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FLY ASH CONCRETE: A TECHNICAL ANALYSIS FOR COMPRESSIVE STRENGTH

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Abstract— Fly ash, a waste generated by thermal power plants is as such a big environmental concern. The investigation reported in this Paper is carried out to study the utilization of fly ash in cement concrete as a partial replacement of cement as well as an Additive so as to provide an environmentally consistent way of its disposal and reuse. This work is a case study for Deep Nagar thermal power plant of Jalgaon District in MS. The cement in concrete matrix is replaced from 5% to 25% by step in steps of 5%. It is observed that replacement of cement in any proportion lowers the compressive strength of concrete as well as delays its hardening. This provides an environmental friendly method of Deep Nagar fly ash disposal.

Keywords— Cement, Compressive strength, Fly ash.

I. INTRODUCTION

Fly ash is very much similar to volcanic ashes used in production of the earliest known hydraulic cements about 2,300 years ago. Those cements were made near the small Italian town of Pozzuoli - which later gave its name to the term “pozzolan”. A pozzolan is a siliceous or siliceous / aluminous material which when mixed with lime and water forms a Cementitious compound. Fly ash is the best known, and one of the most commonly used, pozzolans in the world. Fly ash is the notorious waste product of coal based electricity generating thermal power plants, known for its ill effects on agricultural land, surface and sub-surface water pollution, soil and air pollution and diseases to mankind. Researchers have proposed few ways of reusing fly ash for variety of application. One of the most common reuse of fly ash is in cement concrete. Fly ash particles are almost totally spherical in shape, allowing them to flow and blend freely in mixtures. That capability is one of the properties making fly ash a desirable admixture for concrete. These materials greatly improve the durability of concrete through control of high thermal gradients, pore refinement, depletion of cement alkalis, resistance to chloride and sulphate penetration, and continued micro structural development through a long-term hydration and pozzolanic reaction. The utilization of by-products as the partial replacement of cement has important economical, environmental and technical benefits such as the reduced amount of waste materials, cleaner environment, reduced energy requirement, durable service performance during service life and cost effective structures. In this experimental investigation, an attempt has been made to study the techno-economic analysis for the compressive strength of fly ash concrete. The fly ash is procured from Deepnagar Thermal Power Plant. This plant is located near Bhusawal city in Jalgaon District in Maharashtra state. The plant is an establishment of 1968. It has a generation capacity of 480 MW. It consumes 7500-8500 MT/day of coal and produces 2550 to 2800 MT/day fly ash. Here, in our work a comparative study of the characteristics compressive strength between Ordinary Portland Cement concrete and Fly ash based concrete has been made. Fly ash is used in various proportions ranging from 10% to 50% by weight of cement in steps of 5%. Using the experimental data, a column section is designed. The relative cost of column section designed with OPC as well as various proportion of fly ash is estimated and compared. It is observed that fly ash can be safely and economically used. This also provides an environmental friendly method of fly ash disposal.

II. EXPERIMENTAL WORK

The fly ash is blended in cement at a rate of 10 to 50% by weight of cement in steps of 10%. The cement-fly ash blends are then tested for following properties: consistency, setting time, soundness, workability and compressive strength, as per IS 546-2003.

In the present study, M20 grade with nominal mix as per IS 456-2000 was used. The concrete mix proportion (cement: fine aggregate: coarse aggregate) is 1: 1.5: 3 by volume and a water cement ratio of 0.5 is taken. The fly ash is blended in cement at a rate of 5 to 25% by weight of cement in steps of 5%.

In this test sample of concrete is filled in the mould of size 15cm x 15cm x 15cm and top of mould is strike off. A total number of 18 cubes were casted. Fly ash is added in place of cement in concrete in 6 different percentages starting from 0%, and raised the mixing of fly ash up to 25%, at an interval of 5%. The specimens are covered with the wet gunny bags for 24 hours. Then after sample is removed and kept for curing in curing tank. At the end of curing period sample is removed and tested immediately. The testing is done under Universal Testing Machine model no. UTM 40, Yama Engineers Kolhapur make. The load is applied smoothly and gradually.

III. RESULTS ANDDISCUSSION

As described earlier, various properties of fresh concrete are determined. Considering space limitations, here data sheet is not presented only results are discussed:

The consistency of cement has increased with the addition of fly ash from 32% for 0% fly ash to 48% for 50% fly ash. It may be attributed to the increased specific surface area of cement – fly ash blend due to

finer particles of the later. The initial setting time (IST) has increased from 155 minutes for 0% fly ash to 250 minutes for 50% fly ash. This may be attributed to the retardation of cement hydration due to fly ash. The workability of cement concrete mix has increased from 25 mm (for 0% fly ash) to 120 mm (for 25% fly ash). This may be attributed to the soothing effect of fine fly ash particles in the concrete mix. It is an encouraging result.

The characteristic compressive strength of various blends of concrete is presented in Figure 1.

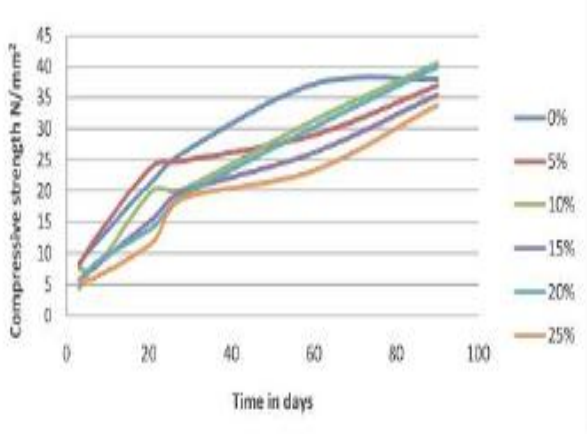

Fig 1: Flexuralstrength development offlyash concrete

The curves in Figure 1 show the rate of compressive strength development of various blends of fly ash concrete over a span of 90 days. It can be seen that 0% fly ash i.e. concrete with no replacement of cement with fly ash, has maximum rate of compressive strength development at 60 days and after it becomes nearly constant. 5% fly ash has maximum rate of compressive strength development up to the age of 21 days and then after its rate decreases. Strength development at later stage is negligible. The rate of strength development is large up to 21 days for 10% fly ash and then after its rate becomes negligible for few days and after 28 days increases uniformly. Its final strength development is also maximum than any other fly ash blends. After 90 days of storage the concretes containing 10 % of fly ash, related to cement mass, gained a compressive strength about 6 % higher than the concrete without addition for Ordinary Portland cement. For fly ash blends greater than 10% fly ash, the rates of strength development as well as final strengths both reduce with addition of fly ash. In long terms, concrete with higher proportions of fly ash gains strength comparable with that of pure concrete. It is important to note that the strength of concrete decreases with the increase in % of replacement of cement with fly ash at 28 days. But, at 90 days we get maximum strength for 10% fly ash addition.

IV. CONCLUSION

This study proves that Deep Nagar fly ash can be successfully used in the cement concrete in minor amount as an additive. Considering the intangible cost of disposal problem of fly ash and hidden cost of environmental protection, the methodology appears to be indeed successful. Fly ash is actually a solid waste. So, it is priceless. If it can be used for any purpose then it will be good for both environment and economy. Use of this fly ash as a raw material in Portland cement is an effective means for its management and leads to saving of cement and economy consequently. Hence it is a safe and environmentally consistent method of disposal of fly ash. However the rate of strength development is less, Due to lesser rate of strength development .ash finds specific application in mass concreting e. g. dam construction. It can be concluded that power plant waste is extensively used in concrete as a partial replacement for cement and an admixture.

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