Experimental Study on Effect of Addition of Fly Ash on Mechanical Properties of Concrete Containing Shredded Polythene Bags

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Abstract— The disposal of polythene waste and fly ash is causing serious threat to the environment. Aim of this study is to decrease environmental pollution by using polythene waste and fly ash in concrete. Fly ash was varied by 0%, 5%, 10%, 15% and 20% by weight of cement with plastic waste in shredded form at a constant dosage of 0.6% by weight of concrete. The specimens were prepared for the concrete mix of M25 grade and water to cementitious material ratio (w/c) was maintained as 0.45. Fresh concrete property like workability was examined during casting the specimens. Hardened properties were found out by carrying out the experimental work on cubes and beams which were casted in laboratory and their behavior under test were observed at 7 & 28 days for compressive strength and at 28 days for density and flexural strength. Overall results of this study show that addition of 0.6% (by weight of the concrete) plastic waste with 10% (by weight of cement) replacement of cement by fly ash result an improvement in properties of the concrete than conventional mix.

Key words: Fly Ash, Plastic Waste, Workability, Density, Compressive Strength, Flexural Strength

I. INTRODUCTION

Concrete is a composite material incorporate cement, sand, aggregate, water and admixture. Concrete is the 2nd most largely used material in the world after water. In India, 370 million m^3 concrete is being utilized by construction industries per year and it is anticipated to broaden 30 million m^3 every year. Also origins of all basic ingredients of concrete are nature, which are reducing with increase in consumption of concrete due to popular growth of construction industry. Therefore it is require finding alternate material which can be utilized in the production of concrete. The revolutionary in construction industry called green concrete, which is produced by adopting the waste.

The production of plastic waste and fly ash has been increasing at an alarming rate, disposal of which has become a serious environmental problem. In this study an attempt is made to utilize wastes like polythene bags (collected from disposed municipal waste) and fly ash (collected from coal based thermal power station). These wastes themselves have such properties which are beneficiary when they are incorporated in concrete as ingredient. For example polythene bags are light weight, so using them in concrete will lead to light weight concrete. Using them as ingredient in concrete will not only enhance the bitter properties of concrete but also help in reducing the environment pollution. Also scarcity of nature origin ingredients of concrete will be reduced. A systematic study is done in this project to find effect of using wastes in concrete at different percentages and then comparison is done to find the permissible dosage of the waste.

II. MATERIALS

Materials utilized in this study to produce concrete are as follow*:*

1) Cement- The cement used in this experimental project was 43 Grade ordinary Portland cement (OPC) conforming to IS 8112-1989 for casting the specimens of all concrete mixes. Physical properties of cement were calculated and tabulated in Table 1.
2) Fine aggregate- The fine aggregate used for investigation belongs to the zone II, was procured from the local fine aggregate suppliers and conform all requirements as per IS: 383-1970. The specific gravity test was performed in the laboratory and value achieved is 2.63.
3) Coarse aggregates- Coarse aggregate of 10 mm and 20 mm sizes were used in this study and they conform all requirements as per IS: 383-1970. It was free from dust particles, vegetation, organic matters, and clay. The specific gravity test was performed in the laboratory and value achieved is 2.78.
4) Water- Ordinary water available in the laboratory was used in this investigation both for mixing and curing the concrete specimen as per IS: 456-2000 throughout the investigation.
5) Plastic waste (polythene bags)- The plastic wastes used in this study were consisting waste polythene bags in shredded form. Bags did not be given any special treatment except the normal water wash, cleaning and day light drying and then cut into plastic shredding machine to achieve shredded form. Specific gravity test was performed in laboratory and value achieved is 0.33.
6) Fly ash- Class F fly ash collected from Shree Singaji Thermal Power Project, Khandwa, Madhya Pradesh was used during the experiment. Specific gravity test was performed in the laboratory and value achieved is 2.5.

Sr. No.	Properties	Test results
1	Consistency	32%
2	Initial setting time Final setting time	130 minutes 213 minutes
3	Specific gravity	3.13
4	7 day compressive strength	34.95 MPa
5	28 day compressive strength	45.29 MPa

Table 1: Physical properties of cement

III. METHODOLOGY

The methodology adopted to accomplish the objective of the experimental investigation and execution of work was done in step by step as follow:

1) Mix design- Mix design was done for M25 grade of concrete as per the guidelines given in IS: 10262 (2009) and IS: 456 (2000). The mixes were designed after considering many trail mixes. The design mix of

1:1.54:2.76 is adopted for casting specimens. Shredded polythene bags were added 0.6% by weight of concrete and fly ash was varied by 0%, 5%, 10%, 15% and 20% by weight of cement. The water to cementitious material ratio (w/c) was maintained at 0.45.

2) Weighing- The quantity of all ingredients of the concrete i.e. cement, fly ash, fine aggregate, coarse aggregate, polythene bags and water for each batch was determined as per the mix design ratio and weighed using weighing machine available in laboratory.
3) Mixing- Process of mixing of various ingredients adopted was as per IS: 516-1959 and machine mixing process was adopted for mixing using pan type mixer.
4) Preparation of moulds- Before casting the specimens, all cube and beam moulds were cleaned, screwed tightly and oil was applied to all surfaces to prevent adhesion of concrete during casting.
5) Compaction- Placing of concrete in oiled moulds was done in three layers and each layer tamped 25 times with the tamping rod. After tamping the moulds, they were compacted using vibratory machine.
6) Curing- After 24 hours, all the casted specimens were removed from the moulds and marked (to identify the casting batch) and immediately put into the curing tank for a period of 7 and 28 days. The specimens were not allowed to become dry during the curing period.
7) Testing- Specimens were taken out from the curing tank after 7 and 28 days to perform various tests. Three numbers of specimens in each sample were tested and the average value was calculated. Fresh concrete property like workability was examined during casting by compacting factor test. Hardened properties were found out by carrying out the experimental work on cubes and beams which were casted in laboratory and their behavior under test were observed at 7 & 28 days for compressive strength and at 28 days for density, flexural strength.

IV. RESULTS AND DISCUSSION

Here discussion on results of tests carried out in the laboratory to investigate the various properties such as workability, density, compressive and flexural strength is done to analyze the data obtained.

A. Workability

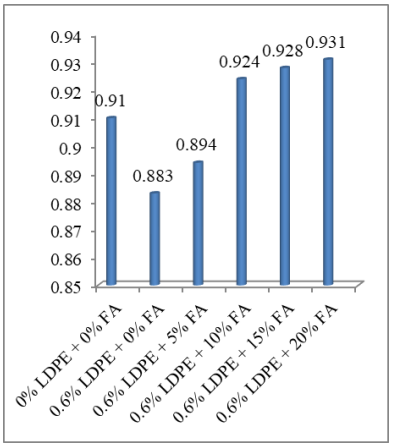

Fig. 1: Variation of compaction factor with fly ash content

Compaction factor test was used for determining the workability of fresh concrete. Bar chart has been plotted for variation of compaction factor with percentage fly ash as shown in Fig 1. Compaction factor value of control mix is achieved as 0.91 which reduced to 0.883 for 0.6% plastic waste addition to the control mix. A general trend observed is increment in compaction factor with increase in fly ash content up to 10% dosage and then decrease in compaction factor. Hence till 10% fly ash dose workability gets enhanced. The reason may be that fly ash gets absorbed on the surface of oppositely charged cement particles and prevent them from flocculation, releasing large amount of water, thereby reducing the water demand for a given workability. Also the increase of the paste volume leads to the increase of plasticity and cohesion. Fly ash particles tend to coat and lubricate the aggregate particles. The spherical shape of the fly ash particles contributes to improvement of the workability of concrete by reducing the friction at the aggregate paste interface and hence improves the pumpability of concrete.

B. Compressive strength

Fig 2 shows variation of compressive strength with % fly ash measured at 7 and 28 days. It can be seen that compressive strength of the concrete increases with increase in curing age. The compressive strength decreases as the addition of fly ash increases for 7 days curing. Whereas after 28 days curing, compressive strength value increases (crosses compressive strength value for control mix) up to 10% fly ash dose and then it started decreasing.

The reason for 28 days strength improvement may be that when water and cement come in contact in concrete mix, chemical reaction takes place (known as hydration of cement) that produces binding material (which consolidates the concrete) and lime. Fly ash reacts with released lime and produces additional binder, which gives additional strength to the concrete mass. Also the unreactive portion of fly ash fills up the micro spaces to enhance packing of matrix and results in increased strength.

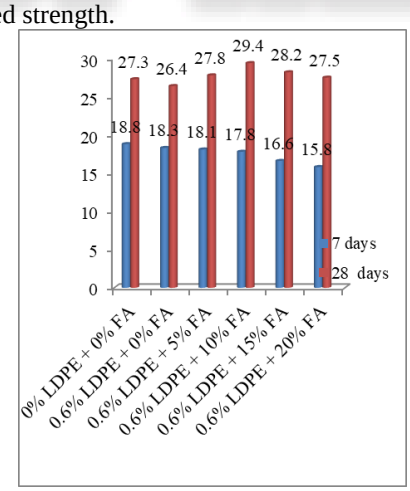

Fig. 2: Variation of Compressive strength with fly ash content

C. Flexural strength

Fig 3 shows variation of flexural strength with % fly ash. The trend observed for variation of the flexural strength with fly ash dose is that strength increases as the addition of fly ash increases up to 10%. After 10% dose, any further increment of fly ash results decrement in strength value, although strength value achieved is more than that of control mix. Thus replacement of cement by fly ash gives positive and improved results than that with cement only. The reason for

improvement in the strength may be due to reaction of fly ash with lime, released during hydration of cement, which produces additional binders to give additional strength.

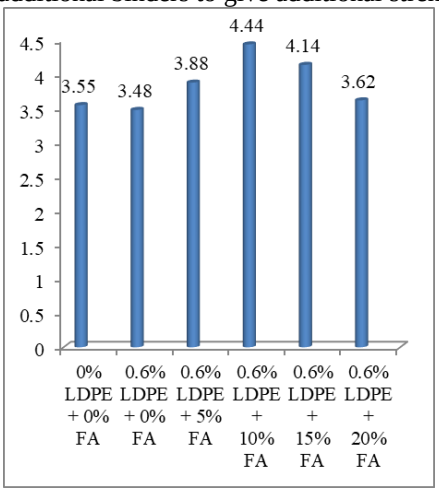

Fig. 3: Variation of Flexural strength with fly ash content

D. Density

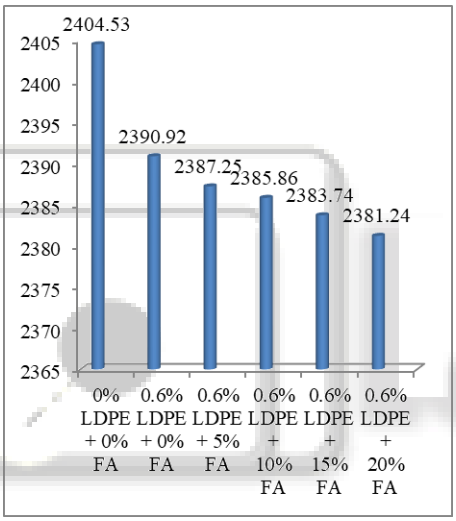

Fig. 4: Variation of Density with fly ash content

Fig 4 shows variation of density with percentage fly ash addition. The general trend observed here is that density decreases as the addition of fly ash increases. The reason for decrement in density is that specific gravity for fly ash (2.5 here) than that of cements (3.13 here).

V. CONCLUSIONS

The main aim of this study was to investigate the possibility of using shredded polythene waste materials and fly ash as concrete ingredients. After using polythene waste and fly ash as concrete ingredients, following conclusions can be drawn:

- The workability of concrete containing polythene waste and fly ash increased with increase in the percentage of fly ash up to 10% fly ash content.
- The density of concrete containing polythene waste and fly ash decreased with increase in the percentage of fly ash. Thus self weight of concrete decreases. Hence become a good option for structures where light weight concrete required.
- The compressive strength and flexural strength of concrete containing polythene waste and fly ash increased with increase in fly ash up to 10% fly ash content.

Based on results it can be concluded that polythene waste and fly ash can be used as concrete ingredients. Fresh and hardened properties of concrete with plastic waste were improved when up to 10% of fly ash utilized. This modified concrete results into a better choice where light weight is one of main concern.

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