

SEISMIC RESILIENCE OF THE SCHOOLS IN BANJA LUKA - some constructional and preparedness aspects

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Abstract

Banja Luka is a city which, in October 1969, experienced the strongest earthquake in the territory of Bosnia and Herzegovina. On that occasion 2/3 of the school buildings were severely damaged or destroyed. Banja Luka students were forced to attend that school year throughout the former Yugoslavia. Seismic risk management for schools on the territory of Banja Luka is significant from the aspect of protecting students as a vulnerable category of society. It is also important observing the fact that school facilities are used as facilities for temporary mass accommodation of the affected population during emergencies. Examining the level of earthquake protection, i.e. seismic resilience of the schools in Banja Luka, as a city with a high seismic hazard, implies the resistance of school buildings (material resilience) but also the preparedness of school communities (administration, students and teachers) to react properly in the event of an earthquake (non-material resilience). The results of the research indicate weaknesses in both the material and non-material resilience of schools. The structural aspects of school resilience include the seismic hazard of the area, the soil at school locations in terms of the expected seismic effect, the age and poor maintenance of the buildings, and the undefined ownership of school buildings. Regarding non-structural resistance, a low level of carrying out preventive activities such as education, training and practical exercises for dealing with earthquakes was identified as well as inadequate planning documentation.

Keywords: earthquake, schools, seismic resilience, preparedness

1. Introduction

The devastated earthquake occurred in Banja Luka October 27, 1969. This EQ with 6.6 Richter scale units magnitude is the strongest in history of the Banja Luka region and entire Bosnia and Herzegovina. The entire city was destroyed and the consequences were severe for educational institutions since Banja Luka was an educational and cultural center. Severe or moderate damage was recorded in 23 elementary school buildings, 9 high school buildings, 3 high school buildings, and two facilities for students accommodation. The extent of the destruction is also shown by the fact that in only 8 out of 346 classrooms in primary and secondary schools education could be continued after the earthquake without any reparations.

During 2016, research and analysis of existing school buildings in the territory of the city of Banja Luka was carried out relating to material resistance to earthquakes, i.e. seismic vulnerability [2]. In the meantime, new researches have not been conducted. The need for research into the non-material and material resistance of school facilities in the territory of the city of Banja Luka comes from the both facts confirmed seismic hazard and the age of the school facilities. Even though Banja Luka is regional educational center, only one new school building has been built in the last 30 years. According to paper [2], about 35,000 students attend primary and secondary schools in the city.

The resilience of the schools to earthquake effects, as objects of mass gathering of people, should be considered from a material and non-material aspect. The material resistance of schools means the resistance of the school building to the effects of earthquakes, while the non-material resistance

refers to the preparedness of users of school buildings for adequate behavior before, during and after an earthquake. The resilience of a school building on earthquake depends on a number of factors such as age, construction, materials used and maintenance of the buildings, as well as the soil type where the buildings were located. Since amplification seismic signal caused by soil is important it is clear that the composition and quality of the soil affects the vulnerability of buildings in case on earthquakes. Importance of the soil types in seismology is shown by the more detailed classification of the soil as part of the modern building codes. The complete risk assessment should include beside parameters of seismic hazard, the seismic vulnerability of buildings, impact of the local soil also assessment of non-material resistance - that is, the preparedness of the school community

The aim of this paper is to highlight some problems related to the material and non-material resilience of the schools in the city of Banja Luka.

2. Constructional resilience of the schools in Banja Luka

Objects of mass residence of people, especially schools, are important for Disaster risk reduction (DRR) plans as well as for the local community's DRR plan in case of earthquake. School facilities are treated as critical infrastructure in these documents and those buildings are planned for temporary mass accommodation of the affected population in the case of earthquake.

Data collected for the 71 school buildings enabled an overview of the basic architectural and structural characteristics of the schools in Banja Luka. The most important data for the assessment of expected structural and non-structural elements damage and the assessment of the usability of the buildings after earthquake are shown in Figure 1.

The largest number of school buildings were built before the catastrophic earthquake in 1969; they are symmetrical in shape and consist of a ground floor and an upper floor. Branch schools are mostly smaller one-storey buildings. The number of students in urban schools ranges from 500-1000 students, in suburbs up to 200, as well as in rural schools up to 50 students. Regarding construction types, the most of the schools are brick buildings of typical construction at the end of the 20th century, mostly of brick and less of stone [2].

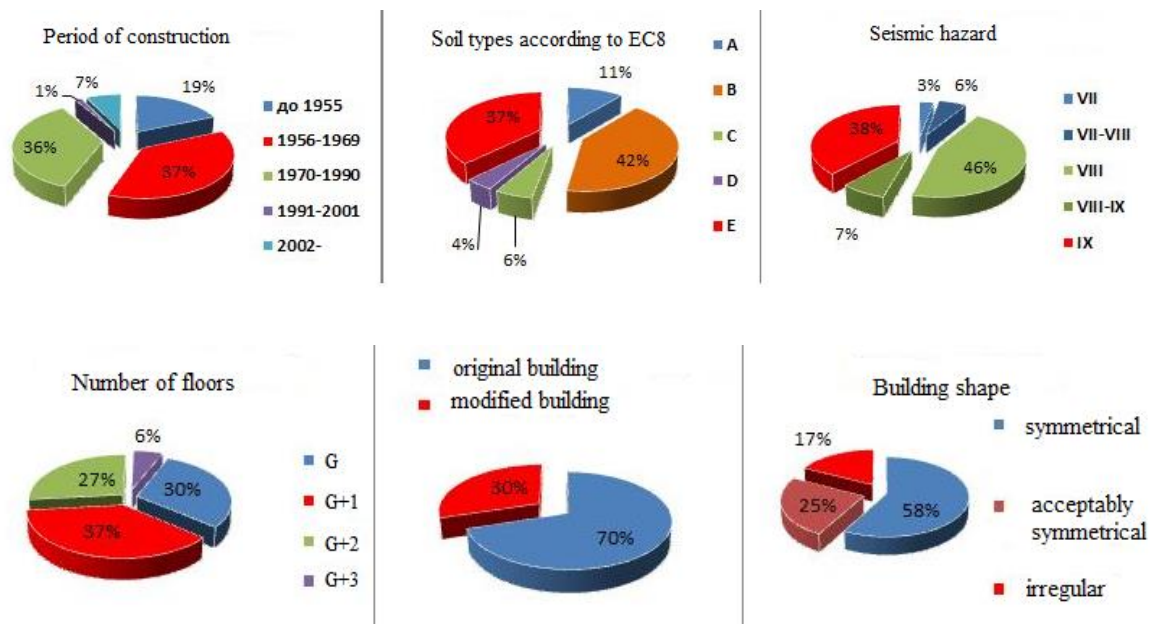


Figure 1. The characteristics of the school buildings [2]

Analysis of the vulnerability of school buildings was carried out on the basis of data related to building construction method, applied materials and knowledge about construction characteristics in specific areas as well as descriptions of individual classes of vulnerability given in the EMS-98 scale, [3]. Vulnerability classes were determined by expert assessment based on the above criteria.

Vulnerability classes based on construction period and applied materials

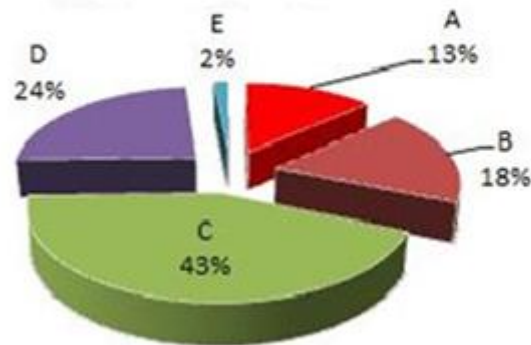


Figure 2. Vulnerability classes according to EMS-98 criteria [2]

Considering that vulnerability classes A, B and C represent buildings where seismic measures have not been applied, we conclude that 74% of existing school buildings are not built under seismic codes which clearly shows that the structural resilience of the schools in Banja Luka is not satisfactory.

Due to the reconstruction after the earthquake in Banja Luka in 1969, the most of the schools buildings belong to vulnerability class C type. According to assessment seismic risk 7% vulnerability class C building are in significant risk to collapse in case of IX earthquake intensity EMS-98 while 17% of buildings of this type can suffer structural damage[4].

Modern science on the design of seismically resistant buildings has recognized the type of soil as extremely important, so Eurocode 8 defines 5 basic soil categories A, B, C, D and E, and two special ones S1 and S2 for which special research is necessary. A map of the local soil of the municipality Banja Luka was created for school risk assessment purposes. Based on the local soil map according to EC8 for the territory of the city of and the geospatial distribution of school facilities, the type of local soil was determined for each school facility. The results of the soil analysis [2] showed that 37% of school buildings are located on type E soil, which is the lowest quality type of soil according to the Eurocode 8 classification.

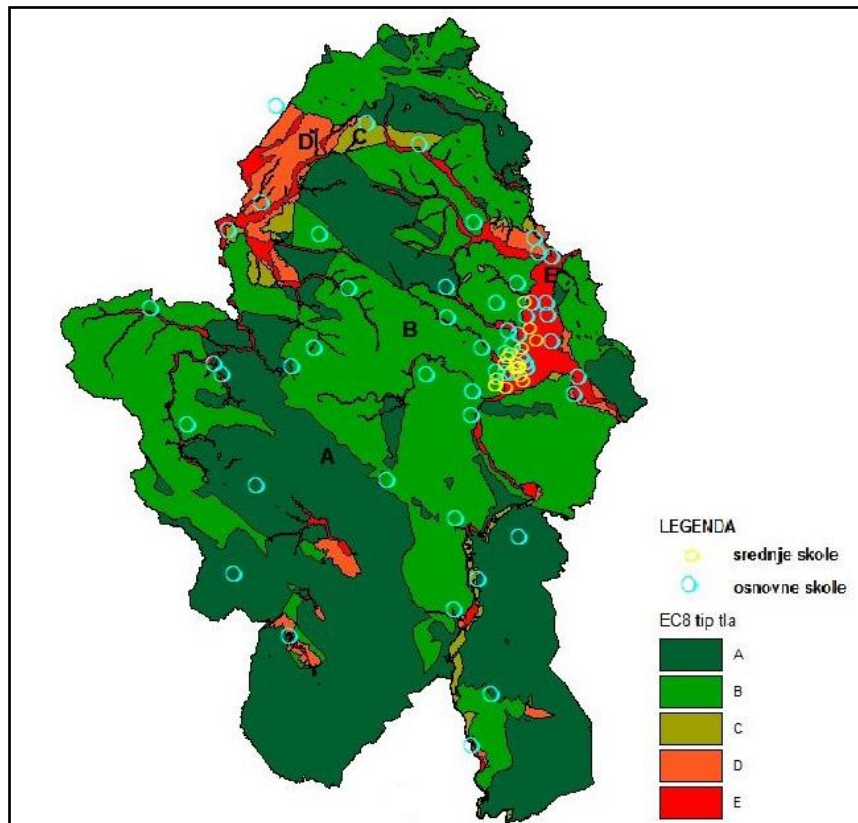


Figure 2. The school building positions on the local soil map [2]

The results of research [2, 4] on the construction characteristics of school buildings showed that their structural resistance is unsatisfactory. The results of the research [5] indicate numerous problems. The official attitude of the Ministry of Education as well as the local community is that complete organization of school life is obligation of the school management. School principals are expected to provide funds for maintaining school facilities, as well as to perform all other duties independently and without any support. The schools itself, according to the principal's statements, barely manage to meet the needs necessary for the basic functioning of the school including conducting teaching process, children stay, providing energy supply, as well as hygienic and office materials, etc. The schools receive funding for material costs monthly, but the school's investment needs are defined by the school's annual working program, which are submitted to the Ministry of Education and the City Banja Luka.

Regarding to structural resilience of secondary schools in Banja Luka, there is a strong attitude by principals and employees that position of secondary schools is poor. Functioning of secondary schools, i.e. the budget for secondary schools is provided by the municipality i.e. all expenses except salaries, which are financed by the Ministry of Education. All respondents in the survey confirmed that the municipality Banja Luka has become more involved in financing both secondary and primary schools in recent years.

City departments do not have funds to carry out this type of maintenance regularly. The department which is in charge for cooperation with educational institutions receives requests from schools and allocates the available funds to selected schools after submitting requests and cost estimates. Those funds are not planned (scheduled) for major investments, but to help schools to resolve specific difficulties. There is no clear criteria for rating requests, assessing priorities or for allocating funds. The supervision of reconstruction and restoration works has not been defined by any department.

The Department for inspection affairs plans funds for emergency interventions on buildings in case of damage. Urban planning and civil engineer inspectors after receiving request do field inspection and record damage on schools building according to their authority but not assess damage. For the

evaluation of the degree and type damage of the building, a civil engineering expert witness should be hired, whose competence is to evaluate the condition of the building.

The owner of the remaining school buildings in the territory of the City of Banja Luka is not known at the moment as well as the status of the school buildings where the ownership transfer process has started but not completed. There are cases elementary schools with several buildings that for instance one building is now in ownership of the City of Banja Luka but another is not (for instance schools with central urban buildings and suburb or rural buildings). Knowing that the central, usually urban school, building with the other school building (suburb, rural) is one legal entity, it is clear how complicated is maintaining buildings and even determining the responsibilities for it.

The problem of using non-purpose facilities as school facilities was recorded in two secondary schools as well as the absence of regular and planned monitoring of the state of school facilities on the territory of the Banja Luka. The department in charge of reconstruction acts upon receiving requests and establishing priorities from the department in charge of educational institutions. None of the departments has obligation to carry out regular and detailed monitoring of the construction characteristics of school buildings, although this would be a useful practice, considering the age and insufficient maintenance of school buildings. When earthquake occurs and some damages, even slight, on school buildings were recorded it is difficult to determine the origin of damage when their previous conditions were not known.

3. Earthquake preparedness of the schools in Banja Luka

Regarding non-material resilience, it is necessary to observe and determine the level of school communities' preparedness and capability for adequately responding if earthquake happens. The adequate reaction means reaction according to the DRR plan and training of school community should be carried out according to regulation [8]. The existence, content, quality and application of planning documentation in schools is one of the key elements of resilience. Another important element of resilience is preparedness, which is achieved through the practical implementation of the DRR plan, by practicing all planned activities as well as other preventive activities such as training and education, which is defined [8]. However, the different authorities started dealing with this issue after the catastrophic floods, which affected in 2014 entire West Balkan countries, including Bosnia and Herzegovina as well as Banja Luka region.

The Mayor of Banja Luka, in accordance with his authority, defined with a decision important subjects of for the protection and rescue system in the City. All primary and secondary schools, according to that document have been declared as subjects of special interest for the protection and rescue system. According to the regulation [9], they have the obligation to prepare planning documents, and to harmonize them with the DRR plan of the City of Banja Luka.

The research of the mentioned resilience elements of school communities [5] following weaknesses were identified. DRR plan exists in most schools, but the schools did not develop it themselves than hired agencies and other entities did it for schools. This is a consequence by lack of supervision related to application of regulations [10] that defines the area, development and implementation of planning documents.

DRR plan is not applied in most schools and the employees are not familiar with its contents. The intention of adopting the DRR plan for the most schools, was formal compliance with the law and nothing else. According to the research results after the DRR plan have been adopted by the School Board and the proof about adoption delivered, according to the Law [9] to the Civil protection department, they do not use the DRR plan at all. In some schools, the DRR plan is available to employees on the notice board but only few of them organize introduction and discussion about the DRR plan at session of the teachers' council. Further application of the DRR plan, especially the Evacuation plan is the most important for schools, were part or even completely absent.

- Education of students related to seismic hazard and protection measures topics practically does not exist in schools. Teachers and principals confirmed there is no seismic hazard or protection

measures as teaching subjects in the regular curriculum. The regulation [10] defines that students get knowledge about natural disaster and protection against it through the class community program. The curriculum for the classwork prepared by the Republic Educational and Pedagogical Institute contains 4 areas: Culture of Living, Children's Rights and Responsibilities, Healthy Lifestyles and Free topics. Since there is no DRR topics it remains to believe that they teach it in the Free topics section.

- Training of employees on the seismic hazard and protection measures topic is not carried out in schools. The research [5] confirmed that training of teachers, professional associates and other employees in schools is one of the activities that is not carried out, although it is defined by the regulation [10]. There is neither an agreement about the way it should be implemented, nor any subordination of authority departments, coordination as well as cooperation on this issue. The representatives of the school management and the teaching staff believe that the initiative for this training should come from the civil protection department of the City of Banja Luka and that they, as "professionals, also carry out this training", without considering the real human capacities or financial resources of this department. The other side opinion from civil protection department is that the initiative, including proposals training topics and modality, should come from the schools.
- Lack of coordination and subordination between the authorities and institutions: Republic Administration of Civil Protection (RUCZ), Civil protection department of the City of Banja Luka, schools, Ministry of Education as well as inspectorates. The key weaknesses is the lack of control and supervision over the development and implementation of DRR plans as well as conducting of the preventive educational and training activities defined by regulation [8]. The RUCZ is in charge of administrative supervision including revision the methodological compliance of the schools DRR plans with the regulation defined this area [10] such as content and methodology as well as compliance with the local community's DRR plan. However, this kind of revision or supervision has never been carried out in schools.
- The Inspectorate of the Republic of Srpska respectively the educational inspection, supervises the schools legal acts as well as checking the legality of citizens 'complaints and requests regarding the activities carried out in schools. Regarding schools protection and rescue activities the jurisdiction of the inspectorate includes checking existence and content of the school DRR plans as well as its compliance with the legal regulations. All respondents from school principals confirmed that there was no any supervision related to implementation of DRR plans or carrying out preventive activities according to regulations [8].

4. Conclusion

The weaknesses related to the structural resilience of the schools are the characteristics of the school facilities, i.e. age, undefined ownership and inadequate monitoring and maintenance. More than 50% of school buildings were built before the earthquake in 1969, when there were almost no earthquake resistance design (ERD) codes. Knowing that vulnerability classes A, B and C are facilities without ERD measures, we conclude that the 74% out of total number of school buildings are without ERD measures according to the descriptions for the EMS -98 classification [3]. The maintaining of the school facilities depends not only of financial resources, than from the legally determined obligation that is related to the determination of ownership. Department in charge of inspections affairs neither do perform regular monitoring of school facilities, nor assess their needs for reparation. In addition, none of the departments does not plan funds for regular investments of the school buildings. The regular procedure is approval of funds after submitting the requests of schools on a case-by-case basis. Schools are according to the law [9] declared as important institutions for protection and rescue

system, and they are obliged to develop DRR plan and to update it once a year. The school's DRR are not updated regularly, and especially not every year. The school management and employees do not prepare DRR plans independently in cooperation with the Department for Civil Protection, which was the intention of the legislator since the process of planning lead to finding DRR solutions and vice versa. Instead of this, school's DRR plans were prepared by third parties/agencies usually with licenses in the field of occupational safety and fire protection. The extremely low level of awareness of the seismic hazard was observed as well as lack of the preventive activities which schools carry out, primarily education and training of students and teachers. The level of the non-structural resilience of the schools in Banja Luka regarding preparedness for adequate response in case of earthquake is very low. Schools in the territory of the City of Banja Luka should be given more attention by the local community, the Ministry of Education as well as other authorities and institutions.

References

- [1] Kuzmanović, R. (1986). *Banjalučko školstvo u zemljotresu*. Banja Luka. Glas
- [2] Šipka, V., Radovanović, S., Jarić D., Kukrić, L.&Sandić C.(2016). Upravljanje seizmičkim rizikom za škola u Banjoj Luci, 5. *Naučno stručno međunarodno savetovanje "Zemljotresno inženjerstvo i inženjerska seizmologija"*, Sremski Karlovci
- [3] European Macroseismic Scale 1998,EMS-98,(1998).Editor G. Grünthal, European Seismological Commission, Luxembourg
- [4] Šipka, V.&Radovanović, S. (2014) Procjena seizmičkog rizika-Banja Luka, 4. *Naučno stručno međunarodno savetovanje "Zemljotresno inženjerstvo i inženjerska seizmologija"*, Bor
- [5] Šipka, V.(2022), Upravljanje seizmičkim rizikom osnovnih i srednjih škola na području Grada Banja Luka, Master teza,Univerzitet u Banjoj Luci, Fakultet bezbjednosnih nauka
- [6] Zakon o utvrđivanju i prenosu prava raspolaganja imovinom na jedinice lokalne samouprave, "Službeni glasnik Republike Srpske ", 70/06
- [7] Zakon o stvarnim pravima, "Službeni glasnik Republike Srpske "124/08, 58/09, 95/11, 60/15 i 107/19),
- [8] Pravilnik o obučavanju lica u okviru osnovnog i srednjeg obrazovanja o opasnostima i zaštiti od elementarne nepogode i druge nesreće , "Službeni glasnik Republike Srpske" 74/14
- [9] Zakon o zaštiti i spasavanju u vanrednim situacijama "Službeni glasnik Republike Srpske" 121/12, 47/17 и 111/21
- [10] Uredba o sadržaju i načinu izrade plana zaštite i spasavanja od elementarne nepogode i druge nesreće, "Službeni glasnik Republike Srpske " 68/13.