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Bohdan Demchyna[1], Leonid Vozniuk[2]

EMERGENCY CONDITION OF LOGGIES IN BUILDINGS WITH SUPPORTING BRICK WALLS

Lviv Polytechnic National University,
[1] Department of building construction and bridges,
[2] Department of architectural design and engineering,
lvoznyuk@gmail.com

This article is devoted to the problems of the existing residential buildings of 70-80 years of construction of the last century, which have been in operation for about 50 years and are subject to immediate technical inspection. The most important factor for the safe operation of such buildings is the quality of construction, as in this period the construction was performed with many shortcomings that are manifested today.

The article describes the problem of joints of loggias with the building in the design and construction of multi-storey buildings with load-bearing brick walls. Poor ligation of bricks in the masonry, as well as the lack of quality ligation of the transverse walls of loggias with load-bearing longitudinal walls of the building leads to the formation of cracks on the entire height of the loggias, which completely cut them at the abutment, which creates an emergency collapse of building structures.

A real example of such a problem in the existing 9-storey building with brick load-bearing walls, where the shortcomings of construction were manifested, namely the poor quality of masonry at the junction of loggias to the load-bearing walls of the building.

The structural scheme is also described, as well as the main structures of the building. The main damages and defects are shown. Using the PC "LIRA-SAPR" created a calculation model and compared the results of calculations with the existing condition of the considered area of the building. Recommendations for strengthening the emergency section of the building are given.

Key words: construction errors, brickwork, defects of brick walls, loggia, modeling, calculation scheme.

Problem statement

The presence in Ukraine of a large existing housing stock of different years of construction allows for a long time of operation to observe, study and analyze the shortcomings of the design, construction and operation of buildings, as well as their individual elements. In particular, a major problem today is the condition of existing loggia structures, which are often in a state of emergency and can pose a danger to human life and health. To prevent such emergencies, it is necessary to conduct scheduled inspections of such buildings and structures with further development of design solutions for the reconstruction and reinforcement of damaged building structures.

Relevance of the research

Emergency structures of loggias pose a significant danger not only to people who are in the building, but also to passers-by and vehicles that may be damaged as a result of their destruction or collapse.

The most common mistakes in the construction and operation of loggia structures in buildings with brick load-bearing walls include:

– application of the type of brick and mortar grades that do not correspond to the design;

– poor ligation of brickwork, no ligation of the longitudinal walls of the building with the transverse walls of the loggia;

– subsidence of foundations due to flooding and soaking;

– masonry defects due to violation of the rules of work in winter conditions;

– non-compliance with modern requirements and design standards.

All these construction errors, individually or in combination, often lead to damage or destruction of the load-bearing structures of loggias, which, in turn, makes the building an emergency. An example of such a situation is the condition of loggias in an existing building with load-bearing brick walls on the street. Volodymyra Velykoho, 44 in the city of Lviv.

Formulating the purpose and objectives of the article

The aim was to determine the reasons for the formation of cracks, as well as deformations of the loggia in a building with load-bearing longitudinal and transverse brick walls on the example of an existing residential building of the 70s in Lviv. The task was to determine the condition of the inspected part of the building and to provide recommendations for strengthening the building structures. To perform the task, studies of load-bearing structural elements were carried out, as well as the main defects and damage of building structures were determined, followed by their comparison with the theoretical results of calculations based on the finite element method.

Analysis of recent research and publications

Many engineers and scientists study and inspect the condition of existing buildings and structures. A detailed survey of the existing emergency building is considered in the paper (Demchyna, 2019). Methods of conducting the survey to determine the technical condition of buildings and structures are described in the works (Barashykov, 1998, 2018; Klimenko, 2005; Sukhanov, 2005; Hladyshev D., 2012, 2016; Hladyshev H., 2017; Mazheiko, 2010; Hryhorovskyi, 2019). Methods for establishing and determining defects in the walls of the premises are presented in detail in (Pevnev, 2009). Options for eliminating defects in load-bearing building structures are described in (Fyzdel, 1970). Restoration of a panel house after the explosion in the city of Kharkiv is presented in the publication (Shmukler, 2013). To better understand the operation of the structure, as well as the causes of damage to building structures, it is necessary to create calculated finite element models using modern calculation systems (Barabash, 2013).

Presentation of the main material

Structural scheme of the building, part of which was inspected, with longitudinal and transverse brick load-bearing walls and horizontal overlapping disks. Residential building (Fig. 1).

The building has a stair and elevator unit. The height of the living floor from floor to ceiling is 2.5 m. The height of the building to the top of the parapet is 28.4 m.

The main structural elements of the building:

– foundations – prefabricated concrete blocks on foundation slabs;

– load-bearing internal walls – brick, 510 mm thick;

– load-bearing walls of loggias – brick, 380 mm thick;

– floor slabs of the building – prefabricated reinforced concrete round-hollow;
– loggia floor slabs – prefabricated reinforced concrete ribbed;
– loggia fencing – prefabricated reinforced concrete panels, glazing;
– crossbeams – prefabricated reinforced concrete;
– stairs and stair landings – prefabricated reinforced concrete.

Fig. 1. Scheme of the building

The main defects of the building (Fig. 2):

– vertical crack along the height of the building at the junction of the load-bearing walls of the loggia and the house with a width of up to 40 mm;

– poor-quality ligation of brickwork of the longitudinal load-bearing walls of the building with the transverse load-bearing walls of the loggia;

– deviation horizontally from the building of the load-bearing structures of the loggia;

– diagonal crack when making a load-bearing wall of a loggia with a difference of seams to 20 mm (Fig. 4).

In (Fig. 2) you can see a vertical crack in the height of the building, the width of which is greatest at the highest point of the building and reaches 40 mm. The crack is mainly in height between the rows of masonry, but there are also cracks in the body of the brick in a row, which serves as a link between the wall of the loggia and the load-bearing wall of the building.

The brickwork of the loggia is three-row with a bandage in one row, which connects the loggia with the perpendicular load-bearing wall of the house. Prefabricated ribbed reinforced concrete floor slabs rest on the end bearing load-bearing brick walls of the loggia and are not attached to the building. This means that the connection of the loggia with the house is solved by only one row of masonry, which is nested in height in three rows.

After the formation of a through crack at the height of the building, the loggia begins to work as a free-standing part, respectively, there is a danger of its destruction.

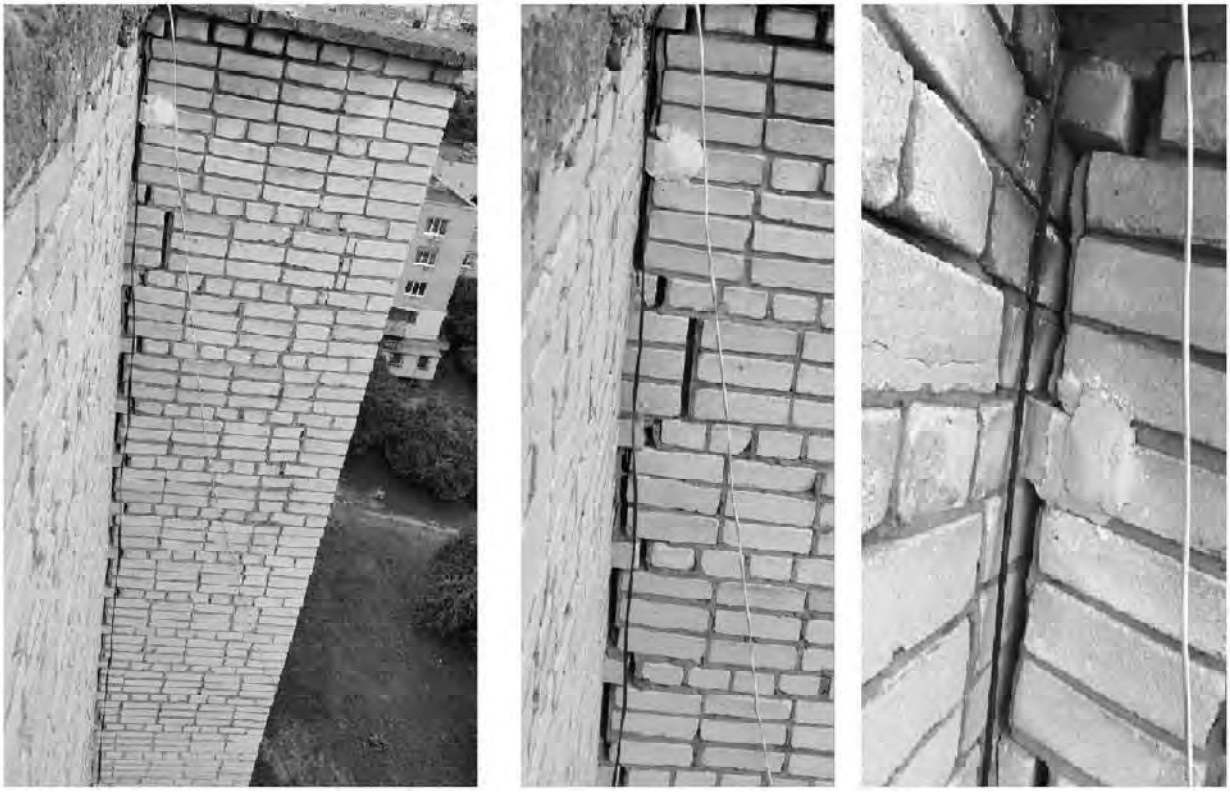

Fig. 2. Vertical crack at the junction of load-bearing walls and loggia

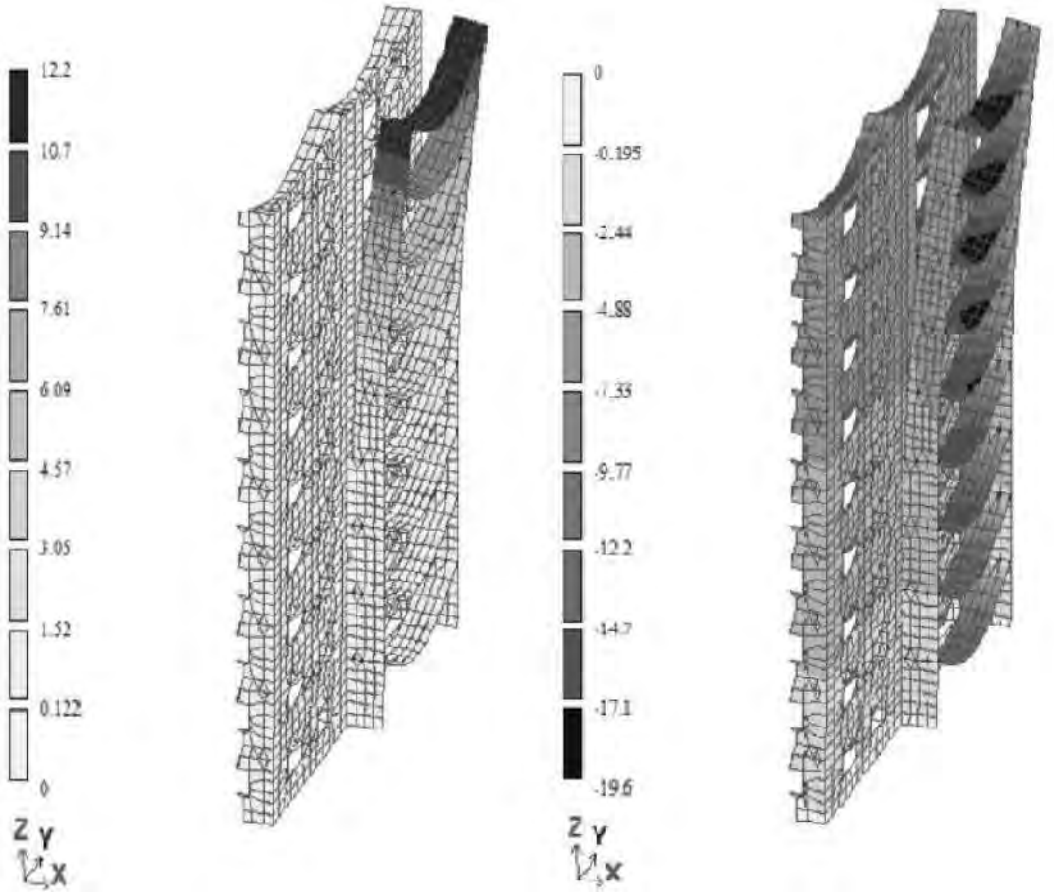

Fig. 3. Isopolies of loggia displacements along X (horizontal component, mm) and Z (vertical component, mm)

To better understand the operation of the structure after the formation of cracks and taking into account its structural scheme and white loading, a calculated finite element model was created in the PC "LIRA-CAD" and the movement of the loggia was obtained (Fig. 3).

The structure of the loggia is designed so that the loads are unevenly distributed, namely on the outside (from the side of the facade) enclosing reinforced concrete panels and glazing create a running load, which causes skew of the loggia structure, because it is not attached to the building properly.

To obtain a more accurate reproduction of the existing structure of the loggia, after the formation of through cracks, in the calculation scheme between the outer load-bearing wall of the building and the 5 upper floors was modeled deformation seam (at this height visually visible crack opening).

A diagonal crack, which is located at the level of the 6th floor, is also fixed in the end bearing wall of the loggia (Fig. 4). The reason for this crack is that after the connection between the walls of the loggia and the walls of the house collapsed, the loggia began to deviate from the building, due to the fact that the facade of the loggia has constant running loads from reinforcing concrete wall panels and glazing.

(Fig. 4) shows the distribution of vertical stresses Ny, as well as the diagonal crack that cuts the brickwork at the seams.

External loads are applied to the facade of the loggia, which, in turn, due to the occurrence of a through vertical crack, leads to uneven stress distribution.

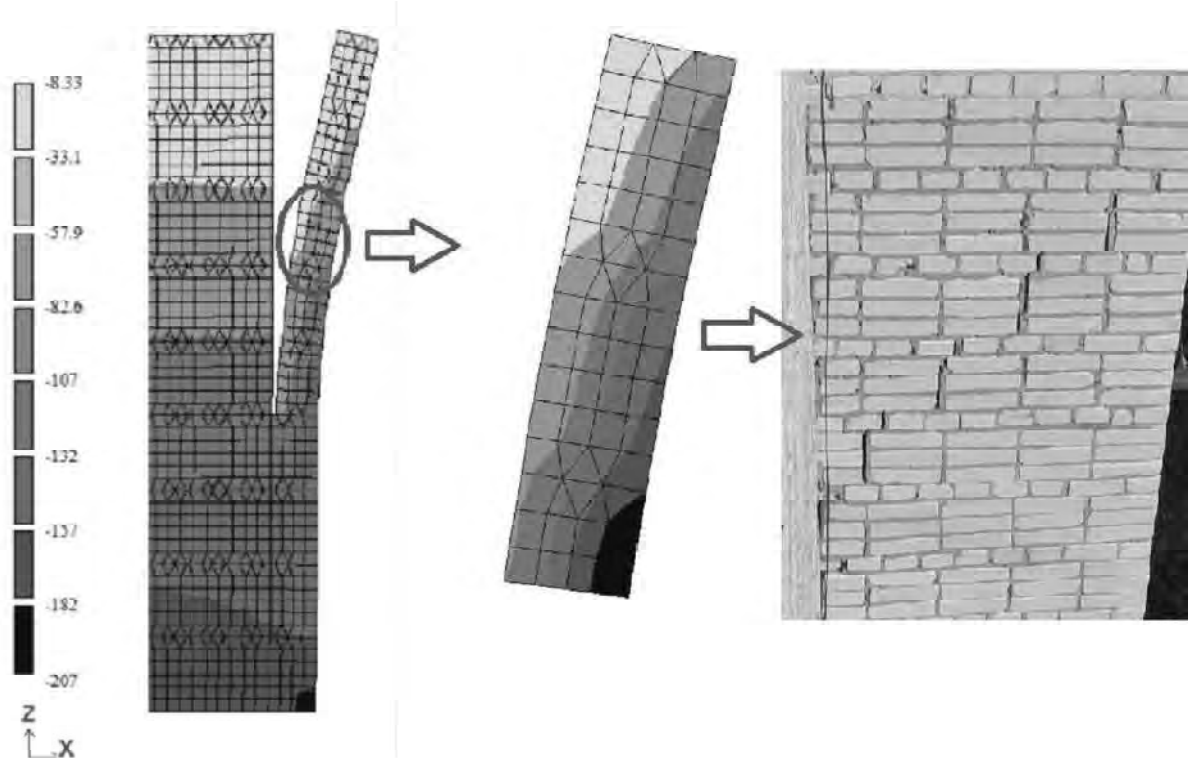

Fig. 4. Comparison of stress distribution Ny with a diagonal crack

According to the comparison, the nature of the stress distribution corresponds to the nature of the development of the diagonal crack.

Based on a visual inspection of the visible part of the building structures and the results of calculations, it can be concluded that the cause of cracks is poor quality masonry load-bearing walls of the loggia and load-bearing walls of the building, which caused an emergency condition of the building.

This situation requires fencing of the area near the loggia, a ban on residents to go to the loggia and the urgent development of a project to strengthen building structures to eliminate the emergency situation.

Reinforcement of the considered building structures can be made of metal structures, namely clamps and straps, which should connect the structure of the loggia with the load-bearing wall of the

building. When implementing the reinforcement project, it is necessary to take into account all regulations in force at the moment.

Conclusions

The disadvantages of building houses of 70–80 years with brick load-bearing walls are manifested today in the state of the existing housing stock, most of which is in disrepair and poses a danger to human life and health. An example of this is the emergency condition of the loggias of the house in Lviv, on the street. Volodymyra Velykoho, 44, which need immediate strengthening to prevent their collapse.

Prospects for further research

The above confirms the relevance of the issues raised, as the current state of the housing stock of Ukraine is a problem of national importance. It is necessary to constantly monitor the condition of existing buildings and on the basis of technical inspections and, if necessary, their reconstruction projects to take measures to prevent accidents in order to ensure human life and health.

References

Demchyna B., Vozniuk L., Surmai M. (2019). Conditions of existing residential buildings 50–60 years and mistakes of their construction. *Theory and Building Practice, Lviv, Vol. 1, No. 1, 43–49. doi: https://doi.org/10.23939/jtbp2019.02.043. (in English).*

Barashykov A. Ia., Malyshev O. M. (2008). Otsiniuvannia tekhnisnoho stanu budivel ta inzhenernykh sporud, *Osnova. Kyiv. (in Ukrainian).*

Klimenko V. Z., Belov I. D. (2005). Vyprobuvannia ta obstezhennia budivelnykh konstruktsii i sporud. *Osnova, Kyiv. 207 p (in Ukrainian).*

Sukhanov V. T., Korobko O. O., Lysenko V. A. (2005). Diahnostyka, otsinka ta metody obstezhennia. *Navchalnyi posibnyk, Odesa, Optimum, 194 p. (in Ukrainian).*

Pevnev V. Ia., Borzov M. N. (2009). Sposoby opredelenyia vnutrennykh defektov v stenakh pomeshchenyi. *Systemy obrobky informatsii, zb. nauk. pr. KhU PS, Vol. 7 (79), pp. 38–40 (in Russian).*

Fyzdel Y. A. (1970). Defekty v konstruktsiiakh y sooruzhenyiakh y metody ykh ustranenyia, *Moskva. Stroiyzdat, 490 pp. (in Russian).*

Hladyshev H. M. (2017). Otsiniuvannia deformovanoho stanu budynkiv v mezhakh ushchilnenoi zabudovy u fiksovanykh inzhenerno-heolohichnykh umovak, *Novi tekhnolohii v budivnytstvi: Naukovo-tekhnichnyi zhurnal, Kyiv, NDIBV, Vol. 3317, pp. 64–71 (in Ukrainian).*

Hladyshev. D., Hladyshev. H., Tsarov Ye., Dats. A. (2016) Analiz vertykalnykh deformatsiia hrupy zhytlovykh budynkiv staroi zabudovy. *Nauka ta budivnytstvo. Vol. 1, No. 7. 28–34 pp. (in Ukrainian).*

Hladyshev. D., Hladyshev. H. (2012) Doslidzhennia tekhnichnoho stanu budivel, sporud ta yikhnikh elementiv. *Monohrafiia. Lvivska politekhnika. 304 p. http://elar.nung.edu.ua/handle/123456789/5039. (in Ukrainian).*

Barashykov A. Ia. (1998). Otsenka tekhnycheskoho sostoianyia stroytelnыkh konstruktsii zdanyi y sooruzhenyi, *NMTs Dernahliadokhoronpratsi Ukrainy, 238 p (in Russian).*

Mazheiko O. (2010). Monitorynh tekhnichnoho stanu nesuchykh kontruktsii budivel i sporud. *Zbirnyk naukovykh prats "Naukovi zapysky", Kirovohrad, Vol. 2, No. 3, 222–228 pp. (in Ukrainian).*

Hryhorovskyi P., Hladyshev H. M., Hladyshev D. H., Hladyshev R. D. (2019). Udoskonalennia metodyky provedennia heodezychnoho monitorynhu pid chas kapitalnoho remontu bashtovoi promyslovoi sporudy. *Novi tekhnolohii v budivnytstvi. Vol. 36 . 32–38 pp. doi: https://doi.org/10.32782/2664-0406.2019.36. (in Ukrainian).*

Shmukler V., Honcharenko D., Konstantynov A., Zync"henko V. (2013). Vosstanovlenye krupnopanelnoho zdanyia, razrushennoho vrezultate tekhnohennoi katastrofy. *Promyslove budivnytstvo ta inzhenernisporudy. Vol. 2. 34–39 pp. https://www.urdisc.com.ua/rl/info/2_13.pdf. (in Russian).*

Barabash M, Henzerskyi Yu. (2013). Kompiuternoe modelyrovanye protsessov zhyznennoho tsykla konstruktsyi. *Mistobuduvannia ta terytorialne planuvannia. Vol. 47, 83–89 pp. http://nbuv.gov.ua/UJRN/MTP_2013_47_13. (in Russian).*

Б. Г. Демчина[1], Л. І. Вознюк[2]
Національний університет "Львівська політехніка",
[1] кафедра будівельних конструкцій та мостів,
[2] кафедра архітектурного проєктування та інженерії

АВАРІЙНИЙ СТАН ЛОДЖІЙ У БУДІВЛЯХ ІЗ НЕСУЧИМИ ЦЕГЛЯНИМИ СТІНАМИ

Ця стаття присвячена проблемам стану існуючих житлових будівель 70–80 років забудови минулого століття, які експлуатуються близько 50-ти років та підлягають негайному технічному обстеженню. Найсуттєвішим для безпечної експлуатації таких будівель є фактор якості будівництва, оскільки у вказаний період будівництво виконувалося із багатьма недоліками, які проявляються у теперішній час.

У статті описано проблему вузлів стикування лоджій із будівлею при проєктуванні та спорудженні багатоповерхових будівель із несучими цегляними стінами. Неякісна перев'язка цегли у кладці, а також відсутність якісної перев'язки поперечних стін лоджій із несучими повздовжніми стінами будівлі приводить до утворення тріщин на усю висоту лоджій, які повністю відрізають їх на примиканні до несучих стін, що створює аварійну ситуацію і може призвести до обвалу будівельних конструкцій.

Розглянуто реальний приклад такої проблеми у існуючій 9-поверховій будівлі із цегляними несучими стінами, де проявилися недоліки будівництва, а саме неякісного виконання кладки у місцях примикання лоджій до несучих стін будівлі.

Описано конструктивну схему, а також основні конструкції будівлі. Показано основні пошкодження та дефекти.

Для більшого розуміння роботи конструкції після утворення тріщин та із урахуванням її конструктивної схеми та завантаження біла створена розрахункова скінченно-елементна модель у ПК "ЛІРА-САПР" та отримано переміщення лоджії. Конструкція лоджії запроєктована таким чином, що навантаження розподілені нерівномірно, а саме по зовні (із сторони фасаду) огороджувальні залізобетонні панелі та засклення створюють додаткове погонне навантаження, яке спричинює перекіс конструкції лоджії, оскільки вона не прикріплена до будівлі належним чином.

На основі проведеного візуального обстеження видимої частини будівельних конструкцій та результатів розрахунків визначено, що причиною утворення тріщин є неякісна перев'язка кладки несучих стін лоджії та несучих стін будівлі, що спричинило аварійний стан розглянутої ділянки будівлі.

Подано рекомендації з посилення аварійної ділянки споруди.

Ключові слова: помилки будівництва, цегляна кладка, дефекти цегляних стін, лоджія, моделювання, розрахункова схема.