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EVALUATION OF THE EPOXY POLYMER COMPOSITIONS EFFECTIVENESS FOR LAMINATED TIMBER FIRE PROTECTION

It is operationally proved the effectiveness of two-component polymer composite materials based on epoxy oligomers, fillers-fire retardants and hardeners for fire protection of laminated timber Ultralam^{TM}. It has been shown that the use of these materials provides obtaining nonflammable and flame-resistant timber.

Keywords: fire protection, laminated timber, polymer epoxy composition.

Problem formulation. Innovative technologies in the field of wood-working industry allow to obtain const-ruktsionnye composite materials based on wood-prevoskho dyaschie solid wood on the physical and mechanical characteristics. In modern practice, widespread glulam beams are not limited by the size of the cross-section and length. New construction material - beams and slabs Ultralam^{TM} (Ultra-lam) - is one of the varieties of plywood received pu-bonding the sheets of veneer sheets softwood. The technology of production laminated veneer lumber and slabs Ultralam^{TM} to reduce by-negatively impact the natural defects of wood, Existing-tively increases the levels of its strength properties [1]. Beam and Plate Ultralam^{TM} produce several types depending on the direction of the fibers and layers of veneer grade specified in the relevant techni-cal conditions (Table. 1). [2]

For the manufacture of veneer used round softwood timber (pine, fir, larch) I-III grades according to GOST 946388. For bonding veneers used phenol-formaldehyde glue Hexion PF179 and PF180, providing a selection of ready-ma-the material harmful substances (phenol, formaldehyde) permitted Class E 1. Humidity emission material is in the range 8-12%. The value of the index of surface roughness beams and slabs Ultralam^{TM} GOST 7016-82 should be no more than 320 micrometers [3].

Structures made of Ultralam can significantly improve the technological and operational indicators buil-and structures due to the high strength, stability, geo-metric sizes and certified SPECIFICATIONS Cams.

Table. 1. Types of materials Ultralam^{TM}

Type of mineral	Characteristic	Application area
Ultralam R	All the layers of veneer are parallel fiber direction	Mainly in the load-bearing structures
Ultralam X	The individual layers of veneer are mutually perpendicular to the fiber direction	Support and walling
Ultralam I	The veneer sheets can have both parallel and perpendicular directions of the fibers	Walling, including blanks for the door and furniture produc Islands and others.

Using Ultralam^{TM} allows to produce designs for the construction of buildings with spans of 36m or more. Construction of plywood lighter than steel by 16 times, which significantly reduces the cost of foundations and rental of construction equipment.

Production Technology Ultralam^{TM}, developed in the US in the 30s and known under the brand name LVL - one of the most rational-governmental ways of wood processing, which allows to save the forest resources of the planet, since it is a non-waste. Thanks svom pre-play assets, high physical and technical characteristics and uni-cal technological process of application Ultralam^{TM} covers a very wide range of building directions: the production of load-bearing structures for civil const-kinds of structures for various purposes, elements of buildings and structures, ma mated architectural forms , decorative and joinery et al. [4].

As a result of comprehensive research laminated veneer lumber type Ultralam^{TM} found that constructions of this ma-the material have not only increased strength compared to timber and plywood (Table. 2) by 30-50%, but also provide increased-ing biological and chemical resistance design [5].

A significant drawback of these materials is their high flammability. According to [2] Ultralam^{TM} refers to the following group-storage fire hazard: G4 - silnogoryuchie materials B2 - moderately combustible materials WP3 - moderately spreading flames materials D3 - high smoke-forming ability, T3 - high-koopasnye toxicity of products of combustion materials.

To improve the fire-technical properties as well as to expand the scope of plywood UltralamTM req-bob processing flame retardants.

Analysis of recent achievements. For many years, check Studies are for the development of flame retardants for Drewes-us and today there is a huge amount of otechest-governmental and foreign materials in the water and an organic basis, the use of which provides also protection against many Agres-sive factors [6]. Selection of flame retardants for laminated nucleus-Vecino complicated by the fact that its technology is included gluing wood elements polymeric adhesives of various hi-nomic nature.

Table. 2. Comparative characteristics of building materials from wood

Kind of stress state	Wood (solid, glued)	Plywood	Ultralam™
Bending along fiber, MPa when loading edge when loading plates	10-15 -	16-33 -	19-27 22-35
Compression along the grain, MPa	10-15	12-28	19-25
Compression across the grain, MPa	1,8	8-23	4-7
Chipping along the grain of the glue line, MPa	2,1	0,8-1,8	2,6
Chipping across the grain of the glue line, MPa	0,6-1	0,0-1,8	1,1
The modulus of elasticity along the grain, MPa	10 000	9 000-12 000	10 800-15 600

There [7] that the presence of the polymer adhesive layer leads to a change in the structure of wood and its properties that must be considered when choosing a flame retardant. Co-phenol-formaldehyde glue becoming used in Ultralam™, no whisker-Teutsch to water and aqueous solutions of [7], which excludes the use of non-advocacy Og water based. Actively used for fire protection of solid wood impregnated with solutions of flame retardants is difficult because the same thanks to the adhesive layer. Taking into account all these factors greatly narrows the range of tools that can be used for fire protection Xia plywood Ultralam™. Perspective on-board is the use of two-component polymer composite materials based on epoxy oligomers on-fillers, flame retardants and curatives.

Statement of the problem and its solution. The objective of the study was to la evaluate the efficiency of polymer-component epoxy composite materials for fire protection laminated wood Ultralam™. For sample processing Ultralam™ used two-component materials (coatings) on the basis of epoxy oligomers and cure the-lei, containing the composition of the mixture of fillers, flame retardants, which are in the process of exposure to high temperatures form a coked-Xia foamy carbon layer: flame retardant-basalt (composition ABCH) and flame retardant -graph (Composition Graphite) [8, 9]. The resulting layer creates a heat shield and increases the warm-Vecino nucleus to the decomposition temperature. In accordance with [10] The samples of solid wood with a thickness of said coating is 0.5-1 mm from a worn-I-II groups retardant efficiency.

Samples of laminated wood Ultralam™, treated with two V-rows of flame retardants, were tested in the experiments, experimental setup for thermogravimetric studies make it possible to explore lyayuschey-combustible and fire-retardant properties of materials and mate-rials [11]. For comparative evaluation used unsheltered plywood Ultralam™. During the experiments were conducted, were observing the behavior patterns when exposed to open og nya, measured the dynamics of mass loss of the sample and the temperature of the exhaust gases. Type of samples before and after the test is shown in Fig. 1.

а) б)

Fig. 1. Samples of plywood Ultralam^{TM}, treated with flame retardants: a - before the test, b - after the test

Fig. 2.3 provides a comparative assessment of changes in exhaust gas temperature and mass loss of samples from the time probationer, tany unsheltered Ultralam^{TM} and processed covering mi ABCH and Graphite.

As seen from the dependencies of all the samples Ultralam^{TM} for 60-85s, a sharp increase in the temperature of exhaust gases before 230 °C. Flue gas temperature in the test sample unprotected Ultralam^{TM} growing rapidly and reaches 440 °C after 230c. Then, the temperature drops, flame retardant post-foam stops and the sample begins to smolder.

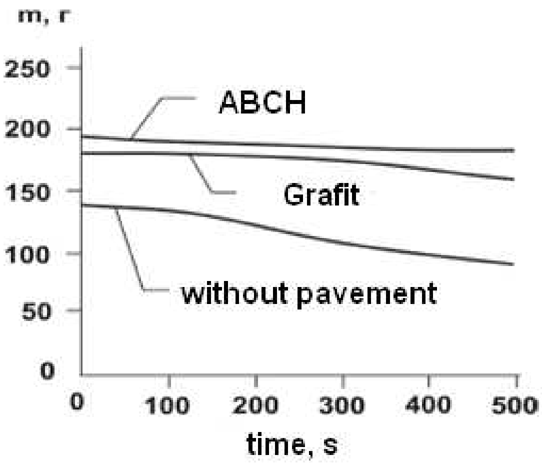

Fig. 2. Change the flue gas temperature in the test sample Ultralam^{TM}

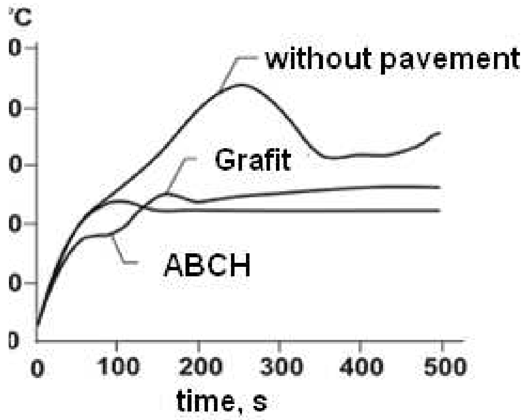

Fig. 3. The change in mass of samples during Ultralam^{TM} of the trial

The treated samples maximum flue gas temperature is not more than 250 ^{o}C and during the experiment (up to 500c) is not increasing. This temperature does not exceed the temperature of the beginning of the process of decomposition of wood macromolecules (265 ^{o}C), accompanied by the release of CO, CH_4 and other gases [6], which ensures the integrity of the coating observed-giving period. The marked difference in the nature of curves of temperature change is explained as follows. When test specimens with the fire-protecting coatings from the onset of exposure to fire at the bottom of hour-minute sample begins to form expanded foam layer (tol-ness it ranges from 20 to 50 mm), which prevents the propagation-pared flame surface, whereby the temperature to end of test is held constant.

Visible benefits application of fire protective coatings based on epoxy oligomers are shown in Fig. 3. The weight loss for unprotected Ultralam^{TM} sample is 36%, which, I agree, but [12] corresponds to Group III of fire protection. Sample Ultralam^{TM}, on-operated fire-retardant coating on the basis of basalt-retardant during the test, lost 6% of its mass, respectively, exists a group I - funds provides a slow-my-wood. Sample Ultralam^{TM}, treated coating on the basis of a-retardant-graphite (graphite) refers to Group II - funds provides a flame-resistant wood (sweat convent weight is 10%).

Conclusions. Analysis of the results of the experiment showed that the use of two-component polymer composite materials based on epoxy oligomers, flame retardants and cure-teley for fire protection laminated wood Ultralam^{TM} delivers a luchenie slow-coated ABCH (I group) and trudnovos-plamenyaemoy coated graphite (II group) timber. Further research should be devoted to assessing the impact of fire retardant polymeric materials on the performance of plywood Ultralam^{TM}, and the development of technological parameters of applying them to the surface.

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