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Study of Multi-Layer Wall Panels Providing Effective Heat Protection

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Abstract: *Walls are one of the main structural elements of buildings and structures. They not only isolate the premises from the external environment, transfer heat, air, moisture, but also undergo a complex set of internal influences, depending on the nature of the production process. Therefore, modern wall structures must have the required strength.*

Keywords: structural element, walls, atmospheric influences, external environment, heat, air, moisture, durable, fire resistance, strength, durability, brick, expanded clay, slag, aerated concrete.

Introduction.

Walls are one of the main structural elements of buildings and structures. Therefore, modern wall structures must have the necessary strength, resistance to weathering and corrosion, have the required heat, water, air and sound insulation qualities, be sufficiently durable and fire resistant, provide industrial and economic efficiency of construction. In addition, the choice of wall design is one of the main design issues, since their cost is a significant part of the cost of the entire building.

Research.

According to the type of material, stone, wooden, concrete and combined walls are distinguished, and according to the type of structural materials used for the construction of walls - walls made of large blocks, panels and piece (small-sized) stone materials. From a thermotechnical point of view, three main types of external walls are conditionally distinguished according to the number of main layers: single-layer, two-layer and three-layer.

Single-layer walls are the most familiar to designers and builders and are the easiest to implement and operate. Single-layer walls, as a rule, are made of a homogeneous material. Their characteristic feature is that this material performs both load-bearing and heat engineering functions.

For the manufacture of single-layer enclosing structures in domestic and foreign construction practice, various types of bricks, expanded clay, slag, gas-ash concrete, concrete of a cellular structure are widely used. A feature of modern single-layer enclosing structures is that their construction is possible mainly from concrete with a density of not more than 600-700 kg / m^3 or from hollow clay bricks with sufficient thermal characteristics.

However, as construction practice has shown, single-layer walls made of various materials have such disadvantages as material inhomogeneity in average density and, consequently, uneven heat-shielding properties; increased humidity of the material in the first years of operation, which causes a decrease in the resistance to heat transfer of walls against the design value and increased humidity of the internal air; insufficient resistance to heat transfer with a relatively large wall thickness, which leads to an increased consumption of materials per 1 m^3 of the product. Therefore, from the point of view of obtaining effective enclosing structures that meet modern requirements in terms of thermal properties, it is optimal to use layered systems - two- and three-layer [1].

Double-layer walls consist of a load-bearing and heat-insulating layers, while thermal insulation can be located both outside and inside.

Internal thermal insulation requires a special thermal engineering calculation to protect it from moisture and moisture accumulation in the thickness of the insulation and careful manufacturing. Systems with external thermal insulation have a number of significant advantages (high thermal uniformity, a variety of architectural solutions for the facade, preference for the reconstruction of thermal protection of walls) and are widely used. in construction practice Currently, two versions of such systems are used; the first option is systems with an outer plaster layer; the second - systems with an air gap.

The method of external thermal insulation of walls with plastering of insulation consists in gluing or mechanically fastening heat-insulating plates to the walls and applying a polymer-cement coating or cement plaster reinforced with fiberglass or steel meshes on them. To strengthen and align the edges of the slab cladding, profiles made of corrosion-resistant materials such as polyvinyl chloride, aluminum alloys, and stainless steel are used. This method was first used in the Scandinavian countries in the 40s, where fiberglass boards and slow setting cement plaster were used, and in Germany in 1959 by the company Drivit, which developed a thermal insulation system using polystyrene foam boards and a polymer coating.

Of the heat-insulating materials, the most suitable for this method and often used is slab polystyrene foam. In addition to conventional heat-insulating boards, a number of foreign companies produce special ones - for thermal protection of external walls. For example, in Germany, Styrodur heat-insulating boards are made from extruded polyetirol foam, coated on both sides with a solution reinforced with fiberglass. For the possibility of mounting, a solution is applied pointwise to their surface and dowels with a diameter of 8 mm are installed in these places every other day [1].

The device of a protective layer of thermal insulation can be carried out by applying a polymer coating or plaster on its surface, reinforced with fiberglass or steel mesh.

Systems that use polymer coatings are developed by paint manufacturers (Zolpan, Senergy, etc.) Plaster mortars based on synthetic binders produced in Germany consist of polymer dispersions and mineral fillers - quartz flour, kaolin mica , barite, talc, titanium dioxide and have several modifications for application with a trowel, spatula, brush or spray. Dispersion plaster sets quickly, has high strength and is little susceptible to cracking.

As an example of using the method of thermal insulation using adhesive fastening of polystyrene foam boards to walls, the Ispo system developed in Germany can be cited, which includes a layer of polystyrene foam boards up to 10 cm thick and a polymer-cement coating 3-6 mm thick, reinforced with fiberglass. In its manufacture, the gluing of polystyrene foam cladding to walls, fiberglass meshes to expanded polystyrene and the creation of a protective coating are carried out with a proprietary polymer-cement mortar obtained by mixing with water a dry mixture consisting of a mineral filler, a hydraulic binder, a vinyl chloride copolymer and additives. stainless steel From domestic systems, the "Teply Dom" system, created in the 90s by OAO "Experimental Plant of Dry Mixes" and adapted to the conditions of the Russian climate, has become widespread. As in other systems of this type, it uses two types of insulation: expanded polystyrene and a rigid mineral wool board, the thickness of which is 100-160 mm. On the surface of the wall, the slab insulation is fastened apart at the seams using a special adhesive composition. A reinforcing layer, which is an adhesive composition 3-4 mm thick, is laid over the insulation fixed and calibrated in the plane, in the outer third of which an alkali-resistant fiberglass mesh is embedded. A special place in this system is occupied by decorative and finishing materials and paints, which are specially designed for it. Their peculiarity lies in the fact that they have high rates of vapor permeability, due to which moisture is actively removed from the inner layers. The mechanical way of heeling is more versatile. Its reliability is determined mainly by the strength properties of the material of the bearing part of the wall and the fastening element. There are two fundamental types of mechanical fastening: with the use of wall lathing made of metal or plastic profiles and with the use of special connecting elements (dowels, anchors, etc.).

An example of a mechanical profile fastening is the Mecafix-Rocarmur 1000 system offered by the French company Cegecol Casco Nobel France, which uses extruded PVC or aluminum profiles. The system is developed in two versions. In the first version, polystyrene foam boards 50x50 cm in size are inserted into anchored horizontal profiles using grooves in the end faces and reinforced with non-anchored profiles inserted into the grooves. In the second case, 83x60 cm and 100x60 cm boards are pushed into anchored horizontal profiles and reinforced with anchored vertical profiles.

For walls made of foam silicate blocks, cellular concrete and other similar materials with low strength characteristics, JSC "Central Research Institute of Industrial Buildings" developed the design of a multi-layer wall of the "Thermofacade" system. In this system, the slabs are attached to the load-bearing part of the wall by movable brackets, which are installed in increments of 600x600 mm and provide free temperature deformations of the plaster layer in its plane with a expansion joint spacing of up to 15 m.

The metal frames of the system can be aluminum, galvanized with anti-corrosion coating, stainless steel. Aluminum substructures of hinged facades are characterized by high linear elongation. Since the operating temperature ranges from -30 to +80°C, the creation of expansion joints and joints is of great importance for the durability of these substructures.

Galvanized metal structures are characterized by low cost and low durability due to the heterogeneity of the zinc and anti-corrosion coating, as well as due to electrical corrosion of the metal.

Stainless steel structures have the highest durability, but they have an increased cost, comparable to imported aluminum systems [2].

The insulation material can be polystyrene foam and polyurethane foam boards, foam plastics based on urea-formaldehyde resins, foam plastics, mineral fiber, vegetable fiber and glass fiber rigid and semi-rigid cork, as well as combined boards using the above materials.

Protective and decorative cladding can be varied: from sheet and tile materials - fiber cement and cement boards ("Volna", "Kraspan", "Dekopan", "Simstone"), composite boards ("Alpolik" FR, "Alumocobond" A-2), laminated paper, natural stone sandwich panels, colored aluminum sheets (“Alkan”), ceramic granite, fiberglass concrete, hinged piece-type-setting plates (“Marmorok”), metal cassettes; in the form of a plaster coating on a stretched mesh; in the form of a layer of brickwork. The type of protective and decorative cladding determines the type of its fastening. Claddings made of asbestos-cement tiles and tiles are attached to the secondary elements of the wooden frame with nails and steel hooks.

The company "Wagner-System" offers for fastening the lining of ventilated facades adhesive composition VS PicTek, which is a two-component polymer adhesive. The adhesive forms a continuous connection between the profile and the cladding, eliminating point loading and weakening of the profile by screws and rivets, while remaining stable against vibration, aging, weathering and UV rays. Thanks to the elastic seam adhesive pad, noise and vibration are absorbed.

According to the technology of wall insulation with URSA slabs, first, an internal - load-bearing wall is built from ordinary building bricks, then heat-insulating slabs are attached to it using fasteners (anchors, dowels, screws), then an external wall is erected from facing bricks. To ensure ventilation of the insulation (removing moisture from it in the form of steam that can penetrate from the interior), an air gap must be provided between the heat-insulating plates and the outer wall.

The main advantage of structures with an air gap is the presence of a naturally ventilated air gap, which ensures the removal of condensation and building moisture from the structure and protection of the heat-insulating material from precipitation, keeping

the insulation in a dry state, and this allows the use of semi-rigid mineral wool and fiberglass boards, in the possibility a wide choice of lining material, which consists in reducing the requirements for vapor permeability and compatibility with the insulation material. The disadvantage of this constructive solution is the relatively high cost of its device [2].

In the construction of industrial agricultural buildings, the most widespread are two-layer wall structures, solved in strip cutting, in the form of panels of increased factory readiness to the floor height. Two-layer wall panels consist of an inner protective layer of heavy or lightweight concrete of class B15 50 mm thick, a heat-insulating structural layer of light concrete of class B3.5 and an outer textured layer of cement concrete mortar of class B7.5.

Three-layer structures consist of two outer layers that perform enclosing and bearing functions, and a middle layer that provides heat and sound insulating properties of products. The middle layer can be continuous when the space between the layers is completely filled (for example, foam filler) and discrete, filling a part of the working volume (for example, filling with porous filler). Depending on the material of the bearing layers, three-layer structures can be concrete, brick, plastic, metal, combined. Combined structures are made, the extreme layers of which should most fully meet the operational requirements (for example, in livestock buildings, enclosing structures inside and outside are exposed to various environments).

According to the sectional structure, three-layer structures are divided into symmetrical, when the outer layers are made with equal thickness and from the same material, and asymmetrical, the bearing layers of which have unequal thickness and are made of different materials. Combinations of materials of the outer and middle layers can be very diverse. Specialists of the domestic construction industry offer a wide range of materials for the manufacture of three-layer structures.

Three-layer walls erected at a construction site using various types of small-piece products as outer layers and a heater located between them have been used for many years. For the first time, such a design was proposed by the Russian engineer A.I. Gerard in 1829, and on its basis, variants of layered systems were subsequently developed [3].

Conclusions:

In Western European countries and the United States, mineral wool materials in the form of wool, fiber, mats and slabs are widely used as heat insulators for brick walls. Cotton wool in a loose state as backfill is also used in Canada and the UK.

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