Experimental Investigation on Strength Properties on Concrete Fractional Replacement of Cement with Fly Ash & Sand with Stone Dust

Palli Mallika Devi[1] M.K.M.V.Ratnam[2] Dr. U. Ranga Raju[3]
[1]PG Student [2]Assistant Professor [3]Professor
[1,2,3]Department of Civil Engineering
[1,2,3]D.N.R College of Engineering & Technology Bhimavaram Andhra Pradesh, India

Abstract— Performance Concrete (HPC) now a day's used widely in the construction industry worldwide. High performance concrete appears to be a better choice for a strong and durable structure. Normal and special materials are used to make these specially designed concrete that must meet a combination of performance requirements. In this project, investigations were carried out on strength properties such as compressive strength, split tensile strength and flexural strength of M40 grade of HPC mixes with different replacement levels such as 25%,30%,35% & 50% of cement by fly ash and 60%,65%,70%,7&100% of stone dust with sand by adopting water-binder ratio of 0.35. Super plasticizer (BASF) is used for better workability for high performance concrete. The HPC mix, grade M40 concrete is designed as per IS: 10262-1982 IS: 456-200, which is conventional. Mechanical characteristics like Compressive strength, Split-tensile strength, Flexural strength were examined. The result of these investigations demonstrates the strength characteristics of stone dust and the properties of fly ash based concrete mixes. Based on the results obtained, the replacement of 100% stone dust and 25% fly ash with 1.2% of super plasticizer which superior characteristics was arrived .The details of the investigations along with the results are presented in this report.

Key words: High Performance Concrete, Fly Ash, M-Sand, Compressive Strength, Split Tensile, Flexural Strength, Super Plasticizer

I. Introduction

High performance concrete (HPC) may be a concrete that meets special mixtures of performance and uniformity necessities that cannot forever be achieved habitually mistreatment standard constituents and traditional mixture and inserting and natural action practices. to provide high performance concrete it's typically essential to use chemical and mineral admixtures additionally to identical ingredients, that area unit typically used for traditional concrete. In recent times, several researches area unit happening for up the properties of concrete with relevancy strength, Durability and performance as a structural material. There are unit several materials like ash, chamber dross, stone dirt and silicon oxide fume etc. one of these special concrete is that the stone dirt that is new rising joined of latest generation construction material in manufacturing high strength and performance concrete for special structures. The interest in ash and stone dirt started in management} of pollution control in several countries. This suggests that the trade had to prevent emotional ash into the atmosphere. To seek out answer to the current drawback studies were initiated and when some investigations, it absolutely was found that the ash and stone dirt can be used as a awfully helpful material in concrete. In India, improved stone dirt and ash is finding its use currently every day.

A. *Scope of study*

In this project through an experiment investigate the result of exchange 25%,30%,35% & four-hundredth replacement of cement by ash and replacement hr,65%,70%,75%&100% of sand by stone dust on strength characteristics particularly compressive strength, flexural strength and split strength

II. Literature review

A variety of compaction instrumentation are often wont to increase the relative compaction of fly ash soil mixtures, dependent on soil kind. Because of its self-cementing properties, fly ash are often a good stabilizer for granular and fine grained materials. Fly ash by itself has very little cementations price however within the presence of wet it reacts with chemicals and forms cementations compounds and attributes to the development of strength and sponginess characteristics of soils. It a protracted history of use as AN engineering material and has been with success utilized in geotechnical applications. Fly ash consists of usually hollow spheres of element, metallic element and iron oxides and unoxidized carbon.

Nicholson conferred variety of patents (1977, 1982) for a series of investigations on cement oven mud (CKD) and fly ash mixtures for manufacturing molding materials with completely different aggregates. CKD was depleted to Sixteen Personality Factor Questionnaire by weight of the mixture, manufacturing a sturdy mass by reacting with water at close temperatures.

Terrel et al. (1979a) counsel initial compaction with a sheepsfoot or padfoot roller and employing a gas roller to end rolling fine-grained materials. Sheepsfoot or padfoot rollers area unit most well-liked as a result of sensible compaction of the elevate from rock bottom up is achieved, whereas the kneading action helps to additional combine the fly ash, soil, and water (Ferguson and Leverson 1999). Compaction delay time ought to even be thought of as a result of the stabilised material will lose strength gain capability because the fly ash hydrates whereas in uncompacted state. for sophistication F fly ash stabilization work, a most compaction delay time of up to four hours has been specific (Terrel et al. 1979a, Vandenbossche and Johnson 1994). With the enlarged reactivity of self-cementing fly ash, however, a far shorter compaction delay time is usually specific. For self-cementing fly ash stabilised sections, compaction ought to begin as before long as doable once final combination and be completed among 2 hours, therefore the stabilised material can show less strength and density decrease (Terrel et al. 1979a, Ferguson and Leverson 1999). In most cases, the initial compaction begins with a padfoot-type roller directly behind the pulvamixer and might be finished among quarterhour once final combination (Ferguson and Leverson 1999). Consistent with Terrel et al. (1979a) and Vandenbossche and Johnson (1994), before significant traffic or pavement sections area unit placed, the finished sections ought to be cured for 3 to seven days.

Miller, et al. (1980) have additionally reportable the utilization of CKD and fly ash because the building material ingredients in developing pozzolanic bases that incontestable comparable properties to those of a stabilised base. it had been detected, however, that the utilization of ANy specific CKD-fly ash combination would need an appraisal of the chemical and strength check knowledge to ascertain optimum properties for an acceptable combine style.

Collins and mineral (1983) incontestable the effectiveness of subbing CKD for lime during a range of lime-fly ash-sandy combination systems for molding construction. The results indicated that the bulk of the CKD-treated fly ash and combination mixtures resulted in materials that were comparable in strength, durability, dimensional stability, and different engineering properties, to those of the standard lime-fly ash-aggregate mixtures.

III. Materials Used

A. *Soil*

The gravelly sand employed in the current study was collected from the outer bypass space close to Gandi Misamma in Hyderabad, AP state, India. The soil could be a greyish to brown colored gravelly sand and has no cohesion. The soil collected was unbroken in controlled conditions within the laboratory and was used for checking as per the Indian customary specifications given within the various test codes. For this soil, the fundamental tests were conducted within the laboratory for its characterization. As per the fundamental properties of soils area unit involved, it indicates that the soil is greyish to brown in color and has soil proportions of gravel, sand and tiny fine fraction.

Property	Value
Specific gravity	2.68
Direct Shear Results (at OMC):	
Cohesion, c (kPa) in Light Compaction	0
Cohesion, c (kPa) in Modified Compaction	0
Angle of Internal Friction, ϕ (deg) in Light Compaction	39.5
Angle of Internal Friction, ϕ (deg) in Modified Compaction	45
Optimum Moisture Content, OMC (%)in Light Compaction	8.0
Optimum Moisture Content, OMC (%)in Modified Compaction	7.5
Maximum Dry Density, MDD (kN/m^3) in Light Compaction	19.95
Maximum Dry Density, MDD (kN/m^3) in Modified Compaction	20.90
California Bearing Ratio Values, CBR (%) (at OMC):	
Unsoaked CBR (%) in Light Compaction	62
Soaked CBR (%) in Light Compaction	46
Unsoaked CBR (%) in Modified Compaction	85
Soaked CBR (%) in Modified Compaction	85
Grain Size Distribution:	
% Gravel	21.3
% Coarse Sand	14.6
% Medium Sand	38.3
% Fine Sand	18
% Silt & Clay	7.8
Effective Diameter, D_{10} (mm)	0.16
Coefficient of Uniformity, c_u	12.5
Coefficient of Curvature, c_c	1.75
Soil Classification	SW

Table 1: Basic Geotechnical Properties of Gravelly Sand employed in the Study

B. *Fly Ash*

The fly ash employed in this investigation was collected from Vijayawada Thermal station (VTPS) Vijayawada. The fly ash sample collected was hold on within the air tight containers. The grain size distribution curve for fly ash is conferred within the chapter four (Fig. 4.5). the varied properties of the fly ash obtained from the VTPS area unit conferred within the Table three.2 and 3.3. The fly ash proportions adopted within the study by dry weight of soil area unit 1/3, 5%, 10%, 15%, two hundredth and twenty fifth.

Property	Value
Specific gravity	1.97
Direct Shear Results:	
Cohesion, c (kPa) in Light Compaction	13
Cohesion, c (kPa) in Modified Compaction	10
Angle of internal friction, ϕ (deg) in Light Compaction	29
Angle of Internal Friction, ϕ (deg) in Modified Compaction	31.5
Compaction Characteristics:	
Optimum Moisture Content, OMC (%) in Light Compaction	19.5
Optimum Moisture Content, OMC (%) in Modified Compaction	18
Maximum Dry Density, MDD (kN/m^3) in Light Compaction	12.65
Maximum Dry Density, MDD (kN/m^3) in Modified Compaction	13.85
California Bearing Ratio Values, CBR (%):	
Unsoaked CBR (%) in Light Compaction	27
Unsoaked CBR (%) in Modified Compaction	34
Soaked CBR (%) in Light Compaction	9
Soaked CBR (%) in Modified Compaction	16
Grain Size Distribution:	
% Gravel	0
% Coarse Sand	0
% Medium Sand	0
% Fine Sand	97.5
% Silt & Clay	2.5
Effective Diameter, D_{10} (mm)	0.085
Coefficeint of Uniformity, c_u	2.2
Coefficient of Curvature, c_c	1.2

Table 2: Physical Properties of Fly ash employed in the Study

IV. RESULTS AND DISCUSSION

A. Compressive Strength of Concrete

After 7 days, 14 days, 28 days, 56 days and 90 days of curing, three 150mm cubes of a concrete mixture were tested using the compression machine. These cubes were loaded on their sides during compression testing such that the load was exerted perpendicularly to the direction of casting. The average value of the three cubes was taken as the compressive strength.

S. No	Specimen	7 Days	14 Days	28 Days	56 Days	90 Days
1	C	46.76	64.66	71.48	78.23	84.51
2	C1-25%	38.45	50.59	58.80	62.36	73.54
3	C2-30%	35.54	50.32	56.0	59.78	69.96
4	C3-35%	34.79	47.44	54.71	57.36	65.19
5	C4-40%	31.2	43.2	48.00	51.23	56.32

Table 3: Compressive strength (N/mm2) - fly ash

S. No	Specimen	7 Days	14 Days	28 Days	56 Days	90 Days
1	C	46.46	64.46	71.38	79.56	84.61
2	S1-60%	35.68	49.01	54.76	68.62	75.49
3	S2-65%	35.32	49.63	55.38	69.79	70.95
4	S3-70%	35.89	49.87	55.68	70.63	68.32
5	S4-75%	40.37	55.82	61.28	75.36	71.34
6	S5-100%	44.0	60.99	67.72	77.21	80.59

Table 4: Compressive strength (N/mm^2) – Stone Dust

Fig. 1: Compressive Strength Test

B. Split Tensile Strength of Concrete

S. No	Specimen	7 Days	14 Days	28 Days	56 Days	90 Days
1	C	2.92	4.0	4.8	5.6	6.2
2	C1-25%	2.92	4.0	4.8	5.6	6.2
3	C2-30%	2.86	3.83	4.4	5.1	5.5
4	C3-35%	2.77	3.62	4.0	4.93	5.14
5	C4-40%	2.64	3.54	4.1	4.71	4.98

Table 5: Split tensile strength (n/mm^2) - fly ash

S. No	Specimen	7 Days	14 Days	28 Days	56 Days	90 Days
1	C	2.9	4.0	4.8	5.12	5.67
2	S1-60%	2.67	3.52	3.93	4.91	5.28
3	S2-65%	2.58	3.63	3.96	4.85	5.20
4	S3-70%	2.67	3.39	3.86	4.79	4.97
5	S4-75%	2.82	3.83	4.34	4.37	4.85
6	S5-100%	3.30	4.35	4.83	4.86	5.01

Table 6: Split tensile strength (n/mm^2) – Stone Dust

Fig. 2: Split Tensile Strength Test

Workability	Fly Ash		Stone Dust	
S. No.	Specimen	Slump (mm)	Specimen	Slump (mm)
1	C	30	C	30
2	C1-25%	50	S1-60%	45
3	C2-30%	51	S2-65%	43
4	C3-35%	53	S3-70%	40
5	C4-40%	55	S4-75%	37
6	---	----	S5-100%	35

Table 7: Durability

Compressive Strength (N/mm^2)	Split Tensile Strength (N/mm^2)	Flexural Strength (N/mm^2	Workability (mm)
61.4	4.65	5.6	50

Table 8: Final Mix – 1:0.35:2.43:0.78 with 25% Fly Ash & 100% Stone Dust

V. CONCLUSIONS

Based on experimental studies the following conclusion is drawn.

From the higher than attention-grabbing points detected within the compaction, strength and cosmic background radiation results, it's perceive that up to regarding ten of fly ash addition to gravelly sand, the properties of gravelly sand don't seem to be dynamic drastically and therefore the mixture is showing encouraging results towards utilization of fly ash in conjunction with gravelly sand for low volume and high volume pavement construction. The penetration response is rigid {in case just in case} of changed compaction as compared to lightweight compaction and additionally the response is rigid in case of unsoaked condition as compared thereto of soaked condition. Hence, up to ten of fly ash are often used in conjunction with gravelly sand in pavement construction while not compromising the strength and stability aspects area unit involved.

VI. FUTURE SCOPE OF STUDY

From the results conferred within the gift study, it are often perceive that regarding ten of fly ash are often used for the pavement construction in conjunction with the gravelly sand while not compromising the cosmic background radiation and Strength values. Even at twenty fifth addition of fly ash to the gravelly sand, it's discovered that the cosmic background radiation price is over two hundredth. Hence, for specific cosmic background radiation values of two hundredth and simply higher than, it is often susceptible that even twenty fifth of fly ash are often used for the building.

A detailed study is often extended on fly ash gravelly sand mixtures towards utilization of fly ash within the low volume and high volume roads. The behavior of mixture underneath drain conditions is often studied. The behaviour of mixture underneath repetitive loading conditions are often disbursed. Model pavement studies are often conducted to check the steadiness aspects of fly ash gravelly sand mixtures towards building.

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