Збірник наукових праць. Галузеве машинобудування, будівництво
Academic journal. Industrial Machine Building, Civil Engineering
http://journals.nupp.edu.ua/znp
https://doi.org/10.26906/znp.2026.66.4672

UDC 692.23:536

Andrii Filonenko*
National University «Yuri Kondratyuk Poltava Polytechnic»
https://orcid.org/0009-0001-0387-0349

Features of reinforcing and repairing building structures after prolonged exposure to moisture

Abstract. Inspections of buildings and structures are conducted to obtain objective data on the actual condition of building structures, taking into account changes over time. The effect of moisture on structures in contact with the ground leads to a decrease in performance and a loss of strength. At a specific major renovation site, a study was conducted on the condition of brick structures that were subject to constant wetting due to leaks in water supply networks. The condition of the brick structures in contact with the ground, as revealed during demolition work, was found to be worse than that determined by visual inspection. The article presents structural solutions for the restoration of building elements that allow for a reduction in their moisture content over the long term.

Keywords: brick wall, soil, soaking, moisture meter

*Corresponding author E-mail: filonenkoandre@gmail.com

Received: 25.04.2026 Accepted: 05.05.2026 Published: 31.05.2026

Introduction.

Publication [1] includes: recommendations for controlling humidity in residential (heated) basements in new buildings located above the water table, recommendations regarding the ground surface around the building, recommendations regarding external drainage (drainage outside the basement or foundation walls), recommendations regarding thermal insulation, airtightness, moisture insulation, and moisture protection for walls, floors, and the transition between them, and recommendations regarding indoor air ventilation in the basement (as this affects moisture conditions within the basement enclosure). Publication [2] presents a methodology for investigating and monitoring the drying of insulated basement walls.

An assessment of the effectiveness of secondary waterproofing in historic buildings constructed of historic brick is provided in [3, 4]. The distribution of moisture in thermal bridges between walls and floors and its impact on mold growth is investigated in [5]. Constant wetting and freezing of wall structures leads to frost-induced damage and, consequently, to a loss of load-bearing capacity. Therefore, research into the thermal and moisture characteristics of building envelopes in contact with the ground is of great relevance.

Problem statement.

Determining the effect of humidity on the performance characteristics of structures adjacent to the ground and developing recommendations for the continued reliable operation of these structures, using a specific construction project as an example.

Main material and results.

The university dormitory building, constructed in 1962, is the subject of a major renovation. An inspection of load-bearing elements and defective areas was conducted as part of a project to thermally modernize dormitories and academic buildings. The building's total height is 15.7 m; it has five stories, including the basement. The building's dimensions are 29.8 x 58.8 m; the height of the living quarters is 2.5 m, and the height of the basement is 2.6 m. An inspection of the existing structural condition was conducted in 2024 prior to the development of design and cost estimate documentation.

The dormitory building is a four-story structure with a basement, L-shaped in plan, with an attached two-story dining hall.

Structural system: the building has a partial frame, with load-bearing and self-supporting exterior and interior brick walls. The building has two stairwells.

The dormitory's load-bearing structures are made of brick masonry, with floors of precast and, in certain sections, monolithic reinforced concrete. The thickness of the exterior walls is 640 mm, and that of the interior walls is 380 mm.

The brick walls (partitions) in the shower rooms and restrooms on the first floor are classified as Technical Category 3—unsuitable for normal use. This is caused by soil subsidence beneath the foundations of the partitions, resulting from leaks in the water supply and sewer lines (Fig. 1).

For the same reason, floor deformation and warping of door jambs have been noted. It is recommended to dismantle the partitions, remove the floor and subfloor, replace the water supply and sewer lines, and restore the partitions and floor. During the preliminary technical inspection of the floors (visual), restoration of the composite floor layers was planned.

Figure 1 – Horizontal cracks on the walls

The building has strip foundations made of reinforced concrete. The basement walls are constructed partly from precast reinforced concrete elements (FBS blocks) and partly from brick. There is no design documentation for the building’s foundation.

A visual inspection revealed local potholes, chips, damage to the basement’s plaster layer, and local damage to the integrity of the paving (this particularly applies to the courtyard facade). Deformations of the foundations that interfere with the normal operation of the building are noted in the area of the facade, where the showers and utility connections to the building are located.

Overall, the technical condition of the foundations can be classified as satisfactory (technical condition category 2).

The thermal modernization project called for the removal of the plaster and the insulation of the exterior walls with mineral wool boards. Provided that the load from the insulation does not exceed the load from the removed cladding, the stress-strain state of the “base-foundation” system will not be adversely affected, which will allow for thermal modernization without additional measures to reinforce the building’s bases and foundations.

The engineering-geological conditions of the university campus are characterized by the presence of heaving soils, meaning that when the foundation soils become saturated, additional deformation may occur. The foundations consisting of driven prismatic piles used in the construction of the dormitory ensure the safe operation of the building even under conditions of soil saturation with water, since they penetrate the thickness of the settlement-prone soils and rest on non-settling soils. However, during major renovation (thermal modernization) work, it is necessary to take all necessary measures to divert atmospheric and meltwater away from the building and to thoroughly compact the backfill soil, as soil moisture can lead to settlement of the foundation.

The destruction of the walls is caused by leaks in the drainage systems, which are made of cast iron and, according to the survey results, require immediate replacement. The leaking pipes contributed to the process of soil suffusion under the foundations of the partitions and walls of the sanitary block. Constant soil saturation around the brick structures caused moisture accumulation in the walls, leading to frost-induced destruction of the bricks and loss of adhesion with the exterior plaster layer.

The major renovation project involved replacing utility lines, removing partitions, replacing the floor subfloor, and rebuilding the partitions.

During the demolition of the interior finishes in the shower rooms in 2025, moisture penetration was discovered in the brickwork of the exterior load-bearing brick walls up to the height of the first floor, as well as in the interior brick partitions.

The exterior brick walls are 640 mm thick. At the time of the demolition work, the portion of the wall that is buried in the ground on the interior side—and which forms a foundation with a ground level of 1.000 m on the exterior—has through cracks. The exterior finish layer has lost adhesion to the brickwork, which shows signs of frost-induced damage, damage extending to a depth of up to 50 mm, and damage to the mortar (Fig. 2). The measured moisture content of the brick on the plinth side was 35–40%, and that of the mortar between the bricks was up to 50%.

Figure 2 – Peeling of the plaster layer on the foundation and frost damage to the bricks

The condition of the structures following the demolition work revealed that it was not possible to implement the design solution—restoring the floor directly on the ground (Fig. 3).

Figure 3 – Photographic documentation of water-saturated soil beneath the shower floor to a depth of 2.5 m from the 0.000 level

It was decided to leave the crawl space open and install a monolithic floor slab above it. The ventilated crawl space will allow the water-saturated brick walls to dry out. However, constructing a monolithic floor slab supported by structures deemed unfit for normal operation required their reinforcement and careful monitoring of their condition at all stages of construction.

The 120-mm-thick interior partitions collapsed during the removal of the finish layer due to constant water saturation.

After excavating the wet soil, it was recommended to reinforce the brick walls with a vertical monolithic concrete layer with prior reinforcement (Fig. 4).

Figure 4 – General view of the basement with the interior brick wall reinforced by a layer of reinforced concrete using permanent formwork

The primary technical solution adopted to restore the serviceability of the shower block floor is a composite steel-reinforced concrete floor using channel sections, profiled sheet metal, and concrete. This solution minimizes the structure's dead weight and ensures rapid installation within the confined space of the old building (Fig. 5).

Figure 5 – Stages of floor construction

During the construction and installation work, a study was conducted to measure the moisture content of a brick wall under field conditions.

Field measurements of the brick wall's moisture content were taken between 2025 and 2026 to track the drying process. The test areas included the inner and outer surfaces of the exterior brick wall and the surface of the interior wall. Measurements were taken using a Testo material moisture meter. This is a portable electronic device designed for the rapid and accurate determination of the moisture content in wood, building materials (concrete, brick, plaster), and air (Fig. 6).

Figure 6 – Photos of moisture measurements of mortar and basement bricks

The basic operating principle of the compact testo 606-1 moisture meter is based on the contact resistive (needle) method: the device's two needle electrodes are inserted into the material being measured (wood or building material).

The measurement result is shown in Fig. 5.

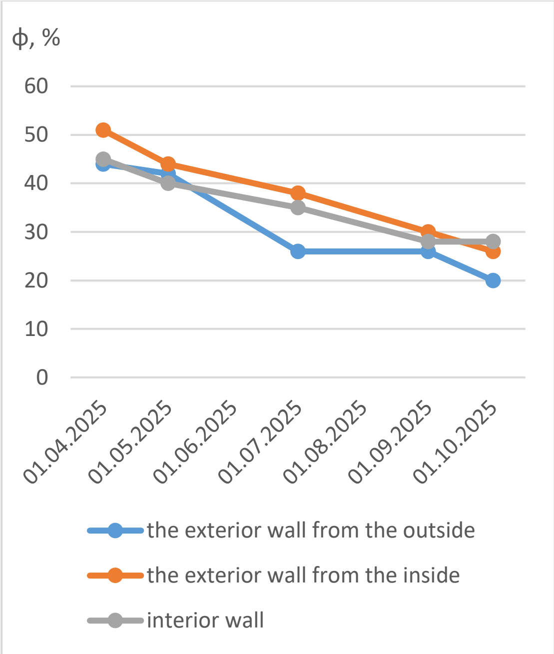

Figure 4 – Graph showing changes in the moisture content of a brick wall

Field studies of the moisture content of brick walls over the course of a calendar year revealed a trend of decreasing moisture content in the bricks and mortar when a new floor design—featuring a technical crawl space—was implemented.

The standard moisture content of bricks in a wall (service moisture content) depends on operating conditions and the type of structure. For ceramic bricks under normal conditions, the following indicators are generally accepted as standards:

average service moisture content is typically set at 1.5–2.5% by weight for dry rooms and 3–6% for conditions of elevated humidity

Conclusions.

During the major renovation, significant damage was discovered in the building structures and utility systems, requiring immediate replacement and reinforcement.

Following the demolition work, all water-carrying utility systems were replaced in accordance with current standards.

The proposed design consists of a monolithic reinforced concrete floor slab, a 100 mm layer of expanded polystyrene insulation, and a leveling cement screed. The floor covering is designed to be made of porcelain stoneware over a layer of waterproofing membrane. It is also recommended to install openings in the exterior wall at the level of the crawl space for ventilation and further drying of the dampened structures.

The technical measures taken have reduced the risk of further damage to the dormitory building's structures.

References

1. Asphaug, S., Hjermann, I., Time, B., & Kvande, T. (2020). Moisture control strategies of habitable basements in cold climates. *Building and Environment, 169*, 106572. https://doi.org/10.1016/j.buildenv.2019.106572
2. Asphaug, S., Hjermann, I., Time, B., & Kvande, T. (2022). Monitoring outward drying of externally insulated basement walls: A laboratory experiment. *Building and Environment, 219,* 109097. https://doi.org/10.1016/j.buildenv.2022.109097
3. Szemiot, N., Hoła, A., & Sadowski, Ł. (2022). Assessment of the effectiveness of secondary anti-damp insulation in limit state design approach for hybrid reinforced concrete column-supported flat slabs. *Structural Concrete, 23*(6), 3444–3464. https://doi.org/10.1002/suco.202100785
4. Brzyski, P., Barnat-Hunek, D., Suchorab, Z., & Łagód, G. (2023). Moisture in heritage buildings made of historic brick: The current state of knowledge, research gaps and perspectives. *Heritage Science, 11*, 198. https://doi.org/10.1186/s40494-023-01043-x
5. Xue, Y., Fan, Y., Lu, J., & Ge, J. (2022). The moisture distribution in wall-to-floor thermal bridges and its influence on mould growth. *UCL Open: Environment, 4*, Article 13. https://doi.org/10.14324/111.444/ucloe.000042

1. Asphaug, S., Hjermann, I., Time, B., & Kvande, T. (2020). Moisture control strategies of habitable basements in cold climates. *Building and Environment, 169*, 106572. https://doi.org/10.1016/j.buildenv.2019.106572
2. Asphaug, S., Hjermann, I., Time, B., & Kvande, T. (2022). Monitoring outward drying of externally insulated basement walls: A laboratory experiment. *Building and Environment, 219,* 109097. https://doi.org/10.1016/j.buildenv.2022.109097
3. Szemiot, N., Hoła, A., & Sadowski, Ł. (2022). Assessment of the effectiveness of secondary anti-damp insulation in limit state design approach for hybrid reinforced concrete column-supported flat slabs. *Structural Concrete, 23*(6), 3444–3464. https://doi.org/10.1002/suco.202100785
4. Brzyski, P., Barnat-Hunek, D., Suchorab, Z., & Łagód, G. (2023). Moisture in heritage buildings made of historic brick: The current state of knowledge, research gaps and perspectives. *Heritage Science, 11*, 198. https://doi.org/10.1186/s40494-023-01043-x
5. Xue, Y., Fan, Y., Lu, J., & Ge, J. (2022). The moisture distribution in wall-to-floor thermal bridges and its influence on mould growth. *UCL Open: Environment, 4*, Article 13. https://doi.org/10.14324/111.444/ucloe.000042

Філоненко А.С. *
Національний університет «Полтавська політехніка імені Юрія Кондратюка»
https://orcid.org/0009-0001-0387-0349

Особливості підсилення та ремонту будівельних конструкцій після тривалого дії вологи

Аннотація. Обстеження будівель та споруд проводиться з метою отримання об'єктивних даних про фактичний стан будівельних конструкцій з урахуванням зміни у часі. Влив вологості на конструкції, які межують з грунтом, призводить до зменшення експлуатаційних показників та втрати міцності. На конкретному обєкті капітального ремонту проведено дослідження стану цегляних конструкцій, які підлягали постійному замоканню, внаслідок протікання водонесучих мереж. Стан цегляних конструкцій, що межують з грунтом, при демонтажних роботах виявився гіршим за визначений за візуальним оглядом. В статті представлено конструктивні рішення заходів з відновлення елементів будівлі, які дозволяють зменшити їх вологість протягом тривалого часу. В умовах капітального ремонту виявлено значні пошкодження будівельних конструкцій та інженерних мереж, що потребують негайної заміни та підсилення.
Після демонтажних робіт проведена заміна всіх водонесучих інженерних мереж згідно сучасних вимог.
Запропонована конструкція складається з сталезалізобетонного монолітного перекриття, теплоізоляційного шару – пінополістиролу, 100 мм та вирівнюючої цементної стяжки. Покриття підлоги запроектовано з керамограніту по шару промазувальної гідроізоляції. Також рекомендовано влаштувати отвори у зовнішній стіні в рівні техпідпілля для вентиляції та подальшого висихання змочених конструкцій.
Прийняті технічні заходи дозволили зменшити ризики подальших руйнувань конструкцій будівлі гуртожитку.

Ключові слова: цегляна стіна, грунт, замокання, вологомір

*Адреса для листування E-mail: filonenkoandre@gmail.com

Надіслано до редакції:	25.04.2025	Прийнято до друку після рецензування:	05.05.2026	Опубліковано (оприлюднено):	31.05.2026

Suggested Citation:	
APA style	Filonenko, A. (2026). Features of reinforcing and repairing building structures after prolonged exposure to moisture. *Academic Journal. Industrial Machine, Building Civil Engineering*, *1*(66), 52-56. https://doi.org/10.26906/znp.2026.66.4672
DSTU style	Filonenko A. Features of reinforcing and repairing building structures after prolonged exposure to moisture. *Academic journal. Industrial Machine Building, Civil Engineering*. 2026. Vol. 66, iss. 1. P. 52–56. URL: https://doi.org/10.26906/znp.2026.66.4672.