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Mechanical and physical properties of cement-bonded OSB

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Subject The objective of this paper was to evaluate the mechanical and physical properties of oriented strand board (OSB) using cement as binder. It was found that an increase of cement-wood ratio resulted in an increase of all, but MOR values. A lower cement-wood ratio than for particleboards is required in order to manufacture acceptable OSB and this may be due to the strands geometry.

1 Introduction

Cement-bonded wood composite panels are not a novel concept, having been on the market for over a century. In the past, these panels have consisted of excelsior and magnesite and have been primarily used as low-density insulating materials. In the early 1960s, a high-density cement-bonded structural flakeboard was developed leading to expanded applications (Deppe 1974). Today, wood-cement panels have found acceptance in a number of countries as a result of certain desirable characteristics. The majority of research in this field has been carried out on particleboards and flakeboards. An excellent review can be found elsewhere (Jorge et al. 2004). The objective of this work was to look for ways of manufacturing oriented strand boards (OSB) using cement as binder. Oriented strand board is a structural reconstituted panel that consists of wood strands glued with an exterior-type, waterproof resin. In the last decade OSB has gained significant growth in the structural wood based panel market.

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2 Experimental

In this study Aspen ring-cut strands (Populus alba) with an average strand size of 75 mm × 20 mm × 0.75 mm (length × width × thickness) were used. The bonding agent employed was commercial grade Portland cement, type I. Ammonium chloride (2% based on weight of cement) was introduced into cement slurry to accelerate cement set during hydration. The boards were manufactured according to methodology described in Moslemi and Pfister (1987). Two replications of each board with cement-wood ratios of 3.0, 2.0, and 1.5 (by weight) were made, giving a total of 6.

3 Results and discussion

The data from the boards made with various cement-wood ratios are summarised in Table 1. Table 1 reveals that a wood-cement ratio of 1.0 is unable to produce boards with acceptable properties. The very low value of IBS is interesting, which denotes the complete failure of the boards. At this wood-cement ratio IBS values of similar magnitude ($0.27\ \text{N/mm}^2$) have also been reported by Fuwape (1995). The lower value obtained in this study may be a consequence of the manual mixing of strands. Preliminary results showed, that mechanical mixing resulted in a breakdown of wood strands and therefore, in the alteration of their final dimensions. Table 1 also shows that an increase of the cement-wood ratio resulted in an increase of all, but MOR values. This is in line with the observations made by Moslemi and Pfister (1987). They found that the modulus of elasticity, internal bond strength and thickness swell increased linearly with greater cement-wood ratios (R^2 values of 0.89, 0.91 and 0.93 were observed from the data shown in Table 1, for MOE, IBS and TS, respectively). The relationship between cement-wood ratio and MOR values is considerably different from that of MOE or IBS or TS. The MOR values decrease with an increase of cement-wood ratio, if we exclude the failure in boards made from 1.0 cement-wood ratio. The higher proportion of wood in the board may enhance

Table 1 Mechanical and physical properties of cement-bonded OSB. (Standard deviations in parentheses)
Tabelle 1 Mechanische und physikalische Eigenschaften von zementgebundenen OSB-Platten (Standardabweichungen in Klammern)

Cement Wood	Density (g/cm^3)	MOR (N/mm^2)	MOE (N/mm^2)	IBS (N/mm^2)	TS (%)
1.0	0.972 (0.08)	3.10 (0.6)	466.7 (31.1)	0.13 (0.009)	34.14 (4.8)
2.0	1.111 (0.09)	12.25 (0.9)	4949.1 (176.3)	0.87 (0.030)	9.42 (1.1)
3.0	1.087 (0.11)	8.27 (0.9)	5212.5 (155)	0.94 (0.05)	4.28 (0.33)

the flexural property of the board. When wood occupies more volume in the board, the areas of stress concentration around the component particles are more diffused, resulting in increased applied stresses (Moslemi and Pfister 1987). Our results are in conformity with those made by other authors (Fuwape 1995, Sudin et al. 1995) regarding the use of cement in particleboard and flakeboard manufacture.

From the data presented in Table 1 it can be assumed that in order to manufacture OSB with acceptable bending properties (MOR in particular), an optimum cement-wood ratio has to be lower than 2.0; probably lower than 1.5. This proposed cement-wood ratio for OSB manufacture appears to be lower than the corresponding ratio for particleboard and flakeboard manufacture. Commercial cement-bonded particleboards made with cement-wood ratios of 2.75 to 3.0 are reported to attain acceptable properties (Bahre and Greten 1977). Research with southern pine showed that cement-wood ratio higher than 2.0 has enabled the manufacture of cement excelsior boards with acceptable bending strength (Lee 1985), whereas research with oil palm chips reported an optimum cement-wood ratio of 2.5 (Sudin et al. 1995). A ratio of 2.0 has been reported by Moslemi and Pfister (1987) and Fuwape (1995), both for particleboard manufacture. For the manufacture of acceptable OSB a lower cement-wood ratio is required than for particleboards and flakeboards which may be due to the strands geometry. A study carried out by Badego (1988) has shown that flake geometry (length and thickness) is highly correlated with board key properties, like MOR, MOE, IBS and TS. He found that the longer and thinner the raw material the stronger, stiffer and more dimensionally stable are the boards.

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