Physical and Mechanical Properties of Reed Fiber Cement Board

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Abstract:
In this work fibers of dry reed was used a reinforcing material to produce cement boards after being chemically treated in order to enhance the bonding between mortar and fiber and prevent the dissociation of the composite material with time. (2\%, 4\%, 6\%, 8\%) percentages of reed fiber was mixed for every Reed fiber size (300\µ, 150\µ, 75\µ).
The curing period was 14 days, physical and mechanical tests were performed according to ASTM standard c-1185.
Different variation in results observed by changing fiber content and fiber size. The results showed an enhancement in density, thermal insulation, by increasing reed fiber content and decreasing in size, while its shows an increasing in moisture content and water absorption by increasing reed content because reed is one type of soft wood, the wood property is absorbing and keeping moisture. The best dry and wet flexural strength is in 8 wt\% of 150\µ reed fiber.

Keywords: cement board, reed fiber, red iron wood (Lophira alata)

1. Introduction:

the fiber cement composite is mostly used in a lot of countries in many different type, size and shapes. Although fiber reinforced cement (FRC) composites have been classified according to many criteria, such as the fiber material (steel, synthetic, and natural organic) or the level of performance, a general, simple and convenient classification has been recently suggested, it is based on the response of the composite under tensile loading, which can be described as either strain softening after first cracking, or strain hardening. Such a classification suggests a level of performance irrespective of the fiber type, fiber content, or matrix composition[1]. Although the use of natural fibers is the oldest form of reinforcing a composite, the concept of utilizing fibers as reinforcement was resumed during the 20-th century toward the evolution of a wide variety of cementitious materials that reinforced with fibers into applications that require specific material...
properties. Compared to fabricated fibers, well common and available worldwide as well as friendlier to the environment since less energy is required to produce them. They are also a renewable resource. However, the properties of natural fibers are not as constant as those of synthetic fibers and natural fibers have a lower tensile strength[2]

Many literatures[3-4] indicated various advantages in the use of natural fibers in cement composites, among them the following: increased flexural strength, post-crack load bearing capacity, increased impact toughness and improved bending strength. Natural fibers exhibit many advantageous properties as reinforcement for composites. By far the best advantage of using natural fibers is that they offer significant cost reduction and benefits associated with processing as compared to synthetic fibers[5]. That’s why they are currently getting a lot of attention for replacing synthetic fibers[6]

Atoyebi [7] tested, the physical and mechanical properties of boards produced from red iron wood (Lophira alata) sawdust and palm kernel shell (PKS). The production of this particle boards involved the synergistic combination of effective parameters such as percentage composition of cement, sawdust and palm kernel shell varied between 25–40, 20–50 and 20–50 respectively. The boards were tested for physical properties such as water absorption (WA), thickness swelling (TS), density and mechanical properties such as modulus of rupture (MOR) and modulus of elasticity (MOE).

He concluded that: Minimum water absorption can be achieved with percentage composition of PKS between 26% and 32%. The density, MOR and MOE increases with increase in cement content of the boards. And The parameter which majorly influences the particleboards properties is sawdust followed by cement and lastly PKS.

Massijaya and etal [8] used Bamboo as raw materials for cement board the age effect of bamboo on the properties of cement board and properties comparation of cement board made from green and used bamboo were investigated. The age of bamboo consist of three group : young bamboo (1-2 years old), mature bamboo (3-4 years old) and old bamboo (> 4 years old). Two Indonesian bamboo species, namely ; ater bamboo (Gigantochloa atter) and betung bamboo (Dendrocalamus asper) and 2% CaCl2 based on cement weight were used for manufacturing cement board.. The result of this study are as follows: 1) The mature bamboo has lowest modulus of rupture compared to the other types of board, while its modulus of elasticity tend to decrease with the increasing of bamboo age. 2) The modulus of rupture of cement board made from ater bamboo was equal with betung bamboo relatively, while their moduli of elasticity tend to inferior compared to cement board made from betung bamboo. 3) The dimensional stability and modulus of rupture of cement board made from used bamboo more superior compared to cement board made from green bamboo while its modulus of elasticity more inferior.

Ali.I.M [2] used date palm (soft wood) and willow (hard wood) as cellulotic fibers for the production of wood-cement composite boards, in addition to enhance their compatibility with cement by using physical pretreatment processes and accelerated carbonation curing. Experiments were performed to assess the physical and mechanical and microstructural properties. The results showed an improvement in the physical and microstructural properties of cellulotic fiber-cement composites by using the optimum manufacturing parameters (100% CO2, 90min., and 39 oC) for willow fiberboards and (60% CO2, 138min., and 56 oC) for date palm fiberboards through accelerated CO2 curing method. In addition, excessive carbonation rate associated with pure gas carbonation does not necessarily led to high strength. Willow and date
palm fibers were suitable waste materials to be used as a reinforcement with cement only if they were pre-treated with hot water immersion cycles for 4hrs at least, since maximum flexural strength exceeds 1.89 MPa,

Shawia and etal [9] prepared fiber-cement panels made from the husks of rice paper and old newspapers, which are used in the prefabricated building panels, The flexural strength reaches 6.99 MP compared with imported panels of 3.5 MP; thus these manufactured panels are resistant to combustion. The present study used rice husk with waste of newspaper at different rate in addition to cement and polymer materials consist of poly vinyl astate (PVA) and poly ol (PO) with rate (3:1) respectively. Experimental results show that the unit weight of natural fiber cement boards are about 1408 to 1630 kg/m3. The flexural strength of natural fiber cement boards is 70% higher than that of typical building materials and thermal conductivity with 0.217 to 0.430 Watt/m°K shows a, The compressive strength of natural fiber cement boards with the value of 17.5 to 22.1 N/mm2 is lower than that of the comparison material with 26.9 N/mm2 good combustion-resistant capability

Liu etal [10] used bamboo fibers, coconut fibers, rice-husks and sugar cane-dregs, respectively, to make natural fiber cement boards for the building partition. Experimental results show that the unit weight of natural fiber cement boards are about 1430-1630 kgf/m3. The flexural strength of natural fiber cement boards is 80% higher than that of typical building materials, except for rice-husks cement board. The length change in the absorption test is within the range of 0.09%-0.16%, and the thermal conductivity with 0.201-0.296 kcal/m·°C·hr shows a good heat-resistant capability.

The aim of this work is to use natural sources so to reduce cost, also to obtain cement board with additional advantages

2. Materials and Experimentation:
Reed fiber, Sand, cement, lime, superplastisizer (sp), water are used in this work

1-reed fiber preparation by many stages:
- Cutting reed primarily into large pieces(5-10cm).
- Initial grinding of reed
- Chemical treatment with NaOH solution (5%concentration) for 3 hours
- Washing by tap water.
- Drying at a temperature not exceeding 50 °C
- Regrinding the reed fiber then sieving to obtain different sizes.

2- prepare the weight fraction of material as in table.1

3-Mix well the dry ingredients separately (cement, sand, lime and fiber) to homogenize the mixture

4-Water and sp are mixed separately.
5-adding water and plasticizer to the mixture and mix it well by mixer for 5 Minutes.
6-Molded in dimensions (305×152×12mm) according to the specification (ASTM C 1185)[75] as shown in the figure.1

7- Curing:
After mixing and casting into the molds the samples are covered by a plastic to prevent evaporation. Then the samples are demolded after 24 hours of casting and placed in a closed medium where curing is done by keeping the surface of the sample moist for 14 days.

Table 1. Mix. Design of work

| Group no. | Fiber size/type | Mix No. | Cement : sand + lime (50% sand + 50% lime) | Sp% |
|-----------|-----------------|---------|------------------------------------------|-----|
| A         | 300µm reed      | A1(2% fiber) 1:2 | 1.8 |
|           |                 | A2(4% fiber) 1:2 | 1.8 |
|           |                 | A3(6% fiber) 1:2 | 1.8 |
|           |                 | A4(8% fiber) 1:2 | 1.8 |
| B         | 150µm reed      | B1(2% fiber) 1:2 | 1.8 |
|           |                 | B2(4% fiber) 1:2 | 1.8 |
|           |                 | B3(6% fiber) 1:2 | 1.8 |
|           |                 | B4(8% fiber) 1:2 | 1.8 |
| C         | 75µm Reed       | C1(2% fiber) 1:2 | 1.8 |
|           |                 | C2(4% fiber) 1:2 | 1.8 |
|           |                 | C3(6% fiber) 1:2 | 1.8 |
|           |                 | C4(8% fiber) 1:2 | 1.8 |
3. Results and Discussion:

3.1. Density:
Increasing in fiber content leads to decreasing in board density so decreasing in fiber size leads to decreasing density too as in figure 2, because of increasing of total surface area then in total size. The best value of density was at (C4) it was (1.658 g/cm³) while the commercial type density is about (2.3 g/cm³), the decreasing percent its (21%).

![Figure 2: Effect of fiber content on density of cement board](image)

3.2 Thermal conductivity test
The coefficient of thermal conductivity decreases, with fiber percent increasing of different sizes when using reed fibers as in figure 3, that leads to increasing the insulation property because reed is consider a type of soft wood and it is known that wood is one of thermal insulating material. the coefficient of thermal conductivity of commercial type board is (0.3498 W/m.k) and the best insulating property was obtained at (C4) is: (0.4444 W/m.k) the decreasing percent in coefficient is 34%.
3.3. Moisture content test

The moisture content increase with increasing reed fiber content and also with reducing the volume of fibers as in figure 4, due to the increase in the Surface area of the fiber, cellulosic fibers absorb and maintain moisture. The best results of this test is at A1 0.73%.

3.4. Water absorption test

The water absorption increase with increasing reed fiber content and also with reducing its volume as in figure 5 due to the increase in total Surface area of the fiber, cellulosic fibers absorb and maintain moisture.
3.5. Wet flexural strength:

The purpose of using fiber in composite materials is to increase the tensile and flexural strength for materials that have high compression strength and low tensile strength. We can increase the flexural strength of the cement boards by using a new type of fiber. The results of flexural strength were varied according to the sizes, percent, and type of fiber. As in Figure 6, the best flexural strength value was obtained when using (B4 8 wt%) reed fiber in size 150µ it was (8.64 Mpa).

3.6. Dry flexural strength

The results of flexural strength were varied according to the sizes, percent, and type of fiber as in Figure 7. The best flexural strength value was obtained when using (B4 8 wt%) reed fiber in size 150µ it was (8.4425 Mpa), this value is within the limits of the ASTM C-1185.
standard. The wet flexural strength when using reed fiber is greater than dry flexural strength because the tensile strength of wet reed greater than dry reed.

![Graph showing effect of fiber content on dry flexural strength of cement board]

**Figure 7** effect of fiber content on dry flexural strength of cement board

**4. Conclusion:**

1. The density of reed and is (1.5 g/cm³), using reed fiber led to reducing in density. the best result (1.658g/cm³) at C4(8% of 75µ reed fiber)

2. Improvement at thermal insulation property when using reed fiber. The best result of coefficient of thermal conductivity is (0.4444 W/m.k) at (C4).

3. There was no improvement in moisture content at reed fiber.

4. Water absorption increased with increasing in fiber content.

5. There was an improvement in mechanical properties (wet flexural strength, dry flexural strength) the best results of wet flexural strength was (8.64,) Mpa for reed, and best result of dry flexural strength was (8.4425) Mpa.

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