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"Experimental Study on Partial Replacement of Fine Aggregate by Bottom Ash in M30 Concrete"

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Abstract – *Now a day there is lots of problem of disposals of waste byproduct which are coming from heavy factories which are harmful to environment therefor we need to find out some alternative methods for the disposal and reuse of such by products. The present works were done by Partially replace fine aggregate by bottom ash in certain varying percentage. In this project bottom ash which is a waste material of coal firing thermal power plant were used as a partial replacement of fine aggregate (sand). The bottom ash was taken from B.M.L, Gola of Ramgarh (Jharkhand). The design strength of concrete and the behaviour of its strength parameters on different composition ratio of mix were prepared by replacing fine aggregate with bottom ash in varying percentage in M30 Concrete. We start by 5% and goes till we find optimum % of bottom ash which is replaced for maximum strength and most cost efficient. we also analyse the variation of cost w.r.t replacement of fine aggregate with bottom ash*

***Key Words*: Bottom ash, cement, fine aggregate, Compressive strength, flexural.**

1. INTRODUCTION

Concrete has been used as a major construction material ever since its inception. The possibility of using solid wastes in concrete has received increasing attention in recent years as a promising solution to the rising solid waste problem. Production of concrete and utilization of concrete has rapidly increased, which results in increased consumption of natural aggregate and sand. Aggregate is one of the main ingredients in producing concrete which covers 75% of the total for any concrete mix. Strength of concrete produced is dependent on the properties of aggregates used Conventionally concrete is mixture of cement, sand and aggregate. The use of Bottom ash can be the substitute for fine aggregate in certain percentage of replacement in mix design.

1.1 Methodology

In this study locally available sand, cement and coarse aggregate are used for preparation of concrete. Here used bottom ash and replace it with a fine aggregate in some different percentage. Concrete cubes were made using mixture of 20mm and 10mm of coarse aggregate and partial replacement of sand by 0%. 5%, 10%, 15%, 20% ,25%,30%,35%,40%,45%,and 50% of bottom ash. until to find the optimum percentage of BA.

1.2 Materials

Bottom ash is a by-product of burning coal at thermal power plants. Bottom ash particles are much closer than the fly ash. It is a coarse, angular material of porous surface texture predominantly sand sized. This material is composed of silica, alumina, and sulfate grain sizes typically range from fine sand to gravel in size. Chemical composition of bottom ash is similar to fly ash but typically contain greater quantity of carbon. Sand stone raw bottom ash is a granular material that consists of a mix of inert materials such as sand, stone, glass, porcelain metals and ash from burnt materials. Ordinary Sand from Tatisilwai (dist. Ranchi) has been used. The properties of the sand have been obtained from the tests carried out in the structure laboratory of C.I.T Ranchi as per specification laid down in IS -383:1970. The sand retained on 4.75 mm sieve was 4.8 and on 10 mm it was found was 0%

Fig -1: Sieving of Bottom Ash

1.3 Literature review

R.G.D Souza (2017) Had concluded that Bottom ash is used as concrete aggregate or for several other civil engineering applications where sand, gravel and crushed stone are used. In his work M20, M 30 and M30 grade of concrete is considered for the experimental investigation. Fine aggregate is fully replaced till 100% percentage of bottom ash. Comparative result of workability and compressive

strength of conventional concrete cube and bottom ash added concrete cube are reported. From the results it is concluded that bottom-ash can be used as a replacement for fine aggregate. The results proved that the replacement of 100% of fine aggregate by bottom-ash achieved higher compressive strength.

Shambalid Ahady et . all (2016): In his works he found that the Bottom ash can be replacement of fine aggregates in concrete and the investigation on the use of bottom ash has been very limited. It gives an overview of the various literature and experimental investigations been carried out by many researchers to study the use of bottom ash as aggregates in concrete.

Jawahar S. et.all, (2017): The engineering and construction industry has faced many challenge for consuming, "Sustainable green and recycled products" in manufacture of concrete. Coal Bottom Ash (CBA) has the potential to be used as concrete materials in place of fine aggregate. Bottom ash is the dominant solid residue generated in power stations. In this study, experimental investigation has been conducted to assess the performance of bottom ash as fine aggregate with various percentages (20 %, 40 %, 60 % & 100 %) in cement concrete subjected to chemical curing. The concrete specimens were casted and tested for compressive strength and tensile strength at 7, 28 and 90 days. The functional properties like Sorptivity, Water Permeability, Rapid Chloride Penetration, Sulphate and Acid Resistance were tested on 28, 56 and 90 days old specimens. It is observed that bottom ash replacement up to 40 % as fine aggregate in cement concrete is durable.

2. Slump test: It is the most commonly used method of measuring consistency of concrete. The apparatus for conducting the slump test essentially consists of a metallic mould in the form of cone having internal dimensions as under

Table- Slump Test data

S.NO	% Replacement	Slump for M30 Grade in (mm)
1	BA0%+FA100%	75
2	BA5%+FA95%	72
3	BA10%+FA90%	66
4	BA15%+FA85%	60
5	BA20%+FA80%	57
6	BA25%+FA75%	51
7	BA30%+FA70%	47
8	BA35%+FA65%	42
9	BA40%+FA60%	38
10	BA45%+FA55%	35
11	BA50%+FA50%	32

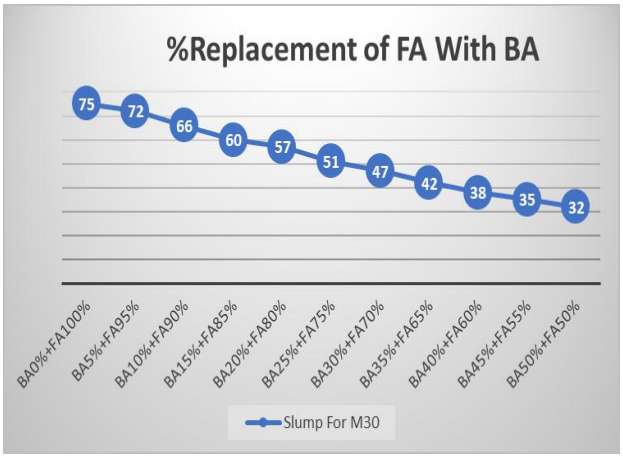

Chart-1. Slump test result

It is observed that degree of workability is medium as per BIS (IS: 456-2000) for the M30 grade concrete. It is also observed that, as the percentage of BA increases from 0% to 50%, the mix becomes stiffer, and workability results in low slump value

3. Compressive strength

The compressive strength is finding using 2000kN compression testing machine in accordance with IS: 516-1959. The compressive strength test is conducted on 150 mm size of cube at 7 and 28 days adopting wet curing process. Three cube specimens were tested for each curing period for 7 and 28 days curing period. A total of 22 cube specimens were tested for compressive strength for each mix in the lab of CIT Ranchi.

Table -2: Compressive strength test results

Compressive strength test results			
S.NO	% Replacement	for M30 grade	
		7days	28days
1	BA0%+FA100%	26.55	40.05
2	BA5%+FA95%	27.05	41.65
3	BA10%+FA90%	27.45	41.8
4	BA15%+FA85%	28.01	42.05
5	BA20%+FA80%	28.18	42.45
6	BA25%+FA75%	28.50	42.55
7	BA30%+FA70%	28.55	42.6
8	BA35%+FA65%	28.73	42.95
9	BA40%+FA60%	28.85	43.05
10	BA45%+FA55%	26.95	40.15
11	BA50%+FA50%	26.02	38.85

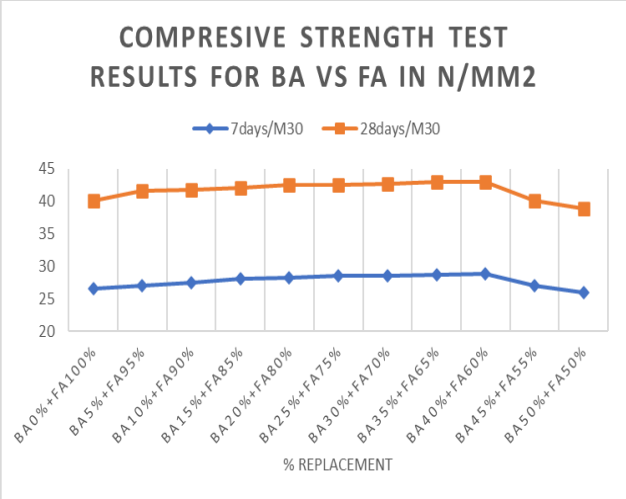

Chart-2. Compressive strength test results

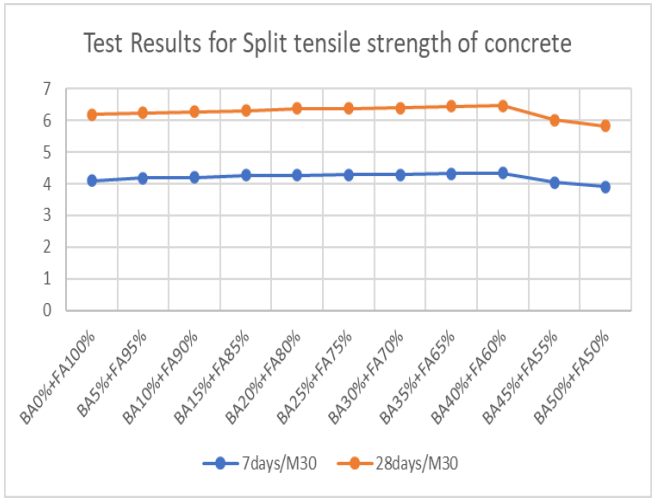

Chart-3. Test Results for Split tensile strength of concrete

4. Split tensile strength

The split tensile strength of concrete was determined after 7 and 28 days of curing on cylindrical specimens of 150 mm diameter x 300 mm height using 1000kN compression testing machine as per the procedure given in IS: 5816-1999.

Table -3: Test Results for Split tensile strength of concrete

Test Results for Split tensile strength of concrete			
S.NO	% Replacement	for M30 grade	
		7days	28days
1	BA0%+FA100%	4.1	6.18
2	BA5%+FA95%	4.19	6.24
3	BA10%+FA90%	4.20	6.27
4	BA15%+FA85%	4.26	6.31
5	BA20%+FA80%	4.27	6.37
6	BA25%+FA75%	4.28	6.38
7	BA30%+FA70%	4.28	6.39
8	BA35%+FA65%	4.32	6.44
9	BA40%+FA60%	4.33	6.46
10	BA45%+FA55%	4.04	6.02
11	BA50%+FA50%	3.90	5.83

5. Flexural strength

This test was performed in accordance with IS: 516-1959 on prisms of size 100 x 100 x 500 mm after 28 days of water curing using 200 KN universal testing machine.

Table -4: Test Results for Flexure strength of concrete

Test Results for Flexure strength of concrete			
S.NO	% Replacement	for M30 grade	
		7days	28days
1	BA0%+FA100%	3.07	4.51
2	BA5%+FA95%	3.07	4.52
3	BA10%+FA90%	3.08	4.53
4	BA15%+FA85%	3.08	4.54
5	BA20%+FA80%	3.09	4.56
6	BA25%+FA75%	3.10	4.57
7	BA30%+FA70%	3.11	4.57
8	BA35%+FA65%	3.12	4.59
9	BA40%+FA60%	3.14	4.59
10	BA45%+FA55%	3.02	4.44
11	BA50%+FA50%	2.97	4.37

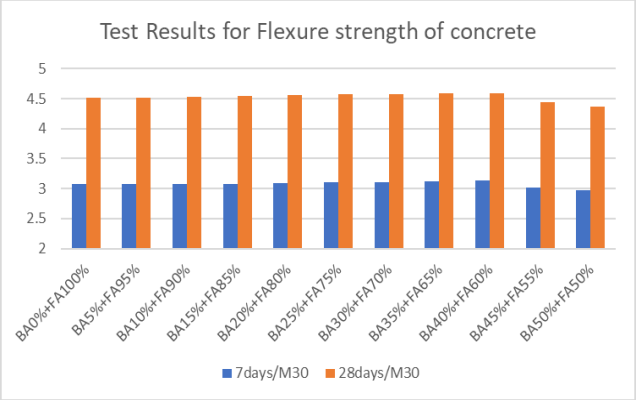

Chart-4. Test Results for Flexure strength of concrete

6. COST ANALYSIS

The comparison of costs regarding project before and after replacement of fine aggregate by bottom ash.

Table -5: Cost analysis of Replacement-0%($FA_{100}BA_0$) mix concrete per cubic meter

Sl. No.	Ingredient	Cost per kg	Content per m^3	Total cost of material
1	Cement	7.00	445.58 kg	3119.06
2	Fine aggregate	1.05	651.76 kg	684.348
3	Coarse aggregate	1.20	1172.4 kg	1406.88
4	Bottom ash	0.2	------	-------
Total cost				5210.324

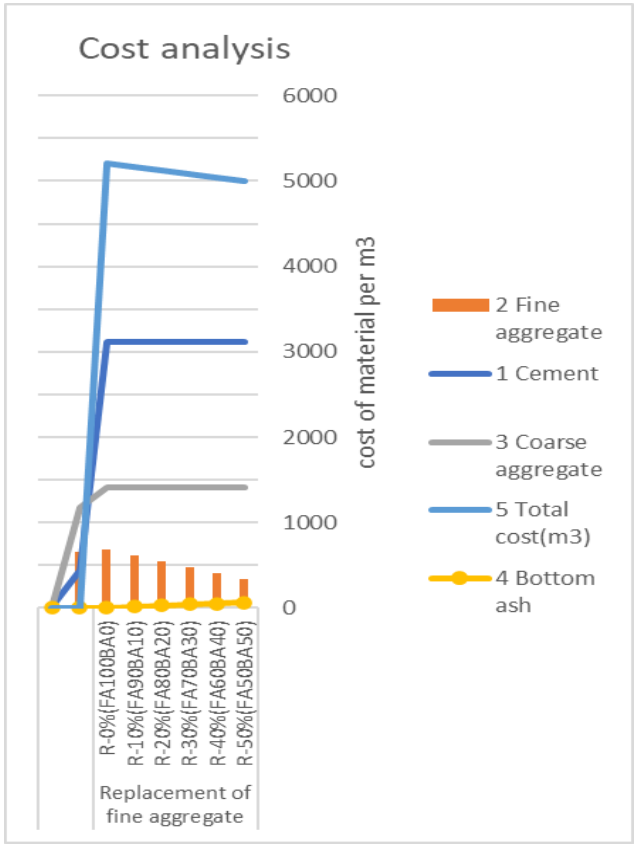

Chart-5 Cost analysis Replacement of fine aggregate

7. CONCLUSIONS

1. Specific gravity and bulk density of bottom ash is less as compared to the natural coarse aggregate

2. The percentage absorption of water in bottom ash (BA) is more as compared to the natural and fine aggregate.

3. The slump value of concrete as we increase the percentage of bottom ash decreases up to 50% of replacements.

4. The various properties of hardened concrete that is compressive strength test, flexural strength test and split tensile strength test increases as we increase the percentage of bottom ash. The compressive strength For M30 grade at 10% BA replacement for 7 days it is found maximum value of 27.45 N/mm^2 and for 28 days its 41.8 N/mm^2. Similarly, for split tensile strength its maximum value is 4.26 N/mm^2 for M30 grade at 15% BA replacement for 7 days also it is found maximum value of 6.31 N/mm^2 for 28 days. Similarly, Flexure strength for M30 grade at 50% BA replacement for 7 days it is found maximum value of 2.97 N/mm^2 and for 28 days its 4.37 N/mm^2. We see that at 10% replacement the values is maximum value that is 4.53 N/mm^2.

5. The challenge in making a lightweight concrete is decreasing the density while maintaining strength and without adversely affecting cost.

6. The bottom ash as aggregate and clay as cement in concrete can reduce the material cost in construction because of the low cost and its availability is abundance.

7. After replacement of 50% of fine aggregate by bottom ash in M30 concrete the cost reduce 5.3% per meter cube.

8. Variation of cost w.r.t % replacement for M30 grade at 60% FA replacement by Bottom ash total cost of concrete per m^3 RS: 4877.89/- as compare to 0% replacement 5210.29/- which is economical.

8. Scope

This project was mainly focused on the partial replacement of Fine aggregate with BA at different percentage in concrete. Research may be conducted on other properties and uses of BA in the near future to make this product a precious building material to improve the quality of building construction industry. Other types of study that can be included with BA may be listed below;

- BA concrete as an acoustic building structure.
- The chemical attack on BA concrete structure.
- The durability of BA concrete as an underwater structure.
- Earthquake effect on BA concrete structure for low cost building.
- BA concrete with plasticizer for higher grade of concrete. Mass utilization of waste' material in construction by using stone dust as a partial replacement material for fine aggregates in concrete.

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