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RESULTS OF THE TECHNICAL SURVEY OF THE HISTORICAL ARCHIVE OF UKRAINE AT SQUARE SOBORNIY IN LVIV

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Abstract. *The article highlights the results of the technical inspection of the Central State Historical Archive of Ukraine building on the 3a Soborna sq., Lviv. The building was built around 1620. It is an architectural monument of national importance and an integral part of the architectural complex, including the Bernardine church. The building is attached to the northern wall of the church, and from the east, it is surrounded by walls with an entrance tower. The portals of the 17th century have been preserved in the interior and fragments of 18th century paintings. In the plan, the building has a complex configuration, and its body covers a square inner courtyard. The building is made of brick, three- and partly four-story. The walls are reinforced with stone buttresses. Tracking indicators of the technical condition of the load-bearing structural elements of the building makes it possible to determine the technical condition of individual elements and the building as a whole [1].*

Most often, the destruction of the object does not occur instantly – this requires a long-term influence of certain factors over time. Scheduled inspections carried out in time make it possible to establish the safety of further operation, to detect defects in the early stages and to prevent emergency technical conditions of buildings and structures [2...5]. In addition, it can significantly affect the cost of construction and installation work and increase the term of further safe operation. Very often, in buildings subject to inspection, atypical constructive solutions are adopted, which are difficult to find in modern literature, and individual recommendations and approaches to solving the problem must be developed. During the inspection of the Central State Historical Archive of Ukraine on Sobornia Square in Lviv, elements of load-bearing structures belonging to an emergency technical condition were discovered. In order to prevent the destruction of the entire building, the detected defects must be eliminated during major repairs by strengthening. The article provides recommendations for removing the building from an emergency state.

Key words: *category of technical condition, technical survey, bearing capacity, cracks, foundation, wall.*

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1. INTRODUCTION

According to [1], the technical condition of the object as a whole is determined depending on the technical condition of the load-bearing structural elements and enclosing structures by assigning it to one of the technical condition categories: «1» – normal; «2» – satisfactory; «3» – unsuitable for normal operation; «4» – emergency. Ensuring the durability and reliability of buildings and structures [6], especially if they are architectural monuments, is always relevant. Timely conducting planned and technical inspections of building elements, identifying defects and eliminating the cause of their occurrence makes it possible to restore the load-bearing capacity by carrying out capital repairs and increasing the durability of the building [7, 8]. Repairing works in compliance with regulatory requirements [9, 10, 11] will ensure the perception of all active loads and allow further safe operation of the building. It should be understood that carrying out capital repair work is a complex process, especially in the conditions of existing buildings. Therefore, it is important to carry out repair work, taking into account the preservation of architectural monuments [12, 13, 14]. At the time of the survey, the building has been in operation for more than 300 years, it should be taken into account that some of the elements have exhausted their normative service life, especially the wooden elements [15, 16].

The building is frameless with load-bearing longitudinal and transverse walls, complex in plan with nominal dimensions of 44,390 x 54,030 m. Partly with a basement and a courtyard (Fig. 1). The foundations and walls of the basement are designed with strips of hewn stone on a lime solution. The framework of the building consists of external brick walls with a thickness of 75...100 cm and internal brick walls with a thickness of 45 and 75 cm. The framework of the building consists of external brick walls with a thickness of 75...100 cm and internal brick walls with a thickness of 45 and 75 cm. The construction of that period is distinguished by the construction of buildings with massive brick walls up to 1.48 m thick. The excessive thickness of the walls was explained by the lack of a theory of calculation of stone structures at that time. The thickness of the walls behind the floors was taken according to the rule, according to which the thickness of the walls decreased from the bottom up. Wall cuts were usually made inside the building. The bearing capacity of the walls was used by 30–50%.

Figure 1. General view of the main facade of the building

Load-bearing walls are placed along the letter and number axes. The building has three and partly four floors. The basement height is 2.45 m, the first floor is 5.75 m and 4.74 m, the second and third floors are 5.3 m, the fourth floor is 3.1 m. The ceiling is brick-arched vaults, and the roof is galvanized steel on wooden rafters.

The condition of the load-bearing structures was determined based on a detailed visual inspection, instrumental examination and recording of existing deformations and damages.

The work aims to evaluate the technical condition of load-bearing structures, determine the nature and causes of defects and damage, as well as their impact on the load-bearing capacity and operational condition, and propose options for strengthening structures using a specific example.

The object of the study is the Central State Historical Archive of Ukraine, located in the central part of the city. Lviv. In the plan, the building has a complex configuration, and its body covers a square inner courtyard. The building is made of brick, three- and partly four-story. The walls are reinforced with stone buttresses. The portals of the 17th century have been preserved in the interior and fragments of 18th century paintings.

Research methods. On the basis of the conducted engineering and geological surveys and the initial project documentation, it is necessary to calculate the limit states of the first and second groups to determine the strength, stiffness and crack resistance and develop recommendations for strengthening brick walls.

2. RESEARCH RESULTS

During the technical survey, the surrounding area was investigated to identify probable natural and man-made actions on the condition of the foundations, a study of human engineering activities within the area and the entire district (construction of various engineering communications, dynamic and aggressive actions, etc.).

In 2005–2006, a drainage system was built around the perimeter of the courtyard, which collects rainwater, melted snow and surface groundwater, which is drained into drainage wells located at the corners of the courtyard. Next, the water is diverted to the sewage well, located at the G axis along the network on Valova Street (see Fig. 2).

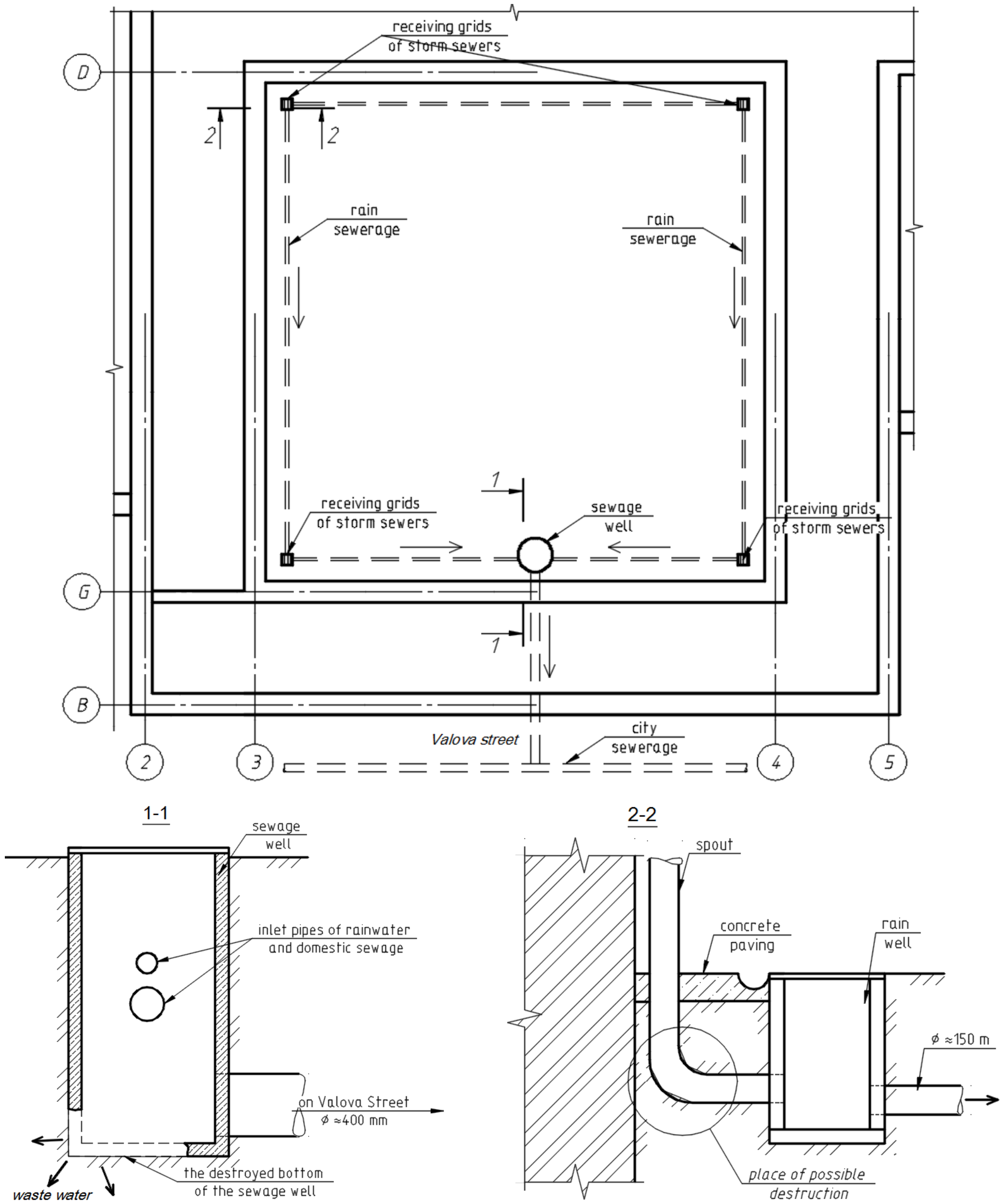

Figure 2. Water drainage scheme from the archive building

The survey revealed that the bottom of the well near the G axis is practically destroyed, and all the water penetrates under the foundations (Fig. 2, 1–1). An additional reason for the jamming of the bases under the foundations can also be the destruction of the elbows of the downpipes (Fig. 2, 2–2) in the places where they adjoin the drainage wells of the storm sewer. Water removes clay and dusty soil particles from the foundations layer by layer – mechanical suffusion occurs, destroying the soil structure and its subsidence. When the minerals of the soil skeleton of the base are dissolved, chemical suffusion takes place, which worsens the physical and mechanical properties of the soil. The presence of such damage over a long period reduces the bearing capacity of foundations (soils) and foundations. Uneven subsidence of the base was detected, as evidenced by the deflections of the floor of the first floor between axes 4…5 along axis D (Fig. 3), as well as in the places where water or sewage communications pass between axes 4...5 and G...D.

Figure 3. Oblique cracks in the wall with a width of up to 2 cm, floor deflection within the first floor between axes 4...5

Wetting of the bases under the foundations is facilitated by the loose connection of the gutters to the drainage pipes on the roof and at the point where these pipes enter the drainage wells of the sewage system. The basement of the building is not plastered. Minor cracks were found. No emergency cracks were found in the plinth.

According to the classification features of the technical conditions, part of the base in axes 3...4 along the G axis is in an emergency 4 and unsuitable for normal operation condition – 3 technical condition. The rest of the base is in a satisfactory condition – 2 technical conditions.

The foundations belong to the 2nd technical condition – satisfactory.

For further safe operation, the bottom and walls of the drainage well should be restored along the G axis; an audit of the drainage system; check the tightness of the connection of drainage pipes on the roof and at the point of entry into the sewage system, in places of floor subsidence, disassemble stone slabs and check the integrity of the pipe, if necessary, replace the pipe. The load-bearing walls of the building are made of brick, with a thickness of 75...100 cm between the first and third floors and 45 cm on the fourth floor. Partitions are made of brick with a thickness of 14 cm.

The examination revealed a vertical crack on 2/3 of the height with an opening width of up to 4 cm along the G axis within the first floor (Fig. 4). The crack continues to the arched lintel and ceiling. Cracks in the wall along the G axis, extending to the lintels and overlaps, were found along the entire length of the wall (Fig. 5, Fig. 6). Also, cracks in the wall extending to the floor were found on the parallel wall along the B axis. Oblique cracks with an opening of up to 1 cm were found in the partition along the D axis between axes 4...5.

Figure 4. A vertical crack on 2/3 of the height, up to 4 cm wide, along the G axis

Figure 5. Cracks in the arched vaults of the floor and the lintel along the G axis

Figure 6. Cracks in the wall and in the arched lintel along the G axis

Most of the second and third-floor premises are after renovation, so no cracks were found there. In those rooms where the repairs have not yet been completed along the G axis, a crack was found in the place where the wall adjoins the floor (Fig. 7). According to the employees of the archive, before the repair, there were such cracks in all rooms of the second and third floors along the G axis. See the scheme of defects (Fig. 8).

Figure 7. A crack at the junction of the arched ceiling and the wall within the 2nd floor along the G axis

Identified cracks reduce the load-bearing capacity of the walls. The nature of the cracks and the geometric measurements that were performed indicate the loss of verticality of the wall along the G axis.

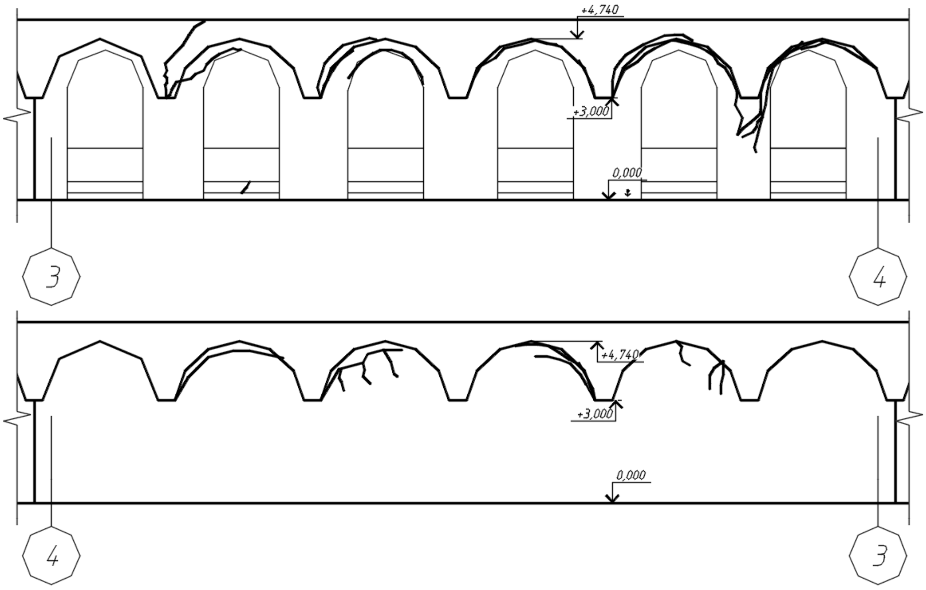

Figure 8. Scheme of defects along the B and G axes

External walls are subject to constant wetting due to the loose connection of downspout pipes along their length. During the inspection, flaking of the plaster from the outer side of the wall was found, and thawing and weathering of the brickwork were found in some areas.

According to the classification of technical conditions for stone and reinforced stone structures, the condition of the brick load-bearing elements along the G axis is classified as an emergency – 4 technical conditions, and the rest of the walls belong to 2 technical conditions – satisfactory.

For further safe operation, it is necessary to strengthen the wall along the G axis according to the previously developed working project, to fill the cracks along the D axis between axes 4...5 with an injection solution, to appoint further observations of the development of cracks in the wall along the G axis.

The ceiling is brick arched vaults. At the time of the survey, considerable defects were found in the arched ceilings of the first floor: cracks were found along the entire length between the axes B...G and 3...5 (Fig. 9), cracks in the wall along the G axis continue to the ceiling and arched lintels. A crack with an opening of up to 2 cm was also found in the place where the wall adjoins the ceiling within the 2nd floor along the G axis (Fig. 10). The nature of the cracks indicates the deviation of the wall along the G axis from the vertical.

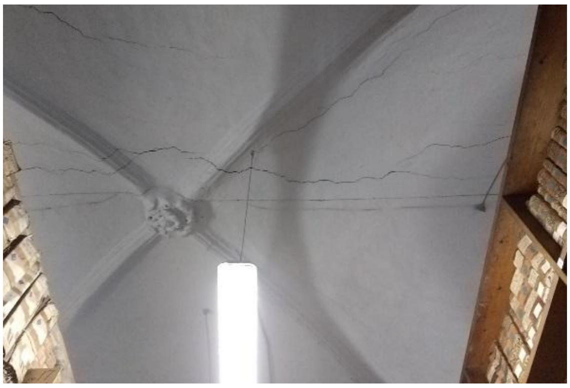

Figure 9. Cracks in the arched ceiling within the 1st floor in the axes B...G

Figure 10. A crack with a width of up to 2 cm. in the place where the wall adjoins the ceiling within the 2nd floor along the G axis

In general, the condition of the floor above the first floor in axes B...G 3...5 is classified as unsuitable for normal operation – 3 technical conditions for stone and reinforced stone structures. The rest of the floor is in a satisfactory technical condition.

To bring the building out of emergency and further safe operation, it is necessary:

- to restore the bottom of the sewer well at the G axis with C15/20 class concrete with local reinforcement with preliminary soil compaction and the installation of a crushed stone pillow;
- carry out an audit of the drainage system;
- in places of floor subsidence, disassemble the stone slabs and check the integrity of the pipe, if necessary, pipe should be replaced;
- check the tightness of the connection of drainage pipes on the roof, along their length and at the point of entry to the drainage wells of the storm sewer;
- appoint further observations on the development of cracks in the wall along the G axis
- cracks along axis D between axes 4...5 should be filled with an injection solution;
- strengthen the wall along the G axis;
- fence off dangerous areas with warning tape, move valuable documents to a safe place;

It is recommended that the walls along the G axis be strengthened with the help of metal elements (see Fig. 11), according to the additional developed working project.

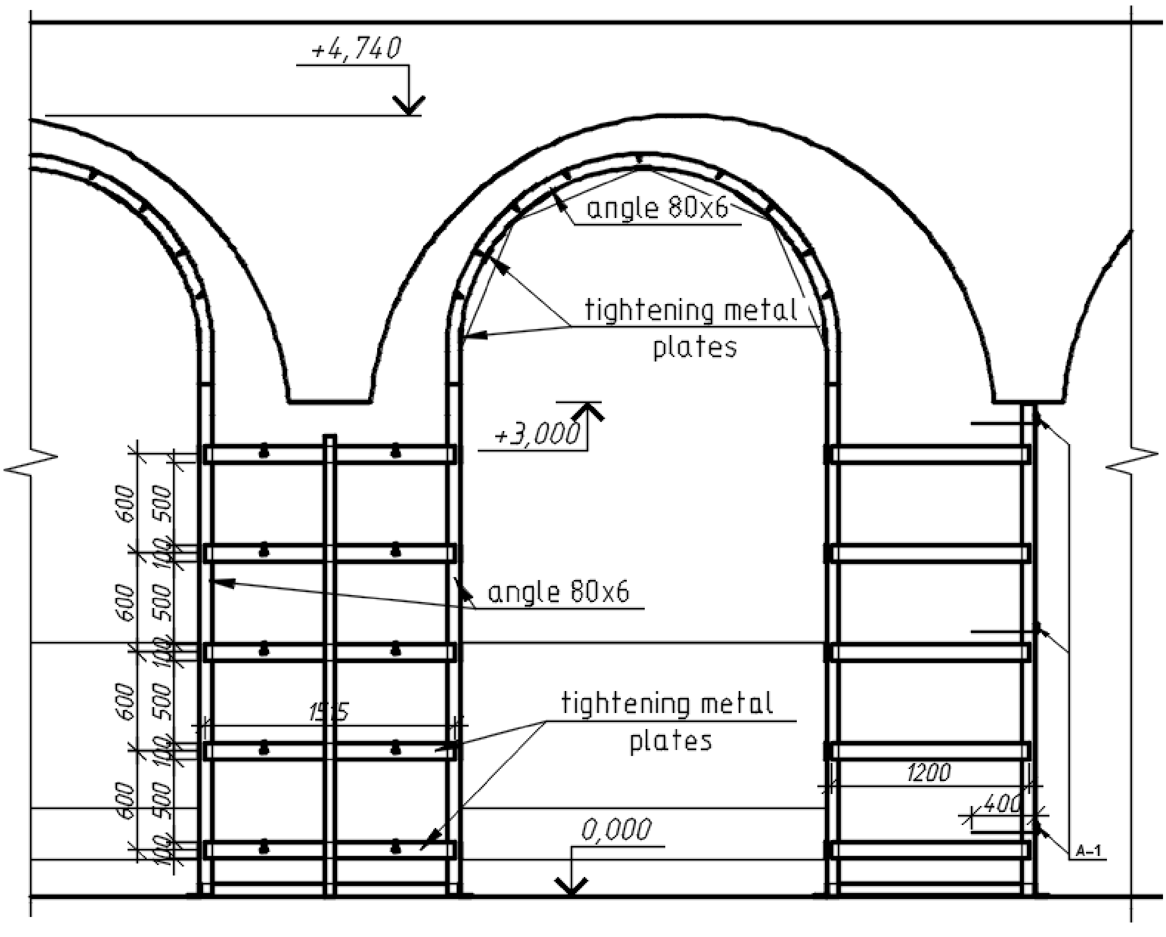

Figure 11. Scheme of strengthening the walls

With the implementation of recommendations on strengthening and compliance with the provisions on the safe and reliable operation of buildings and structures, the further operation of the building will generally be safe.

3. CONCLUSIONS

Based on the results of the survey and analysis of the technical condition of the building structures, it was established that the technical condition of the brick walls along the «G» axis is emergency – category «4»: the requirements of the first group of limit states are violated, the analysis of defects and damage shows the impossibility of guaranteeing the integrity of the structures before their repair or reinforcement. Due attention should be paid to proper maintenance and operation, and project organizations with relevant experience in strengthening and reconstructing similar objects should be involved. Carrying out the strengthening of the walls according to the developed proposals will ensure the strength and reliability of the structure, as well as the normalized service life according to the requirements of current design standards.

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РЕЗУЛЬТАТИ ТЕХНІЧНОГО ОБСТЕЖЕННЯ ІСТОРИЧНОГО АРХІВУ УКРАЇНИ, ЩО НА ПЛОЩІ СОБОРНІЙ У ЛЬВОВІ

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Резюме. *Висвітлено результати технічного обстеження будівлі Центрального державного історичного архіву України по вул. Соборній, 3а в м. Львові. Будівля збудована близько 1620 р. Пам'ятка архітектури національного значення, вона є складовою архітектурного комплексу, до якого входить і костел бернардинів. Будівля прибудована до північної стіни костелу, а зі сходу оточена мурами з в'їзною вежею. В інтер'єрі збереглися портали XVII ст. і фрагменти розписів XVIII ст. У плані будівля має складну конфігурацію, її корпус охоплює квадратне внутрішнє подвір'я. Споруда мурована з цегли, три- і частково чотириповерхова. Стіни укріплені кам'яними контрфорсами.*

Відстеження показників технічного стану несучих конструктивних елементів будівлі дає можливість визначати технічний стан окремих елементів та будівлі в цілому [1]. Найчастіше руйнування об'єкта не відбуваються миттєво – для цього потрібен тривалий вплив певних факторів у часі. Вчасно проведені планові обстеження дають можливість встановити безпечність подальшої експлуатації, виявити дефекти на ранніх стадіях та запобігти аварійним технічним станам будівель і споруд [2…5]. Крім того, це може суттєво вплинути на вартість будівельно-монтажних робіт і збільшити термін подальшої безпечної експлуатації. Дуже часто в будівлях, які підлягають обстеженню, прийнято нетипові конструктивні рішення, що складно знайти в сучасній літературі. Доводиться розробляти індивідуальні рекомендації та підходи до вирішення проблеми. При обстеженні Центрального державного історичного архіву України по вул. Соборній у м. Львові виявлено несучі конструктивні елементи, що відносяться до аварійного технічного стану. Аби запобігти руйнуванню всієї будівлі слід усунути виявлені дефекти шляхом підсилення при капітальному ремонті. Запропоновано рекомендації для виведення будівлі з аварійного стану.

Ключові слова: *категорія технічного стану, технічне обстеження, несуча здатність, тріщини, фундамент, стіна.*

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