Experimental Investigation on Light Weight Concrete Block

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Abstract - *This paper summarizes the experimental work intended to manufacture economical, light weight concrete blocks which are sustainable. Industrial waste products like EPS & glass powder are efficiently used to replace coarse aggregate and fine aggregate to reduce the self-weight at the same time maintain the expected strength. Light weight concrete blocks are produced by partially replacing coarse aggregate with EPS beads and then compensating the reduction in strength by replacing fine aggregate with glass powder*

Key Words: **EPS, Glass powder, Coarse aggregate, Fine aggregate, Light weight**

1. INTRODUCTION

Concrete technology is growing and many advances and innovations have been made to cope with challenges of many construction aspects. Many productions of lightweight concrete blocks had been designed and among them are by the use of lightweight aggregates. Brick is a major building material in construction industry. For decades, conventional clay bricks are widely being utilized in many types of construction specially to form walls for buildings. However, the use of clay bricks caused the ongoing mining of clay soil which is not sustainable for the industry. Concrete blocks came to the industry later which provides more solutions for the industry. The main problems associated with concrete blocks are environmental and economic concerns.

If the weight of concrete blocks can be reduced the need of a stronger foundation and thereby total cost of construction can be reduced One of the main problems associated with the use of conventional light weight aggregates produced from clay, slate and shale in concrete block is that these porous aggregates absorb very large amount of the water mixed in concrete. This affects the performance of concrete. Thus, by using materials like EPS and glass powder this defect can be greatly reduced and also the waste disposal problem can be reduced as well, because both EPS and glass powder are waste materials.

EPS is a stable, low density foam, which consists of 98% of air and 2% of EPS material. It has closed structure and cannot absorb water. It has good impact resistance. EPS is used as packaging material used in medical industry. It is also a non- biodegradable material, so it creates disposal problems. Utilizing recycled EPS as a construction material will be a good waste disposal method. Glass powders are functional fillers and extenders produced from post-industrial clean glass feed stocks. Waste glass as a partial replacement of fine aggregate reduces the cost of concrete blocks. If fine aggregate is replaced by waste glass by specific percentage and in specific size range, it will decrease fine aggregate content and thereby reducing the ill effects of river dredging and thus making concrete manufacturing industry sustainable.

2. MATERIALS USED

i, Cement
ii, Coarse aggregate
iii, Fine aggregate
iv, Water
v, EPS beads
vi, Glass powder

3. METHODOLOGY

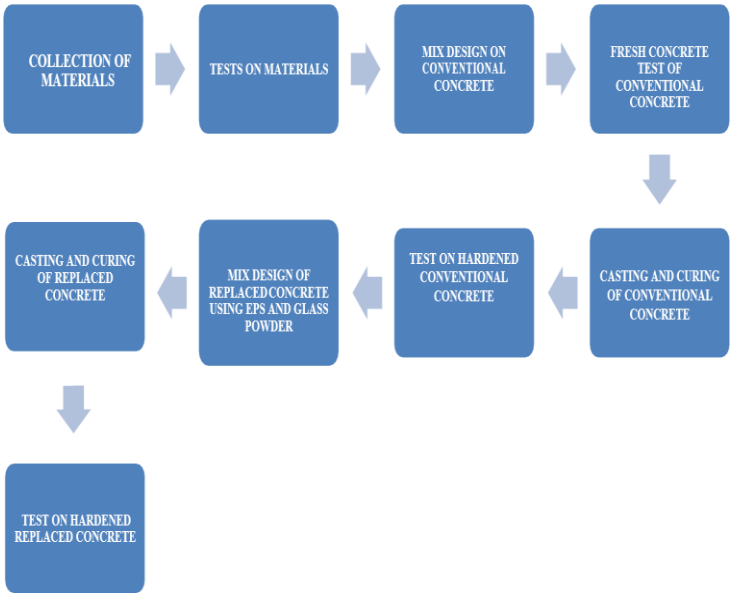

Fig-1: Methodology

4. CASTING OF SPECIMENS

4.1 Specimen details

Table-1: Details of Specimen

Sl. No	Specimen	Size(mm)
1	Cube	150x150x150

4.2 Mix design proportions

As per IS: 10262-2009, a mix proportion was suitably designed for M40grade concrete. The mix proportioning was done based on the properties of various materials like cement, fine aggregate and coarse aggregate. The mix proportion of control mix is given in below Table.

Table-2: Mix design of M40 grade concrete

Sample designation	Proportion	W/C ratio
Control mix	1:1.36:2.61	0.43

4.3 Preparation of specimens

The experimental investigation was carried out in three phases. In the first phase, coarse aggregate from the mix proportion was replaced by silica fume at 5% 10%, 20%, 30%, 50% by volume of source material used. In the second phase of work, fine aggregate from the mix proportion was replaced by glass powder at 10%, 20%, 30%, 40% along with optimum EPS%.

Table-3: Mixes with different percentages of EPS

Mix	EPS %
OPC	0
M1	5
M2	10
M3	20
M4	30
M5	50

Table-4: Mixes with different percentages of Glass powder and optimum EPS%

Mix	Glass powder %
M1	10
M2	20
M3	30
M4	40

5. TESTS PERFORMED ON HARDENED CONCRETE

The compressive strength test was conducted as per IS: 516-1959. This test was performed on cube of standard size 150mm×150mm×150mm. The compressive strength of any mix was taken as average of strength of three samples. All the specimens were tested using a compression testing machine (CTM) of 2000kN capacity equipped with a monitor to display the results. The failure load and corresponding compressive stress value was read from the screen and noted down. Compressive strength of concrete cube test provides an idea about all the characteristics of concrete. Compressive strength of concrete depends on many factors such as water-cement ratio, cement strength, quality of concrete material, quality control during production of concrete etc. Test for compressive strength is carried out either on cube or cylinder. Various standard codes recommend concrete cylinder or concrete cube as the standard specimen for the test. Compressive strength is the ability of material or structure to carry the loads on its surface without any crack or deflection. A material under compression tends to reduce the size, while in tension, size elongates.

In Cube test two types of specimens either cubes of 15x15x15 cm or 10x10x10 cm depending upon the size of aggregate are used. For most of the works cubical moulds of size 15*15*15 cm are commonly used. This concrete is poured in the mould and tempered properly so as not to have any voids. After 24 hours these moulds are removed and test specimens are put in water for curing. The top surface of these specimens should be made even and smooth. This is done by putting cement paste and spreading smoothly on whole area of specimen. These specimens are tested by compression testing machine after 7 days, 14 days or 28 days curing.

$$Fcu = \frac{P}{A}$$

Where,

Fcu = Compressive Strength of Cube (N/mm^2)

P = Compressive Load at Failure (N)

A = Area of Loading Face of Cube (mm^2)

Fig-2: Testing the Cube Specimen

6. TEST RESULTS

The compressive strength is one of the important properties of hardened concrete in general it is the characteristic value for classification of concrete in various grades. The testing was done in the compressive strength testing machine.

Table-5: 7 Day Compressive Strength Results of control mix

	TEST RESULTS			
	Load Applied (kN)			Compressive strength (N/mm^2)
Mix design 1:1.36:2.61	630	635	630	28.07

Table-6: 14 Day Compressive Strength Results of control mix

	TEST RESULTS			
	Load Applied (kN)			Compressive strength (N/mm^2)
Mix design 1:1.36:2.61	880	895	890	39.48

Table-7: 28 Day Compressive Strength Results of control mix

	TEST RESULTS			
	Load Applied (kN)			Compressive strength (N/mm^2)
Mix design 1:1.36:2.61	925	920	925	41.03

Table-8: 7 Day Compressive Strength Results of mix with varying EPS %

	TEST RESULTS	
	EPS %	Compressive strength (N/mm^2)
Mix design 1:1.36:2.61	5	27.34
	10	25.18
	20	23.68
	30	19.46
	50	15.36

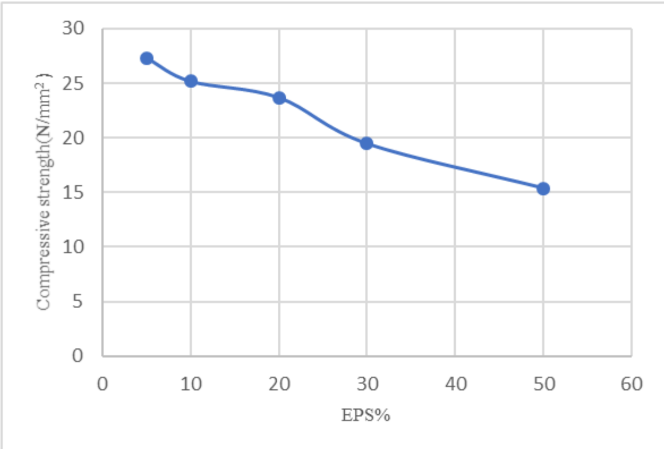

Chart -1: 7 Day Compressive Strength results of mix with varying EPS %

Table-9: 14 Day Compressive Strength Results of mix with varying EPS %

	TEST RESULTS	
	EPS %	Compressive strength (N/mm^2)
	5	37.41
	10	35.33

Mix design 1:1.36:2.61	20	31.12
	30	28.54
	50	24.64

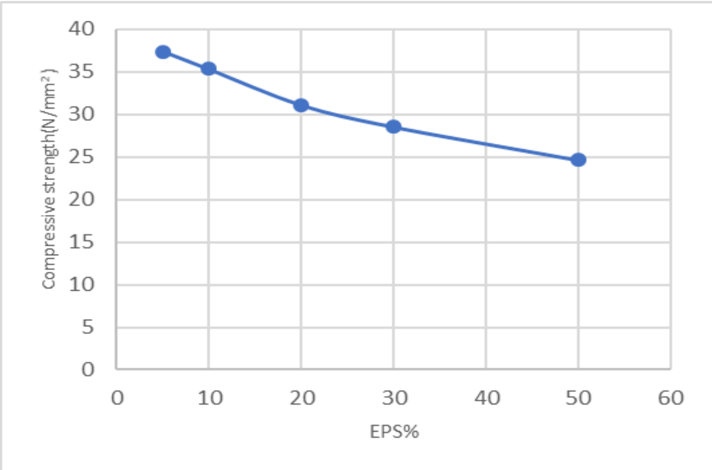

Chart -2: 14 Day Compressive Strength results of mix with varying EPS %

Table-10: 28 Day Compressive Strength Results of mix with varying EPS %

	TEST RESULTS	
	EPS %	Compressive strength (N/mm²)
Mix design 1:1.36:2.61	5	40.78
	10	38.42
	20	34.16
	30	30.67
	50	26.31

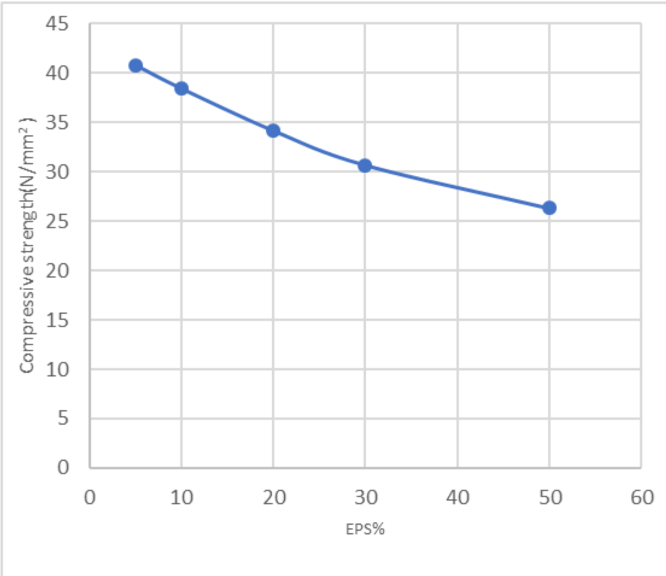

Chart -3: Day Compressive Strength results of mix with varying EPS %

- From the obtained results it is understood that as the percentage of EPS beads increases the compressive strength decreases.
- The optimum EPS percentage is selected as 20%.

Table -11: 7 Day Compressive Strength results of mix with varying glass powder % and optimum EPS %

	TEST RESULTS	
	Glass powder %	Compressive strength (N/mm²)
Mix design 1:1.36:2.61	10	24.86
	20	25.72
	30	27.86
	40	24.31

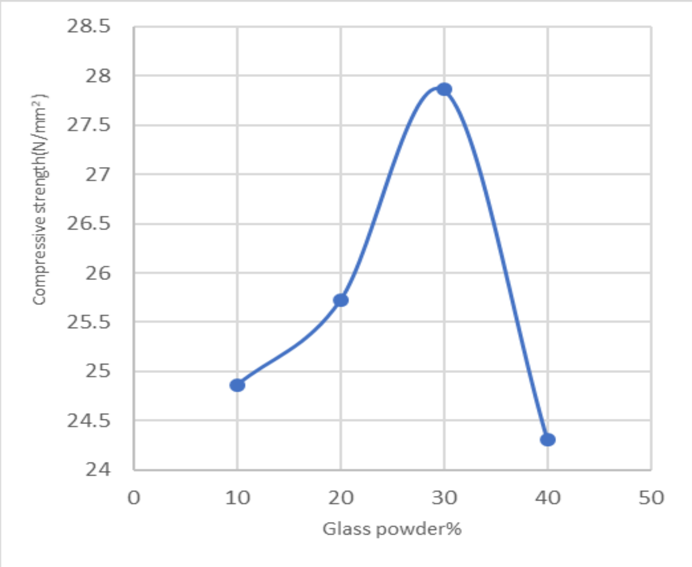

Chart -4: 7 Day Compressive Strength results of mix with varying glass powder % and optimum EPS %

Table -12: 14 Day Compressive Strength results of mix with varying glass powder % and optimum EPS %

	TEST RESULTS	
	Glass powder %	Compressive strength (N/mm²)
	10	32.56
	20	36.63
	30	39.16
Mix design 1:1.36:2.61	40	32.43

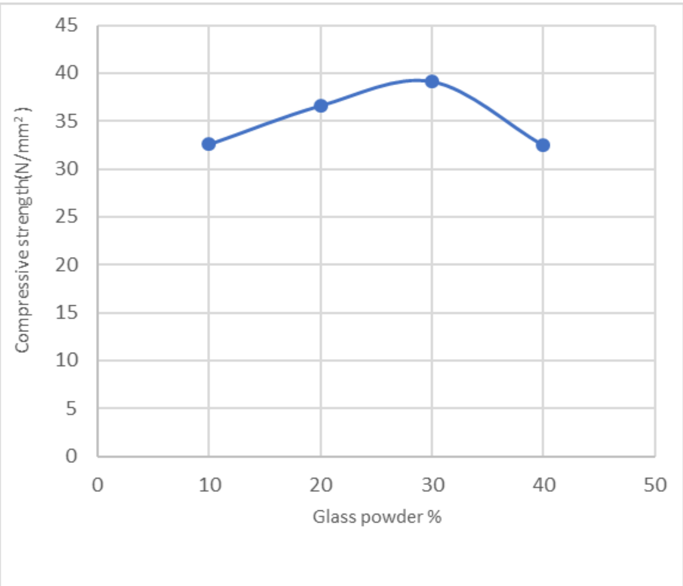

Chart -5: 14 Day Compressive Strength results of mix with varying glass powder % and optimum EPS %

7. CONCLUSIONS

From this experimental work it is understood that as the percentage of EPS increases compressive strength and weigh of the block reduces and hence 20% of EPS is taken as optimum and glass powder is varied with respect to this obtained percentage to obtain a block of adequate strength and of lower weight.

From the obtained results it is determined that as the percentage of glass powder increases compressive strength increases but after 30% replacement of F.A by glass powder compressive strength decreases due to insufficient cement paste available within the mix to facilitate the glass powder percentage and hence 30% of glass powder is selected.

Therefore, lightweight blocks are constructed with 30% replacement of F.A with glass powder and 20% replacement of C.A with EPS beads.

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