INVESTIGATION ON GLUING LARCH WOOD BY MODIFIED GLUE

Kirill Chauzov, GalinaVarankina, Aleksander Tambi
Saint- Petersburg Forestry University , Saint-Petersburg, Russian Federation
tschauzovkirill@mail.ru, varagalina@yandex.ru, a_tambi@mail.ru

Keywords: larch, wetting, density, gluing, glulam, modification, natural filler

ABSTRACT:

The paper presents the studyconcerning theinfluence of the density of larch woodon the strength of adhesive joints and its ability to wet modified adhesive. Physical and mechanical properties of adhesive joints are investigated based on a modified adhesive.
Ascertainment of the possibility of using the modified adhesive melamine-urea-formaldehyde reduces production costs and improves the water resistance of adhesive joints.

1. INTRODUCTION

The main tree species in Russian Federation are larch (Larix), pine (Pinus), fir (Picea), birch (Betula) and aspen (Populus tremula). They cover about 90% of the forest area, including coniferous tree species group – 68,4%, hardwood – 2,4%, softwood – 19,4% [1]. Stands of larch occupied 35,8%, pine – 15,6%, spruce – 10,1%, birch – 15,0% of the area wooded land.
Larch (Larix) is most prevalent wood species in the Russian Federation. Of greatest economic importance are the two species Daurian larch (Gmelini) - Larix gmelenii andSiberianlarch - Larixsibirica Lebed. The dominant species - Daurian larch - is widespread in the Far East and Eastern Siberia. Siberian larch grows mainly in West Siberia and in parts of Eastern Siberia.
Larch wood has high density, strength and biological stability [2].

2. PROBLEMS

In spite of the good physical- and mechanical properties and the natural biological stability, larch remains a not too demanded timber species.Reasons for it arethe specific properties like the large difference in density between sapwood and core as well as the high content of natural resins and gums.

Becauselarch wood hashigh strength properties and high biological stability, it used in construction in the form of lumber and laminated beams. In recent years, modern wooden construction has moved beyond low-rise and passed to the construction of large-span buildings, such as swimming pools, shopping centers, sport- and entertainment buildings. In this fields of applications larch wood can be used for the manufacturing of load-bearing structures, beams, arches or trusses of long length.

Formation of adhesive joints is a complex physical and chemical process of interaction of wood with a binder, which depends on the properties of wood and glue. The high requirements on structural elements requires from the manufacturer not only the right choice of the glue and optimal bonding conditions but also the choice of sawn timber as the density essentially affectsthe physical and mechanical properties of the bonded structures [4-5].
The main problem working with larch is the difficulty of forming bonded joints due to low wetting ability conditioned by the presence of fatty resins acids [3].

2.1. Statement of the problem and its solution

Through the bonding with modern synthetic adhesives supporting structures can reach strengths which are superior to the strength of solid larchwood. Currently, the production of supporting structures became widespread following kinds of glue: resorcinol formaldehyde (RF), polyurethane (PUR), emulsion polymer isocyanate (EPI), melamine-urea-formaldehyde (MUF) adhesive compositions.
The most promising for the modification of binders is melamine-urea-formaldehyde (MUF)resins, as they are most prevalent in the production of supporting structures and have a high water resistant. The advantages include the ability to use MUF heating HFC (currents of high frequency) to speed up the curing of the adhesive layer. However, MUF adhesives have some disadvantages, which include: high cost, almost transparent adhesive layer (which makes it difficult visual inspection of the continuity of the adhesive layer).
Melamine ($C_3H_6N_6$) reacting with formaldehyde gives a more developed three-dimensional structure than urea. This leads to a higher strength, weather resistance, water resistance and durability of the adhesive joint. The method for modifying urea formaldehyde resins with melamineis known [6], but direct modification melamine with urea formaldehyde resin was not widespread because of the difficulty of melamine dissolved at room temperature and cure time increases 1,25-2 times.Much better results are obtained by the combination of urea formaldehyde resin with melamine-formaldehyde resin. For example, to obtain a water-resistant particle board used a mixture of melamine and urea-formaldehyde resin in the ratio of 45:55. However, for a given component ratio to provide the desired water resistance of this adhesive composition has a relatively high level of formaldehyde, which in its turn does not correspond to the emission class E0, E1.
Proved [7, 8] that the adding of the shungitsorbent in urea-formaldehyde resin reduces the toxicity index for chipboard from 0,2 to 0,03 mg/m^3.Shungite sorbents are quartz carbon frame of the basic structural units packed loose, and the architecture of shungite sorbents creates areas free of cavities, connecting intersecting channels. These channels have hollow cavities whose diameters allow them to penetrate into the molecules, in this case formaldehyde. Thismechanismiscalled "molecularsieveeffect."
To investigate the formation of adhesive joints on the basis of preliminary tests was optimal composition of the composite adhesive comprising urea melamine formaldehyde resin, urea formaldehyde resin and shungite sorbent.
The target of this work is to study the influence of the modified adhesive on physical andmechanical properties of the bonded structures Larch.

2.2. The research results

For this study samples of Arkhangelsk larch(Larix archangelica) density of 450-750 kg/m^3, humidity 8-10%, and two types of glue: melamine-urea-formaldehyde glue (MUF) brand in 1249 with hardener 2579 byAkzo Nobel and modified adhesive were used.The composition of the modified adhesive: 70 parts by weight melamine-urea-formaldehyde glue 1249, 30 parts by weight urea-formaldehyde glue KF-HV (high viability) which was introduced in the 10 parts by weight filler - shungite sorbent.
Researches by definition of physical and mechanical properties were made by known methods [9, 10]. The criteria for assessing the quality of bondselected shear strength by glue line.

In order to determine wetting ability the method used recumbent drops depending on the density of larch determined by the weight method. The dependence of the contact angle on the density larchare presented in Figure 1.The graphs show that using MUF with increasing density there is an increase of the contact angle, which in turn reduces the wettability adhesive. But composite adhesive using the density increases the contact angle decreases, which can be attributed to a reduced viscosity of the adhesive composition due to the introduction of the composite modified urea-formaldehyde resin.

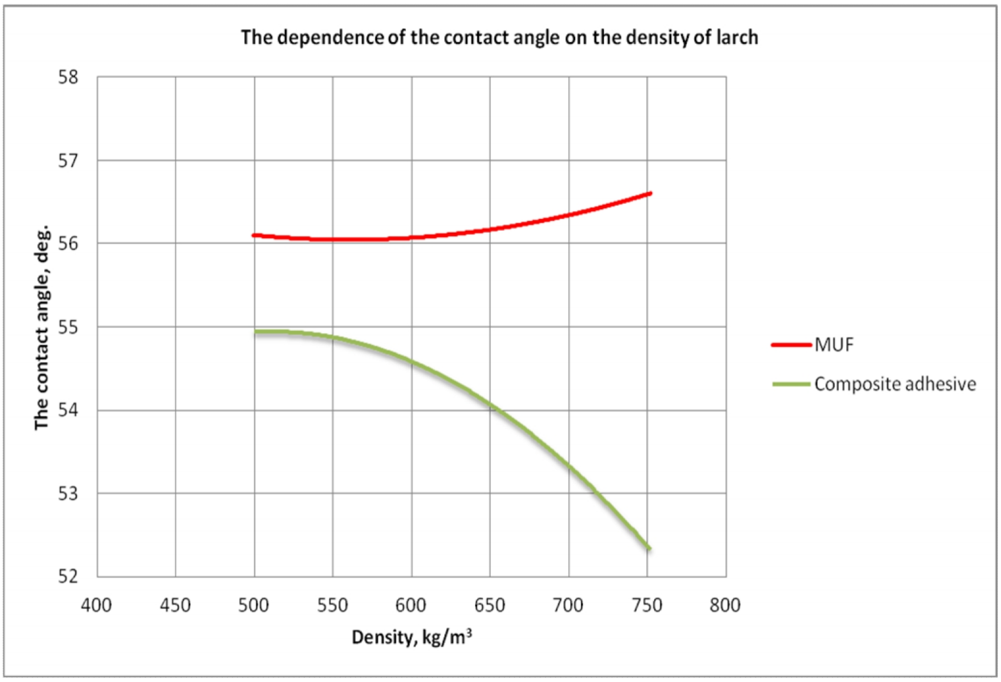

Figure 1: The dependence contact angle on the density of larch.

According to the requirements of the load-bearing structure the glued samples were stood in cold water for 48 hours and boiled for 3 hours.

The obtained results regarding the hear strength along the fibers of the density of larch are shown in the following two graphs. Analyzing figure 2 shows that anincreasingdensity results also in increasing bond strength. Hoverer it reaches its extremum (dry samples) after 630 kg/m3, and then starts to decline. Exact same trend is observed for samples subjected to boiling and exposure to cold water for 48 hours.

Figure 3 shows that a reduction ofthe bond strength takes place after 680kg/m^3. A tendency to decrease in strength can be explained by an insufficient diffusion of glue, due to the decrease of the pore diameter timber.

It can be stated that theglue joints, based on compositional adhesive, satisfy the requirements of the standardsEN 1194-1999,EN 384:2004in terms of strength and water resistance.Adhesive bonding belongs to the group of increased water resistance. When using sorbents shungite adhesive composition is painted in a dark color, which facilitates visual inspection of the continuity of the adhesive layer.

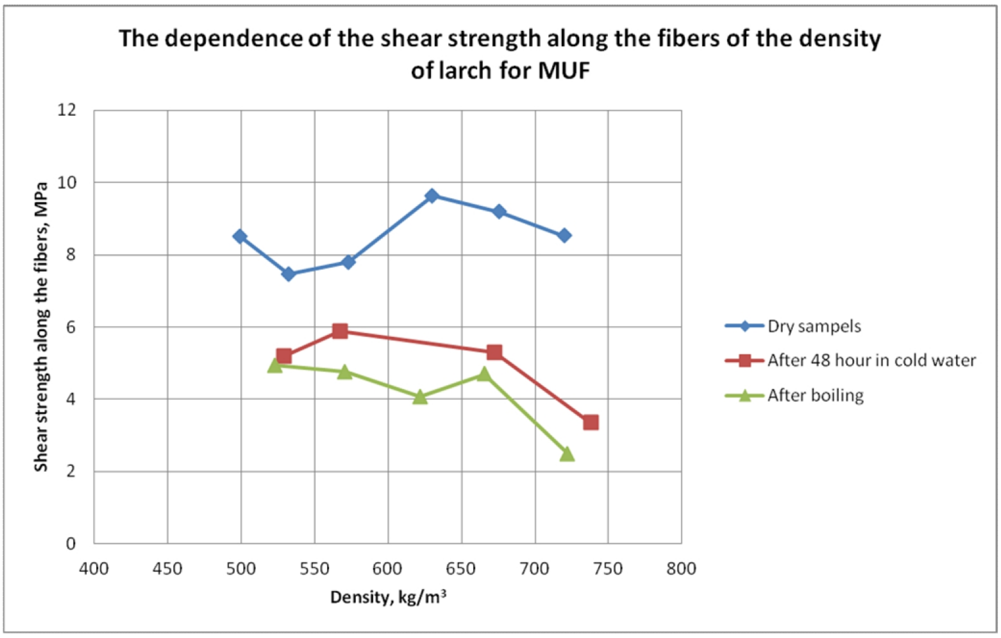

Figure 2: The dependence of the shear strength along the fibers of the density of larch glued on MUF binder.

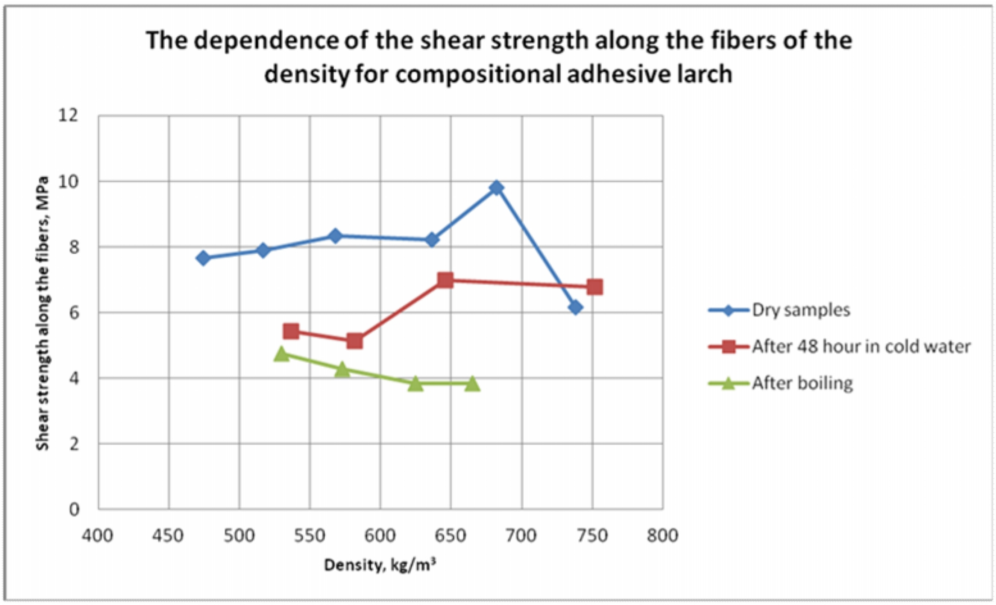

Figure 3: The dependence of the shear strength along the fibers of the density of larch glued on composite adhesive.

3. CONCLUSIONS

On the basis of this work the following conclusions can be made: the application of MUF and modified adhesives allows the creation of glue joints with the required strength characteristics. Modification of MUF adhesives with added urea-formaldehyde resins withschungite sorbents can improve the water resistance of the adhesive bonding. In the formation of adhesive bonds a sorting of Larch by density is necessary. It should also be noted that the use of MUFadhesive composition may reduce the costs of the glue by 26%.

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