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A Robustic Analysis on Structural Behaviour of a Bubble Deck Slab over Conventional Deck Slab

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ABSTRACT: Bubble deck slab is a method of virtually eliminating all concrete from middle of floor slab which is not performing any structural functions, thereby dramatically reducing structural dead weight. High density rubber hollow spheres replace in-effective concrete in centre of the slab thus decreasing dead weight and increasing the efficiency of floor .Bubble deck slab has less material consumption, hence it reduce emission of carbon dioxide in to atmosphere, thus we can achieve green construction.. Thus structural behaviour of a bubble deck slab is compared with conventional deck slab and advantages of using bubble deck slab is highlighted.

I. INTRODUCTION

In building constructions, the slab is a very important structural member to make a space. And the slab is one of the largest member consuming concrete . In a general way, the slab was designed only to resist vertical load. However, as people are getting more interest of residential environment recently, noise and vibration of slab are getting more important. In addition, as the span is increased, the deflection of the slab is also increased. Therefore, the slab thickness should be increase. Increasing the slab thickness makes the slabs heavier, and will increased column and foundations size. Thus, it makes buildings consuming more materials such as concrete and steel reinforcement. To avoid these disadvantages which were caused by increasing of self-weight of slabs, the Bubble Deck slab system, also known as void slab, was suggested. This system is known as bubble deck system.



Fig 1.1:Bubble deck slab

1.2OBJECTIVES OF THE STUDY

The main objective of this study is practical analysis of hollow spherical rubber balls in reinforced concrete slab and its effects.

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- To study the structural behaviour of the bubble deck slab and conventional deck slab
- To study the load carrying capacity on conventional slab & bubble deck slab.
- To study the bending (deflection) behaviour of conventional slab & bubble deck slab.
- To study the failure or crack on conventional slab & bubble deck slab.

II. LITERATURE REVIEW

Many journals are collected related to the topic area. The aim is to reducing the dead weight to attain the light weight structure without reducing the strength of the concrete. In journals different types of balls are used such as polyethylene balls, polypropylene balls, rubber balls, plastic balls etc..with different diameter. The behaviour of bubble deck slab is influenced by the ratio of bubble diameter to slab thickness. These bubbles can decrease the dead weight up to 30 – 50% and can increase the capacity by almost 100% with same thickness. As a result bubble deck slab can be lighter, stronger and thinner than regular reinforced concrete slabs.

III. MATERIALS USED

3.1 AGGREGATE (COARSE AND FINE)

Various properties of aggregates can influence the performance of concrete, therefore various considerations have to be kept in mind while selecting the material.

3.2 CEMENT

Ordinary Portland cement of 53 grade was used as it satisfied the requirements of IS 269-1969

3.3 WATER

IS 456-2000 water, used for mixing and curing of concrete. Permissible limits for solid in water as per IS 456-2009. The maximum permissible limits of chloride content in water for RCC work has been reduced from 1000 mg per litre in IS 456-1978 to 500 mg per liter in IS 456-2000

3.4 Hollow Bubbles

These hollow bubbles are made using high density rubber materials. They are usually made with nonporous material that does not react chemically with the concrete or reinforcement bars. The bubbles have enough strength and stiffness to safely support the applied loads. They be of spherical or ellipsoidal in shape.

3.5 REINFORCEMENT

High grade steel of Fe 500 is used. Here 8 mm diameter steel bar is used as the reinforcement. Reinforcement provided in both transverse and longitudinal direction in the form of mesh.

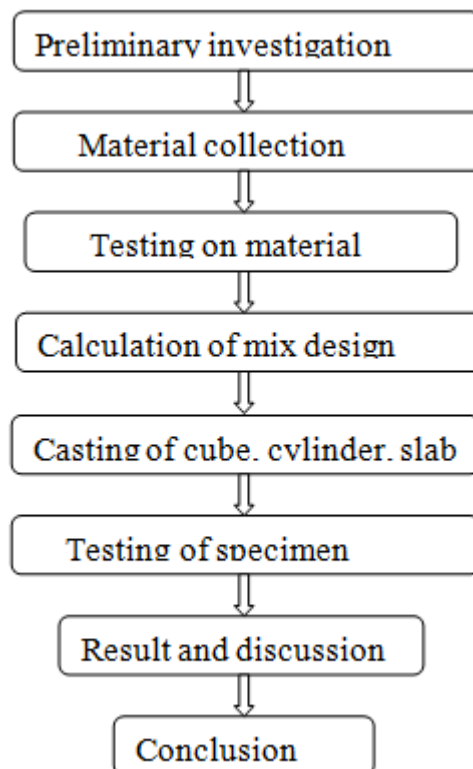
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IV. METHODOLOGY



4.1 PARAMETERS STUDIED

The experiments are conducted on four series of test specimens. The following properties were studied for all the three grades of concrete.

Mechanical Properties

- ✓ Compressive strength of concrete – cubes
- ✓ Split tensile strength of concrete – cylinders
- ✓ Flexural strength of concrete - slab

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V. RESULT AND DISCUSSION

5.1 COMPRESSIVE STRENGTH TEST

CUBE SPECIMEN ID	COMPRESSIVE STRENGTH (N/MM ²)		
	7 days	14 days	28 days
C 1	12.22	18.90	25.20
B1	12.20	19.11	24.53
C2	12.42	20.10	24.52
B2	13.34	22.26	25.34
C3	12.92	19.07	24.11
B3	13.12	20.32	24.56

Table 5.1 Compressive Strength of concrete

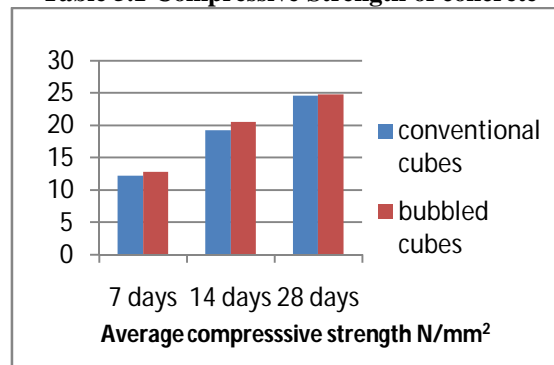


Chart 5.1 compressive strength of cube

From the results it is noted that the compressive strength of conventional concrete is almost similar to the bubbled cube. Only slight variations is occurred.

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5.2 SPLIT TENSILE STRENGTH TEST

SPLIT TENSILE STRENGTH (N/MM ²)			
Specimen id	NO OF DAYS		
	7	14	28
Cylinder A1	1.94	2.36	2.79
Cylinder B1	1.91	2.43	2.43
Cylinder A2	1.77	2.01	2.19
Cylinder B2	1.80	2.05	2.17
Cylinder A3	1.55	1.93	2.28
Cylinder B3	1.50	1.92	2.38

Table 5.2 Split Tensile Strength of concrete

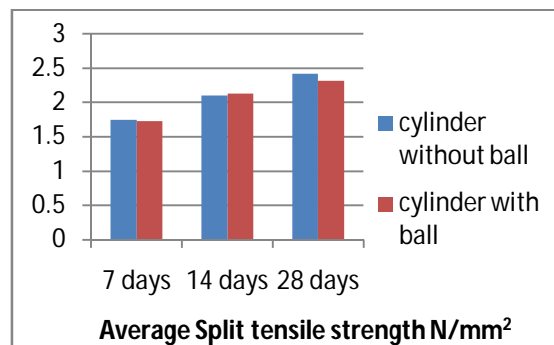


Chart5.2: Split tensile strength of cylinder

The Split tensile strength of normal concrete is 10% of its compressive strength. From the results the split tensile strength of cylinder without ball is similar to cylinder with ball. Only slight variations occur.

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5.3 SLAB TESTING

5.3.1 Details of tested slabs

- Size of slab= (300 x 500)mm
- SB1- solid slab of 80 mm thickness
- BD1- Bubble deck slab of 80 mm thickness with 50 mm rubber ball used.
- SB2 – solid slab of 100 mm thickness
- BD2 – bubble deck slab of 100 mm thickness with 80 mm ball used.
- SD3 – solid slab of 120 mm thickness
- BD3 – bubble deck slab of 120 mm thickness with 100 mm ball used
- Reinforcement – 8 mm diameter bar is used

5.3.2 Load vs Deflection

The load vs deflection graph was plotted taking the deflection along the X axis and the load along the Y axis. The graphs were compare with different specimens as deflection at center. It was observed that deflection increased as the load increased that is the load and deflection is proportional.



Fig 5.1 slab testing

Table 5.3 first cracking load vs cracking deflection

SI.no	Slab id	First cracking load	Cracking deflection
1	SD1	12	1.5
2	BD1	12.5	1.2
3	SD2	14	1.8
4	BD2	16	1.4
5	SD3	18	2.1
6	BD3	20	1.8

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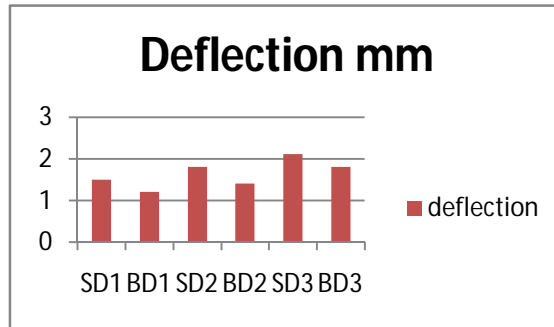


Chart 5.3 first cracking deflection

Sl.NO	slab id	ultimate load	ultimate deflection
1	SD1	35	22
2	BD1	38	19
3	SD2	37	20
4	BD2	40	17
5	SD3	41	18
6	BD3	45	15

Table 5.4: Ultimate load vs ultimate deflection

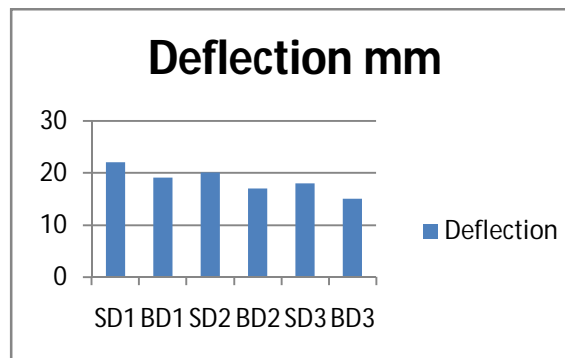


Chart 5.4 Ultimate deflection

Sl.no	slab id	weight of slab kN
1	SD1	12.45
2	BD1	10.34
3	SD2	14.56
4	BD2	11.12
5	SD3	16.7
6	BD3	13.78

Table 5.5 weight of the slab

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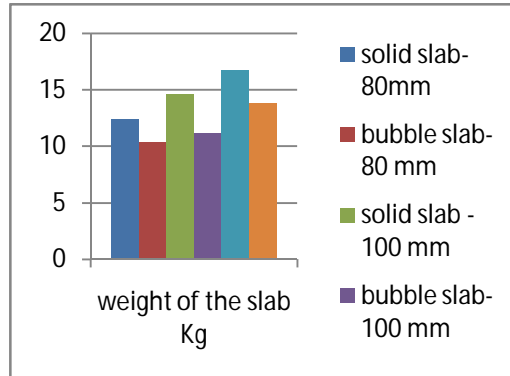


Chart 5.5 Weight of the slab

Sl.NO	Specimen id	Flexural strength N/mm ²
1	SB1	3.9
2	BD1	4.2
3	SB2	4.3
4	BD2	4.5
5	SB3	4.5
6	BD3	4.9

Table 5.6 flexural strength of slab N/mm²

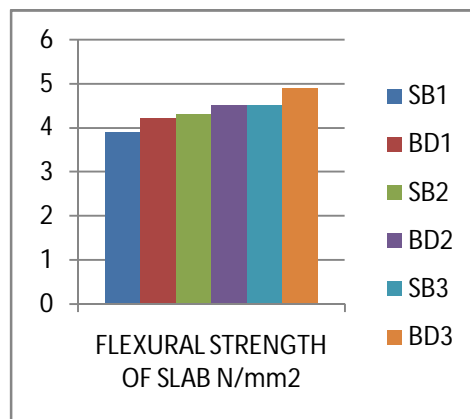


Chart 5.6 flexural strength of slab N/mm²

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Sl.NO	Description	Conventional slab	Bubble deck slab
1	Steel	1500	2000
2	Cement	3000	2500
3	Sand	2000	500
4	Aggregate	799	600
5	Rubber ball	-	900
6	Other	500	300
	Total	7799	6800
	Contractor profit 10 %	779.9	680
	Grand total	9000	7500
	Net profit	$(9000-7500)/9000 \times 100 = 16 \%$	

Table 5.7 : cost comparison between conventional slab and bubble deck slab

VI. CONCLUSION

It is concluded that bubble deck slab is better than conventional slab. It can be done by experimental study. The compressive strength of bubbled cube is similar to the conventional cube. The split tensile strength of cylinder with bubble is similar to the cylinder without bubble. The strength of bubble deck slab in 120 mm thickness is higher than other slab. There is 30 % reduction in weight of bubble deck slab when compared to the conventional slab. The cost of the bubble deck slab is 16 % less when compared to the conventional slab. This technology is environmentally green and sustainable. This detailed investigation prove to be the bubbled slab is more efficient than conventional slab.

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