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Fractional Restoration of Manufactured Sand and Alkali Activated Fly Ash with Concrete

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Abstract: *The use of fly ash in concrete is limited due to its low early strength of fly ash concrete. To eliminate this problem studies have been conducted on accelerating the pozzolanic properties of fly ash. The pozzolanic property of fly ash can be improved by various types of activations namely, thermal activation, mechanical activation and chemical activation. Thermal activation by heating and mechanical activation by grinding requires costly equipment and energy Compared to this chemical activation is cheap and easy. In addition to that fine aggregate is partially replaced with M-sand in various proportions. Many researchers have carried out studies on micro structural development of strength with chemical activation. Calcium oxide and sodium silicate are used in 1:8 ratios for activating fly ash in the project study. The main objective of the research was to study the compressive strength, split tensile and flexural strength behavior of concrete using chemically activated fly ash at 20% replacement of cement with water binder ratio 0.45 and also replacement of fine aggregates using M-sand by 10%, 20% & 30%. The results were compared with ordinary cement concrete and activated fly ash concrete.*

Keywords: *Alkali Activated Fly Ash, Compressive Strength, Flexural Strength, Manufactured Sand, ozzolanic, Split Tensile Strength*

I. Introduction

Concrete is a composite material composed of mainly of water, aggregate, and cement. Often, additives and reinforcement are included in the mixture to achieve the desired physical properties of the mass that is easily molded into shape. Fly Ash is one of the major waste materials available from thermal power plants. Its treatment and disposal was a problem in the early stages. Researchers found out a useful method of replacing fly ash for cement in calculated qualities. Here an experiment has been conducted to study the performance of concrete using fly ash as the major binding material without of cement. Low calcium fly ash is preferred as a source material than High calcium fly ash because of to reducing more carbon di-oxide emission. Alkaline liquid Sodium hydroxide and Sodium silicate solution are used in this project as binders. Manufactured sand is the alternative for river sand. Due to fast growing construction industry, the demand for sand has increased tremendously, causing deficiency of suitable river sand in most part of the word. Due to the depletion of good quality river sand for the use of construction, the use of m-sand has been increased. Another reason for use of m-sand is its availability and transportation cost. Since this sand can be crushed from hard granite rocks, it can be readily available at the nearby pace, reducing the cost of transportation from far-off river sand bed. Thus, the cost of construction can be controlled by the use of m-sand as an alternative material for construction. The other advantage of using m-sand is, it can be controlled easily so that it meets the required grading for the given construction.

[1] A combined chemical and mechanical activation system by which highly reactive fly ash suspension can be prepared. A wide variety of inorganic salts have been used in this study. From the study it is found that, Calcium chloride produces low early strength Nitrate salts of calcium, sodium and ammonium show a low activation effect Activation effect enhanced if mechanical activation is combined with chemical activation. [2] Fly ash concrete was produced to find the effects of sodium hydroxide were used as alkali activation. Cube samples 150 x 150 x 150 mm were cast to perform compressive strength test and cured at room temperature. The results showed that compressive strength increases with increase in concentration of sodium hydroxide, however beyond optimum concentration of sodium hydroxide compressive strength decreases. [3] The microscopic study of a set of alkali-activated and thermally cured fly ash samples enabled the authors to establish a descriptive model for the micro structural development of fly ash-based cementitious geo-polymers. The conclusions drawn from the study are, the activation reaction rate as well as the chemical composition of the reaction products depend on several factors like, the particle size distribution and the mineral composition of the starting fly ash, the type and concentration of the activator, etc. The mechanisms controlling the general process of activation are independent of those variables. [4] Two samples of fly ashes from Austria (Spain) were activated mechanically by wet milling and chemically by leaching with sulphuric acid. . A comparative study was carried out of several mortars, in some cases using different additions of silica fume or activated fly ash. The influence that these additives have on the mechanical resistance of the mortars was studied. As well as the

possible use of these activated fly ashes as a replacement for silica fume in producing high-strength mortar or concrete. It was found that mortars containing activated fly ash presented higher compressive strengths. The conclusions drawn are, Longer curing time resulted in lower porosity values. The increase in the mechanical resistance related to the large reduction in porosity. [5] For this study, alkali-activated fly ash pastes and mortars were prepared. In pastes, morphology was studied using scanning electron microscopy (SEM/EDS) and micro structural properties with X-ray Diffraction (XRD) analysis. Mortars were evaluated according to their mechanical performance measured using compression strength tests. The results show that the N/S molar ratio plays an important role in the mechanical and morphological characteristics of geo polymers. The mortars prepared with a N/S 0.40 molar ratio had the greatest compression strength. The analysis of paste morphology revealed that N/S 0.40 pastes had a denser appearance, which is in agreement with results of compression strength tests. [6] They investigated the setting and mechanical properties of alkali-activated fly ash/slag concrete manufactured at room temperature. It also examines to what extent the slag in the alkali-activated fly ash/slag mixture improves the mechanical properties of the mixture under room-temperature curing conditions. A series of tests of the compressive strength, elastic modulus, splitting tensile strength, flow, setting time, and porosity of the alkali-activated fly ash/slag concrete were carried out. The test results showed that the setting time decreased as the amount of slag and the concentration of the NaOH solution increased. The proper slag content in an alkali-activated fly ash/slag mixture was determined to be 15–20% of total binder by weight considering the setting time and compressive strength of the alkali-activated fly ash/slag concrete cured at room temperature.[7] The Manufactured sands are made by crushing aggregate to sizes appropriate for use as a fine aggregate. During the crushing process the manufactured sand have irregular shapes. Due to irregular shape of the aggregates there is a batter packing among the particles there by reducing the voids in concrete. Results of the experimental studies show that resistance to penetration of water as proved by rapid chloride penetration test and water permeability test, is increased with increasing proportion of M sand in concrete. Results show that river sand can be fully replaced by manufactured sand. The use of manufactured sand in the construction industry helps to prevent unnecessary damages to the environment and provide optimum exploitation of the resources. [8] For geo-polymer concrete, the curing period is an important factor when curing is done under ambient room temperature. The strength gain is found to be more than 60 percent at 90 days when compared to that of 28 days strength .The strength gain in geo-polymer concrete is significant when heat cured for 72 hours. The strength of heat cured specimen is found to be almost equal to the corresponding strength of 90 days ambient cured specimen. The fly ash content is much significant when the geo-polymer concrete is cured in ambient temperature. However, the change in strength of heat cured specimen is nominal with the variation of fly ash content from 395 to 425kg per cubic meter of concrete. The present study promotes the use of fly ash, which is otherwise considered as waste material. Hence the fly ash geo-polymer concrete is a sustainable material for future construction works. [9] For this study, to evaluate the workability, unit weight and compressive strength of concrete mix with 10% replacement of cement content by fly ash in addition to varying doses of super plasticizer.self-compacting concrete not only establishes the uniform and homogenous mix but also gives marginal reduction in weight of hardened mix of concrete.

II. Research Significance

To improve the quality of concrete Activation by partial replacement of fine aggregate using manufactured-sand in Activated fly ash concrete. By this modified approach, we can obtain low cost eco-friendly concrete material for our society.

III. Material Properties

Ordinary Portland Cement (OPC) 43 grade conforming to IS 8112 was used in this study. Nominal size 10mm as per IS: 383-1970.The maximum size of coarse aggregate is generally limited to 20mm and maximum water cement ratio of 0.45. Aggregate of size 10 to 12mm is desirable for structures having congested reinforcement. Well graded cubical or rounded aggregates are desirable. Aggregate should be having uniform quality with respect to shape and grading. Table 1 summarizes material properties of cement, fine aggregate and coarse aggregate. The various test like compressive, split tensile and flexural was performed as per Indian standard.

Table 1 Description of Material Properties

S.No	Description	Result
1	Fineness Test on Cement	4.67%
2	Consistency Test on Cement	8.67mm
3	Specific Gravity or Cement	2.92
4	Specific Gravity of Fine Aggregate	2.64
5	Specific Gravity of Coarse Aggregate	2.66
6	water absorption test for coarse Aggregate	0.5%
7	water absorption test for Fine Aggregate	1.0%

IV. Methodology

36 Specimens was casted for this study with the help of mix design shown in Table 2. The Specimens are tested for compressive strength on at reliable compression test machine provided with two steel bearing platens with hardened faces. The tests should be made at recognized ages of test specimen. The three specimens, preferably form different batch, was made for testing at each selected age. Specimens stored in water and while they are in the wet condition. In the case of cubes, the specimen should be placed in the machine in such a manner that the load is applied to the opposite sides of the cubes as cast, which is not to the top and bottom. The load should be applied without shock and increased continuously at a rate of approximately 140% Kg/ cm2 / min. until the resistance of the specimen to the increasing load breaks down and no greater load can be sustained. The measured compressive strength of the specimen is calculated by dividing the maximum load applied to the specimen during the test by the cross – sectional area, calculated from the mean dimensions of the section. Average of three values should be taken as representative of the batch, provide the individual variation is not more than ± 15 present. Otherwise repeat test should be made. For Split tensile Strength, Take the wet specimen from water after 28 days of curing. Wipe out water from the surface of specimen. Draw diametrical lines on the two ends of the specimen to ensure that they are on same axial place. Set the compression testing machine for the required range. Bring down the upper plate to touch the specimen. Apply the load continuously without shock at a rate of approximately 14-21 kg/cm²/minute (which corresponds to a total load of 9900 kg/min to 14850 kg/min). Direct measurement of tensile strength is not feasible. Hence beam tests are found to be dependable to measure the flexural property of concrete. Modulus of rupture is taken as the extreme fiber stress in bending. The value of modulus of rupture depends on the dimensions of the beam and the type of loading. The loading adopted is central or two-point loading. In the central point loading, the maximum fiber stress occurs below the point of loading where the bending moment should be higher. In the two point loading, the critical crack may appear at any section, where the bending moment is high or resistance is weak. In general, the two point loading yields lower value of modulus of rupture than the center point loading.

Table 2 Mix Proportion

Description	Water	Cement	Fine Aggregate	Coarse Aggregate
Weight in kg/m³	197	493	737.61	945.89
Ratio	0.40	1	1.5	2

Different specimen and dimension was casted for different strength was shown in table 3.The compressive strength, split tensile and flexural strength are conducted for both conventional concrete and chemically activated fly ash at 20% replacement of cement with water binder ratio 0.45 and also replacement of fine aggregates using M-sand by 10%, 20% & 30%. The results were compared with ordinary cement concrete and activated fly ash concrete.

Table 3 Details of Specimen for Strength Test

S.No	Description	Specimen	Dimension
1	Compressive Strength	Cube	150*150*150
2	Split Tensile Strength	Cylinder	150*300
3	Flexural Strength	Prism	100*100*5000

V. Results And Discussion

Compressive strength value of conventional concrete and alkali activated fly ash concrete with different percentage manufactured sand was shown in figure 1.Average compressive strength of cube at 7 days = 31.40N/mm².For 20% of Manufactured Sand& 20% of Fly Ash material, the average compressive strength of cube at 7 days gives greater strength than the standard mix. Average compressive strength of cube at 28 days = 43.11N/mm². For 20% of Manufactured Sand& 20% of Fly Ash material, the average compressive strength of cube at 28 days gives greater strength than the standard mix. Split Tensile strength value of conventional concrete and alkali activated fly ash concrete with different percentage manufactured sand was shown in figure 2.The average split tensile strength of cylinder at 7 days= 3.34N/mm. For 20% of Manufactured Sand& 20% of Fly Ash material, the average split tensile strength of cylinder at 7 days gives greater strength than the standard mix. The average split tensile strength of cylinder at 28 days= 4.84N/mm². For 20% of Manufactured Sand& 20% of Fly Ash material, the average split tensile strength of cylinder at 28 days gives greater strength than the standard mix. Flexural strength value of conventional concrete and alkali activated fly ash concrete with different percentage manufactured sand was shown in figure 3The average flexural strength of prism at 7 days= 3.44N/mm². For 20% of Manufactured Sand& 20% of Fly Ash material, the average flexural strength of prism at 7 days gives greater strength than the standard mix. The average flexural strength of prism at 28 days= 5.25N/mm². For 20% of Manufactured Sand& 20% of Fly Ash material, the average flexural strength of prism at 28days gives greater strength than the standard mix.

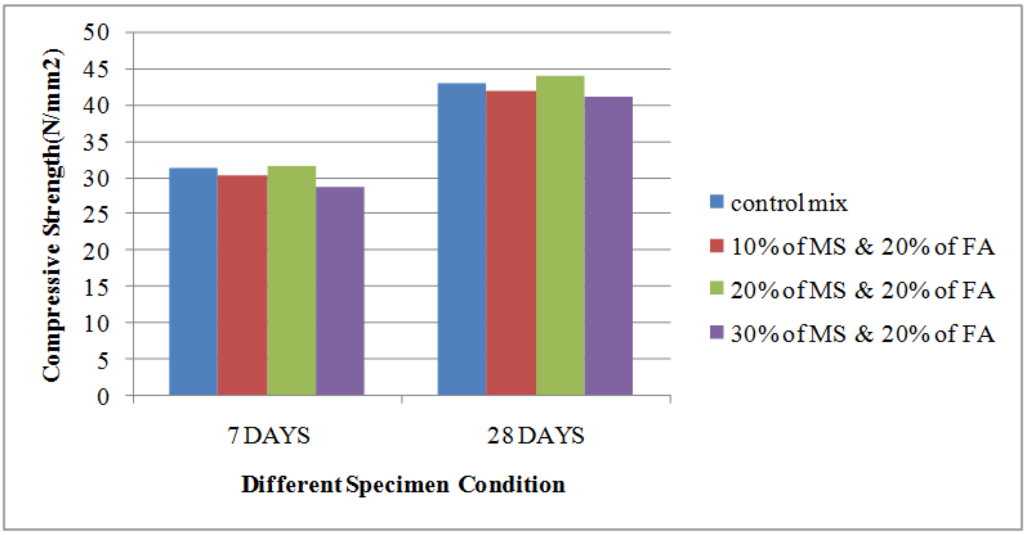

Figure 1 Compressive Strength at 7 and 28 days

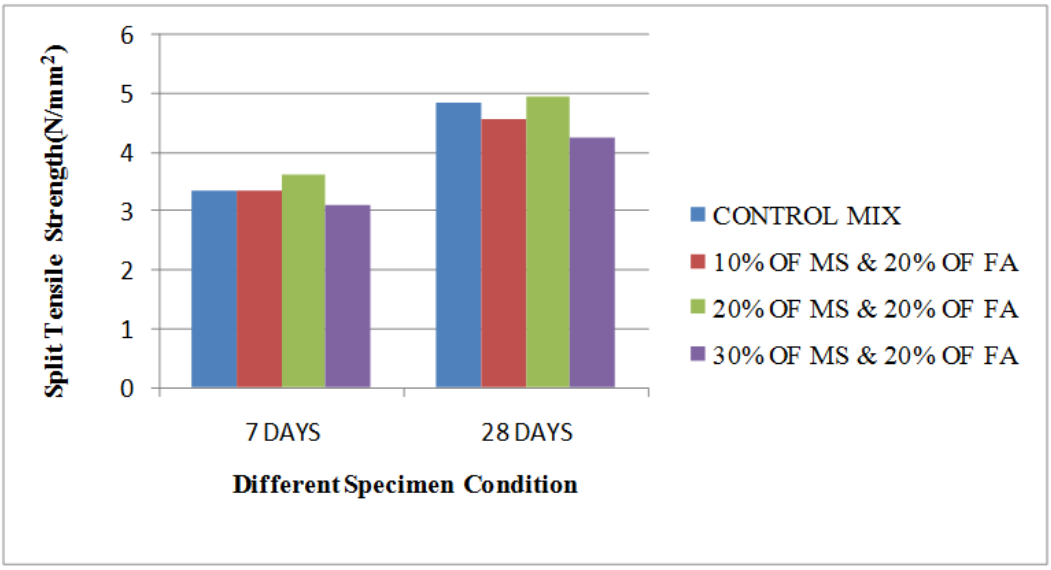

Figure 2 Split Tensile Strength of Concrete at 7 and 28 Days

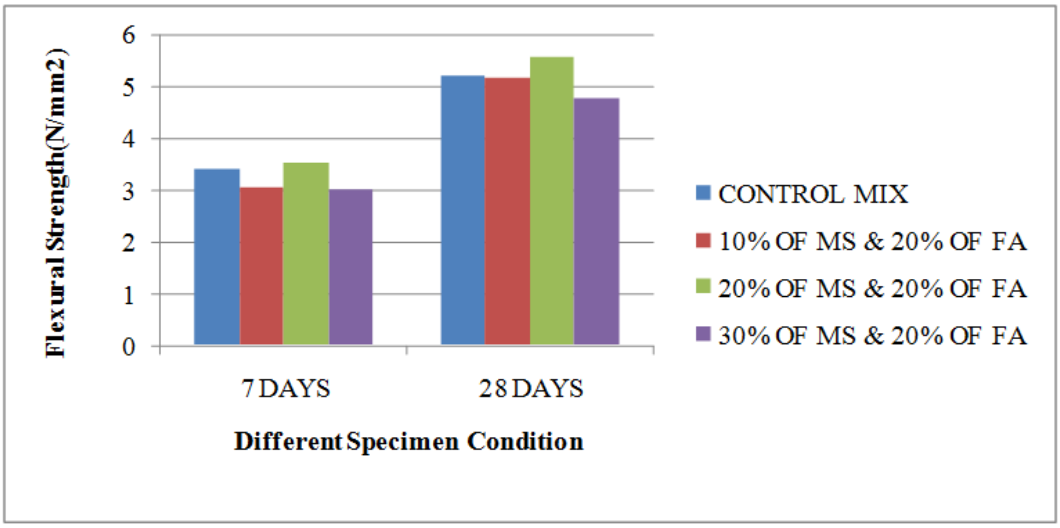

Figure 3 Flexural strength of concrete at 7 and 28 days

VI. Conclusion

Result shows that 20% replacement of fine aggregate by Manufactured sand and 20% replacement of cement by fly ash specimen shows a greater average compressive strength, split tensile strength & flexural strength of at 7 and 28 days while comparing with standard Concrete. Some important analysis for this replacement level for different test result are shown below

- 20% of Fly Ash and 20% of Manufactured Sand improves the compressive strength value up to 56% and 68% for 7 days and 28 days respectively.
- 20% of Fly Ash and20% of Manufactured Sand improves the Split Tensile strength value up to 59% and 71% for 7 days and 28 days respectively.
- And also 20% of Fly Ash and20% of Manufactured Sand improves the Flexural strength value up to 51% and 65% for 7 days and 28 days respectively.

In future, Fly Ash – Manufacture Sand based concrete can be checked for different environment conditions like Chloride and Sulphur.

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