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Incorporation of Flyash and Coir Fiber in Paver Block Manufacturing

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***Abstract*—The living planet earth has encountered global warming due to various issues. One of the main reasons is construction industries since the foremost component of concrete is cement, which has its own environmental problems. The cement industry is one of the prime producers of carbon-di-oxide. On other hand disposal of solid waste is a major problem. Coal power plants produce solid waste called fly ash whose disposal is difficult. Therefore urgent changes are required relating to emissions, production and application of sustainable and eco-friendly materials. This led to concept of paver block in which cement replaced by flyash in concrete. This paper aims to develop paver blocks using fly ash and coir fiber. Different mix proportions of 10%, 20%, 30%, 40% and 50% are prepared using cement replaced by fly ash and 0.3 % of coir fiber. This project indicated that fly ash and coir fiber can be effectively used as cement replacement. The paver blocks developed are tested for their compressive, flexure and water absorption.**

Keywords: Coir fiber; concrete; Flyash; partial replacement of cement.

I. INTRODUCTION

Pavers are the modern day solution for less cost outdoor application. Paver block is used in various places like in street road and other construction places. Concrete paver blocks are made with concrete basically consisting of cement, fine aggregates, coarse aggregates (10 mm and below), water, chemical agents etc. The demand for concrete as a material of construction will increase as the demand for infrastructure development increases, especially in countries such as China and India. In order to meet this demand, the production of Portland cement must increase. Environmental issue has become a crucial issue in concrete industry. This is mostly because of the emission of greenhouse gasses from the production of Portland cement, a primary binder in making concrete. Many efforts have been made to reduce the use of Portland cement in concrete that in turn will reduce the greenhouse gas emission. Those efforts include use of supplementary cementing materials and finding alternatives for Portland cement.

Fly ash is an artificial pozzolana produced from coal fired thermal power plants. The annual production of fly ash in India is about 75 million tons. The disposal of fly ash has become a serious environmental problem. This has created the necessity for developing a new eco-friendly concrete where large quantity of fly ash is used. The use of fly ash in concrete paver blocks is aimed at reducing cement content and heat of hydration leading to better economy and durability.

The aim of the study is to partially replace cement with fly ash in paver block and coir fiber as strengthening material.

The objectives of the work are:

- To assess the significance of fly ash and coir fiber additives in terms of strength ,durability, and economic effectiveness
- To compare the stability and strength of paver block using fly ash with concrete paver block

II. METHODOLOGY

A. Materials and its testing

First stage of the project is to collect raw materials such as cement, coarse aggregate, fine aggregate, flyash, coirfibre and water. The various tests such as compressive strength test, Flexural strength test and water absorption test were conducted on the materials and results are checked with IS specifications.

TABLE 2.1 PROPERTIES OF CEMENT

Properties	Value obtained	Limits as per IS 2386
Specific Gravity	3.2	3.1-3.2
Fineness	8.67%	Wt. shall not exceed 10%
Initial Setting Time	32 min	Wt. shall not exceed 10%
Consistency	35%	26-35%

TABLE 2.2 PROPERTIES OF COARSE AGGREGATE

Properties	Value Obtained	Limits as Per IS 2386
Specific Gravity	2.59	2.5-2.9

TABLE 2.3 PROPERTIES OF FINE AGGREGATE

Properties	Value Obtained	Limits as per IS 2386
Particle Size Distribution	Cu=6.67 D_{10}=0.15 Fineness Modulus=4.793	4-6 <4.75
Specific Gravity	2.51	2.5-2.9

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TABLE 2.4 PROPERTIES OF FLY ASH

Properties	Value Obtained	Limits as Per IS 2386
Specific Gravity	2.5	1.57-2.5
Fineness	15.16%	<34%
Consistency	33%	Upto 35%

B. Coir fiber

Coconut fiber is extracted from the outer shell of a coconut. It is the natural fiber of the coconut husk where it is a thick and coarse but durable fiber. Coir fiber of length 3 cm is used.

C. Coir fiber treatment

The coir fibers are properly washed and drawn into strands before use. Treatment of fibers removes dust and other residual particles left on the fiber so as to augment the surface of contact between the fiber and mix resulting in better binding between the concrete and ultimately higher strength. It also helps to prevent the water absorption.

Fig 2.1 Treated coir fiber

The fiber is washed in tap water for 10 minutes so as to loosen the fibres and to remove the coir dust. The softened fibers are straightened manually and combed with a plastic comb. The fibers are then completely dried in the open air, combed again and finally cut into the required length of 3cm and soaked in oil for 15 min and dried in sun for 24 hours.

D. Mix design

A mix design was conducted as per IS code 15658:2006 to arrive at M_{35} mix concrete. Paver blocks by considering IS specification. Selected grade of concrete for paver block casting was M_{35}.From the IS 15658:2006 Recommended grades of paver block for different categories Characteristics, the compressive strength required in the field at 28 days is 35 N/mm^2.

TABLE 2.5 MIX PROPORTION

Water	Cement	Fine aggregate	Coarse aggregate
208L	594.286Kg/m^3	527.964Kg/m^3	947.788Kg/m^3
0.35	1	0.8	1.6

TABLE 2.6 QUANTITIES OF MATERIALS REQUIRED FOR EACH MIX

Name of mix	Materials					
	Cement (Kg)	Fine aggregate (Kg)	Coarse aggregate (Kg)	Fly ash (Kg)	Coir fiber (g)	Water (litre)
MIX1	18.67	14.97	29.88	0	0	6.53
MIX2	16.803	14.97	29.88	1.86	56.01	6.53
MIX3	14.93	14.97	29.88	3.73	56.01	6.53
MIX4	13.06	14.97	29.88	5.60	56.01	6.53
MIX5	11.202	14.97	29.88	7.46	56.01	6.53
MIX6	9.335	14.97	29.88	9.33	56.01	6.53

E. Casting procedure

Base preparation, concrete mixing, casting, demoulding and curing are the steps involved in the casting of paaver block. Specimens of size 20x20x6 cm are casted. Different mix proportions of 10%, 20%, 30%, 40% and 50% are prepared using cement replaced by fly ash and 0.3 % of coir fiber. Total 48 no of paver blocks were casted for testing

III. RESULT AND DISCUSSION

In order to find workability, slump cone test was done for all mixes and compressive strength test, flexural strength test and water absorption test were done on paver blocks. These results help to arrive at a conclusion regarding the project.

A. Slump Cone Test

Slump test is the most commonly used method of measuring consistency of concrete which can be employed either in laboratory or at site of work. The slump value is measured as the difference in height between the height of the mould and the average value of the subsidence. The slump value for all mixes ranges between 25-50 mm and it comes under stiff-plastic.

TABLE 3.1SLUMP TEST RESULTS

%Of Flyash In The Mix	0%	10%	20%	30%	40%	50%
Slump (mm)	40	40	50	40	50	50

Fig 3.1 slump cone apparatus

Fig 3.2 slump cone obtained

B. Compressive Strength Test

200x200x60 mm sized specimens were used for compressive strength test of concrete. A total of 6 concrete mixes were made, one corresponding to conventional concrete and five others with 10%,20%, 30%,40% and 50% of flyash along with constant proportion of coir fiber ie,0.3% .The total mixing time was 5 minutes the specimen were compacted by placing in vibrating machine and then leveled. After 24 hours they were demoulded and then placed for curing, until the day of test.

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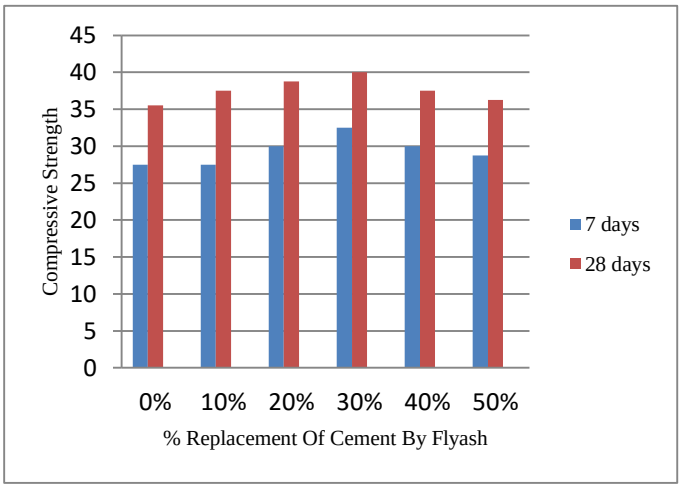

Fig 3.3 Compressive Strength of paver block for 7 and 28 days

Fig 3.4 Test set up in CTM

Fig 3.5 Tested specimen

C. *Flexural Strength Test*

The tensile strength of the concrete is expressed in terms `of flexural strength. The specimens for testing the strength was made as 60cm thick paver blocks and are prepared with different replacement levels of cement by flyash and constant proportion of coir fiber. These paver blocks were tested at different ages. 7 days and 28 days flexural strength were calculated.

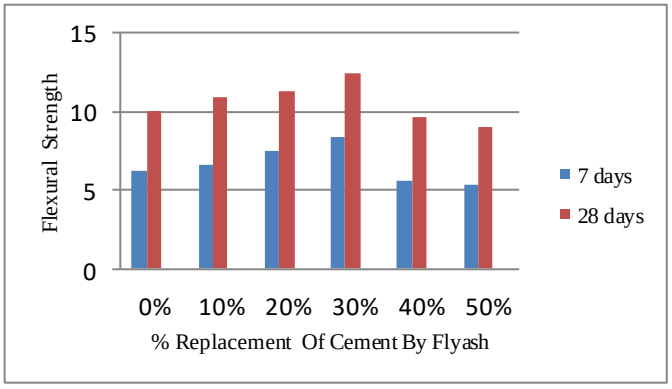

Fig 3.6 Flexural Strength of paver block for 7 and 28 days

3.7 Test set up in UTM

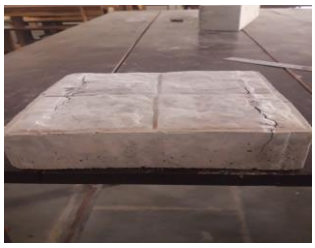

Fig 3.8 Tested specimen

D. *Water Absorption Test*

The ability of a material to absorb and retain water is known as its water absorption. It mainly depends on the volume, size and shape of pores, present in the material. The completely dried pavement blocks are weighed and immersed in clean water for 24 hours.

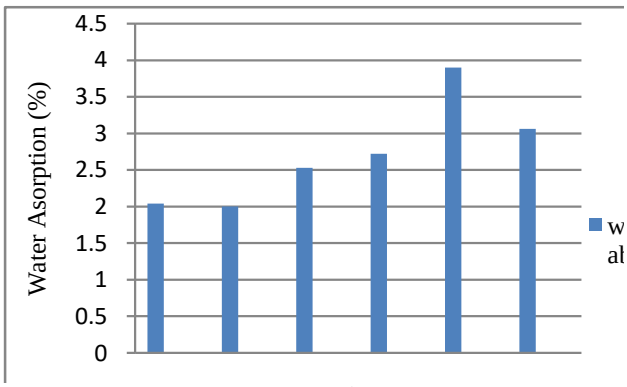

Fig 3.9 Graphical analysis of Water Absorption

IV. CONCLUSIONS

From the present investigation, the following conclusions are arrived;

- From the workability test it is found that the mix is stiff plastic.ie; slump value ranges between 25-50 mm .There is a slight increase in the workability upto 20% replacement of cement with flyash.
- Compressive strength of paver block mixes upto 30% replacement of flyash and 0.3% addition of coir fibre by weight of cement is greater than conventional paver block. Maximum compressive strength was obtained for MIX4(30% flyash by weight of cement and 0.3% coir fibre by weight of cement)
- The flexural strength obtained for the tested paver blocks is greater than the conventional paver block. Maximum flexural strength was obtained for MIX4 (30% flyash by wt of cement and 0.3% coir fiber by wt of cement).
- From water absorption test the maximum value of water absorption is obtained for 40% flyash and the minimum is for 10% flyash.
- The outcomes demonstrate that the flyash remains in high extent can be effortlessly utilized as a part of financially saving material and it is an efficient method for the disposal of coir mattress waste.
- From the above observations, it was understand that the mix 30% flyash and 0.3% coir fibre by weight of cement is most suitable with respect to strength.

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The present work has good scope for future research. Some of the research areas are as follows:

- Work can be extended by using different thickness for the interlock.
- Instead of coir fibres hair fiber can be introduced.
- Durability tests can be conducted to check the suitability of using fly ash and cement for the manufacturing of paver blocks in structures which needs longer life span.
- Investigation can be done by different percentage addition of fibres with respect to suitable strength.
- Investigation can be done by using different aspect ratio of steel fiber of different shape.
- Behaviour under creep and shrinkage can be determined.
- Replacement of cement by other binding material such as glass powder, silica fumes; stone dust etc incorporated with different types of fiber can be done.

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