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Carrying Capacity and Deformation of the Joints of the Fitting with Wood When Pulling Out

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Abstract: *The junction of wooden columns with the foundation is the most responsible part. The strength of the glued wooden column attached to the foundation with metal elements depends on the stress-strain state of the elements used in the joint under the influence of longitudinal load and bending moment. The article provides theoretical data on determining the strength and deformation of the base node.*

Keywords: *Glued wooden column, responsibility knot, metal plate, basic assumptions, shear, bending of the coating, bending, cutting surface.*

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Introduction:

A critical unit of buildings with an all-wood frame is the support unit of glued columns, rigidly connected to the foundation. As you know, the strength of such joints depends on the strength and deformability of the connecting elements under the action of a longitudinal force and a bending moment [1].

There are various options for the support units of glued columns, rigidly connected to the foundations [2].

The analysis of the results of the studies carried out shows that the most acceptable nodes are those with the use of joints on glued rods, and the study of the strength and deformability of such joints is an urgent and responsible task.

To this end, the author set the following main tasks.

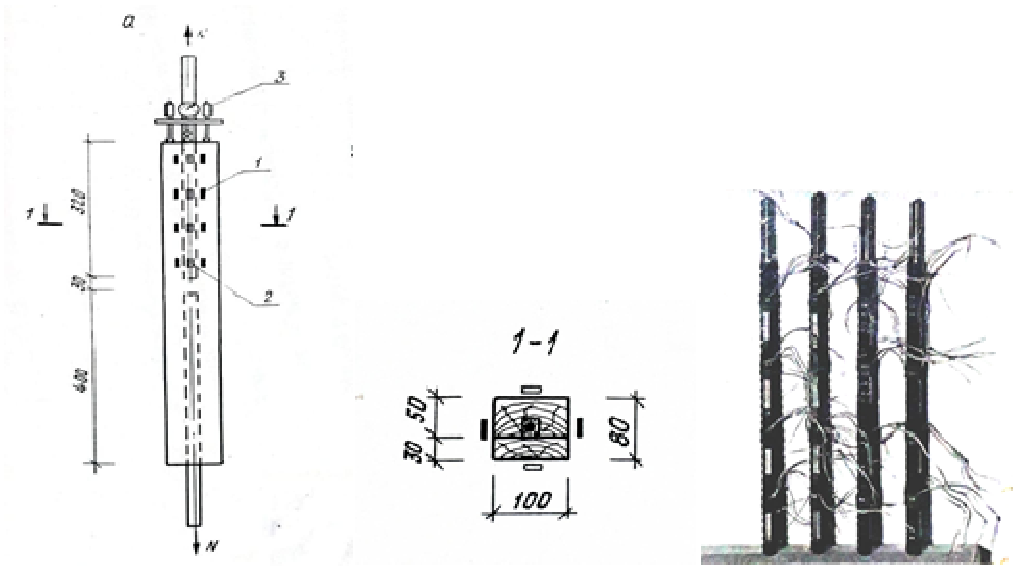
- to investigate the actual bearing capacity and deformability of the joints, depending on the dimensions of the grooves, the diameter and length of the insertion of the rods, as well as the design features of the inclusion of the rods in the work when pulling out;
- to reveal the nature and picture of the destruction of joints when pulling out;
- to experimentally check the method of approximate calculation of the rods glued into the wood for pulling out.

Materials:

The study of the joints in order to study the effect of the dimensions of the grooves during pulling out was carried out on samples with a section of 80x100 mm and a length of 750 mm.

The samples were wooden prisms; reinforcing bars with a diameter of 16 mm were glued into the grooves. The length of the glued-in part of the rod l was taken equal to 320 mm, i.e., 20 rod diameters. Thus, the ratiol / d for all tested samples was equal to 20. The grooves had a square section with side dimensions of 2, 4, 6 and 8 mm. larger than the outer diameter of the bar. A total of 16 samples were tested (4 of the same type for each test).

The general view of the samples, their cross-section and the location of the measuring instruments in the reinforcing bars are shown in Fig-1.



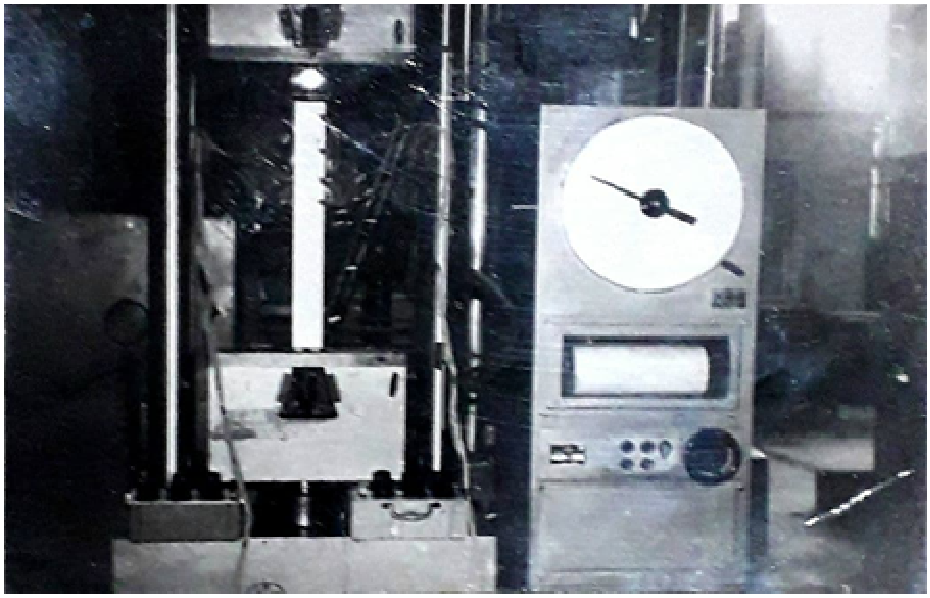
Pic. 1. General view of the sample and the layout of the measuring devices: 1 - load cells on wood; 2 - also, on fittings; 3 - dial indicators (ICh-10).

The pull-out test was carried out on a R-50 tensile testing machine; speedloading was taken equal to 60-50 N/s, and the loading step - 5 kN.From fig. 1 that when pulling out the rods, the transfer of tensile forces from the rod to the wooden prism was carried out through the glued interlayer.

Methods:

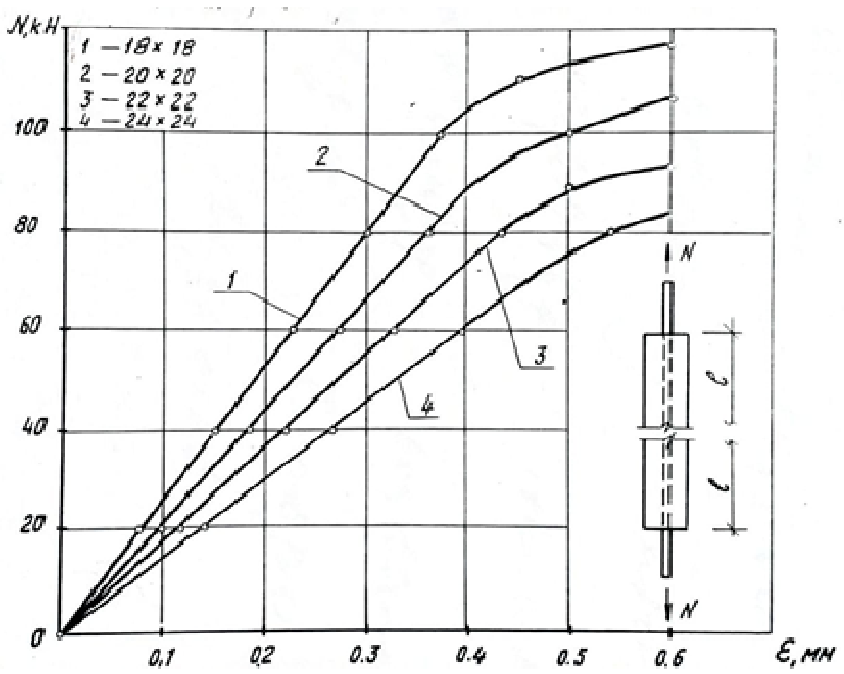
The deformations of the pulling out of the rods relative to the end of the wooden prism and the deformations of the wooden prism were measured with dial gauges with a graduation of 0.01 and 0.001 mm.

The photograph (Fig. 2) shows the process of testing samples for pulling out.



Pic. 2. Samples during testing.

As the analysis of the test results shows, the dimensions of the groove significantly affect the deformations of the connection during pulling out. For example, if, under a load of 60 kN, the deformation of pulling out the rod from the groove with the size exceeding the diameter of the rod by 2 mm, is equal to 0.23 mm, then with an increase in the difference of these dimensions to 4, 6 and 8 mm, the mentioned deformations turned out to be, respectively, equal to 0.27, 0.33 and 0.39 (Fig. 3) ... Thus, with an increase in the size of the groove from 18 x 18 mm to 24 x 24 mm, the deformations when pulling out the rod relative to the prism end increased by approximately 1.7 times.



Pic. 3. Deformation of the joints when pulling out (average values): 1 - with grooves with dimensions of 18x18 mm; 2 - the same 20x20 mm; 3 - the same 22x22 mm;4 - the same 24x24 mm.

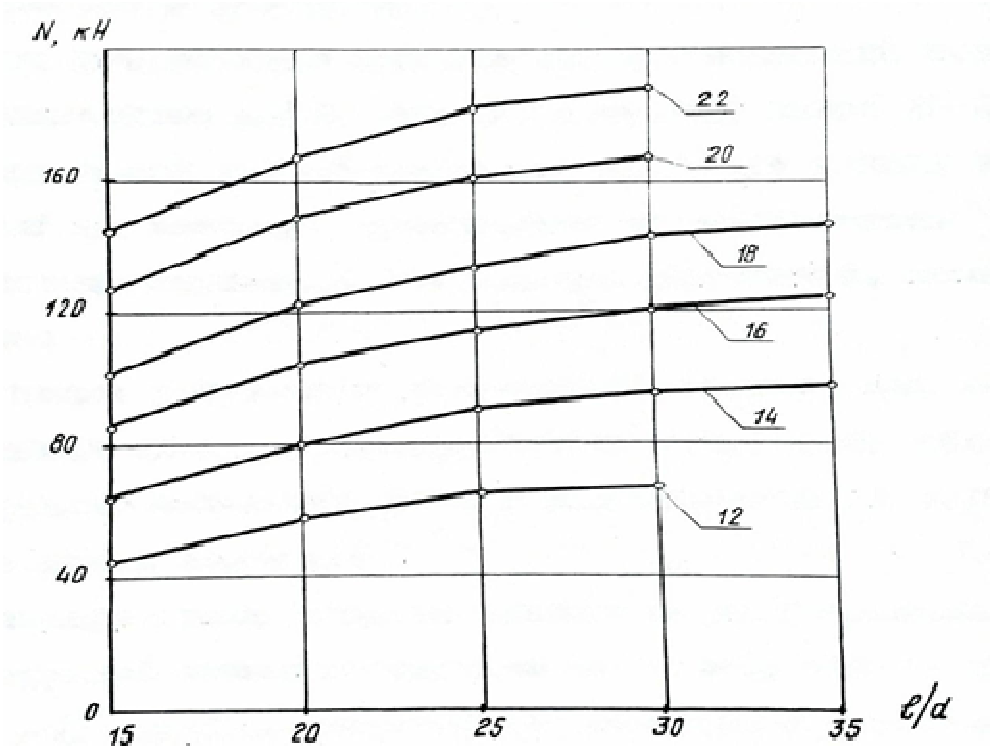
Results:

As can be seen from Fig. 3, the size of the groove significantly affects the bearing capacity of the glue joint of the rod with the wood when it is pulled out. So, for example, if the value of the pull-out force during the destruction of samples with grooves 18x18 mm turned out to be on average 110 MPa, then with an increase in the dimensions of the grooves to the above values, it decreased, respectively, by 9, 19 and 26 percent.

Note that the destruction of the samples when pulling out the rods was accompanied, as a rule, by the splitting of the wood.

The effect of the diameter of the rods and their length during pulling was studied on samplessimilar samples shown in Fig. 1. In this case, the diameters of the rods were taken equal to 12, 14, 16, 18, 20 and 22 mm, and the length of the gluing was taken equal to 15.20, 25, 30 and 35 the diameters of the rod. The dimensions of the grooves for the rods were taken to be minimal and exceeded their outer diameter by 2 mm. A total of 44 samples were manufactured and tested.

According to the test data of four samples of the same type, the arithmetic mean value of the pull-out force during the destruction of the samples was determined. The test results are shown in Fig. 4.



Pic. 4. Values of destructive pulling forces depending on the diameter of the rods and the relative length of their insertion

Discussion:

As seen from Fig. 4 meanings of pulling forces causing the destruction of samples, with an increase in the length of the rods, increases. For example, if this value for rods with a diameter of 12 mm with an insert length of 15d is equal to 45.05 kN, then with the same diameter and lengths of 20, 25 and 30d, the values of the breaking forces increase, respectively, to the values of 52.05, 57.47 and 63, 45 kN.

The size of the destructive forces is also significantly influenced by the diameter of the glued in rods. If for rods d = 12 mm with a gluing length of 20d it is equal to 52.05 kN, then for samples with rods 14, 16, 18, 20 and 22 mm. destructive the force increases to values, respectively, equal to 76.22, 98.97, 124.15, 147.37 and 163.05 kN [4].

Analysis of the research results shows that with an increase in the length of the insertion of rods over 25-30, the growth of the breaking forces slows down, and when the length of the insertion is more than 30d, their values do not change significantly [5].

Conclusion:

Evaluating the results of the tests carried out, it can be argued that:

- in order to reduce deformations, the support nodes on the glued-in rods should be designed in such a way that the transfer of compressive forces to the ends of the rods and to the end of the column is ensured;
- the dimensions of the grooves should be taken as minimum, exceeding the outer diameter of the rods by no more than 2 mm;
- it is advisable to set the length of the insertion of the rods in the range of 20-30d;

the obtained data are reliable and can be used for practical calculation of the glued-in rods for pulling out.

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