EXPERIMENTAL ANALYSIS ON PARTIAL REPLACEMENT OF CEMENT BY FLY ASH, COARSE AGGREGATE BY COCONUT SHELL AND FINE AGGREGATE BY SAW DUST IN CONCRETE

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Abstract -

The contemporary world is heavily focused on green and ecological development. Concrete is the utmost widely used building material in the world. Cement, fine and coarse-aggregate, water, make up this composite material.

The replacement impacts that fly-ash, sawdust, and coconut-shell bring to concrete are the main topic of this thesis. Cement and usual fine-aggregates were moderately substituted with fly-ash and sawdust, individually. Here, the coarse aggregate in the solid is swapped out for coconut shell. Determining the compressive-strength, split-tensile strength, and slump value is how the experiment is conducted. Sawdust is added to concrete in percentages of 5.0%, 10.0%, 15.0%, 20.0%, and 25.0% in place of natural fine aggregates. Fly Ash is consistently added to the mix at a weight of 30.0% cement having strong pozzolonic qualities, sawdust has properties comparable to those of usual fine-aggregates, and coconut-shell gives the concrete strong split-tensile strengths. The outcomes are contrasted with the design mix M30 control mix. Testing is done on the specimens 7, 14, 21, and 28 days after they have cured. It has been found that, during 7, 14, 21, and 28 days of curing, concrete can have up to 20.0% of its natural fine-aggregate substituted by sawdust and 20.0% of its coarse-aggregate substituted by coconut shell, all without compromising its strength. Fly-Ash should remain at 30% of the mix. As the quantity of resources increases, slump's value diminishes. Additionally, the price of concrete decreased to the total price per cubic meter of concrete.

Key Words: coconut shell, saw dust, fly ash, sustainable concrete, pozzolonic.

1. INTRODUCTION

After water, concrete is the most extensively utilized man-made stuff worldwide. Sand, aggregates, cementing constituents, and occasionally admixtures are further in the appropriate amounts to achieve it. Every day, there is an enormous enhance in demand for it. In order to convene this requirement, a large amount of natural possessions must be used, which puts the ecosystem at serious risk. Thus, the goal of this study is to address environmental issues by falling the quantity of fly-ash, sawdust and, coconut that is dumped on landfills. This will undoubtedly help diminish the amount of carbon dioxide (CO2) that is released into the atmosphere, which otherwise contributes to global warming, one of the main issues facing the modern world. Therefore, fly ash, sawdust, and coconut shell are being used in this project to partially supernumerary cement, fine-aggregate and coarse-aggregate in concrete. Fly-ash is made up of silicon dioxide, aluminum oxide, and calcium oxide and is produced when coal is burned. Fly-ash can be used to partially swap cement in concrete since it has great pozolonic qualities and reacts with water quickly. Saw-dust is a waste product obtained from sawmills. Particularly in this area, using coconut-shells in place of coarse-aggregates in concrete is becoming more and more popular. The hard exterior of the coconut is called the shell. Since it worked, we can conclude that in many concrete applications, excess and by-product can be used in consign of natural materials.

1.1 1.2 OBJECTIVES

These are the following objectives of this work:-

1. The primary goals of this work are to determine the ideal saw-dust percentages to substitute for natural fine-aggregates, fly ash percentages to substitute for cement, and coconut-shell percentages to substitute for coarse-aggregate.

2. To determine and compare the slump values of regular concrete with modified concrete that has been treated with fly-ash, saw-dust, and coconut-shell.

3. To ascertain the changed concrete's hardened behavior, such as its compressive-strength.

4. To make the composite more inexpensive in association to regular O-P-C concrete.

5. To utilize these leftover elements to create lightweight concrete.

2. METHODOLOGY

The methodology for the whole thesis work shall be conducted as follows.

1. Literature assessment - In this various journal papers were studied after which the final best examination work is selected.

2. Materials to be used - The materials which are to be used in the research is selected. The materials of fly-ash, saw-dust and coconut-shell is finally selected which are to be moderately substituted in concrete. Fly-ash to be fixed on 30%, Saw dust between 0 to 20% and Coconut-shell between 0 to 20.0%.

3. Concrete Mix-Design - After the selection of supplies M30 grade concrete mix-design is done.

4. Laboratory work - Testing of materials to be used in concrete is evaluated. Final concrete after the replacements is also experienced with the workability, compressive-strength test and split-tensile examination.

5. Cost Analysis - After the laboratory work the cost analysis of concrete is done and associated with the normal OPC concrete.

6. Data-analysis and presentation -Analyse the consequences of various tests conducted and convert it in tabular form.

7. Conclusion and proposal - After analysis and presentation we conclude the results.

3. MATERIALS & METHODS

3.1 FLY-ASH: - They are the by-product remaining after the combustion of coal. It is of two types: Class-C and Class-F.

3.2 SAWDUST: - Sawdust is a by-product of a wood obtained after cutting, grinding or sanding with saw or other industrials tool.

3.3 COCONUT-SHELL: - The hardest portion of a coconut is its shell, which is situated on the side of the husk to protect the meat. Coconut-shell is a waste product from agriculture that is widely accessible in tropical nations across the globe.

3.4 COARSE & FINE AGGREGATES:- The aggregate classified as coarse aggregate is that which is retained on a 4.75mm IS screen and Fine aggregate is defined by IS:383-1963 as the aggregate that, when filtered over a 4.75mm IS-sieve and held on a 0.07mm IS-sieve

FOR M30 GRADE CONCRETE

Volume of Concrete = 1 cu.m
Total Volume of Cement = Cement/(S.G*1000)
= 422/(3.15*1000)
= 0.134 cu.m
Volume of Water = Water/(S.G*1000)
= 190/(1*1000)
= 0.190 cu.m
Total Aggregates Requirement = A-(B+C)
= 1-(0.133+0.190) = 0.677 cu.m
Coarse-Aggregate (C.A) = D*C.A ratio*S.G*1000
= 1168.6 kg
Fine-Aggregate (F.A) = D*F.A ratio*S.G*1000
= 0.677*0.37*2.74 *1000
= 686.3KG

Table -1: Show the M30 mix design of Concrete

Grade of Concrete				M30	
Cement				420 kg/m3	
Aggregates	Fine aggregates			1855 kg/m3	685 kg/m3
Coarse-aggregates • 20mmaggregates • 10mmaggregates				1170kg/m3 702kg/m3 468kg/m3	
Proportion of mix				1:1.63:2.8	
Water/Cement ratio				.45	
Replacement % of fly ash	Amount of fly-ash in Kg/ m3	Replacement Percentage of saw-dust	Amount of saw dust in Kg/ m3	Replacement Percentage Of coconut-shell	Amount of coconut shell in Kg/ m3
30%	126	5%	34	5%	34
30%	126	10%	68.5	10%	68.5
30%	126	15%	102.75	15%	102.75
30%	126	20%	137	20%	137
30%	126	25%	171.25	25%	171.25

4. EXPERIMENTAL ANALYSIS

- **Proportioning**
- **Mixing**
- **Casting**
- **Curing**

- **Proportioning-** The design mix of preparation of 30 cubes of size 15cm x15cm x 15cm can be made.

- **Mixing-** Raw materials i.e. fly-ash, coarse aggregate and sand was weighted manually according to the design mix. Then supplies were blend sequence in the pan and hand mixture was done. After the combination succeeded their homogeneity, the water was gradually assorted in the mix.

- **Casting-** The fresh concrete is poured in moulds and compressed. Additional compaction was made by vibrating machine. The technique of intercourse and casting is similar to cement concrete cubes. Total 60 No. moulds of size 150mm X 150mm X 150mm is prepared.

Fig -1: Mixing of Materials

Fig -2: Filling the moulds

- **Curing-** The test samples/specimen are cured in curative tank for desired period. After that the cubes are tested at the scheduled time.

Fig -3: Concrete Cubes

4.1 COMPRESSIVE-STRENGTH-TEST (IS-516, 1959)

Lift the specimen from laboratory floor or outside after specified age and wipe out any dirt from the surface. Make sure the load is applied to the opposing sides of the cube cast by positioning the sample inside the machine in this manner. Position the specimen center wise on the machine's bottom plate.

Hand-rotate the variable section smoothly until it reaches the specimen's upper face. Until the specimen or cube fails, apply the load gradually, steadily, and without shock, at a rate of 140 kg/cm2/minute. Note the highest capacity and it should also be noted that any unusual structures in the sort of failure must not occur.

4.2 SLUMP CONE TEST (IS-1199-1959)

In this test, a conical mold with an upper diameter of 10 cm, a lower diameter of 20 cm, and a altitude of 30 cm is used to measure the workability of the mix. The concrete is first prepared, then it is poured into the mold in four stages. 25 tamps were applied to each layer. Using a trowel, the surplus concrete was detached from the mold and the surface was leveled.

Lift the mold using your hands, and then observe how the height of the specimen and the mold differ.

Fig -4: Performing Compressive-Strength Test

Fig -5: Performing Slump Cone Test

4.3 Splitting-Tensile Test (IS-5816-1999)

The cast specimen needs to be kept somewhere between 27° and 2°C for 24 hours, giving or taking 0.5 hours, after the water is added to the dry materials. Subsequently, the sample needs to be labeled, taken out of the mold, and immediately immersed in either renewed water that has been eviscerated or a elucidation of lime that has been soaked. Adjust the compression testing apparatus to the required range. After positioning the specimen, place the plywood stripe on the lower plate. Over the sample, position the second piece of plywood. Lower the top plate until it is in contact with the plywood strip. Apply the load continuously and shock-free at a rate between 0.7 and 1.4 MPa/min (1.2 and 2.4 MPa/min according to IS 5816: 1999). At the end, record the infringement load (P). Finally, three samples will be cast and evaluated for each analysis. Next, it will occupy the average tensile-strength.

5. RESULT

Table -2: Average Compressive-Strength of Concrete after intercourse 30.0% fly ash, 5.0% saw-dust and 5.0% coconut-Shell.

Days	S.No.	Wt.	Load in KN	Strength in MPa	Avg. strgn.
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 -3: Average Compressive-Strength of Concrete after intercourse 30.0% fly ash, 10.0% saw-dust and 10.0% coconut-Shell.

Days	S.No.	Wt.	Load in KN	Strength in MPa	Avg. strgn.
7 days	1	7.75	715	31.78	32.15
	2	7.68	730	32.44	
	3	7.80	725	32.22	
14 days	1	7.75	735	32.66	32.73
	2	7.74	730	32.44	
	3	7.84	745	33.11	
21 days	1	7.78	785	34.89	33.93
	2	7.80	735	32.67	
	3	7.85	770	34.22	
28 days	1	7.80	780	34.67	34.74
	2	7.85	785	34.88	
	3	7.85	780	34.67	

Table-4: Average Compressive-Strength of Concrete after intercourse 30.0% fly ash, 15.0% saw-dust and 15.0% coconut-Shell.

Days	S.No.	Wt.	Load in KN	Strength in MPa	Avg. strgn.
7 days	1	7.55	770	34.22	34.07
	2	7.60	760	33.77	
	3	7.60	770	34.22	
14 days	1	7.58	815	36.22	35.93
	2	7.62	810	36.00	
	3	7.64	800	35.55	
21 days	1	7.60	820	36.44	36.52
	2	7.64	820	36.44	
	3	7.65	825	36.67	
28 days	1	7.60	830	36.88	36.96
	2	7.65	835	37.11	
	3	7.67	830	36.88	

Table 5: Average Compressive-Strength of Concrete after intercourse 30.0% fly ash, 20.0% saw-dust and 20.0% coconut-Shell.

Days	S.No.	Wt.	Load in KN	Strength in MPa	Avg. strgn.
7 days	1	7.35	755	33.55	33.03
	2	7.40	745	33.11	
	3	7.42	730	32.44	
14 days	1	7.37	760	33.77	33.85
	2	7.42	755	33.55	
	3	7.44	770	34.22	
21 days	1	7.39	780	34.66	34.56
	2	7.44	780	34.66	
	3	7.45	785	34.39	
28 days	1	7.40	790	35.11	35.18
	2	7.45	795	35.33	
	3	7.45	790	35.11	

Table 6: Average Compressive-Strength of Concrete after intercourse 30.0% fly ash, 25.0% saw-dust and 25.0% coconut-Shell.

Days	S.No.	Wt.	Load in KN	Strength in MPa	Avg. strgn.
7 days	1	7.30	640	28.45	29.18
	2	7.25	680	30.22	
	3	7.22	650	28.88	
14 days	1	7.30	690	30.67	29.92
	2	7.28	680	30.22	
	3	7.25	650	28.88	
21 days	1	7.32	725	32.22	32.15
	2	7.30	730	32.44	
	3	7.27	715	31.78	
28 days	1	7.33	745	33.11	33.48
	2	7.32	750	33.33	
	3	7.30	765	34.00	

Table 7: Experimental Results of slump Cone Test

S.no.	Replacement Percentage of fly ash, Saw Dust & Coconut Shell	Slump
1	0%, 0%, 0%	92mm
2	30%, 5%, 5%	90mm
3	30%, 10%, 10%	89mm
4	30%, 15%, 15%	85mm
5	30%, 20%, 20%	80mm
6	30%, 25%, 25%	78mm

Table 8: Experimental Results of Split Tensile Test

Days	S.No.	% replacement	Avg. strgn.
7 days	1	5%	2.98
	2	10%	3.08
	3	15%	3.15
	4	20%	3.21
	5	25%	3.06
14 days	1	5%	3.08
	2	10%	3.16
	3	15%	3.19
	4	20%	3.31
	5	25%	3.07
21 days	1	5%	3.16
	2	10%	3.23
	3	15%	3.32
	4	20%	3.41
	5	25%	3.12
28 days	1	5%	3.33
	2	10%	3.40
	3	15%	3.47
	4	20%	3.54
	5	25%	3.18

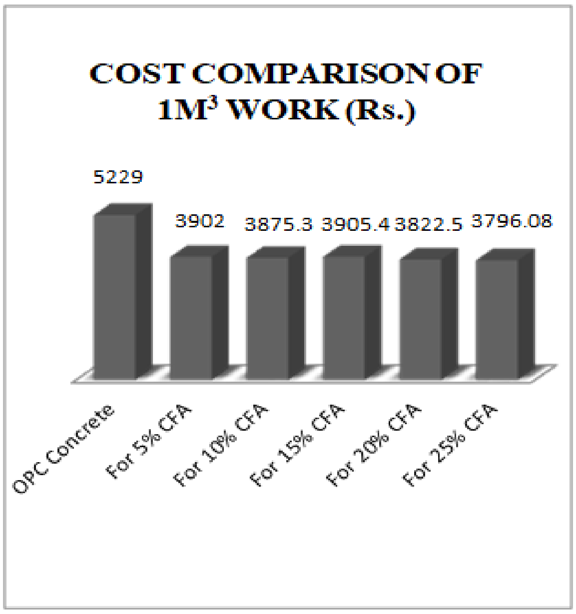

Chart -1: Cost Comparison for Different Types of Samples Used

6. CONCLUSIONS

From this study, the following observations were made:

1. Based on the experimental work it can be concluded that for 7 and 28 days curing up to20 % of saw-dust and coconut-

shell can be used in concrete because it provides good strength. For Compressive strengths up to 15 % sawdust and coconut Shell shows good increment in the results whereas for split tensile strength, up to 20.0% saw-dust, coconut-shell replacement can be made in concrete.

2. There is very minor decrement in the slump value of concrete which can be deliberated for the construction work.
3. The split tensile strength also increases up to 20% and its value decreases after that percentage.

4. The period of concrete has no consequence on the compressive-strength of concrete.

5. As we have done cost analysis of the modified composite which is associated with the normal OPC concrete in which the cost reduction is observed if we are using modified concrete which means that using this concrete is economical as related to normal OPC.

6. As the result shows that we can use 20% replacement as a material, so a cost saving of about Rs.1400 approximately is observed if we are constructing a 1m3work.

7. Sawdust exhibits strong strength because of its superior adhesion, which limits and absorbs breaks in the solid. Fly ash's good pozzolonic characteristic also helps this mechanism.

8. In addition, the concrete exhibits superior compaction ease as compared to the governor mix.

9. Furthermore, the introduction of sawdust in the concrete also helps to diminish the improper dumping of the hard excess into landfills and thereby making the concrete more biodegradable.

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