SUITABILITY OF *EREMOSPATHA MACROCARPA* CANES FOR THE PRODUCTION OF CEMENT-BONDED COMPOSITES

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Received August 2010

ADEFISAN OO. 2011. Suitability of *Eremospatha macrocarpa* canes for the production of cement-bonded composites. The suitability of untreated *Eremospatha macrocarpa* canes for cement-bonded composites (CBCs) and the effect of cold water pretreatment on the compatibility of the species with cement were investigated using the hydration test approach. *Eremospatha macrocarpa* particles were mixed with cement and water, and placed in insulated thermos flasks. Temperature rise was monitored for 24 hours. Suitability of the species for CBC production was assessed based on setting time (t_{max}), maximum hydration temperature (T_{max}) and time ratio (t_R). The t_{max}, T_{max} and t_R of the cement composites ranged from 7.2–8.5 hours, 55.0–57.1 °C and 1.2–1.4 respectively. Pretreatment of particles with cold water reduced the t_{max}, T_{max} and t_R of the cement composites by 15.3, 3.7 and 14.3% respectively. Cold water pretreatment significantly improved the compatibility of untreated particles of *E. macrocarpa* with cement.

Keywords: Rattan canes, hydration, pretreatment, compatibility indices

ADEFISAN OO. 2011. Kesesuaian rotan *Eremospatha macrocarpa* dalam penghasilan komposit berikatan simen. Kesesuaian rotan *Eremospatha macrocarpa* yang tidak dirawat dalam penghasilan komposit berikatan simen (CBC) dan kesan rawatan air sejuk terhadap keserasian spesies ini dengan simen dikaji menggunakan pendekatan ujian penghidratan. Partikel *E. macrocarpa* dicampur dengan simen dan air serta dimasukkan ke dalam kelalang termo yang ditebat. Kenaikan suhu diawasi selama 24 jam. Kesesuaian spesies dalam penghasilan CBC dinilai berdasarkan tempoh pensetan (t_{max}), suhu penghidratan maksimum (T_{max}) dan nisbah masa (t_R). Nilai-nilai t_{max}, T_{max} dan t_R bagi komposit simen masing-masing berjulat dari 7.2 jam–8.5 jam, 55.0 °C–57.1 °C dan 1.2–1.4. Rawatan dengan air sejuk mengurangkan t_{max}, T_{max} dan t_R komposit simen masing-masing sebanyak 15.3%, 3.7% and 14.3%. Rawatan air sejuk menjadikan partikel *E. macrocarpa* yang tidak dirawat sesuai diguna bersama-sama simen.

INTRODUCTION

Cement-bonded composites (CBCs) are low cost construction materials made from a mixture of cement, water and wood/lignocellulosic materials. They are used primarily for ceiling, panelling, sheathing and flooring in modular housing units, and as sound barriers. They have good properties such as insect, fungi and fire resistance, ease of manufacture, environment-friendly, durability and stability (Badejo 1989, Ramirez-Coretti et al. 1998, Mrema 2006). However, wood, the reinforcing agent in CBCs, is becoming scarce due to the increasing demand for wood and wood products (Ramirez-Coretti et al. 1998, Schuler & Adair 2003). Therefore, alternative lignocellulosic materials are now incorporated in the production of CBCs. Examples of such materials include maize and cotton stalks, rice and coffee husks, bagasse and sawdust from both softwood and hardwood (Lee & Hong 1986, Miller & Moslemi 1991, Badejo 1992, Oyagade 1995, Badejo 1998, Wolfe & Gjinolli 1999). However, many of these lignocellulosic materials are often produced in small quantities in scattered locations. Therefore, collection and haulage are often difficult and expensive (Olorunnisola 2006).

Olorunnisola et al. (2005) and Olorunnisola (2006) reported that the choice of any particular lignocellulosic as furnish for CBC production is dependent on availability and accessibility. Rattan, a versatile climbing palm, available in many forests in southern Nigeria can therefore be considered as a potential material for CBC manufacture. This is because rattans have short rotation and can be harvested in less than seven years after planting. The harvesting and processing of rattans for CBC manufacture require simple and relatively cheap technology and can augment small-scale industrial enterprises especially in the low income communities in Nigeria (Olorunnisola et al. 2005).

Of the three rattan species commonly utilised in the rattan industry in Nigeria, two, namely, *Calamus deerratus* and *Lacosperma secundiflorum* have been investigated for CBC production (Olorunnisola et al. 2005, Adefisan & Olorunnisola 2007, Olorunnisola 2007, 2008). The potential of the third rattan species, *Eremospatha macrocarpa*, for CBC manufacture is not known. Since different rattans exhibit different physical and mechanical properties (Dahunsi 2000) which may affect CBC manufacture, it is necessary to investigate the suitability of different rattan species for CBC production. Rattan contains sugars and extractives (Olorunnisola & Adefisan 2002) which may likely hinder rattan–cement interaction. Therefore, pretreatments such as soaking in cold water are often required to remove these offending substances, thus enabling strong crystalline bond formation (Olorunnisola 2008).

This study investigated the effects of cold water pretreatment on the compatibility of particles of *E. macrocarpa* canes with cement.

MATERIALS AND METHODS

Samples of *E. macrocarpa* canes were harvested from Kajola Oniparaga Forest Reserve in Odigbo Local Government Area, Ondo State, Nigeria. These were identified through comparison with stocks kept at the herbarium of the Department of Botany and Microbiology, University of Ibadan. The harvested canes were converted into billets of about 6 cm and hammer milled. The milled particles were collected and sieved using 1.18, 0.85 and 0.60 mm sieves. Particles that passed through the 0.85 mm sieve and were retained in the 0.60 mm sieve were collected, air dried to 10% moisture content and separated into two portions, namely, those to be used 'as is' and those to be subjected to cold water pretreatment. Pretreatments involved soaking of particles in deionised cold water (25 °C) for 30 min, draining and rewashing with deionised water to remove soluble extractives, and air drying for 14 days to an average moisture content of 10%.

Hydration test

For the hydration tests, 15 g of rattan particles, 200 g of ordinary Portland cement and 93 ml of deionised water were mixed in a polyethylene bag to form homogeneous slurry (Adefisan & Olorunnisola 2007). The neat cement was mixed with 90 ml of deionised water. The tests were performed in a set of well-insulated thermos flasks. Temperature rise was monitored for 24 hours using a T-type thermocouple. Three replicates of each mixture were prepared. The compatibility was assessed using the compatibility indices shown in Table 1.

Table 1 Cement compatibility assessment schemes

Parameter	Classification index	Reference
Time to maximum temperature (t_{max})	Suitable (< 15 hours)	Hofstrand et al. (1984)
	Unsuitable (> 20 hours)	
Maximum hydration temperature (t_{max})	Suitable (T_{max} > 60 °C)	Sandermann & Kohler (1964)
	Intermediately suitable (T_{max} = 50–60 °C)	
	Unsuitable (T_{max} < 50 °C)	
Time ratio (t_R): ratio of setting time of rattan–cement composite to neat cement, i.e. $t_R = t_{WC} / t_{NC}$	$1 \le t_R \le 1.5$ (suitable)	Olorunnisola (2008)
	$1.5 < t_R \le 2.0$ (acceptable)	
	$t_R > 2.0$ (inhibitory)	

RESULTS AND DISCUSSION

Setting time of *E. macrocarpa*–cement composites

The setting time of the *E. macrocarpa*–cement composites ranged from 7.2 hours for particles pretreated with cold water to 8.5 hours without pretreatment (Table 2). Based on classification by Hofstrand et al. (1984), the untreated *E. macrocarpa* canes were suitable for CBC manufacture. Pretreating particles of *E. macrocarpa* canes with cold water significantly reduced the setting time of rattan composites. This suggested that untreated particles of *E. macrocarpa* canes could be used for CBC production without pretreatment. Soaking seemed to have removed offending substances that might hinder the formation of strong crystalline bond. This implied that sugars and extractives present in *E. macrocarpa* canes were soluble in cold water. The removal of these substances from rattan may have caused reduction in the setting time of cement mixes. This finding is in accordance with that of Olorunnisola (2008) in that cold water pretreatment improves the setting time of rattan–cement composites during CBC production.

Hydration temperature of *E. macrocarpa*–cement composites

Eremospatha macrocarpa–cement composites attained maximum hydration temperature of 57.1 °C without pretreatment (Table 2). Based on the classification by Sandermann and Kohler (1964), untreated *E. macrocarpa* particles are suitable for CBC production. This suggested that *E. macrocarpa* particles could be used for CBC manufacture without pretreatment.

Pretreating particles of rattan with cold water, however, significantly reduced the hydration temperature of the composites. This may mean that some sugars and extractives in *E. macrocarpa* canes are not amenable to cold water pretreatment and thus impair the cement hydration. This finding was, however, contrary to that of Olorunnisola (2008) who found that cold water pretreatment improved the hydration temperature of rattan–cement composites.

Dahunsi (2000) reported the presence of parenchyma cells (storage tissues containing starches and tannins) in *E. macrocarpa* canes harvested in the forests of southern Nigeria as against sclerenchyma cells (strengthening tissues) in *L. secundiflorum* canes. Alberto et al. (2000) noted that different lignocellulosics might require hot or cold water pretreatment depending on their constituents. Cold water pretreatment might not have totally removed the cement inhibitors (starches and tannins) present in particles of *E. macrocarpa*. This may have impaired the hydration temperature of the cement mixes. It is possible that pretreating particles of *E. macrocarpa* canes with hot water will improve the hydration temperature.

Time ratio index of *E. macrocarpa*–cement composites

The time ratio of the rattan composites ranged from 1.4 without pretreatment to 1.2 when soaked in cold water (Table 2). Based on the criterion by Olorunnisola (2008), the untreated *E. macrocarpa* canes are suitable for CBC production. Cold water pretreatment significantly improved the time ratio of the *E. macrocarpa* composites. This showed that although particles of *E. macrocarpa* were amenable to soaking in cold water, the particles did not need to be pretreated prior to CBC manufacture.

Table 2 Results of hydration test

Pretreatment	Setting time (hours)	Maximum hydration temperature (°C)	Time ratio
Untreated	8.5 a (0.62)	57.1 a (0.59)	1.4 a (0.033)
Cold water treatment	7.2 b (0.21)	55.0 b (0.62)	1.2 b (0.016)
Neat cement (control)	6.0	63.6	1.0

Means with the same letter within the same column are not statistically different; standard deviations in parentheses

CONCLUSIONS

Eremospatha macrocarpa canes were suitable for CBC manufacture without pretreatment. Cold water pretreatment significantly reduced the setting time, hydration temperature and time ratio indices of *E. macrocarpa* composites. Cold water pretreatment improved the compatibility of *E. macrocarpa* particles with cement.

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