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BUBBLE DECK SLAB

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Abstract — *In recent times, the main obstacle with the concrete constructions in case of horizontal slabs is the high weight which limits the span. For this reason major developments of reinforced concrete have focused on enhancing the span, either by reducing the weight or overcoming concrete's natural weakness in tension. The bubble deck slab is a revolutionary biaxial concrete floor system developed in Europe. It based on a new patented technique- the right way of linking air and steel. High density polyethylene hollow spheres replace the ineffective concrete in the centre of slab, thus decreasing the dead weight and increasing the efficiency of the floor. This system reduces dead weight of the floor slab 33%. These biaxial slabs have many advantages over a conventional solid concrete slab such as lower total cost, reduced material use, enhanced efficiency, decreased construction time and is a green technology*

Keywords-*concrete construction, bubble deck, biaxial slab, high density polyethylene hollow spheres, etc*

I. INTRODUCTION

The bubble deck slab is a revolutionary biaxial concrete floor system developed in Europe. High density polyethylene (HDPE) hollow spheres replace the ineffective concrete in the centre of the slab, thus decreasing the dead weight and increasing the efficiency of the floor. These biaxial slabs have many advantages over a convectional solid concrete slab: lower total cost, reduced material use, enhanced structural efficiency, decreased construction time, and is a green technology. Through tests, models and analysis from a variety of institutions, bubble deck was proven to be superior to the traditional solid concrete slab. The reduced dead load makes the long term response more economical for the building while offsetting the slightly increased deflection of the slab. However, the shear and punching shear resistance of the bubble deck floor is significantly less than a solid deck since resistance is directly related to the depth of concrete. Design reduction factors have been suggested to compensate for these differences in strength. This system is certified in the Netherland, the United Kingdom, Denmark and Germany.

The bubble deck slab is mainly consisting three materials, i.e., steel, plastic spheres and concrete. Steel reinforcement is a grade of Fe 500 strength. Plastic spheres are made from recycled high density polyethylene. Concrete is made of standard Ordinary Portland Cement with a maximum aggregate size of 20 mm. No plasticizers are necessary for the concrete mixture. The only elements working are the concrete cover on the compression side and steel provided on the tension side. In the 1990s, Jorgen Breuning invented a way to link the air space and steel within avoided biaxial concrete slab. The bubble deck technology uses spheres made of recycled industrial plastic to create air voids while providing strength through arch action. As a result, this allows the hollow slab to act as a normal monolithic two way spanning concrete slab. These bubbles can decrease the dead weight up to 35% and can increase the capacity by almost 100% with the same thickness. As a result, bubble deck slabs can be lighter, stronger, ant thinner than regular reinforced concrete slabs. It is used for constructing all types of buildings especially for sky scrapers. It is best for the construction of larger span halls such as theatre and auditorium.

II. PREVIOUS RESEARCH

Reshma Mathew, Binu (2006) conducted an investigation on Punching shear strength development of bubble deck slab using GFRP stirrups. It says that Shear strength of any concrete slab is mainly dependent on the effective mass of concrete. Due to the introduction of plastic bubbles, the shear resistance of a bubble deck is very low compared to a solid slab. No plasticizers are necessary for the concrete mixture. The only element working is the concrete cover on the compression side and the steel provided on the tension side. The punching shear strength of the bubble deck slab is limited to be 60-80% of a solid slab with the same thickness. For all the flat slab systems, the floor to column junction is a region of high shear. The design of bubble deck slab is similar to that of typical flat slabs. Material weight reduction, construction and time saving, cost saving, eco friendly and high thermal resistance are the main advantages of bubble deck slab.

Bhagyashri G. Bhade, S. M Bareliker (2016) investigated on the topic An Experimental study on two way bubble deck slab with spherical hollow balls. The behaviour of bubble deck slab is influenced by the ratio of bubble diameter to slab

thickness, the effectiveness and feasibility of the application of bubble deck in the construction. The distance between the bars are kept corresponds to the dimensions of the bubbles that are to be embodied and the quantity of the reinforcement from the longitudinal and the transversal ribs of slab. The distance between bubbles must be greater than 1/9th of bubble diameter.

Steel is fabricated in two forms- the meshed layers for lateral support and diagonal girders for vertical support of the bubbles. The distance between the bars are corresponding to the dimensions of the bubbles that are to be used and the quantity of reinforcement from transverse ribs of the slab. This proves a wide range of cost and construction benefits. It also proves benefits of factory manufactured elements in controlled conditions along with on site completion with the final monolith concrete, resulting a complete floor slab.

M.Surendar, M. Ranjitham (2016) studied on Numerical and Experimental study on Bubble deck slab. Plastic hollow spheres balls replace the ineffective concrete in the centre of the slab, thus decreasing the dead weight and increasing the efficiency of the floor this new technology is called Bubble deck slab. Bubble deck slab is the two directional reinforced composite concrete slab made up of Reinforced concrete or precast concrete with spherical shaped bubbles. Hollow sphere ball is made up of recycled plastic. Bubble Deck slab uses hollow balls made by recycled plastic and therefore it is an innovatory method of virtually eliminating the concrete part in the middle of conventional slab which does not contribute to the structural self weight and also leads to 30 to 50% lighter slab which reduces the loads on the columns, walls and foundation, and of course of the entire building.

The proposed work carries to reduce the overall self weight of the slab or to reduce the overall dead load of the slab. Here, bubble deck slab is designed as per Indian condition by using plastic balls which reduces the cost of the project. Finally the comparison has been made for bubble deck slab with conventional slab over its self weight. From the evaluation of these results, Bubble deck slab gives better performance than that of the Conventional slab.

Neeraj Tiwari, Sana Zafar (2016) experimented on Structural behaviour of bubble deck slabs and its application: An overview. Bubble Deck is intended to be a flat slab, two way spanning slab supported by columns. It consists of plastic spheres that are sandwich between two steel meshes. This type of slab is optimal for construction area with compact spacing because these modules can be stacked on top of one another for storage until required. Shear strength of slab mainly depends on effective mass of concrete. Due to use of plastic bubbles, the shear resistance of bubble deck greatly reduces in comparison of solid slabs.

The slab is cast with the same capabilities as a solid slab, but with considerably lesser weight due to elimination of excessive concrete. This innovation technology has been applied to a few hundred residential high rise buildings, and industrial floor slab due to limited understandings. This floor system is designed to reduce the strength to weight ratio of typical concrete slab, it replaces or removes concrete from centre of slab, where not or less useful. In place of that concrete, HDPE spheres are used.

Mohammed Shafiq Mushfiq, Shikha Saini, Rajoria (2017) conducted Experimental study on bubble deck slab. Plastic hollow sphere balls were used to replace the ineffective concrete in the centre of the slab, thus decreasing the dead weight and increasing the efficiency of the floor and enhance the performance of the bubble deck slab in moderate and severe seismic susceptibility areas. The slab of conventional and bubble deck slab were subjected to uniformly distributed load. The ultimate load, stress, deformation were measured by analytically. The bubble deck slab can withstand 80% of stress when compared with conventional slab. Slight variation occurs in the deformation when compared to conventional slab. Slight variation occurs in the deformation when compared to conventional slab. The stress and deformation results of bubble deck slab were evaluated and compared with conventional slab, using finite element analysis.

It is a patented integration technique of linking air, steel and concrete in a two way structural slab. The geometry of the Bubble Deck slab is identified by sphere of a certain size, placed in a precise modular grid. The decreased weight of materials means lower transportation costs, and would be more economical to lift the components.

III. MATERIALS AND METHODOLOGY

A. Methodolgy

Literature review was done on the selected topic. Then conducted study on material availability and test conducted on it. The materials were tested. The study was conducted on testing apparatus. Concrete mix was made and test on fresh and hardened concrete. The conventional and bubble deck slab was casted and cured for a period of 28 days. The compressive strength was found for both the specimen. Compared the test results.

B. Raw Materials

Steel

The steel reinforcement is Fe500 grade. The steel is fabricated in two forms- meshed layers for lateral support and diagonal girders for vertical support of the bubbles. 8 mm diameter steel bar is used for meshed layer and 6 mm diameter steel bar is used for vertical support.

Plastic Hollow Spheres

The hollow sphere is made from recycled high density polyethylene or HDPE. Here, we use hollow sphere of 60 mm diameter.

Concrete

M25 concrete mix is used for the concrete mix, which uses OPC 53 grade cement. Modulus of elasticity of concrete is 25000 MPa.

IV. RESULT AND DISCUSSION

Property	Value
Fineness of cement	9%
Specific gravity of cement	3.14
Consistency of cement	31.16%
Specific gravity of fine aggregate	2.59
Sieve analysis of fine aggregate	Cc- 0.863 Cu- 9.702 D10-0.17
Specific gravity of coarse aggregate	2.8
Slump value	74 mm

Table 1. Properties Of Materials

A. Compressive Strength of Conventional Concrete block

Compressive strength test of Conventional concrete block was done on Compression testing machine. The weight of the block was found to be 22.67 kg. The dimension of the block is 50cm*50cm*10cm. The maximum load was found to be 640 KN. Thus, the compressive strength of block is 25.55 N/mm^2, after a curing period of 28 days

B. Compressive Strength of Bubble Deck Block

Compressive strength test was conducted on bubble deck block. The weight of the block is found to be 20.43 kg. The maximum load on the block was found to be 655 KN. Thus, the compressive strength of block is 26.2 N/mm^2, after a curing period of 28 days.

Fig 1: Bubble deck block

C. Discussion

The weight of the bubble deck slab is less than that of the conventional concrete slab. Also, the compressive strength is more for bubble deck slab, as the amount of concrete is less for bubble deck slab at compression area. Thus, the bubble deck slab is more economical than that of conventional reinforced concrete slab.

V. CONCLUSIONS

The weight of bubble deck slab is less when compared to the conventional solid slab. The internal forces and maximum stresses in the bubble deck are lesser than solid slab due to reduced dead weight by use of HDPE spheres. This type of slab will provide better durable floor slab with better long term result under a dominant gravity and uniform load.

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