

Wood as element of façade cladding in modern architecture

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Abstract

Wood is a natural ecological material. Today, in architecture, wood is used not only in the traditional way but there are also present numerous products of wood industry. Wood and wood products as an element of façade cladding in modern architecture are the subject of research in this paper, with an objective to expand knowledge of the possibilities and limitations of their use, and to create the foundation for their correct and wider use.

The modern method of treatment of the façades involves multi-layered façades as an assembly of a façade layer, which consists of several layers: the structural part, thermal insulation and final façade cladding. Wood and wood-based products that are used as external, facade, wooden wall coverings, except for humidity protection (especially from heavy rain), the impact of temperature (summer and winter thermal fluctuations), solar radiation and wind, have a particular impact on the architectural appearance of a building. They represent what most determines the appearance of an architectural structure, its exterior and have an impact on the overall experience of the building.

Wood can also be used to produce façade cladding for small products such as boards and shingles, but also for medium and large panels. Wood and wood-based products are very suitable for external cladding, since they not only have a beautiful and unique visual appearance, but also, with proper use, their durability can be provided. What gives the advantages to wood and wood products as a material for the external coating is the possibility of replacement in case of damage; because some parts of the coating can easily be changed. In the design and construction of the façade, the criteria of proper selection of the type of wood, suitable surface treatment, protection from various harmful impacts, and fire protection- must be applied.

Key words: wood, wood products, modern façade coating, potential of wood

1. Introduction

Innovations and industry development, have led to increased interest of architects and builders for the construction in wood; with a tendency to use wood as natural material, as well as greater prosperity of the application of wood in architectural buildings in the world.

Log cabins and “talpara” (sheet pile cabins), are the only two types of wooden houses with façade wall made of monolithic wood, full solid timber - logs and piles, and that is how the houses got their names. All other types of wooden houses have multi-layered facade walls - multi-layered façade [1].

The multi-layer wooden facade includes an assembly of a façade layer that consists of structural part, thermal insulation and a proper wood cladding as a separate layer. What characterizes this type of façade structure is a layer of air between the final façade layer (the outer cladding) and the interior part of the façade wall.

1.1. The classification of the multilayer façades with the final coating of wood and wood products

Classification of multi-layered facade can be made depending on the characteristics of the layers. Between the final wood cladding, which is the outer covering, and the inner part of the façade , which includes structural part and thermal insulation, there is a gap filled with air that can be ventilated or non-ventilated.

Depending on that, laminated wooden facades can be divided into: ventilated, non-ventilated and poorly ventilated . Climatic zones in which the facility is located influences directly the choice of the wall assembly – ventilated or non-ventilated assembly. Selection of the façade wall assembly also depends on the type of wood cladding.

Ventilated façade assembly implies a constant circulation (flow) of air between the exterior wood

coating and the interior part of the façade (the structural part and thermal insulation). In this way ventilation of the façade cladding prevents overheating of the entire façade assembly in summer months and allows drying of the façade cladding due to weather conditions.

Application of the ventilated assembly, in conditions of summer climate regime in certain climatic zones directly affects the summer stability of the façade wall and energetic efficiency (globally on the level of the entire building). The fulfillment of the conditions of thermal comfortableness in winter, is provided by adequate thermal insulation.

Non-ventilated façade assembly includes lack of air flow between the exterior cladding and the interior part of the façade (the structural part and the thermal insulation). In this way, between the façade cladding and the interior part of the facade can appear stationary layer of (trapped) air or the façade cladding can directly be in contact with the inner part of the façade (directly connected).

Application of such facade assembly is possible only in the climatic regions where there is no need for protection from the sun in the summer months, or possibility of overheating and where it is not necessary to prevent the overheating with constant cooling. This concept requires the solution to the problem of protection of facade wall from atmospheric moisture (problem of dehydration of the cladding) because in some cases the exterior coating is in direct contact with the inner part of the facade. Then it is necessary to set a rain barrier between the façade cladding and the rest of the wall or to use solely moisture resistant panels on the façade and thus exclude the possibility of rapid deterioration of the façade cladding as well as deeper penetration of moisture into the interior of the façade wall.

This type of facade should be accepted conditionally, considering the fact that it is a wooden cladding and since wood is a natural material, it is almost impossible to completely shut down the flow of air between the elements of façade cladding. If the façade cladding consists of elements (boards, shingles), it is impossible to perform connections and joints in a way that completely excludes the flow of air, due to possibility of swelling and shrinkage and changes in dimensions of wood elements. The exchange of air that occurs between the final façade cladding and the interior part of the

façade, in this case, when the cladding and the interior façade layer are in direct contact, is negligible, because it does not allow the fulfillment of the requirements set for the ventilated assembly.

For the above mentioned reasons the type of poorly-ventilated façade within a multi-layer façade with a final wood coating should not be treated separately.

Multi-layered façades with a final coating of wood and wood products differ also by their constructive characteristics. Wood coating as part of a multi-layered façade can be carried out on a masonry wall, concrete wall (cast on site), precast concrete panel, or panel of wooden skeleton structure over proper substructure, wooden or metal.

According to the way of executing, this type of multi-layer facades can be classified as:

- Façades executed on-site – façades made of all kinds of wood panelling (natural wood and wood products) placed on-site on the interior part of the façade (wall or panel), with or without substructure,
- Prefabricated façades - façades derived from all types of wood panelling (from natural wood and wood products) placed in the plant, in factory, on ready-made inner set of panels, and as such brought to the construction site and installed as a single panel; this way of construction enables faster and more economical building,
- Prefabricated only final layer of cladding, applied for reconstruction.

Multi-layered façades with a final coating of wood, according to the degree of finishing can be divided into:

- Finally treated façades where the coating of wood panels has been finally processed, brought and as such mounted on a wall over the substructure, regardless of whether it is done on-site or prefabricated. This type of façade cladding does not require any additional treatment after implantation,
- Cladding that requires processing after execution - these are the wood claddings of natural wood and wood products which require protection from: weather conditions (humidity), the impact of solar radiation and fire.

By the way of attaching, multiple layered façade with a final coating of wood and wood products are categorized as:

- Multi-layered façades that require substructure - wood exterior cladding over the existing solid wall (masonry, cast concrete, prefabricated concrete, prefabricated wooden panel, wooden panels built on the site),
- Multi-layered façades attached directly to the primary structure without substructure - wooden façade cladding over the existing panel of wooden skeleton structure (prefabricated panel or a wall built on the spot) in case of non-ventilated façade assembly.

According to the final cladding material multi-layered facade with a final coating of wood and wood products can be divided into:

- Façades with a final coating of natural wood: boards, wood shingles, half logs, (Figure 1),
- Façades with a final coating of wood products: waterproof veneer board, manufactured boards - composites.

By the appearance, multi-layered façade with a final coating of wood and wood products can be divided into:

- Façade of individual elements - with a final coating of natural wood: boards, wood shingles, half logs,
- Plate façade - with a final coating of industrially obtained plates - composite,
- Façade in combination of single wooden elements and industrially obtained plates - composite (Figure 2).



Figure 1. The façade with a final coating of half logs, Winter boat house, Lake George, New York, Architects: Peter Bohlin, Royce Earnest, Robert McLaughlin 1992 [2]



Figure 2. The façade performed in combination of wooden plate cladding and wooden cladding from single elements, House in Toronto, Canada, Shim - Sutcliffe Architects - architectural team, 1994 [3]

1.2. Application of multi-layered façades with a final coating of wood and wood based products

Multi-layered facade with a final coating of wood and wood-based products can be applied to many buildings and in combination with other materials (glass, concrete, bricks, sheet metal).

This type of coating allows to change and improve the aesthetic experience of a building over time, following modern architectural and environmental trends. Replacement of the final cladding on the façade during the exploitation can be of aesthetic and economic importance.

Multi-layered façades with a final coating of wood and wood-based products can be applied in the following situations:

- Construction of new facilities,
- Reconstruction of already constructed buildings:
 - by changing the existing façade lined with wood or any other coating (Eternit, sheet metal ...) and replacing it with final

- wood cladding or coating of wood-based products,
- Over the existing dilapidated façade: plastered or made of facing brick.

The advantage of applying such façades is reflected in the possibility of their use in rehabilitation and reconstruction of buildings, regardless of the type material used for the basic structural part of the wall, because this type of double façade is attached directly to the existing façade wall over the substructure. If assembly prefabricated element is applied as a final coating, the installation is done at a very low labor cost.

2. Wood and wood products as a façade cladding in multi-layered façades

2.1. Products made of solid wood as a facade cladding in multi-layered façades

Most wood claddings can be made from sawn timber - full boards (Figure 3). Based on the shape of their cross-section, as well as depending on the way of their attachment to the surface, various external effects are obtained. Organic materials, such as wood, have qualities based on its anatomical, cellular structure. Features of wooden cladding vary according to their natural structure, mechanical and biophysical qualities, and depending on the direction of fibers.

Monolithic timber, when used for the outer coating, does not need surface treatment unless we want to avoid the natural aging process. In this case, the application of coatings containing pigment and providing protection from UV radiation is necessary. The method of treatment of the surface of the wooden element or cladding influences the effectiveness of protection, both aesthetically and in terms of durability of the coating. Good basis for the protection is a smooth surface of wood (sanded) or a flat surface without roughness and distinctive fibers and, essentially, with rounded edges.

Technical characteristics of wood that are very important for the façade construction are [4]:

- High hardness of wood in relation to the low specific weight,
- Good processing capabilities and different types of processing,

- High thermal resistance,
- Hygroscopicity (moisture absorption characteristics) and the impact on the balance of moisture on the interior side of the façade,
- Most types of wood with high hardness are suitable for outdoor use without any additional protection.

The most common species used for the façade cladding are the spruce, red cedar, larch, yew, oregon, pine, European redwood (Californian sequoia) and Scots pine [5].

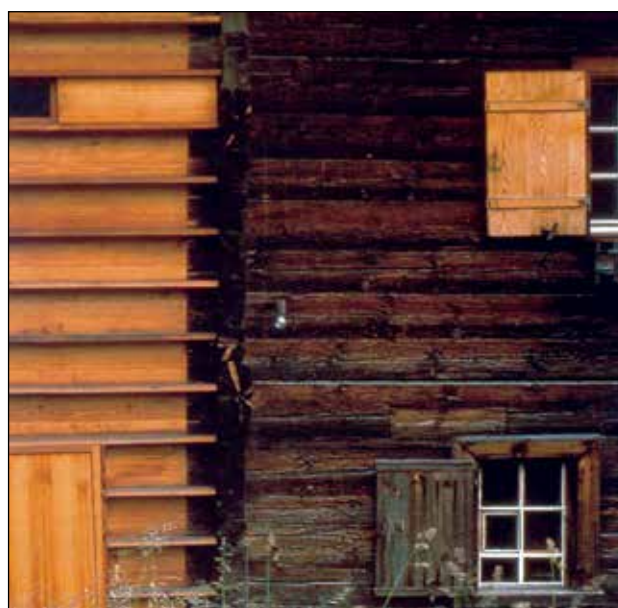


Figure 3. Solid wood as façade cladding, Grison Family House, Switzerland, the architect Peter Zumthor, 1994 [4]

Façade cladding with wood represents mounting boards of different shapes and ways of laying: horizontally, vertically or obliquely -diagonally. This setting can be made to touch or with an overlap, depending on the manner and direction of the cladding placement. It is recommended to use wood substructures and non-corrosive metal fasteners for attaching wood coating elements on the façade, due to possible chemical reactions between common metals and various substances in the wood that can cause the appearance of blue or black stripes on timber.

Uneven quality of wood as a façade cladding is most clearly seen in the appearance of swelling and shrinkage, which must be taken into account

when the wood is used for external cladding. Wood is hygroscopic and because of absorption or loss of moisture in the wood, we should always strive to establish a balance with the external environment, i.e. with the environment in which wood is placed as a coating.

In addition to the full boards, wooden shingles can also be applied as a façade cladding. (Figure 4). Types of wood of which shingle for façade cladding is cut are fir, spruce, yew, larch, oak.

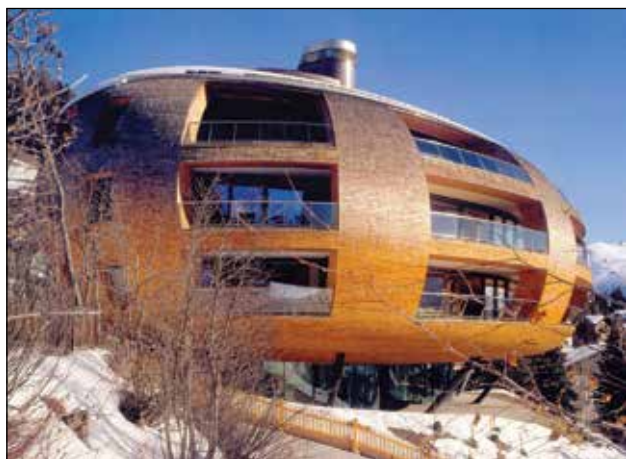


Figure 4. Wood shingles as façade cladding, House of the future – Apartment building, St. Moritz, Switzerland, Architectural team Foster and Partners - 2004 [6]

2.2. Thermally treated wood as an element of the façade cladding of multi-layered façades

Heat treatment of wood is performed in special furnaces in which the wood is heated in the absence of air at a temperature of 160 to 260°C. When thermally treated, it is essential to achieve an increase in dimensional stability and resistance, which significantly increases the durability of wood. Under the influence of high temperature twist, swelling and shrinkage of wood are reduced by 50%, which allows the use of thermally treated wood in conditions of high humidity and direct exposure to the atmospheric elements [7]. With this procedure moisture is extracted from the wood, and sugars in the wood crystallize. Wood treated in this way loses its elasticity, and its density is approximately 10% greater than the density of untreated wood [9]. The resin from the softwood is removed with thermal treatment. On account of

that, the resin does not leak or drip later, so the façade itself requires no special maintenance.

Thermally treated wood is a fully organic product, i.e. does not contain substances that may be harmful to the environment. Siberian larch and thermally treated softwood do not contain harmful chemicals and are resistant to insects and rot. Wood treated in this way is used as the façade wood cladding and it can be used for covering façade of the whole building or, in combination with other types of cladding, a part of a building. (Figure 5).



Figure 5. Thermally treated wood as façade cladding [9]

Thermal treatment increases the longevity of wood so that, without any additional protection and maintenance, heat-treated spruce has a lifespan of 15 years, heat-treated larch 20 years, heat-treated ash 25 years. There are special chemicals for maintenance and repair of thermally treated wood, for aesthetic reasons, in order to maintain its original appearance. Special chemicals may be used once a year to clean the wood and remove impurities from it, then it should be coated with a special maintenance oil. In this way, the old tone and luster of wood that, under the influence of sunlight, fades over the time, will be recovered. If we do not treat the wood with these chemicals for maintenance and repair, it will be exposed to the natural aging under the influence of solar radiation and, without any maintenance, eventually get a silver patina, but will not be exposed to the process of rotting.

2.3. Waterproof veneer panels as an element of the façade cladding of multi-layered façades

Waterproof veneer panels are obtained by gluing several layers of veneer with alternating direction of the fiber with water-resistant binder. The term waterproof is no guarantee that the board is suitable for outdoor use, because the stress of tension between the finishes and the next layer of veneer in the interior of the panels placed at right angle, differ [8]. Only veneer boards specifically made for that purpose and by cladding manufacturer have a guarantee to be used for external façade cladding (Figure 6).



Figure 6. Waterproof veneer panels as façade cladding, Dormitory, Campus II, Coimbra, Portugal, Architects -Manuel Aires Mateus and Francisco Aires Mateus, 1999 [6]

2.4. Composite materials as elements of the façade cladding in multi-layered façades

Composite panels - substitutes represent the industry products with very little wood, which means they are not made only of wood, but they look like wood because of their final appearance - the face of the product (Figure 7).

This layered composite panels are manufactured under various commercial names and with different composition and quality, which is reflected in the aesthetics. Some examples of these types of products have the following names: “Prodema”, “Parklex”, “Trespa” and “FunderMax”.



Figure 7. The façade coated with “Prodema” composite plates, Clinica Pombaldial, Lisboa, Portugal, Architect - Filipe Sousa[10]

Composite products for façade cladding differ by the structure of the core. Layered composite wood panel “Prodema” consists of a bakelite core with both sides protected with a liner - wood veneer; and on the outer side with coatings based on acrylic resins [10]. The core of the composite panel “Parklex” is made from thermally treated papier-mâché under conditions of high pressure and temperature and finally coated on both sides with natural wood veneer [11]. Homogeneous core of composite panels such as “Trespa Meteon” is made of European pine wood fiber, thermally treated with the addition of resins and pressed under conditions of high pressure and high temperature [12].

The panels protected in this way are resistant to extreme solar radiation, do not change the original tone and do not fade over time, unlike the façade cladding made of natural wood. The face of a plate is of veneer, that is 100% natural wood, and made to endure special requirements of the environment related to atmospheric elements - rain, snow, wind, hail, and the chemical effect e.g. the graffiti [10]. These composite panels behave just like hardwood. The material does not melt, it is non-flammable, does not explode, does not smoke and in case of fire keeps its stability. Composite materials as façade cladding are widely used in modern architectural buildings.

4. Conclusion

Wood as a natural, ecological material is applied in architecture which relies on the tradition as well as in the architecture that follows current

trends. The development of wood industry has contributed to the higher interest of architects and builders for building in wood, with the tendency of its application as a natural material, as well as increased use of wood products in modern architectural facilities.

The research confirmed that the world trend of re-use of wood and wood products as construction and cladding materials in architectural buildings is not solely due to meet the aesthetic, visual and formal requirements and to seek the inspiration in the return to tradition and nature, but also in its ecological, economic and energetic justification and fitting into the modern trends of sustainable development and use of modern technical and technological solutions in the production of materials, all in order to maintain the connection with nature, environment and tradition.

The development of modern technological solutions in wood processing led to obtaining composite wood-based materials that are extremely resistant, stable and far more durable than wood, and which, in terms of aesthetics, retained all the characteristics of wood that make it unique and unrepeatable. It is acknowledged as conclusion that in the exterior of modern architectural buildings contemporary façade wood-based cladding should be applied for lining and the use of wood should be reduced to a minimum.

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