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## MAIN PROBLEMS OF SEISMIC RISK REDUCTION DUE TO INTERNAL AND EXTERNAL STRUCTURAL PROPORTIONS' MASS VIOLATIONS IN MULTISTOREY RESIDENTIAL BUILDINGS CARRIED OUT BY THE POPULATION

*One of the factors to determine the high level of seismic risk in the city of Yerevan is the insufficient seismic resistance of residential buildings, the important characteristics of which are the quality of construction and proper operation of the building. The exclusion of residents' "unauthorized reconstructive interventions" became a pressing security concern. In this regard, it's very important to urgently adopt and strictly enforce the law on the prohibition of the legalization of unauthorized buildings and redevelopment of residential premises. This article discusses the problems of seismic risk reduction associated with massive violations of the internal and external structural proportions of multi-storey residential buildings carried out by the population, and indicates ways to eliminate these violations.*

**Keywords:** seismic risk, seismic resistance, reduction of seismic vulnerability, constructive proportions, residential area, unauthorized construction.

On February 6, 2023 a 7.8-magnitude earthquake occurred in Turkey's Gaziantep province, killing tens of thousands. This is one of the most powerful earthquakes in the region in the last century, if not the most powerful [5]. We have recently passed through the nightmare of the Spitak earthquake, but the deep pain of the wastes has not disappeared, and the earthquake's consequences have not been fully overcome. However, we never learned a lesson from these continuous warnings of nature, rather, from the real and sooner or later threat. Experts have repeatedly referred to the factors determining the high level of seismic risk in Armenia and especially in Yerevan, such as the possibility of a powerful earthquake, the high density of the capital's buildings and the insufficient seismic resistance (seismic vulnerability) of most of them [1]. It is obvious that in order to overcome the last factor it requires to increase the earthquake resistance of all buildings and structures and to improve their technical condition. Solving the above mentioned problem is a matter of years, decades, but a clear plan should be urgently developed, strictly followed and implemented step by step every year.

The important characteristics of the earthquake resistance of the building are its age (or the degree of wear and tear), dimensional and structural solutions and their compliance with the requirements of the existing norms of earthquake-resistant construction. The apartment buildings left over from the Soviet years, that are the predominant part in the capital, were built according to norms, where the level of seismic danger in Yerevan was artificially reduced from the actual level (by about 2-3 points) [2]. In addition, there are some quality deviations in the construction, and the residents' "reconstructive" interventions have further complicated the situation. There are multi-storied buildings, where the residents "removed" the supporting column of the building's foundation, demolished the supporting wall, or built 1, 2, and even 3 additional floors on the roof.

Every resident of an apartment building thinks that the space in the apartment is always "small" and uses all tricks to expand it. Especially the residents of small apartments use any option of expansion. It is very common to increase the number of rooms at the expense of the balcony. And if many people just glass the balcony, there are also resourceful people who take the idea of expansion to absurdity. As a result, the additional structure can disturb the neighbors, moreover, it can be dangerous for the residents or people passing by the building. In almost all the yards of Yerevan, you can find ordinary standard apartment buildings, in which, however, there are apartments with extended living space. For example, in Figure 1, it is clearly visible where the original structure ends and the added outbuilding begins, in Figure 2, the additional building does not look so "monumental" and is expressed only in the form of a single balcony, and in Figure 3, more striking examples of residents' "ingenuity" are provided.

As a result of the progressive development of industrial construction in the Republic of Armenia in the 1970s-1990s, the city of Yerevan was built up with multi-story residential buildings built with prefab RC frame, frame-panel, large-panel, raised floor method and other constructive solutions [2]. New residential districts appeared (Nor Nork, Erebuni, South-Western, Avan, Davitashen), where the majority of Yerevan's population lives today.



**Fig. 1. Added outbuilding**



**Fig. 2. Added balcony on full height of building**



**Fig. 3. Appearances of added external structures carried out by resident**

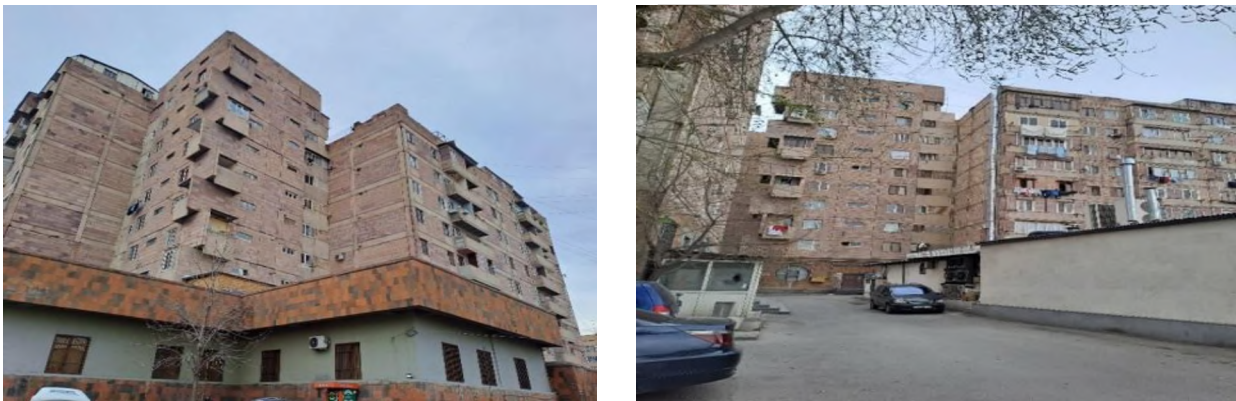
According to the seismic risk map of the city of Yerevan, the South-Western District (SWD) is located in the zone of high seismic risk. This is due to the difference between the city territory's seismic hazard level in new micro-zoning map and the seismic hazard level adopted during the design of the buildings, the unfavorable ground conditions of the site, the high population density in city and the predominant number of buildings built according to the 111 series standard design. The Spitak earthquake, along with its terrible consequences, was a serious test from the point of view of earthquake-resistant construction for evaluating the earthquake resistance of buildings and structures with different constructive solutions. In particular, more than 120 9-story frame-panel buildings built according to the standard project of the 111 series were completely destroyed in the city of Gyumri during the Spitak earthquake. It is true that in the case of this earthquake, the ground conditions were considered unfavorable for such type of buildings, but nevertheless, these buildings also had serious defects in terms of design and implementation of construction works [4].

The global experience of analyzing the consequences of both Spitak and other devastating earthquakes shows that every violation of the requirements of earthquake-resistant construction norms is fraught with unpredictable consequences. During an earthquake, buildings and constructions can be seriously damaged as a result of being in inadequate operating conditions. Residents of Yerevan have a tradition before living in a new apartment they carry out structural transformations in the apartment, according to their own taste and desire: they demolish and change the shape of the partitions, open holes and openings in the main load-bearing walls. There are separate cases when the rigidity diaphragms, intended to increase the seismic resistance of the building, are removed in the RC frame-panel buildings, cellars are adapted in the basement (semi-basement) floor of the building by demolishing the foundation of the building, etc. In the 1990s, as a result of the privatization of buildings and the transfer of control over their operation processes to communities (condominiums), an indifferent attitude towards the normal operation of buildings was formed. In particular, as a result of water supply and sewage piping systems' accidents, water and sewage flow into the basement of the building, and the condominium ignores this problem. As proves the research on the consequences of earthquakes, the mentioned and other similar facts have a negative impact on the seismic resistance of buildings and increase their seismic vulnerability (therefore, seismic risk) level.

The head of the Earthquake Engineering Center of the "Regional Survey for Seismic Protection" Z. Khlghatyan finds that it is necessary to pay attention to another worrying and dangerous reality, which is of a mass nature, particularly in the B-1 and B-2 districts of the SWD of Yerevan [2]. During the development and design of the districts' general plans, the high-rise residential buildings with different plan and constructive solutions were brought to a certain spatial combination, based on the functional and volume-spatial considerations. As a result of that combination, inner courtyards with their playgrounds and sports fields were created, and the buildings with a square and elongated (rectangular) plans were combined with a distance of about 2m from each other so that the space separating them acts as a means of communication between the courtyard and the street.



From the point of view of the construction solution, the square-in-plan building is a frame-panel building, built according to the 111 series typical project, with 9 residential and 1 additional technical floors. Moreover, the 1st floor is non-residential and compared to the other floors, it has a greater height and, in a certain sense, greater "flexibility". Starting from the 2nd floor (that is, on the residential floors), the building has open balconies in the corner parts, which give the building and the overall architectural complex a unique architectural look. Due to the presence of these balconies, the area of separation between adjacent buildings is reduced, the size of which is different in different cases. In many cases, it is 1-2 m, and in some cases, thanks to the balconies, the buildings even come close to the size of the required seismic seam. Taking advantage of this circumstance, our "creative" and "builder" residents got the opportunity to get more space and, clearly, they did not miss the opportunity (especially since the wall of the neighboring building in front of the balcony is "deaf"). Thus, as a result of the implementation of the residents' intention to close the balconies and get more space, the much-needed seismic seam between the buildings disappears. Moreover, the buildings with different constructive solutions are connected to each other by means of artificial rigid connections (Figure 4). As a result, 6 or more (in some cases even 12) buildings form one general spatial building (Figure 5). The described phenomenon is massive in B1 and B2 districts.



***Fig. 4. "Elimination" of the separation area between adjacent buildings by means of added solid structures***



***Fig. 5. "Combining" six buildings into one general spatial building***

From the point of view of earthquake-resistant construction, this is strictly unacceptable, as it negatively affects the buildings' spatial free operation during a possible earthquake. Even in the case of seismic effects, assumed in the basis of the design of these buildings, unpredictable consequences become possible, because the predicted seismic hazard becomes higher than the one assumed in the basis of the design.

It is obvious that the problem presented in this article has an economic and social nature. In our opinion, in case of earthquake, the only way to minimize the number of human casualties due to the described reconstructive voluntary intervention and to preserve the material values to the maximum is to dismantle and eliminate the above-mentioned connections. However, the awareness level of the population in the fields of earthquake-resistant construction and seismic protection is low, in addition, the material security is not good, so it will be difficult to expect them to voluntarily perform the mentioned works. Solving the problem requires the use of all the appropriate levers of the legislative, legal and administrative systems [3].

In September 2020, a draft law was submitted for public discussion. After its implementation, it was planned to exclude the legalization of voluntary constructions [6]. According to the project developed by the Ministry of Justice, it was proposed to make changes in the process of legalization of voluntary structures. The main goal of the project was to exclude the possibility of further legalization of voluntary structures built or to be built after the law came into force. However, due to objective reasons, the law has not been adopted to date.

In conclusion, it is necessary to note once again that the strict observance of the earthquake-resistant construction norms, the quality implementation of construction works, the normal operation of buildings and structures, as well as the successful prediction of earthquakes, the preparation of the population and the mastery of the rules of conduct of seismic protection form the perfect complex system, the implementation of which it is necessary to strive and achieve. Academician E. Khachiyan writes in his review "Issues of Earthquake Forecasting and Earthquake Safety": "From a scientific point of view, it is possible to "cooperate" with an earthquake, fight against it, restrain its destructive "encroachments" and even win." Yes, it is possible to defeat the earthquake, if each of those responsible for that matter (official, scientist, designer, builder, as well as every citizen) fulfills his obligations responsibly in his field of activity.

## References

1. **Balasanyan S.Yu., Nazaretyan S.N.**, Seismic Protection And It's Organization, Study manual (in arm.) – Gyumri, «Eldorado». 2002. – 263 p.
2. **Khghatyan Z.M.**, Disaster Damage Prevention and Children's Vulnerability Reduction Program in Armenia». Yerevan, «Bulletin of the Builders' Union of Armenia», N 1-2/2017. P. 233-234.
3. **Khachatryan A.P.**, Disasters Consequences' Overcoming: Japan Experience – *CMSA Scientific Joournal "Crisis Management and Technologies"*, Yerevan, N<sup>o</sup> 1 (18), 2021, P. 133-141.
4. URL: <http://www.construction.am> - (Date of visit: 17.02.2023).
5. URL: [armtimes.com/hy](http://armtimes.com/hy) - (Date of visit: 09.03.2023).

## Ա.Պ. Խաչատրյան

### ՍԵՅՍՄԻԿ ՌԻՍԿԻ ՆՎԱԶԵՑՄԱՆ ՀԻՄՆԱԽՆԴԻՐՆԵՐԸ՝ ԿԱՊՎԱԾ ԲՆԱԿԶՈՒԹՅԱՆ ԿՈՂՄԻՑ ԲԱԶՄԱԲՆԱԿԱՐԱՆ ՇԵՆՔԵՐԻ ՆԵՐՔԻՆ ԵՎ ԱՐՏԱՔԻՆ ԿՈՆՍՏՐՈՒԿՏԻՎ ՀԱՄԱՄԱՍՆՈՒԹՅՈՒՆՆԵՐԻ ՄԱՍՍԱՅԱԿԱՆ ԽԱԽՏՈՒՄՆԵՐԻ ՀԵՏ

Երևան քաղաքի սեյսմիկ ռիսկի բարձր մակարդակը պայմանավորող գործոններից է բնակելի շենքերի ոչ բավարար սեյսմակայունությունը (սեյսմիկ խոցելիությունը), որի կարևոր բնութագրիչներից են շինարարության որակը և շենքի ճիշտ շահագործումը: Բնակիչների «վերակառուցողական միջամտությունների» բացառումը դարձել է հրապապ անվտանգային խնդիր: Այդ առումով խիստ կարևոր է ինքնակամ շինությունների օրինականացումը արգելող օրենքի հրապապ ընդունումը և խստագույնս գործարկումը: Սույն հոդվածում դիտարկվում են սեյսմիկ ռիսկի նվազեցման խնդիրները՝ կապված բնակչության կողմից բազմաբնակարան շենքերի ներքին և արտաքին կոնստրուկտիվ համամասնությունների մասսայական խախտումների հետ, և նշվում են վերջինների վերացման ուղիները:

**Առանցքային բառեր.** սեյսմիկ ռիսկ, սեյսմակայունություն, սեյսմիկ խոցելիության նվազեցում, կոնստրուկտիվ համամասնություններ, բնակելի փարածք, ինքնակամ շինություն:

## А.П. Хачатрян

### ОСНОВНЫЕ ПРОБЛЕМЫ СНИЖЕНИЯ СЕЙСМИЧЕСКОГО РИСКА, ОБУСЛОВЛЕННЫЕ МАССОВЫМИ НАРУШЕНИЯМИ ВНУТРЕННИХ И ВНЕШНИХ КОНСТРУКТИВНЫХ ПРОПОРЦИЙ МНОГОЭТАЖНЫХ ЖИЛЫХ ДОМОВ, ОСУЩЕСТВЛЕННЫХ НАСЕЛЕНИЕМ

Одним из факторов, определяющих высокий уровень сейсмического риска в городе Ереване, является недостаточная сейсмостойкость жилых зданий, важными характеристиками которой являются качество строительства и правильная эксплуатация здания. Исключение «самовольных реконструктивных вмешательств» жителей стало насущной проблемой безопасности. В этой связи очень важно безотлагательное принятие и неукоснительное исполнение закона о запрете легализации самовольных построек и перепланировки жилых помещений. В данной статье рассмотрены проблемы снижения сейсмического риска, связанные с массовыми нарушениями внутренних и внешних конструктивных пропорций многоэтажных жилых домов, осуществленных населением, и указаны пути устранения указанных нарушений.

**Ключевые слова:** сейсмический риск, сейсмостойкость, снижение сейсмической уязвимости, конструктивные пропорции, жилая площадь, самовольное строительство.

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