PARTIAL REPLACEMENT OF CONCRETE BY PLASTIC SPHERICAL BALLS AND REDUCING STRUCTURAL DEAD WEIGHT BY LINKING AIR AND STEEL DIRECTLY (BUBBLE DECK TECHNOLOGY)

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***Abstract*— Bubble deck slab is a method of virtually eliminating all concrete from the middle of a floor slab, which is not performing any structural function, thereby reducing structural dead weight. High density polyethylene hollow spheres replace the in-effective concrete in center of the slab, thus decreasing the dead weight and increasing the efficiency of the floor. By introducing the gaps, it leads to 30 to 50% lighter slab which reduces the loads on the columns, walls and foundations, and of course of the entire building.**

The aim of this project is to explore and explain the various properties of bubble deck slab based on experimental research methods. The paper provides a brief idea about the different Bubble deck slabs, their production and advantages over traditional concrete slabs.

Index Terms*: Bubble Deck Technology ,Plastic spherical Balls *etc.

1 Introduction

Concrete is one of the crucial material for infrastructure development due to its versatile application, globally used as a main component of construction. Due to the increased amount of concrete make the structure not reliable for everyone from constructing point of view. For this objective , the researcher are trying to use different components in concrete technology . In this research we are studying the effect of Plastic Spherical Balls with the partial replacement of concrete to make the structure economical as well as environmental friendly as compare to normal solid concrete structure.

1.1 MATERIALS USED AND METHODOLOGY

DESIGEN AND ANALYSIS IN LABROTARY: The design of bubble deck slab in the laboratory consist different steps. The bubble deck slab is the combination of reinforced concrete and Plastic spherical balls. The mixer of cement sand and aggregate on the basis of INDIAN STANDARAD (concrete mix proportioning) 10262:2009

1.2. CALCULATION OF MATERIALS FOR THE SOLID DECK SLAB-1 :

Dimensions of solid deck slab :

Length = 1000mm
width = 1000mm
Thickness = 100 mm

Volume of Solid Deck slab = 1000mm x 1000mm x 100mm
$= 1 \times 10^8$ mm³

Required quantity of Coarse aggregate for solid deck slab :

$$= \frac{\text{quantity of Coarse aggregate for 1 m}^3 \text{ x Space available of SD}}{\text{volume of 1 mm}^3}$$

$$= \frac{1016 \times 10^8}{10^9}$$

$$= 101.6 \text{ kg}$$

Required quantity of fine aggregate for solid deck slab :

$$= \frac{\text{quantity of fine aggregate for 1 m}^3 \text{ x Space available of SD}}{\text{volume of 1 mm}^3}$$

$$= \frac{739 \times 10^8}{10^9}$$

$$= 73.9 \text{ kg}$$

Required quantity of Cement for solid deck slab :

$$= \frac{\text{quantity of Cement for 1 m}^3 \text{ x Space available of SD}}{\text{volume of 1 mm}^3}$$

$$= \frac{422 \times 10^8}{}$$

10^9

= 42.2 kg

Required quantity of water for solid deck slab :

$$= \frac{\text{quantity of water for 1 m}^3 \text{ x Space available of SD}}{\text{volume of 1 mm}^3}$$

$$= \frac{226 \times 10^8}{10^9}$$

= 22.6 liter

1.3. CALCULATION OF MATERIALS FOR THE BUBBLE DECK SLAB-1 :

Dimensions of one Plastic Sphere Ball :

Diameter = 64 mm

Radius = 32 mm

Volume of one Plastic Spherical Ball = $4/3 \times \Omega \times r^3$

$= 4/3 \times \Omega \times 32^3$

$= 137258.2 \text{ mm}^3$

No. of Spherical balls used = 144 No.

Now the actual volume of spherical balls = No. of balls x Volume of one balls

$= 144 \times 137258.2$

$= 0.19 \times 10^8 \text{ mm}^3$

Actual volume of space for concrete in slab = vol. of solid deck slab - vol. of spherical balls

$= 1 \times 10^8 \text{ mm}^3 - 0.19 \times 10^8 \text{ mm}^3$

$= 0.80 \times 10^8 \text{ mm}^3$

Calculation for material required of the bubble deck slab:

Required quantity of Coarse aggregate for solid deck slab :

$$= \frac{\text{quantity of Coarse aggregate for 1 m}^3 \text{ x Space available of BD}}{\text{volume of 1 mm}^3}$$

$$= \frac{1016 \times 0.80 \times 10^8}{10^9}$$

= 81.28 kg

Required quantity of fine aggregate for solid deck slab :

$$= \frac{\text{quantity of fine aggregate for 1 m}^3 \text{ x Space available of BD}}{\text{volume of 1 mm}^3}$$

$$= \frac{739 \times 0.80 \times 10^8}{10^9}$$

= 59.12 kg

Required quantity of Cement for solid deck slab :

$$= \frac{\text{quantity of Cement for 1 m}^3 \text{ x Space available of BD}}{\text{volume of 1 mm}^3}$$

$$= \frac{422 \times 0.80 \times 10^3}{10^9}$$

= 33.76 kg

Required quantity of water for solid deck slab :

$$= \frac{\text{quantity of water for 1 m}^3 \text{ x Space available of BD}}{\text{volume of 1 mm}^3}$$

$$= \frac{226 \times 0.80 \times 10^8}{10^9} = 18.08 \text{ liter}$$

2. TYPES OF MATERIAL AND THEIR SHAPE AND SIZE:

For the design of bubble deck slab the main material is the cement sand and aggregate .for the better result we done the test of different type of material.

2.1 CONCRETE :

The concrete is mixture of standard Portland cement, fine aggregate and with max aggregate size of 10 mm with some amount of water. water is mainly depend upon the water cement ratio. No plasticizers are necessary for concrete mixture. Different type of tests have proved that the bubble deck slabs characteristic compressive strength of concrete is achieved in the same manner like

that of solid slabs. In many type of bubble deck slab a thin layer coating of concrete at the bottom is precast for preparing a base at the manufacturing plant .

2.2 PLASTIC SPHERE :

The hollow spheres are a recycled product and made from recycled high-density polyethylene or HDPE. Which are ready to be transported to the construction site. Due to based on the size of structure i.e. diameter of bubble, span and slab thickness; the plastic bubbles are available in market in different sizes, shape. Table 2.2.1 shows the different shape and size of bubble. The main disadvantage of bubbles is that it is not stackable. These HDPE bubbles can be salvaged and reused again by recycling. This contributes to the Green properties of bubble deck slab.

T**able 2.2.1**: Different Types Of Plastic Bubbles Available In Market

Description	Slab Thickness (mm)	Bubble Diameter (mm)	Cantilever Maximum length (m)	Span (m)	Compacted slab mass (KN/m2)	Site Concrete quantity ($m^3/m^{2)}$
BD230	230	180	<=2.8	5-6.5	4.26	0.112
BD280	280	225	<=3.3	6-7.8	5.11	0.146
BD340	340	270	<=4.0	7-9.5	6.22	.0191
BD390	390	315	<=4.7	9-10.9	6.92	0.219
BD450	450	360	<=5.4	10-12.5	7.85	0.252
BD510	510	410	<=6.1	11-13.9	9.09	0.298
BD600	600	500	<=7.2	12-15.0	10.30	0.348

2.3. PREPARATION OF REINFORCEMENT MESH :

We know that concrete are provided in the bubble deck slab for the compressive zone and the steel bar are provided for the tension zone. The mesh of bar are given below. Plates - Preparation of mesh The size of steel bar vertical direction is 100cm and in the horizontal direction is 24 cm and the spacing between is 6.5cm and the diameter of bar is 8mm.and the diameter of plastic spherical ball is 6.4cm.the combination of bar and ball are show in fig.2.3.1 are given below.

Fig.2.3.1

3. Analysis and Interpretation :

Table-3.1Descriptions of Bubble Deck slab	
Dimensions of Bubble deck-1/64	1000mm x 1000mm x100mm
Diameter of Plastic sphere	64 mm
Cement used	33.76 kg
Fine aggregate used	59.12 kg

Coarse Aggregate used	81.28 kg
Water	18.08 L
Total weight of solid deck slab-1	192.3 kg
No. of spherical Balls used	144
Ultimate Load	551 KN
Ultimate Deflection	27.0

Table-3.2Descriptions of solid slab	
Dimensions of solid deck-1	1000mm x 1000mm x100mm
Cement used	42.2 kg
Fine aggregate used	73.9 kg
Coarse Aggregate used	101.6 kg
Water	22.6 L
Total weight of solid deck slab-1	240.3 kg
No. of spherical Balls used	NIL
Ultimate Load	549 KN
Ultimate Deflection	25.4mm

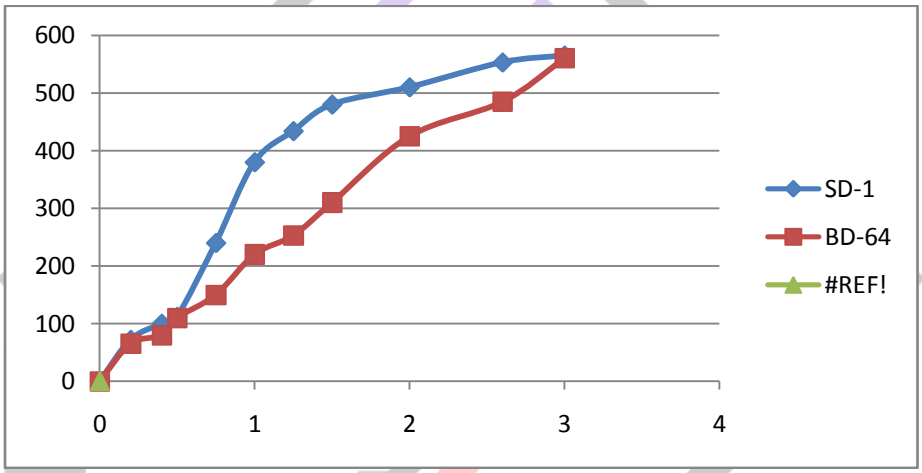

Fig. 3.1: Load Vs Control Deflection Relationship (H=100mm)

4. CONCLUSIONS FROM THE TEST :

The two- dimensional flexural experiments on two-way Bubble deck slabs with plastic sphere voids were tested and the following conclusions can be drawn:-

1. Hardness values of Bubble deck slabs were different from solid slab. Mainly specimens like (BD-1/64 and SD-1) which showed one-way flexural cracks and minimum stiffness or hardness. on the basics of experiment result study, two-way Bubble deck slabs act like general R.C slabs basically and their flexural capacities were good enough to use for the construction purpose.

2. The use of plastic spheres in reinforced concrete slabs (B/H=0.51, 0.64), had a result in comparison with reference solid slabs (without plastic spheres), bubbled deck slabs has the ultimate load of a similar reference of solid slab i.e. (100%,) .

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