Optimizing the Strength of Rigid Pavement by Replacing Class F Fly Ash in Geopolymer Concrete by Coconut Fiber Ash

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Abstract— Geopolymers are a type of inorganic polymer & light weight material that can be formed at room temperature with less energy losses by using industrial waste or by-products as source materials to form a solid binder. Geopolymer concrete is manufactured from utilization of waste material from industrial waste such as fly ash. Geopolymer concrete is a type of by which we can be used in applications to fully or partially replace OPC with environmental and technical alternative to Ordinary Portland Cement (OPC) based concrete. In the manufacture industry the creation of Portland cement causes the secretion of air pollutants which results in environmental contamination. It reduces 80 - 90% CO2 emissions. Coconuts fiber is collected from temples & shops and it is burn in open air then the ash obtained by coconut fiber ash is passed through 150 micron sieve. And then replacement of class f fly ash by coconut fiber fly ash replace 0%, to 1.5% and when it is increase from 1.5% i.e. up to 2% result obtained is decreasing in compressive strength. Fly ash plays a vital role in Geopolymer concrete, and class f fly ash is used in construction purposes which contain 10% of lime also to replace the use of conventional ordinary Portland cement. The binding agent is the only difference to the ordinary Portland cement concrete because OPC is responsible for high content of energy losses and it requires high temperature for manufacturing. To trigger the substance in fly ash, sodium hydroxide solution and sodium silicate solution was used in amalgamation.

Key words: Fly Ash, Coconut Fiber Ash, Geopolymer, Sodium Hydroxide

I. INTRODUCTION

Concrete is the mostly used man made material in the world after water. It is attain by incorporation cementing materials, sand, aggregates, and sometimes admixtures within require proportions. The mixture of these materials when placed in moulds and allowed to cure hardens into the rock like mass known as Concrete. The OPC is the main ingredient for the manufacturing of Ordinary Portland Cement Concrete. Replacement of low calcium fly ash with ash of coconut fiber up to 1.5% is done & when it is added to 2% strength is decreasing.

The requirement of concrete is increased as the demand for infrastructure development is increased. The exploitation of cement pollutes the environment and produces raw resources in the manufacturing of Ordinary Portland Cement (OPC), it also requires large quantities of fuel for burning as well as the decomposition of limestone, resulting in considerable emissions of CO2. Cement plants have been emitting up to 1.5 billion tons of CO2 into the atmosphere annually. Upto80- 90% of carbon is emitted from cement so GPC is a substitution to cement. Geopolymer Concrete is the solution for this problem and has been introduced to reduce this problem. Geopolymer concrete is an inert polymer concrete that can be easily formed at standard room temperature by using industrial waste or by-products as foundation materials to form a solid mass and it is looks like OPC and performs similar function to OPC.

Geopolymer concrete is a type of concrete that is made by reacting aluminates and silicate bearing materials with a alkaline activator. Commonly, waste materials such as fly ash or slag from iron and metal production are used, which helps lead to a cleaner environment which is necessary to prevent hadrons environment. This is because the waste material is actually decomposed within the concrete itself and it also does not have to be liable of as it is being used. Geopolymer concrete does not require any heat or fuel to compose it and does not produce any amount of carbon dioxide. Standard Portland cement based concrete requires both heat and as well as also released carbon dioxide.

A. Objectives

1) To study on effect of Molarity of Additive Activator on Compressive Strength of Geopolymer Concrete (GPC) by replacing class f fly ash by fly ash of cocunut fiber
2) To study the engineering properties of fresh and hardened Geopolymer Concrete.
3) To utilize the waste materials available in the agro-industries.
4) To reduce the emission of Co2 caused due to manufacturing of cement.

B. Methodology

1) Stage-1

a) Literature Survey

In this various literature papers have been studied after which the final best research work was selected.

2) Stage-2

a) Materials to be used

The materials which are to be used in the research is selected.

3) Stage-3

After the selection of materials M30 grade concrete mix design is done.

4) Stage-4

Testing materials and method of geopolymer concrete for determination of various parameters.

5) Stage-5

Data analysis and presentation: -Analyze the results of various tests conducted and convert it in tabular form.

6) Stage-6

a) Conclusion and recommendation

After analysis and presentation we conclude the results.
Test the Doped Soil in C.B.R apparatus to obtain the value of following percentage.

II. LITERATURE REVIEW

According to Mohammed Rabbani Nagral(2014) In the present paper the effect of curing temperature, curing hours on Geo-polymer Concrete (GPC). Specimens and also the effect of extra water on workability and compressive strength of GPC cubes were studied. Fly ash and GGBS were used as binder, combined with an alkaline solution to form geopolymer paste instead of cement paste to bind the aggregates. The experiments were conducted on GPC cubes for curing temperature of 80° C, 90° C and 100° C with curing period of 12 and 24 hours by adopting hot oven curing method.

Maximum strength was obtained at temperature of 90°C for 12 hours of curing period. Beyond this, increase in curing temperature resulted in decrease in compressive strength of GPC specimen.

According to R Bayuaji et al examined that the research is to explore coconut fibers ash and fly ash. This material was used as cement replacement materials on cement paste. Experimental method was used in this study.

SNI-03-1974-1990 is standard used to clarify the compressive strength of cement paste at the age of 7 days. The result of this study that the optimum composition of coconut fiber ash and fly ash to substitute 30% of cement with 25% and 5% for coconut fibers ash and fly ash with similar strength if to be compared normal cement paste.

According to AMARNATH YERRMALLA(2012) et al studied the strength of coconuts fiber fly ash(CFA) replacement and different and study the transport properties of geo polymer concrete with CFA as fly ash replacement .they concluded that.

1) increase in CFA percentage decreased density of concrete
2) With CFA percentage increased the 7 days strength gain also increased with corresponding 28 days curing strength.

III. MATERIALS USED

A. *Fly Ash*

For experimental work class f or siliceous fly ash or low calcium fly ash is used.

1) Coconut Fiber Ash

a) Coarse Aggregates

IS:383-1970 defined the Aggregate which is retained on 4.75mm IS sieve and containing only so much finer material as is permitted by is termed as coarse aggregate. We have taken 10mm and 20mm Sizes of coarse aggregate for the experiment

b) Fine Aggregates

IS:383-1963 defined the fine aggregate is the aggregate most of which will passes 4.75mm IS sieve and retained on 0.07mm IS sieve is known as fine aggregate. Nearby available stream sand, which is obtained from Narmada River, having a lower size of about 0.07mm was used as a fine aggregate in concrete.

2) Alkaline Solution

A combination of sodium hydroxide solution and sodium silicate solution was selected as the alkaline activator, to activate the inactive material flyash. The NaOH solution was prepared by dissolving either the flakes or the pellets in water.

IV. LABORATORY WORK

- Proporting
- Mixing
- Casting
- Curing

A. *Proporting*

The design mix of preparation of 60 no of cubes of size 15cm x15cm x 15cm.

Geopolymer mix			
Material		Unit	Quantity
Fly ash		kg	72
Aggregates	20 mm	kg	120
10 mm		kg	96
Sand		kg	96
Alkaline activator	Chemical activator-I (NaOH)	kg	12
Chemical activator-II (Na2SO3)			
Water		lts	16
Percentage of Coconut fiber fly ash 0.5% coconut fiber fly ash 1% coconut fiber fly ash 1.5% Coconut fiber fly ash 2% coconut fiber fly ash		gram gram gram gram	90 180 270 360

Table 1: Proporting

1) Mixing

Raw materials i.e. fly ash, coarse aggregate and sand was weighted manually according to the design mix. Then materials were mix sequence in the pan and hand mixing was done. After the mixture achieved their homogeneity, the alkaline solution was added gradually in the mix. Mixing was continued for further 20 minutes or until it develops a uniform mix. The fresh mix was first tested for workability by means of Slump Cone Test & then poured into the moulds.

2) Casting

The fresh concrete is poured in moulds and compressed. Further compaction was done by vibrating machine. The procedure of mixing and casting is similar to cement concrete cubes. Total 48 No. moulds of size 150mm X 150mm X 150mm is prepared.

3) Curing

There are two types of curing

a) Ambient Curing

In ambient curing after casting the specimen were left to air for desire period

b) Oven Dry Curing

In oven dry curing the specimen were cured in oven after that the specimen were left to air dry in the laboratory for the next 6 ,13 ,20,and 27 days and the testing is done on 7, 14 ,21 and 28 days.

Fig. 1: Casted Cube

Procedure for compressive Strength Test of Geopolymer Concrete Cube

- Lift the specimen from laboratory floor or outside after specified age and wipe out any dirt from the surface.
- The bearing surface of the test machine must be clean.
- Place the sample in the machine in such a way that the load must be applied to the conflicting sides of the cube cast.
- Line up the specimen centrally on the bottom plate of the machine.
- Rotate the variable portion smoothly by hand so that it touches the top face of the specimen.
- Apply the load slowly and steadily without shock and continuously at the rate of 140kg/cm2/minute till the specimen or cube fails.
- Note the highest load and it should also be noted that any unusual features in the type of failure must not occur.

c) Note

Minimum three cubes must be tested at each chosen age. Average of three specimens gives the crushing strength of mortar i.e. the strength requirements of mortar.

d) Calculations

Size of the cube =15cm x15cm x 15cm.
Load on failure in KN = ……
Compressive strength at …. Days = Load in N/ Area in mm2=……N/mm2 or MPa

B. Slump Cone Test for Workability

1) In this test the workability of the mix is determined with the help of conical mould of upper dia. 10cm, lower dia. 20cm & height 30 cm.
2) First of all the concrete is prepared and it is filled in 4 layers into the mould.
3) Each layer was tamped 25 times.
4) Excess concrete was removed from the mould and surface was level with help of trowel.
5) Raise the mould with the help of hand and note the difference in height of the mould and the specimen.
6) The slump (Vertical settlement) measured shall be recorded in terms of millimeters of subsidence of the specimen during the test.

Slump for the given sample= _____mm

V. Result & Analysis

In one batch 60 total numbers of cubes were casted. All the cubes were thermal cured or oven cured at 60C for 24 hours. Average Compressive Strength of Geopolymer Concrete cube is consider of thermal cured at 60 C for 24 hrs. and after that left at ambient at room temperature. Geopolymer concrete cubes of Morality 14 M of Additive Activator at 7, 14, 21 and 28 days

A. Table show the Average Compressive Strength of GPC Cube

Compressive strength					
Days	S.No.	Weight of cube in kg	Load in KN	Strength in MPa	Average strength in MPa
7 days	1	8.2	710	31.55	30.91
	2	7.93	700	31.11	
	3	8.4	690	30.07	
14 days	1	7.83	705	31.33	31.33
	2	7.90	710	31.55	
	3	8.1	700	31.11	
21 days	1	7.8	730	32.44	32.66
	2	8.0	725	32.22	
	3	8.3	750	33.33	
28 days	1	8.1	765	34.00	33.77
	2	7.8	745	33.11	
	3	8.0	770	34.22	

Table 2: Average Compressive Strength of Concrete At 0.5 %

Compressive strength					
Days	S.No.	Weight of cube in kg	Load in KN	Strength in MPa	Average strength in MPa
7 days	1	8.1	715	31.78	32.15
	2	8.3	730	32.44	
	3	8.0	725	32.22	
14 days	1	7.9	735	32.66	32.73
	2	7.88	730	32.44	
	3	8.3	745	33.11	
21 days	1	8.23	785	34.89	33.93
	2	8.20	735	32.67	
	3	8.0	770	34.22	
28 days	1	8.1	780	34.67	35.04
	2	8.3	795	35.33	
	3	8.1	790	35.11	

Table 3: Average Compressive Strength of Concrete At 1.0 %

Compressive strength					
Days	S.No.	Weight of cube in kg	Load in KN	Strength in MPa	Average strength in MPa
7 days	1	7.9	770	34.22	34.07
	2	8.1	760	33.77	
	3	8.0	770	34.22	
14 days	1	8.3	815	36.22	35.93
	2	8.2	810	36.00	
	3	8.1	800	35.55	

21 days	1	8.2	840	37.33	37.41
	2	8.3	850	37.78	
	3	8.1	835	37.11	
28 days	1	7.9	850	37.78	37.85
	2	8.0	845	37.55	
	3	7.9	860	38.22	

Table 4: Average Compressive Strength of Concrete At 1.5 %

Compressive strength					
Days	S.No.	Weight of cube in kg	Load in KN	Strength in MPa	Average strength in MPa
7 days	1	8.3	755	33.55	33.03
	2	8.0	745	33.11	
	3	7.9	730	32.44	
14 days	1	7.9	760	33.77	33.85
	2	8.23	755	33.55	
	3	8.2	770	34.22	
21 days	1	8.1	810	36.00	35.02
	2	8.2	780	34.66	
	3	7.9	785	34.39	
28 days	1	8.0	815	36.22	36.22
	2	7.8	810	36.00	
	3	8.1	820	36.44	

Table 5: Average Compressive Strength of Concrete At 2.0 %

Compressive strength					
Days	S.No.	Weight of cube in kg	Load in KN	Strength in MPa	Average strength in MPa
7 days	1	8.1	640	28.45	29.18
	2	8.2	680	30.22	
	3	8.0	650	28.88	
14 days	1	7.88	690	30.67	29.92
	2	8.0	680	30.22	
	3	8.23	650	28.88	
21 days	1	7.9	725	32.22	32.15
	2	8.0	730	32.44	
	3	7.9	715	31.78	
28 days	1	8.1	745	33.11	33.48
	2	7.88	750	33.33	
	3	8.0	765	34.00	

Table 6: Average Compressive Strength of Concrete At 2.5 %

The slump for different percentage of coconut fibre ash is

S.no.	Coconut Fibre ash percentage	Slump
1	0%	85mm
2	0.5%	84mm
3	1.0%	82mm
4	1.50%	81mm
5	2.0%	79mm
6	2.5%	76mm

Table 7:

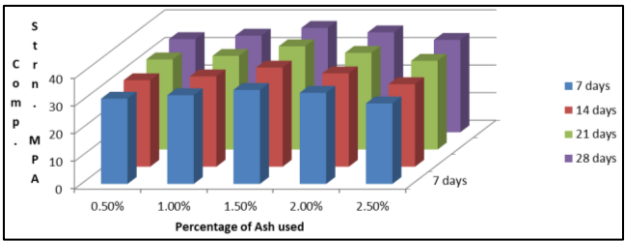

Fig. 2: Comparison chart of Compressive strength

VI. CONCLUSION

From this study, the following observations are made:

1) Geopolymer concrete is activated by sodium silicate and sodium hydroxide, since the molarity of NAOH increases the compressive strength also increases, if percentage of coconut fiber increases up to 1.5%, increase in compressive strength is noted but after 2% compressive strength decreases.
2) Curing can be done in two format i.e. an in ambient curing and oven drying curing, we have done oven drying curing at 60ºC.
3) There is very slight decrement in the slump value of concrete which can be considered for the pavement.
4) With the increase in moisture content the workability also enhances.
5) The rest phase for the fresh fly ash based geopolymer concrete is between 2 to 3 days.
6) Coconut fiber should have good durability and abrasion resistance characteristics.
7) If cellulose content of coconut fiber increases then compressive strength decreases.
8) High lignin content as it has high resistance to different weather and therefore coconut fiber is suitable material for construction of road.
9) The handling time of fresh geopolymer concrete is upto 2 hours.
10) The age of concrete has no effect on the compressive strength of geopolymer concrete.
11) Molarity also affects the viscosity. The viscosity increases with the increase in molarity.
12) Inorganic-organic hybrid alkaline activator (concentration of NaOH) can be used in many civil engineering applications such as building work, dry lean concrete and precast Items.
13) The coconut fiber is used as a fuel but after its burning the ash is of no use, we are utilizing the same ash.
14) Coconut fiber ash does not require very high temperature for its production. As cement requires very high temperature for its production which pollutes the environment.
15) The coconut fiber ash will be very useful in the pavement construction because it can save the material cost.

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