Influence of the addition of carbon black on the mixed polyurethane resin used to manufacture particleboards

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Abstract

Composite wood panels are produced through hot pressing of particles or vegetable fibers, which are bound by synthetic or natural resins, commonly known as polymeric adhesives. The adhesive is considered a determining factor in the production process of these composites, as it exerts a great influence on the degree of compaction, fixation and wetting between the wood particles. Polymers reinforced with nanometric particles, usually of ceramic origin, have received the attention of many scientific and industrial societies in the area. This is due to the good chemical interaction generated between nanometric particles and polymeric adhesives, enabling greater filling of voids and improving the performance of composite materials by increasing the interfacial interaction between the constituent phases. In this context, this research presents an analysis of the influence of the addition of carbon black, widely used to improve the physical-mechanical properties of polymeric matrices in different industrial fields, on the static bending (modulus of strength (MOS) and elasticity (MOE) of particleboards of *Pinus spp*. and resin mixed polyurethane of vegetable oils. For this purpose, particleboards were made with the following concentrations of carbon black mixed with resin: 0%, 5%, 15%, 30%, 60% and 100%. According to ABNT NBR 14810-2, static bending tests were performed and the values of modulus of strength and elasticity were obtained for each type of panel. As a result, there was a significant improvement with the addition of carbon black, where it was possible to notice linear growth in the average values of MOS and MOE.
Keywords: particleboard, carbon black, static bending.

Introduction

Particleboards as an alternative to the problems presented in the use of solid wood, mainly from low to medium density species, such as low durability against wood-deteriorating organisms, low mechanical strength, anisotropy and limited dimensions [1,2].

The particleboards are produced by agglutinating particles, or vegetable fibers, by a synthetic or natural polymeric resin, through hot pressing. Among its applications, the use in walls, floors, ceilings, office partitions, cabinets, furniture and benches stands out [2,3,4]. The pressing of the panels takes place under predetermined pressure and temperature to ensure complete curing of the resin and good interaction between the constituent phases [5,6].

Urea-formaldehyde is the most used polymeric resin for the production of these composites due to its low cost, high cure speed and good flame resistance [7]. However, due to the emission of formaldehyde during hot pressing, the demand for alternative resins that are not

toxic to health and the environment, such as resin from castor oil-based polyurethane (PU-Castor) [8,9] and mixed polyurethane resin based on vegetable oils [6].

Currently, with nanotechnology applied in the field of materials science and engineering, polymers reinforced with nanometric particles have received the attention of many scientific and industrial societies [10]. Nanometric particles, generally ceramic in nature, are compatible with polymeric adhesives used in the manufacture of composite wood panels, and have a great capacity to fill voids and improve the physical-mechanical performance of these composites [11].

Carbon black is a material classified as ceramic and is characterized by the nanometer dimension of its particles that have a large surface area. When added as a filler in polymer composites, it greatly improves the physical-mechanical. This can be explained by its great capacity to fill voids and by providing good chemical interaction between the phases, improving the performance of polymeric composites, such as wood panels [12,13]

Experimental Procedure

Ten specimens of each type of particleboards were made using the following concentrations of carbon black in the mixed polyurethane resin of vegetable oils: 0%, 5%, 15%, 30%, 60% and 100%. *Pinus spp*. and the resin used in the proportion of 48 g of prepolymer and 48 g of polyol was acquired from the company IMPERVEG in Aguaí - SP. For each type of panel, 640 g of *Pinus spp* particles were used.

All tests were carried out at the Wood Laboratory and Timber Structures, Department of Structural Engineering (SET), School of Engineering of Sao Carlos (Brazil). The static bending tests were carried out in accordance with ABNT NBR 14810-2 [14] in the EMIC machine (Figure 1) where, with the plot of the curve given by the test, the mean values of modulus of strength (MOS) and modulus of elasticity (MOE) in static bending test are estimated.

Figure 1 – Bending test with a specimen with 5% carbon black in the EMIC machine.

Results and Discussion

Table 1 presents the mean values obtained for the static mean values of modulus of strength (MOS) and modulus of elasticity (MOE) in static bending test.

Table 1 – Mean values of MOR and MOE.

Concentration of carbon black	MOS (MPa)	MOE (MPa)
0%	24	3203
5%	28	3345
15%	30	3483
30%	32	3598
60%	33	3745
100%	33	3807

From the results, an increase in the mean values of MOS and MOE can be verified, where it was possible to improve up to 37% the MOS and 18% the MOE.

Conclusions

The addition of carbon black in the manufacture of panels made with mix resin proved to be extremely beneficial, where it

was possible to notice a significant improvement in MOS and MOE up to the addition of 30% of carbon black and after that concentration reached a plateau.

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