ISSN: 0975-833X

Available online at http://www.journalcra.com

International Journal of Current Research
Vol. 8, Issue, 11, pp.40843-40846, November, 2016

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

RESEARCH ARTICLE

UTILIZATION OF ABACA FIBER AS A COMPONENT MATERIAL IN CONCRETE HOLLOW BLOCKS

***Dr. Grace O. Manlapas**

Research Director, Eastern Samar State University, Borongan City, Eastern Samar, Philippines

ARTICLE INFO

Article History:
Received 17th August, 2016
Received in revised form
24th September, 2016
Accepted 23rd October, 2016
Published online 30th November, 2016

Key words:
Concrete hollow blocks,
Component material,
Aggregates.

ABSTRACT

The objectives of the study was to determine the quality attributes of the aggregates such as sand and pea gravel as to sieve analysis, moisture content, unit weight/mass determination, specific gravity, and absorption; to determine the compressive strength of the concrete hollow blocks using two different treatments- 1:2:4+0% (without abaca fiber) and 1:1.88:3.76+6% (with abaca fiber) after 14 days curing period; to determine the significant mean difference between the two treatments; and to determine the cost and return analysis. Tests showed that on the 14th day of curing, the CHB samples with abaca fibers attained a compressive strength of 500 psi, the minimum value stipulated in ASTM C129 for hollow non-load bearing concrete masonry unit. It's not only about the addition of abaca fiber that improved the CHB, but equally significant is the potential of recycling materials for a better environment and the economic impact in communities where abaca industry is active.The difference between the two treatment means is significant material at 5% level. Hence, the CHB with abaca fiber has higher compressive strength than the CHB without abaca fiber. CHB A with a design mix of 1:2:4+0% abaca fiber can produce 55 pcs. Per bag of cement at Php10.00 per block while CHB B with a design mix of 1:1.88:3.76+6% abaca fiber can also produce 55 pcs at Php9.90 per block with a return of investment of 19% for one year.

Citation: Dr. Grace O. Manlapas. 2016. "Utilization of abaca fiber as a component material in concrete hollow blocks", *International Journal of Current Research*, 8, (11), 40843-40846.

INTRODUCTION

Plain concrete has low resistance when it comes to flexure and deflection. The weakness was attributed to the crack formation that sometimes developed in the concrete. Enhancement of such properties in concrete could be achieved by the addition of fibers with the basic role that is to bridge across the crack. Concrete Hollow Block (CHB) is very common nowadays in building and construction for it is time proofed and earthquake resistant walling materials. It can be produced by hand and by machine. Moreover, the utilization of abaca fibers as a component material is environment- friendly as well as it gave more strength to the blocks due to the crack control capability of the fiber and it is environment- friendly as well. Abaca (*Musa textilis*), a tree-like herb which is of the same genus as the common banana as it closely resembles is three times stronger than the coniferous fiber and is far more resistant to salt water decomposition than most vegetable fibers. The fiber has remarkably high physical strength properties such as tensile, burst, folding, tear and inter fiber bonding strength, which are primarily due to its high Runkel ratio (Abaca Philippines, 2007).

Corresponding author: Dr. Grace O. Manlapas,
Research Director, Eastern Samar State University, Borongan City, Eastern Samar, Philippines.

Abaca leaves are narrower with pointed ends and the general coloration of the leaves is glossy dark green about 8 ft. in length and 12 ft. in width. The stem grows to a height of 9-12 ft., 3 inches in thickness. When mature, the abaca plant consists of about 12-30 stalks, 12-20 ft. high, radiating from a central root system, the source of fibers. Initially, it requires 2 to 4 years for the abaca plant to ripen. However, the abaca can grow shoots that develop roots and become ready for harvest in 4-8 months after the initial crop. When all the leaves have been formed from the stem, flower buds develop, at which time the plant has reached maturity and ready for harvest (Abaca Philippines. 2007). The physical property of the abaca fiber in Leyte Region as to its tensile strength is 52.15 kgf/g/m; the variety are more elastic with 7.05% elongation. For the morphological property, abaca fiber in Leyte has the shortest fibers which ranges from 4.79 to 4.22m. It has a fiber diameter that ranges from 20.03μ. It appears to have wider lumen which ranges from 11.36μ to 12.78μ. It has a medium cell wall that ranges from 4.34μ to 4.05μ. As to the chemical property, the variety from Leyte has the lowest lignin content that ranges from 9.54% to 9.79% and soluble in alcohol-benzene that ranges from 0.58% to 0.61%. Fiber Medium in Holo from 89.20% to 89.76% and Alpha from 65.41% to 64.74% Cellulose Content (Fiber Technology and Utilization Division, 1997).

Across the globe, abaca products are known for its versatility. It's about the by-products such as ropes, cloth, furniture, paper, cordage, fashion accessories, and home decors. Although this material has been popularly used for many decades, what may not be generally known is that abaca fiber can also be utilized as a component material of concrete hollow blocks (CHB), which is primarily used as building materials in the construction of walls and other structures. A concrete hollow block is sometimes called a concrete masonry unit. It is one of the precast concrete products used in construction as it is formed and hardened before they are used or brought to the job site. The concrete that is commonly used to make concrete hollow blocks is a mixture of powdered Portland cement, sand, pea gravel and water which produces a light gray block with a fine surface texture.

Statement of the Problem

This study on the utilization of abaca fiber as a component material in Concrete Hollow Blockaims to determine as to:

- What are the quality attributes of the aggregates as to:
  - sieve analysis,
  - moisture Content,
  - unit weight/ mass determine,
  - specific gravity,
  - water absorption
- What is the compressive strength of the concrete hollow blocks with and without the abaca fiber after 14 days curing period?
- What is the significant mean difference of the concrete hollow blocks considering its compressive strength after 14 days curing period?
- What is the cost and return analysis of the concrete hollow blocks?

Review of Relevant Literature

Abaca fibers have several industrial applications for building materials such as fiber boards, ceramic tiles, wall facades, plumbing fixtures, reinforced concrete and roofing, caulking, flooring and electricity poles. It was even used as ropes by American navy since 1834 for it had a remarkable tensile strength as it is more resistant to salt water decomposition. In fact, it was and still the strongest of all natural fibers and these qualities were appreciated by other foreign shipping companies as well. These facts are published by Abaca Philippines (2007). According to Beltran (2005), plain concrete is a brittle material with low tensile strength and strain capacities. The addition of fibers in concrete at considerable amount provided contribution in the compressive strength of the composite due to the intertwining effect of the fibers. It has an obvious enhancement on the flexural strength of the fiber reinforced concrete. A greater increase in the flexural resistance or modulus of rupture was observed at considerable amount and length of abaca fiber (Beltran, 2005). The American Society for Testing and Materials (ASTM) C129 covers hollow and solid non-load bearing units that are intended for use in non-load bearing partitions. It reported that hollow and solid non-load bearing units require a minimum compressive strength of 500 psi (3.5 MPa) for individual units. The use of recycled and biodegradable materials instead of plastics and other synthetic materials has encouraged many industries to shift back to the utilization of environmentally-friendly natural raw materials such as abaca. As abaca is indigenous in the Philippines and is considered as the strongest among natural fibers, this moreover promoted the conduct of the study.

MATERIALS AND METHODS

The study was an experimental type of research which involved the preparation of material such as the cutting of the abaca fibers into an approximate length of 10-15mm to be strong enough and to prevent from bending during the mixing process. The abaca fiber used in the study was the wastes or rejected abaca fiber. The aggregates samples such as sand (fine aggregates) and pea gravel (coarse aggregates) were taken from the locality. The aggregate samples and abaca fiber were prepared for the laboratory tests conducted at the College of Engineering and Technology-Testing and Laboratory to determine the quality attributes as to sieve analysis, moisture content, unit weight/mass determination, specific gravity and water absorption. There were two treatments (design mix) employed in the production of the concrete hollow blocks, namely: 1:2:4 + 0% (1 bag of Portland cement Type 1, 2 $ft.^3$ sand, 4 $ft.^3$ pea gravel), and 0% Abaca Fiber (no fiber); and the 1:1.88:3.76 + 6% (1 bag of Portland cement Type 1, 1.88 $ft.^3$ sand,3.76 $ft.^3$ Pea gravel, and 6% Abaca Fiber). The 6% of the 2 $ft.^3$ of sand that is equivalent to 0.12 $ft.^3$ and the 6% of the 4 $ft.^3$ of pea gravel which is equivalent to 0.24 $ft.^3$ was removed and was replaced with its equivalent volume by the 10-15mm cut abaca fibers equivalent to 0.36 $ft.^3$. For each design mix, the materials were prepared according to the volume as stated in Table 1. The aggregates such as sand and pea gravel were first mixed, and the cut abaca fibers were sprinkled to the mixed sand and pea gravel and were mixed again. The cement was mixed and a certain amount of clean water was poured until it reached to its readiness and good workability. When the concrete was thoroughly mixed, it was placed in a 4"x8"x16" CHB molder and released in an open space for drying. After 14 days curing period, the concrete hollow blocks were brought to DPWH Laboratory-Borongan City for the quality tests to determine its compressive strength using a Universal Testing Machine (UTM). As presented in Table 1, CHB A with a design mix of 1:2:4+0% used 1 bag of Cement, 2 ft.3 of sand, 4 ft.3 of pea gravel, no abaca fiber added, 15 liters of clean water that produced 55 pcs. CHB with a design mix of 1:1.88:3.76+6% used 1 bag of cement, 1.88 ft.3 sand, 3.76 ft. pea gravel, 0.36 ft.3 abaca fiber, 15 liters of clean water resulted to 55 pcs CHB.

RESULTS AND DISCUSSION

Quality Attributes of Aggregates

The quality attributes of aggregates (sand and pea gravel) as to sieve analysis is presented in Table 2, likewise for its moisture content, unit weight /mass determination, specific gravity, and absorption are presented in Table 3. Based on the results presented in Table 2 for the sieve analysis of the aggregates, Using 3", 1 ½" and 3/8" passed the governing specifications. No. 4 sieve, no. 10, 40, and no.200 also passed the governing specifications. Based on the laboratory results presented in Table 3, the moisture content of is 8.78%, pea gravel has 4.29%. Sand has a unit weight/mass determination of 1560.40 kg/m^3, pea gravel has 1636.53 kg/m^3 .specific gravity of 2.18, and pea gravel has 1.23. Sand has absorption of 4.25%, and pea gravel has 2.25%.

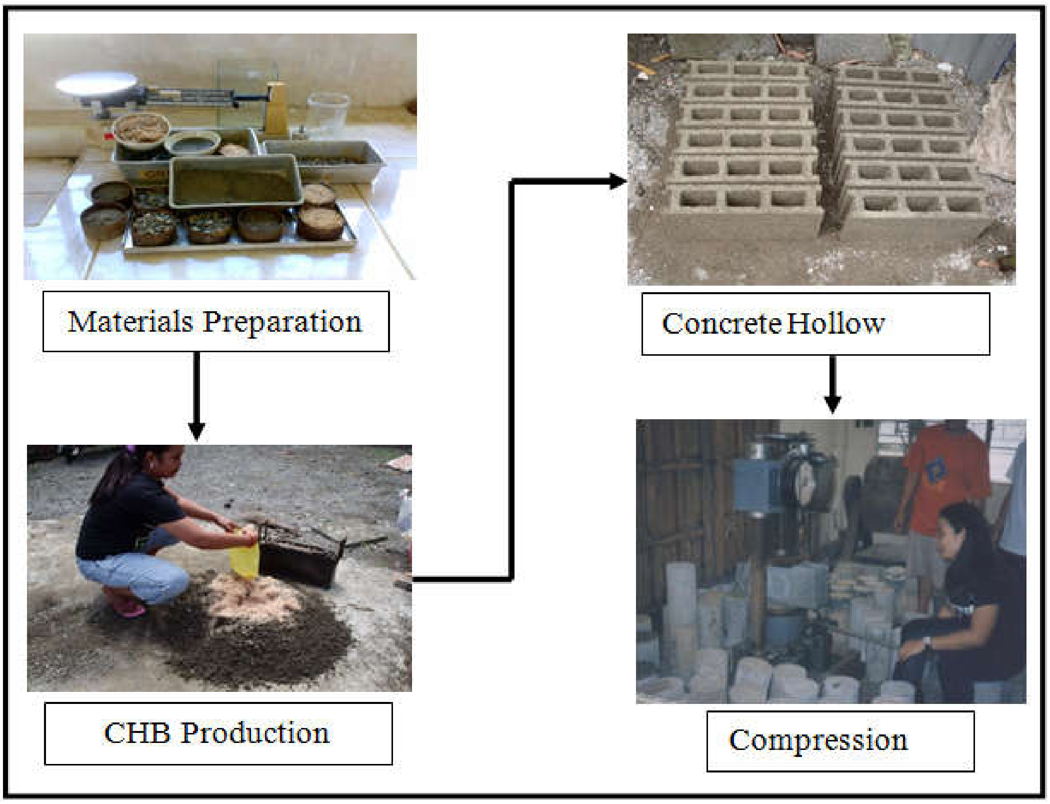

Figure 1. Flow of the Study

Table 1. Materials of the Concrete Hollow Block

CHB	Design Mix	Cement (Bags)	Sand (ft.^{3})	Pea Gravel (ft.^{3})	Abaca Fiber (ft.^{3})	Water (liters)	CHB (pcs.)
A	1:2:4 + 0%	1	2	4	0	15	55
B	1:1.88:3.76 +6%	1	1.88	3.76	0.36	15	55

Table 2. Quality Attributes as to Sieve Analysis

Sieve size		Wt. Ret. gm	Cumulative			Governing Specification
Inch	MM		Weight Passing	% Passing	% Retained	
3”	75	0	6707	100	-	100
11/2”	37.5	0	6707	100	-	80-100
3/8”	9.5	872	5835	87	-	45-100
No.4	4.75	3555	2280	34	-	30-85
No.10	2.99	1140	1140	17	-	15-65
No.40	425µm	738	402	6	-	5-35
No.200	75µm	268	134	2	-	0-3
Pan		3	-	-	-	-
Wash Loss Passing No. 200		131	-	-	-	-
TOTAL		6707				

Table 3. Quality Attributes of Aggregates as to Moisture Content, Unit Wt./Mass Determination, Specific Gravity and Absorption

Quality Attributes	Sand	Pea Gravel
Moisture Content, %	8.78	4.29
Unit Weight/Mass Determination, kg./m^3	1560.40	1636.53
Specific Gravity	2.18	1.23
Absorption, %	4.28	2.25

Table 4. Compressive Strength of CHB

CHB	Compressive Strength, Psi			Average, Psi
	1	2	3	
A	488.50	602	610	566.83
B	495	605	632.50	577.50

Table 5. T-Test of CHB Compressive Strength

CHB	Compressive Strength, Psi			Total	Mean
	1	2	3		
A	488.50	602	610	1700.50	566.83
B	495	605	632.50	1,732.50	577.50

Table 6. Cost Analysis

Design Mix	Material Cost (Php)				Total Material Cost	Labor Cost	Total Cost (TC)	Profit (20% of TC)	Net Cost	Output (Pcs.)	Price/ Block
	Cement	Sand	Pea Gravel	Abaca Fiber							
(A)1:2:4 + 0%	240	34.20	73.45	-	347.65	110	457.65	91.53	549.18	55	10.00
(B)1:1.88:3.76 + 6%	240	31.80	68.90	5.00	345.70	110	455.70	91.14	546.84	55	9.90

Table 7. Return of Investment (ROI) for One Year

CHB	Gross sales for 1 Year, Php	Expenses for 1 Year, Php	Net profit, Php	ROI, %
A	633,600.00	529,412.80	104,187.20	19.68
B	627,264.00	527,166.40	100,097.60	19.00

Based on the results presented in Table 4 for the compressive strength of concrete hollow block, CHB A (without abaca fiber) yielded an individual strength of 488.50 psi (pounds per square inch), 602 psi, and 610 psi with an average of 566.83 psi. CHB B (with 6% abaca fiber) yielded a higher individual compressive strength of 495 psi, 605 psi, and 632.50 psi respectively. CHB B has the average compressive strength of 577.50 psi. It passed the standards set by the American Society for Testing and Materials (ASTM C129) for individual compressive strength of non-load bearing concrete hollow blocks which is 500 psi (3.45 Mpa). For the statistical analysis, t-test was used in the study. Based on the compressive strength results presented in Table 5, the difference between the two treatment means is significant at 5% level. The df being 4.

Hence, the concrete hollow block with the 6% abaca fiber (CHB B) has a higher compressive strength than the concrete hollow block without abaca fiber (CHB A). As presented in Table 6, the CHB A with a design mix of 1:2:4+0% Abaca Fiber (without abaca fiber) has a total cost of P457.65 for the Labor and Materials and a 20% profit of the TC amounting P91.53. The Net Cost amounted to P549.18. The total number of CHB produced was 55 pcs. That amounted to P10.00 per block. CHB B with 6% Abaca Fiber has a Total Cost for the Labor and materials of P455.70 and a Profit of P91.14. It has a Net Cost of P546.84. The total number of CHB produced was 55 pcs. That amounted to P9.90 per block. The cost of Portland cement type 1 is Php240/bag, sand is Php600/m^3, pea gravel is Php650/m^3, and abaca fiber is Php50/kilo. As presented in Table 6, the Return of Investment (ROI) for one (1) year investmentof CHB A (without abaca Fiber) is 19.68%, while CHB B (with abaca fiber) is 19%.

Conclusion

The utilization of abaca fiber as a component material had a very good performance in the production of concrete hollow blocks (CHB).

The aggregates passed the quality attributes tests conducted as to sieve analysis, moisture content, unit weight/mass determination, specific gravity, and absorption. The concrete hollow block with abaca fiber (CHB B) yielded a higher compressive strength that passed the standards set by ASTM C129 for individual non-load bearing units, whereas the concrete hollow block without abaca fiber (CHB A) that yielded a lower compressive strength and did not passed the allowable compressive strength for individual non-load bearing units set by ASTM C129. There was a significant mean difference between the CHB at 5% level. CHB B with the abaca fiber was more economical that amounted to Php9.90/pc., compared to CHB A (without abaca fiber) that amounted to Php10.00/pc. and to the prevailing price in the locality which ranges from Php10.00-Php10.50/pc. The increase in strength of the concrete hollow block was attributed to the capability of abaca fiber to hold grains in sand and pea gravel in place which prevented the crack formation in the block. Therefore, abaca fiber is considered as a good component material of concrete hollow block.

Acknowledgement

The author would like to thank Eastern Samar State University Administration for the financial support and the ESSU College of Engineering.

REFERENCES

American Society of Testing and Materials.Standard Specification for Non-load Bearing Concrete Masonry Units. ASTM International. USA. 2003.

Beltran, Gil S. A Study on the Abaca Fiber Reinforced Concrete Composite. Technological University of the Philippines. Cavite. 2005.

Fiber Industry Development Authority. Determination of the Characteristics of Selected Abaca Variety.Fiber Technology and Utilization Division. BAI Compound, Visayas Avenue, Diliman Quezon City. Phils. 1997.

****