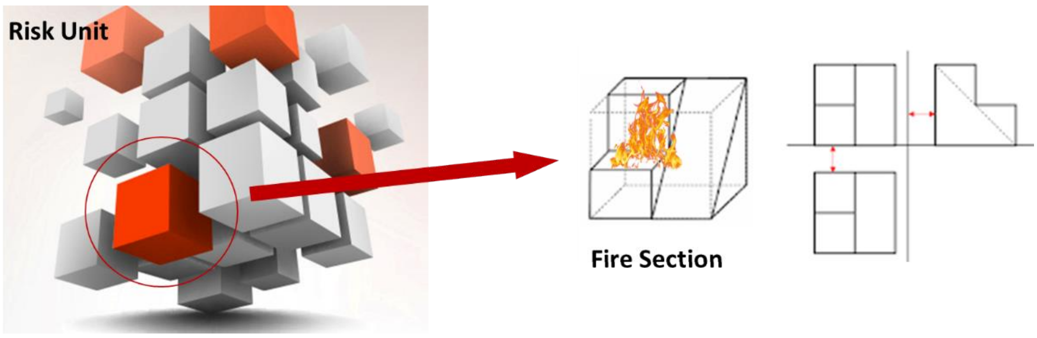

Figure 3 - 3D risk unit analysis (made by the authors)

The aim is to move fire protection planning and above all the protection against fire spread from two-dimensional planes into three-dimensional spaces in order to achieve the appropriate and expected level of long-term sustainable safety. Various computer software and CAD programs are now available for this purpose. These include expensive premium software for serious complex design tasks and cheaper software for simpler tasks. The thinking of a fire protection designer and the engineering approach are supported by the relevant Fire Protection Technical

Directives (TvMI). These include basic technical solutions for fire protection that reflect the 3D spatial complexity of buildings. The guidelines show the direction in case of protection against the spread of facade fire, the fire sections connected in space and the fire section planes at an angle to each other. On the one hand, they do not cover all solutions, and on the other hand, they are not the only solution to meet the given OTSZ requirement. [4]

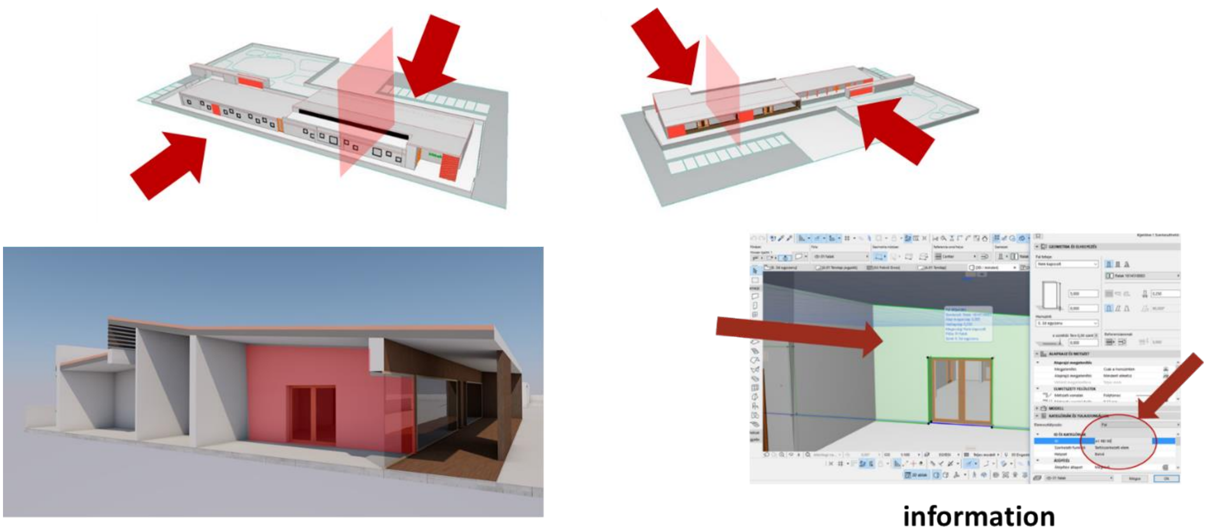

Figure 4 - 3D BIM analysis (made by the authors)

One of the most suitable methods of today's innovative engineering solutions for the adequacy of the spatial design of fire protection is building information modelling (hereinafter BIM). In addition to 3D visualization and design methodology, BIM can also encode the characteristics of fire protection quality as data and information in the design phase of a building. In the virtual model created with the BIM method, which contains fire protection characteristics and parameters, it is possible to analyse more complex spatial and other technical problems. From the point of view of protection against the fire spread, a complex building forms a network-connected system in the field of evacuation and escape routes, which determine the safety of life. In the theoretical graph of this fire protection network forming a temporary protected space system, the network points are the fire sections, the connections that connect them (grey lines) show the spatial interoperability. The green lines are the free connections to a network point, they mean a spatial connection to a safe outdoor space. The degrees of the network points (superscript) indicate the number of connections in the fire section of a given network point. This means the degree of interoperability of the temporary protected space through alternative escape routes. [5]

Fire sections with the highest number of degrees (= most spatial connections): Nr. 5, 6, 10: pressurized smoke-free staircase, 11: pressurized smoke-free staircases provide the backbone of the building's passive fire safety and the protection against the fire spread, because they play a central role with their 5 or 6 spatial connection, which gives the degree. The temporary protected space system of the building and its evacuation are also based on this. Network points with a fundamentally high number of degrees, i.e. fire sections, also show the probability of implementing an evacuation that provides a safe and expected safety level. The higher is the number of network points, i.e. the alternative escape option in case of fire sections, the safer can be the temporary protected space system. It can form the basis of the passive fire protection of the building. The network points with a particularly high number of degrees show the realization of a central fire section, which has a decisive impact on the complex fire safety of the entire building, and therefore plays a key role in terms of the fire protection. Based on the above, according to the degree indexes, staircases 10 and 11 play a central role, therefore by designing them as a pressurized smoke-free staircase, the highest level of the fire protection can be achieved. Fire sections 5 and 6 show the image of a central fire section based on its amount of degree. Therefore, the main fire protection systems and firefighting methods, the fire alarm centre, the fire control centre, etc. it is recommended to be located in these key fire protection units. [6]

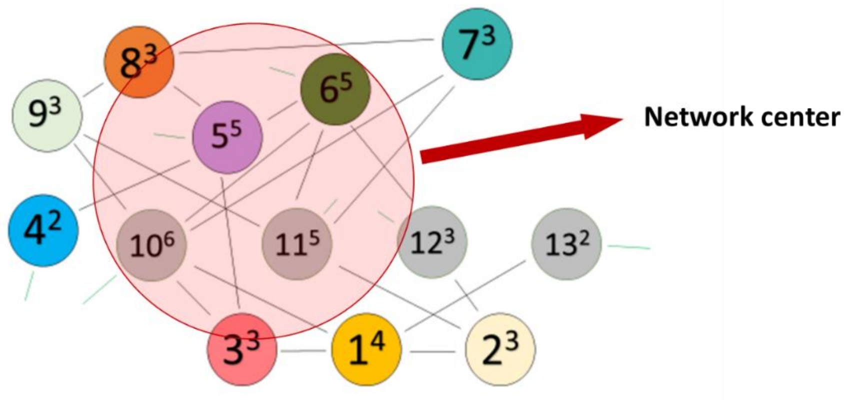

Figure 5. -Fire section network analysis (made by the authors)

5. SUMMARY

It can be seen from the above mentioned example that there was no question of the obligation to comply with the minimum requirements required by the OTSZ. The analysis of the models created with the BIM methodology, the possibilities of their spatial analysis, as well as their evaluation with network analysis methods are the innovative engineering methods of optimal design. In case of buildings created by such methods and designed by such a process, the specified complex fire protection system can be broken down into components. These results can be compared with the requirements obtained by the OTSZ and evaluated in terms of compliance with the expected safety level. However, thanks to the holistic methodology, they provide much more complex solutions in terms of the fire protection quality, as opposed to traditional technical solutions.

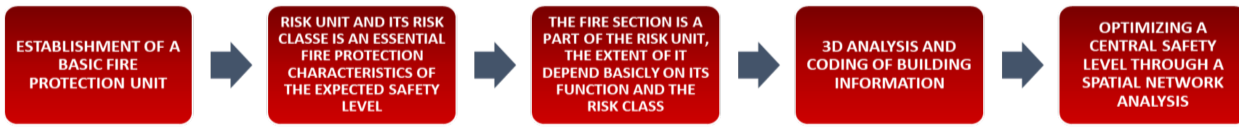

Figure 6. - Analysis method of fire protection unit (made by the authors)

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Gergő Érces PhD., assistant lecturer
University of Public Service Faculty of Law Enforcement Institute of Disaster Management
E-mail: erces.gergo@uni-nke.hu
ORCID: 0000-0002-4464-4604

Sándor Rácz PhD., assistant professor
University of Public Service Faculty of Law Enforcement Institute of Disaster Management
E-mail: racz.sandor@uni-nke.hu
ORCID: 0000-0001-9955-924X