“THE ROLE OF FIREFIGHTERS IN EARTHQUAKES IN THE REPUBLIC OF CROATIA”

Research Paper

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“Abstract”

The research paper will describe the fire department that participates in different types of interventions. Elaborating on the topic, earthquakes in general will be described. Firefighters, as an important service in the operational response to natural disasters, teach, educate and train their personnel. Therefore, firefighters understand their role in earthquakes, the risks and dangers during earthquake interventions, and stress as a source of danger for the long-term health of firefighter-rescuers. As the physical danger is very explicit, it is important to mention stress as a source of danger in rescue operations from the ruins. If we divide crisis management into phases, we conclude that there is a preventive and operational phase. When we talk about the operational phase, these are primary and secondary activities. Firefighters participate in interventions in both primary and secondary activities. Any type of investment in firefighting increases the safety of the area where the fire department operates.

Keywords: Firefighting, Earthquake, Stress, Rescue from rubble.

1 Introduction

Firefighting is a multidisciplinary activity that has been active since the time of the Roman Emperor Augustus (63 BC - 14 AD). With the development of firefighting, the distribution of firefighters by duty begins. With the organization of the fire service and the division of firefighters by duty, firefighting is gaining more and more dimension and importance in society. The history of overall firefighting is based on fires, fire protection, firefighting methods and fire extinguishing vehicles (syringes). Fire is one of the most extensive branches of firefighting, and the majority of interventions are based on fires, but we should certainly mention other interventions performed by firefighters.

As we have mentioned, firefighting is a multidisciplinary activity that participates in the implementation of fire and explosion protection measures, extinguishes fires and explosions, rescues people and property endangered by fire or explosion, provides technical assistance in accidents and dangerous situations and performs other tasks in accidents and environmental and other accidents.

With the modernization of technology and the World globalization, the need for firefighters is growing. As the new technology came, so did the fire danger, the number of technical interventions in traffic increased with the increase in traffic, with the construction of industries, the number of interventions related to environmental catastrophe is growing, and so on. We cannot say that technology alone is the main culprit for the increase in the number of interventions, changes in climate and soil composition, and housing in unfavorable terrains that cause natural disasters (Ambrenac, 2020).

The role of firefighters in natural disasters has been proven from the recent past until today. In the event of an earthquake, classified rescuers are engaged, who are most often members of fire brigades and have the appropriate equipment to respond to such interventions. When it comes to casualties who are on the surface, the rescue can be done by any civilian who is found near the accident. With devastating earthquakes, the victims remain buried and walled up in buildings, and then there is a need for the

intervention of specialized rescuers who are trained for such interventions and have developed the necessary knowledge.

Qualified rescuers from the rubble are familiar with a number of secondary consequences caused by the accident, rescue equipment and rescue techniques. Intervention for the purpose of rescuing people from the ruins, becomes a separate unit and is separated from the technical service in the fire department. The importance of intervening in the ruins has increased sharply due to public pressure and the approach and manner of intervention has changed. Interventions are happening faster and faster, there are sudden changes in the situation and the reaction time to interventions is greatly reduced compared to the past. The dangers of rescue interventions in the ruins are very great, they need to be eliminated, and if this is not possible, they need to be reduced to an acceptable level for rescuers and victims trapped in the ruins.

By studying new techniques, improving in the form of technique and individual resourcefulness of individual firefighters-rescuers, the quality and efficiency of such interventions is increased, and the speed of execution is reduced, which greatly increases the chances of success in rescue (Gorički, 2014).

2 Earthquake

An earthquake is a movement of the soil and is caused by natural forces in the interior of the country (Pevec, 2001). The short periodic movement of the soil is strong enough that it can be felt by humans, animals and even seismologists in a wide area around the epicenter (Humski et al, 2021). The cause of an earthquake is the release of energy in a certain area of the interior of the country, in the hypocenter or the focus of the earthquake. With the release of energy, i.e. at the moment of rock rupture, the energy passes into seismic energy, which consists of two waves, longitudinal and transverse, and the waves propagate on all sides of the hypocenter. The longitudinal wave is faster and longitudinal, and the transverse wave is slower and transverse.

When they come to the surface, the waves propagate like surface waves. There are two places of earthquakes, the epicenter as a place on the surface of the Earth and is located just above the hypocenter which is inside the country or the place where the earthquake occurred. The earthquake is strongest in the epicenter, and the beginning of the earthquake is manifested as a shock, while moving away from the epicenter occurs irregular rocking left-right (cause of longitudinal wave) and up-naked (cause of transverse wave).

There are three groups of earthquakes if we divide them according to their origin. The first group includes earthquakes caused by the collapse of side walls, in underground cavities, and vaults. Such earthquakes are very few, or they are rare, they make up only 3% of all recorded earthquakes on Earth. The hypocenter of such earthquakes is close to the surface, the energy released is small, so the intensity of earthquakes is very small. Such earthquakes usually result in local ones. The second group of earthquakes are volcanic earthquakes, and they are caused by a blow to the earth's crust during a volcanic eruption. The energy source of these earthquakes is the place of the explosion, and the earthquake-affected area is small due to the very small depth of the epicenter. The strength of these earthquakes is not negligible, moreover, such earthquakes can have a very high strength in the narrower area of the volcano. Only 7% of such earthquakes on Earth were recorded. The third and most common group of earthquakes are tectonic earthquakes. They are formed due to the movement of tectonic plates that were formed by the cracking of the Earth's crust in the earlier stages of the Earth's development. Tectonic earthquakes make up only 90% of all earthquakes on Earth and take on a range of weak to the most terrible earthquakes (Pevec, 2001).

The intensity and strength of an earthquake depends on the amount of energy released. Tectonic earthquakes are divided according to depth into: shallow (up to a depth of 60 km), medium deep (up to

a depth of 300 km) and deep (700 km and more) (Pevec, 2001). Earthquakes in Zagreb and Banovina 2020, according to the classification, belong to shallow earthquakes because the depth of their hypocenter was between 10 and 15 km (Bonevska et al, 2020; Ros Kozarić, 2020).

Until the end of the 19th century, earthquakes were recorded in descriptions and written words, and at the beginning of the 20th century, scientists Richter and Mercalli invented scales for monitoring and recording earthquakes (Nola et al, 2013; Pevec 2001).

The Mercalli and Richter scales are the two scales that are mainly used to record and monitor the intensity of earthquakes in Europe (Humski et al, 2021). Until the end of the 19th century, earthquakes were recorded in descriptions and written words, and at the beginning of the 20th century, scientists Richter and Mercalli invented scales for monitoring and recording earthquakes (Nola et al, 2013; Pevec 2001).

3 The Role of Firefighters in Earthquakes

The fire brigade, in addition to protecting and rescuing people and property from fires, has the task of helping victims of various natural disasters and various accidents and disasters, including this natural disaster. To properly use the equipment owned by the fire brigade, it is inevitable and mandatory to educate firefighters in this direction. It is necessary to acquaint the fire brigade with rescue techniques in a variety of situations.

Each situation requires special improvisation and a separate work approach, and all selected procedures must be performed precisely. As there are many injured people in this catastrophe, it is obligatory for the firefighter to know how to provide immediate first aid (Šimić, 2019).

Rescues according to specifics are divided into rescues from heights, from depths, from ruins, from water and in industry. Earthquakes, as a natural disaster, are characterized by rescue from depths and ruins, and there may be a need for rescue from heights (Popović et al, 2010). After the primary rescue of human and animal lives, it is necessary to mention the performance of various supports, dissections and cleanups (Fišter et al., 1997).

Every rescue begins with a reconnaissance of the commander. The situation assessment and rescue plan are made on the basis of the actual situation on the ground, available forces and equipment. The method of rescue, the road, the necessary forces and equipment contain a plan that should be realized in the shortest possible time. The specific cause of the ruins requires a different approach to rescue. Such interventions, depending on the circumstances, can take days. People trapped in the ruins can survive a certain number of days. Practice has shown that people survived for ten days (Popović et al., 2010).

If we estimate that the rescue will take several hours or even days, it is necessary, if possible, to provide food and water to the victims so that they can survive as long as possible. Firefighters use a variety of available equipment to rescue from the rubble. The Public Fire Brigade of the City of Zagreb is the only unit in the Republic of Croatia that has a special vehicle for heavy rescue in which there is equipment for urban rescue from the ruins. The vehicle can serve two rescue teams in the event of rescue interventions from heights and depths and in the event of serious accidents. This vehicle has greatly facilitated the work of firefighters in the areas affected by the earthquake in the Republic of Croatia because it contains devices and equipment that is distributed to the vehicle and has 2,000 different parts. All the equipment in the vehicle is necessary for the uninterrupted performance of interventions in the form of rescue from the ruins (Gorički and Runjić, 2021).

Rescue from the ruins takes place in phases and the rescue process is divided into five phases. In the first phase, we rescue people who can be seen, who are injured, but are on the surface of the ruins or are

very little buried. We are conducting the first phase during the initial reconnaissance, i.e. in the preparation and elaboration of the rescue operation. The importance of this phase is that the injured can give us complete and accurate information about other victims and the condition of the ruins. People we hear, but they are covered with surface layers of rubble and easy to reach, we rescue in the second phase of rescue. In this phase, access is possible even without major works on clearing the passage. The third phase involves a deeper penetration into the ruin, we do not hear the injured and we must look for them. In the third phase, the technical work of firefighters and the fire brigade operating in the rescue operation comes to the fore. If, after the third phase, we find that there are still buried people under the ruins, the work continues in the fourth phase. To continue the rescue, it is necessary to re-analyze the data on the location and number of buried people. After the teaching analysis of the data, rescue from the deepest layers of the ruins comes to the fore by making deep passages, tunnels and ditches that provide us with access to all living people that we have to pull out of the ruins. The fifth phase consists in rescuing all missing persons from the ruins, both living and dead, if there are any after the first four phases of rescue. In this phase, heavy construction machinery is used, if during excavation and clearing we find certain parts of the body, we immediately stop the operation of the machine and continue manually. All rescues are performed quickly but carefully, the directions of penetration must be as short as possible, the existing openings for entering the ruin are used, and parts of the material must not be rocked, torn or pushed so as not to cause additional collapses that endanger the safety of the injured. and savior. It is always necessary to secure the rubble from collapsing, not to pull the buried person out of the rubble, but to free him from all sides, after the release of the injured person to pull his head forward due to the extremities. Use mechanization only where there is no danger of additional collapse, and only hand tools in order to access the buried. During the rescue of people from the ruins, various methods of supporting, securing, tying, planting the ruins are used, but most things are based on the improvisation and resourcefulness of firefighters (Popović et al, 2006).

After saving of the injured from ruins, firefighters have a big role to play in securing the place affected by the earthquake. Removal of destroyed chimneys, removal of parts of the facade, removal of sloping walls, securing ruins that threaten additional collapse, transportation of drinking water, roof repairs, taking care of people affected by the earthquake are just some of the jobs that firefighters in the Republic of Croatia performed after the devastating earthquakes. Such interventions are complex and complex, requiring knowledge and skills, organization of crisis headquarters, activation of personnel trained in crisis management, and good organization and timely responses. Necessary actions, such as training, education, equipment, planning, etc., should be prepared preventively before a disaster occurs so that everything is ready for a prompt response in the event of a disaster. activation of personnel trained for crisis management and good organization and timely reactions. Necessary actions, such as training, education, equipment, planning, etc., should be prepared preventively before a disaster occurs so that everything is ready for a prompt response in the event of a disaster. activation of personnel trained for crisis management and good organization and timely reactions. Necessary actions, such as training, education, equipment, planning, etc., should be prepared preventively before a disaster occurs so that everything is ready for a prompt response in the event of a disaster.

3.1 Risks and dangers during earthquake interventions

Rescue from ruins, as one of the biggest and most important tasks during an earthquake, is a complex area that contains great danger. Broken utilities, collapse, dust, explosion, poisoning, fire, drowning is just some of the dangers that threaten this rescue (Popović et al, 2010).

In law, due to the dangers posed by earthquake interventions, interventions must be performed by specially trained people who are familiar with the potential dangers. When performing interventions,

the availability of medical staff is required to respond promptly to any injury. Moving through the ruined area, firefighters can fall into the depths or fall from a height. Danger of movement occurs in all forms of firefighting interventions, whether the firefighters were moving at the same level or at an elevated level. The cause of this danger lies in the fact that firefighters move where it is not normal to move, both due to inaccessibility and due to impaired safety. By ensuring the path of movement, we minimize the risks. By dragging firefighters through various areas during firefighting interventions, there are dangers of sharp objects at rest, possible consequences are bodily injuries without permanent consequences, and the possibility of protection against this danger is very small. Sources of mechanical hazards when handling objects and hand tools occur during the clearing of rubble, the transfer of injured persons and property for rescue. Hazards like this are less common, and the consequences can result from minor to more severe injuries that can ultimately result in permanent loss of ability to work. Overloading, loosening, insufficient stability, and the like are typical dangers for interventions in the ruins and pose a great danger to the firefighter-rescuer and can result in fatal consequences. When performing interventions on the ruins, the firefighter may be partially or completely buried, which ultimately puts him in the position of a victim because he is unable to help himself. The firefighter is exposed to several risks with broken communal installations. Danger of electric shock, danger of drowning, danger of various biological hazards (Popović et al, 2006).

Before starting the intervention, it is necessary to stop the flow of all energy sources such as electricity, water, gas and the like and thus reduce this risk to an acceptable level. Precisely due to broken utility installations, sparking of electrical cables in water and the like, fires occur, so that an earthquake very often results in fire hazards. When carrying out interventions in the ruins, firefighters usually come in a naval vehicle equipped for extinguishing fires, because it is not uncommon for a fire to occur as a result of an earthquake (Gorički and Runjić, 2021).

Interventions in ruins are often complex and demanding, so the firefighter must be physically and mentally ready to intervene in them. In addition to the physical risks that cause physical injuries to firefighters, there are also psychophysical hazards such as psychological stress in firefighters when intervening. Large-scale earthquakes that result in injuries and / or deaths are a highly stressful situation for most people, including firefighters (Šimić, 2021).

3.2 Stress as a source of danger in rescue operations from the ruins

Medically defined stress is the action of specific external and internal influences - stress, which cause psychological and physiological reactions in humans and animals and lead to physical and spiritual damage. Stresses are defined as all internal and external influences that the organism divides into positive and negative in the form of stimuli (Kendić et al, 2007).

Workplace stress can be defined as a series of harmful behavioral, physiological and psychological reactions to employee situations at work (Poredoš and Kovač, 2005). Firefighters are exposed to psychological stress during their daily work and routine interventions. When performing rescue operations from the ruins, firefighters are additionally exposed to psychological stress because there are a number of different sources of stress, and common sources of psychological stress can be:

- All problems related to education and training of firefighters, including feelings of lack of competence for the activity, lack of prescribed operational procedures, unclear and contradictory procedures, the need for immediate first aid, management of untrained civilians, poor coordination and difficult cooperation, loss of control and insecurity, jobs that are not primarily firefighting;

- Technical shortcomings that are almost always present in the event of large-scale natural disasters such as interruption of communication or difficult communication, difficult communication between the coordinator and the fire brigade, lack of necessary equipment to successfully carry out the action;
- Possibility of physical injuries due to intervention due to the high risk of subsequent collapse and trapping in the rubble, uncertainty of the occurrence of new earthquakes and the occurrence of new earthquakes;
- Psychophysical forms in the form of lack of rest and insufficient amount of sleep, duration of activities is significantly longer than working hours, work in difficult conditions, insufficient and poor nutrition;
- Exposure to public pressure from the media, families, families of victims, communication with victims trapped in the rubble, pressure from citizens to help that is not within the competence of fire services;
- High level of responsibility of the management staff for the safety of citizens and firefighters participating in rescue operations and frustration with the inability to provide timely and necessary assistance to all citizens affected by the earthquake.

It is especially important to highlight the additional stress of firefighters living and working in the quake-affected area because their source of stress is duplicated. As they are already affected by the stress due to the possible loss of a family member, property, movables, they are also exposed to psychological stress at work during rescue operations. Such firefighters are in a very ungrateful situation due to their dual role, the role of earthquake residents and the role of firefighter-rescuer. On one side is the family of the firefighter and his endangered property, and on the other hand an urgent call - the fire department. Regardless of the disaster that struck firefighters personally and their families, during the earthquakes in Zagreb and Banovina, all firefighters put themselves at the service and greatly contributed to rescue and rehabilitation of the earthquake-affected area (Šimić, 2021).

In addition to stress during rescue operations in the domestic climate, high risks of psychological stress also occur in international rescue operations. By joining various international associations, the Republic of Croatia was given the opportunity to ask for help during accidents and disasters. Thus, the Republic of Croatia has accepted the obligation to help other countries that may also be affected by disasters and accidents. In addition to all the sources we have listed in the rescue operations from the ruins, there are additional sources when participating in international rescue operations:

- Lack of knowledge of the material and type of facilities and lack of knowledge of the terrain on which the rescue operation is carried out;
- Linguistic as well as other cultural barriers;
- Difficult communication with the Republic of Croatia, both with family and acquaintances;
- Difficulty in helping rescuers affected by mental shock;
- Variety of tactical action;
- Cooperation with unknown services and teams that also participate in rescue operations;
- Difficult coordination and overlapping of work teams when performing activities;
- Transport of forces by air.

To reduce the risk of psychological stress, it is necessary to conduct psychological preparation of firefighters for rescue from the rubble. Psychological preparation of firefighters is necessary during the implementation of various training and education programs and immediately before going to the rescue operation, if possible (Šimić, 2019).

Some form of psychological support for firefighters can be carried out immediately after the end of the rescue operation from the ruins, but its effectiveness is much reduced compared to the preparations of firefighters before going into action. During the training and education of firefighters, selection is also done. Regardless of the will, effort and knowledge of the equipment, firefighters who are not mentally ready to respond to rescue operations during an earthquake should be assigned to other tasks (Šimić, 2019).

In the fire service, every firefighter has his own place for which he is competent and qualified. If someone is unable to respond mentally to rescue operations, his contribution will be much more pronounced in other areas and tasks, such as logistics, coordination, transportation of firefighters, transportation of equipment and the like.

4 Conclusion

Firefighting as a multidisciplinary activity provides great operational support to all residents. In the event of natural disasters, firefighters are the only emergency service that can respond promptly and be on the ground in just a few minutes, at the service of unfortunate citizens. With the modernization of society, the movement of the world forward, firefighting is counting more and more technical interventions.

For quality and efficient performance of technical interventions, continuous training of firefighters is required, as well as the purchase of additional equipment that greatly helps firefighters in performing their tasks. By continuous education and training of members, the risk of injuries is reduced to a minimum, firefighters are informed about possible dangers and the skills of performing such types of interventions are developed.

All firefighters-rescuers need psychological help, both before the intervention and after the intervention in order to avoid stress, which is ubiquitous and dangerous for the long-term health of the firefighter.

An earthquake as a great natural disaster has a very great power to destroy the affected area. Firefighters are employees who provide support to citizens in two phases during an earthquake. The first phase is the first operational response and work on primary interventions in the form of rescuing people and material goods. After that, firefighters help citizens in secondary activities in terms of recovery and restoring the area to its original state.

When talking about firefighters, it is safe to conclude that it is an activity that is present during all phases of the response to an earthquake, be it preventive or operational phases.

This is precisely why it is necessary to continue to invest more and more in the development of firefighting, in the education of personnel, but also in the acquisition of equipment.

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