Organizational and design requirements for facade systems works in structures and buildings

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Abstract. As a result of recent trends in energy consumption, innovative facade systems are being used more and more in both new building construction and renovation of old buildings. A wide range of interface system types are used to meet these requirements. Many of these systems are very complex and require not only fire safety requirements, but also other requirements such as humidity, rain protection, stability, thermal insulation and other functions. Social and technical aspects are also important. This review article provides general information about façade systems in buildings, modern facades and façade manufacturing materials. This study also deals with evaluations and technical requirements for facade systems, including aesthetic standards, insulation and other criteria. And other ideas that we will address in this article.

1 Introduction

Over time, the facades of buildings formed a wide field for development and research. Sometimes architects adopt their decoration, and sometimes they strip them completely.

In ancient historical times, the design of buildings focused on the facades and was concerned with their decoration, then the matter changed, so the focus was on the projections first, especially after the development of architectural education. [1-2]

With modern architectural trends, that is, since the beginning of the twentieth century, the facades were completely stripped of decorations, as the architectural belief prevailed to focus on solving various design problems that were considered more important than the decoration of the facades. Attention is focused on liberating the facades by abolishing their structural and environmental role. The façades were separated from the structural system, and modern façades were invented, which are the curtain wall façades, and modern technologies were relied on in terms of air conditioning and heating. And the aesthetic evaluation of the facades, which was based on artistic decoration, turned to relying on economic, technical, cultural and environmental solutions to design the facades, so that the external walls of the buildings were seen not as facades of buildings, but rather as their outer cover. [3-4]

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In the seventies, the world realized that it was facing major economic and environmental problems, which lie in the rise in energy prices and the need to search for effective solutions to save energy consumption in buildings and the need to preserve the environment. Double façades such as those consisting of a glass façade and another that protects the first from the sun's rays. Planted façades also appeared due to increasing the green area in cities, in addition to their heat-insulating role and improving the various means of insulation.

Today, facades are going through a new phase in which all of the design options coexist with the decorative, functional, or environmentally friendly aspects that the architects have chosen, each in accordance with his or her viewpoint on architecture. This is because of the technological revolution, which made it possible for architects to implement any design concept, regardless of how it relates to construction systems or materials .

Technologies such as light-emitting diode facade lighting and lightweight, transparent and insulating materials, as well as materials that can change their nature to improve the thermal insulation of buildings, are becoming more diverse. This has led to the ability to simultaneously perform a large number of functions, which in itself is a favorable trend in the economy, such as:

- Environmental Protection
- connection or separation between external and internal
- Construction function expression
- Get attraction
- Structural differences [5-7]

2 Facade systems

Facade systems are modern structures with excellent thermal and external aesthetic characteristics. They are used for almost all types of buildings during the construction phase, including residential buildings, industrial buildings, warehouses and office buildings, (6-7) as well as during the reconstruction of various objects. [6-8]

Facade systems made of galvanized steel do not have the disadvantages inherent in aluminum and plaster facades. The substructure of reinforced fixing brackets can be mounted vertically, horizontally or crosswise. It includes all the necessary elements: dowels, thermal insulation, waterproofing, anchors, hardware and anchors. The cladding of ventilated facade systems can be made with metal siding, linear panels, corrugated board, facade cassettes or porcelain stoneware, depending on the purpose, building type and architectural design. When using facade systems, endless possibilities open up for the external design of buildings and the implementation of almost any architectural ideas due to the variety and widest range of colors of these materials.

Facade systems are characterized by a design that allows free air circulation, which prevents the accumulation of moisture and the reproduction of microorganisms and keeps them in a safe environment. A healthy indoor climate and durability of the structure as a whole are the results of using such a system.

Modern facades are distinguished by certain materials and colors. In addition, ecology and proximity to nature are becoming increasingly important when designing building facades.

Modern trends in the exterior design of buildings have arisen as a result of necessity or have been developed in accordance with the trends of the times. In the coming years or decades, these important elements will determine the design of the exterior.

Modern exterior structures use environmentally friendly materials such as wood and stone (such as sandstone and natural stone), whether the building is new or under renovation. Even the well-known stucco façade, which is particularly flexible in terms of

design, is still popular today. These days, stucco is often used in combination with other materials to meet unique design needs, such as wood. [9-11]

Facades are also made from surface treated metals such as zinc, titanium, zinc and steel. Rust-free metals are very strong and durable. Once upon a time, aluminum facades were the most common material for commercial premises. Now, however, aluminum, titanium and zinc panels are more often used for cladding a gable or individual parts of facades.

In general, metal has many advantages, especially when it comes to facades. It is weather and corrosion resistant, durable and requires minimal maintenance. Corten steel is distinguished by the fact that it looks rusty in appearance, and its surface does not rust, which makes the facades more attractive. [12-13]

Traditional brick walls are combined with modern large glass facades and darker paneling combined with light wood facades. Recently, it has become more and more popular to clad solar panels on the sunny side, and the rest of the building in rough or smooth wood or plaster. [14-15]

Modern buildings have facades in the colors of white and light gray. New and renovated buildings often use sand colors. This should be in harmony with the natural tones of the selected materials. Someone wants to combine environmentally friendly materials, and someone wants to create visual elements.

Intense colors such as dark gray or rust-colored Corten steel make the façade unique, but they are usually only used for decoration and not to cover the entire façade. A slate façade is the only option. Natural panels in dark gray color have a modern design, and their facades are very durable. [15]

Recently, the use of advanced façade systems for new and old buildings has increased the demand for energy consumption.

This is because buildings are responsible for almost 40% of global energy consumption.

In addition, proper thermal insulation of buildings is critical to achieving energy efficiency goals. This is due to the fact that facades serve as the main source of heat transfer between the building and the environment. As a result, improving the thermal insulation properties of façade systems can lead to significant energy savings for both existing and new buildings. This applies to both winter and summer conditions. [16-17]

There are additional methods for insulating exterior walls, such as exterior wall cladding systems. These methods may include rain protection with decorative panels such as glass or ceramic panels, and the use of alternative energy sources such as solar panels.

Air gaps, fastening systems, reinforcing layers, various types of insulation materials, wind protection, rain protection, etc. can be part of the cladding systems. [18-20]

Fig. 1. Example of a complex "rain screen" system on a façade**.**

2.1 Technical configuration of the interface system

The assessment of the fire-fighting efficiency of facade systems depends on the assessment of the system as a whole, and not its individual parts. This also applies to elements that are not flammable. Although the systems can be made more fire resistant, it is important not to forget other important functions of the façade, such as moisture protection and thermal insulation.

All technical aspects of the design must be considered. However, if quality control systems are not working properly, additional measures may be required that can affect the overall performance of façade systems, regardless of the characteristics of the building. [19-20]

2.2 Types of façade systems

Due to the fact that the facade system is part of the outer wall, various building systems can be used for its construction:

The load results from the use of brick, block or reinforced concrete.

Frame: The outer wall can be inside the frame or as infill panels positioned deep within the frame.

Rain screen: This is a thin sheet of metal, clay, or other material that is attached to a lightweight frame that is bolted to the structure of a building. The appearance of the interface is usually hidden, indicating that it has received a relatively thin design. There is usually a ventilation gap between the back of the cladding panel and the façade or interior wall of the building. Rain can improve the insulation of existing buildings. [21-22]

2.3 Technical requirements and standards for exterior façade systems

1. aesthetic requirements:

Aesthetics is critical to the appearance of a building, although this may not be immediately considered a purely technical property. This part is especially important for architects because it includes many technical requirements regarding design, engineering, window integration, ventilation and other issues. [23-24]

2. Isolation Rules: Recently, insulation has again become important for buildings. Due to the need to reduce energy consumption and carbon dioxide emissions in recent years, the insulation of facades has become a vital task.

3. Humidity indicators: The facade system provides protection of the building from moisture. Physical processes are complex and depend on the day and night, as well as on the climate in a particular region.

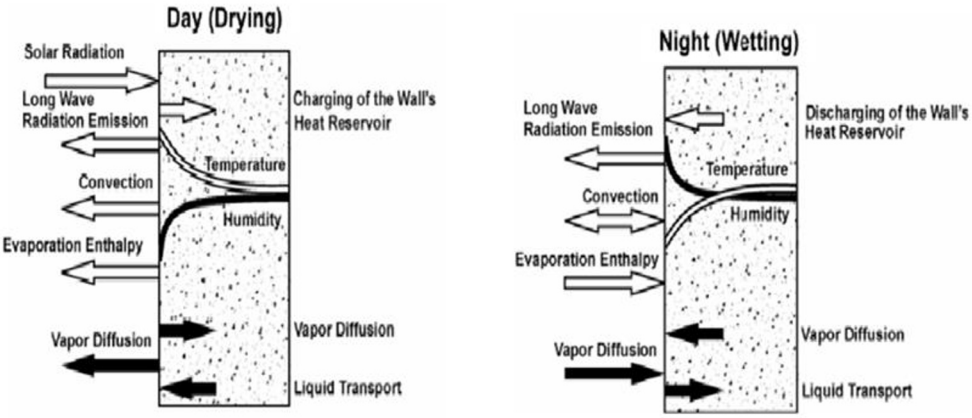

Fig. 2. Physical processes of water transport at night.

4. Acoustical requirements: The façade of the building also acoustically separates the interior and exterior spaces. Wall structures made up of heavier components (such as brick or precast concrete) usually provide better acoustic separation.
5. Mechanical requirements: In order to ensure the mechanical stability of facades, the various parts of the facade systems must be designed in such a way that they can withstand mechanical loads caused by the structure itself or any external loads.
6. The characteristics of the rain screen must meet the following requirements:
In the case of rain cladding, the effectiveness of the rain screen on the outer layer of the façade system depends primarily on protecting the internal structure from significant rain exposure while providing a dense cover on the outer surface of the façade. Openings between panels in high-rise buildings also provide pressure equalization to prevent the risk of large pressure drops causing forces on the panels as a result of the rain screen. Thus, the requirements are focused on these two characteristics. However, often a complete overview of the system must take into account various physical requirements. [25-26]
7. Fire safety standards: Each type of façade system requires an appropriate fire safety solution as fire propagation can occur if the façade system is not properly designed. [27]

2.4 Technical assessment of the quality of practical documents for projects of facade systems of buildings

Base prices for the technical assessment of the quality of working documentation of projects regarding the installation of facades of buildings and structures, designed to improve the safety and reliability of the facade structures used, are calculated taking into account the following types of construction work [28-29]

- arrangement of facades during the construction of a new building;
- construction of facades during repair, reconstruction or restoration;
- installation of facades on architectural monuments, unique buildings and structures with a height of more than 75 meters;

also for finishing facades of the following types:

- external thermal insulation systems with a small layer of plaster;
- hinged facade system with an air gap;
- transparent hanging structures.

The value of the base price is determined taking into account the scope of work required for the technical assessment of the quality of the working documentation of projects in terms of the arrangement of facades of buildings and structures.

When conducting a technical assessment of the quality of working documentation for projects related to the installation of facades of buildings and structures, the following work is expected to be performed:

- acceptance and consideration of applications for a technical assessment of the quality of the working documentation of projects in relation to the installation of facades of buildings and structures; initial verification of the package of necessary documents; collection of initial data about the object;[30]
- familiarization with the documentation provided by the customer regarding the installation of facades at the facility;
- assessment of methods for the production of facade works, reliability of operation, fire and environmental safety, as well as the effectiveness of the proposed design solutions;
- analysis of the compliance of the working documentation of projects in relation to the installation of facades of buildings and structures with the current regulatory document and standards of the organization;
- analysis of the requirements for materials used in the facade structure, as well as for its components;
- analysis of heat engineering calculations taking into account the requirements for resource and energy saving,
- analysis of the binding of the proposed design solutions to a specific building, taking into account all its design and architectural features;
- inform the customer about the need to make changes and additions to the composition of the project, if errors or inconsistencies in the materials are found in the working documentation for the installation of facades;[31-32]
- development of an opinion on the technical assessment of the quality of the working documentation of projects in relation to the installation of facades of buildings and structures;
- draw up an agreement and transfer it to the customer organization.

3 Safety precautions

Only persons over the age of 18 can mount ventilated facades. In addition, as a result of the performance of their duties, all employees receive special clothing, fixing belts and non-slip shoes. Installers must wear heavy-weight gloves when performing work to protect their hands.

Installation work on the construction site with a wind of 6 points or more is prohibited.

During thunderstorms, heavy rain or fog, work must also be suspended. Working on ladders is prohibited.

Before starting work, it is necessary to determine the zone of increased danger around the building. During operation, tools, mastics, other materials or mortars may fall from a height within this area. When calculating from the facade of the building, this area should be at least two meters.

To start work, it is necessary to check the strength and reliability of scaffolding and scaffolding, on which workers and materials for installation will be placed.

At the end of the working day, all tools and materials must be removed from a height or securely fastened with a special wire. At the end of work, it is strictly forbidden to throw tools and materials. There should be a first aid kit on the site during work, which can be used to provide first aid if necessary. [32-33]

For external fixings and scaffolding, particularly complex work is required. Gutters are attached using special brackets, which contain not only fasteners, but also the tools and materials necessary to complete this task.

When performing installation work in winter, all workers must use installation straps and nylon ropes.

4 Conclusion

All buildings have a facade, which serves as a kind of calling card. They can be finished with both natural and artificial materials, such as brick, plaster, trim stone, porcelain stoneware or aluminum panels. Since building materials have a limited lifespan, the repair of building facades is an important point that should be given special attention.

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