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PARTIAL REPLACEMENT OF CEMENT BY FLYASH IN PERVIOUS CONCRETE

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Abstract: *Many places were covered with impermeable surfaces like cement concrete and bitumen it leads to major impact on the ground water table. Pervious Concrete pavement is an effective way to minimize this issue. Pervious concrete is an open graded structure with interconnected voids through which rain and storm water is permitted. Pervious concrete is one of the most effective pavement surface to improve ground water level. Porous concrete is an innovative material which is a mixture of coarse aggregate , cement, water and little amount of sand or no sand along with or without chemical admixtures. Porous concrete is a new concept to increase the ground water table level. The main aim of this work is to study the compressive strength and permeable rate on pervious concrete by replacing the cement by fly ash.*

Keywords*- Pervious concrete, fly ash, strength , permeability.*

I. INTRODUCTION

In reviewing technology advances through the centuries it is evident that material development plays a key role. Considerable efforts are still being made in every part of the world to develop the new construction materials.

About 35% to 70% of our construction sites are being covered by paved surfaces. This impervious surface blocks natural water infiltration into the soil, pervious concrete is one such solution for this problem.

1.1 Pervious concrete / Porous concrete is an innovative material which is a mixture of coarse aggregate, cement, water and little to no sand along with chemical admixtures, containing a network of holes or voids, to allow air or water to move through the concrete. This allows water to drain naturally through it and allows replenishment of groundwater where conventional concrete does not. Absence of sand or fine aggregate permit the properly placed pervious concrete to have about 15 to 30% of void space, the pores can range from 2 to 8mm, which permit water to pass through without causing any damage to the matrix of the porous concrete.

1.2 Fly ash consists of fine, powdery particles that are predominantly spherical in shape, either solid or hollow and mostly glassy (amorphous) in nature, having similar physical characteristic with silt. Compared to its physical properties, its chemical properties are more influenced by the type of burned coal and the techniques used for handling and storage. **Class C** and **Class F fly ash** are classified according to the ASTM C 618. Class C contains more lime than class F fly ash. Class C fly ash has both pozzolanic and cementitious properties and is mostly used in the situations where high early strength is important such as prestressed applications. Class F fly ash is considered an ideal pozzolanic material in mass concrete and in high strength mixes and it is recommended to be used in concrete exposed to ground water.

II. LITRATURE REVIEW

M. Uma Maguesvari et al. (2013), investigated the influence of fine aggregate and coarse aggregate quantities on the properties of pervious concrete and observed that the increase in fine aggregate results in reduction of volume of voids which in turn increase of compressive strength. This study illustrates angularity number, which effects the properties of pervious concrete like Coefficient of permeability increases from 0.4cm/sec to 1.26 cm/sec when the angularity number is in the range of 4 to 8.

Vanchai Sata et al.(2012), evaluated the properties of pervious concrete made of high-calcium fly ash. The tests were conducted on pervious concrete to find out void content of concrete, water permeability coefficient, compressive strength. The compressive strengths were found out in the range of 5.43 and 11.49 MPa. Which is slightly more than conventional concrete strength. They concluded that the high void contents at 25 - 30% led to the high water permeability coefficients between 1.5 and 6 cm/s.

Ravindrarajah et al.(2010)investigated the properties of pervious concrete by replacement of 20% and 50% of cement content with fly ash. He found out that pervious concrete with high porosity shows low compressive strength and high permeability. The results of their investigation described that the permeability of pervious concrete was not notably affected when 50% or more of cement content was replaced by fly ash and compressive strength was decreased with increase in the percentage of fly ash content.

Yukari et al.(2009),experimented on the properties of pervious concrete by replacing the cement with 20% of fly ash. He concluded that compressive strength increase with increment of fly ash content. When fly ash content is increased up to 20% in concrete permeability is decreasing, but compressive strength increase as compare to normal.

Ajamu et al.(2012), evaluated the performance of pervious concrete in construction industry. They concluded that the compressive strength with smaller aggregate size gives high compressive strength and also the permeability was high. The mix with high aggregate to cement ratio was considered efficient to use for construction of pavement which requires low compressive strength and high porosity.

III. OBJECTIVE OF THE PRESENT WORK

The objective of this study is to investigate the effects on the important engineering properties of pervious concrete with the use of fly ash. The physical properties examined include compressive strength and permeability of pervious concrete.

IV. MATERIALS USED AND ITS PROPERTIES

A. ***Cement:*** In the present study ordinary Portland cement of grade 43 is used. The choice of brand and type of cement is the most important to produce a good quality of concrete. The type of cement affects the rate of hydration, so that the strengths at early ages can be considerably influenced by the particular cement used. It is also important to ensure compatibility of the chemical and mineral admixtures with cement. The tests are conducted as per IS-12269:1987.

Sl No.	*Particulars*	*Results*
1	Specific Gravity	2.8
2	Fineness of Cement	6.92%
3	Standard Consistency	32%
4	Initial Setting Time	41 min

Table 1: Properties of cement

B. ***Course Aggregate*****:** Crushed Cysts stone with fraction I (25mm passing -20mm retained) , fraction II (12.5mm passing -10mm retained) was adopted. Tests are conducted as per IS-2386:1963.

Sl No.	*Particulars*	*Results*
1	Fineness Modulus	7.39%
2	Specific Gravity	2.8
3	Crushing Value	22.43%
4	Abrasion Value	30.2%
5	Water Absorption	0.5% by weight of aggregate.

Table 3: Properties of Course Aggregate

C. ***Fly Ash*****:** For the present work Class F fly ash sourced from brick factory shanti nagar wardha and tests are conducted as per IS-3812:2003

Sl No.	*Particulars*	*Results*
1	Fineness Modulus	298
2	Specific Gravity	2.0
3	Soundness	0.035
4	Particle Retained on 45µm IS sieve	38.5

Table 5: Physical Properties of Fly Ash

SI. No.	*Tests Conducted*	*Obtained Results %*
1.	$(SiO_2) + (Al_2O_3) + (Fe_2O_3)$, % by mass,(Min.)	90.90
2.	(SiO_2), % by mass, (Min.)	58.2
3.	(MgO),% by mass, (Min.)	0.98
4.	Total Sulphur as SO_3, % by mass, (Max.)	0.15
5.	LOI, % by mass, (Max).	0.50

Table 6: Chemical Properties of Fly Ash

V. METHODOLOGY ADOPTED

1. ***Mix design*****:** In the present work, 1:4:0.2 mix design is adopted for M30 grade pervious concrete.

2. ***Proportioning:*** Weigh Batching is used for the experimental study. The weighed cement is mixed with 0%,10%,20% fly ash.The whole dry sample is mixed thoroughly by hand mixing. Water is added to the dry sample and mixed well until a uniform homogeneous mix is obtained, the mixing time should not exceed 3-5 minutes.

3. ***Trial mix*:** The main objective of the trial mixes were to determine the percentage of fly ash required to achieve a suitable workability for pervious concrete and also to determine the optimum proportion which give better strength and permeability results.
4. ***Final mix*:** Based on the results of trial mix or batches the proportions which is resulted in higher compressive strength value with good workability is selected for the final mix, to find the 28th days compressive strength.

5. ***Curing****:* After 24 hrs of moulding, concrete specimens are removed from the moulds and kept for curing in water bath for 7 days & 28 days as per standard procedure.

6. ***Test***: The specimens are tested for compressive strength and percolation rate as per Indian standard code.

VI. RESULTS AND DISCUSSION

A. Workability of Pervious Concrete: Slump test is used to get the required workability of pervious concrete as per Indian standard specifications. The pervious concrete samples momentarily held the shape of the slump cone before collapsing for producing slump of 100mm by replacing the cement with flay ash.

B. The specimen with 20% replacement are showing strength higher than the strength of controlled concrete in compression.

C. Specimen with 10% replacement to controlled specimen.

D. 20% replacement of cement with fly ash as fial mix for 28th day compressive strength and other engineering properties of pervious concrete.

VII. CONCLUSION

Based on the analysis of results following conclusion are drawn

1. The compressive strength of concrete with 20% replacement results in increased strength compared to the pervious concrete without fly ash.
2. By the use of cementicious material fly ash, the usage of cement can be reduced which will reduce the cost of concrete to certain extent.
3. As the pervious concrete with 20% replacement of fly ash gives slight increase in compressive strength, hence this material can be used for road pavement at the places of low volume of traffic road, parking lots, play grounds etc which helps in recharging underground water table.

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