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RESEARCH ARTICLE

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STUDY OF COMPRESSIVE STRENGTH OF CONCRETE MADE USING FLY-ASH

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ABSTRACT

The study examined the effect of Fly ash as supplementary cementitious material on the compressive strength of concrete with a view to comparing its established relation with an existing model. Specimens were prepared from a mix of designed strength 40N/mm^2. The replacement of cement with Fly ash was from 0 to 60% by weight. A total of 54 cubical specimens were cast and tested for 7 to 56 days curing periods. The results revealed that the Fly ash met the minimum chemical and physical requirements for class C Fly ash. The compressive strength were observed to increase with increased in curing age but decreased with increasing Fly ash content. The design strength was attained with 30% Fly ash at age of 56 days. In all the curing ages, 0% Fly ash content recorded higher value than the blended cement concrete. The statistical analysis indicated that the percentage Fly ash replacement and the curing age have significant effect on the properties of the concrete at 95% confidence level.

Keywords: Blended cement; Compressive strength; Fly ash; cementitious

INTRODUCTION

Use of industrial by-products in concrete will lead to green environment and such concrete can be called as “Eco-friendly Concrete”. There are various types of industrial wastes which can be considered for usage in concrete. The most commonly used industrial waste to replace cement and fine aggregates in concrete are Fly Ash, Rice Husk Ash, Blast Furnace Slag, Pond ash, Red Mud and Phosphor, Gypsum, Silica Fume, Fumed silica, Crushed glass, Eggshells.

India depends primarily on coal for its power requirement and its power generation is likely to go up with each passing day. The fly ash generation in Indian Thermal Stations is likely to shoot up to several million tonnes as mentioned by Prasenjit et al. The disposal of fly ash will be a huge problem to environment, especially when the quantity increases from the present level. Most of the early research work has been conducted on the compressive strength of concrete. These studies are successful in bringing out the advantages of use of Fly ash in concrete in terms of enhancement in long-term strength. Fly ash is a fine powder resulting from combustion of powered coal transported by the flue gases of boiler and collected in the electrostatic presipitator. Fly ash is a non-conventional material which is found in abundance and can be used in cement manufacturing as supplementary material. Although, fly ash is used in production of Portland Pozzolana Cement (PPC) as an alternative of Ordinary Portland Cement (OPC), however, the consumption of fly ash in cement industry is still not up to saturation limit. By addition

of fly ash in concrete as part of cement replacement, its property can be improved. Electricity is the key for the development of our country. Coal is a major source of fuel production of electricity generation. Large quantity of fly ash get produced and become available as by product of coal based power stations. Maslehuddin carried out investigations to evaluate the compressive strength and corrosion resisting characteristics of concrete mixes in which fly ash was used as an admixture (equal quantity of sand replacement). Concrete mixtures were made with fly ash additions of 0%, 20% and 30% and water cement ratios of 0.35, 0.40, 0.45 and 0.50.

Hussein *et al*. in his study replaced OPC with 5 to 50% fly ash and observed that 10% fly ash showed the highest compressive strength at all ages, use of 15%-30% fly ash significantly increased the compressive strength at 90 and 180 d. Mukherjee *et al*. reported that the zero slump concrete showed higher compressive strength compared to workable concrete with super plasticizer up to 60% replacement with fly ash. The strength gain with time is higher compared to the OPC concrete at all replacement level of cement by fly ash and the optimum strength gain was noted at 70% replacement at 28 days.

LITRATURE REVIEW

Carolyne namagga (et.al) "optimization of fly ash in concrete" published in 2004 world coal ash, 2009 found that high lime fly ash in concrete increases the strength of concrete. The test done by them indicated that replacing proportions of cement with high lime fly ash would provide improved strength and a most effective solution. Bharathi et al. studied on the characterization by analysing the engineering properties of Pond ash as Fine aggregate in concrete. Properties such as specific gravity, fineness, gradation, texture, physical and chemical characteristics of ash samples collected from Raichur Thermal Power Station as per standard sampling procedure were evaluated and compared with that of natural sand. Pond ash is finer in size and hence the water demand is more in comparison with natural river sand. As per the studies done it was found out that nearly 63.6% - 80.5% of Pond ash was coarser than 150 microns. Variation in grain size distribution was very small and can be ignored. Specific gravity values recorded did not show noticeable variation. Blain's Fineness of typical sample was found to be 178m^2/kg, indicating the presence of large amount of coarser particles in the samples

RESEARCH SIGNIFICANCE

The research reported in this study, fly ash obtained from Raichur thermal power station is used as replacement material in concrete M40 design mix. The ultimate focus of this work is to ascertain the performance of concrete mix containing fly ash powder and compare it with the plain concrete mix of ratio (1:1.4:1.73)

This is expected to provide -

1. Environmental friendly disposal of waste fly ash.
2. To boost the use of industrial waste.
3. To partial replace cement content in concrete as it directly influences economy in construction.

Materils and methods

Experimental design: In order to study the effect of

fly ash as partial cement replacement on the strength of concrete, 54 cubes for a mix have been cast in the laboratory .Cubes (150 mm × 150 mm × 150 mm) were cast using a design mix of 1:1.4:1.73 and water cement ratio of 0.36 was maintained to get the strength of cubes made up with different percentage of fly ash to the respective strength of conventional concrete at the end of 7, 28 and 56 days of moist curing. Optimum percentage of fly ash which does not affect the strength of non-conventional concrete was noted.

The properties of cement are given in Table 1. The fine aggregate was locally available river sand which is passed through 4.75 mm sieve. The specific gravity of fine aggregate is 2.3 and fineness modulus of fine aggregate is 2.84. The coarse aggregate was locally available quarry having two different sizes; one fraction is passed through 20 mm sieve and another fraction is passed through 12.5 mm sieve. The specific gravity of coarse aggregate is 2.68 for both fractions. In the present study, the fly ash is

obtained from the Raichur thermal power station, Karnataka.

The physical properties of fly ash are given in Table 2.

Table 1. Properties of cement

Properties	Results
Specific gravity	3.1
Initial setting time	90 min
Final setting time	360 min

Table 2. Physical properties of fly ash

Properties	Results
Specific gravity	2.41
Mean grain size (µm)	20
Specific area (cm2/g)	2672

Potable water is used for mixing and curing. The water cement ratio (w/c) of 0.36 has been used. The concrete mix design is done in accordance with IS 10262. The cement content used in the mix design is taken as 380 kg/m3 which satisfies minimum requirement in order to avoid the balling affect.

RESULTS AND DISCUSSION

Compressive strength of referral concrete as well as fly ash concrete at 7, 28 and 56 d are found and it is evident that beyond 28 d, the strength increased with the addition of fly ash Strength was comparable up to 60% fly ash content and after that it decreased. However, increase in strength was more prominent at 30% replacement level.

The compressive strength of concrete without fly ash was 20.2 N/mm^2, 30.2 N/mm^2 and 36.0 N/mm^2 at 7, 28 and 56 d respectively for a water cement ratio of 0.36. It was also observed that on addition of fly ash, 7 d strength was decreased at all replacement level.

The decrease in strength may be due to slow hydration process since fly ash is a slow reactive pozzolans which delays the hydration process. From the findings it was seen that the strength decreased above 30% replacement level at all the ages. It appears that above 30% replacement level on equal weight basis, surface area of mix was increased due to addition of fly ash, since specific gravity of fly ash is less than that of cement. Further, it was observed that at 7 d curing strength of fly ash, ordinary concrete decreased with increase in replacement level. It was observed that at 30% replacement of cement with fly ash, compressive strength at 7 d curing is decreased 30% than that of referral concretes. Decrease in strength at 7d curing was 44, 53 and 76% at replacement level of 40, 50 and 60% respectively. It showed that increase in fly ash content in concrete reduced the rate of strength gain at early ages due to slow hydration process. However, the trend at 28 d was not similar as the trend of 7d. At 28 d curing, strength of fly ash concrete was more than that of referral concrete up to 20% replacement level. Beyond 20% replacement level, a decreased in strength was observed with increase in replacement level. At 30% replacement level, strength of fly ash concrete was marginally decreased (about 10%). Decrease in strength at 28 d curing was 39, 42 and 56% at replacement level of 40, 50 and 60% respectively. It showed that increase in fly ash content in concrete, the rate of strength gain was only up to 20% replacement level after that there was a decrease. It was observed that at 56 d curing, strength of fly ash concrete increased up to 20% and equal at 30% replacement with referral concrete and then, strength decreased with increase in replacement level. It was observed that at 20% replacement of cement with fly ash on the compressive strength at 56 d curing is increased about 3.38% than that of referral concretes and 30% replacement level strength is equal to the referral concrete. Decrease in strength at 56 d curing was 22.7, 33.41 and 54.93% at replacement level of 40, 50 and 60% respectively. It showed that increase in fly ash content in concrete, the rate of strength gain was only up to 20% replacement level as same as the 30% replacement.

In the present study, it was also observed that up to 30% replacement level, the prepared mix were sticky. Beyond 30% replacement level, workability and finishability of mix was decreased. It may be due to the fact that up to 30% replacement level, fly ash particles also worked as filler material to fill the pores betweens fine aggregate particles, resulting in a dense sticky mix since, more water was available for lubrication. However, beyond 30% replacement level, more water was needed for

lubrication due to more surface area. As such workability and finishability of mix was decreased beyond 30% replacement.

CONCLUSION

The following conclusions were made based on the findings of the study:

1. Optimum replacement level of fly ash is 30%.
2. It was observed that at 28 and 56 d in 30% replacement of Cement by fly ash, the strength marginally increased from 2.2% to 3.48%.
3. It was also observed that up to 30% replacement of
4. Cement by fly ash, the strength is almost equal to referral concrete at 56 d.
5. Fly ash concrete gains strength after the 56 d curing because of slow hydration process.

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