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POTENTIALS OF WATER HYACINTH ASH IN PARTIAL REPLACEMENT OF CEMENT

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ABSTRACT

The need to achieve more housing for all requires the reduction in the persistent increase in the cost of building materials such as cement and also finding new materials. This research work is aimed at determining the possibility of using some percentage of water hyacinth with cement for concrete production. The water hyacinth was completely dried and ground to ash form. Using a mix ratio of 1:2:4, the compressive strength of cubes made from cement/water hyacinth of different percentage ratios of 100:00, 70:30, 60:40, 50:50 results were compared. The results showed that after 28 days of curing the compressive strength test of 100% cement concrete was quite higher than that of other ratios of cement/water hyacinth mixture. Even though the strength is not high enough for structures requiring high compressive strength, it could still be applicable to storage structures with low compressive strength. Its use in other areas such as in water treatment plants and the production of biogas is also recommended.

Keywords: Cement, Water- Hyacinth Ash, Concrete, Compressive Strength, Storage Structure

1.0 INTRODUCTION

Concrete may be defined as a mixture of cement as a binder and aggregate where water and cement form paste and the aggregates form at the inert filler (Neville 1995). The use of 100% cement in concrete technology has been in existence for a long time. With the persistent increase in the cost of cement, various attempts aimed at resolving this serious issue in construction industry include using a high percentage of aggregate to cement ratios and the

partial replacement of cement with other materials especially pozzolanas with similar properties as cement.

Fly ash, rice husk ash, maize husk ash, groundnut shell ash and palm kernel bunch ash have been tested and had proved to be successful at various replacements of cement in concrete (Alabadan and Amah, 2005 and Alabadan *et al*. 2006). Water hyacinth (*Eichhornia crassipes*) is an attractive aquatic flowering plant. The water hyacinth can be seen in botanic gardens and private conservatories, floating in tubs or pools by means of its inflated bladder-like leaf stalks, and lavishly dispensing its loose spikes of pale violet flowers throughout the summer season. In Nigeria, the plant grows so abundantly in the southern coastal rivers and other navigable waters, and it obstructs the passage of ship and other water vessels. It also poses a problem in irrigation channels and ditches, the plant is very difficult to eradicate and it has clogged the channel of many rivers. If not controlled, water hyacinth can entirely take over our water ways, canals and ponds. This impedes the movement of water vessels, prevents sunlight from reaching native aquatic life and starves the water of oxygen, often leading to death of this aquatic life. The plant also creates a prime habitat for mosquito which spreads malaria, hence the need to investigate its economic importance in the area of engineering construction Alabadan *et al*. (2006). The main objective of this project work is the determination of the suitability of using the water hyacinth ash as a replacement for cement for concrete production.

2.0 MATERIALS AND METHODS

2.1 Materials

The major materials used in the laboratory include ordinary Portland cement (OPC), waterhyacinth Ash, sand (fine aggregate), mould (150mm x 150mm x 150mm), shovels, hand trowels, head pan, curing tanks, wire brush, gravels, mixing pan, tapping rod, clean water and slump cone.

2.2 Water Hyacinth Ash Production

The water hyacinth was harvested manually from the river Benue, Makurdi, Benue state. The water hyacinth was first sun-dried and burned at a temperature of 500 ^{0}C to 700 ^{0}C in a furnace to obtain its ash. The burnt ash was sieved through 75 microns BS sieve after grinding. The ash was carried for further analysis and its resultant oxide composition was conformed to standard.

2.3 Concrete Specimen Preparation

The different ratio of concrete mix was prepared using 1:2:4 mix ratio. The ratios used for the one part of cement and water hyacinth paste were 100:00 cement/water hyacinth as control, 70:30 cement/water hyacinth 60:40 cement/water hyacinth and 50:50 cement/water hyacinth.

The partial replacement of cement with these different ratios of water hyacinth ash was done by absolute volume method. The volume of compacted concrete is equal to the sum of the absolute volume of all ingredients.

2.3.1 Cast of Concrete

The moulds of sizes 150mm x 150mm x 150mm (length, breadth and height) were used. The mixed concrete was scooped in to the mould. Compaction was then carried out in order to send out air bubbles and ramming the surface of the concrete to make the particles more compacted. 48 cubes of concrete were casted. Stripping is removal of the newly laid concrete from the mould. This is done after the concrete is set and strong enough to support its own weight. It was done 24 hours after setting under air. Curing was done by complete immersion in clean water in the curing tank for 28 days.

2.6 Compressive Strength Test

The cubes prepared in moulds were crushed in a compression machine at 7-, 14-, 21- and 28-days period of curing in water. Before crushing the cubes were brought out of water and weighed on a weighing balance and then taken to the crushing machine. The cubes experienced cracks due to failure in its strength as a result of the applied load by the compression machine. The readings were taken and recorded.

2.7 Slump Test

The slump cone was placed on a flat non-porous surface; it was then filled with the fresh concrete and compacted into two layers. Each layer was compacted by taping 35 times with a bullet point iron rod. The mould was removed immediately by raising it vertically and it was placed beside the slump concrete. The slump measured at the difference between the top of the cone and the top of the slump concrete was recorded for all mixes [CP (1972) and BS 1881 (1970)].

3.0 RESULTS AND DISCUSSIONS

3.1 Chemical Analysis

The chemical analysis of water hyacinth presented in Tables 1 and 2 showed great similarities with ordinary Portland cement. From the various analysis carried out, it is evident that water hyacinth contains all the six constituents of ordinary Portland cement but in varying proportions. This to some extent justifies one of the objectives of this project work.

3.2 Discussion of Results

The results from Tables 1 and 2 showed that cement and water hyacinth ash shows great similarities in chemical constituents, hence a great possibility of its use. The most significant difference is the percentage of lime that is 60 percent in cement but 8.50 percent in water hyacinth ash. The results of the compressive strength test from Table 3 shows a gradual increase in strength from 7 days to 28 days with an exceptional drop in strength of the 50:50 ratios which may be due to defects during compaction of the concrete cube. Results also showed a gain in weight of all the casted cubes. Also from Table 3 above, it can be clearly seen that at 70:30 cement/water hyacinth ratio has the highest strength of 6.67 N/mm^2 at 28 days curing period which is less than 100 percent cement which has strength of 24.22 N/mm^2. This then makes it imperative to use the water hyacinth ash that is less than 30% in the mix in other to fully achieve the desired or comparative strength.

Table 4 shows the slump test results. It can be clearly seen that the concrete with pure cement (100%) in the mix has a greater workability (slump) than others where water hyacinth was incorporated. The 100% cement mix has a higher compaction and uncompaction weights than those with of other combinations where water hyacinth ash was added.

Table 1: Chemical Analysis of Ordinary Portland cement

CONSTITUENT	**Lime**	**Silica**	**Alumina**	**Iron**	**Magnesia**	**Sulphur trioxide**
PERCENTAGE	**60**	**18**	**8**	**8**	**5**	**3**

Table 2: Chemical Analysis of Water Hyacinth Ash

CONSTITUENT	**Lime**	**Silica**	**Iron and Alumina**	**Magnesia**	**Sulphates**	**Potash**	**Phosphoric Oxide**	**Chlorine**	**Undetermined**
PERCENTAGE	8.50	39.40	17.00	5.61	2.57	11.20	4.00	9.23	2.49

Table 3: Average Compressive Strength Results

RATIO	**AGE (Days)**	**AV. WEIGHT (kg)**	**AV. LOAD (kN)**	**AV. CRUSHING STRENGTH (N/mm^2)**	**TYPE OF FAILURE**
100:00	7	7.25 6.86	482	21.42	Normal
70:30		6.92	68	3.02 1.78	
60:40		7.00	40	1.11	
50:50			25		

100:00	14	7.75 7.00	490	21.78	—
70:30		7.15	80	3.56 2.31	
60:40		7.30	52	1.51	
50:50			34		
100:00	21	8.19 7.18	510	22.67	—
70:30		7.10	92	3.09 2.58	
60:40		7.15	58	1.78	
50:50			40		
100:00	28	8.30 7.32	545	24.22	—
70:30		7.15	150	6.67 2.84	
60:40		7.17	64	1.60	
50:50			36		

Table 4: Slump Test Results

RATIO	**100:00**	**70:30**	**60:40**	**50:50**
COMPACTION (kg)	14.90 13.60	14.40 13.10	14.20 13.00	14.05
UNCOMPACTION (kg)	30	24	20	12.90 14
SLUMP (mm)				

The 70:30 mix of cement and water hyacinth which has a slump of 24mm which is quite close to the pure cement mix (100%) which has a slump of 30mm. This also shows that if the water hyacinth is processed with improved techniques coupled with less percentage of water hyacinth ash in the mixtures, the resulting concrete could yield better results.

The basic idea behind this research work is not to eliminate cement as a main constituent in making concrete, but it is meant to test the suitability of replacing cement partially with water hyacinth ash which is equally another way in which water hyacinth can be put into productive use. Despite these low strength results from the combinations, concrete from these could still be tried out for simple farmstead structures such as fish ponds and yam barns that requires minimal heat conduction, withstand light flexural loading and light load bearings. This will eventually reduce the cost of construction. Similarly the durability of the cement/water

hyacinth concrete should be ascertained, this will also aid in determining the life span of the structure.

CONCLUSION AND RECOMMENDATIONS

Conclusions

The results obtained from the compressive strength test shows that the cement and water hyacinth mixture for concrete has its highest strength at the 70:30 percent ratio. It can therefore be concluded that the cement and water hyacinth mixture cannot withstand as much load as the pure cement mixture. Hence water hyacinth ash at a lower percentage less than 30% can be used to some extent in replacing ordinary Portland cement in concrete production depending on the type of work to be carried out.

The chemical analysis of water hyacinth shows a great similarity with ordinary Portland cement thus, with improved researching techniques could turn out to be a huge success bearing in mind the huge abundant of the resources worldwide.

Recommendations

The followings are recommended.

1. A prototype structure should be constructed to determine its actual durability.
2. Other areas of use of water hyacinth such as in water treatment plants and in the production of biogas should be explored rather than disposal after clearing it off our coastal waters.
3. Production of quality water hyacinth cement composite should be encouraged. This will save both money and improved housing for all in the country since the material is cheap and readily available in the coastal waters of Nigeria.

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