

## CHARACTERISTIC ILLEGAL CHANGES IN MULTIAPARTMENT BUILDINGS THAT LEAD TO DAMAGE TO THE BUILDINGS DURING THE 1988 SPITAK EARTHQUAKE

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*Abstract. The studies show that in the multi-apartment buildings of the Republic of Armenia, many illegal modifications reducing the seismic resistance of the buildings have been carried out by the residents. As a result of the devastating 1988 Spitak earthquake, the reason for the collapse of 10 percent of the stone buildings in the city of Gyumri was illegal structural changes and damage to the bearing structures. It is not known how many buildings were damaged. The performed illegal modifications were classified according to the degree of danger.*

*Keywords: multi-apartment building, seismic vulnerability, illegal modification, seismic risk.*

### Introduction

While studying the consequences of the devastating 1988 earthquake in Spitak and its causes, experts noticed that one of the many reasons for the collapse and severe damage of a large number of apartment buildings was the illegal modifications made by the residents in the apartments. Some of these have resulted in reduced seismic resistance of the buildings. Of course, this fact is not news, many experts alerted about this [1,2,4]

However, the problem remains relevant to this day and such illegalities must first be prevented, and those committed must be eliminated. If we take into account that one of the main reasons for the tragedy of Spitak in 1988 is the low quality of the construction carried out during the Soviet years (especially 1957-1989) (non-observance of construction technologies, non-compliance with the required standards of building materials, deviations from approved projects, etc.), the underestimation of the seismic hazard of almost the entire territory of the republic, design flaws, etc., then the importance of the issue under discussion becomes obvious, because all these reasons combined brought about the unspeakably severe consequences of the earthquake [2,3,5].

In February 2022, the "Rules for the maintenance, operation, modernization of multi-apartment buildings (including increasing energy efficiency and energy saving)" developed by the Urban Development Committee of the Republic of Armenia were put into effect, which further tightens the requirements for the operation of buildings, as well as to exclude dangerous illegal reconstructions [6]. However, the problem is complex and requires a systemic state approach. At the time, it was not particularly noticed by local governments, and the residents carried out many illegal modifications of the building elements in their apartments and common areas at their own discretion. Buildings are designed and built according to many norms, and illegal modifications lead to such modifications of the building elements that in the event of an earthquake can cause the entire building to be damaged or even collapse.

### 1. Research results of the problem

The results of the study of the consequences of the 1988 earthquake in Spitak showed that many illegal modifications were carried out by the residents in the apartment buildings, reducing the buildings' seismic resistance. For example, the reason for the collapse of at least 10 percent of 147 multi-story residential stone buildings in Gyumri was also those illegalities, and the number of badly damaged buildings was many times more [2]. Residents had grossly violated almost all points of the building operation order, which led to the deterioration of the building's technical condition (weakening of the foundations, damage to bearing columns and wheels,

making openings in the bearing walls, and demolishing the inner layer of the row of walls, installing large volume water tanks on the roofs, inside the building implementation of redundant buildings, etc.). In terms of earthquake resistance and safe operation of buildings, overloading of the load-bearing structures of buildings is a serious problem. Residents, for various purposes, in addition to modifications of structural elements, make additions to attics and balcony platforms. Residential and auxiliary structures are built with structural solutions different from the stiffness and load capacity of the building's bearing system, which causes damage to the buildings during an earthquake. The installation of heavy water tanks on the roofs also negatively impacts the seismic resistance of buildings, which, in addition to additional loading, also causes additional inertial forces due to water oscillations [1].

These illegalities gained a greater scale after the privatization of housing. Severe damage was done to the buildings when the first-floor flats of the multi-story buildings were allowed to be converted into service facilities en masse. For this purpose, substantial reconstructions were carried out in the apartments, most of them with appropriate permits and approved projects. However, as the works were carried out and there were no deviations from the projects, there are grounds for serious concerns.

In Akhuryan, we randomly selected two apartment buildings, one built before the 1988 Spitak earthquake, and the other after it. The results are presented in table 1.

Table 1. The results of the investigation of two apartment buildings in Akhuryan, regarding the illegal modifications carried out by the residents in the building.

Address of the building	Modifications that do not affect seismic resistance	Modifications that can be easily eliminated	Modifications, complete or partial demolition of bearing walls	No modifications
Akhuryan Highway, 83	77.8%	11.0%	5.6%	5.6%
New Akhuryan, Ghambaryan, 3a	12.5%	-	-	87.5%

## 2. The essence of the problem

The seismic risk of most of the settlements in the territory of the Republic of Armenia, that is, the total of all possible losses in the event of a strong earthquake in the given area, is very high, especially due to the low seismic resistance of multi-apartment buildings. Illegal modifications and reconstructions of buildings contributed to this as well. Therefore, it is necessary to identify and try to eliminate those illegal modifications and prevent new illegalities from being carried out. Often, those implementing the management of buildings do not perform the control functions assigned to them, and the municipalities do not deal with this issue properly. Today, this problem has reached alarming levels, especially in the capital and major cities.

The main problem can essentially be divided into two groups of problems.

1. To prevent new illegal changes in apartment buildings.
2. To detect and eliminate the previously committed illegalities.

In order to solve the problems of the first group, in addition to the implementation of the functions of the relevant state bodies, the local self-government bodies and the residents of apartment buildings have an important role. Municipalities should clearly perform the following functions under the authority of the construction department, the council of elders, and the management bodies of housing operation:

- Prohibit any modification of the structural elements of the building without a professional opinion, project documents, and construction permit. These are works requiring special permission and are carried out by licensed organizations.
- The municipality and the council of elders must control the processes and exclude the corruption risks.
- Local governments, in addition to the rings that organize the operation of condominiums and buildings under their authority, should conduct explanatory work among the population.

In order to solve the problems of the second group, it is necessary:

- Detect illegal modifications or reconstructions made by residents in all multi-apartment buildings.
- Classify illegal modifications according to their degree of danger, accessibility of elimination, the time required, and financial resources. Separate the illegalities that can be eliminated by the means of the apartment owner or the building management body, and order to eliminate the illegalities that are dangerous from the point of view of earthquake resistance, require financial resources, time, and professional skills (reconstruction of the supporting elements of the building), submit justified proposals to the Ministry of Territorial Administration and Infrastructure of the Republic of Armenia and the Committee for Urban Planning of the Republic of Armenia.
- We consider it necessary to develop complex state programs to eliminate the illegal reconstructions carried out in the buildings, which have led to the reduction of their seismic resistance, using the state budget of the Republic of Armenia and other means. The works must be carried out according to the procedure established in the republic by involving licensed organizations and individual entrepreneurs in the assessment of the technical condition, design and expertise, implementation of construction and its control, and other functions.

### 3. The most common types of illegal modifications in apartment buildings

When describing the illegal modifications carried out in the buildings, we conventionally divided the buildings into three parts according to the storeys: basement, first, second and higher floors. In the case of such a division, the detected illegalities in the corresponding parts of all types of buildings are basically the same (tables 2 and 3).

Table 2. The most common illegalities in stone apartment buildings.

Floor	Illegal modification								
	Digging pits below the base	Damage to the foundation of the building	Partition changes	Damage to bearing walls	Partial demolition of the inner row of bearing walls	Demolition of bearing walls to the outside	Expansion of living spaces due to balconies	Dismantling or damage of reinforced concrete connections	Making an opening in the ceiling covering of the last floor
Basement floor									
First									
Second and above									

Table 3. The most common illegalities committed in multi-apartment buildings with reinforced concrete structures.

Floor	Illegal modification									
	Digging pits below the base	Damage to the foundation of the pillar	Partition changes	Damage to bearing walls	Openings in panel walls	Damage to bearing reinforced concrete columns	Expansion of living spaces due to balconies	Dismantling or damage of reinforced concrete connections	Making an opening in the ceiling covering of the last floor	Damage to exterior wall panels
Basement floor										
First										
Second and above										

Residents carry out illegal modifications in buildings for various purposes, often not realizing the consequences of what they have done in terms of reducing the seismic resistance of the whole building or its individual parts. Among the most common purposes of modifications are the construction of basements and garages, changes in the layout of rooms at the expense of other rooms, corridors, and kitchens, opening of doors or windows, partial demolition of the inner row of stone walls to open cupboards or doors, "beautification" of the apartment or rooms by dismantling structural elements, expansion of the apartment at the expense of outbuildings or balconies, opening of exits from the roof slabs to the roof, etc.

### Conclusion

1. Almost all multi-apartment buildings in the settlements of the Republic of Armenia, especially buildings built during the Soviet years, have been and are being illegally modified, including those that have reduced the building's seismic resistance.

2. The illegal modifications and especially the reconstructions carried out in the buildings in the past, regardless of who did it, on what grounds, and when they are eliminated, can be conditionally divided into three groups:

a. modifications that do not affect the seismic resistance of the building.

b. Irregularities that affect the seismic resistance of the building can be eliminated quickly, at a low cost, with the help of non-licensed professionals.

c. Reconstructions that have a significant impact on the seismic resistance of the building and their elimination are mandatory and require certain financial resources, time, also the involvement of licensed professional forces (for a project, construction, supervision, acceptance-handover, etc.).

d. To prevent new illegal modifications in multi-apartment buildings, a key place should be given to strengthening and monitoring local self-government bodies and councils. It is important to involve the professional forces of the municipal administration, the territorial inspection bodies of the Republic of Armenia, and the seismic service of the Ministry of Emergency Situations of the Republic of Armenia. Emphasize the implementation of explanatory works for residents of multi-apartment buildings.

### Offers

1. After revealing the committed illegalities and the classification mentioned in point 2, the following solutions are proposed regarding them: a/ the illegalities of the first group, in case of the agreement of the Urban Development Committee of the Republic of Armenia, to keep; b/ to eliminate illegalities of the second group by the means and forces of the apartment owners and the local government; c/ consider the illegal reconstructions of the third group to be systemic and solve them at the state level with the help of medium-term programs with the help of various donors and state funds.

2. It is necessary to take realistic steps, first of all, to prevent new illegal modifications, including the reconstruction of structural elements in multi-apartment buildings, and secondly, to identify and document the illegalities that have already been carried out.

3. In order to prevent new illegal modifications in multi-apartment buildings, a key place should be given to the strengthening and monitoring of local self-government bodies and councils.

4. Emphasize the implementation of explanatory work with residents of apartment buildings. For this purpose, it is necessary to involve the mass media, the lecturers-instructors of the public works department of the Urban Planning Committee, the Seismic Protection Territorial Service of the Ministry of Emergency Situations of the Republic of Armenia, to conduct explanatory works with different layers of the population and employees of local governments through different means of agitation.

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