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JOINTING, STRESS-DEFORMATION STATE AND STRENGTH OF ELEMENTS OF WOODEN ROOFING STRUCTURES.

Kadyrov Giyozjon Mirzajonovich
Fergana State Technical University
g' .qodirov @gmail.com Tel . +99891 112-10-53

Annotation: The article discusses methods for fastening elements of wooden roofing structures, their design features, advantages and disadvantages, as well as measures to improve seismic resistance.
Keywords: wooden joints, fasteners, bending, stretching, crushing, cracking, strength, deformation.

Login

Roofing structures made of wooden materials are widely used both historically and in modern construction. They are distinguished by their lightness, ease of processing and environmental safety. However, for such structures to be strong and durable, it is of great importance to correctly and efficiently connect their elements.

Ensuring high strength of joints of wooden structural elements, stability of joints in terms of strength in the state of stress-deformability is one of the important tasks in the field. In the world, certain scientific and practical results are being achieved in the development of the building materials industry, the use of resource-saving technologies that allow the economy of natural raw materials and the use of local raw materials in production, and the increase in the production volumes of new building materials, products and structures. In particular, due to the increasing number of options for increasing the spans of buildings and structures , special attention is paid to the need to improve the length and width of joints of wooden structural elements with limited geometric parameters using local raw materials [1].

Materials and methodology .

In this regard, the authors have improved the connections and are currently implementing such work in new modern construction sites . Improved connections are in accordance with the urban planning norms of SHNQ 2.03.10-24 " Roofs and Roofing " , SHNQ 2.03.08-22 "Wooden Structures" and The connection was improved by using steel screw nails of various sizes, taking into account that the joints in it are attached without screws .

Analysis of results.

The main elements of the roof structure

Wooden roofing mainly consists of the following elements:

Mauerlat is the main horizontal element mounted on the walls. Mauerlat is a special wooden beam (usually 100×100 mm or 150×150 mm in cross section) that is laid on top of the wall. It is the main support of the roof structure and the rafters are attached to it.

Rafters are the main part that gives the roof its curved shape. One of the main load-bearing elements of roofing structures is the rafters. The rafter elements rest on the Mauerlat, internal supporting walls or special columns. Therefore, their connection is of decisive importance for the stability and strength of the structure. The connection of the rafters with the supports can

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be performed in various ways. Their choice depends on the loads on the building, the length of the rafters, the type of material and the construction conditions.

Columns (stairs), rafters (runs), and purlins are auxiliary elements that ensure the stability of the roof.

Proper and strong attachment of these elements to each other affects the reliability of the entire roof structure .[2]

The types of wood structural joints we recommend and use are shown in Figure 1 .

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Figure 1. Examples of joining wooden roofing elements.

Experimental tests were carried out in series 1, in which the elements of wooden structures were connected by screws according to GOST 58959-2020. All indicators of the joints of wooden structures correspond to the type of coniferous wood with high load-bearing capacity, and in the final experiment, the joints of wooden structure elements were tested [3]. Boards, beams (slats), plates or beams are used for rafter legs. Trusses made of boards and slats are used in modern prefabricated industrial is the main solution for construction.

In areas where wood is a local building material, rafters are mainly made on site; in such conditions, the reconstruction of rafters from circular-section timber beams, which has certain advantages, can be successfully used in construction practice.

In our country, the construction of rafters from poplar wood is widely used.

Rafters are usually made of small (12-24 cm in diameter) beams. Rafters are up to 2 times cheaper than sawn wood materials. The calculated bending resistance of beams (R_u =1600 n/cm ^{2}) is somewhat higher than that of boards (R_u =1300 n/cm ^{2}); the fire resistance limit of beams is higher than that of boards. It is clear that it is advisable to use beams in rafters.

General view of wooden roofing elements .

Properly constructed and installed sloping rafters are considered to be a non-span structure. To prevent the formation of a span force in the rafters , the supporting surfaces of the carved forms at the points of support of the rafter legs on the Mauerlats and purlins should be made horizontal, and the span force arising from longitudinal stresses in the rafter legs should be damped by placing a pair of horizontal braces or beams.

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Roof slope angle $\alpha \leq 10^o$ if - rafter legs are calculated as beams with a horizontal axis, $\alpha > 10^o$ if - as beams with an oblique axis. In the second case, the value of the load acting on 1m α^2 of the roof surface (slope) is divided by cos , and is reduced to the load acting on 1m ^{2} of the roof plan. The load acting on the rafter leg is summed over the load area, the width of which is equal to the pitch of the rafters.

The maximum bending moment generated in a freely supported rafter leg with two supports is determined by the following formula:

$$M = \frac{q \cdot \ell^2}{8},$$

where : q is the total (permanent and snow loads) load acting on 1 m of the horizontal projection of the rafter leg;

ℓ - the distance between the rafter legs in horizontal projection.

according to the following formula, taking into account the slope of the element axis e ' :

$$\frac{f}{\ell_1} = \frac{5q^n \cdot \ell^3}{384 \cdot E \cdot J \cdot \cos\alpha} \leq \frac{1}{200}. \quad (1)$$

If the rafter leg has an additional support in the form of a progon (Figure 1) or a truss (Figure 2), it is considered a two-span continuous (bonded) beam.

The bending moment generated in the section at the middle support is determined by the following formula:

$$M = \frac{q \cdot \left(\ell_1^3 + \ell_2^3\right)}{8 \cdot \left(\ell_1 + \ell_2\right)}, \quad (2)$$

where : ℓ_1 and ℓ_2 - the horizontal distances from the edge supports of the rafter leg to the middle support.

The wooden structural joints were prepared under the same conditions and in such a way that the structural elements could be assembled and disassembled using screws. For experimental testing, the cross-sections of the wooden structural elements were taken as 50x150 mm. The fastening of the wooden elements was carried out on beams (rafters) located horizontally to each other , and the reinforcement of the structural elements with respect to the wood fibers was ensured in this way [4].

In accordance with GOST 58959-2020 , in which the elements of wooden structures were connected by screws. All indicators of the joints of wooden structures correspond to the II-grade pine wood type with high load-bearing capacity, and in the final experiment, the joints of wooden structure elements were tested.

The wooden structural joints were prepared in the same conditions and in such a way that the structural elements could be assembled and disassembled using screws. For experimental testing, the cross-sections of the wooden structural elements were taken as 50x150x800 mm. The fastening of the wooden elements was carried out on beams (rafters) located horizontally to each other , and the reinforcement of the structural elements with respect to the wood fibers was ensured in this way.

That we recommend and use are shown in Figure 2. Experimental tests were carried out to determine the deformation states of the joints of wooden structural elements, and the samples were loaded under the influence of loads. After the load was applied, the bending parameters

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of the joints of wooden structural elements were obtained and the next stage of loading was carried out. The samples were loaded until failure .

Of buildings and structures should be carried out in conjunction with the study of all building structures within the object. The main characteristics characterizing the technical condition of wooden parts of buildings and structures should be considered in the following, loss of priority of form and condition, any appearance of distortion violation of the geometric invariance condition indicators of existing and quantitative mechanical, biological, entomological, corrosion and other damage received by elements of wooden structures during use Deformation of structures as a result of cold weather, fluidity of materials and displacement in joints Performance of wooden structures under temperature-humidity operating conditions moisture content of wooden structural elements quantitative details of external influences on wooden parts of buildings and structures.

When studying wooden parts of buildings and structures, data is collected on the entire object, including its load-bearing barrier structures, strength and physical and mechanical properties of materials, and use of the object. The study of wooden parts of buildings and structures should be carried out by direct and detailed (instrumental) methods, as well as the study and determination of the following: Visible damage to the wooden parts of the object as a result of the destruction of sections, loss of priority and the appearance of cracks; cracks in wooden elements; cracks in protective or decorative coatings of wooden parts of buildings and structures; wooden parts of buildings and structures exposed to unfavorable atmospheric conditions, condensation and technical dampness, as well as cold-conducting "bridges"; schemes of permanent and temporary loads acting on the wooden parts of the building and structure, taking into account external influences, including the structural and technological characteristics of the object, the specific gravity of the materials, and their indicators; calculation schemes and geometric dimensions - spans, cross-sectional areas, support conditions and fastening schemes of wooden structures and elements; spatial integrity of the building and structure, including their wooden parts; the condition of the structural and wooden element joints; the degree of damage to the structural elements of wooden parts of buildings and structures from bio-entomological, fire and corrosion effects; Actual deflections, deformations and displacements of wooden parts of individual elements and joints in the structure of the object and structures; strength and physical and mechanical properties of materials; temperature and humidity operating conditions of structures; chemical aggressiveness of the operating environment affecting wooden structures; the presence and technical condition of the processed protective layer of the wooden parts of the object; compliance of the facility and its exposed parts with fire safety requirements; In cases where a project exists, the compliance of the wooden parts of the object with the project requirements.

Wooden roofing structures are considered functional, efficient and aesthetically very convenient in construction. They can be very durable and reliable when filled with modern materials. Therefore, their proper design and installation are very important. Wooden roofing structures have historically and in modern construction practice occupied an important place due to their convenience, lightness and reliability. Such structures are not only cheap and useful as building materials, but also distinguished by the fact that they are built using natural, environmentally friendly and renewable resources [5].

Wooden structures are widely used, especially in small and medium- sized buildings, such as private houses, dacha buildings, structures of folk architecture, and household

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buildings. When these roof structures are enriched with modern engineering solutions (for example, metal fasteners, additional attachments, covers), their seismic resistance, resistance to wind and snow loads, and durability increase even more. If factors such as the type of roof structure, element interconnections, geometry, and load analysis are correctly selected and designed, wooden roofs are not only beautiful and aesthetically pleasing, but also durable and economically viable. The importance of wooden roof structures in agricultural buildings, mosques, madrasas, historical monuments, and modern architecture is very high, and ways to restore and modernize them remain the subject of separate studies [6 ,7].

Conclusion:

Proper design and effective assembly of wooden roofing structures ensures not only the strength of the roof, but also the long-term and safe service of the entire building. The correct selection of traditional and modern assembly methods should be made depending on the construction conditions and the level of seismic activity.

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