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DEFORMATION OF ROUND PINE ASSORTMENT
OF CONSTRUCTION SIZE

Urgency of the research. *Study of wood behavior under load will allow us to deepen our understanding of technological processes and evaluate performance characteristics of finished product.*

Target setting. *Knots are the main flaw that forming defects. Their influence on strength and deformation of small diameter wood has not been studied yet. Therefore, determination of indicators for wood mechanical properties with defects, taking in consideration their moisture content will allow to determine beams design in wooden structures.*

Actual scientific researches and issues analysis. *There are some studies today how to determine mechanical state of wood under different methods of load application. However we don't have publications which examine the issues of applying load to samples of construction dimensions with defects.*

Uninvestigated parts of general issues defining. *Construction is one of the main wood consumer. It is known that wood structures can come as round wood of coniferous and hardwood . The presence of wood flaws such as knots and cracks affects it's strength significantly. It should be noted that experimental and theoretical results of studies of wood flaws influence on its strength refer only to the presence of knots in lumber. Dependence of round timber strength characteristics on flaws and wood moisture content is not well understood. In this regard it becomes necessary to determine these dependencies and opportunity to use small diameter logs in building structures.*

The research objective. *The main purpose of this study is to present some results of experimental investigation of how deformation of small diameters round pine assortment depends on presence of knots and moisture content under compression parallel to grain.*

The statement of basic materials. *This article presents some study results about a pattern of deformation development in small diameters round pine assortments depending on size of knots and wood moisture content. Deformation was higher in test samples with knots and moisture content above saturation limit of cell walls than in control samples. The lower deformation was observed in dry samples with W – 16-18 %% as well as in samples with the knots. Total value of residual deformation of dry wood is determined . It should be noted that dry wood has residual deformation after 30th loading cycle.*

Conclusions. *It is determined that under application of compressive static load along the grain with the upper compression limit which is lower than conditional limit of proportionality the process of deformation for wood with knots and without knots is almost the same. The control samples were deformed less and deformation value of samples with knots had higher numerical value and increased with the size of the knots.*

Keywords: *wood, round logs, knot, loading along the grain, deformations*
Fig.: 3. Table: 1. References: 10.

Introduction. Wood has been used since ancient times as a building material. Its strength can compete considerably with steel, exceeding steel's thermo technical parameters. The wood perfectly withstands compressed and tensile states. The operational quality of wood quite often results in deformations taking into consideration the time factor and exposure to loads. Study of wood behavior under load application will allow us to deepen our understanding of technological processes and evaluate performance characteristics of finished product. It will give us opportunity to use small cross-section wood for structural elements efficiently.

Target setting. Knots are the main flaw that forming defects. Their influence on strength and deformation of small diameter wood has not been studied yet. Therefore, determination of indicators for wood mechanical properties with defects, taking in consideration their moisture content will allow to determine beams design in wooden structures.

Actual scientific researches and issues analysis. The study of wood strength under lasting loads and it's deformations were conducted by some scientists such [1-8].The studies [9] have shown that lasting use of wood largely depends on operating conditions. The necessity of calculation of timber structure elements has led to a number of studies concerning the impact of reloads on wood deformation.

For the first time the detailed studies have been conducted by Y. M. Ivanov [2, 3] for different mechanical conditions of the wood when deformations are proportional to the strain and beyond of elastic stress, i.e. irreversible changes and permanent deformations occur. The test were carried out on small samples without defects. Research of deformation of circular cross- section wood of construction dimensions with defects was not conducted. Thus this study objective was to investigate deformation dependence on knots and moisture content of the round assortments of small diameter pine.

Uninvestigated parts of general issues defining. Construction is one of the main wood consumer. It is known that wood structures can come as round wood of coniferous and hardwood. The presence of wood flaws such as knots and cracks affects it's strength significantly. It should be noted that experimental and theoretical results of studies of wood flaws influence on its strength refer only to the presence of knots in lumber. Dependence of round timber strength characteristics on flaws and wood moisture content is not well understood. In this regard it becomes necessary to determine these dependencies and opportunity to use small diameter logs in building structures.

The research objective. The main purpose of this study is to present some results of experimental investigation of how deformation of small diameters round pine assortment depends on presence of knots and moisture content under compression parallel to grain.

The statement of basic materials. The studies have been conducted to identify the patterns of deformation development. Work samples were selected in two regions of Ukraine (conditionally designated as 1st region and 2nd region). Growth conditions and age of the trees were approximately the same. The age of trees was about 50-60 years. Samples were cut from dead crown area of the trees. It was provided 15 logs totally. They were used for samples making.

All samples were divided into lots, diameters fluctuation of the logs was 14–24 cm, for the knots it was 40–73 mm, the height of the samples was equal to two diameters [10]. Each lot of samples contained a control group without defects. During the testing some samples were dried to moisture content of 16–18 %. Bark was removed from logs for even drying. Drying was carried out in a heated premises. At the same time some part of samples exceeded a fiber saturation point. The test were conducted on the test machine UMM 200 (Figure 1).

Elastic deformation of control samples was observed in the first cycle. These deformations gradually decreased during subsequent cycles of loading and disappeared after the 20th cycle.

Fig. 1. Testing machine UMM-200

Diagram of deformation was recorded in P coordinates deformation during the test. A special measuring complex was used to record compression diagram. To measure deformation of samples П shaped electromechanical strain gauges with movement measurement bases are used for measuring samples deformation. The strain gauge consisted of rigid stand, two elastic elements with glued-on strain gages and special knives for mounting on the measuring object. The measuring complex was pre-calibrated using certified dynamometer DOS-100.

Fig. 2. Electromechanical strain gauge

Strain gauge was attached to sample with special elastic threads. In a case of changing the sample size as a result of its loading by compressive force the distance changed between the points of contact of strain gauge knives and sample cuts. At the same time there was a bending of elastic elements on which strain gages were glued. Before testing, the diameters of samples were measured, base of deformation measurements was marked and showed 80 and 100 mm.

According to the test procedure the samples were loaded slowly. Then load was gradually removed and loading was stopped after reaching the upper limit of loading. The load was applied to the samples 30 times during this test. Each succeeding cycle of loading took place after samples unloading and resting for 5 min.

The voltage at the upper level was assumed to be equal to 16,5 MPA which corresponded to average 0,68 of conditional level of proportionality and 0,55 level of strength, obtained from our previous test.

Both lots of control samples with moisture content of W > 30 % had less deformation value after first cycle of loading than the samples with knots and we observed it's decrease in the next cycle. Deformation of the samples from the second region showed decrease by 8.1% from the first to the thirty cycles, and for the first region control samples respectively by 8.5 %. Deformation of the samples with the knots d = 39 – 40 mm were higher than control ones by 6.3 – 7.1 % at the end of the testing and decreased by 5.8 – 6.1 %. Deformation of the samples with the knots d = 69 – 70 mm were higher by 8.7– 10.9 % compared to control samples and decreased by 6.3 – 6.6 % at the end of the testing.

Deformation of the samples with the knots also increased with increase of the knots size and was 1,5 times higher compared to control samples. Deformation occurred in each cycle after unloading and its value was approximately the same. Deformation was always present after the load was removed from the sample then it completely disappeared after "rest" for 40 – 60 min and samples returned to their original size (Table 1).

Total value of permanent deformation of dry wood after the 1st cycle of loading is higher almost 2 times than all control wet wood and for the samples with knots d = 41– 42 mm is 1.5 times higher, and samples with the knots d = 71 – 73 mm is higher by 18 % (Figure 3).

Table 1

Wood deformation under compression along the grain during repeated static load application, W > 30%

1nd	2nd	5th	10th	20th	30th
ε					
1st region					
Control samples					
23.14 * / 1.90 *	21.52 / 0.90	21.48 / 0.65	21.41 / 0.37	21.45 / 0	21.49 / 0
Samples with knots d = 40 mm					
24.78 / 2.26	23.95 / 2.06	23.47 / 1.99	23.43 / 1.84	23.24 / 1.66	23.27 / 1.51
Samples with knots d = 69 mm					
25.63 / 3.20	25.19 / 3.03	24.85 / 2.16	24.81 / 2.11	24.57 / 2.05	24.03 / 2.01
2nd area					
Control samples					
23.17 / 1.63	21.60 / 1.00	21.50 / 0.60	21.37 / 0.40	21.42 / 0	21.45 / 0
Samples with knots d = 39 mm					
24.63 / 2.22	23.88 / 2.02	23.42 / 1.83	23.39 / 1.80	23.22 / 1.60	23.21 / 1.49
Samples with knots d = 70 mm					
25.69 / 3.22	25.21 / 3.07	24.89 / 2.19	24.83 / 2.00	24.60 / 1.98	24.10 / 1.97

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* – in numerator - deformation under load

* – denominator - after removal of the load
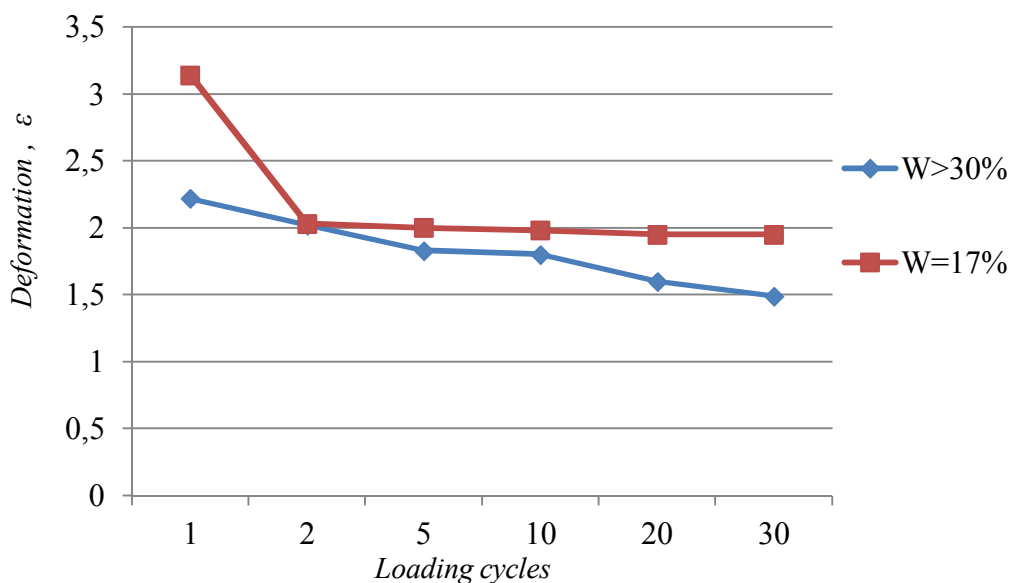
Fig. 3. Wood deformation with the knots d= 39 – 41mm after unloading at different moisture content for example samples from the first region.

Complete and permanent deformations of the samples with knots have a smaller value. Obviously the knot which has a higher density works as a wedge that reduces wood deformation. V. N. Volynskii [7] noticed the reinforcing role of the knots for boards.

Conclusions. This paper presents the results of an experimental research and analyses indicating that under repeated application of compressive static load along the grain with upper compressive limit which is lower than conditional limit of proportionality the process of wood deformation with the knots and without them is almost the same.

The value of deformation of control samples in all lots were less than for control samples with knots and slightly increased after the first cycle of loading. It remained almost unchanged after then. The control samples were deformed less, deformation value of the samples with knots had a greater number and increased with the larger sizes of the knots.

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ДЕФОРМАТИВНІСТЬ КРУГЛИХ СОРТИМЕНТІВ СОСНИ БУДІВЕЛЬНИХ РОЗМІРІВ

Актуальність теми дослідження. *Вивчення поведінки деревини під навантаженням дасть змогу поглибити уявлення про протікання технологічних процесів та дати оцінку експлуатаційним характеристикам готової продукції.*

Постановка проблеми. *Вплив основних сортоутворюючих вад, а саме – сучків, на міцність та деформативність стовбурів малих діаметрів майже не досліджувався. Тому визначення показників механічних властивостей деревини з вадами, з урахуванням їх вологості, дозволить визначити розрахункові опори в конструкційних елементах дерев'яних споруд.*

Аналіз останніх досліджень і публікацій. *Сьогодні існують дослідження з визначення механічного стану деревини за різних способів прикладання навантаження, проте відсутні публікації, де висвітлювалися б питання прикладання навантаження до зразків будівельних розмірів із вадами.*

Виділення недосліджених частин загальної проблеми. *Одним з основних напрямів використання деревини є будівництво. Відомо, що деревні конструкції можуть бути у вигляді круглих лісоматеріалів хвойних і листяних порід. Наявність вад деревини (сучків, тріщин) істотно впливає на їхню міцність. Треба зазначити, що експериментальні й теоретичні результати досліджень впливу вад деревини на її міцність відносяться лише до наявності сучків у пиломатеріалах. Залежність міцнісних показників круглих лісоматеріалів від вад і вологості вивчена недостатньо. У зв'язку з цим виникла необхідність визначення цих залежностей і можливості використання колод малих діаметрів у будівельних конструкціях.*

Метою статті *є визначення залежності деформації круглих сортиментів сосни малих діаметрів від розмірів сучків і вологості при стискуванні уздовж волокон.*

Виклад основного матеріалу. *У статті наведені результати дослідження закономірностей розвитку деформацій круглих сортиментів сосни малих діаметрів від розмірів сучків і вологості деревини. У зразків із сучками і з вологістю вище за межу насичення клітинних стінок деформація була вища, ніж у контрольних. У сухих зразках, з W 16-18 % відмічено менше значення деформації як для контрольних зразків, так і для зразків із сучками. Визначені загальна величина залишкових деформацій сухої деревини. Необхідно зауважити наявність залишкових деформацій у сухій деревині після 30-го циклу навантаження.*

Висновки відповідно до статті. *Встановлено, що за дії повторного статичного навантаження під час стискування уздовж волокон із верхньою межею навантаження нижче умовної межі пропорційності процес розвитку деформації деревини без сучків і з сучками практично однаковий. Контрольні зразки деформувалися менше й величина деформації зразків із сучками мала більше чисельне значення і зростала зі збільшенням розмірів сучків.*

Ключові слова: *деревина; колоди; сучок; навантаження вздовж волокон; деформація.*
Рис.: 3. Табл.: 1. Бібл.: 10.

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