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QUALITATIVE AND QUANTITATIVE FIRE RISK ASSESSMENT OF HIGH SCHOOL "SAMI FRASHERI"

Almir Rushiti[1], Meri Cvetkovska[2]

[1] Faculty of Civil Engineering and Architecture, University "Mother Teresa", Skopje, Republic of North Macedonia*
[2] Department of Mechanics and Materials, Faculty of Civil Engineering, University "Ss. Cyril and Methodius", Skopje, Republic of North Macedonia
[*]Corresponding author e-mail: almir.rushiti@unt.edu.mk

Abstract

A fire risk assessment of High School "Sami Frasheri" was conducted, and the results are presented in this paper. The level of fire risk was defined by using qualitative and quantitative methods and depending on the defined level of risk, adequate measures for risk reduction are proposed. The elementary approach of Five Steps and the Matrix method were applied as qualitative methods for fire risk analysis and the Euroalarm method was used as a quantitative method for fire risk analysis. The analysis showed that the school does not meet the fire safety measures and this is due to several factors: lack of appropriate fire protection measures, lack of an adequate number of fire extinguishers and hydrants, lack of alarm for fire detection, lack of trained staff, lack of fire department, lack of fire stairs, doors, and lack of adequate signaling. Based on the results of the performed analysis, qualitative risk assessment method can be applied for rapid and initial fire risk assessment, but for a more detailed analysis, the use of quantitative methods is more effective and provides more specific results.

Keywords: Five step Method, Matrix Method, Euroalarm Method, hazard, risk, risk assessment

1 Introduction

The subject of the research presented in this paper is an assessment of risk pertaining to the fire outbreak for the High School "Sami Frasheri" in Kumanovo. Measures for protection against fire have been the subject of research, namely, whether they exist and, if they exist, whether they are appropriate and sufficient for the management of hazards causing fires, or whether they should be improved.

The main objective of the investigations presented in the paper has been the definition of the reasons for the occurrence of fire in the school and the damage it will cause.

Using these data, an assessment has been made as to whether the structure satisfies some or all necessary conditions for protection against fire and whether corresponding measures are taken to avoid fire outbreaks.

Assessment of the risk pertaining to a fire outbreak in the structure has been made by means of a prepared and conducted poll based on the Elementary Method for assessment of the risk pertaining to a fire outbreak. In combination with the Matrix Method for risk assessment, is made the classification of structures according to their associated risk related to fire outbreak.

The final task of this method is to define the range of risk values corresponding to three risk categories.

For more detailed analysis, the quantitative method Euroalarm has been used as the basis for decision-making about the establishment of an automatic stationary system for fire extinguishing as well as making decisions about additional measures for protection against fire. The justification for the installation of a fire extinguishing system has been defined based on a more detailed analysis and application of the Euroalarm Method, which is the basis for deciding on installation of an automatic stationary system for fire extinguishing as well as taking of additional measures for protection against fire. The installation of a fire extinguishing system is justified based on:

1. The number of elements at risk related to fire outbreak in the structure (bearing elements, floor structures, roof structures, etc.): the risk of the structure related to fire depends on the possible intensity of the fire and its duration due to structural characteristics, i.e., bearing elements of the structure (resistance of the structure to high temperatures). It is computed by use of the following expression:

$$\mathrm{Ro} = \frac{\left((Po * C) + Pk\right) * B * L * S}{W * Ri}$$

2. The risk related to fire outbreak for the contents of the structure (people, equipment, furniture, stored goods and alike) is computed according to the following expression:

$$R_s = H \cdot D \cdot F$$

For the obtained values of R0 and Rs, the computation point is defined by means of the enclosed diagram, using the known abscissa (risk related to fire outbreak for the contents of the structure) and ordinate (risk related to fire outbreak for the structure). When the computation point is within the derived part of the diagram, the installation of a stationary fire extinguishing system in structures is justified based on the size of the risk of fire outbreak in the structure. If the computation results in a point that is beyond the diagram, it is necessary to take measures such as, for example, replacement of the main structural elements, reduction of the fire load on the structure, establishment of a firefighting unit, or other measures.

2 Quality Assessment of Risk Pertaining to Fire Outbreak

From the poll conducted at High School “Sami Frasheri”, it has been concluded that the structure is in very bad condition from the aspect of conditions related to protection against fire.

The probability of a fire outbreak in this school is very high. In case of a fire outbreak, the fire may be spread very easily. This is due to the low-quality interior structure, the presence of flammable matters inside the structure, the lack of devices for protection against fire, the lack of an alarm system for the detection of fire, and the lack of trained personnel.

The fire outbreak in this structure would result in large consequences and the people present in the structure would be exposed to great danger. Table 2.1. shows the category of risk to which the structure is exposed, obtained by use of the Matrix Method.

Table 2.1: Category of risk to which High School “Sami Frasheri” is exposed

Structure	Fire Hazard	Fire Risk	Risk value	Risk Category
	Description	Description	Fire Hazard x Fire Risk	
High School “Sami Frasheri”	Difficult (4)	Probable (4)	**16**	**High**

Based on the results obtained, it is recommended to increase the number of existing extinguishers and the number of trained personnel, who will know how to use them, install a fire alarm system, make an evacuation plan, perform drills for the teachers and the pupils from time to time to explain to them how to act in case of fire and equip the structure with corresponding signalization and signs for exit from the structure.

3 Quantitative Assessment of Risk Pertaining to Fire Outbreak

The risk related to fire outbreak for the structure depends on the possible intensity and duration of fire due to structural characteristics, i.e., bearing elements of the structure (resistance of the structure to high temperatures) and is computed by use of the following expression:

$$\text{Ro} = \frac{\left((Po * C) + Pk\right) * B * L * S}{W * Ri}$$

The fire load has been considered in accordance with the special standard MKS. U.J.1.030 and is given in the following tabular presentation:

Type of structure	P_0 (MJ/m^2)	Hazard category	Smokiness	Corrosion
School building	**251**	**IV**	**-**	**-**

Table 1: Coefficient of fire load on contents of the structure P_0

Heat power - P_0 (MJ/m2)	P_0
0÷251	1
252÷502	1.2
503÷1004	1.4
1005÷2009	1.6
2010÷4019	2
4020÷8038	2.4
8039÷16077	2.8
16078÷32154	3.4
32155÷64309	3.9
64310 -	4

Table 2: Coefficient of combustibility of the contents of the structure C

Category of fire resistance	VI	V	IV	III	II	I
Combustibility coefficient - C	1	1	1	1.2	1.4	1.6

Table 3: Coefficient of fire load due to materials built-in the structure of the building P_k

MJ/m^2	0-419	435-837	845-1675	1691-4187	4203-8373
P_k	0	0.2	0.4	0.6	0.8

Table 4: Coefficient of size and position of fire sector B

Characteristics of the structure	Coefficient B
Fire sector of up to 1500 m^2	1
Height of premises of up to 10 m	
Three storeys at the most	
Fire sector 1500-3000 m^2	1.3
4 to 8 storeys	
Height of premises 10-25 m	
One souterrain storey	
Fire sector 3000-10000 m^2	1.6
More than 8 storeys	
Height of premises of more than 25m	
More than two levels at the souterrain	
Fire sector of over 10000 m^2	2

Table 5: Delay coefficient of the extinguishing start L

Time until beginning of extinguishing (min)		Up to 10	10 to 20	20 to 30	over 30
Distance (km)		1	1 to 6	6 to 11	over 11
Type of firefighting unit	The professional industrial firefighting unit	1	1.1	1.3	1.5
	The voluntary industrial firefighting unit	1.1	1.2	1.4	1.6
	Territorial Fire Fighting Unit	1	1.1	1.2	1.4
	Territorial voluntary firefighting unit that is permanently on duty	1.1	1.2	1.3	1.5
	Territorial voluntary firefighting unit that is not permanently on duty	1.3	1.4	1.6	1.8

Table 6: Coefficient of width of the fire sector S

The least width of the fire sector (m)	S
up to 20	1
20 – 40	1.1
40 – 60	1.2
over 60	1.3

Table 7: Coefficient of resistance of bearing structures to fire W

Resistance to fire in (min)	At least up to 30	30	60	90	120	180	240
W	1	1.3	1.5	1.6	1.8	1.9	2

Table 8: Coefficient of reduction of the risk pertaining to fire outbreak R_i

Risk assessment	Factors affecting risk assessment	R_i – Coefficient of risk reduction
Maximum	The high flammability of the material and storage at large inter-distances	1
	Fast spreading of fire is expected	
	In the very process of functioning, there is a great number of possible fire outbreaks.	
Normal	The flammability is not particularly high, whereas storage is at distances sufficient for handling.	1.3
	The normal speed of fire spreading is expected	
	In the very process of functioning, there are normal sources of ignition	
Less than normal	Reduced flammability due to the use of inflammable packing	1.6
	Fast spreading of fire is not expected	
	Ground floor structures covering an area of up to 3000 m^2	
	Structures in which the elimination of smoke and heat is anticipated	
Negligible	Low probability of ignition	2
	Quite slow fire spreading is expected	

$$\text{Ro} = \frac{\left((Po * C) + Pk\right) * B * L * S}{W * Ri} = 1$$

$R_o < 1$ – The structure should be protected by manual extinguishers as are portable and vehicle-mounted extinguishers.

R_o = (1 – 1,6) – The structure should be protected by upgrading the previously mentioned measures of protection with a corresponding system for detection, information and alarm.

R_o = (1,6 – 4,5) – The structure should be protected by both previously mentioned measures of protection and a corresponding fire extinguishing system.

$R_o > 4,5$ – In addition to the previously stated measures for protection, the structure should also be protected against fire by additional prevention measures in order to reduce the risk pertaining to fire outbreak.

4 Exposure of the Structure Contents to Risk Related to Fire Outbreak

The risk related to a fire outbreak to which the contents of the structure (danger for the people, the equipment, and alike) are exposed is indicated by Rs and is computed by use of the following expression:

Table 9: Danger to which people are exposed H

Level of endangerment	Coefficient H
There is no danger for the people in the structure	1
There is a danger for the people in the structure, but they can save themselves	2
There is a danger for the people and evacuation is aggravated (high smokiness, a large number of present persons, fast spreading of fire, multi-story structure, presence of disabled persons – sick persons, old people, children)	3

Table 10: Coefficient of risk for the devices D

Concentration of values	Coefficient D
The contents of the structure are not of high value and have a low tendency to destruction	1
The contents of the structure have value and a tendency to destruction	2
The destruction of the value is final, and the losses are irreparable (cultural goods and alike), or with their destruction, the existence of the inhabitants is directly endangered.	3

Table 11: Smoke efficiency F

Factors leading to the occurrence of smoke	Coefficient F
There is no danger of the occurrence of smoke and corrosion	1
More than 20% of the total weight of all flammable materials cause smokiness or release poisonous products from combustion	1.5
More than 50% of the total weight of all flammable materials causes smokiness or release of poisonous products from combustion	2
More than 20% of the total weight of all flammable materials consists of materials that release highly corrosive matter.	2

$$R_s = H \cdot D \cdot F = \mathbf{3}$$

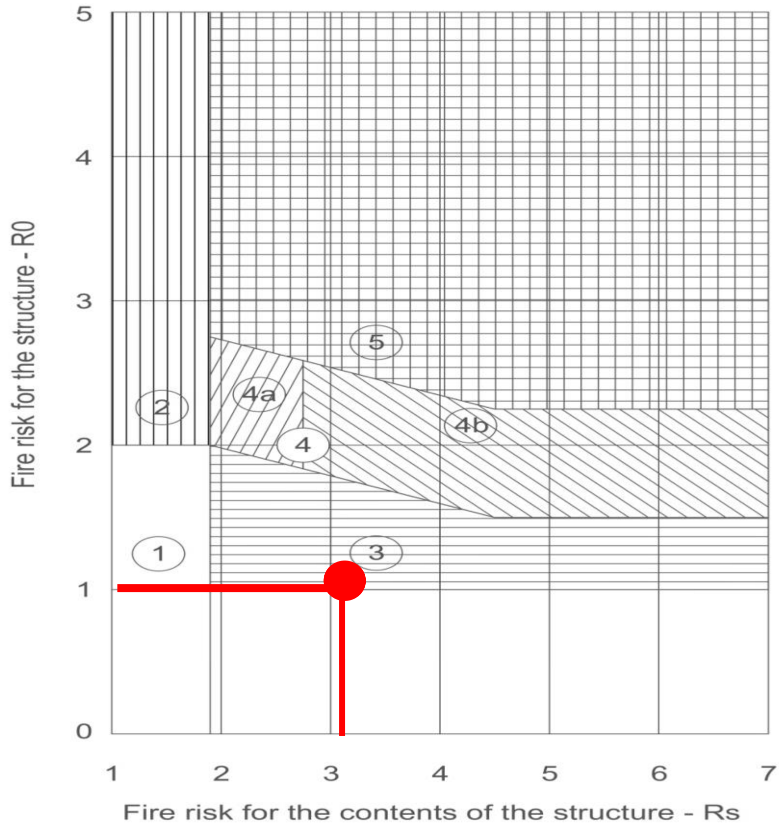

Figure 1: $R_0 – R_s$ graph

From the presented graph, one can define the computation point from the obtained values of fire risk for the structure – R_0 and fire risk for the contents of the structure – R_s. If this point is in the zone of the given curve and in the zone below the given curve, it is considered that, for such structures, it is justified to install an automatic stable system for detection and alarm in case of a fire outbreak, but not an automatic stable system for fire extinguishing (for example, a system of sprinklers). From the above computations and analyses, the **installation of a fire alarm system is necessary for the structure**.

Conclusion

In accordance with the conducted research, it can be concluded that High School “Sami Frasheri” is in very bad condition and does not fulfill the measures for protection against fire outbreaks.

The analysis has shown that, for fast and initial, but still sufficiently accurate assessment of the risk pertaining to a fire outbreak, one can use qualitative methods such as the Matrix Method and the Elementary Five-Step Method.

Compared to quality methods, in accordance with the conducted research, one can conclude that the application of quantitative methods as is the Euroalarm Method, is more effective and these methods are used for more detailed analyses in assessing the risk related to fire outbreaks in a specific structure

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