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## MOISTURE EFFECTS ON THE BUILDINGS ENCLOSING STRUCTURES

*Analysis of the most common damages due to moisture effects on brick, reinforced-concrete and wooden buildings enclosing structures has been carried out. Causes of their occurrence and prevention ways have been analyzed. The most dangerous moisture types such as constructional, soil, atmospheric, operational, hygroscopic and condensed have been outlined. Measures to ensure protection against water-saturation of building elements such as eaves size, walls waterproofing, available airways, protective painting, hydrophobic impregnation, sufficient ventilation, heating, water supply systems and draining timely repairs have been recommended.*

**Key words:** damage, moisture effects, brick, reinforced-concrete, wooden buildings enclosing structures

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## ВПЛИВ ВОЛОГИ НА ОГОРОДЖУВАЛЬНІ КОНСТРУКЦІЇ БУДІВЕЛЬ

*Виконано аналіз найбільш поширених пошкоджень від впливу вологи цегляних, залізобетонних і дерев'яних огороджувальних конструкцій будівель, проаналізовано причини їх виникнення та шляхи запобігання. Виділено найбільш небезпечні впливи від таких видів вологи, як будівельна, ґрунтова, атмосферна, експлуатаційна, гігроскопічна, конденсат. Рекомендовано для забезпечення незамокання елементів будівель достатні розміри карнизних звисів, наявність гідроізоляції стін, продухів, захисного фарбування, гідрофобного просочування, достатньої вентиляції, опалення, своєчасних ремонтів систем водопостачання та водовідведення.*

**Ключові слова:** пошкодження, вплив вологи, цегляні, залізобетонні, дерев'яні огороджувальні конструкції будівель.

**Introduction.** Buildings enclosing structures moisture conditions is connected with their thermal behavior [5, 6] and should be complied with requirements [1]. Therefore, it is necessary to pay sufficient attention to buildings enclosing structures protection from hydration with construction (basic), soil, and atmosphere, operational, hygroscopic and condensed moisture. Constructional materials moisture has a negative impact on hygiene and operational performance of buildings enclosing structures, and results in premature failure of constructions under the temperature effects influence [2].

**Recent studies and publications analysis.** Moisture effects on roofing system enclosing structures at heat insulation, repair and reconstruction of flat roof are outlined in [3, 4]. Moisture effects on enclosing structures of foam mortar [7] structural ceramics [8] facade systems with external plaster layer [9] and ventilated interlayers [10] have been researched. The issues of buildings enclosing structures protection from moisture effects, frost destruction were researched by various specialists, such as [11, 12]. Due to thermal modernization of existing housing facilities, the need to assess buildings enclosing structures technical condition has appeared; the damage from moisture effects to brick, reinforced-concrete and wooden buildings enclosing structures has been systematized.

**Purpose** of the paper is to review the most common damages of moisture effects on building brick, reinforced-concrete and wooden buildings enclosing structures as well as to analyze causes of their occurrence and their prevention ways.

**Main material and results.** A special effect on buildings bricks enclosing structures has ground, atmospheric, operational, hygroscopic and condensed moisture. Operational moisture is available in premises with wet processes (showers, baths, car washes, etc.), increased moisture level inside the premises leads to soaking of brickwork that increases its thermal conductivity. Moistened brickwork has intense sorption processes of brickwork moisture extension vertically and horizontally. Traditionally, such processes are clearly visible on building face (see Fig. 1), they result in mortar ablation, active brickwork frost destruction, the brickwork fragments fall, formation of buildings enclosing structures brickwork local emergency sections.



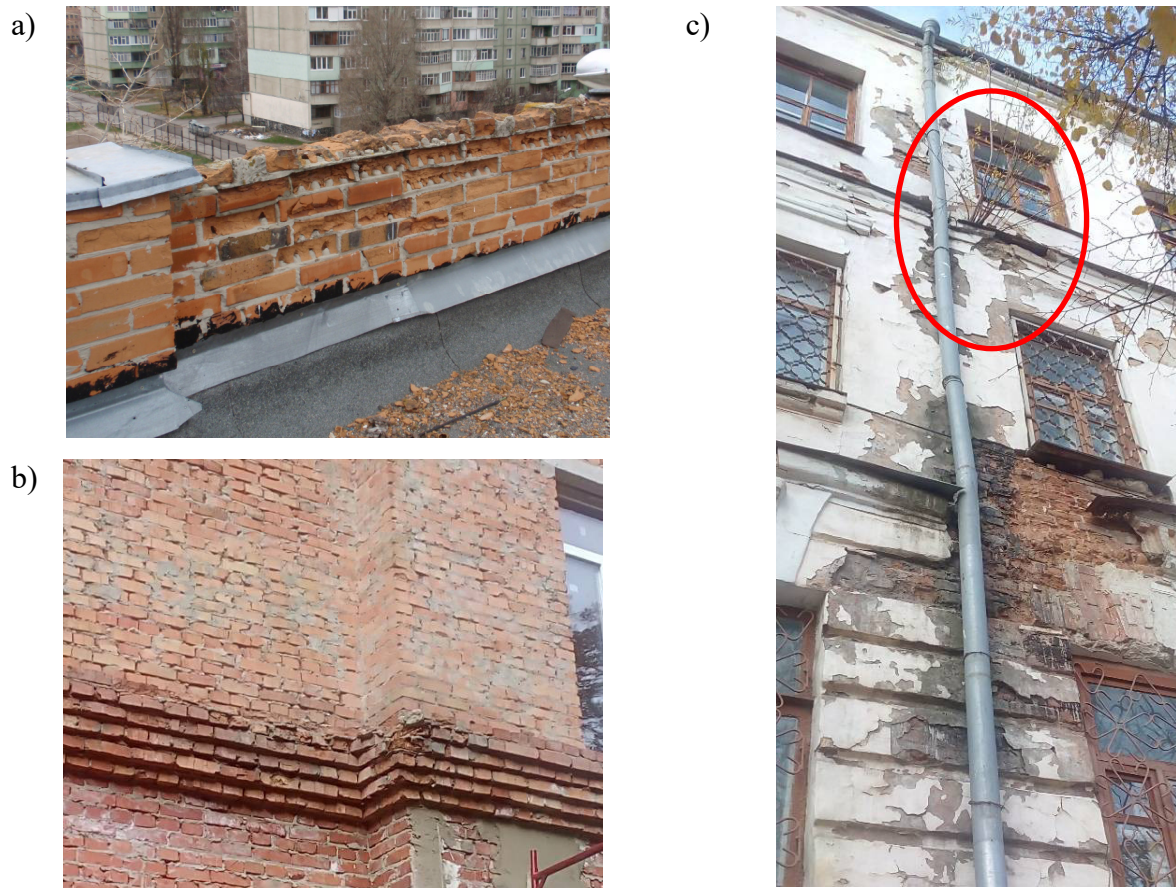
**Figure 1 – Mortar ablation, brickwork frost destruction, the brickwork fragments fall, buildings enclosing structures brickwork local emergency sections due to the operational moisture impact**

Significant atmospheric moisture effects on the brickwork of buildings enclosing structures arises in case of eaves insufficient width, drainage absence, installment of horizontal pipes underneath the drainage cunette (see Fig. 2, a). Lack of drainage and incorrect installment of the blind area around the building leads to splashing of rain water that leads to water-saturation of the brickwork of buildings enclosing structures basement part (see Fig. 2, b). Brickwork of eaves and parapet, that are not installed or partially destroyed flashing of parapet cover (see Fig. 3, a), buildings enclosing structures architectural elements without water channel at drip nose or absence thereof (see Fig. 3, b) is subjected to substantial water-saturation due to atmospheric moisture. Water-saturation of the buildings enclosing structures brickwork due to atmospheric moisture leads to acceleration of sorption processes, bricks frost destruction, mortar weathering. Excessive water-saturation of the brickwork leads to formation of biological pollution (i.e. moss, grass, bushes, trees) on buildings enclosing structures (see Fig. 3, c).

Soil moisture effects on the buildings enclosing structures brickwork as a result of destruction or lack of horizontal waterproofing, in case of banked up building sidewalks level above the level of horizontal waterproofing (see Fig. 4).



**Figure 2 – Atmospheric moisture effects to brickwork of buildings enclosing structures:**  
a) mortar weathering, frost destruction of the brickwork;  
b) water-saturation of the sole plate as a result of spraying water, fall of the brickwork fragments



**Figure 3 – Atmospheric moisture effect on the buildings enclosing structures brickwork:**  
 a) destruction of the parapet cover in the absence of flashing; b) architectural elements destruction in the absence of drip nose; c) brickwork biological pollution



**Figure 4. – Soil moisture effect as a result of destruction or lack of horizontal waterproofing, in case of banked up building sidewalks level above the horizontal waterproofing level**

Construction moisture in the buildings enclosing structures brickwork leads to thermal conductivity increase within first 2–3 years of operation, as well as it can lead to formation of mold on construction surface, contractible non-uniform deformation of the building. In order to reduce the influence of initial moisture effect on the buildings enclosing structures, it is necessary to provide the building heating and ventilation system normal functioning.

The main types of moisture effects on reinforced-concrete constructions are atmospheric and operational moistures. Other types of moisture effects are less extended. The nature of atmospheric and operational moisture effects on buildings reinforced-concrete enclosing structures is identical. The danger is caused by defects arising during construction as well as with poor performance of works. The main reason of reinforced-concrete constructions defect is insufficient thickness of the concrete protective layer, porosity of the reinforced-concrete element because of the large water-cement ratio, which leads to reinforcement corrosion. At the time of inside reinforcement corrosion of reinforced-concrete constructions with increase of corrosion products volume by 2–2,5 times. There is concrete protective layer emission– formation of «blowings» – that leads to intense actions of capillary moisture to concrete protective layer is been destroyed in due course time. Such damages are typical for buildings reinforced-concrete enclosing structures that contact with atmospheric and operational moisture, for example, bridges in brick walls (see Fig. 5, a), balcony plate (see Fig. 5, b) external wall panel (see Fig. 5, c). For constructions made of lightweight concrete any moisture effect is dangerous: because of increased porosity, the concrete rapidly gets soaked, that leads to increase of thermal conductivity coefficient, which leads to condensate formation and even more water saturation.



**Figure 5 – Destruction of protective concrete layer of reinforced-concrete lintel (a), balcony plate (b), wall panel (c)**

For buildings wooden enclosing structures, the most dangerous is the atmospheric moisture effect. Thus, for loft wooden constructions, moisture effect arises due to defects in roof (atmospheric moisture) as well as incorrect design of ventilation framing scheme (condensed moisture) (see Fig. 6). In order to exclude atmospheric moisture effect, it is necessary to repair the damaged roof timely, there shall be eaves gutter and pectinal airway and roof windows designed on the loft in order to avoid formation of condensed moisture, their area should be 1/300 – 1/500 of the loft space. Typical for wooden floor construction is operational and condensed moisture effect. For normal operation of wooden floor constructions, it is necessary to make airways under the floor that should be opened during the spring, summer and autumn. It is also necessary to carry out fire retardant and antiseptic treatment of wooden constructions



**Figure 6 – Damage to wooden construction covering due to atmospheric and condensed moisture effect**

### **Conclusions**

1. Atmospheric, operational and soil are the most dangerous types of moisture for buildings enclosing structures.
2. Moisture effects on the buildings enclosing structures load-bearing capacity made of wood, brick and reinforced-concrete the most.
3. Measures to ensure protection against water-saturation of building elements are constructive (eaves size, walls waterproofing, available airways), technological (protective painting, hydrophobic impregnation, compliance with regulatory requirements for walls thermal resistance) and operational (sufficient ventilation, heating, timely repairs of water supply systems and draining) nature.

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