A PARTIAL REPLACEMENT OF POND AND STONE ASH IN CONCRETE CEMENT

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ABSTRUCT

Extensive study has born undertaken through the project to explore the possibility of utilizing this pond ash in the construction industry, especially in concrete and from view of sand becoming scare & contaminated with harmful chemicals & pond ash accumulation posing environmental problems, replacement of sand by pond ash in concrete attempted without compromising on strength. Pond ash sample was procured from Bhusawal Thermal Power Station (BTPS). Characterisation of pond ash sample was carried out and results indicated that pond ash sample can be tried as fine aggregate in concrete

Keywords: - Ponded Fly Ash, Cement Concrete, Thermal Power Station

1. INTRODUCTION

The power required of the country is rapidly increasing due to increasing the growth of industry sector. India depends on thermal power as its main source of electrical energy the 75% of country's total installed electrical power generation is thermal, out of which coal based generation is 90%.According to an estimate the annual consumption of coal in the country for electrical power is 300MT. The average of 35% of ash content, thus as a result more than 110 MT coal ash generated every year. The present practice of handling coal ash generated from thermal power plant in majority of cases is in wet from by disposing of it in ash pond, which leads to degradation of land and thus harmful for environment.

The area where the pond ash is dumped is characterized by very low density and poor bearing capacity. These sites are usually unsuitable for any construction activities all though it may be possible to improve the geotechnical properties of pond ash deposits by some suitable insitu stabilization techniques, so that the sites may be utilized for light construction activities example low height building, parking area and community centres.

2. LITERATURE REVIEW

Priyanka A et.al(2009) Examined the "Effect of replacement of natural sand by stone dust on the properties of cement mortar" The effect of water cement ratio on fresh and hardened properties of concrete with partial replacement of natural sand by stone dust was investigated. Concrete cube, beam and cylindrical specimens were tested for evaluation of compressive, flexural and split tensile strength respectively. Workability was measured in terms of slump and compacting factor. The concrete exhibits excellent strength with 60% replacement of natural sand, so it can be used in concrete as viable alternative to natural sand.

Shwetha P C(2015) This paper reveals the "Experimental Study on Replacement of Cement by Pond ash and sand by Stone dust Partially". In this study Pond ash was used as a mineral ingredient in cement for M-20 grade concrete. Stone dust are used as additional reinforcement of constant 0.17% by weight of cement. Here Pond ash has been partially replaced with cement at 10% and 20%. For determining the mechanical properties at the age of 7,14 and 28 days. The compressive strength of Pond ash concrete specimens was seemed to be higher than the corresponding Stone dust concrete at 7, 14 and 28 days. 20% FA and 20% MS seemed to give good flexural strength compared to the control mix and Pond ash concrete mixes. 10% FA and 10% MS combination seemed to give good tensile strength compared to the control mix and Pond ash concrete mixes.

Rahul Bansal(2015) This report reveals the experimental studies on the "Effect on Compressive Strength with Replacement of Pond ash and Stone dust partially". In this paper the Pond ash Stone dust is partially replaced with cement at 10%, and 20%. For all the above proportions three cubes of M-20 grade of size 150X150X150 mm were tested on compression testing machine and compression strength of these cubes were noted at the age of 7,14 and 28 days. The result showed that the 10% Pond ash and Stone dust replacement gives 20% to 50% increase in the compressive strength at the age of 7 ,14 and 28 days respectively. It was observed with replacement of 20% Pond ash and Stone dust individually in concrete the compressive strength was increased by 7% and 11% as compared to normal concrete cubes. It was seen that with 20% of Pond ash and Stone dust 23% to 25% increase in compressive strength at 7, 14 and 28 days period of curing. It was also observed that with increase in age the compressive strength also increases for Pond ash and Stone dust replaced concrete.

MATERIAL AND METHODOLOGY

In this research work, the India standard method of concrete mix design (IS: 10262:1982) for M20 grade of concrete is used. The physical and chemical characteristic of cement conforms BIS 12269:1987.

The laboratory test for finding the specific gravity and water absorption of coarse aggregate are performed which result as 2.61 and 0.5% respectively. The other materials, which are used as fine aggregates are locally available sand, stone dust and the pond ash. The coarse aggregate and stone dust is taken from local quarry near pendurthi , Visakhapatnam and sand is taken frostone dust mine in river Sarada Anakapalli . The pond ash is collected from ash pond near Visakhapatnam steel plant, Andhra Pradesh .

In this research work, the materials used are coarse aggregates of 20 mm and 12mm nominal size, locally available sand, pond ash and stone dust as a fine aggregate in different proportions.In hardened state; the strength tests such as compressive strength, split tensile strength and flexural strength were studied and the Non-destructive tests such as rebound hammer test and ultrasonic pulse velocity test were conducted for each mix.

MIX DESIGN:

MIX-1:- NORMAL CONCRETE

M_{20}- 1:1.5:3

Total = 1 + 1.5 + 3 = 5.5

According to our mould container dimensions are

$150 \times 150 \times 150\ mm^3 = 0.15 \times 0.15 \times 0.15\ m^3 = 0.0033\ m^3$

Constant value = 1.54 (multiplying factor for converting wet concrete to dry concrete)

Cement:-

Cement content = V × Density of Cement × Constant value × (Proportion/ Total)= 0.0033 × 1440 × 1.54 × (1/ 5.5) = 1.33 kg

Fine Aggregate:-

Fine Aggregate content = V × Density of Fine Aggregate × Constant value × (Proportion/ Total)= 0.0033 × 1450 × 1.54 × (1.5/ 5.5)= 2.009 kg

Coarse Aggregate:-

Coarse Aggregate content = V × Density of Coarse Aggregate × Constant value × (Proportion/ Total) = 0.0033 × 1500 × 1.54 × (1.5/ 5.5) = 4.15 kg

Water Content:-

Water Content = W/C ratio = 0.5

W = 0.5 × 1.33

= 0.665 lit = 655 ml

MIX-2:- 20 % REPLACEMENT OF CEMENT WITH POND ASH

M_{20}- 1:1.5:3

By removing 20 % of Cement and replacing it with 20 % of Pond Ash.

= 1330 × (20/ 100)

Pond Ash = 266 grams = 20 %

Cement = 1330 – 266 = 1064 grams

W/C ratio = 0.5

W = 0.5 × 1064 = 532 ml

Therefore W = 532 ml

MIX-3:- 20 % REPLACEMENT OF FINE AGGREGATE WITH STONE DUST

M_{20}- 1:1.5:3

By removing 20 % of Fine Aggregate and replacing it with 20 % of Stone Dust.

= 2009 × (20/ 100)

Stone Dust = 401.8 grams = 20 %

Fine Aggregate = 2009 – 401.8 = 1607.2 grams

W/C ratio = 0.5

W = 0.5 × 1330 = 665 ml

Therefore W = 665 ml

MIX-4:- 10 % REPLACEMENT OF CEMENT WITH POND ASH AND 10 % REPLACEMENT OF FINE AGGREGATE WITH STONE DUST

M_{20}- 1:1.5:3

By removing 10 % of Cement and replacing it with 10 % of Pond Ash.

= 1330 × (10/ 100)

Pond Ash = 133 grams = 10 %

Cement = 1330 – 133 = 1197 grams

By removing 10 % of Fine Aggregate and replacing it with 10 % of Stone Dust.

= 2009 × (10/ 100)

Stone Dust = 200.9 grams = 10 %

Fine Aggregate = 2009 – 200.9 = 1808.1 grams

W/C ratio = 0.5

W = 0.5 × 1197 = 598.5 ml

Therefore W = 598.5 ml

RESULTS FOR DENSITY TEST

Table 1: Mix Design

S.NO	MIX DESIGNATION	%OF POND ASH AND STONE DUST IN CONCRETE	7-DAYS			14-DAYS		
			SIZE-150X150X150mm			SIZE-150X150X150mm		
			DENSITY(KN/m³)			DENSITY(KN/m³)		
			Wt(gm)	Density	Avg	Wt(gm)	Density	Avg
1	MIX-1	20-00	8723	25.350	25.23	8690	25.53	25.78
			8639	25.110		8760	25.88	
			8772	25.492		8678	25.933	
2	MIX-2	50-10	8531	24.796	24.86	8440	24.53	24.78
			8578	24.933		8560	24.88	
			8550	24.852		8578	24.933	
3	MIX-3	60-10	7934	23.04	23.12	7990	23.1	23.24
			7966	23.09		8010	23.41	
			8002	23.25		7991	23.26	

RESULTS AND DISCUSSION

COMPRESSIVE STRENGTH

- The cube size 150*150*150mm cubes of 6 numbers are casted for different mix proportions and cured.
- The compressive strength for different mixes after curing 7 days and 28 days is tested in the laboratory.
- The average of 3 cubes is tested for 7 days and 28 days is tested for each mix proportion of M20 grade concrete

Fig: 1 Compression Testing Machine

Take 1 part of cement, 2parts of sand and 4 parts of aggregate to form a concrete mix of 1:2:4. Mix cement and sand till uniform colour is obtained. Spread this mixture over the course aggregate and thoroughly mix all the ingredients using a trowel. Find the quantity of water required by adopting a water – cement ratio of 0.6. That is quantity of required in ml= weight of cement taken in gms * 0.6. Add the water to the mixture and mix the concrete thoroughly using the trowel. Oil the inner surfaces of the steel mould. Fill the mould with

concrete in 3 layers. While filling compact each layer by a standard tamping bar with 354 strokes.

Finish the top surface of concrete with top of the mould by means of the trowel. Then, allow the cube to dry at a temperature of 24 + 2º C for 24 hours. Remove the concrete cube from the mould and cure it under water for 7 days in a curing tank. Apply the load till the cube completely crushes or fails and note down the load failure. Determine the compressive strength of the given concrete cube by using the following relation:

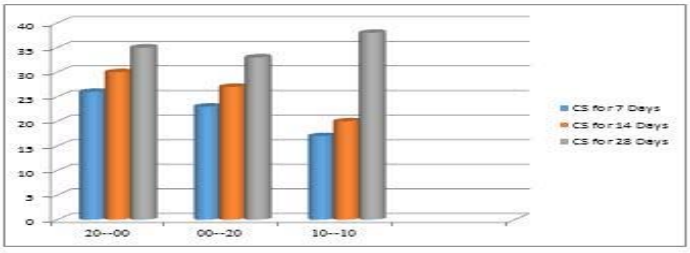
Compressive strength= Load failure (P) in N/Bearing area (A) in mm^2

REULTS FOR COMPRESSIVE STRENGTH

Table 2: Compressive Strength Result

DAYS	CEMENT	CEMENT +20% Pond Ash	CEMENT +20% Stone dust	CEMENT 10+10% Pond Ash +Stone dust
7	16N/mm²	18.4N/mm²	20N/mm²	21.7N/mm²
14	17.1N/mm²	20.2N/mm²	21.5N/mm²	23.5N/mm²
21	18.6N/mm	21.7N/mm²	23.3N/mm²	25.7N/mm²
28	20.4N/mm	23.5N/mm²	25.3N/mm²	27.7N/mm²

COMPRESSIVE STRENGTHS FOR DIFFERENT MIX PROPORTIONS

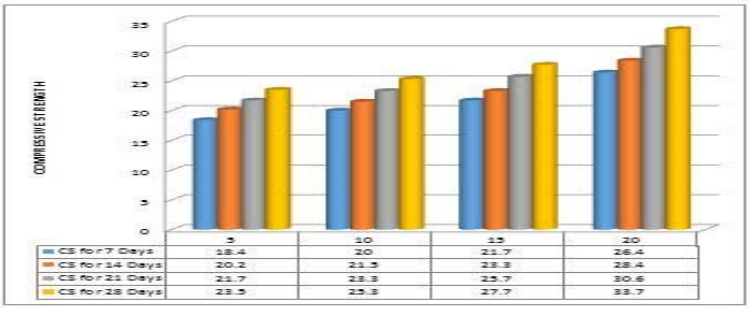


Graph 1: Compressive Strength for Different Mix Proportions

Graph shows the varying percentage of pond ash which is replaced in the Fine aggregate with respect to the compressive strengths. With the above results the optimum percentage of pond ash is taken as 50% replacement of pond ash with 10% replacement of stone dust in Fine aggregate in cement concrete. The use of pond ash partial replacement of sand as fine aggregate in concrete gives higher strength than conventional mix. The experiment with coarse aggregate (20mm), sand, stone dust and pond ash is done. The cubes of M20 grade concrete with varying percentage of pond ash are made as per mix design of concrete. In this work we tried different proportions in fine aggregates with pond ash and stone dust with varying percentages In different mix which we have mentioned in the above tables.

The pond ash is replaced in fine aggregates with 10% of stone dust in each mix for the proper grading in the cement concrete. The pond ash is replaced with 30, 40, 50 percentages in FA from the results obtained the optimum percentage of pond ash is decided and the graph is plotted for the different proportions with respect to the density.

GRAPHICAL COMPARISON OF STRENGTHS



Graph 2: Graphical Comparison of Strengths

OPTIMUM % OF POND ASH

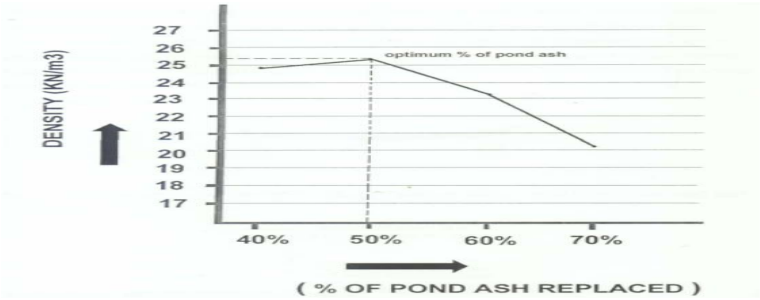


Fig 2: Optimum % of pond ash

This test method is used for determining the flexural strength of concrete by the use of a simple beam with center – point loading. Hydraulic testing machines provided on Portland cement concrete paving projects shall conform to AASHTO T- 177.

Practically all of the hydraulic machines have a micro pump in the loading line to facilitate control of the last half of the load within specifications, and without pause in loading. Either before or after the beam is placed in the testing machine, draw a reference line on the top and bottom of the beam, as cast, about 10 in. (250mm) from the end of the specimen. The two reference lines should be exactly opposite each other. A line drawn across the bottom of the beam, as placed in the machine, will meet these two lines, and will be perpendicular to them. The bottom of the beam as placed in the machine will be the side of the beam as cast.

Insert the stirrup pins in the slots at the bottom of the stirrups to prevent the stirrups from swinging while the beam is being placed in the machine. This also assures that the support bearings are in the correct position. Place the beam in the testing machine so that the two reference lines on the side of the beam are directly under the center line of the center bearing. The maximum fiber stress during application of the load will occur in the outer fiber in the line drawn across the bottom of the beam, this line being directly under the load.

Rotate the micro pump handle counter-clockwise to expose the maximum number of the threads, and close the loading valve on the pump. Apply a small initial load, and remove the stirrup pins.

The load may be applied rapidly up to approximately 50 percent of the estimated breaking load with the pump handle. The final half of the loading is accomplished by turning the crank of the micro pump, at a rate that the extreme fiber stress does not exceed 150 psi (1.0 Mpa) per minute. This is approximately 1200 pounds (500kg) per minute on the test gauge.

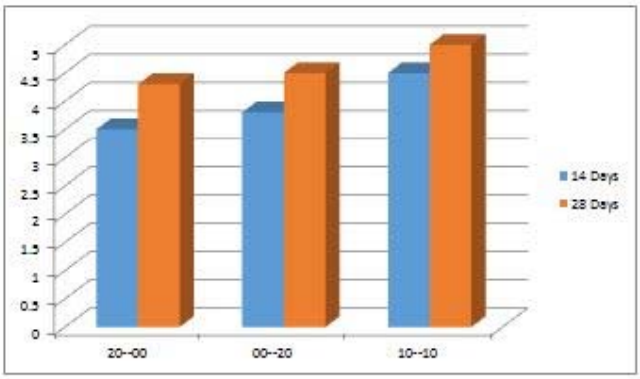
Using one of the fractured faces, take one measurement at each edge and one at the center of the cross section for each direction (width and depth). Make measurements to the nearest 0.05 in. (1mm). Average the three readings to determine the average width and average depth of the specimen at the section of failure.

RESULTS FOR FLEXURAL STRENGTH

Table 3: Results for Flexural Strength

S.NO	MIX DESIGNATION	%OF POND ASH AND STONE DUST IN CONCRETE	7-DAYS			14-DAYS		
			SIZE-150X150X150mm			SIZE-150X150X150mm		
			FLEXURAL STRENGTH(N/mm²)			FLEXURAL STRENGTH(N/mm²)		
			Divisions	FS	AVG	Divisions	FS	AVG
1	MIX-1	20-00	9	3.6		9	3.6	
			7	2.8		9	3.6	
			8	3.2	3.2	10	4	3.7
2	MIX-2	00-20	9	3.6		11	4.4	
			9	3.6		9	3.6	
			7	2.8	3.33	8	3.2	3.73
3	MIX-3	10-10	7	2.8		7	2.8	
			6	2.4		7	2.8	
			7	2.8	2.66	8	3.2	2.93

GRAPH PLOTTED FOR FLEXURAL STRENGTH



Graph 3: Flexural Strength

The graph shows the flexural strength of concrete for different mix degradation which have been tested in the laboratory.

The mix proportions are with the mix degradation in the fine aggregate with 40%, 50%, 60% respectively and 10% of stone dust is also replaced along with pond ash for proper grading and result obtained are shown in the above graph.

SPLIT – TENSILE STRENGTH OF CONCRETE

A tensile test, also known as tension test, is probably the most fundamental type of mechanical test you can perform on material. Tensile tests are simple, relatively inexpensive, and fully standardized. By pulling on something, you will very quickly determine how the material will react to forces being applied in tension. As the material is being pulled, you will find its strength along with how much it will elongate.

6. ADVANTAGES

- By using pond ash in cement concrete, we can reduce the cost of concrete without compromising the strength.
- This concrete is more useful in the areas where the cost of sand is expensive.
- By utilizing dumped pond ash we can protect the hectors of land from degradation.
- Compressive strength is high compared to the conventional.

17. DIS-ADVANTAGES

- The quality of Pond ash can affect the quality and strength of Cement concrete.
- Poor quality Pond ash can increase the permeability of the concrete and cause damage to the building.
- Workability issues: Stone Dust can be of a coarser and angular texture than natural sand, which is smooth and rounded due to natural gradation. This can lead to more water and cement requirement to achieve the expected workability, leading to increased costs.

18. CONCLUSION

- The density of concrete mix decreases with increase in percentage of pond ash. It is evident that density decreases by 7.85% for 60% pond ash as compared to 50% pond ash.
- The compressive strength of concrete mix design with addition of pond ash up to 50% and there after it decreases. It is evident that compressive strength increases by 7.08% (28 days) corresponding to pond ash 50%.
- This evident that the addition of pond ash results in almost constant compressive strength at early stage of (7 days) and increases in later stage (28 days).

9. REFERENCES

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