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Analysis of the Possibility of Adapting Basement Premises in Multi-Story Buildings as Civil Protection Shelters

Abstract. The article examines the possibility of adapting basement premises in multi-story buildings in light of state building code requirements. Based on drawings, the author conducted an analysis of key structural parameters such as entrance width, ceiling height, area, and their compliance with regulatory requirements. The study aims to evaluate the effectiveness of using basement premises as shelters in the context of modern civil protection challenges. The analysis results can be used to improve regulatory documentation and adapt existing basement premises for civil protection needs.

Keywords: basements of multi-story buildings, civil protection shelters, civil protection.

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Introduction.

In the context of modern geopolitical challenges, particularly the increasing military threats, ensuring the safety of the civilian population has become critically important. One of the key directions in this process is the creation and improvement of a network of civil protection shelters that meet modern safety requirements. This necessity is reinforced by strategic initiatives at the state level. In 2025, in the presence of heads of state, the Minister for Strategic Industries of Ukraine, Herman Smetanin, and the Minister of the Interior of the Republic of Finland, Mari Rantanen, signed a joint letter of intent, which initiated the formation of a coalition for civil protection shelters aimed at enhancing international cooperation in this area.

Basements of multi-story buildings, as one of the most accessible types of civil protection shelters in urban areas, can play a significant role in ensuring population protection. In the existing dense urban development, there is no possibility to build separate civil protection facilities due to limited free space. Therefore, the adaptation of existing premises can be considered an economically justified and technically feasible solution. However, their functional suitability largely depends on a number of technical characteristics, such as the width and number of entrances, ceiling height, effectiveness of ventilation systems, accessibility for different population groups, and others. In this context, there is a need for a thorough analysis of the compliance of such structures with regulatory requirements, as well as an assessment of their ability to provide an adequate level of safety.

The purpose of this study is a comprehensive analysis of the architectural and structural parameters of basements in multi-story buildings in Poltava, constructed in different years, based on drawings developed by the author. The work aims to assess the compliance of these structures with current regulatory requirements and determine their suitability for use as civil protection shelters in the context of modern challenges.

Review of the research sources and publications.

The issues of organization, design, and operation of protective structures are addressed in current regulatory documents, particularly [1], which establishes the primary requirements for capacity, structural elements, engineering support, airtightness, and conditions for human occupancy in shelters. Guideline [2] provides the opportunity to consider the technical condition of the load-bearing structures of basements and the building as a whole. The study [3] conducted an inspection and assessment of the technical condition of basement and semi-basement structures in public buildings aged between 60 and 130 years to evaluate their suitability for use as primary shelters. The issue of the need for civil protection shelters in existing residential areas was examined in the work [4], while the authors of [5] addressed the adaptation of basement premises in buildings for use as shelters for the civilian population.

Main Material.

For the analysis, drawings of basement premises of several multi-story buildings developed by the author within the framework of dissertation research were used. The objects of the study were typical basement premises of residential buildings ranging from 5 to 16 floors. The main parameters for analysis included the width and number of entrances, ceiling height, area of the premises, and their location relative to above-ground structures. The technical condition of the load-bearing structures of the basement and the building as a whole was also considered. The data were compared with regulatory requirements, in particular DBN V.2.2-5:2023 "Civil Protection Shelters" and other standards regulating the design of protective structures. The analysis was conducted by measuring parameters both on drawings and directly in the basement premises of residential buildings, systematizing them, and evaluating them in terms of functionality and safety.

Let us analyze the compliance of existing basement premises layouts with modern requirements for civil protection shelters, as defined by DBN V.2.2-5:2023 "Civil Protection Shelters," based on the drawings presented in Figures 1-6. Protective structures must meet a set of criteria, including both mandatory requirements and recommended or desirable characteristics.

Data obtained from drawing 1:

1. Total basement area: 349.2 m².
2. Ceiling height: 2.5 m.
3. Number of entrances: 2.
4. Entrance width: 0.8 m.
5. Stair width: 1.09-1.13 m.
6. Stair slope: 34.64°.
7. Internal door opening width: 0.7-0.9 m.
8. Corridor width (in clear): 2.36 m.

Within the framework of the study, measurements of the specified parameters were carried out for other buildings, and the obtained results are systematized and presented in Table 1.

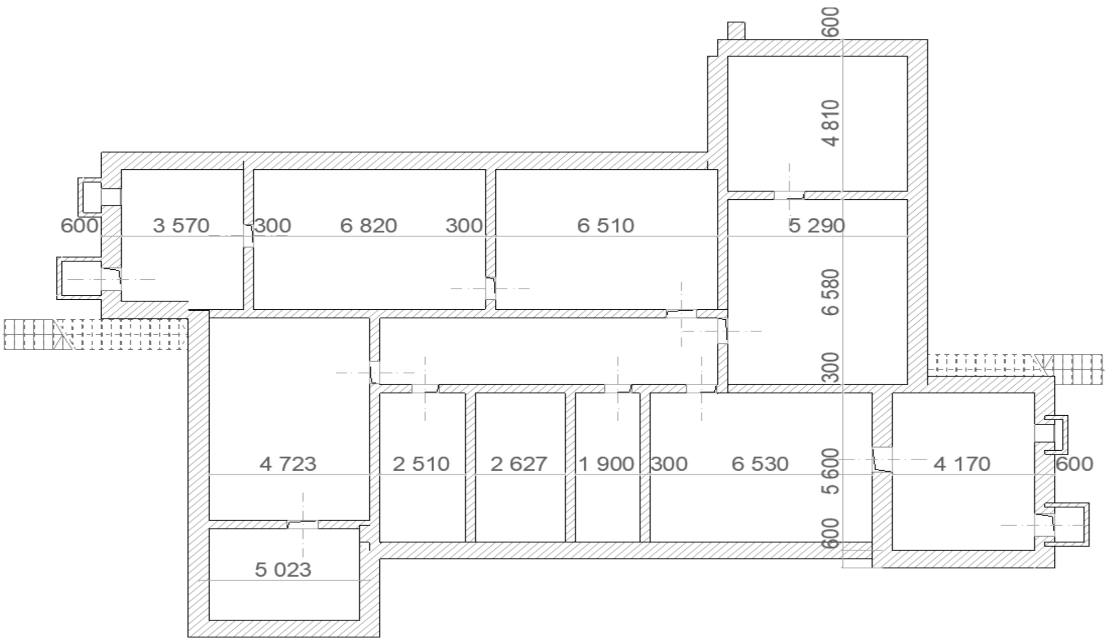

Figure 1 – Sixteen-story residential building with 79 apartments in Poltava. Total basement area: 349.2 m²

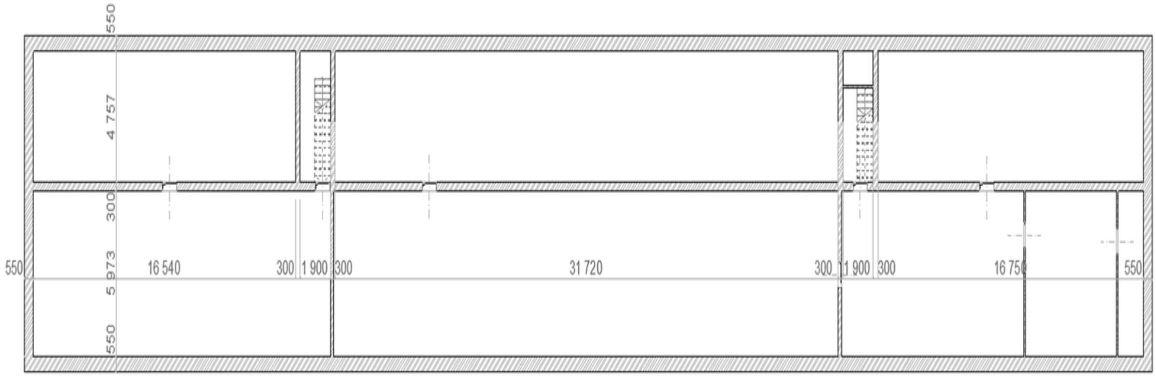

Figure 2 – Nine-story residential building with 72 apartments in Poltava. Total basement area: 1100 m²

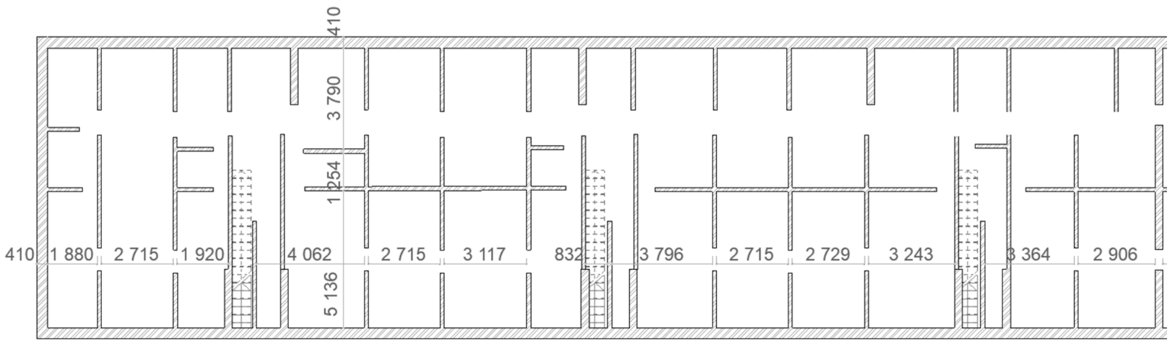

Figure 3 – Five-story residential building with 90 apartments in Poltava. Total basement area: 979 m²

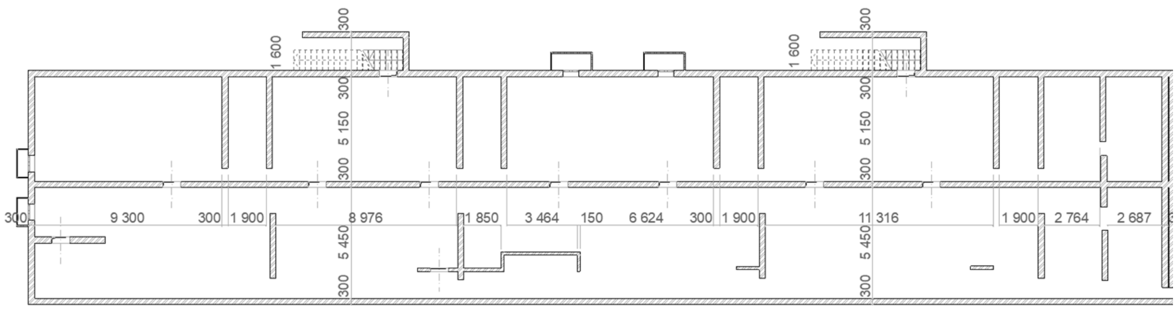

Figure 4 – Five-story residential building with 129 apartments in Poltava. Total basement area: 1226 m²

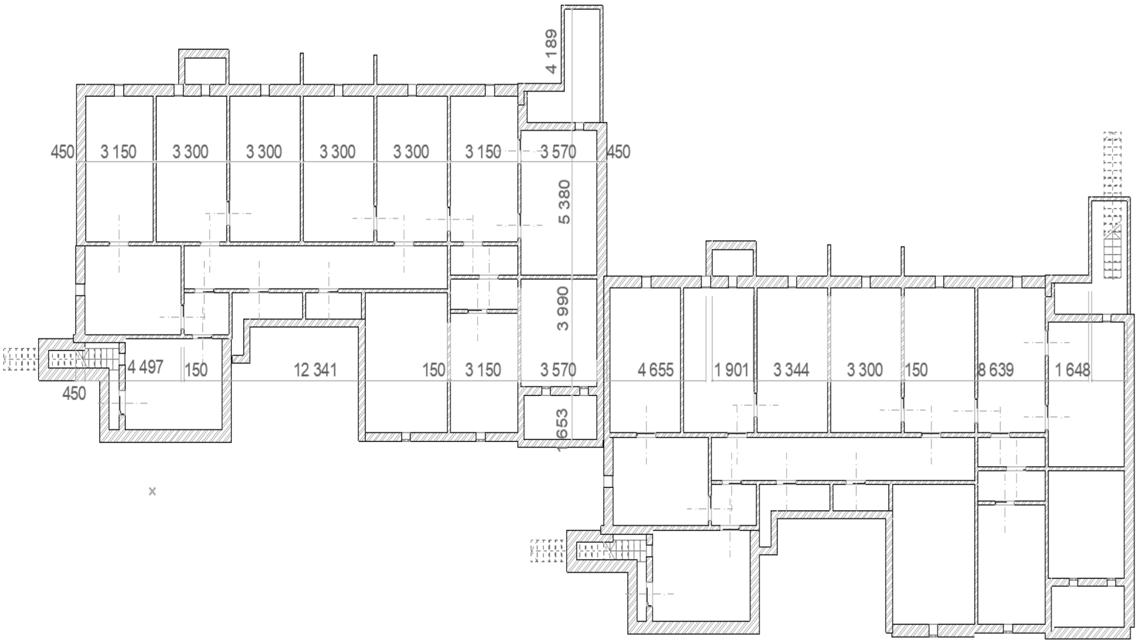

Figure 5 – Ten-story residential building with 100 apartments in Poltava. Total basement area: 560 m²

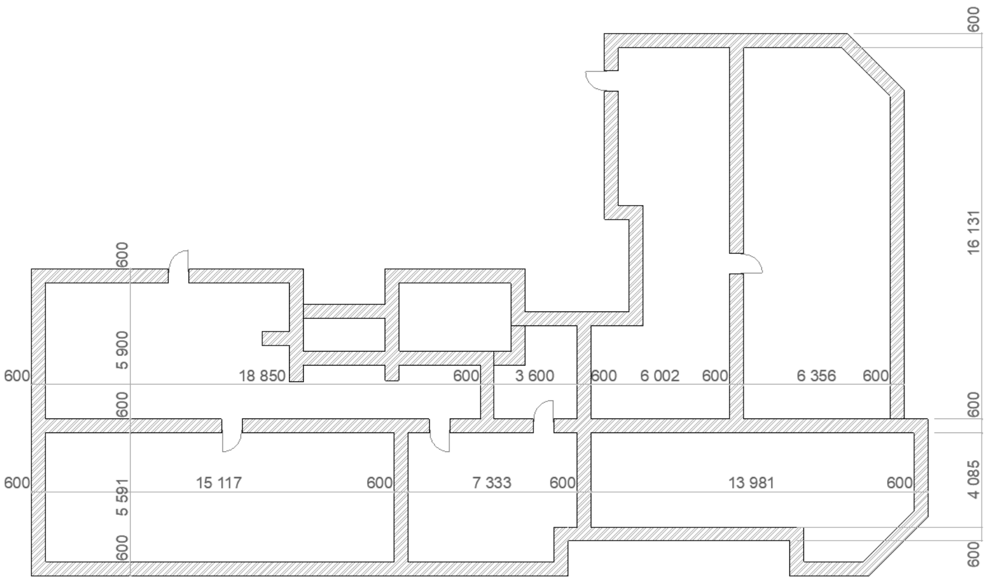

Figure 6 – Ten-story residential building with 115 apartments in Poltava. Total basement area: 710 m²

Table 1. Architectural and structural parameters of the premises

No.	Parameter	Unit of measurement	No. of the basement					
			1	2	3	4	5	6
1	Total basement area	m²	349,2	1100	979	1226	560	710
2	Ceiling height	m	2,5	1,7-2,35	1,9	2,35	2,4	2,14
3	Number of entrances	pcs	2	2	6	4	4	2
4	Entrance width	m	0,8	0,8	1	0,9	1	0,91
5	Stair width	m	1,09-1,13	1	1	1,3	1,2	1,33
6	Stair slope	degree	34,64	39	38	25,6	39,7	34,15
7	Internal door opening width	m	0,7-0,9	0,7-0,9	1	0,6-1	0,8-1	0,95
8	Corridor width (in clear)	m	2,36	5,82	1	5,6	1,62	1,06

The analysis of the drawings showed significant variability in the structural characteristics of the basements. The total area of the basement premises ranges from 349.2 m² (Basement No. 1) to 1226 m² (Basement No. 4). If we take the area of the main and auxiliary premises at 2 m² per person, this allows for sheltering 174-613 people, respectively.

The ceiling height in the studied basement premises ranges from 1.7 m (Basement No. 4) to 2.5 m (Basement No. 1). According to DBN V.2.2-5:2023, during the reconstruction of existing protective structures and dual-purpose structures (DPS), if technically possible, the height of the premises (from floor level to the bottom surface of the ceiling or covering) should be at least 2.5 m. One of the studied basement premises meets this requirement, while the other five do not. Given the presence and significant number of engineering networks typically located under the ceiling, achieving the specified height is technically challenging or impossible without substantial structural changes in two premises. Additionally, insufficient ceiling height creates difficulties for integrating ventilation systems, which are critically important for ensuring the normative level of air exchange and comfort for people in protective structures. At the same time, in three of the premises, there is the possibility of lowering the floor level, which potentially allows for addressing this issue.

The number of entrances to the basement premises ranges from 2 (Premises No. 1, No. 2, No. 5, No. 6) to 9 (Premise No. 3). According to DBN V.2.2-5:2023, protective structures must be equipped with at least two evacuation exits to ensure safety during evacuation. All studied basement premises meet this minimum requirement. Moreover, considering the presence of window openings, in many cases, there is a technical possibility to arrange additional evacuation exits, which can enhance the safety and capacity of the structures in emergency situations.

The entrance width ranges from 0.8 m (Premises No. 2, No. 3) to 1.3 m (Premise No. 5). According to the requirements, during major repairs, if technically impossible, it is allowed to arrange entrance door openings of at least 0.8 m in clear. Thus, the entrance width in all premises meets the minimum allowable standard, but a width of 0.8 m may create difficulties for rapid evacuation and accessibility for people with reduced mobility. To improve safety and inclusivity, it may be necessary, if technically possible, to widen the door openings in some premises. Additionally, in five out of six premises, there is a technical possibility to arrange a vestibule, which is an important element for preventing the ingress of harmful substances or excess pressure into the main shelter premises.

The stair slope to the basement premises ranges from 25.6° (Premise No. 4) to 39.7° (Premise No. 5). According to DBN V.2.2-5:2023, the stair slope for DPS with shelter properties during reconstruction is allowed at 1:1.5, which corresponds to an angle of 33.69°. The analysis shows that the stairs to Premise No. 4 (25.6°) meet the normative slope of 1:1.5 (26.57°), ensuring convenience and safety for evacuation. The stairs to all other premises exceed the allowable slope, which can complicate descent, especially for people with reduced mobility, and do not meet the requirements of DBN V.2.2-5:2023.

The stair width to the basement premises ranges from 0.8 m (Premises No. 2, No. 3) to 1.3 m (Premise No. 5). According to the regulatory documentation, the stair width in clear should be 1.35 m. None of the studied premises meet this requirement. Insufficient stair width combined with a steep slope creates additional risks during evacuation, especially in emergency situations.

The internal door opening width in the basement premises ranges from 0.6–1 m. According to DBN V.2.2-5:2023, the internal door opening width in protective structure premises should be at least 0.9 m. In the case of major repairs, if technically impossible, a reduction to 0.8 m in clear is allowed. For doors to technical premises (e.g., electrical, ventilation), the minimum width can be 0.7 m. It can be concluded that this parameter partially meets the requirements in different premises, although for comfortable movement of people with reduced mobility (PRM) with wheelchairs, it is desirable to increase the width to 1.2 m.

The corridor width in the basement premises ranges from 1 m (Premise No. 3) to 5.82 m (Premise No. 2). According to DBN V.2.2-5:2023, the corridor width in clear in protective structures and dual-purpose structures should be at least 1.5 m during reconstruction and at least 1.2 m during major repairs. From the data obtained, Premises No. 3 (1 m) and No. 6 (1.06 m) do not meet even the minimum requirement for major repairs (1.2 m), which poses significant risks during evacuation and limits accessibility for PRM. The corridor width in all other premises meets the requirements for reconstruction (1.5 m) and exceeds the minimum standard for major repairs (1.2 m).

Conclusions.

The analysis of existing design solutions for basement premises in multi-story buildings showed that none of the six studied premises fully meets the requirements of DBN V.2.2-5:2023 regarding safety, accessibility, and functionality.

The overall technical condition of the structures in the studied objects can be assessed as satisfactory, with signs of local wear of enclosing structures (plaster detachment, metal corrosion, presence of cracks), but no signs of emergency were detected.

The total area of the basement premises varies widely, allowing for their use for various purposes, including as protective structures.

Ceiling height meets regulatory requirements in only one premise. In three premises, it is possible to achieve compliance by lowering the floor level. In two objects, there is no technical possibility to ensure the normative height, which creates discomfort for people staying and complicates the integration of ventilation systems and other engineering networks.

The number of entrances in all premises meets the minimum requirement of having two evacuation exits, and the presence of additional windows and ventilation ducts creates potential for arranging additional exits, which can enhance safety. The entrance width in four premises is 0.8 m, which is the minimum allowable standard for major repairs but insufficient for the access of people with reduced mobility. In five out of six premises, it is possible to widen the openings to the normative width.

The stair slope in most premises exceeds the allowable values, and their width is less than the normative 1.35 m, creating significant risks during evacuation and complicating accessibility. In four premises, stair reconstruction with slope reduction is possible; in two, such a possibility is absent.

The internal door width in most premises does not meet the minimum requirement of 0.9 m, although in some cases, this standard is observed. However, during reconstruction, this issue can be resolved in five out of six studied premises. In contrast, the corridor width in two premises does not meet the regulatory requirements and cannot be changed without interfering with the building's structural elements.

The study demonstrated that basements of multi-story buildings have the potential for use as civil protection shelters but require significant adaptation. Comprehensive reconstruction is needed, including widening entrances, corridors, and stairs, reducing stair slopes, and eliminating structural barriers to ensure accessibility, safety, and comfort for all population categories.

Further research can focus on analyzing the strength of floors, assessing the possibility of arranging ventilation systems, using alternative energy sources, organizing evacuation exits, and other aspects that will contribute to ensuring the full functionality of protective structures.

References

1. Міністерство розвитку громад, територій та інфраструктури України. (2023). *ДБН В.2.2-5:2023. Будинки і споруди. Захисні споруди цивільного захисту*. Київ.
2. Міністерство розвитку громад, територій та інфраструктури України. (2024). *ДСТУ 9273:2024. Настанова щодо обстеження будівель і споруд для визначення та оцінювання їхнього технічного стану. Механічний опір та стійкість*. Київ.
3. Семко, О., Філоненко, О., Юрін, О., Ільченко, Т., Семко, В., Рабенсайфер, Р., & Магас, Н. (2024). Питання оцінки технічного стану підвальних конструкцій будівель. У *Матеріалах Міжнародної науково-практичної конференції «Інновації в будівництві та розумні будівельні технології для комфортного, енергоефективного та сталого способу життя»* (Дніпро, Україна, 21 лютого 2024 р., с. 51–54).

1. Ministry for Communities, Territories and Infrastructure Development of Ukraine. (2023). *DBN V.2.2-5:2023. Buildings and structures. Civil defense protective structures*. Kyiv.
2. Ministry for Communities, Territories and Infrastructure Development of Ukraine. (2024). *DSTU 9273:2024. Guidelines for inspection of buildings and structures for determining and assessing their technical condition. Mechanical resistance and stability*. Kyiv.
3. Semko, O., Filonenko, O., Yurin, O., Ilchenko, T., Semko, V., Rabensayfer, R., & Mahas, N. (2024). Issues of assessing the technical condition of basement structural elements of buildings. In *Proceedings of the International Scientific and Practical Conference "Innovations in Construction and Smart Building Technologies for a Comfortable, Energy-Efficient and Sustainable Way of Life"* (Dnipro, Ukraine, February 21, 2024, pp. 51–54).

4. Гасенко, А. В., Гасенко, Л. В., Слонь, В. В., & Дарієнко, В. В. (2025). Визначення потреби у сховищах цивільного захисту в існуючих житлових масивах. *Таврійський науковий вісник. Серія: Технічні науки*, (1), 551–559. https://doi.org/10.32782/tnv-tech.2025.1.57

5. Жидкова, Т., & Глеба, В. (2023). Пристосування підвальних приміщень будівель для укриття цивільного населення. *Міцність матеріалів та теорія споруд*, 110, 483–495. https://doi.org/10.32347/2410-2547.2023.110.483-495

4. Hasenko, A. V., Hasenko, L. V., Slon, V. V., & Dariienko, V. V. (2025). Determining the demand for civil defense shelters in existing residential areas. *Tavriiskyi Scientific Bulletin. Series: Technical Sciences*, (1), 551–559. https://doi.org/10.32782/tnv-tech.2025.1.57

5. Zhydkova, T., & Hleba, V. (2023). Adaptation of basement premises of buildings for sheltering the civilian population. *Strength of Materials and Theory of Structures*, 110, 483–495. https://doi.org/10.32347/2410-2547.2023.110.483-495

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Аналіз можливості пристосування підвальних приміщень багатоповерхових будинків як захисних споруд цивільного захисту

Аннотація. У статті розглядається можливість пристосування підвальних приміщень багатоповерхових будинків для використання їх як захисних споруд цивільного захисту з урахуванням чинних державних будівельних норм та стандартів. Такий підхід є особливо актуальним в умовах існуючої щільної забудови в містах, де не має можливості будувати окремо розташовані укриття. На основі існуючих планувальних рішень було здійснено аналіз ключових архітектурно-конструктивних параметрів підвальних приміщень — ширини входів, висоти стель, площі та конфігурації приміщень, кількості евакуаційних виходів, а також ширини сходів, коридорів і дверних прорізів. Проведено зіставлення отриманих даних із нормативними вимогами, встановленими ДБН В.2.2-5:2023. Особлива увага приділена можливості технічної адаптації підвалів до функціональних вимог захисних споруд — зокрема, шляхом пониження рівня підлоги, реконструкції сходових маршів, розширення прорізів, створення тамбурів тощо. Дослідження також враховує технічний стан конструкцій, наявність ознак зношення та потенціал до реконструкції без порушення несучої здатності будівлі. Результати можуть бути використані для удосконалення проєктних підходів, розробки рекомендацій щодо модернізації існуючих об’єктів та формування типових рішень.

Ключові слова: захисні споруди, цивільний захист, підвали багатоповерхових будинків.

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