Innovative Designs of Wooden Beams in Conditions Far North

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Abstract. In the conditions of the Far north of the country, the use of lightweight and environmentally friendly supporting structures of buildings and structures is rational. It is proposed to use innovative reinforced wooden beams, consisting of two symmetric across the width of the beams packets glued boards that are interconnected to the length of the coupling rods and wooden slats. Packets glued boards fitted with reinforcing elements in the form of longitudinal and transverse plates of composite material. The study was carried out using programmatically-SCAD computer, based on the method of finite elements. Comparative theoretical researches of an intense strained state wooden and fittings of wooden beams on the basis of results of the automated and manual calculation in compliance with existing rules are conducted. The rational parameters of reinforcing elements and their location in the beam in the conditions of the Far north are determined.

1. Introduction

Comparison The wooden beam structures, find more application in coatings civil and industrial buildings. The wood by virtue of their deficiencies does not apply often in conditions Far north [1].

However, with the development of effective protective coatings and wood impregnation, durability wooden structures increases significantly and their use currently may be justified on row of objects for northern regions [2-3].

With the aim of enhance carrier abilities and reliability of such structures is rational use of glued reinforcement of wooden beams, constructions which can be quite diverse [4-5].

Are known their wooden beams, including a packet of glued boards, in the lower and upper zones of which are reinforced elements, consisting of longitudinal horizontal rods and sloping rods, with this group inclined rods are accommodated on the support plots beams [6-7].

The disadvantage of such technical solutions is, as a rule, high labor intensity of manufacturing, due to the implementation of the system of grooves and boreholes of complex configuration in a laminated package for reinforcing ele-ments, as well as low durability associated with corrosive wear of reinforcing bars for objects for northern regions. In addition, the disadvantage is the low carrying capacity of the wooden beam, due to the limited width of the package of glued boards and insufficient anchoring of the inclined rods in the middle height of the wooden beam, where tangents stresses reach the maximum.

Perspective may be the use of composite materials based on polymer as rein-forcement of wooden beams, as well as the use of a more rational constructions steel reinforcement in conditions Far north [8-9].
2. Methods

It is proposed to use innovative reinforced wooden beam (fig. 1) consisting of two symmetric across the width of the beams packet glued boards that are interconnected to the length of the coupling rods and wooden slats.

Packages of glued boards are equipped with reinforcing elements in the form of longitudinal and transverse plates of composite material, for example, carbon plastic, capable of receiving tensile forces, as well as compression and shear, while ensuring their stability, which is established experimentally [10-11].

Reinforcing elements glued to surfaces packets glued boards, while longitudinal plates have variable thickness, height and span wooden beams and transverse blades have variable thickness to span wooden beam. Change the thickness of the reinforcing elements can be achieved or gluing of several longitudinal and transverse plates (laminates) at each other.

Wooden planks secured to half with help insolent, for example, self-cutting screws, nails, wood and provide collaborative work packets glued boards, wooden beams.

The constructive solution of beams patented author of and will reduce the complexity of production, increase the carrying capacity and durability of wooden beams. The effectiveness of such structures already has some justification in both domestic and foreign studies [12-13].

Reinforcing elements of such beams are glued to surfaces packets glued boards, thus avoiding time-consuming operations on a sample of grooves or holes in wood and reduces labor intensity of manufacturing wooden beams.

Reinforcing elements made from composite material whose properties can vary [14] that allows you to improve the effectiveness of the beams, to avoid corrosion of material and, consequently, improve the reliability and durability of wooden beams.

Reinforcing elements are inside cross-section wooden beams, composed of two packets glued boards, and closed with wooden slats that protects the reinforcing elements from high temperatures and solar radiation and, as a consequence, increases the the durability of wooden beams in General.

Reinforcing elements glued to the wood between packages glued boards, work with them and are able to work not only on stretching, but compression and slice. When this longitudinal plates have a variable thickness.

![Figure 1](image_url)

**Figure 1.** 1 - General view of the wooden beam: 1-package glued boards, 2-coupling studs, 3-wooden laths, 4-reinforcing element, 5-longitudinal plates, 6-cross plates, 7-pins.
3. Results and discussion
In traditional wooden beams with transverse steel reinforcement bearing capacity of beams on the effect of shear force is not growing, and the transverse reinforcement is designed exclusively for the perception of the shear effort between layers laminated packets boards. In the case of the use of plates of composite material can increase the bearing capacity of beams on the effect of shear force due to continuous reinforcement.

Wooden laths, located on the upper planes packets glued planks can be made from hardwood and be supporting platforms for distribution of large concentrated forces, attached to the frame, resulting in increased bearing the ability of the wooden beam to the action of local stresses.

Cross-section sizes of packets glued boards, the material and the thickness of the reinforcing elements, the material and the thickness of the wooden planks, the diameter and pitch of coupling studs and pins are determined by calculation.

The proposed wooden beam compared to prototype allows to reduce labor intensity and intensity beams while increasing its reliability and durability [15-16], which may be highly relevant in the far North.

For the selection of cross-section of innovative wooden beam was considered a variant of the Rafter span L = 18 m, B = 6 m, under the snow load for the 5th district of the Russian Federation. Reinforcement-plate carbon with the module of elasticity E = 150 GPa. Alternatives considered glue boards beams without reinforcement and reinforced steel rod. Calculation of beams with engaging design SCAD computer on plastichato-core schema for analysis of stress-strain State wood and reinforcing elements [17-18].

The results of calculation of beams and their constructive solution and comparative analysis are summarized in the table 1.

Table 1. Sranitelnyj review design calculation of wooden beams.

| Parameter                  | Wooden laminated beam | Reinforced wooden beam with steel fittings | Reinforced wooden composite beam with reinforcement |
|----------------------------|-----------------------|-------------------------------------------|---------------------------------------------------|
| 1. Cross-section           | 1.3x0.3м (hxb)        | 1x0.3м (hxb) + 8d25А400                   | 1х0.24м (hxb) + 1х0.3м (hxb) + 100x30мм |
| 2. h/L                     | 1/14                  | 1/18                                      | 1/18                                              |
| 3. Flow fittings, τ        | -                     | 0.3                                       | -                                                 |
| 4. Composite consumption, τ| -                     | -                                         | 0.2                                               |
| 5. Bending stiffness, f/L  | 1/375                 | 1/300                                     | 1/300                                             |

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Work on manufacturing of innovative wooden beams can be performed in the following order:
- packet elements glued boards glued together and pulled together with clamps until the glue set design strength;
- from the side edges of the packet glued boards lengthwise and transverse plate joints which are performed using cold or ultrasonic welding;
- in packets glued boards at the level of the mid-section with a regular height step performed holes corresponding to the diameter of the coupling studs;
- two packets of laminated boards are prepared internal planes to each other and unite among themselves by coupling rods and wooden planks on dowels [19-21].

4. Conclusions
1. It is proposed that the application of innovative reinforced wooden beams, con-sisting of two symmetric across the width of the beams packets glued boards that are interconnected to the length of the coupling rods and wooden slats. Packets glued boards fitted with reinforcing elements in the form of longitudinal and transverse plates of composite material for cold areas.
2. Research was carried out using programmatically-SCAD computer, based on the method of finite elements. Comparative theoretical study of stress-strain State of wooden beams on the basis of the results of automated and manual calculation in line with current standards. Defined rational parameters of reinforcement elements of their location in a beam.
3. The use of plates (laminates) of composite allows more voltage is distributed evenly across the section of wooden beams and avoid significant concentrations of stresses in the wood.
4. Increase the rigidity of the innovative beam compared to traditional wooden or decrease its cross-section height will be 20-25%. Dematerialization innovation beams consumption in comparison with analogue of wood will be 35-40%. Dematerialization innovation beams of wood consumption in comparison with analogue of wood reinforced with steel rods will be 15-20%.

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