Dr Malina Čvoro 1[1]

Dr Saša Čvoro 2

URBAN AND ARCHITECTURAL MEASURES FOR THE PROTECTION OF THE FIRE /CASE STADY BANJA LUKA/

Abstract: Fire safety is a fundamental consideration in building design and management, but unfortunately, one that is often overlooked. Prevention of fire protection is ensured by planning and implementing preventive measures and actions to prevent the outbreak of fire in the most efficient way. In the event of a fire, the risk to human life and health, the endangering of material goods, as well as environmental damage, shall be reduced to a minimum and limited fire at the place of outbreak. This lecture is focused on the urban and architectural measures for protection of the fire. By two case studies the influence of the fire in process of architectural design are presented and discussed.

Key words: fire protection, fire barrier, horizontal fire facilities, evacuation

The European Commission support for the production of this publication does not constitute an endorsement of the contents which reflects the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

[1] Dr Malina Čvoro, Assistant Professor, Faculty of Architecture, Civil Engineering and Geodesy, University of Banja Luka, Stepe Stepanovića 77/3, email: malina.cvoro@aggf.unibl.org

Dr Saša B. Čvoro, Assistant Professor, Faculty of Architecture, Civil Engineering and Geodesy, University of Banja Luka, Stepe Stepanovića 77/3, email: sasa.cvoro@aggf.unibl.org

1. INTRODUCTION

From the aspect of fire safety, the construction and design of architectural structures is done in such a way that in the event of a fire, the structure can withstand for a certain period of time in terms of load-bearing capacity; zones are designed inside the building that provide restrictions during the creation and spread of fire and smoke within the building, the spread of fire to nearby buildings is limited by the correct distances and heights of buildings, safe evacuation of occupants from the building in flames.

Achieving the above requirements is enabled by active and passive fire protection measures, Active fire protection measures include alarm systems, sprinklers, fire removal installations, etc., Passive fire protection measures include the use of appropriate structural systems, appropriate materials and management risks in case of fire.

1.1. Categorization by fire threat

In order to determine the appropriate organization and undertaking the measures necessary for the successful functioning and implementation of fire protection, the Ministry carries out the categorization of facilities, activities and land according to the threat of fire, depending on;

- the technological process that takes place in them;
- types and quantities of materials produced, processed or stored;
- types of materials used to build the building;
- the importance and size of the building;
- the type of plant cover.

Objects, activities and land are classified into the following categories: with a high risk of fire outbreaks - the first category of vulnerability to fire; with an increased risk of fire outbreaks – the second category of vulnerability to fire and a certain risk of outbreaks - third category of fire hazard.

2. MEASURES FOR FIRE PROTECTION IN URBANISM

Design of fire protection in residential, public, commercial and infrastructural facilities is performed on the basis of certain laws and regulations and accepted standards in the field of fire protection. [1].

Reconstruction of existing buildings in settlements should not increase the total existing fire load of the building or settlement. In the planning, design and reconstruction of buildings, it is important to take into account the maximum reduction of fire risk, sometimes with the necessary certain changes in project documentation. In order to prevent the spread of fire from one building to the neighboring building, it is necessary to determine the exact distance between them. Free space between buildings, if it is wide

enough, is the safest fire barrier. If the distance between the two buildings is small, the fire will easily spread to the neighboring building. In the past, entire villages or parts of the city disappeared in a fire because the buildings were very densely built.

The sizing of the free space should be performed in a way that would prevent the spread of fire from one building to another, without taking up too much construction space. The minimum distance between two moderately risky buildings with normal windows facing each other is 12 m; for a four-storey building - 16 m, for eight-storey buildings - 22 m and for six-storey buildings - 30 m [2].

Spatial and urban plan, in addition to the conditions prescribed by a special law, contain:

- sources of water supply and capacity of the city water supply network that provide sufficient quantities of water for extinguishing the fire;
- access roads and passages to facilities for fire-fighting vehicles;
- safety belts between buildings that prevent the spread of fire;
- the distance between the zones envisaged for housing and facilities for public purposes and the zones envisaged for industrial objects and special purpose objects.

2.1. Hydrant network

Water supply sources and the capacity of the city water supply network should provide enough water for firefighting. For powering the hydrant network, any source whose capacity can provide the required amount of fire extinguishing water for a period of 2 hours can be used: groundwater from excavated or drilled wells, temporary water supply of surface waters, buried tanks, semi-tanks or above the ground.

- External hydrant network - underground and overhead hydrants
- Inner hydrant network
- Dry hydrant network
- Pressure boosting devices

External hydrant network it is made in the form of a ring pipeline system, the distance between the two hydrants is not more than 80 m, in the populated areas with predominantly residential buildings - the distance between the external hydrants can be up to a maximum of 150 m, the distance of the hydrants from the wall of the building must be at least 5 m and at most 80m.

Hydrant network with all devices and armature is controlled at least once a year. During control, the pressure of water in the hydrant network is measured while simultaneously operating all external and internal hydrants that provide the necessary flow of fire extinguishing water in a particular object. Hydrants are equipped with nozzles with a mouthpiece of 16 mm in diameter, and on the inner hydrants, nozzles with a mouthpiece of 12 mm in diameter are placed. The pressure is measured at the control nozzle on the highest floor or on the hydrant that is farthest it from the connector [2].

2.2. Access roads and passes for fire trucks to objects

The access road for fire trucks has the following characteristics: minimum width of the carriageway (one-way vehicle movement is 3.5 m, and two-way vehicle movement 6 m); the inner radius of the curve leaving the vehicle's wheels is 7 m, and the outer radius of the curve is 10.5 m. The rise (ramp) must be less than 12%, if there is freezing, then less than 6%. Access and stopping other vehicles is not allowed on the access road for fire vehicles, especially on the side of the building where the increased risk of fire.

Preventing access by other vehicles to an access road for fire-fighting vehicles is carried out: barrier in the form of disassembling "pyramids", weighing more than 60 kg and less than 100 kg and a wired or similar fence that can be easily cut with a tool that use by firefighters. Traffic circle for fire trucks can be: circular, "O" or "P" - where the vehicle is moving only in advance and the "T" shape where the maneuvering of the vehicle is allowed.

2.3. Safety belts between objects

The free space between the two buildings if it is wide enough representing the safest fire barrier. The minimum allowed distance between the buildings depends on the type and purpose of the buildings, the fire load, the size of the individual openings, and others.

L min = h1 / 2 + h2 / 2 + a

where h1and h2 is the height of the adjacent objects and the constant a represents the width of the free-of-ruin road and is 4 m [3].

3. FIRE SECTORS - PURPOSE AND OBJECTIVE

Time is more important to the evaluation of manual extinguishment than any other component, except perhaps life safety by leaving. Therefore, estimating the time duration for a series of relatively independent, albeit related events, becomes vital for understanding fire performance. Fire diagnosis, building design, detection and notification of firefighters are under the supervision of the owner and tenants. The response of the fire service from the notification to the first arrival is under the management of the community. The performance analysis of the building has the advantage of knowing the location and condition of the fire at the time of the arrival of the fire service. The time from control to extinguishing can be relatively short or very long, depending on the size and conditions of the complex fire, the design of the building and the resources of the fire service.

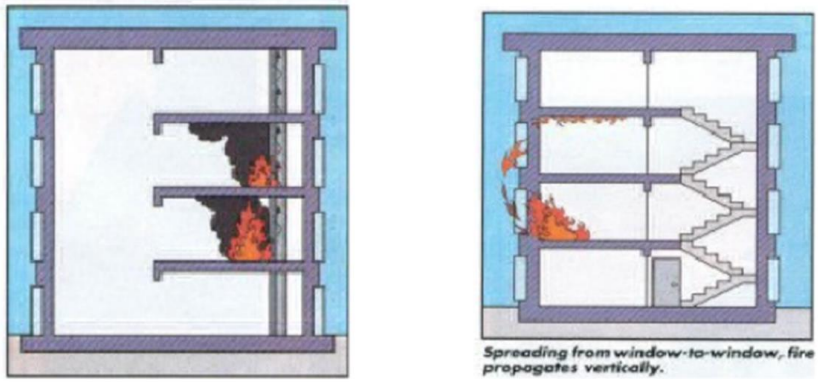

Figure 1 – Spreading from window to window, fire propogotes vertically

The fire department is a space in a building that is separated from other parts by a firewall or an ceiling. We look at the fire department as part of a building that will be completely destroyed by the possible fire. In order to minimize the damage, it is trying to minimize the fire sector.

3.1. Horizontal fire facilities

Horizontal barriers - interconnected structures of non-combustible materials with higher fire resistance (1h - 4h) are installed to prevent the spread of fire in the vertical direction.

As a rule, fire barriers should not have any openings on a section, but at the present level of the construction industry it is not possible, because there are a number of openings for installations in the landings. Such sites are very dangerous in terms of fire propagation and must be effectively protected. Barriers are important for normal building functions as well as fire safety performance. Horizontal and vertical barriers separate spaces to define rooms and provide privacy, security, and noise control. Barrier openings provide routes for physical, visual, and informational communication using devices such as doors, windows, piping, and electrical conduits. They sometimes provide or hide routes to convey services such as electricity, water, waste disposal, heat, and air [4].

In order for people to be able to leave the endangered room in time during a fire and thus avoid danger, it is necessary to have a sufficient number of exits of appropriate dimensions. It is also necessary that the layout of the exits be such that it is possible to leave the building at any time.

Table 1- the distance between two adjacent exits from the building

degree of fire resistance of the building	the greatest distance from the exit (m)
I and II	15
III	20
IV	25

3.2. Fire (safety) stairs

Exterior staircases - non-combustible material, stairs are not allowed to be located at a distance less than 1.5 m from the facade opening, the height of the guard rail must not be less than 1.2 m, the staircase must not be spiral, the width of the stair arm must be at least 1,25 m.

Interior stairs - enclosed by a wall of fire resistant material of 1.5 hours of fire resistance, must have built-in materials A class which are non-combustible, the staircase must be provided from the fire and smoke.

3.3. Lifts (Elevator)

Since we can not put any horizontal barriers in the elevators, then the basic protection measure remains a good insulation of the elevator from the rest of the building with fireproof constructions.

Elevator wall / 2 h /, elevator doors / 1 / 2 h /, lift installations in the highest part of the lift window in a separate room, in case of danger the elevator cab in the upper part must have an escape hatch.

Obstacles are important for firefighting. Partitions can direct smoke and heat toward or away from firefighters. They can prevent the spread of fire or they can block firefighters and water use. Barriers can help establish a fire control line. Partitions sometimes help put out fires; sometimes interfere with effective firefighting. Regardless of their usefulness, the existing obstacles in the building are part of firefighting and building performance assessments.

4. CASE STUDY BANJA LUKA

The Faculty of Architecture, Civil Engineering and Geodesy in Banja Luka does not have its own building, since the moment when it was formed in 1996, classes have been held at several different locations in the city. In 2008, the Faculty and the University of Banja Luka launched an initiative to develop a conceptual design and then investment and technical documentation for the construction of a new building of the Faculty of Architecture, Civil Engineering and Geodesy in the University City of Banja Luka within the University City complex.

The location for the construction of the building of the Faculty of Architecture and Civil Engineering is located in the complex of the former JNA barracks Vrbas, which is today part of the University City in Banja Luka. The complex "University City" in Banja

Luka was placed under protection by the Decision of the Ministry of Physical Planning, Construction and Ecology of the Republic of Srpska, number 15.04-960-39 / 11 from 16.05.2012. [5] The University Park has become the most important park in the city, and is officially on the list of protected due to its plant and historical significance. There are 1,500 trees in the park, of which the rows of plane trees, hundreds of years old, stand out. In addition to trees, the park is home to 48 species of birds, some of which are legally protected.

4.1. Case study 1 - Faculty of Architecture Civil Engineering and Geodesy, University of Banja Luka

The basic task in the process of building a new building of the Faculty, which we gave ourselves as authors through the Preliminary Design, is to set new values and ways of behavior in this specific space [6]. As well as the establishment of order in the morphological structure of the University City, in accordance with the spatial context dominated by the existing fund of nature.

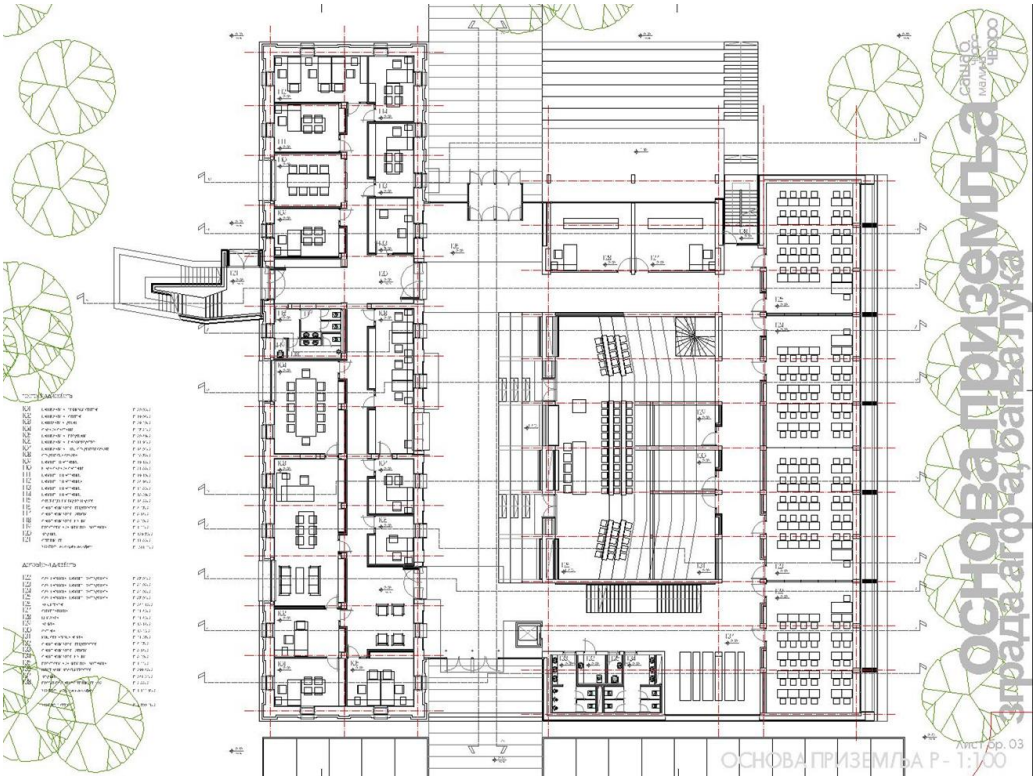

Figure 2 – plan of building , authors Saša Čvoro and Malina Čvoro

The building was built as an extension of the old building from the 19th century and this is a project and a model for the new building. In the project we take care of:

- Orientation of the building is in the direction of the dominant air flow for the purpose of good ventilation;
- The central street is an upright vertical, which allows for a good squeeze and push the air /smoke/ out;
- The building is divided into two fire departmental areas that are separated by a central street;
- External fire stair risers;
- Staircase verticals installed in a way that meets the statutory standards;
- Internal and external hydrant network.

At the photographs of the process of building new Faculty of Architecture, Civil Engineering and Geodesy in Banja Luka it can be seen that the building is not finished yet.

Figure 3 – New Faculty of Architecture, Civil Engineering and Geodesy in Banja Luka.

4.2. Case study 2 - Student dorms

This building is also built in the University Campus in Banja Luka. The location is very close to Boulevard Vojvode Petra Bojovica. In the beginning of the project there were three buildings in this location.

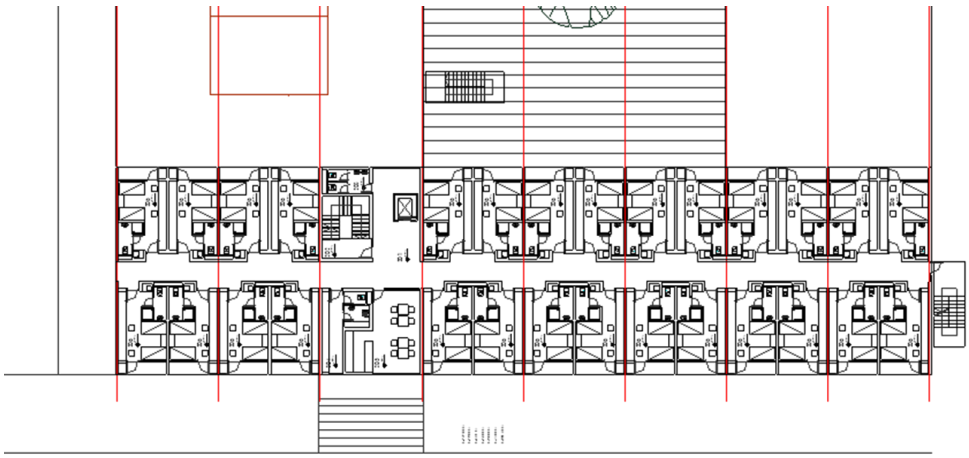

Figure 4 – plan of student dorms , authors Saša Čvoro and Malina Čvoro

We built only one building from this complex and we followed these rules:

- The possibility of access to the facility by vehicles from all sides;
- Internal and external hydrant network;
- Internal communication staircases;
- External fire staircases;
- The object is divided in the fire department. One floor is one fire department;
- Fire clips at the breakthroughs of installation verticals through the fire department.

This is how the building looks today.

Figure 4 - Student dorms Nikola Tesla Pavilion 4, Banja Luka

5. CONCLUSIONS

Saving lives is of great importance for ensuring the basic goal of fire protection of buildings. For this reason, it is very important to take into account all measures of active and passive fire protection when designing buildings. Unlike daily leaving the building during normal use, forced evacuation in case of fire occurs suddenly without the possibility of its prediction. The architectural plan of the building should basically ensure the unhindered movement of the mass of people.

6. REFERENCES

[1] J. Radosavljevic, L. Milosevic, A. Vukadinovic, D. Ristic, A. Petkovic, (2015) *Urban Planning and Fire Protection*, University of Niš, Niš

[2] Government of Republika Srpska, *Fire Protection Act* (2019) 94/19- 11/13/2019

[3] *Rule Book on technical standarda for protection of high buildings from fire* (2017) "Official Gazette of RS", No. 80/2015, 67/2017 and 103/2018

[4] Robert W. Fitzgerald, Brian J. Meacham (2017) Fire Performance Analysis for Buildings. Worcester Polytechnic Institute, MA, USA

[5] S. Čvoro, M. Čvoro (2015),,*The transformation of existing*“, INTERNATIONAL INTERDISCIPLINARY SCIENTIFIC CONFERENCE - RADICAL SPACE IN BETWEEN DISCIPLINES“ Novi Sad ISBN: 978-86-7892-755-3

[6] University of Banja Luka, Institute for Genetic Resources, University of Banja Luka, Genetic Resources Institute http://gri.unibl.org/index.php?idsek=158