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Methods for determining the critical deformations of wood with various moisture content

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Abstract. During construction of bridges, the possibility of flooding periods should be considered. Therefore, it is necessary to understand the degree of possible deformation of wooden structures and calculate the limit of their plasticity and elasticity at different values of moisture content. Thus, the purpose of study is to find the method for determining the relative critical deformations of wood with different moisture content and analyse the dynamics of their change. Problems of a deformable solid material were investigated by the analysis of a model of complete deformation diagram "stress σ_c – deformation u_c", methods of mathematical statistics, and systematic analysis of experimental results. This study allowed formulating the method for determining the relative critical deformations of solid wood at different moisture levels by axial compression along the fibres of experimental samples. Based on the experiment results, the

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formula for determining the relative critical deformations of solid wood with different moisture was proposed. The dynamics of changes in critical relative deformations at different moisture, and its elastic and plastic components were presented. It was found that in case of drying wood from 30 to 12%, the plastic component of relative critical deformations decreases and the elastic one, on the contrary, increases. The findings can be used in the deformation calculation methodology for wooden elements and structures of bridges, hydraulic structures, buildings, taking into account the changes in the moisture content of the material

Keywords: moisture content; "stress-strain" curve; compression along the fibres; modulus of elasticity; ultimate strength

INTRODUCTION

The load-bearing elements of bridge crossings, road and railway wooden bridges across rivers are affected by various influences, such as dynamic loads, seismic oscillations, and floods. Some load-bearing elements of such transport facilities are completely or partially in the water. Under such conditions, the elements and structures of bridges can reach stresses and strains that can be close to critical ones or exceed them. Thus, the study of hardwood and coniferous wood material under maximum stress, especially when the wood constantly changes its moisture content, for example, during floods, is of great interest.

Wood is one of the main raw materials in the world and will remain it for many years (Kulman *et al.*, 2019; Rudavska *et al.*, 2020; Pinchevska *et al.*, 2019). It is used in many sectors of the world economy, including the construction and renovation of bridges and overpasses (Kulman *et al.*, 2021; Gomon *et al.*, 2022, Sobczak-Piąstka *et al.*, 2022), transport facilities, railway, hydrotechnical and mining buildings, and in other sectors of the economy (Zhou *et al.*, 2018; Rudavska *et al.*, 2018; Bosak *et al.*, 2021).

Wood of deciduous and coniferous species of different moisture has been studied since the middle of the last century. Usually, researchers investigated the strength of wood with different moisture content (Kulman *et al.*,2020). Vasic & Stanzl-Tschegg (2007) revealed distinct changes in wood fracture behaviour as a function of moisture content. But these studies do not contain all important characteristics such as deformation parameters, which are also very important. The paper by Zhou *et al.* (2018) described deformation diagrams of bamboo wood and determined critical deformations at a standard moisture content of 12%. Da Silva & Kyriakides (2007) analysed the critical deformations of balsa wood in a similar way.

Since wood works in the elastic-plastic stage, it is necessary to consider not only the elastic stage, but in a complex with the plastic component. Chen Huang *et al.* (2020), Fothe (2021), Jin-Kyu Song *et al.* (2007) described characteristics of wood under compression and mathematical modelling of the stress-strain curve of wood. These studies in general showed method for determining yield point between elastic and plastic zone. The modulus of elasticity (MoE) decreased during increasing fixation time by applied compression level. Chen Huang *et al.* (2020) Báder and Németh (2018, 2019) also determined the relationship between compressive stress change during fixation, shortening and some mechanical properties. In addition, the researchers calculated the bending modulus of elasticity (MoE). For plastic characteristics, the main research is aimed only at determining the standard moisture content at which wood will retain the shape obtained during deformation. Thygesen *et al.* (2010), Báder and Németh (2017) analysed the influence of different moisture content on other physical and mechanical properties of wood. Huang *et al.* (2006) showed the influence of moisture content on the mechanical properties of wood-based composites. But these investigations were made for standard moisture content under standard conditions.

T*he purpose of the study* was to find the method for determining the relative critical deformations of wood with different moisture content experimentally and theoretically, including elastic and plastic components, and determine the dynamics of their change.

MATERIALS AND METHODS

Bridges and overpasses are usually made of hardwood and softwood material. Thus, such species were chosen for the experiment. A set of samples of 1 grade of solid wood with structural dimensions of different species in the form of rectangular prisms with a cross-section of 30x30x120 mm aged 60±5 years were taken (Fig. 1). These dimensions of the prisms allow considering the micro- and macrostructure of the wood and ensuring the absence of friction between the press plate and the end face of the sample. Therefore, the following wood species were selected for testing: birch, alder, ash, larch, pine, spruce. Samples of the trees such as pine and spruce were grown in the forests of Rivne Oblast (Ukraine); birch, alder, ash – in Volyn Oblast (Ukraine); larch was grown in the forests of Ivano-Frankivsk Oblast (Ukraine).

ASTM D 143-14 (2014), DSTU EN 380-2008 (2008), and DSTU 3129: 2015 (2015) suggest using a tree with a straight trunk and a small number of branches. This allowed reducing a number of samples with a lot of knots of wood and increasing the parallelism of the fibres. Trees were transported to carpentry shops by the trunks. There trees were cut into bars. The received elements were marked.

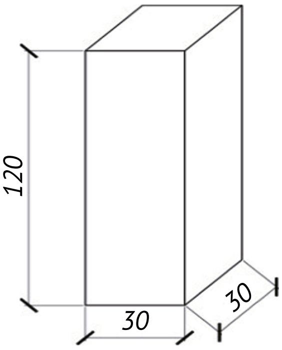


***Figure 1**. Geometric dimensions of solid wood samples*

***Source:** Yasniy et al. (2022), Varenik et al. (2019)*

The wood with moisture content of 30%, 21%, 12% was taken for experiment. DBN B.2.6-161:2017 (2017), Eurocode 5 (2004), DSTU EN 380-2008 (2018) suggest using wood samples that were pre-dried in the laboratory to an average moisture of 30±1% at the temperature of 20°C and moisture content of about 65% and in special drying chambers to moisture of 21±1% and 12±1. The moisture content was controlled using a moisture meter MD-814 (Fig. 2). Samples were cut from pre-prepared long bars. Each of the obtained samples, as required, was without visible defects. The prism samples were rejected if they not met this condition (Fig. 2).

A plan for conducting experimental research was developed in accordance with current regulatory documents. It is given in Table 1.

***Figure 2**. Moisture meter MD-814*

***Table 1**. The data of experimental studies of solid wood of hardwood and softwood*

No.	Wood species	Moisture content, %	Age, years	Deformation speed mm/min	Number of samples, pieces
1	Birch	30	60	1.5	6
2	Birch	21	60	1.5	6
3	Birch	12	60	1.5	9
4	Alder	30	60	1.5	6
5	Alder	21	60	1.5	6
6	Alder	12	60	1.5	9
7	Ash	30	60	1.5	6
8	Ash	21	60	1.5	6
9	Ash	12	60	1.5	9
10	Larch	30	60	1.5	6
11	Larch	21	60	1.5	6
12	Larch	12	60	1.5	9
13	Pine	30	60	1.5	6
14	Pine	21	60	1.5	6
15	Pine	12	60	1.5	9
16	Spruce	30	60	1.5	6
17	Spruce	21	60	1.5	6
18	Spruce	12	60	1.5	9

***Source:** compiled by the authors*

Total number of studied samples was 126 pieces. Yasniy *et al.* (2022); Dvorkin *et al.* (2021); Reiterer *et al.* (2002) performed the testing of wood samples and composite materials under the rigid regime of application with the single short-term load on a universal modern servo-hydraulic test machine STM-100 (Fig. 3). Such machine was used in this experimental study. The deformation rate for all investigated prisms was 1.5 mm/min (Nilsson & Johansson, 2019; Huč *et al.*, 2018; Zakic, 1974). The samples were tested by axial compression along the fibres untill their complete destruction (Rabko *et al.*, 2021; Pysarenko, 1988; Gomon *et al.*, 2022). Figure 4 shows the character of the destruction of the samples.

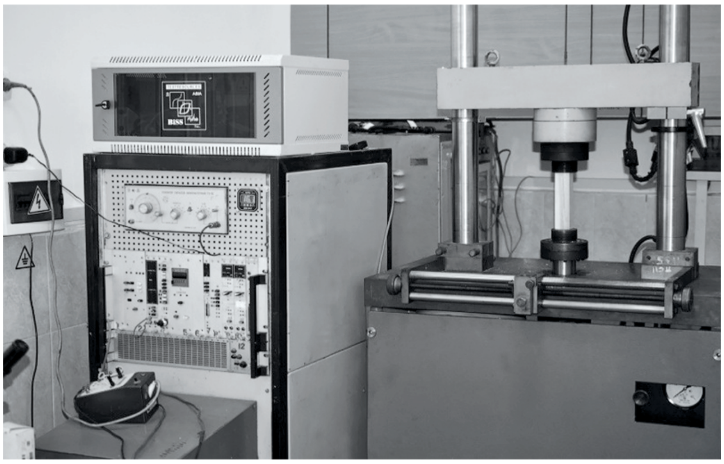


Figure 3*. Servo-hydraulic testing machine STM-100*

Figure 4*. Fracture of a pine wood sample at the moisture content of 21%*
Source: *compiled by the authors*

The given technique allows conducting out experimental studies of deformable properties at different moisture content levels with high accuracy of measurements.

RESULTS AND DISCUSSION

The average complete diagrams of hardwood and softwood fracture 'stress-strain' at moisture content of 30% (Fig. 5a, 6a), 21% (Fig. 5b, 6b) and 12% (Fig. 5c) were constructed based on the conducted experimental research.

The average relative critical deformations of wood (upper point of the diagrams) from the obtained diagrams (Fig. 5a, Fig. 5b, Fig. 5c, Fig. 6a, Fig. 6b, Fig. 6c) were determined. It corresponds to the maximum stresses. Therefore, the values of relative critical deformations uc,0,d,exp of all studied wood species were determined (Fig. 7).

It was found that deformable parameters were reduced by drying wood from 30 to 12%. The dynamics of changes the relative critical deformations were as follows (Fig. 7): for birch prisms it decreased by 19%, alder – by 21%, ash – by 16%; larch – by 18%; pine – by 19%; spruce – by 22%.

Yasniy *et al.* (2022) found that the determination of relative critical deformations of hardwood and softwood uc,0,d at different moisture levels corresponds to the maximum stresses fc,0,d of this material under short-term axial compression loading along the fibres. Such results were obtained in this experimental study and are shown in Figure 8.

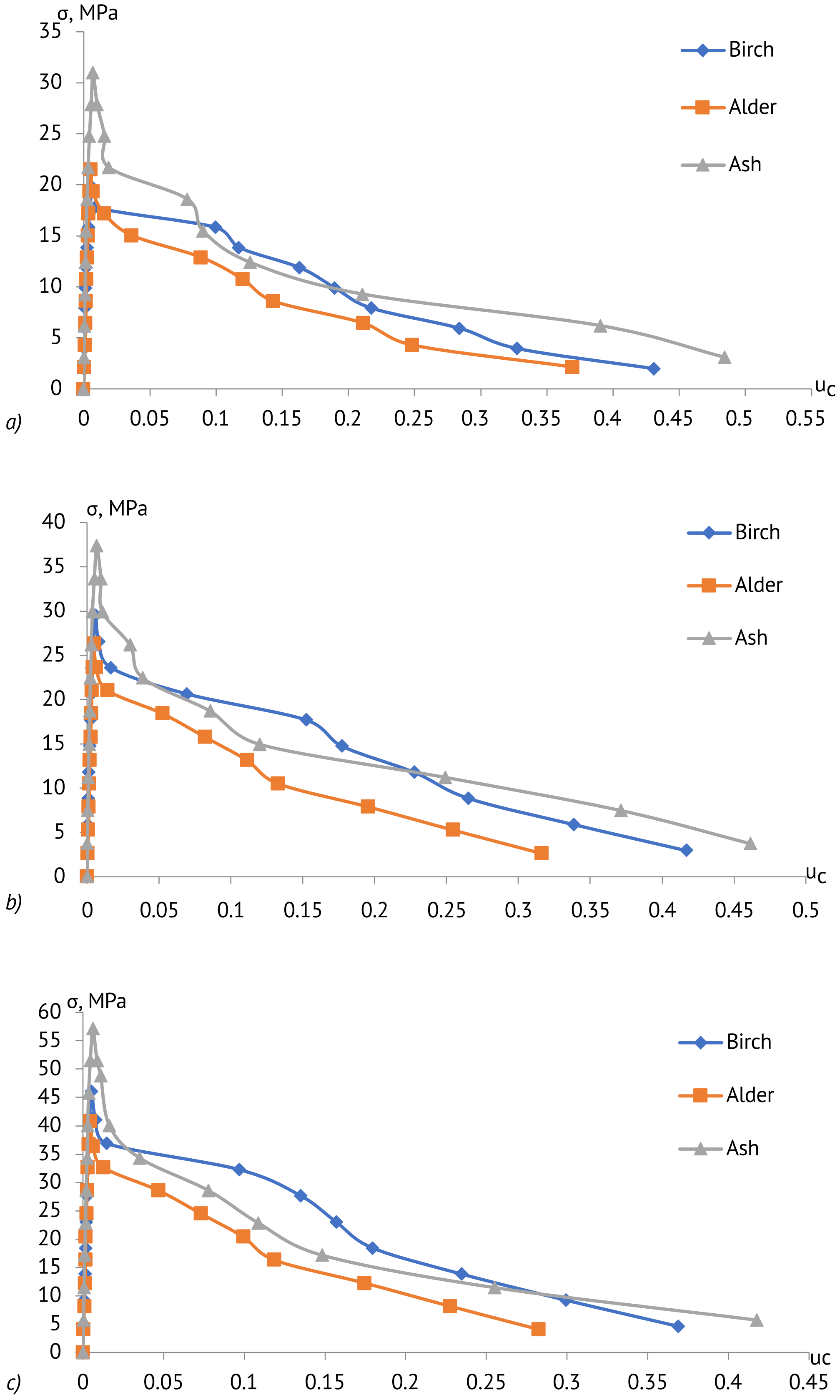


***Figure 5**. Complete diagrams of deformation of 60-years-old aged solid hardwood at moisture content: a) 30%; b) 21%; c) 12%*

***Source:** compiled by the authors*

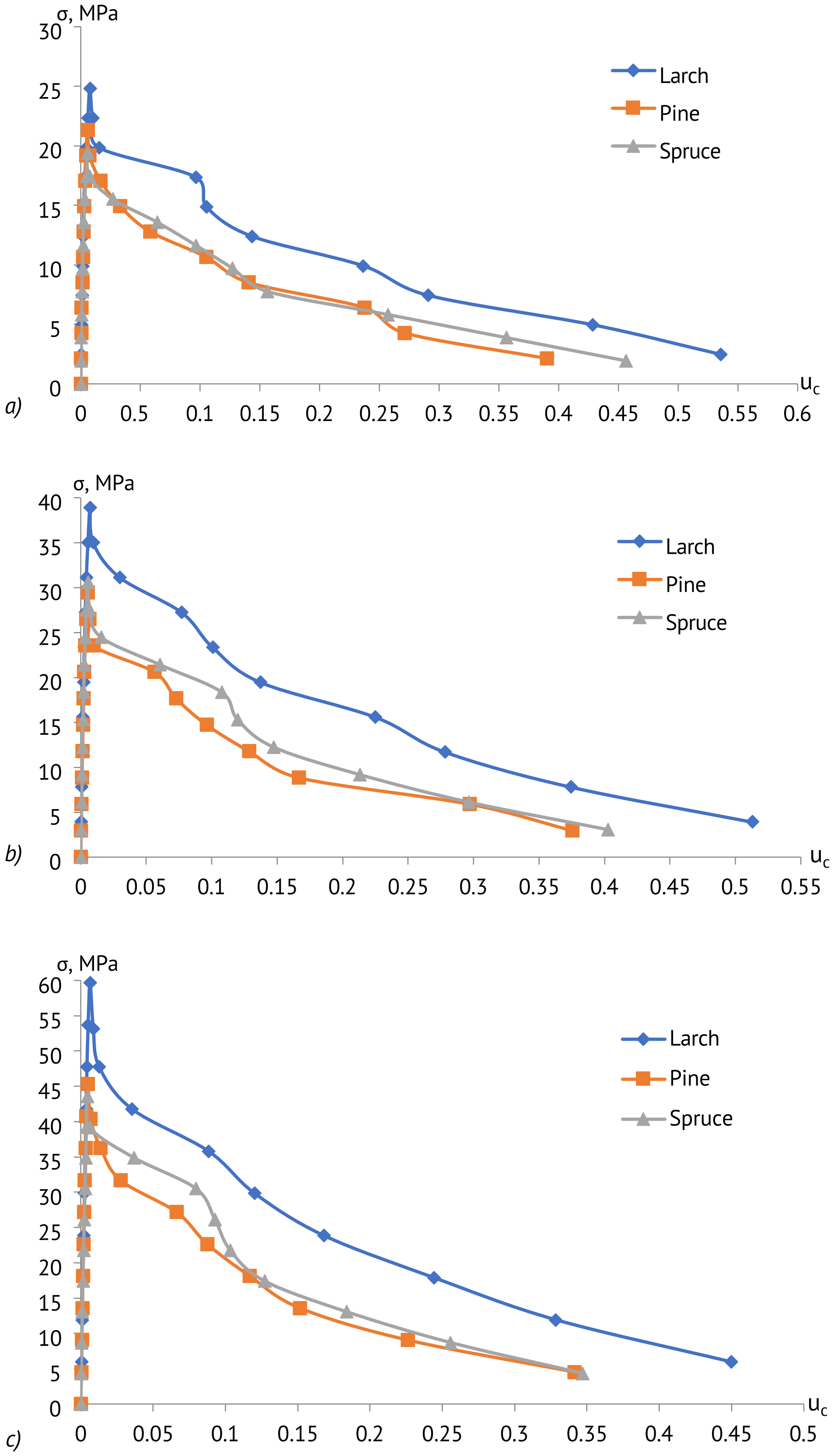
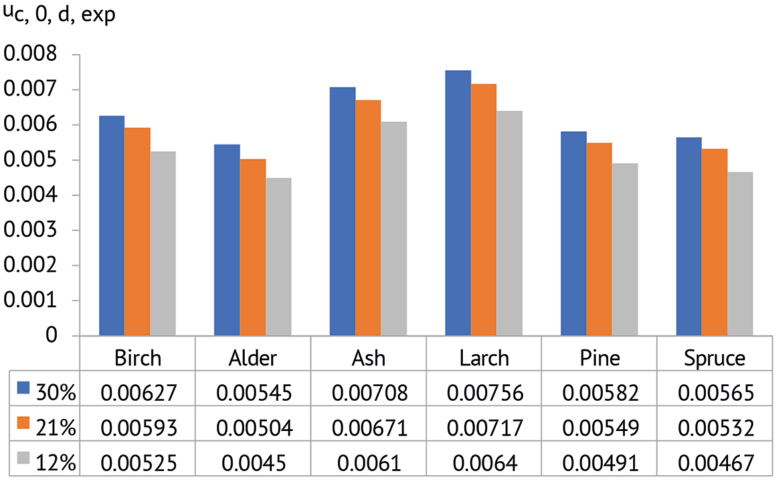


***Figure 6**. Complete diagrams of deformation of 60-years-old aged softwood at moisture content: a) 0%; b) 21%; c) 12% (obtained from our experimental study by S. Homon et al.)*

***Source:** compiled by the authors*



	Birch	Alder	Ash	Larch	Pine	Spruce
🟦 30%	0.00627	0.00545	0.00708	0.00756	0.00582	0.00565
🟧 21%	0.00593	0.00504	0.00671	0.00717	0.00549	0.00532
⬜ 12%	0.00525	0.0045	0.0061	0.0064	0.00491	0.00467

Figure 7*. Dynamics of changes the experimental relative critical deformations of hardwood and softwood at various moisture content (obtained from experimental study by S. Homon et al.)*

Source: *compiled by the authors*

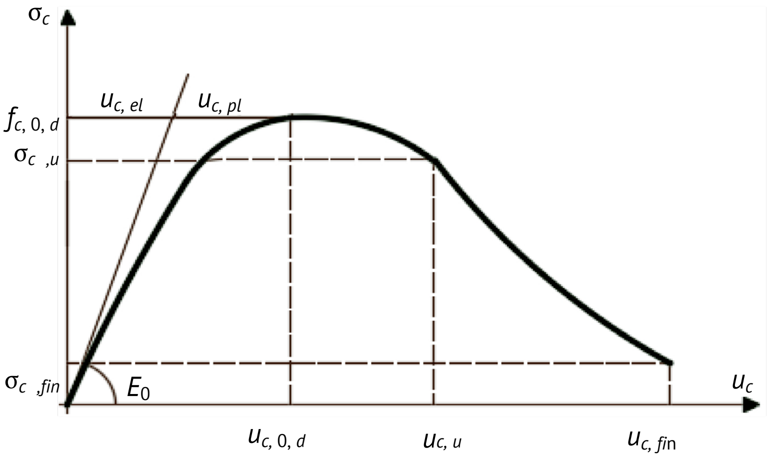


Figure 8*. Complete diagram of deformation*

Note: *ʻstress σ_c – deformation u_c' of wood by axial compression along the fibres where: σ_c – stress of wood by axial compression along the fibres; u_c – relative deformations of wood by axial compression along the fibres; $f_{c,0,d}$ – maximum wood stresses; $u_{c,0,d}$ – relative critical deformations of wood corresponding to maximum stresses; $u_{c,el}$ – elastic component of relative critical deformations; $u_{c,pl}$ – plastic component of relative critical deformations; $u_{c,u}$ – relative limit deformations of wood; $\sigma_{c,u}$ – stresses corresponding to the limit deformations; $u_{c,fin}$ – relative residual deformations of wood; $\sigma_{c,u}$ – stresses corresponding to the relative residual deformations of wood; E_0 – initial modulus of elasticity of wood*

Source: *compiled by the authors*

Zhou *et al.* (2018); Da Silva *et al.* (2007); Varenik *et al.* (2019) used a model of the complete deformation diagram ʻstress σ_c – deformation u_c' for wood operation at standard moisture of 12%. Yasniy *et al.* (2022) modified this model. Moreover, complete deformation diagram ʻstress σ_c – deformation uc' was obtained in this study (Fig. 8).

Then critical theoretical deformations were determined. The relative critical deformations were proposed to be determined by equation (1), distinguishing between elastic and plastic components

$$u_{c,0,d}=u_{c,el}+u_{c,pl}, \tag{1}$$

where $u_{c,el}$ – relative elastic deformation of solid wood; $u_{c,pl}$ – relative plastic deformation of solid wood.

By used experimental studies, equation (1) can be rewritten as

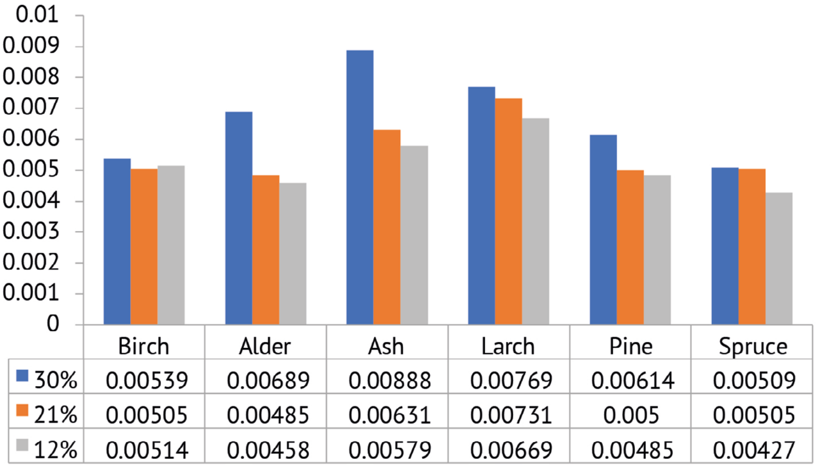
$$u_{c,0,d}=f_{c,0,d}/E_0+c_1\cdot f^2_{c,0,d}, \tag{2}$$

where c_1 – coefficient which depends on the moisture and the age of solid wood.

The relative critical deformations of solid wood of all studied species were determined by equation (2) at a moisture content of 30, 21, and 12%, respectively (Fig. 9), and separately elastic (Fig. 10) and plastic

components (Fig. 11). The coefficient c_1 for any hardwood and softwood was: – 30% – c_1=8.70·10^{-6} (MPa)$^{-2}$;
– 21% – c_1=2.69·10^{-6} (MPa)$^{-2}$;
– 12% – c_1=6.55·10^{-6} (MPa)$^{-2}$;

The maximum wood stresses (ultimate strength) $f_{c,0,d}$ were set as in Fig. 5a, 5b, 5c, 6a, 6b, 6c (Table 2). Yasniy *et al.* (2022) determined the initial modulus of elasticity of wood E_0.



	Birch	Alder	Ash	Larch	Pine	Spruce
🟦 30%	0.00539	0.00689	0.00888	0.00769	0.00614	0.00509
🟧 21%	0.00505	0.00485	0.00631	0.00731	0.005	0.00505
⬜ 12%	0.00514	0.00458	0.00579	0.00669	0.00485	0.00427

Figure 9*. Dynamics of changes the plastic component of relative critical deformations of hardwood and softwood at various moisture content level determined by equation (2)*

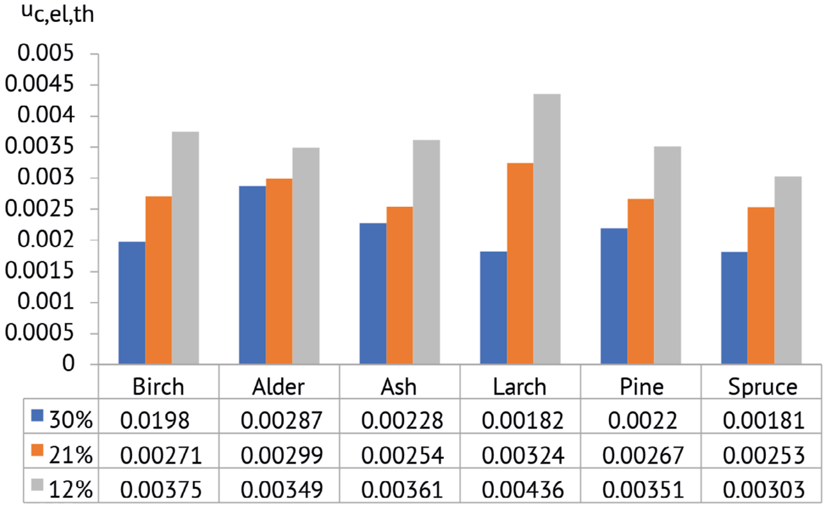
Source: *compiled by the authors*

Table 2*. Values of relative critical deformations of wood at different moisture content determined experimentally using equation (2)* $u_{c,0,d,th}$

No.	Wood species	$f_{c.0.d}$, MPa	E_0, MPa	$u_{c.0.d.exp}$	$u_{c.el.th}$	$u_{c.pl.th}$	$u_{c.0.d.th}$
			Moisture content 30 %				
1	Birch	19.8	10.000	0.00627	0.00198	0.00341	0.00539
2	Alder	21.5	7.500	0.00545	0.00287	0.00402	0.00689
3	Ash	31.0	13.600	0.00708	0.00228	0.00660	0.00888
4	Larch	24.8	10.600	0.00756	0.00182	0.00587	0.00769
5	Pine	21.3	9.700	0.00582	0.00220	0.00394	0.00614
6	Spruce	19.4	10.700	0.00565	0.00181	0.00328	0.00509
			Moisture content 21 %				
7	Birch	29.5	10.900	0.00593	0.00271	0.00234	0.00505
8	Alder	26.3	8.800	0.00504	0.00299	0.00186	0.00485
9	Ash	37.4	14.700	0.00671	0.00254	0.00377	0.00631
10	Larch	38.9	12.000	0.00717	0.00324	0.00407	0.00731
11	Pine	29.4	11.000	0.00549	0.00267	0.00233	0.00500
12	Spruce	30.6	12.100	0.00532	0.00253	0.00252	0.00505
			Moisture content 12 %				
13	Birch	46.1	12.300	0.00525	0.00375	0.00139	0.00514
14	Alder	40.8	11.700	0.00450	0.00349	0.00109	0.00458
15	Ash	57.7	16.000	0.00610	0.00361	0.00218	0.00579
16	Larch	59.7	13.700	0.00641	0.00436	0.00233	0.00669
17	Pine	45.3	12.900	0.00515	0.00351	0.00134	0.00485
18	Spruce	43.6	14.400	0.00467	0.00303	0.00124	0.00427

Source: *compiled by the authors*

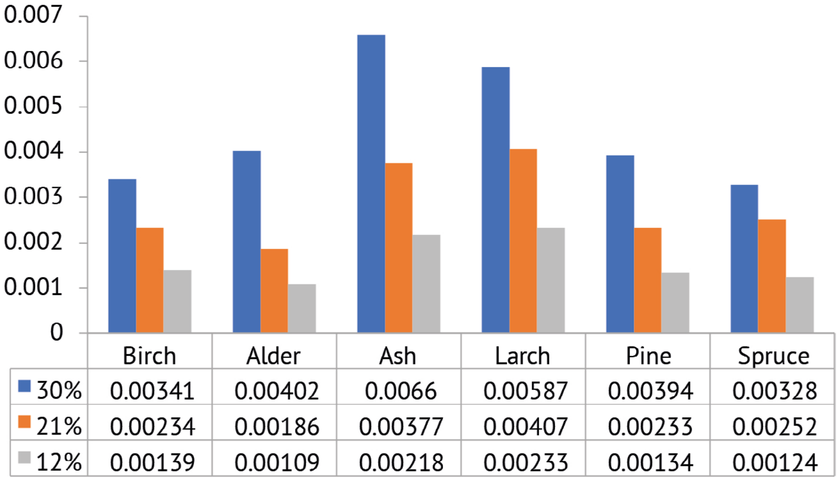
The critical deformations of solid wood of all studied species at the moisture content of 30 to 12% according to experimental studies is shown in Figure 9 and Table 2. This parameter was determined by equation (2). Results showed that critical deformations decreased only on a slightly different interval. Moreover, equation (2) determines the elastic and plastic components of critical relative deformations at different moisture content. According to it, values of these parameters presented in Figure 10 and Figure 11 were obtained.



	Birch	Alder	Ash	Larch	Pine	Spruce
🟦 30%	0.0198	0.00287	0.00228	0.00182	0.0022	0.00181
🟧 21%	0.00271	0.00299	0.00254	0.00324	0.00267	0.00253
⬜ 12%	0.00375	0.00349	0.00361	0.00436	0.00351	0.00303

***Figure 10**. Dynamics of changes the elastic component of relative critical deformations of hardwood and softwood at various moisture content level determined by equation (2)*

***Source:** compiled by the authors*



	Birch	Alder	Ash	Larch	Pine	Spruce
🟦 30%	0.00341	0.00402	0.0066	0.00587	0.00394	0.00328
🟧 21%	0.00234	0.00186	0.00377	0.00407	0.00233	0.00252
⬜ 12%	0.00139	0.00109	0.00218	0.00233	0.00134	0.00124

***Figure 11**. Dynamics of changes the plastic component of relative critical deformations of hardwood and softwood at various moisture content level determined by equation (2)*

***Source:** compiled by the authors*

The elastic component of relative critical deformations increases during decreasing moisture, and plastic one – vice versa, according to Figure 10, Figure 11, and Table 2. At the moisture content of 21%, they are very close in value.

Therefore, a methodology for determining critical deformations of wood with different moisture content, which includes elastic and plastic components, was proposed. It gives a good convergence with the experimental values (Table 2). Deviation of experimental values of critical deformations with theoretical ones according to the equation (3) for solid hardwood and softwood at moisture 30% is shown in Figure 12a and at moisture 21% is shown in Figure 12b.

Deviation of experimental values of critical deformations with calculated by equation (4) values for the same experiment data is shown in Figure 13.

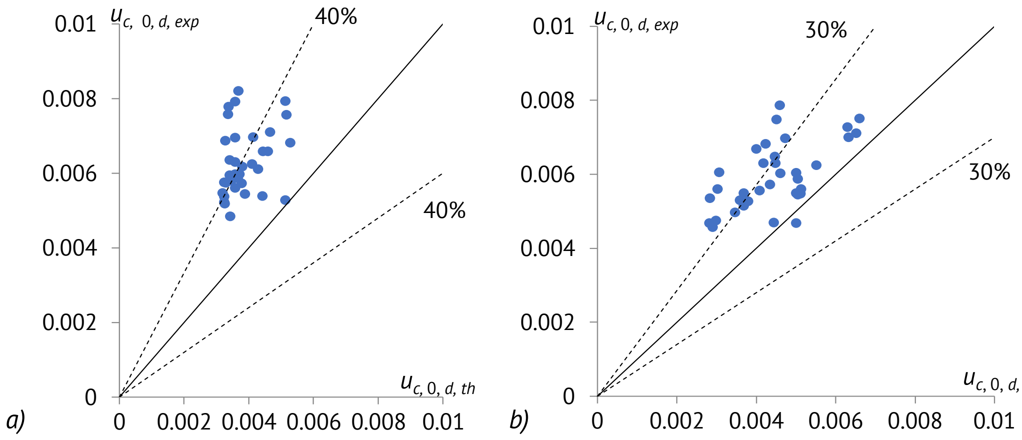


***Figure 12**. Deviation of experimental values of critical deformations with theoretical ones according to the equation (3) for solid hardwood and softwood at moisture content: a) 30%; b) 21%*

***Source:** compiled by the authors*

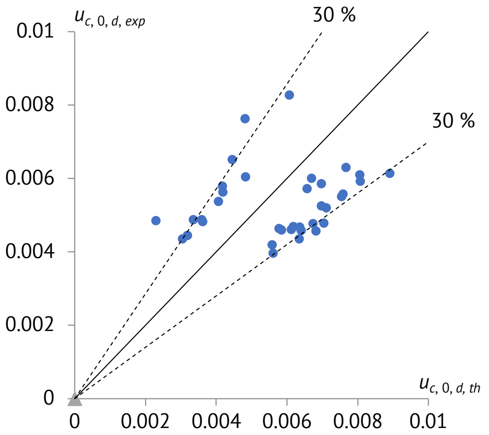


***Figure 13**. Deviation of experimental values of critical deformations with theoretical ones according to the equation (4) for solid hardwood and softwood at moisture content of 21%*

***Source:** compiled by the authors*

The convergence of experimental and theoretical relative critical deformations determined by equation (2), respectively, at the moisture of 30% is shown in Figure 14a and at the moisture of 21% – in Figure 14b. Convergence of results is achieved within 20%. Yasniy *et al.* (2022) obtained the results at standard moisture content.

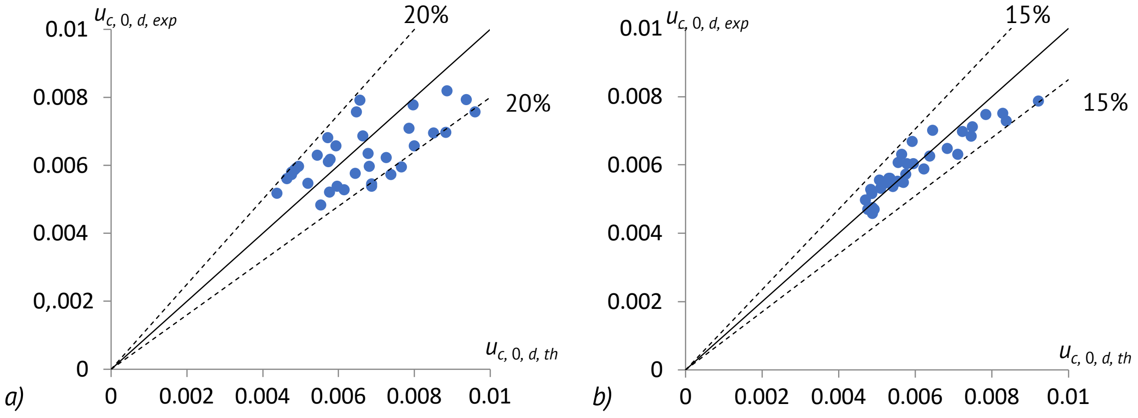


***Figure 14**. Deviation of experimental values of critical deformations with theoretical ones according to the equation (2) for solid hardwood and softwood at moisture content: a) 30%; b) 21%*

***Source:** compiled by the authors*

The calculation of critical deformation values for solid hardwood and softwood at 30% moisture content using equation (3) shows that it is almost 40%. But such the deviation with equation (2) that is proposed in this study is less than 20%. In addition, there is a huge range of deviation experimental values with theoretical obtained by equations (3) and (4) for some separate experiments that can be almost 50% and to be closed to experiment value with deviation less than 5%. Almost the same results were obtained for study wood at moisture content of 21%. Deviation of experimental values of critical deformations with obtained by equations (3) and (4) are still almost 30%, and using equation (2) – less than 15%. Therefore, the obtained theoretical equation (2) provides more accuracy of calculation of the critical deformations compared to equation (3) or equation (4).

Popescu *et al.* (2003) proposed the methodology for determining the critical deformations of wood of different moisture content. The researchers conducted experimental studies of pine wood with a section of 20x20x30 mm in axial compression along the fibres under various aggressive environments including water. The researchers obtained the results of the temporary ultimate strength and the initial modulus of elasticity of pine wood at different moisture levels. Popescu *et al.* (2003) proposed to describe the diagram "σ_c-u_c" (Fig. 8) by a second degree polynomial. The researchers also pointed out that this diagram had non-linear characteristic. A formula for determining the value of critical deformations of wood at different moisture levels was proposed based on their own experiments and numerous studies by other researchers:

$$u_{c,0,d} = \left(735.825 \cdot \sqrt{f_{c,0,d}} - 3.902\right) \cdot 10^{-6}. \tag{3}$$

The main drawback of the proposed formula is that it is empirical and is based on individual experimental studies. Another disadvantage is that experiments were carried out on outdated experimental facilities. Such experiments did not allow directly obtaining the critical deformations. Although the proposed equation (3) was the first formula that determined approximate value of critical deformations. Popescu *et al.* (2003) proposed a methodology for the calculation of compressed wooden elements and structures influenced by the aggressive environment based on the findings of the study. Such methodology considers the nonlinearity of the material.

Eurocode 5 (2004) also provides a methodology for determining critical deformations of wood at different moisture levels. It is based on the analysis of experimental studies of the temporary ultimate strength of wood at a standard moisture content of 12% for compression along the fibres. Critical deformations at different moisture content are determined by the coefficient K_{def}:

$$u_{c,0,d} = \frac{f_{c,0,d}}{E_0 \cdot K_{def}} \tag{4}$$

where K_{def} – coefficient of deformations that can be determined according to Eurocode 5. (2004)

This coefficient depends on the operating class of the environment. According to Eurocode 5 (2004) it can be applied to elements, materials and, constructors that have moisture content between 10 and 24%

The disadvantage of this method is that it considers only the elastic properties of wood and does not include the plastic ones. Thus, wood works according to the linear law of distribution. But this does not correspond to reality because wood at high moisture has quite significant value of plasticity. This is confirmed by the findings of this study. Another drawback is that critical deformations cannot be determined at a moisture content of more than 24%. Wood can be used only inside buildings.

S. Vasic & S. Stanzl-Tschegg, (2007) carried out experimental study with moisture content higher than 12%. The researchers constructed complete wood deformation diagrams "σ_c-u_c". The researchers showed a change in the structure as results of changing moisture content. The authors experimentally determined the critical deformations and other important mechanical characteristics of beech, oak, spruce, and pine wood at different moisture levels. The theoretical methodology of studying deformable parameters at different moisture content levels was not provided in the paper. The researchers determined only the values of the total relative deformations, but not the elastic and plastic components separately.

Varenik *et al.* (2019) proposed a methodology for determining the critical deformations of wood at different moisture content. The researchers conducted experimental studies on pine wood with a section of 30x30x120 mm by compression along the fibres under a strict test regime. Critical deformations of pine were determined experimentally. The authors also proposed to describe the "σ_c-u_c" diagram (Fig. 8) as a third degree polynomial. Moreover, they pointed out that wood works non-linearly at different moisture content levels. Critical deformations can be determined from the polynomial dependence describing the "σ_c-u_c" diagram (Fig. 8) by using the polynomial at maximum stresses coefficients. This methodology is quite complicated, because it is quite difficult to determine the coefficients of the polynomial. The study considered only pine wood. Thus, it is not clear if such methodology could be successful for another wood species.

The advantages of the proposed methodology over another analysed methodologies are the following: 1) allows determining elastic and plastic components, which is not observed in other methodologies; 2) works at moisture content from 12 to 30%; 3) critical deformations can be determined for any wood species; 4) allows determining the elastic and plastic components separately; 5) it is non-empirical and easy to calculate; 6) describes wood by a nonlinear characteristic.

CONCLUSIONS

New experimental data was obtained from the study of critical deformations of deciduous (birch, alder, ash) and coniferous (larch, pine, spruce) wood species by axial compression along the fibres. Based on it, the method of determination of relative critical deformations of solid hardwood and softwood at various moisture content levels by axial compression along fibres of bridge structures and bridge crossings was developed. The formula for determining the relative critical deformations of solid hardwood and softwood with various moisture content, which includes elastic and plastic components, was proposed.

It was found that value obtained by proposed formula had good correlation with the experimental values. The dynamics of change of critical relative deformations at different moisture content, and its components – elastic and plastic, were obtained. It was determined that drying of wood from 30 to 12% reduced its deformability: for birch prisms decreases by 1.19 times, alder – by 1.21 times, ash – by 1.16 times, larch by 1.18 times, pine – by 1.19 times, spruce – by 1.22 times. It was revealed that the plastic component of relative critical deformations decreases when drying wood from 30 to 12%, and elastic, on the contrary, increases.

It is necessary to develop methods for determination of relative limit deformations $u_{c,u}$ and relative residual deformations $u_{c,fin}$ considering the value of moisture content by axial compression along the fibres in further studies. Moreover, based on obtained experimental and theoretical data on critical deformations, a methodology for calculating wooden elements and structures that are operated under the influence of a water environment of varying intensity should be developed (elements and structures of bridges, overpasses, hydrotechnical structures, dams, structures of the mining industry and others).

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CONFLICT OF INTEREST

None.

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Методика визначення критичних деформацій деревини за різної вологості

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Анотація. Під час реконструкції та будівництва мостів слід враховувати можливість настання періодів паводків. Для цього необхідно розуміти ступінь можливих деформацій дерев'яних конструкцій, враховувати межу їх пластичності та пружності при різних значеннях вологості. Отже, метою статті є пошук методу визначення відносних критичних деформацій деревини за різного рівня вологості та аналіз динаміки їх зміни. В статті застосовувались методи дослідження проблем деформованого твердого тіла шляхом аналізу моделі повної діаграми деформування «напруження σ_c – деформація u_c», методи математичної статистики та системного аналізу експериментальних результатів. Проведені в роботі дослідження дозволили сформулювати методику визначення відносних критичних деформацій деревини листяних та хвойних порід при різному зволоженні шляхом осьового стиснення вздовж волокон експериментальних зразків. З урахуванням результатів експерименту запропоновано формулу для визначення відносних критичних деформацій суцільної деревини різної вологості. Було наведено динаміку зміни критичних відносних деформацій за різної вологості, а також її пружної та пластичної складових. З’ясовано, що запропонована формула дає хорошу збіжність з експериментальними значеннями. Встановлено, що пластична складова відносних критичних деформацій зменшується при висушуванні деревини від 30 до 12 %, а пружна, навпаки, збільшується. Результати досліджень можуть бути використані в деформаційній методиці розрахунку дерев’яних елементів і конструкцій мостів, гідротехнічних споруд, будівель з урахуванням зміни вологості матеріалу

Ключові слова: вміст вологи; діаграма «напруження-деформація»; стиснення вздовж волокон; модуль пружності; межа міцності