Waterproofing And Calculation Of The Thickness Of The Insulation Of The Basement Wall Of A Low-Rise Energy-Efficient House In Accordance With Domestic And Foreign Standards And Norms

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Abstract: Insulation of basement walls is necessary when placed in the basement auxiliary premises, warehouses, etc. the result is a reduction in heating costs, eliminates the possibility of condensation on the walls, increases comfort and improves working conditions of constructions.

Keyword: The ingress protection against water, thermal insulation of walls, energy-efficient house, the aggressiveness of groundwater, pressure-free waterproofing pressure, waterproofing, anti-droplet waterproofing, degree-day heating period, given heat-transfer resistance.

1 INTRODUCTION.

In order for the Foundation to serve for a long time and also protect the basement, ground floor and house from dampness, it first of all itself requires protection – from ground, rain and meltwater. Moreover, not only the underground part of the Foundation needs protection, but also the aboveground-the basement. Waterproofing should not only resist the flow of water during the spring melting of snow or heavy rains, but-last but not least! - protect the walls of the Foundation from capillary moisture, prevent water absorption by its surfaces. [8]

Moisture penetrating into building structures is a serious cause of their destruction. In conditions of high humidity, wooden structures are destroyed by rotting for 2-3 years, steel structures lose strength due to corrosion in 10-12 years, stone, concrete and jelly-concrete structures are destroyed after 40-50 years of operation. Therefore, protection against water penetration (waterproofing) is an important factor in the safety and durability of buildings.

At high level of standing of ground waters there is a danger of their penetration into basements, formation of a leak and damp spots on walls. The capillary moisture rising on pores in the massif of the base and a socle from a damp ground, can extend and in a laying of walls of the lower floors. And in case of aggressiveness of groundwater materials of the Foundation and underground parts of the building can be destroyed. To protect the building from groundwater provide measures to combat the movement of groundwater and the penetration of precipitation. In a ground of the basis and arrange a protective waterproofing from penetration of soil moisture in a building design. To prevent the penetration of rain and melt water.

In the underground part of the building, carry out the planning of the surface of the building site, creating the necessary slope for the removal of surface water from the building. Around the building along the outer walls arrange blind area of dense waterproof materials (asphalt, asphalt concrete, etc.). For protection against penetration of soil moisture in a building design at new construction external isolation of designs from influence of water is usually carried out, and for old building apply internal waterproofing in basements. There are three types of waterproofing, corresponding to the types of water impact-non-pressure, anti-pressure and anti-capillary.

- Non-pressure waterproofing is performed to protect against the temporary effects of moisture precipitation, seasonal flooding, as well as drained floors and ceilings;
- Anti-pressure waterproofing-to protect enclosing structures (floors, walls, foundations) from hydrostatic groundwater backup;
- Anti-capillary-for insulation of walls of buildings in the zone of capillary rise of soil moisture.

The device of waterproofing of basements is determined by the nature of the impact of water, the peculiarity of drained structures and materials, as well as functional requirements for the premises for operation, purpose and permissible humidity. This affects the choice of type and material of insulation, determined by the necessary indicators for water permeability, water resistance, vapor permeability and durability. The possibilities of contractors, the season and the pace of work should also be considered in the selection of waterproofing materials. There are various methods of waterproofing exterior wall surfaces: basic gluing, painting, waterproofing, plastering, sheet (caisson) and clay and a special injection, penetration (penetration), geomembrane preservative, suture, underwater, the elimination of active

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leaks, etc. [7] For protection of walls from capillary dampness in the bases arrange a waterproofing-horizontal and vertical (Pic. 1). By method of the device distinguish waterproofing: painting, plaster (cement or asphalt), cast asphalt, pasting (from rolled materials) and shell (from metal).

Pic.1. Waterproofing of foundations: a) the water table is below the basement floor level; b) with groundwater pressure less than 200mm; c) at a head of 200-1000mm; d) when pressure is over 1000mm. 1. Rolled waterproofing; 2. Painting waterproofing (a slip by hot bitumen for 2 times); 3. Glue hydro isolation; 4. Protective wall of brick; 5. Fiberglass; 6. expansion joint; 7. Clay; 8. Basement floor; 9. Tie; 10. Reinforced concrete slab; 11. Loading layer of concrete; 12. Preparation from crushed stone or sand; 13. Reinforced concrete slabs; 14. Foundation block; 15. Cement layer or tile; 16. Concrete base; 17. Blind area; 18. Wall; 19. The underlying waterproofing. Horizontal waterproofing in the absence of basements is advisable to put in a level concrete floor of the first floor, 15-20 cm above the blind area. In the presence of a cellar a waterproofing arrange also under a cellar floor. In domestic basements horizontal insulation is placed at the level of the edges of the Foundation. Structurally horizontal waterproofing most often represents two layers of roofing material or roofing on mastic, a layer of asphalt 10-12 mm or a layer of cement mortar 20-30 mm thick. Vertical waterproofing suit to protect the walls of the basement. The type of waterproofing depends on the soil moisture. At dry soils it is possible to be limited to two-time covering with hot bitumen. In wet soils suit cement and lime plaster, which after drying produce a coating with bitumen for 2 times or pasting by rolled materials. It is necessary to pay special attention to ensuring compatibility of work of all types of a waterproofing. If the water table is below the floor level of the fall and does not rise above it (Pic.1 a), but for capillary moisture may penetrate into the basement, the floor and the plaster walls made of tiles or of cement-sandy solution with a dry topping, and with the outer side of the Foundation cover with a waterproof mastic. In this case, the precipitation of the building, developing after the device floor and plaster walls in the basement, can damage them. However, due to the relatively small penetration of moisture through individual cracks, this has little effect on the humidity regime of basements. In addition, such cracks can easily be sealed from the basement. If the water table is or can rise above the level of the basement floor, it is necessary to perform a continuous waterproofing under the floor and on the walls above the mark of its maximum position (Pic.1, b). Such waterproofing experiences the hydrostatic pressure directed towards the isolated room. To keep the waterproofing in a given design position, it is pressed with a special design capable of perceiving the specified pressure. If the groundwater table rises above the basement floor is not more than 0.5 m (Pic.1, c), then to hold it in position enough or low brickwork outside or ballast concrete layer inside. In other cases special designs working on a bend are required (Pic.1, d). Depending on the nature of this design, there are external and internal waterproofing. With a high location of the groundwater horizon (above the basement floor), special measures may be required to strengthen the construction of foundations and waterproofing, up to the device of hermetic shells made of polymer films or metal sheets. At the same time carry out measures to reduce the level of groundwater - drainage and similar activities. One way to isolate the underground parts of a building or structure from surface water (precipitation) is the device outside around the building blind area with a slope of 1-2%. The desire for comfort and the high cost of electricity makes modern builders think about the need for thermal insulation of the foundations of houses. Quite often, the foundations are combined with the walls of basements. Their reliable operation can be ensured only in the presence of thermal insulation of external structures in contact with the ground. The need for insulation is due to the fact that heat loss through the underground part of the cottage in some cases up to 20% of the total heat loss. In the presence of a heated basement insulation will protect the walls of the basement from freezing, will help prevent condensation, dampness and mold development. [3] It should be noted that the insulation of the underground part of the house can eliminate or significantly reduce the impact on the Foundation of the forces of frost heaving, which is especially important in the construction of cottages, where about 80% of all soils (loam) are classified as heaving.
When they are frozen on the Foundation, located in the ground, the forces of frost heaving begin to act, leading to deformation of the bases and enclosing structures. Warming of walls of unheated cellars, at first sight, is deprived of practical sense, but it not absolutely so. The fact is, the soil temperature at a depth of 2 m never falls below 5-10 °C, so properly performed insulation of the basement walls allows in winter to maintain a temperature of 5-10 °C without additional heating. [4] The thickness of the insulation is determined depending on the thermal properties of the coefficient of thermal conductivity of the material. The required heat transfer resistance of the basement walls above ground level is taken equal to the heat transfer resistance of the external walls of the building, which is on the table.5 used at BC and R-2.01.01-94 depending on the degree-day value of the heating period.

The degree-day \( D_d \) of the heating period is calculated by the formula:

\[
D_d = (t_B - t_{\text{or.nep.}}) \cdot Z_{\text{or.nep.}} \quad (1)
\]

where \( t_B \) is the internal air temperature [2]. Indoor climate parameters; \( t_{\text{om.nep.}} \), \( Z_{\text{or.nep.}} \) - the average temperature and duration of period with average daily air temperature is not more than 10 °C, used at BC and R-2.01.01-94. The required thickness of the insulation of the basement wall, located above ground level, is taken equal to the thickness of the insulation of the outer wall and is calculated by the formula: [6]

\[
\delta_{\text{yr}} = (R_0^{\text{pmn}} - 0.16 - \frac{\delta}{\lambda}) \cdot \lambda_{\text{yr}} \quad (2)
\]

where \( R_0^{\text{pmn}} \) is the reduced heat transfer resistance of the outer wall, taken as a function of the ГСОП value, [1]

\( \delta \) - thickness of the bearing part of the wall, m;

\( \lambda \) - coefficient of thermal conductivity of the material of the bearing part of the wall,

Reduced heat transfer resistance, \( R_0^{\text{pmn}} \) \( \text{m}^2 \cdot \text{°C}/\text{BT} \) the walls of the basement, located below ground level, determined by the formula: [5]

\[
R_0^{\text{pmn}} = 1.05 + \frac{\delta_{\text{yr}}}{\lambda} + \frac{\delta_{\text{yr}}}{\lambda_{\text{yr}}} \quad (3)
\]

where \( \delta_{\text{yr}} \) - insulation thickness, m;

\( \lambda_{\text{yr}} \) - thermal conductivity coefficient of thermal insulation material, \( BT/(\text{m} \cdot \text{°C}) \).

The required thickness of the insulation of the basement wall, located below ground level, is calculated by the formula: [5]

\[
\delta_{\text{yr}} = (R_0^{\text{pmn}} - 1.05 - \frac{\delta}{\lambda}) \cdot \lambda_{\text{yr}} \quad (4)
\]

Example. Calculation of the thickness of the insulation of the basement wall.

Based on conditions:
- the construction site of the city of Samarkand;
- buildings for their purpose-residential;
- internal air temperature \( t_B = 20 \) °C;
- average humidity 55 %;
- average design temperature of the heating period:
  - for the period with average daily air temperature \( t_{\text{or.nep.}} \leq 8 \) °C average temperature \( t_{\text{or.nep.}} = +3.1 \) °C, the duration of the period is 172 days;
  - for the period with average daily air temperature \( t_{\text{or.nep.}} \leq 12 \) °C average temperature \( t_{\text{or.nep.}} = +4.8 \) °C, duration of the period 133 days;
- determine the average temperature with an average daily air temperature of not more than 10 °C
  \[ t_{\text{or.nep.}} = \frac{3.1 + 4.8}{2} = 3.95 \text{ °C} \]
- determine the duration of the heating period:
  \[ Z_{\text{or.nep.}} = \frac{133 + 172}{2} = 152.5 \approx 153 \text{ days}' \]
- humidity conditions of the room-normal.

The construction of the wall is concrete with a thickness of the bearing part of 400 mm, insulated with plates of extruded polystyrene with \( \lambda_{\text{yr}} = 0.031 \) and a protective layer of cement-lime plaster with a thickness of 20 mm.


1. Determine the degree-day of the heating period:
\[ D_d = (20 - 3.95) \cdot 153 = 2455 \text{ degree-day}. \]

2. The required resistance to heat transfer is determined by the formula:
\[ R_0^P = a \cdot D_d + b \]
For residential, medical and children’s institutions, schools, boarding schools, hotels and hostels for the roof coefficients are assumed to be 
\[ a = 0.00035 \text{ and } b = 1.4. \]
\[ R_0^P = a \cdot D_d + b = 0.00035 \cdot 2455 + 1.4 = 0.86 + 1.4 = 2.26 \text{ m}^2 \cdot \text{°C}/\text{BT}. \]

3. The required thickness of the insulation of the basement wall located above ground level:
\[ \delta_{yt} = (R_0^{\text{pwx}} - 0.16 - \frac{0.02}{0.74}) \cdot \lambda_{yt} = (2.26 - 0.16 - \frac{0.02}{0.74}) \cdot 0.041 = (2.1 - 0.23 - 0.03) \cdot 0.041 = 0.08 \text{ m}. \]
We accept the thickness of thermal insulation equal to 80 mm.

4. Calculate the thickness of the insulation of the basement wall, located below ground level:
\[ \delta_{yt} = (R_0^{\text{pwx}} - 1.05 - \frac{0.02}{0.74}) \cdot \lambda_{yt} = (2.26 - 1.05 - \frac{0.02}{0.74}) \cdot 0.041 = (1.21 - 0.23) \cdot 0.041 = 0.022 \text{ m}. \]

We accept the thickness of thermal insulation equal to 22 mm;

Thus, the minimum thickness of thermal insulation of extruded polystyrene in the proposed roof structure is 22 mm.

When placing the thermal insulation layer on the inside of the wall determine the location of the condensation zone graphically.

**REFERENCES**


