УДК 674.028.9.004.15:519.216.3 *Доц. Б.Я. Кишвецький, д-р техн. наук – НЛТУ України*

Оптимізація впливу вологості і температури на міцність і довговічність термопластичних клейових з'єднань деревини

Наведено методику оптимізаційної задачі та запропоновано градієнтний метод для розрахунку оптимальних показників впливу вологості та температури навколишнього середовища на міцність і довговічність термопластичних клейових з'єднань. За допомогою запропонованого методу і методики та математичного моделювання напружено-деформаційного стану з'єднань деревини, здійснено оптимізацію впливу вологості і температури навколишнього середовища на міцності та довговічність термопластичних клейових з'єднань деревини під час експлуатації. Встановлено оптимальну вологість і температуру навколишнього середовища для експлуатації термопластичних полівінілацетатних клейових з'єднань деревини.

Ключові слова: термопластичні полівінілацетатні клеї, клейове з'єднання, математична модель, оптимізація, міцність, довговічність.

UDC 674.620.168 ***Master's degree S.B. Pobereyko; assoc. prof. O.M. Petriv; prof. B.P. Pobereyko − UNFU***

DEVELOPING SOFTWARE FOR MODELLING THE STRENGTH OF BIAXIALLY STRESSED WOOD

An algorithm and the software for modelling the strength of biaxially stressed composite materials have been developed.

Keywords: algorithm, strength criterion.

Introduction. An important problem when rationalizing the selection of the criterion for the short-term strength of wood is constructing the curves of the short-term strength of biaxially stressed material according to the given strength criteria for the purpose of their verification in the particular case. Nowadays, for composite anisotropic materials, the class of which includes wood, there are more than 10 criteria of strength, namely those of R. Mises, A. K. Malmeister, K. V. Zakharov, Goldenblatt-Kopnov, E. K. Ashkenazi etc. However, the main criterion tested on wood is Ashkenazi's criterion, which does not fully reflect the strength peculiarities of materials under combined stress. According to the data in [1], this criterion adequately describes mainly the limit stress state of hardwood. It cannot be employed to define the strength of softwood.

The problem is therefore relevant. One way of solving it is analyzing the curves of strength constructed for each of the abovementioned criteria from such viewpoints: a) the strength surface in case of the combined stress state of the composite material, namely wood, in stress space should be gradual, closed, smooth and convex; b) the correlations between the strength characteristics of the composite material should satisfy the so-called Goldenblatt-Kopnov's heuristic principle according to which, if at least one constant of the material changes, the new surface of strength should be located inside or outside the initial one.

These are the crucial conditions for the verification of the existing strength criteria. If during the adaptation of some of the criteria at least one of these conditions is not satisfied, then such a criterion is unreliable and deserves no further attention.

Problem. The analysis of the existing strength criteria for biaxially stressed composite anisotropic materials has shown that their mathematical models are the implicit functions of two variables:

$$F_m(\sigma_t, \sigma_r) - F_m^* = 0, \quad (1)$$

where: σ_t , σ_r are the main components of the stress tensor; F^*_m – the threshold limit value of the function $F_m(\sigma_t , \sigma_r)$.

Therefore, the problem of constructing the curves of strength according to the given criteria of strength (1) consists in constructing the lines (contour lines) of the function of two variables.

The algorithm of constructing the contour lines of the function of two variables. In order to solve the problem, an algorithm has been suggested, the application of which involves the following steps:

- tabulating the function of two variables

$$f(\sigma_t, \sigma_r) = A\sigma_t^2 + B\sigma_t\sigma_r + C\sigma_r^2 + D\sigma_t + E\sigma_r, \quad (2)$$

- with tabulation steps $\Delta\sigma_t$ and $\Delta\sigma_r$;
- finding for the fixed values σ_t such values of argument σ_r for which the following conditions are satisfied:

$$f(\sigma_t, \sigma_r) > 0, \text{ and } f(\sigma_t, \sigma_r + \Delta\sigma_r) < 0, \quad (3)$$

$$f(\sigma_t, \sigma_r) < 0, \text{ and } f(\sigma_t, \sigma_r + \Delta\sigma_r) > 0; \quad (4)$$

- choosing from the pair of numbers σ_r and $\sigma_r + \Delta\sigma_r$ such a number for which the absolute value of function $f(\sigma_t , \sigma_r)$ is minimal;
- constructing the curves of strength by the obtained coordinates of points (σ_t , σ_r).

The results of the practical application of the algorithm and their analysis. The suggested algorithm is applied as program code in development environment Microsoft Visual Studio 2010, and the results of its practical application are shown in Fig. 1.

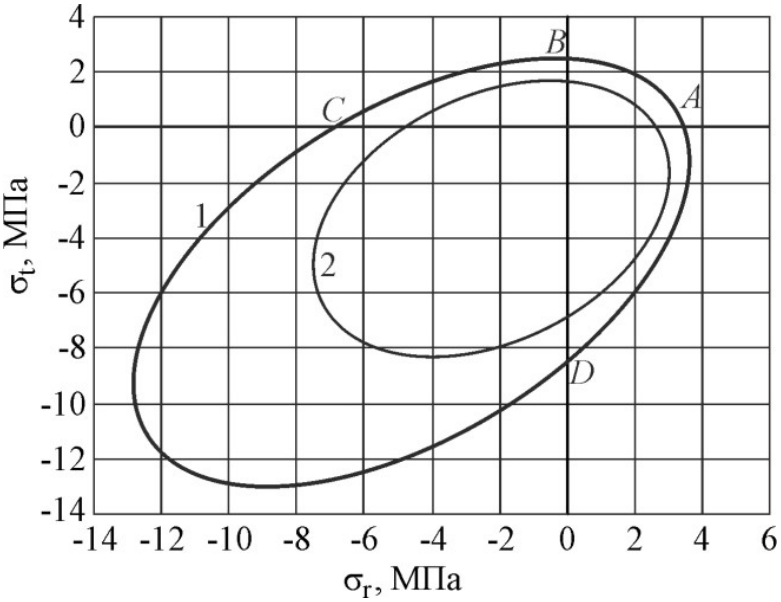

Fig. 1. The curves of the short-term strength of pine wood with temperature T=20°C, relative humidity W, and biaxial stress states in the radial-tangential plane of structural symmetry: *1 – W=12%; 2 – W=18%*

Conclusions:

1. An algorithm and the respective software for constructing the curves of strength of biaxially stressed wood have been developed.

2. Based on the analysis of the software application results, it has been shown that the strength of pine wood is adequately described by Goldenblatt-Kopnov's criterion.

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УДК 674.620.168

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Розроблення програмного забезпечення для моделювання міцності деревини з двовісним напруженим станом

Розроблено алгоритм та програмне забезпечення для моделювання міцності композитних матеріалів з двовісним напруженим станом.

Ключові слова: алгоритм, критерій міцності.

UDC 674.023.0

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PRODUCTION OF WOOD-BASED COMPOSITES MADE FROM RAPE STRAW WASTES

The article deals with the analysis of the component structure, the structure of plant material made from rape stems in terms of prospects of their use in the manufacture of particle board or other composite-based materials. It has been presented the basic technological aspects of production of wood-based composite materials using rape raw materials and some of their physical and mechanical property indicators.

Keywords: wood-based composites, particle boards, plant based raw materials, physical and mechanical properties, rape stem.

The current state of the issue. Wood is considered to be a traditional raw material for production of wood-based composites. The intensity of global deforestation and its impact on the environment has been forced manufacturers of these products to search for alternative sources of raw materials. This is mainly lignocellulosic raw materials of agricultural production, straw in particular. One of the main factors that hinder the use of straw as a raw material for the production of wood-based panels is the presence of wax with a rather complex chemical composition. The fact is that wax is not scattered throughout straw mass as it is in the case of wood but it is almost entirely spread on the surface of the stem. The formation of such a layer of adhesive coatings on the surface of the straw prevents wetting of the particle surface and impede bonding.

Research results. Equally with the use of straw as one of the most promising types of plant material for the production of wood-based composite materials (WCM) there is a stalk of rape. Rape raw is an extremely valuable oil crop but it can be also as one of the elements of resources in the manufacture of these materials.

The chemical composition of the stalks of rape is like wheat straw but they have a number of ***peculiarities*** (Table 1). It should be noted that stalks of rape are differ from the straw of different crops by their increased thickness and stiffness, and because of that fact they are not applied for traditional agricultural purposes. In contrast to the hollow stalks of rye, rape stalk axial channel is filled with a porous white parenchyma tis-