Manufacture of Paver Block Using Demolished Construction Waste

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Abstract- In India, with fast growing constructions, the natural resources are becoming inadequate to fulfill the needs of construction. Materials like natural sand, coarse aggregate natural available good clay for bricks have become scarce, resulting in increase in masonry work, concrete work, and overall construction cost. Also, prices of cement, the main binding material, is going in increasing day by day. the issues of environmental and economic concern are addressed by the use of waste glass as partial replacement of fine aggregates in concrete. In the present investigation, concrete paving blocks may be produced with locally available cement, aggregates, fly ash and waste glass powder as the mineral admixture. Different mix proportions are prepared using cement replaced by equal quantity of fly ash and waste glass powder. The study indicated that fly ash and waste glass powder can effectively be used as cement replacement without substantial change in strength.

Index Terms -*Waste glass, flyash,, M -Sand, compressive strength, Flexural strength, fine aggregate, Paving block.*

I. INTRODUCTION

In India, there is large amount of use of concrete which is made from natural material like river sand, course aggregate from demolition of mountains by stone crusher and artificial material like cement, Indian buildings in 2013 have generated more than 626 million tones of solid waste which is 52 times more than official estimate. A great part of this waste is being used illegally for dumping and filing up urban water bodies. From the large amount of solid waste generated from various industries, construction and demolition waste contributes in large amount Construction and demolition waste is the waste which is generated from various activities like residential construction work, road work, renovation work, demolition etc.

The main challenge before the Indian concrete industry now is to meet the demand of economical and efficient construction materials required by large infrastructure needs due to rapid industrialization and urbanization. All these call for use of good quality concrete with use of minimum resources (eg. Limestone, energy &money) and achieving maximization of strength, durability and other intended concrete properties. In recent years there has been an increasing worldwide demand of concrete paving blocks for the footpaths, roads and airfields which has led to a local depletion of aggregates. In some urban areas, the enormous quantities of aggregate that have already been used means that local materials are no longer available and the deficit has to be made up by importing materials from other locations. Most cities have areas of land covered by spoil heaps which are unsightly and prevent large areas of land being used for anything else.Concrete paving block is a versatile, aesthetically attractive, functional, and cost effective and requires little or no maintenance if correctly manufactured and placed.

II. OBJECTIVES AND SCOPE

- Capability of being moulded in different sizes, shapes, and colours.
- Good stability and durability, if properly manufactured and installed.
- Easy to produce ,Easy laying
- Good indoor climate (balanced humidity; cool) Various attractive patterns can be formed

  Equipment to produce tiles can be easily made by local workshop
- Information on amount of debris generated in Barshi- This information was collected from the “Solid Waste Management” department of Pune Municipal Corporation.
- To study the conventional paver blocks- This implies about the materials, manufacturing process, used of paver blocks and growing recent trends in that. It was done by having an actual visit to a paver block manufacturing industry.
- To use the concrete waste from debris in manufacturing paver block- This involves collection of concrete waste from nearby site, its crushing and separating the materials and using it in paver block manufacturing.
- To perform various physi-mechanical test in laboratory and compare the results with those of conventional concrete paver blocks if available or with the flexure strength, their result analysis and comparison.
- To achieve economy- This contributes to achieve the economy in comparison with the conventional blocks by considering various factors.

III. MATERIAL USED

A) Materials-

Materials used in making paver block are as bellow:

1. Cement:

Ordinary Portland Cement 53 grade cement which is available in local market by confirming to IS 12269:2013

Test performs on cement:

a) Consistency: Testing was done as per IS code 12269-2013. This test was done by Vicat's apparatus as per IS code 5513-1976.

b) Initial Setting Time: This Testing was done as per IS code 12269-201.

c) Final Setting Time: This Testing was done as per IS cod e12269-2013.

d) Fineness of cement: This Testing was done as per IS code 4031-1988{Part –1}.

TABLE: 3.1

Test performs on cement

Sr. No.	Test Of Performance	Result
1	Fineness of cement	2.86%
2	Standard consistency of cement	26%
3	Initial setting time	32 min
4	Final setting time	600min

2. Aggregate:

a) Aggregates - Material obtained after crushing manually and by machine inspected and aggregates passing from 12mm and retaining on 4.75mm were used as coarse aggregates.

b) Grit – When crushing by machine, mixed material of various sizes was obtained. Out of that, material passing from 4.75mm and retaining on 2m IS sieve was used as fine aggregate.

3. Crush sand: When crushed through machine, lot of powder form was obtained which include all mix ingredients from concrete waste. Material passing from 2mm IS sieve was taken as crush sand.

4. Water: Free from deleterious matter and shall fulfill the requirement as per IS 456-2000.

B) Indian Standard Method:

The Indian standard code IS: 10262 -2009, presents guidelines for mix design which includes design of normal concrete mixes. (Non-air entrained) both for medium and high strength concrete. The basic assumption made in mix design is that the water/cement ratio by and large governs the compressive strength workable concrete.

In this method of mix design, the water content and proportion of fine aggregate corresponding to a maximum size o aggregate are first determined for reference values of workability, water/cement ratio and grading of fine aggregate. The water content and the proportion of fine aggregate arte then adjusted for any case from the reference values. The batch weight of materials per unit volume of concrete is finally calculated by the absolute volume method. The specific design data developed in this method is based on the exhaustive experimental work conducted at the cement research institute of India and based on data on concrete being designed and produced in the country. However, there are various other factors, which affect the property of the concrete such as the quality and quantity of cement, water aggregate batching and size and shaped of aggregates. Therefore, the specific guidelines recommended in proportioning concrete mixes should be considered only as a basis of trial, subject to modification.

C) Design Stipulations:-

1. Systematic Procedure Of Mix Design As Per IS (10262 (2009)

a) Grade designation: M-35

b) Type of cement: OPC 53 grade conforming to IS

c) Maximum nominal size of aggregate: 12.5 mm

d) Minimum cement content: 240 kg/m3 (Moderate)

e) Maximum water cement ratio: 0.60% - IS 456-2000

f) Workability: 13mm

g) Exposure condition: Moderate (PCC)

h) Method of concrete placing: Manual

i) Degree of supervision: good

j) Type of aggregate: Recycled crushed aggregate

k) Maximum cements (OPC) Content:

l) Chemical admixture content: Hardner and laquer

2. Test Data for Materials:-

a) Cement used: OPC 53 grade

b) Specific gravity of cement: 3.15

c) Specific gravity of:-

I. Coarse aggregate: 2.12

II. Fine aggregate: 2.63

d) Water absorption:-

I) Coarse aggregate: 5.21%

II. Fine aggregate:-

e) Free (surface) Moisture

I. Coarse aggregate: Nill

II. Fine aggregate: Nill

f) Sieve analysis

I. Coarse aggregate: -

II. Fine aggregate: Conforming to grading Zone 1

3. Target strength of mix proportioning

f'ck = fck + 1.65 s

Where,

f'ck = Target average compressive strength at 28 days

fck = Characteristics compressive strength at 28 days

s = Standard deviation.

4. Selection of Water Cement Ratio

0.55<0.60……OK

Cement content = water content / water t cement ratio

= 157.14 / 0.60

=261.9 kg/m3

Minimum cement content for moderate condition = 240 +30

= 270 kg/m3

From table, no 6 no IS 456-2006

5. Selection of Water Content
(From Table 2 of IS 10262-2009) Water content for 12.5 mm maximum size of aggregate = 202.5 kg
3 % reduction for slump range 0-25. Therefore, water content = 196.42 kg
As hardener is used in casting of paver blocks, water content was reduced by 20%.
Therefore, water content = 157.14 kg.

6. Proportion of Volume Of Coarse And Fine Aggregate Content
From table 3 of IS 10262-2009, volume of coarse aggregate corresponding of 12.5 mm size aggregate and fine aggregate(Zone 1) for water-cement ratio of 0.36=0.48.
In present case water – cement ratio is 0.36. Therefore, volume of coarse aggregate is requiring to be increased to decrease the fine aggregate content. As water cement ratio is lower by 0.10, the proportion of volume of coarse aggregate is increased by 0.02. Therefore, corrected proportion of volume of coarse aggregate for water –cement ratio of 0.36=0.51.
Volume of fine aggregate content=1-051=0.49
The mix calculations per unit volume of concrete shall be as follows:
a) Volume of concrete = 1m3
b) Volume of cement = Mass of cement x 1
Specific gravity of cement 1000
= 561.9 x 1
3.15 1000
= 0.083 m3
c) Volume of water = Mass of water x 1
Specific gravity of water 1000
= 157.14 x 1 = 0.157 m3
1 1000
d) Volume of chemical admixture =
For bottom layer = 0.0002 m3
f) Mass of coarse aggregate = e x volume of coarse aggregate x specific gravity of coarse aggregate x 1000
= 0.75 x 0.51 x 2.12 x 1000
= 810.9 kg
g) Mass of fine aggregate = e x volume of fine aggregate x specific gravity of fine aggregate x 1000 =
= 0.75 x 0.49 x 2.63 x 1000
= 966.52 kg

7. Final Mix Proportion
Cement: 261.9 kg
Water: 157.14 kg
Fine aggregate: 966.52 kg
Coarse aggregate: 810.9 kg
Water-cement ratio: 0.55
1: 3.09: 3.69

D) Experimental Process
Casting
1) The moulds are used for making of concrete Paver Block as per IS: 15658-2006 methods of tests for Strength of concrete.
2) Paver back mould of 200×160×80 mm size.
3) Firstly decide the number of sample to be taken during concreting.
4) Before casting of materials shuttering oils should be used inside the mould properly.
5) Collect the all material in the pan before the mixing properly.
6) Mix the all material in the pan.
7) Use of vibrating machine/table in compacting concrete to a voids formation of air voids in concrete.
8) Submerge the specimen in water at a temperature of 27o C for 7 days, 14 days and 28 days respectively.
9) Finally check its compressive strength as per as IS: 15658-2006.

IV RESULT AND DISCUSSION

1) Waste Glass
The tested results of compression strength and flexural strength of manufacturing of paving blocks by replacing fine aggregate by waste glass 10%,20%,30% and cured for 7 days, 14 days and 28 days. The result is as follows:

TABLE NO: 4.1
Compressive strength of waste glass (N/MM^2)

	compressive strength		
%	7 days	14 days	28 days
10%	33.9	34.2	34.95
20%	35.82	36.15	37.5
30%	36.1	36	36.5

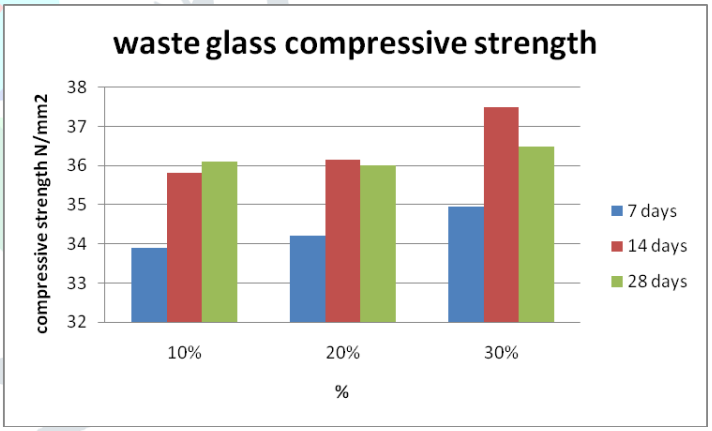

Fig 4.1 Compressive strength of waste glass

TABLE NO: 4.2
Fig 4.2 flexural strength of waste glass (N/MM^2)

	flexural strength		
%	7 days	14 days	28 days
10%	3.7	4.1	4.27
20%	3.8	4.64	4.8
30%	4.2	4.3	5.2

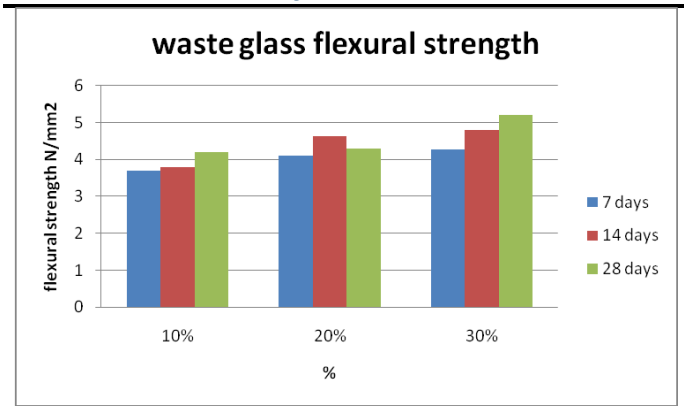

Fig 4.2 flexural strength of waste glass

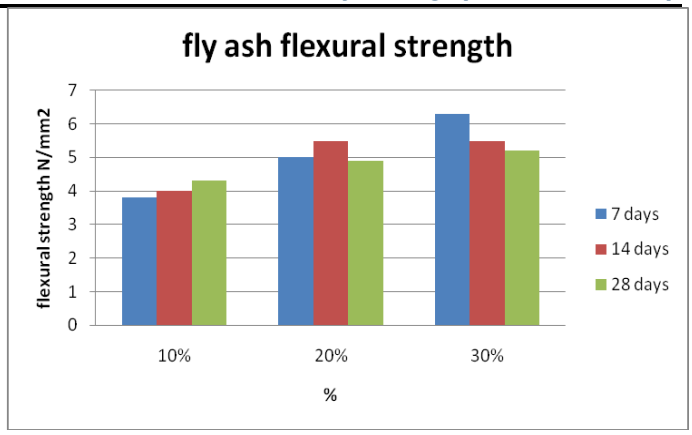

Fig 4.4 flexural strength of Fly Ash

2) Fly ash

The tested results of compression strength and flexural strength of manufacturing of paving blocks by replacing fine aggregate by flyash 10%,20%,30% and cured for 7 days, 14 days and 28 days.the result are as follows:

TABLE NO: 4.3
Compressive strength of Flyash (N/MM^2)

	compressive strength		
%	7 days	14 days	28 days
10%	32	32.5	30
20%	36.5	36	35.4
30%	35.5	37.2	36.3

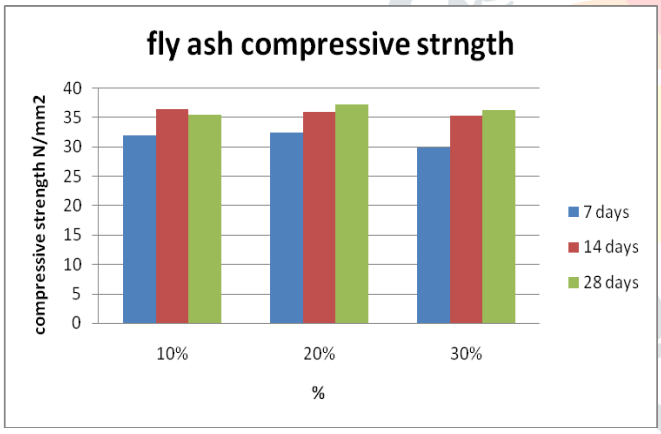

Fig 4.3 Compressive strength of fly ash

TABLE NO: 4.4
Flextural strength of Flyash (N/MM^2)

	flexural strength		
%	7 days	14 days	28 days
10%	3.8	5	6.3
20%	4	5.5	5.5
30%	4.3	4.9	5.2

3) M-Sand

The tested results of compression strength and flexural strength of manufacturing of paving blocks by replacing fine aggregate by M-Sand 10%,20%,30% and cured for 7 days, 14 days and 28 days.the result are as follows:

TABLE NO: 4.5
Compressive strength of M-Sand (N/MM^2)

	compressive strength		
%	7 days	14 days	28 days
10%	32.1	33.1	33
20%	33.3	35.1	35.5
30%	34.6	32	34

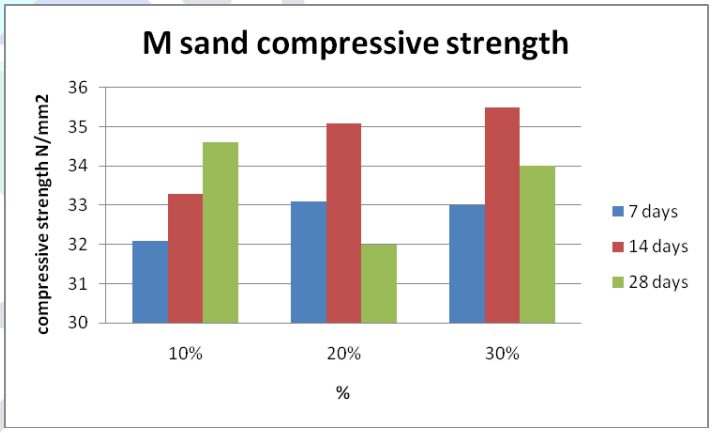

Fig 4.5 Compressive strength of M Sand

TABLE NO: 4.6
Flextural strength of M-Sand (N/MM^2)

	flexural strength		
%	7 days	14 days	28 days
10%	3.7	4.8	5.8
20%	4.1	5.2	5.2
30%	4.4	4.8	5

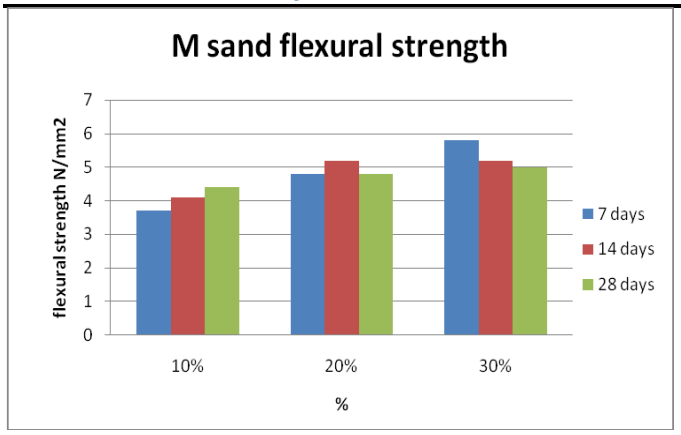

Fig 4.6 flexural strength of M sand

V. CONCLUSIONS

1. 20% replacement of fine aggregates by waste glass showed 8% increase in compressive strength at 7 days and 20% increase in compressive strength at 28 days
2. Characteristics compression strength of interlocking paver block obtained, which is more than design standard for m35 was 37.5 N/mm2 after replacement of 30% waste glass.
3. Water absorption is well below the permissible limit.
4. All the samples satisfy the requirement given in IS 15658: 2006 for concrete paving blocks to be used in non traffic, light traffic and medium-heavy traffic areas.
5. It is concluded that the use of fly ash and glass powder in concrete paving blocks as partial cement replacement is possible.
6. Use of waste glass in concrete will secured natural resources particularly river sand.
7. Use of waste glass as fine aggregate will completely destroy the disposal problem of waste glass & prove to be eco-friendly.

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