2. The developed software is created without usage of expensive software that increases its value.

3. The software SAWing_lumber operates the data that can be obtained directly in the real cutting process of lumber on blanks, which indicates the possibility of its application in a real production environment of cutting.

4. For increase of the efficiency of software SAWing_lumber it is necessary to make FES settings and compare the results with actual results of cutting.

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УДК 674.093.6:674.061.2 ***Асист. Я.В. Мацишин; доц. В.О. Маєвський; студ. А.М. Дель Ріо – НЛТУ України; доц. С.І. Білик д-р техн. наук – КНУБА***

Спеціалізоване програмне забезпечення для моделювання процесу поперечного розкрою пиломатеріалів

Розроблено спеціалізоване програмне забезпечення “SAWing_lumber” яке моделює процес поперечного розкрою пиломатеріалів на заготовки керуючись ріненням нечіткої експертної системи стосовно вибору поточної схеми розкрою. Наведено діаграму класів, описано алгоритм роботи та правила користування інтерфейсом програмного забезпечення. За допомогою програмного забезпечення змодельовано процес поперечного розкрою пиломатеріалів на заготовки. Результати моделювання підтвердили адекватність та практичну цінність програмного забезпечення.

Ключові слова: програмне забезпечення, моделювання, пиломатеріал, розкрій, заготовка, бездефектна ділянка, схема розкрою, експертна система, нечітка логіка.

UDC 674.028.9. ***Competitor R.S. Marunych – UNFU***

A STUDY ON THE ISSUE OF ADHESIVE JOINTING DURABILITY AND THE WAYS OF THE DURABILITY PREDICTION

The paper deals with the analysis of glueing process, considers the adhesives that are used in woodworking industry. The problems associated with studying adhesive jointing durability have been examined. The main means and ways of enhancing the adhesive jointing durability are described.

Keywords: adhesive jointing, durability, adhesive, ageing process, stresses, operating conditions, prediction.

It is difficult to imagine the modern furniture making process without application of various kinds of adhesive. By way of glueing, one can obtain new forms of ware design; it is possible that different materials could be combined with wood thereby mitigating the effect of wood's natural defects. It should be remembered, however, that the woodwork item in the process of glueing must be considered as not a uniform body, but a complex structure consisting of different materials that have their own properties.

That is why the corresponding requirements are placed upon the woodwork item in terms of strength, reliability, and durability. Upgrading of the reliability and durability of furniture stock is an important task of the woodworking industry, while also being a significant scientific problem. It is well known that the durability of wood glued articles is strongly dependent on the quality of the adhesives used, glueing conditions, and the quality of the wood material. A variety of adhesives and glues are used for glueing wooden items: glutinous (bone and hide), casein, and synthetic adhesives, the last are being most widely used ones at the present state of the industry [1].

Synthetic adhesives offer a certain number of advantages over the other types of glues: they are water-resistant, fungi-resistant and make for obtaining a strong glue line. They come in various forms: solid, powder, liquid, and film (sheet). The adhesives can be dissolved in water, alcohol, emulsion [2]. The totality of operating experience of synthetic adhesives (over 80 years) shows that the glued articles give extended service as evidenced by many examples. Besides, the results from experimental investigations on the durability of wood joints glued with synthetic adhesives also point to their high degree of durability. However, the problem of glued wood durability is not still completely solved. Great difficulties emerge when generalizing the results of previous studies because there is not enough information about the adhesives being investigated, also the glueing techniques have not been adequately studied yet.

When analyzing the problem of durability, it is pertinent to define the meaning of the term "durability" as such. "Durability" is considered to mean the length of service time during which an adhesive jointing is capable of retaining the required strength, stability, and serve all necessary functions. As to the glue line, its durability is defined as the operating life under loading to the point of initial stage of destruction [3].

The study of wood adhesive jointing durability is impossible without knowledge of physical-and-mechanical, chemical properties of polymers, wood science, woodworking techniques, etc. although wood adhesive jointing is technologically simple, it is, however, rather a complex structure in terms of scientific analysis, One of the most cjmplicated tasks,when studying the adhesive jointing durability, is to find the way of evaluating the combined effect of internal stresses and the ageing process. The current approach to analyzing the mechanism of adhesive jointing failure under operating conditions involves discriminations between these two groups of factors: it is believed that, in some cases, the stability of adhesive jointing is determined by the process of ageing, at other times it is determined by internal stresses. In most cases, the laws of mechanics for polymers allow for integration of these two views to create the basis for common criteria for assessment of adhesive jointing properties. With knowledge of the fundamental tenets of the theory of strength, deformation, and mechanism of polymer failure, it is possible to gain an impression, with a high degree of accuracy, of how adhesive jointing behaves and varies over time under the action of external factors. The internal stresses and relaxation processes are of considerable importance, these are often the factors that determine the behavior of adhesive jointing during its operation. When assessing adhesive jointing durability, the effect of environmental factors such as temperature, moisture, atmospheric conditions, various kinds of radiation should by taken into account. The ageing of adhesive jointing can be caused by evaporation of the solvent, the plasticizer migration and various diffusion processes. The most contributing factors that deteriorate the properties of adhesive jointing during its service life are as follows: loads – static and dynamic; temperature and electro-magnetic fields; water, air, light; various microorganisms. The above factors may affect the adhesive jointing singly or together. In order to obtain a comprehensive idea of the adhesive jointing behavior during its service life, let consider the main methods of durability identification. The study of ageing processes is based on determining relationship between variation in mechanical strength values and duration of the experimental studies.

The study of adhesive jointing durability should also involve the notion of prediction. By prediction is meant foreseeing the degree of change in output characteristics of the adhesive jointing under certain conditions of prolonged service. The main methods of prediction can be divided into two groups: (1) the methods that do not take into consideration the action of external loads; (2) the methods involving prolonged loading. The methods of group 1 are not widely used since adhesive jointing is mainly operated under loads. The prediction for adhesive jointing that is not subjected to prolonged loading, is based on the studies involving considerable temperature and moisture differences that exceed the normal conditions of service by several times, which may eventually result in rapid loss of strength. The use of the results obtained by this method is not possible until they are correlated with the values obtained from natural ageing of adhesive jointing [4]. In predicting mechanical properties of adhesive jointing, which takes into account the action of loads, two methods (a method of computation and a physical method) are used. The method of computation allows the adhesive jointing durability to be predicted by way of estimation of the maximum stress in the glue line with regard for relaxation time, or without this, and then to compare it with the strength value obtained under conditions of standard investigation. From this standpoint, methods of computation are suitable for predicting the integrity of adhesive jointing. The physical method is based on the concepts of strength and durability of solid bodies with consideration for molecular structure of the objects under investigation. The most accessible subject for macroscopic inspection and the purpose of prediction is time – dependent strength of solid bodies based on the kinetic theory of strength. There are two kinds of prediction: approximate and accurate. The approximate prediction is made on the basis of comparison and correlation with the data for similar adhesive jointing constructions. The basis for such predictions is the application of coefficients by means of which the nature of relationship between the normal and speeded-up conditions of service is determined. The accurate prediction is impossible without knowledge of the rate of change in the adhesive jointing properties. In this case, the procedure of experimental investigation is based on the speeded-up process of ageing. The methods of approximate and accurate prediction make it possible to obtain necessary information which is relevant when creating adhesive jointing, introducing new glueing materials, developing new bonding techniques as well as introducing new methods of quality control for adhesive jointing. The methods of studying speeded-up ageing or ageing under standard conditions of service are the only way of determining adhesive jointing durability. A knowledge of methods of accurate prediction makes it possible not only to determine the durability of adhesive jointing, but also allows for taking a step forward: to control durability.

In the last few decades, radically new techniques have emerged, which allows carrying out diagnostics of constructions during the whole period of their service. Previously, designer's task was to create a construction that would have the greatest possible service life, while today they are trying to create a construction with controlled durability. This does not mean that the problem of enhancing durability is no longer topical. Resent approach to setting up this problem lies in the fact that one way of enhancing durability is how timely the damages are diagnosed. The problem of controlled durability can be considered from two points of view: ensuring trouble-free service for a certain length of time; setting up the time of performing maintenance work. The main causes of adhesive jointing may failure be as follows: formation of central crack that gradually grows and increases in size, which may lead to the adhesive damage; progressive accumulation of stresses that may result in formation of many microcracks, which, beginning with a certain point, may cause the adhesive to decompose with further breakage of the adhesive jointing as such [5].

Probable causes of defects and the probability of their impact on the durability can be divided into three groups: group 1 refers to the errors that arise when designing the constructions; group 2 is associated with the production process; group 3 is due to improper operating conditions. The factors of group 1 influence the rate of crack propagation whereas group 2 and 3 are associated with the factors causing the glue line defects. The dependence of defect formation probability on the design, technological and operating factors makes it possible to predict and prevent adhesive jointing failure. The problems in predicting should be solved step-by-step at the design stage: working out technological requirements that are to include a detailed list of operating conditions; the preparation of adhesive that is capable to meet the most part of the requirements; developing optimal glueing conditions; selection of means for controlling the materials and production process when training the technical personnel.

Once all probable problems are revealed and the ways of their timely solution are found, the probability of failure can be easily reduced to a minimum. Also, this will help reduce the probability of damage to glued constructions in case of accidental loading. The traditional methods of ensuring high durability include: proper design of the adhesive jointing; the jointing is to withstand heavy operating loads; high penetrating power and spreading of the adhesive; the use of the adhesives that are capable of restoring their original properties.

One way of ensuring high durability of adhesive jointing is strict observance of technological requirements at all, without exception, work stations. Everything, even small things, is of importance in this matter; all technological process operations are indiscriminately important in providing high quality adhesive jointing.

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УДК 674.028.9. ***Здобувач Р.С. Марунич – НЛТУ України***

Аналіз питання довговічності та способи її прогнозування

Наведено аналіз процесу склеювання, клеїв що використовуються у деревообробці. Проаналізовано проблеми, що виникають при дослідженні довговічності. Приведено основні способи впливу на довговічність клейових з'єднань.

Ключові слова: клейове з'єднання, вологість, адгезія, довговічність, прогнозування довговічності, міцність з'єднань.

UDC 674.04 ***Competitor B.M. Myakush – UNFU***

DEVELOPMENT OF THE CONDITIONS PARAMETERS OF GLUING PARQUET BOARDS WITH THERMOPLASTIC ADHESIVES

Presented in this work are the results of experimental study of gluing parquet board with thermoplastic polyvinylacetate adhesives (PVA). Gluing conditions parameters were developed for gluing three-layer parquet boards with polyvinylacetate adhesives.

Keywords: adhesive joint, parquet board, gluing conditions, polyvinylacetate adhesives, production process.

Among the main factors that affect the strength of glued wood structures is the type of adhesive used. In parquet manufacturing, urea-formaldehyde adhesives are commonly used for gluing. The main disadvantage of these adhesives are brittleness of the glue line, considerable shrinkage, low heat- and moisture-resistance [1, 2].

Obtaining environmentally-friendly parquet boards as well as wood adhesive jointing is of major importance today, this being the requirements for modern production process. It is possible to use polyvinylacetate-based thermoplastic adhesives instead of thermosetting urea-formaldehyde adhesives for gluing parquet boards. This was supported by investigations conducted at Ukrainian National Forestry University. According to the results of the investigations, these types of adhesive exhibit good adhesion properties as to wood, they form elastic glue line, they are nontoxic and can bear loads of D3 and D4 classes according to European standard DIN [5]

The use of these types of adhesive would make it possible to produce parquet boards on an environmentally sound basis as the adhesives meet the existing sanitary and technical standards; they can ensure low water absorption of the end product, the parquet boards are easy to machine after gluing and they will also have good heat and sound-insulation properties etc. To study the effect of thermoplastic PVA adhesives on the strength, a three-layer parquet board was used as a test specimen while gluing was done with thermoplastic PVA adhesives of D4 load class that have been formulated at Ukrainian National Forestry University. The direction of grain of each layer of the three-layer parquet board is at an angle of 90º to the grain of each other layers. The primary layer is the upper one which is called thin parquetry. It was made of oak wood. The thickness of the layer is 6 mm, its quality meeting standard GOST 862.3-86 [5].

The core of the parquet board was made of softwoods species – pine wood. For this purpose, strips of cross-section 26x9mm were fabricated. The allowable variation of the strips width is up to 1mm while the gap between the strips edges does not exceed 3mm. The selection of the stock was done according to GOST 2140, in so doing the size of the knots was determined by the smallest diameter. The strips of the core were laid