

Bonding quality of veneers protected with fireproofing preservation based on diammonium hydrogen phosphate, citric acid and sodium benzoate

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Abstract: *Bonding quality of veneers protected with fireproofing preservation based on diammonium hydrogen phosphate, citric acid and sodium benzoate.* In the study, joints strength in three-layer plywood glued with urea-formaldehyde resin, made from pine and beech veneers impregnated with fireproofing preservation based on diammonium hydrogen phosphate ammonium phosphate, citric acid and sodium benzoate, was determined. It was established that for pine plywood, veneers impregnation does not affect the strength of joints, and in case of beech plywood veneer impregnation caused a decrease in strength by about 20%.

Keywords: bond quality, fireproofing protection, plywood

INTRODUCTION

Plywood is a valuable construction material used in building industry, both for a permanently embedded components and interior furnishings devices. Its use is justified due to advantageous strength parameters resulting from its layered structure. Certain limitation of its use arises from lack of fire resistance. This aspect plays an important role in terms of buildings safety (Wytwer 1994). One of the possibilities of improving plywood resistance to fire is impregnation of veneers with flame-retardants, during technological process, before gluing of veneers. This solution allows to receive a material protected in the entire volume. However, in case of this solution, there is a danger of glue joints strength declining, due to the negative impact of impregnant on the adhesion of glue to the wood surface, as well as impregnant reaction during hot pressing of plywood (Wytwer and Starecki 1995, Dziurka et al. 2006, Domański et al. 2007, Borysiuk et al. 2008).

The current market offers new preservatives reducing flammability of wood, which are based on ecological and non-toxic organic ingredients, so that they can be successfully used in a human environment. One of such agents is fireproofing preservation based on diammonium hydrogen phosphate, citric acid and sodium benzoate (US 7736549). In these studies, the influence of the veneer impregnation (with this preservation) on the strength of glue joints in plywood based on these veneers was identified.

MATERIAL AND METHODS

Pine and beech veneers with a nominal thickness of 1.5 mm and density, respectively: 484 kg/m³ and 676 kg/m³ were pressure protected with fireproofing preservation based on diammonium hydrogen phosphate, citric acid and sodium benzoate. The product was used as water solution having a concentration of 20%. Average retention of the preparation was 50 kg per 1 m³ for beech veneer and 47.5 kg per 1 m³ to pine veneer. After impregnation, veneers were dried at 50 - 60 °C, to the moisture content of about 5%. 3-layer plywood from impregnated and non-impregnated veneers was produced on the basis of urea-formaldehyde resin. Glue recipe and parameters of plywood gluing are presented in Table 1.

Table 1. Glue recipe and parameters of plywood gluing

Parameter	Value
Glue recipe	UF resin – 100 pbw, hardener (10 % solution of $(\text{NH}_4)_2\text{SO}_4$) – 4 pbw, aggregate (wheat flour) – 15 pbw, water – 10 pbw
Glue spread	160 g/m ²
Pressing temperature	110 °C
Unit press pressure	pine veneer – 1.0 MPa, beech veneer – 1.2 MPa
Time of pressing	330 sec

After production, plywood was conditioned for 1 week under laboratory conditions, and then samples were obtained for shear strength of glue joints testing in accordance with EN 314-1. The study was conducted on both dry samples and after wetting samples in water for 24 h. For each variant 15 samples were prepared.

RESULTS AND DISCUSSION

Research results of plywood gluing quality are shown in Table 2 and Figures 1 and 2. Generally it can be stated, that statistically, impregnation of veneers with the fireproofing preservation did not influence the strength of joints in pine plywood. Both in the dry test and after wetting in water for 24 h, similar strength results were observed at the level of: 1.5 N/mm² and 1.1 N/mm².

Table 2. Research results of plywood gluing quality

Sample	Shear strength of glue joints			
	Dry conditions		After wetting	
	[N/mm ²]	x [%]	[N/mm ²]	x [%]
Pine plywood – non-impregnated veneers	1.48	9	1.08	19
Pine plywood – impregnated veneers	1.52	9	1.19	27
Beech plywood – non-impregnated veneers	1.86	8	1.22	20
Beech plywood – impregnated veneers	1.50	8	1.03	28

x – coefficient of variation

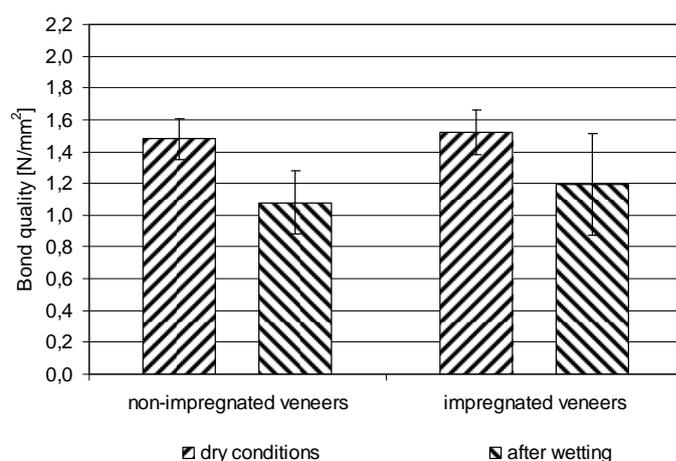


Fig. 1. Shear strength of pine plywood made of impregnated and non-impregnated veneers

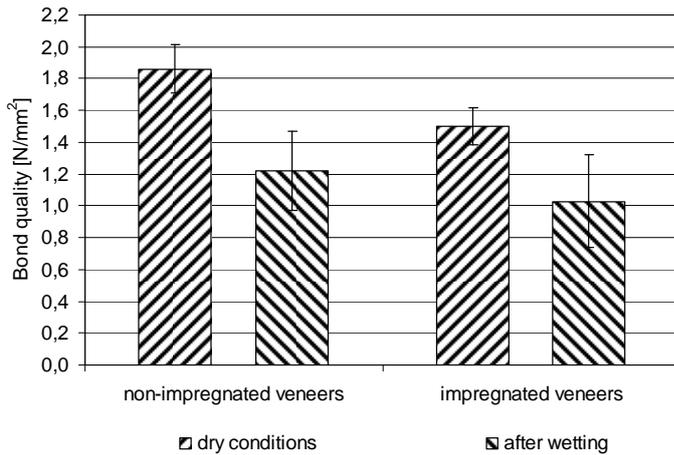


Fig. 2. Shear strength of beech plywood made of impregnated and non-impregnated veneers

In case of beech plywood, veneer impregnation with preparation influenced on declining of glue joints strength in 19% for dry test and 16% for the determination after wetting in water for 24 hours. Obtained differences were statistically significant in nature, however it should be noted that glue joints produced in both cases meet the assumptions of the EN 314-2 (glue joints strength of more than 1 N/mm²).

For both pine and beech plywood, diversity of destruction of glue joints in wood achieved in dry test was in the range of 30 – 100%. In case of testing the samples after wetting in water, destruction of joints usually took place in glue joints (wood failure 0 – 10%). At the same time it can be noticed, that at the examination of samples after wetting in water, the results obtained for plywood produced from impregnated veneers were characterised by an average of 8% greater variability performance compared to plywood made of non-impregnated veneers.

CONCLUSIONS

On the basis of conducted researches it can be stated:

1. Impregnation of pine veneers with fireproofing preservation based on diammonium hydrogen phosphate, citric acid and sodium benzoate does not affect joints strength in plywood made from them with the use of urea-formaldehyde resin, in the range tested.
2. Impregnation of beech veneers with fireproofing preservation based on diammonium hydrogen phosphate, citric acid and sodium benzoate reduces joints strength in plywood made from them with the use of urea-formaldehyde resin, in the range tested. However, it should be noted that obtained results meet the requirements of EN 314-2 in the scope of joints strength.

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Streszczenie: *Jakość sklejenia fornirów zabezpieczonych środkiem ogniochronnym na bazie wodorofosforanu amonu, kwasu cytrynowego i benzoesanu sodu. W ramach badań określono wytrzymałość spoin w sklejках trójwarstwowych klejonych żywicą UF wytworzonych z fornirów sosnowych i bukowych zaimpregnowanych preparatem ogniochronnym opartym na kompozycji wodorofosforanu amonu, kwasu cytrynowego i benzoesanu sodu. Ustalono, że w odniesieniu do sklejek sosnowych, impregnacja fornirów nie wpływa na wytrzymałość spoin, zaś w przypadku sklejek bukowych impregnacja fornirów powodowała spadek wytrzymałości o około 20 %.*

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