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CONDITIONS OF EXISTING RESIDENTIAL BUILDINGS 50–60 YEARS AND MISTAKES OF THEIR CONSTRUCTION

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This article deals with the condition of existing residential buildings 50–60 years, which are outdated and are subject to immediate technical inspection and reinforcement. The most important factor for the safe operation of such buildings is the quality of construction factor, since in the 50–60s the construction was carried out with many of the shortcomings that are presently present.

As a real example of such a house where there were shortcomings in construction, a residential house in Drohobych was considered, where a four-storey building collapsed. The design scheme and basic structures of the building are described. Main defects and damage to the building, including those that appeared after the collapse, are presented. Using the finite element method in LIRA-SAPR, the models of the parts of the residential building that remained after the collapse were calculated. Tests were carried out on specimens of bricks taken directly at the site of the collapse, on the basis of which the strength of masonry was determined. The theoretical results of the calculations are compared with the actual condition of the building parts.

Key words: construction errors; apartment building; defects in existing structures; modeling; design scheme.

Problem statement

Every year in Ukraine the problem of the state of the existing housing stock becomes more and more acute. More than 70 % of the state's housing stock is outdated and many buildings are in a state of disrepair. The largest percentage of emergency buildings are 50's – 60's buildings, namely the so-called "Khrushchevky", 3–5-storey, panel and brick, which according to the plan were designed as temporary housing for 25 years. In the 1950s, due to the large shortage of living space, the goal was to build a lot, cheap and fast, which laid down the major problems in the future operation and safety of buildings that are beginning to emerge today.

Relevance of the research

The most common shortcomings, defects, and damages of such buildings include:

- absence or damage of the drainage system along the perimeter of the building in areas with high groundwater level;
- absence or damage of waterproofing of foundations;
- use of a small brand brick without equipment in the arrangement of the bearing walls of the basements;
- damage to the system of organized drainage and drainage;
- freezing of walls due to lack of insulation;
- poor performance of overlapping disks, namely fastening and anchoring of precast concrete slabs of overlapping;
- non-compliance with modern design requirements and standards.

The problems described lead to complex and tragic consequences, namely the destruction and collapse of buildings and great human and material losses. An example of this is the collapse of part of a 4-storey apartment building on the street. Hrushevskogo, 101/1 in the city of Drohobych.

Formulating the purpose and objectives of the article

The main purpose is to analyze the consequences of mistakes of construction of houses of 50–60 years on the example of a real house in Drohobych. The task was to evaluate the condition of the building after an emergency, to determine the main defects of the building structures and to compare them with the results of theoretical calculations on the basis of the finite element method in PC "Monomakh-SAPR" and PC "LIRA-SAPR".

Analysis of recent research and publications

Many scientists and engineers are studying the current state of buildings and structures. Famous works of [Gladyshev, 2017] which describes the performance of instrumental surveys of structures for various purposes in the conditions of dense construction, as well as the development of progressive structural solutions that significantly extended the life of existing buildings and structures. In the works of [Barashikov, 1998], [Klimenko, 2005], [Suhanov, 2005] indicative procedure for testing and inspection of building structures. Ways to determine internal defects in the walls of rooms are described in detail in the work of [Pevnev, 2009]. Options for repairing defects in building structures are reviewed and presented in the work of [Fizdel, 1970].

Presentation of the main material

The structural design of the examined building is rigid with longitudinal and transverse load-bearing brick walls and horizontal overlapping disks. A residential building, L-shaped with four entrances (Fig. 1). The building has one staircase in each of the entrances. The height of the residential floor from the floor to the ceiling is 2.5 m. Covering a tent type with an attic height to the bottom of the ridge 4 m.

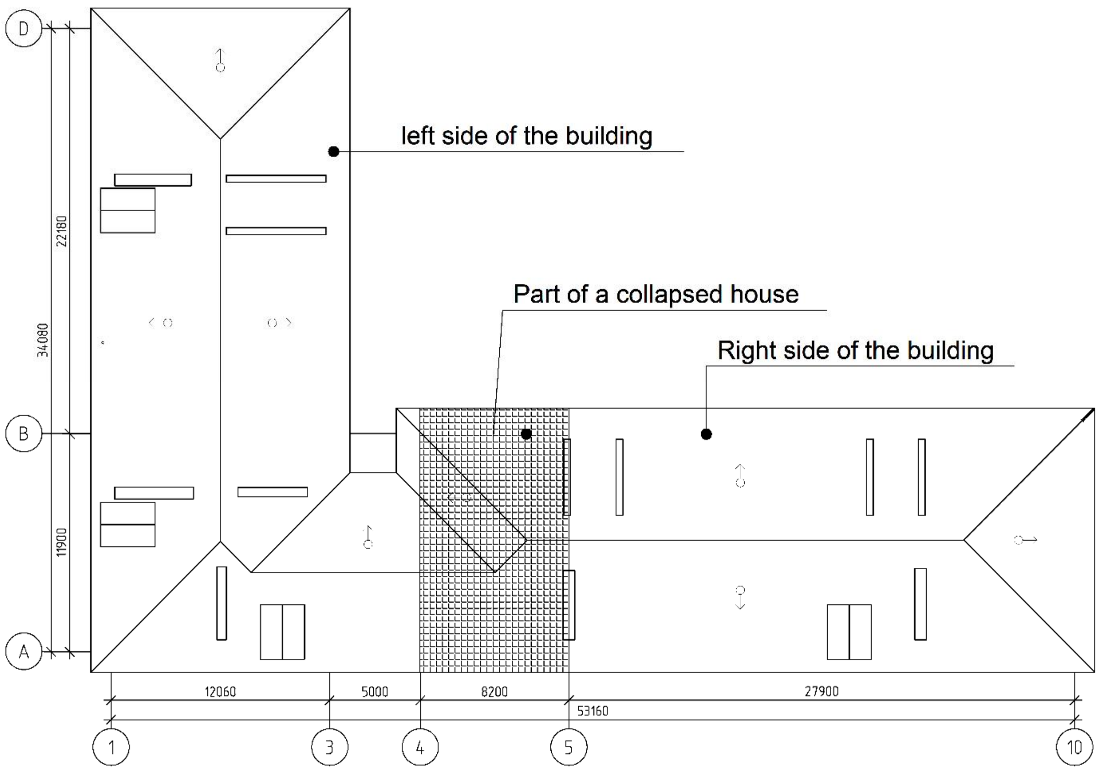

Fig. 1. Scheme of the building

The main structures of the building:

– foundations soles – strip monolithic soles width 0.8–1.0 m;

– external foundation walls in the part with basements of monolithic concrete at a height of 1.45 m (0.6 m thick), above the brick height of 1.05 m (0.64 m thick);

– the inner walls of the basement are brick without equipment, 0.38 m thick;

– external walls – brick plastered, 0.51 m thick;

– internal walls – brick plastered, bearing a thickness of 0.38 m;

– floor slabs – precast reinforced ribs (ribs up);

– balconies – monolithic reinforced concrete on metal beams;

– jumpers – precast concrete;

– ladders and stairs – precast concrete;

– tent attic structures – wooden rafters, racks, struts, beds.;

– roof – asbestos-cement wavy sheets on a wooden crate.

The main defects of the building:

− collapse of building structures of a part of a building of all 4 floors (Fig. 2);

− basement walls and basement walls, no waterproofing;

− visible loss of stability of the middle bearing wall of the basement, vertical cracks in the wall with opening up to 10 mm in height of the bearing brick wall with the destruction of the masonry (Fig. 3). No brickwork of the basement walls. Wrapping of walls, vysolyas, fungus damage, destruction of bricks, as well as weathering and loss of strength of seam solution;

− strong humidity of basements, absence of a floor. The floor is a soil foundation that is in the wet state;

− the destruction of the plinth, in some places the lack of equipment, the equipment of the brickwork, the destruction of the brick, the wall wall, the vysoly, the defeat of the fungus, the weathering of the solution from the seams;

− vertical and horizontal cracks on walls and sidewalls throughout the building;

− sagging, insufficient area of support of the slabs of the staircase, sagging of slabs of overlapping and crossings on which they were carried out due to collapse of structures;

− there are cracks under the floor slabs in the ceiling level, as well as fresh cracks between the seams of the floor slabs, indicating the breach of the flooring discs as a result of the impulse that may have caused the collapse of the building structures of part of the building;

− sagging structures of a wooden tent roof over the collapsed part of the building;

− there is no drainage on the perimeter of the building.

Fig. 2. The collapse of part of the building

Fig. 3. Visible loss of resistance, as well as vertical and horizontal cracks in the middle bearing wall on axis B in axes 6–8

The basic mistakes of building construction were identified:

- lack of drainage and waterproofing in the examined building. Executed engineering-geological surveys have shown that during the period of intense atmospheric precipitation or melting of the snow cover a temporary water horizon of type “top” can be formed on the soils of IGE-2 (loam semi-solid), which could lead to flooding of the house, so during construction it was necessary to provide measures for drainage of the territory and waterproofing of the foundations, which was not done during the construction of the building;
- low grade of brick and mortar, which is confirmed by laboratory tests.

The design models of the right and left parts of the building were created, on the basis of which the distribution of stresses in the middle bearing and the most loaded walls of the right part, along axis B, in axes 1–10 (Fig. 4) was obtained.

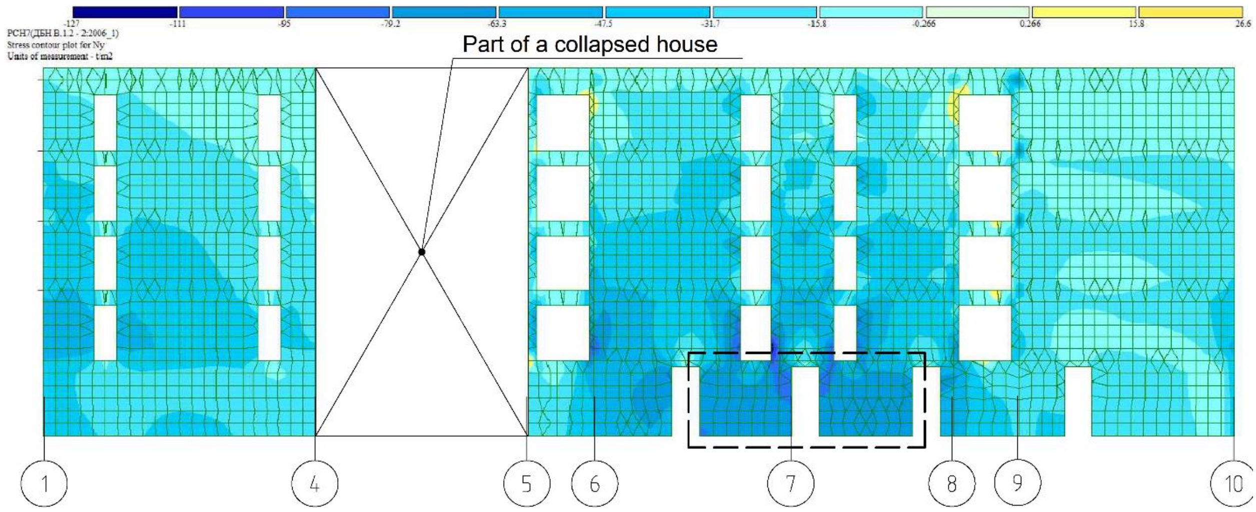

Fig. 4. The distribution of stresses in the middle bearing walls along the axis B, in the axes 1–10, after the collapse

The selected walls in Fig. 4 basement floors along axis B, axes 6–7, 7–8 are fragmented and analyzed further in Fig. 5.

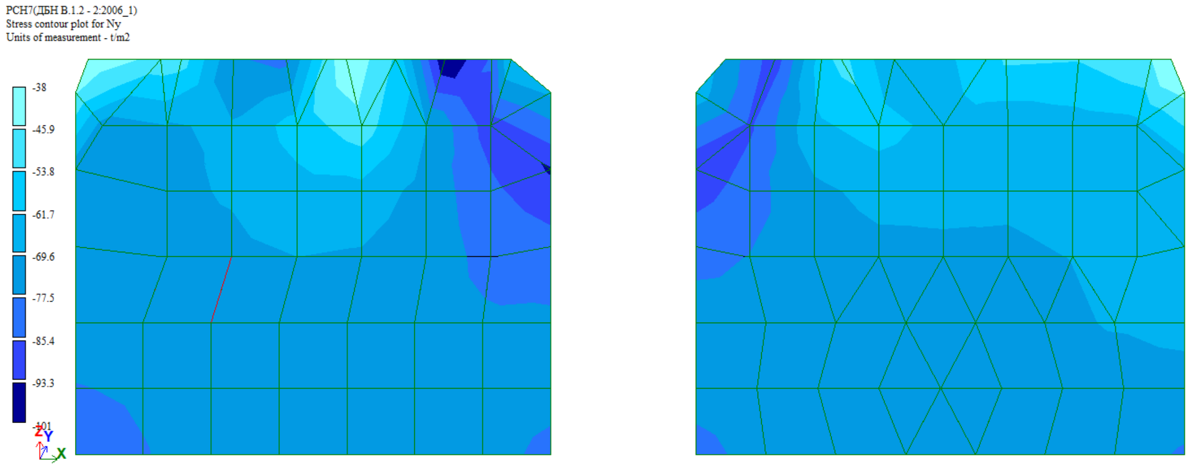

Fig. 5. Distribution of stresses in the basement walls of the right part of the building along axis B, in axes 6–7 and 7–8

The maximum stresses in the basement walls along axis B, in the axes 6–7, 7–8 exceed the allowable values of compressive strength of masonry R = 29,56 т/m^2.

Ny = –38…101 т/m^2 > R = 29.56 т/m^2.

As can be seen from the calculations – the compression stresses that occur in the walls of the middle bearing wall of the right side of the building, along the axis B in the axes 6–8, significantly exceed the bearing capacity of the brickwork. This phenomenon is also confirmed by the results of the survey of the building where the emergency walls were identified (Fig. 3).

To analyze the possible impact of the collapse on a part of the building, in axes 1–3, AD, a dynamic calculation was made of the possible impulse that caused the collapse, which allowed to obtain the character of the movement of the building structures from fluctuations, in particular in Fig. 6 shows the nature of the movement from the 2nd translational form of oscillations.

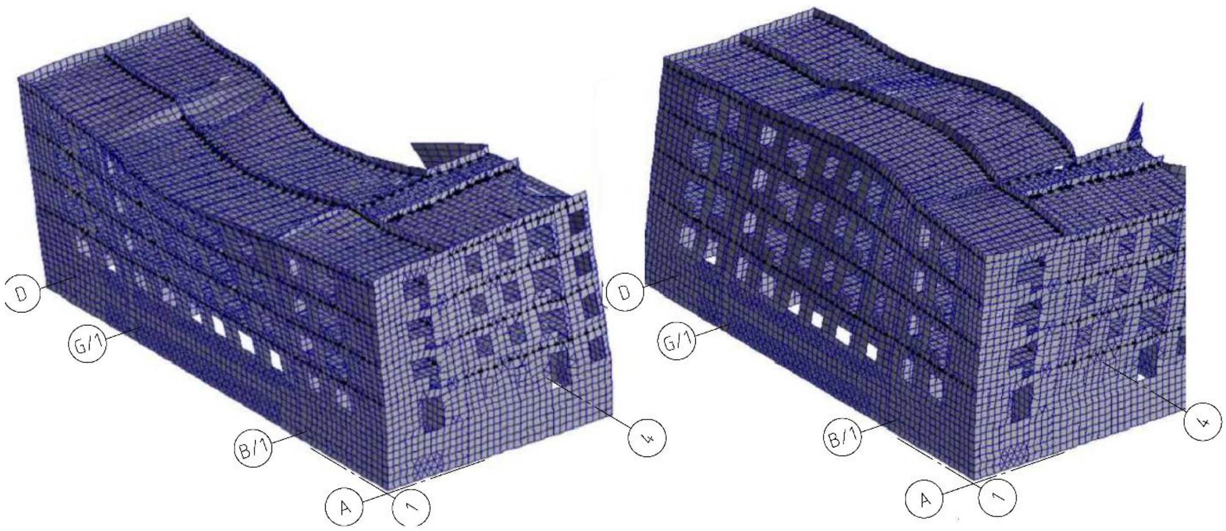

Fig. 6. The nature of the movement of building structures of the left part of the house after the collapse of the 2nd translational oscillation

Such character of displacements is confirmed by the results of the survey presented on the scheme of location of defects with fixed fresh cracks between slabs of overlapping and at the top of partitions at the junction with the overlapping disk of the 4th floor of the left part of the building (Fig. 7).

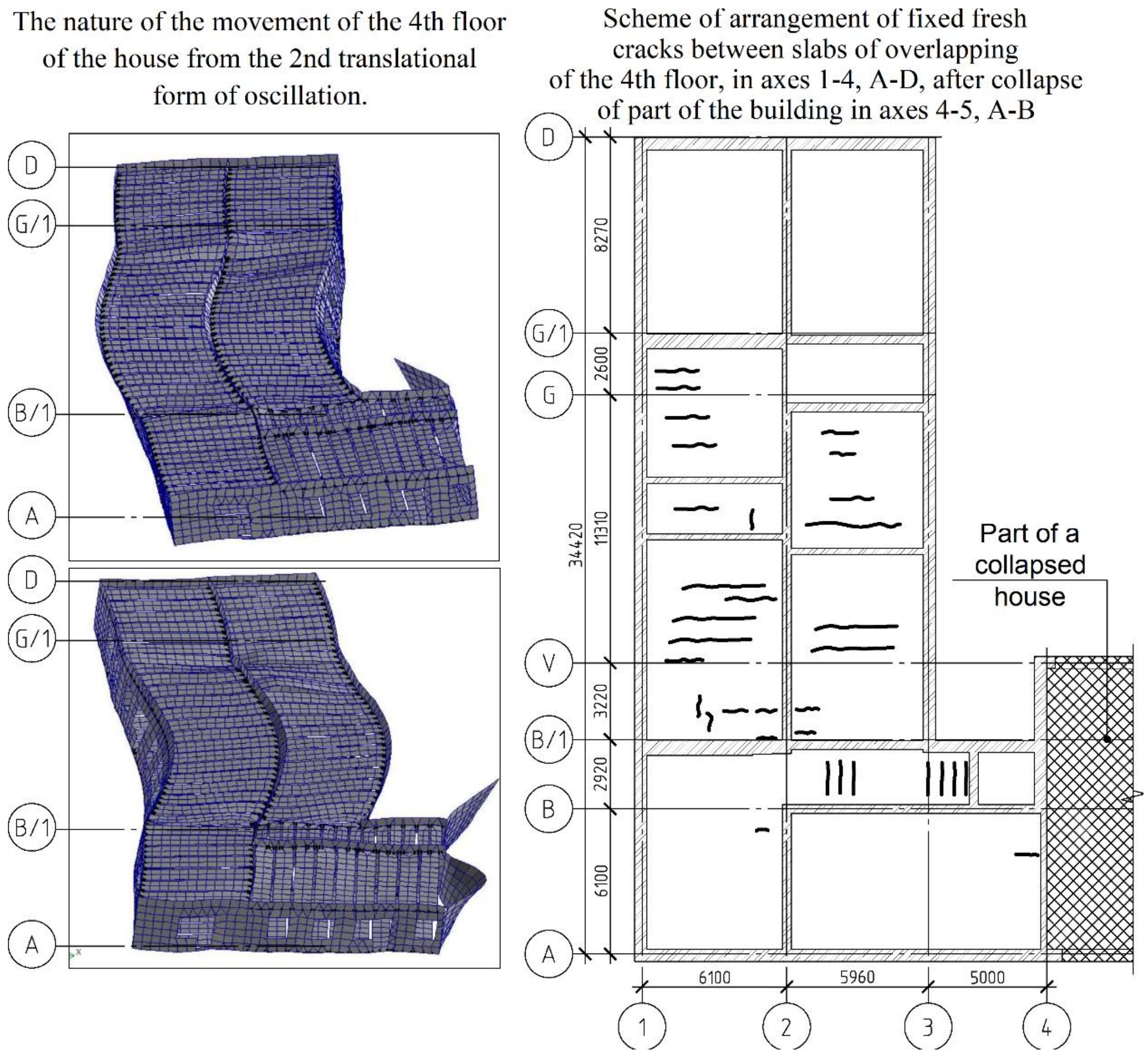

Fig. 7. Comparison of the nature of the movement of the building structures of the left part of the house after the collapse from the 2nd translational oscillation with the actual placement of fresh cracks formed after the collapse of part of the building

Throughout the building, there are cracks under the floor slabs in the ceiling, as well as fresh cracks between the seams of the floor slabs, indicating the movement and disturbance of the flooring discs due to the impact caused by the collapse of the structures in axes 4–5, AB. These defects were further confirmed by the results of the dynamic calculation, using the finite element method in the PC "Monomakh-SAPR", which allowed to obtain a similar nature of the movement of the overlapping disks of the building.

Conclusions

Mistakes in the construction of residential buildings 50–60 years affect the current state of the housing stock, a large part of which is in a state of disrepair and is a danger to human life. An example of this is the collapse of a part of a house in Drohobych, on the street. Grushevskogo, 101/1, where the possible cause of the collapse was the destruction of the brickwork of the middle load-bearing wall of the house due to the low brand of brick and mortar, due to strong moisture due to lack of drainage and waterproofing.

Buildings 50–60 years, designed for up to 50 years, today require detailed surveys of their technical condition, in order to ensure their safe operation.

Prospects for further research

The above studies confirm the relevance of the topic, as the existing condition of the housing stock is a problem of national importance. It is necessary to constantly monitor existing buildings and, on the basis of technical inspections, take measures to prevent emergency situations to ensure the life and health of people.

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СТАН ІСНУЮЧИХ ЖИТЛОВИХ БУДІВЕЛЬ 50–60-х РОКІВ ЗАБУДОВИ ТА ПОМИЛКИ ЇХ БУДІВНИЦТВА

Розглянуто проблеми стану житлових будівель 50–60-х років забудови, які застаріли та підлягають негайним технічним обстеженням та посиленню. Для безпечної експлуатації таких будівель найістотнішим є фактор якості будівництва, оскільки у 50–60-ті роки будівництво виконувалося із багатьма недолікам, які проявляються тепер. У 50-ті роки, через великий брак житлових площ, за мету було поставлено будувати багато, дешево і швидко, що заклало основні проблеми майбутньої експлуатації та безпеки будівель, які почали проявлятися нині.

Як реальний приклад такого будинку, в якому проявилися недоліки будівництва, розглянуто житловий будинок у м. Дрогобичі на вул. Грушевського, 101/1, де стався обвал частини чотириповерхової будівлі. Описано конструктивну схему та основні конструкції будівлі, вказано основні дефекти та пошкодження будівлі, разом із тими, які з’явилися після обвалу. Із використанням методу скінченних елементів у ПК “ЛІРА-САПР” та ПК “МОНОМАХ-САПР” виконано розрахункові моделі частин житлової будівлі, які залишися після обвалу. Виконано випробування зразків цегли, взятих безпосередньо у місці обвалу, на основі чого визначено міцність кладки. Теоретичні результати розрахунків порівняно із фактичним станом частин будівлі.

Причиною обвалу стало руйнування цегляної кладки середньої несучої стіни будинку через низьку марку цегли та розчину, внаслідок сильного зволоження через відсутність дренажу та гідроізоляції. Виконані інженерно-геологічні вишукування показали, що в період інтенсивних атмосферних опадів або танення снігового покриву може утворюватися тимчасовий водний горизонт типу “верховодка” на ґрунтах ІГЕ-2 (суглинок напівтвердий), що може призводити до підтоплення будинку, тому під час будівництва треба було передбачити заходи із дренування території та гідроізоляції фундаментів, що не було зроблено під час будівництва.

Будинки 50–60-х років, які проєктувалися на термін до 50 років, сьогодні потребують детальних обстежень технічного стану з метою забезпечення їх безпечної експлуатації.

Ключові слова: помилки будівництва; житловий будинок; дефекти наявних конструкцій; моделювання; розрахункова схема.