Construction and Building Materials 26 (2012) 131–134

Contents lists available at ScienceDirect

Construction and Building Materials

journal homepage: www.elsevier.com/locate/conbuildmat

Cement-bonded composite boards made from poplar strands

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ARTICLE INFO

Article history:
Received 2 March 2011
Received in revised form 25 May 2011
Accepted 2 June 2011
Available online 22 June 2011

Keywords:
Cement-bonded composite
Building material
Calcium chloride
Inhibitory index

ABSTRACT

This study was carried out to explore the possibility of making cement-bonded wood composite building products using poplar (*Populus deltoides*) chopped strands. The experimental design consisted of two treatments namely wood strand and calcium chloride contents. Boards measuring 450 × 450 × 15 mm^3 were manufactured using wood/cement ratios of 40:60, 60:40 and 70:30 by weight and 3% and 7% of an accelerator ($CaCl_2 \cdot H_2O$). At least four replications were fabricated for each treatment, and the mechanical properties and water absorption of the boards were evaluated according to DIN 68763. The mechanical properties in terms of modulus of rupture, modulus of elasticity, internal bond and impact strength were investigated and compared to the neat cement controls. Test results showed that addition of $CaCl_2$ tends to enhance both the mechanical and water-resistance of wood–cement composites. The bending and impact strengths of the wood–cement specimens increased with an increase in the wood content, and the maximum values were obtained at wood loading of 60% by weight. The negative influence of wood content on the internal bond can be explained by the reduced bonding ability because of weaker wood strands compared to cement. Water absorption and internal bonding were inversely proportional to the increase of cement mixture ratio, and their values increased proportional to the increase of wood ratio in the mixture. In addition, all properties of the boards were improved when the $CaCl_2$ content was increased from 3% to 7%.

1. Introduction

Cement-bonded wood composites (CBWCs) have the potential to provide a wide range of products for building applications by using a wide variety of wood based materials. During the last two decades, the application of woody materials in CBWCs have been gaining momentum and woody materials have been applied to enhance the properties of the construction materials [1,2]. CBWC is made of strands, particles or fibers of wood mixed with Portland cement and small amounts of additives manufactured into panels, bricks, tiles and other products used in the construction industry. Wood is the aggregate and the reinforcing agent, cement is the binder, water is the reactant, and the additives are the catalysts [3,4].

A number of factors contribute to the properties of CBWC products such as the presence of cement inhibitors in woody materials. Although a wide variety of wood species has been used in the manufacture of CBWCs, only a few of them are classified as low inhibition. Papadopoulos [5] reported that poplar has the least inhibition index (highest compatibility) on cement hydration (Tables 1 and 2). The compatibility term refers to the degree of cement setting after mixing with water and with a given wood in fragmented form. Generally, if the chemical process of cement hardening is undisturbed by the presence of wood, it is considered that cement and wood are compatible. On the other hand, if cement hardening is impaired by the presence of wood, then cement and wood are referred to as incompatible [6]. As described by Hachmi and Moslemi [7], wood–cement compatibility generally decreases as the extractive content increases. These extractives are generally composed of terpenes, fatty acids, tannins, carbohydrates, and inorganic materials [8]. It has been reported that the water-soluble extractives of wood retard and sometimes inhibit the normal setting and strength development properties of cement during the production of CBWCs [3,4].

According to a previous study by Olorunnisola [9] on the behavior of husk–cement systems showed that the inhibitory effects could be minimized with the use of calcium chloride ($CaCl_2$) as an accelerator. However, other previous studies have also shown that $CaCl_2$ tends to have some effects on the bending elasticity, compressive strength and sorption properties of CBWC products [4,10].

More information on the strength, stiffness and sorption of CBWCs is needed to extend their acceptance and use, in the outdoor and indoor structural applications. The first step in assessing the suitability of different wood species for use in CBWCs involves

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doi:10.1016/j.conbuildmat.2011.06.001