Comprehensive Restoration of the Workable Technical Condition of Expanded Clay Concrete Panels of Industrial Buildings with Moral and Physical Wear

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Abstract. The article discusses the development of a technical solution to the problem of a restoration of a workable technical condition of building envelopes, including the provision of mechanical and heat engineering requirements. During the engineering survey of the building located at Kursk region, significant defects and damages affecting the technical condition of the building envelope were revealed. According to the results of studies, some flaws were identified that need to be eliminated. The ways of solving the identified problems and defects associated with the building envelope are given and described to restore the building to its proper condition. During surveys of building structures, it is necessary to pay attention not only to strengthening building structures, but also to restoring the thermal characteristics of building envelopes and bringing them in conformity with the requirements of current regulatory documents. To accomplish this task, a reinforcement design has been developed that creates the necessary reinforcement and brings the thermal characteristics of the building envelope in accordance with modern requirements to ensure the necessary energy efficiency of the building envelope.

1. Introduction

The main goal in the inspection of buildings and structures is to determine the category of technical condition of building structures. The need for these studies is associated with the assessment of the residual resource and the life of industrial facilities and urban infrastructure. When performing a comprehensive survey of building structures of a building located in the Kurchatov district, Kursk region, in the settlement named after K. Liebknecht, revealed significant defects and damages that affect the technical condition of the structures that were inspected.

2. Materials and methods

A survey of the technical condition of buildings and structures is necessary to determine the residual life and service life of building structures of buildings and structures¹. According to the current regulatory requirements for buildings put into operation, it is necessary to conduct an inspection of the technical condition at least once every 10 years. The comprehensive technical survey of industrial buildings in the Kursk region, built in 1970 was performed. The building had a reinforced concrete frame and hinged panels made of expanded clay concrete. Critical defects and damages affecting the
technical condition of the building envelope were revealed. These defects and damages should be repaired in order to bring the structures to working condition.

When examining the building, it was revealed:
1) corrosion damage to embedded parts of hinged expanded clay concrete panels;
2) the destruction of the protective layer of hinged expanded clay concrete panels. Still reinforcement bars were exposed;
3) deviation from the design position in the wall plane of expanded clay concrete panels at the attachment points from 10 to 20 mm.

When conducting a building survey [1-7], a verification calculation of the vertical building envelope was performed according to SP 50.13330.2012 «Thermal protection of buildings».

The walls of the building are made of expanded clay concrete panels 200 mm thick

3. Results and its discussion
According to the results of the heat engineering calculation, the value of the reduced heat transfer resistance $R_{0\text{тр}}$ is 67% less than required $R_{0\text{норм}}$ ($0.38 \text{ m}^2 \cdot \text{C/W} < 1.18 \text{ m}^2 \cdot \text{C/W}$).

According to the results of the survey, including the analysis of project documentation and the assessment of defects and damages, the tasks are formulated to bring the structures to a required condition [8-14]:
- to strengthen the fastening to the columns of expanded clay concrete panels and stained-glass windows;
- to make insulation on the principle of a ventilated facade in accordance with the developed proposals.

Performing these tasks, you should to:
- Strengthen the fixing parts of the existing building envelope;
- develop a cross-rod system to ensure spatial rigidity;
- to make insulation of walling.

To solve the first problem, it was proposed to install metal posts from a profile pipe of square section 120x6 with a 6 m spacing on separate foundations with a laying depth of 1.2 m (figure 1).

To connect the metal post with the enclosing panel and the existing reinforced concrete two-branch column, channel 12 is welded to it. Holes are drilled through expanded clay concrete panels; through them, pieces of smooth reinforcing bars with a diameter of 20 mm are inserted with screw-threads at the ends. Through pieces of channel №10 on the inner and outer sides of the wall, a steel post, enclosing panels and a reinforced concrete column are pulled together.

To create a frame for a ventilated facade, it is necessary to install channel № 12 between adjacent posts with the spacing of 1200 mm vertically.

Between the channels, the diagonal elements were installed. From the outside, the elements are made from an angle 50x50x5, from the inside - from a strip 10 mm thick 100 mm wide. This grid will provide spatial rigidity (figures 2, 3).

To meet the requirements for heat transfer, the wall envelope was calculated (figure 4).

The calculation showed the value of the reduced heat transfer resistance $R_{0\text{тр}} > R_{0\text{норм}} (1.66 \text{ m}^2 \cdot \text{C/W} > 1.18 \text{ m}^2 \cdot \text{C/W})$ [15-20], whence it can be concluded that the building envelope complies with the heat transfer requirements.

When insulating facades, it is necessary at the first stage to lay a semi-rigid or rigid mineral wool insulation 100 mm thick with a coefficient of thermal conductivity 0.035 W/m·°C with layers of vapor barrier and wind protection according to the scheme of Fig. 3. At the second stage, mount vertical guiding elements from a galvanized steel profile with a step corresponding to the width of the profile sheet for its fastening. At the third stage, fix the corrugated sheet (Fig. 4).
Figure 1. Strengthening scheme of fixing parts of expanded clay concrete panels.

Figure 2. The scheme for laying insulation.
5. Conclusions

When conducting surveys of building structures of buildings and structures, attention must be paid not only to strengthening building structures, but also to improve the thermal characteristics of building envelopes and bringing them into line with the requirements of current regulatory documents. To accomplish this task, a reinforcement design has been developed that creates the necessary...
strengthening and improves to thermal characteristics building envelope in accordance with modern requirements to ensure the necessary energy efficiency of the building envelope.

6. References

[1] Dubrakov S V, Kutsenko O I, Andriyenko V V, Afanasyeva N V, Galaev D X 2016 Theoretical study of thermal properties of enclosing structures of buildings after reconstruction Science today: problems and prospects of development. Materials of the international scientific and practical conference (Vologda) Nauchnyitsentr "Disput" Publ. pp 36-38

[2] Kazachek V G 2010 Problems of standardization of service life of buildings and structures Bulletin of Polotsk state University. The F-Series: Construction. Applied science 6 pp 56-71

[3] Smorchkov A A, Kereb S A, Orlov D A, Baranovskaya K O 2012 Assessment of the technical condition of the operated building structures of buildings and structures Civil engineering journal 7(33) pp 70-75

[4] Dobromyslov A N 2008 Assessment of reliability of buildings and structures on external signs (Moscow) ASV Publ. 72 p

[5] Fedyushkin A N 2013 Diagnostics of technical condition of building structures, as a basis for safe operation of buildings and structures Modern trends in science and education Collection of scientific works on materials of the International scientific-practical conference (Tambov) pp 147-148

[6] Jeo R F, Zhernovoy S V, Soldatov A A, Dunaenko A V 2019 Survey of structures of buildings and structures Collection of articles XXIII International scientific and practical conference: "Fundamental and applied research: current issues, achievements and innovations" (Penza) pp 97-99

[7] Smirnov A A, Cereb S A, Orlov D A, Baranovskaya O K Criteria for the technical condition of building structures of operated buildings and structures

[8] Collection International scientific-practical conference devoted to memory of honoured architect of Russia V N Gorodkov: "Architecture, urban planning, historical-cultural and ecological environment of the cities of Central Russia, Ukraine and Belarus" (Bryansk) pp 177-182

[9] Garkina I A, Garkin I N 2016 From the experience of inspection of building structures of objects of agro-industrial complex Successes of modern science and education vol 3 6 pp 110-114

[10] Duvalina A, Martyushev A, Ospishchev I 2015 The use of indirect methods of non-destructive testing of concrete strength and brickwork materials in the survey of buildings and structures Regulations 5(43) pp 126-127

[11] Rybalko A S, Kozhenko N V 2016 Survey and reconstruction of buildings and structures Collection materials of regional scientific and practical conference of students, postgraduates, undergraduates and teachers "Actual questions of economy and technological development of branches of national economy" (Maikop) pp 151-156

[12] Rodin A I, Neverov A N Survey of elements of buildings and residential brick house in Moscow Collection materials of the fourteenth