Structural Behaviour of Concrete Block with Flyash Content and Waste Rubber as its Loading Surface for Industrial Purpose

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Abstract- This paper presents the results of a series of tests conducted to assess the influence of block shape, thickness, size, compressive strength of concrete block. The test setup discussed here is based on static plate loading. The effect of load on rubberier surface, the mechanism of load transfer and edge restraints are discussed here.

It is emphasized on optimum use of waste materials generated from thermal plants and vehicles amalgamating it with proper ratio with concrete materials that would generate a desired new material which would satisfy the customer needs.

I. Introduction

In recent years there has been a great interest in gaining strength of concrete using waste materials in terms of replacement against fine aggregate , coarse aggregate or cement. The corresponding replacement also brings out the different w/c ratio and use of waste with optimum quantity in order to gain the targeted strength. It is highly characterised by additionof superplasticizers and the amount of condition of curing that determines proper attainment of strength.

In concrete blocks, the blocks make up the wearing surface and are major load-spreading component of the pavement and loads. It differs from other concrete blocks as normal concrete blocks have concrete surfaces carrying load on it whereas here we are trying to make it on a rubber surface.With upcoming of various industrial schemes and manufacturing subsidies, it is forecasted that India would be a manufacturing hub.With the growth of small scale industries and machine equipments, there should be a focus from civil engineering point of view to ease and facilitate the necessities that is being needed in it.The majority of machineries that is being carried out in small scale industries are of medium weight and are transported frequently or displaced due to replacements, repairs, maintainance etc.

Here are some problems faced by SME’s ; shifting machineries from one place to another, cracking and wearing of concrete pavements due to vibrations and water attack, difficulty in cleaning the base of machineries, unnecessary wastage of materials and not being cost effective,noise and vibrations.In order to address these problems we are trying to make a compounded concrete block with waste tyre as its loading surface for machineries of medium weight, hence it would act as a load bearing agent suppressing all the problems faced in SME’s mentioned above.

Figure1. A offset machine used in SME’s

II. Literature Review

2.1. FLY ASH REPLACEMENT:

In this programme waste material (fly ash and waste tyre) has been tried to use in an optimum way to get through a result that is feasible to both in economic and industrial favoring use.Fly ash is replaced with cement to achieve strength as fixed that is M_{25}.From NiyaziUrgurKocklal (2011) “utilization of fly ash by replacing coarse aggregate with flyash and concluded that durability of high strength air entrained light weight concrete could be produced using sintered or cold bonded light weight fly ash aggregates having comparable performance with normal weight concrete.Fly ash aggregate light weight concrete and normal weight concrete being air retraned are highly resistant to freeze and thaw action with minimum durability factor. Erdemdamci (2014) indicated that fly ash samples in the ratio of 15% in clinker markedly increases the compressive force strength value at 90 days and decreasing the particle size of flyash in blended Portland cement increases the compressive strength.Thereforefineness is an important factor than composition in improving strength.

III. Material Properties

3.1. Cement:

Ordinary Portland Cement (OPC) is the most common cement used in general concrete construction when there is no exposure to sulphates in the soil or groundwater.The cement that used is of Ramco cement, Ordinary Portland Cement (OPC) 43 grade as per standard specification of India. Ramco Cement OPC 43 confirms to IS 8112. The grade is based on the 28-day compressive strength of the cement mortar, which in this case is not less than 43 MPa. The physical properties of cement is given in the Table 1.

Table 1.Physical properties of cement.

Characteristics	**OPC 43 Grade cement**
Initial setting time	86 minutes
Final setting time	274 minutes
Specific gravity	3.15
Normal consistency	35%

3.2. Aggregate:

Aggregates are the important constituents in concrete. They give body to the concrete, reduce shrinkage and effect economy. One of the most important factors for producing workable concrete is good gradation of aggregates. Good grading implies that a sample fractions of aggregates in required proportion such that the sample contains minimum voids. Samples of the well graded aggregate containing minimum voids require minimum paste to fill up the voids in the aggregates. Minimum paste means less quantity of cement and less water, which are further mean increased economy, lower shrinkage and greater durability. All the test results of aggregate and fly ash are given in the table 2.

3.2.1. Coarse Aggregate(CA):

Coarse aggregate from stone crusher having a nominal maximum size of 20 mm was used. River Sand was used as a fine aggregate in mix of having a nominal maximum size of 4.75 mm was used.

3.2.2. Fine aggregate(FA):

Natural sand as per IS: 383-1987 was used. Locally available River sand which is the most commonly used natural material for the fine aggregates that is used. For this study the river sand Zone-III is used.

3.3. Fly ash:

In India, coal is major source of fuel for power generation. Indian coal is having low calorific value (3000-5000 K cal) & very high ash content (30%-45%) resulting in huge quantity of ash generated.F grade Fly ash is a kind of ash that is extracted from flue gases through electrostatic precipitator in dry form. This ash is fine material and possesses good pozzolanic property. The pozzolanic property of fly ash makes it a source for making cement and other ash based products.

Table 2. Physical properties of aggregates and fly ash

[1] **Characteristics**	[2] **CA**	[3] **FA**	[4] **FLY** [5] **ASH**
[6] **Specific Gravity**	[7] 2.62	[8] 2.62	[9] 2.05
[10] **Water Absorption, %**	[11] 1.65	[12] 0.806	[13] 0.69

3.4. Waste tyre:

The mentioned material was obtained from waste tyre of heavy vehicle like truck.Aftercutting the size was varied from 14cm, 12cm and circular size of dia 10cm with proper perforations in order to make a good gripping with the concrete after casting.

3.5. Water:

The common specifications regarding quality of mixing water is water should be fit for drinking. Such water should have inorganic solid less than 1000 ppm. This content lead to a solid quantity 0.05% of mass of cement when w/c ratio is provided 0.5 resulting small effect on strength.

But water which is not potable may be used in making concrete with any significant effect. Dark color or bad smell water may be used if they do not posses deleterious substances. PH of water to even 9 is allowed if it not tastes brackish. In coastal areas where local water is saline and have no alternate sources, the chloride concentration up to 1000 ppm is even allowed for drinking. But this excessive amount of alkali carbonates and bicarbonates, in some natural mineral water, may cause alkali-silica reaction.

3.6. Super Plasticizers (Sika):

High Range Water Reducer (HRWR) admixtures are used to reduce the amount of water by 12% to 30% while maintaining a certain level of consistency and workability (typically from 75 mm to 200 mm) and to increase workability for reduction in w/cm ratio. The use of superplasticizers may produce high strength concrete (compressive strength up to 22,000 psi). Superplasticizers can also be utilized in producing flowing concrete used in a heavy reinforced structure with inaccessible areas.

IV. Mix Design

In these present work the grades of concrete mix i.e. M25 grade is considered and the proportions is 1:1.73:3.05 calculated as per IS:10262-2009. The water cement ratio is 0.45. The total mixes prepared are of 6 types.

The properties of fresh concrete i.e. the slump value is evaluated for :

TM1(NCA or 0% replacement),
TM2(5% FLYASH),
TM3(10% FLYASH),
TM4(15%FLYASH),
TM5(5%FLY ASH+RUBBER SURFACE)
,TM6(10% FLY ASH + RUBBER SURFACE).

The properties of harden concrete i.e. compressive strength is investigated with different mixes as mentioned above at 7 days and 28 days. Then the strength of concrete is compared with the load of different machineries.If the compound block of concrete with rubber as its loading surface is able to carry the load then we find our aim to be successful. All the quantities and mix proportions for M25 grade of concrete are given in the table 3.

Table 3: Trial Mix Calculation

Trial mix no.	**Cement in (kg/ m^3)**	**FA in (kg/ m^3)**	**CA in (kg/ m^3)**	**Water in (kg/ m^3)**	**Sika in (%)**
TM1	370	670	1186	166	0.8% of Cement
Proportion	1	1.81	3.20	-	-

V. Results and Discussion

5.1. Slump Test:

The replacement of fly ash with cement affects the workability of the concrete. The workability of fly ash replaced concrete shows a decrease in slump with increase of fly ash content of total cement volume and the workability of fly ash replaced concrete shows also decrease in slump with increase in fly ash content of total cement volume. The low slump may be due to high absorption of water during the mixing process. The results of the slump test are shown in Table 4 and figure 2.

Table 4.Slump Test Result

% of Fly ashreplacement	w/c ratio	Slump in mm
0%	0.45	45
5%		42
10%		39
15%		38

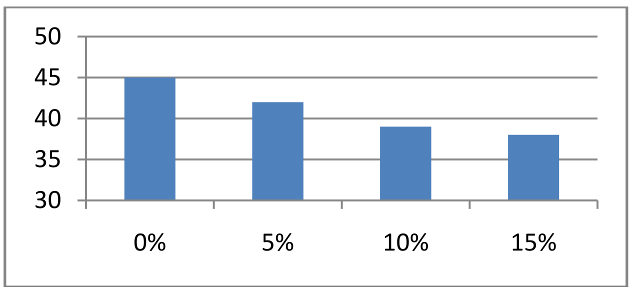

Figure.2 Workability of concrete in terms of slump value.

5.2. Compressive Strength test:

The compressive strength tests were carried out after 7 days and 28 days for the concrete cubes. The specimen of size 150×150×150 mm cubes were cast according to IS: 516-1969. These specimens were cast in steel forms and were well cured under water till the day of test. Compression test according to IS: 516-1959 was carried out on these cubes.These specimens were loaded at a constant strain rate until failure. The strength of concrete is controlled by the proportioning of cement, coarse and fine aggregates, water, and various admixtures. The ratio of the water to cement is the chief factor for determining concrete strength. The lower the water-cement ratio, the higher is the compressive strength. The results of compressive strength of cubes for 7 days and 28 days are given in Table5, 6 and figure 3, 4respectively.The compressive strength of specimen was observed to be optimum with specified percentage of fly ash replacement that was 10% of cement and with same optimum percentage cubes with rubber surface as its loading surface was made and tested for compressive test.

Table 5.7days Compressive strength test

Sample	w/c	Area (mm^2)	Load (KN)	Stress (N/mm^2)
TM1 (0%)	0.45	22500	**505**	**22.44**
TM2 (5% Fly ash)			**525**	**23.37**
TM3 (10%Fly ash)			**596**	**26.51**
TM4 (15% Fly ash)			**464**	**20.62**
TM5 (5% Fly ash + Rubber surface)			**315**	**14.00**
TM6 (10% Fly ash + Rubber surface)			**300**	**13.33**

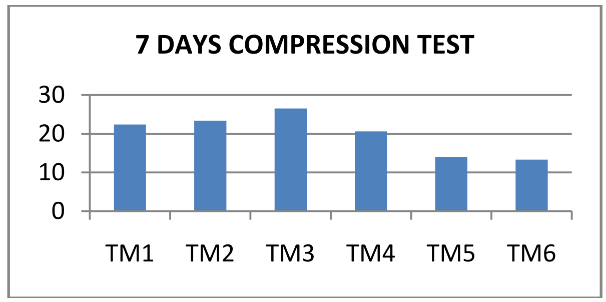

Figure 3.

Table 6. 28days Compressive strength test

Sample	w/c	Area (mm^2)	Load (KN)	Stress (N/mm^2)
TM1 (0%)	0.45	25000	**1040**	**45.33**
TM2 (5% Fly ash)			**840**	**37.75**
TM3 (10%Fly ash)			**945**	**41.95**
TM4 (15% Fly ash)			**851**	**37.75**
TM5 (5% Fly ash + Rubber surface)			**500**	**22.22**
TM6 (10% Fly ash + Rubber surface)			**460**	**20.44**

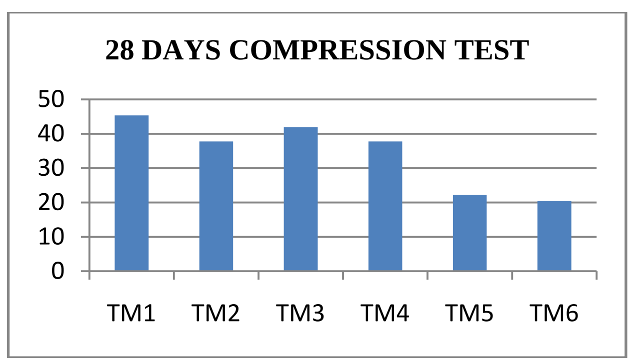

Figure 4.

The result of the compound cube with waste rubber as its loading surface saw a decline in the strength but it is much more than the required strength for loading of medium weight machineries.Therefore we can place it and take into account.

5.3. DISCUSSION AND CONCLUSION :

- The concrete got decreasing slump value with increase in fly ash percentage but it is quite negligible which shows that it has good pozzolanic property and at optimum fly ash content that was 10 % it showed last minimal slump that is 36cm but after that slump value increased which infers at definite proportion the binding attains a good bond.
- The compressive strength of cubes with no replacement was after 28 days was nearly to cubes with 10% fly ash replaced cubes leaving behind 5% and 15% replaced cubes which indicates that it is optimum ratio at which concrete attains greater strength.
- On making the waste rubber tyre as loading surface with 10% fly ash replacement with cement we saw a decline in the strength of 28 days test that is with stress value 18 N/mm2 that is with load 400 ton.This is due to reduction in concrete surface area and volume of mortar.
- The waste rubber was properly gripped so that is makes a good bind with the concrete and was placed carefully in the mould with little gap above so that the concrete fills its upper part.
- On placing the compound cube of concrete under the macine of middle heavy weight we saw it easily

A medium weight machine placed above the compound concrete blocks with loading surface on waste rubber.

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