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# Incorporation of Water Hyacinth in Concrete

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***Abstract* - Water hyacinths, in the rivers of Kerala, are the worst aquatic weed ever known, and the aqua life killers. These water plants are notorious for their fast growth. Hyacinths are considered as one of the most productive aquatic plant. A plant which can spread over the whole river in a small amount of time. Water hyacinths collected from a small area of river can weight upto tonnes. Water hyacinths are known to make allergies from their plant saps to humans. Also some diseases are seen in people living around the water bodies filled with hyacinth weeds. Recently they clogged the spillway of a dam in Kerala while trying to open the shutters and made serious damage to the Dam sidewalls. In this study the potential use of water hyacinth fibres (WHF) in the partial replacement of fine aggregate is studied. WHF was used as replacement for fine aggregate at 0.5, 1, 1.5 and 2 wt. %. Concrete cubes and cylinders were tested for compressive strength upto the age of 28 days. Test results reveal that concrete cubes with 0.5% WHF substitution for fine aggregate produced comparatively high compressive strength values. It was observed that the use of WHF in concrete has reduced water absorption characteristics, enhanced durability and improved compressive strength at higher temperature**

***Keywords-Water hyacinth, aggregates, concrete, tests on concrete***

## 1. INTRODUCTION

In recent year, the usage of natural fibers as reinforcement in polymer composites for producing low cost materials of engineering has created much attention. Natural fibers are very abundant, especially they derived from water plant are very easy to grow up. One of this was water hyacinth plants that grow very rapid and float on the water surface. *Eichhornia crassipes*, commonly known as water hyacinth, is a flowering monocot and an aquatic weed species of family Pontederiaceae, originally native to tropical and sub tropical South America Hyacinths are considered as one of the most productive aquatic plant. A plant which can spread over the whole river in a small amount of time. Water hyacinths collected from a small area of river can weight upto tonnes. Water hyacinths are known to make allergies from their plant saps to 1humans. Also some diseases are seen in people living around the water bodies filled with hyacinth weeds. Recently they clogged the spillway of a dam in Kerala while trying to open the shutters and made serious damage to the Dam side walls

Fig1: Water Hyacinth

## 2. METHODOLOGY

In this project, we are incorporating water hyacinth (W-H) in concrete to improve the permeability and tensile strength of concrete. We have collected water hyacinth from Kottapuram Integrated Development Society, Trissur. They were treated ones, The water hyacinth were first kept for sun burning for one day and then cleaned. The W-H were cut into pieces of length 5mm. 5mm was selected to avoid segregation and also size less than 5mm will not give better results.

It is done by preparing concrete cubes having W-H of 0%,0.5%, 1%, 1.5% & 2% of mass of fine aggregate for compressive and cylinders for splitting tensile test. Compressive and splitting tensile test is done on a compression testing machine.

Casting and testing of cubical specimens of size 150mm×150mm×150mm for compressive strength and cylindrical specimen of 15mm diameter and 30mm length for splitting tensile strength was done as per IS 516:1959 specifications. Compressive strength test was performed on 150mm cubes, tested at 28 days and cured in the water tank completely immersed at ambient temperature until the test age. All the test specimens were demoulded after 24 hours of casting. In this experiment, specimens with each percentage of W-H were casted. Results were found and compared with that of normal concrete. The cubes giving higher compressive and tensile strength is taken for further concrete tests. The other tests done are sorptivity test, rebound hammer test, water absorption test, heat resistance of concrete. A comparison of compressive strength of normal concrete with river sand as fine aggregates and concrete with river sand W-H as fine aggregates is also done.

## 4.TESTS DONE ON CONCRETE

*4.1. Compressive Strength Test on Concrete Cubes*

The test was conducted as per IS 516-1959. While casting W-H incorporated concrete 0%, 0.5%, 1%, 1.5%, 2% of W-H by weight of fine aggregate is used. All specimen was produced in a laboratory. The coarse aggregate fraction was mixed first, followed by the cement, sand, W-H and water, after 24 hours the moulds were removed and the specimen were kept for curing in a moist atmosphere for 28 days and then dried properly before testing. Compression test is the most common test conducted on hardened concrete, partly because it is an easy test to perform, and partly because most of the desirable characteristic properties of concrete are quantitatively related to its compressive strength.

*4.2. Splitting Tensile Strength Test On Concrete Cylinders(Is: 5816-1999, Is:456-2000)*

The tensile strength of concrete is one of the basic and important properties. Splitting tensile strength test on concrete cylinder is a method to determine the tensile strength of concrete. The concrete is very weak in tension due to its brittle nature and is not expected to resist the direct tension. The concrete develops cracks when subjected to tensile forces. Thus, it is necessary to determine the tensile strength of concrete to determine the load at which the concrete members may crack.

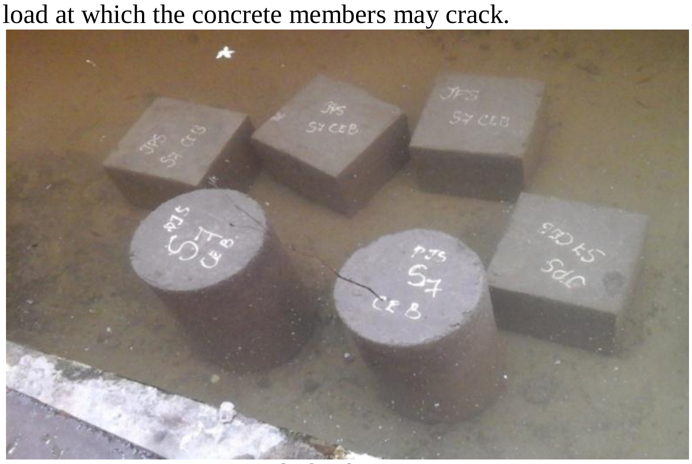


Fig 6: Cylindrical Specimen

*4.3water Absorption Test On Concrete*

For determination of water absorption of concrete specimen, wide variety of tests has been developed in the world. In these tests, usually weight gain of test specimen, volume of water entering the test specimen, depth of water penetration from surface or a combin1ation of two is measured. Standard testing procedures to determine water absorption of hardened concrete have been developed in the world, The expression to calculate water absorption is

Water Absorption = [(B-A)/A]×100

where,

A = Dry weight of test specimen

B = Wet Weightof test specimen after immersion in water for 48hrs

*4.4sorptivity Test on Concrete*

The sorptivity can be determined by the measurement of the capillary rise absorption rate on reasonably homogeneous material. Water was used of the test fluid. The cylinders after casting were immersed in water for 90 days curing. The specimen size 100mm dia x 50 mm height after drying in oven at temperature of 100 + 10°C were drowned as shown in figure 4with water level not more than 5 mm above the base of specimen and the flow from the peripheral surface is prevented by sealing it properly with non-absorbent coating. The quantity of water absorbed in time period of 30 minutes was measured by weighting the specimen on a top pan balance weighting upto 0.1 mg surface water on the specimen was wiped off with a dampened tissue and each weighting operation was completed within 30 seconds.

Fig 7 :Sorptivity Test

Sorptivity (S) is a material property which characterizes the tendency of a porous material to absorb and transmit water by capillarity. The cumulative water absorption (per unit area of the inflow surface) increases as the square root of elapsed time (t)

$I=S.t^{1/2}$

therefore $S=I/ t^{1/2}$

Where;S= sorptivity in mm,

t= elapsed time in mint.

I=Δw/Ad

Δw= change in weight= W2-W1

W1 = Oven dry weight of cylinder in grams

W2 = Weight of cylinder after30 minutes capillary suction of water in grams

A= surface area of the specimen through which water penetrated.

d= density of water

*4.5 Heat Resistance Test on Concrete*

At 28 days, a control set of unheated samples was tested for compressive and tensile flexural strength. Other specimens were heated in an electric furnace a heating rate of 10ºC/min to target temperature. Three target temperatures; namely, 300, 500and 700ºC were used. At each target temperature, the specimens were maintained at the target temperature for the duration of 3, 6 and 9 hours so that the temperature in the middle of the specimen is close to the target temperature, as measured by a Type K thermocouple. The specimen after heating is checked for compression testing and the compressive strength of both W-H incorporated concrete and normal concrete is obtained.

*4.6 Comparison Of Normal And Water Hyacinth(W-H) Incorporated Concrete With River Sand As Fine Aggregates*

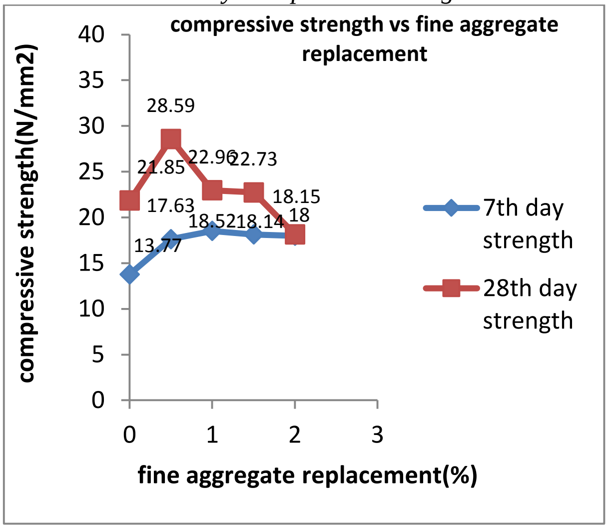
Concrete is made with river sand as fine aggregate and another cube with W-H and river sand as fine aggregate. It is kept for curing for 28 days. Compression test is the most common test conducted on hardened concrete, partly because it is an easy test to perform, and partly because most of the desirable characteristic properties of concrete are quantitatively related to its compressive strength.

## 5. RESULTS

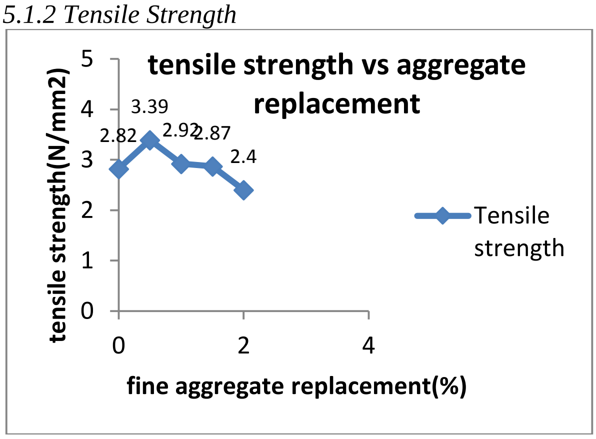
*5.1. Compressive Strength ($M_{20}$)*

Concrete cubes incorporating water hyacinth of 0%, 0.5%, 1%, & 1.5% of fine aggregates were casted. A total of 6 cubes were casted for 7th day and 28th day testing.

*5.1.1 7th And 28th Day Compressive Strength Test Result*




*5.1.2 Tensile Strength*




Here concrete with 0.5% W-H incorporated has got a higher compressive and tensile strength. So tests were further done on 0.5% W-H incorporated concrete and results were obtained.

*5.2 Water Absorption Test*

Water Absorption = [(B-A)/A]×100

where,

A = Dry weight of test specimen

B = Wet Weight of test specimen after immersion in water for 48hrs

Weight of normal concrete (kg)= 8.508 kg

Weight of W-H incorporated concrete=8.382 kg

After 24 hrs immersion,

Weight of normal concrete(kg)= 8.614 kg

Weight of W-H incorporated concrete=8.478 kg

Water absorption of normal concrete= (8.614-8.508)/8.508*100=1.24%

Water absorption of W-H incorporated concrete= (8.478-8.382)/8.382*100=km1.15%

5.3 SORPTIVITY TEST

Sorptivity, S=I/ t½

Where; S= sorptivity in mm,

t= elapsed time in mint.

I=Δw/Ad

Δw= change in weight= W2-W1

W1 = Oven dry weight of cylinder in grams

W2 = Weight of cylinder after30 minutes capillary suction of water in grams

A= surface area of the specimen through which water penetrated.

d= density of water

Sorptivity of normal concrete=2.613 mm/min$^{0.5}$

Sorptivity of W-H incorporated concrete=2.613 mm/min$^{0.5}$

*5.4 Comparison of River Sand And W-H As Fine Aggregate*

7th day compressive strength of concrete with river sand as fine aggregate

Table 21: 7th Day Compressive Strength Of Concrete Cube With River Sand As Fine Aggregate

| SI NO. | BREAKING LOAD (kN) | COMPRESSIVE STRENGTH (N/mm$^2$) |
|---|---|---|
| 1. | 370 | 16.44 |
| 2. | 370 | 16.44 |
| 3. | 370 | 16.44 |

The average value =16.44N/mm$^2$

7th day compressive strength of concrete with river sand and W-H as fine aggregate

Table 22: 7th Day Compressive Strength Of Concrete Cube With W-H And River Sand As Fine Agggregate

| SI NO. | BREAKING LOAD (kN) | COMPRESSIVE STRENGTH (N/mm$^2$) |
|---|---|---|
| 1. | 450 | 20 |
| 2. | 470 | 20.88 |
| 3. | 450 | 20 |

The average value =20.29N/mm$^2$

*5.5 HEAT RESISTANCE OF CONCRETE*

For normal concrete

Table 23: Compressive Strength Of Normal Concrete Cube After 24 Hours Heating

| SI NO. | BREAKING LOAD (kN) | COMPRESSIVE STRENGTH ($N/mm^2$) |
|---|---|---|
| 1. | 500 | 22.22 |
| 2. | 500 | 22.22 |
| 3. | 500 | 22.22 |

The average value =22.22N/mm$^2$

For 0.5% W-H incorporated concrete

Table 24: Compressive Strength of W-H Incorporated Concrete Cube After 24 Hours Heating

| SI NO. | BREAKING LOAD (kN) | COMPRESSIVE STRENGTH ($N/mm^2$) |
|---|---|---|
| 1. | 750 | 33.33 |
| 2. | 750 | 33.33 |
| 3. | 700 | 31.11 |

The average value =32.59N/mm$^2$

## 6. STRUCTURAL APPLICATIONS

Structural application of water hyacinth incorporated concrete are discussed here

- Can be used in marine structures: As the water absorption capacity of W-H incorporated concrete is more than that of normal which implies that it is has got less permeability capacity compared to normal concrete. As marine structures are constantly in contact with water, it should regain water within the water source and should not permeate through the structure. So this type of concrete gives more life to marine structures as it absorbs less water. So it can be used for marine structure.
- Retaining walls can be built using this concrete
  Crack resistance is a major property of our concrete as the W-H acts as reinforcement. So as a retaining wall it provides greater stability against pressure from soil. Also it avoids percolation of water through the structure. So it can be used for the construction of retaining walls. W-H incorporated concrete has got a sorptivity value same as normal concrete. So it provides appreciable resistance against freezing and thawing.
- Used as a coating layer in heat resisting structures
  W-H incorporated concrete have shown a higher compressive strength than normal concrete after heating at a higher temperature. So it can be used as an insulating material in industry, buildings which are prone to explosions.
- Used to built foundation for machine operation rooms
- Used to built highly durable buildings
  Sorptivity is a measure of durability of concrete. It implies that it offers resistance against freezing and thawing.
- Generally used in components such as columns and slabs.

Column is a compression member and our concrete has got a higher compressive strength than normal concrete so it can be used as a column member. This concrete has got lesser water absorption capacity value. So it can be used as a roofing material which prevents leakage of water.

## 7. CONCLUSION

From this project work we came to the following conclusions :-

- Optimum value is obtained for 0.5% W-H incorporated concrete.
- Compressive and tensile strength for the same is greater than the normal concrete which shows the strength of water hyacinth incorporated concrete.
- Sorptivity value for both remains same so that normal concrete and W-H incorporated concrete has same durability.
- Compressive test done after heat transfer in cubes also gave good results for W-H incorporated cube which implies that they have good heat resistance capacity and also increases its overall strength.
- Water absorbing property of W-H incorporated cube is less than normal concrete so that it can be used in exposed surfaces.
- Water hyacinth incorporated concrete can be used where the weight of structure has to be reduced as its weight is less than normal concrete .
- Strength of concrete cubes with river sand as fine aggregate is higher than that with manufactured sand

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