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Effect of Replacement of Fine Aggregate by Stone Dust and Bottom Ash in Concrete

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ABSTRACT
Depleting natural resources are posing a threat to the environment , hence conservation of natural resources is great challenge for civil engineers since construction activities cannot be diminished as they are very important. The only way is to search alternative materials for construction. In this paper, detailed investigation is carried on concrete by replacing natural sand by stone dust and bottom ash and study the behavior and strength characteristic. Stone dust and bottom ash is replace partially from 0% ,15%,20%,25%,50%,75% and 100% in place of natural sand in Plain cement concrete. This replacement was done to check the workability and compressive strength of concrete by casting concrete blocks of size (150*150*150) mm.
Keywords: Stone dust, Bottom ash, waste materials, concrete.

I. INTRODUCTION

Concrete is commonly used construction material due to its ease of availability, mouldable, rigidity, and durability. It consists of binding material , fine aggregate, coarse aggregate and required quantity of water, where sand is normally used as fine aggregate. Concrete is an extensively used material for most of the civil engineering projects. It is produced with cost effective material. Concrete industry is drawing upon enormous natural resources. One day this natural resources will become extinct which compels for replacement of these materials with alternative materials. The search for compatible material to replace sand in concrete has become very vital in the light of the world facing serious problem due to decreased availability of river sand.

Bottom ash is the residue and non-combustible substance formed after the combustion of lignite or coal in the furnace at a temperature of 1300 degree Celsius. It is removed as slag from the bottom of the furnace. Bottom ash being coarser and less pozzolonic then fly ash can used as fine aggregate in concrete by a partial replacement. Particles of bottom ash range from fine sand to fine gravel. Bottom ash is composed of silica, alumina and iron with small amounts of calcium, magnesium, sulphate, etc. the of helps to produce more cohesive concrete and is less prone to segregation & bleeding.

concrete move more freely and more fineness of particles allows better filling of the pores.PPC cement

In PPC concrete, the lime [Ca (OH) 2] liberated during initial hydration is consumed by reactive silica & forms an insoluble cementitious compound instead of leaching on the concrete surface.

size distribution of coal bottom ash is similar to that of river sand. These properties of bottom ash make it attractive to be used as fine aggregate in production of concrete.

During the process of production of coarse aggregate in crushing plants, a huge quantity of stone dust is produced which is considered as worthless for any substantial use. This stone dustbeing a waste material can be effective used in concrete production as a partial replacement of fine aggregate. This will result in conservation of natural resources (Natural Sand) upto some extent, besides helping in environment protection and disposal of stone dust in abundance.

II. METHODOLOGY:

2.1 Materials:

2.1.1 Cement:

Portland pozzolona cement (fly ash based) will be used throughout the experiment. We preferred Portland pozzolona cement- fly ash based instead of ordinary Portland cement because now-a-days practically PPC is used in concrete.Portland pozzolona cement has spherical cement particles and they have higher fineness value. Due to the spherical shape

furnace and are cooled. The above portion of the ash burning furnace during its operation.

The portion of the ash that escapes up the chimney or stack is, however, referred to as fly ash. The clinkers fall by themselves into the bottom hopper of a coal-burning is referred to as bottom ash too.

Bottom ash is a hazardous by-product from coal based National thermal power plants. It is obtained from Eklahare

Tests carried on cement

1. Fineness
2. Standard Consistency
3. Initial and Final setting time
4. Compressive strength

Results for cement:

Table 1: Results for cement

Standard Consistency	35%
Initial Setting Time	40 min
Final Setting Time	160 min
Fineness	5%
Specific Gravity	2.71
Compressive Strength 7 days	27 Mpa
28 days	38.5 Mpa

2.1.2 Coarse Aggregates:

Aggregate size of 20mm is used throughout this investigation. The specific gravity of coarse aggregate is 2.8.

2.1.3 Fine Aggregates:

2.1.3.1 Natural Sand:

The Fine aggregates used for casting is clean river sand. Specific gravity of this sand is 2.6.

Table 2: Sieve analysis of natural sand.

Sieve sizes (mm)	Weight retained (gm)	%weight retained	Cumulative % weight retained	% passing
4.75	0	0	0	100
2.36	75	15	15	85
1.18	200	40	55	45
0.600	125	25	80	20
0.300	85	17	97	3
0.150	15	3	100	0
0.090	0	0	0	
Pan	0	0	0	

2.1.3.2 Bottom Ash:

Bottom ash is part of the non-combustible residue of combustion in a furnace or incinerator. In an industrial context, it usually refers to coal combustion and comprises traces of combustiblesembedded in forming clinkers and sticking to hot side walls of a coal-

2.1.3.4 Water:Tap water is being used for mixing and curing.

Table 3: Sieve analysis of bottom ash

Sieve sizes (mm)	Weight retained (gm)	% weight retained	Cummulative % weight retained	% passing
4.75	15	3	3	97
2.36	10	2	5	95
1.18	25	5	10	90
0.600	20	4	14	86
0.300	40	8	22	78
0.150	260	52	74	26
0.090	100	20	94	6
0.075	10	2	96	4
Pan	20	4	100	0

2.1.3.3 Stone Dust:

During the process of production of coarse aggregate in crushing plants, a huge quantity of stone dust is produced which is considered worth less for any substantial use.

This stone dust being a waste material can effectively be used in concrete making, as partial replacement of fine aggregate. The use of stone dust in concrete as partial replacement of fine aggregate will be an alternative material instead of conventional fine aggregate. This will result in conservation of natural resources (fine aggregate) up to some extent, besides helping in environment protection and disposal of stone dust in abundance.

Stone dust is collected from local stone crushing unit located at Savlivihir. It was initially wet in condition when collected, then oven dried and is sieved before mixing in concrete.

Table 4: Sieve analysis of stone dust

Sieve sizes (mm)	Weight retained (gm)	% weight retained	Cummulative % weight retained	% passing
4.75	0	0	0	100
2.36	10	2	2	98
1.18	30	6	8	92
0.600	50	10	18	82
0.300	60	12	30	70
0.150	120	24	54	46
0.090	160	32	86	14
0.075	40	8	94	6
Pan	30	6	100	0

2.2. Mix Design:

Mix Ratio is 1:1.43:2.69

5. Grade designation - M30

6. Type of cement - PPC
7. Nominal size of aggregate - 20mm
8. Workability - 50mm
9. Exposure condition - Moderate
10. Type of aggregate -crushed angular aggregate.
11. Cement content - 435 kg/m3
12. Water content - 174.8 kg/m3
13. Fine aggregate - 629.9316 kg/m3
14. Coarse aggregate - 1177.52 kg/m3
15. 11. Water cement ratio - 0.40

2.3 Mix Proportions:

Table 5: Mix Trials

Mix Trials	Natural Sand %	Bottom Ash %	Stone Dust %
R	100	0	0
M1	0	100	0
M2	0	0	100
M3	25	75	0
M4	25	0	75
M5	50	50	0
M6	50	0	50
M7	75	25	0
M8	75	0	25
M9	80	10	10
M10	85	10	5
M11	85	5	10

2.4Tests conducted:

2.4.1 Workability:

Workability is property of the concrete mixture which determines the ease with which it can be placed and the degree to which it resists segregation. Workability in this investigation is experimented using compaction factor test.

2.4.2 Compressive Strength:

Compressive strength of concrete will be determined on cubes of size 150 mm x 150 mm x 150 mm at the age of 7 and 28 days using Compression Testing Machine (CTM).

IV. CONCLUSIONS:

1.Stone dust and bottom ash are such materials which absorb more water; hence the w/c ratio gets disturbed. Also the concrete becomes less workable. But we have noticed in trials M9, M10, and in M11 that workability did not reduce.

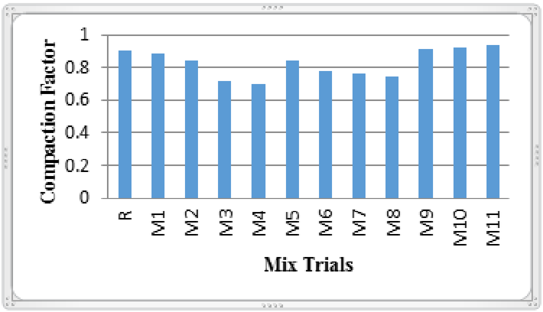
2.By the partial replacement of stone dust and bottom ash the compressive strength obviously gets reduced when compared to reference mix, but these strengths are considerable.

3.So if the optimum replacement is done using stone dust and bottom ash or both at a time can be used for low budget constructions, etc.

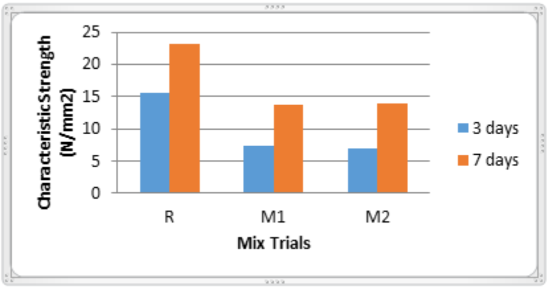
4.For 25% replacement of stone dust we got same results for compressive strength as that of reference

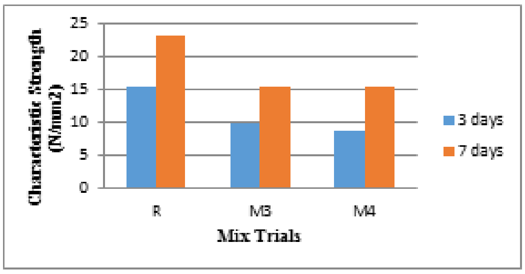
III. RESULTS:

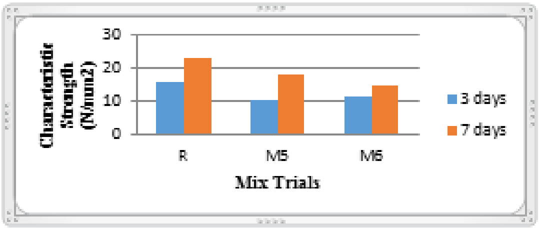
3.1 Workability

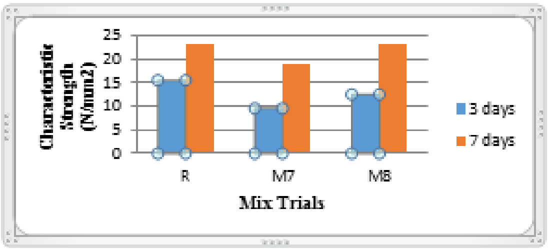


3.2 Compressive Strength

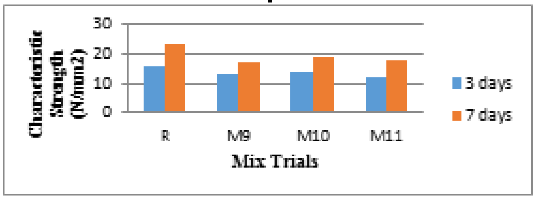








mix.



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