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A Review of Comparative Study between Conventional Slab and Bubble Deck Slab

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Abstract - *Slab is a structural member which plays an important role in transferring the load safely to beam and column. While designing the reinforced concrete structure the main parameter considered is the span of the slabs between columns. For designing larger span slabs, support beams or/and thick slabs are provided which results in heavy or large amount use of concrete and which results is increase of self-weight of slabs. Lighter structures are mainly preferable than the heavier structures because a larger dead load for a building increases the magnitude of inertia forces the structure must resist as large dead load contributes to higher seismic weight. Incorporating support beams can also contribute to larger floor-to-floor heights which consequently increases costs for finish materials and cladding. So, to avoid the increase in self-weight of slab, the centre inactive concrete in slab is replaced with HDPE Balls (High Density Polyethylene Balls). The bubble deck is also known as voided slab. Use of spherical balls to fill the voids in the middle of a slab eliminates 35% of a slab self-weight compared to solid slab having same thickness without affecting its deflection behavior & bending strength. This helps in reduce of self-weight, less emission of CO2 as less concrete will be used in slab and large spans in slabs can also be adopted. In short, the HDPE balls helps to fill the voids in centre of slab.*

***Key Words*: Bubble Deck Slab, Conventional Slab, Comparison, HDPE Balls**

1. INTRODUCTION

Bubble Deck Slab is a biaxial hollow core slab invented in Denmark. It is a method of virtually eliminating all concrete from the middle of a floor slab not performing any structural function (fig 1), thereby dramatically reducing structural dead weight. Bubble deck slab is based on a new patented technique which involves the direct way of linking air and steel. Void forms in the middle of a flat slab by means of plastic spheres eliminate 35% of a slab's self-weight, removing constraints of high dead loads and short spans. Its flexible layout easily adapts to irregular and curved plan configurations. The system allows for the realization of longer spans, more rapid and less expensive erection, as well as the elimination of down-stand beams.

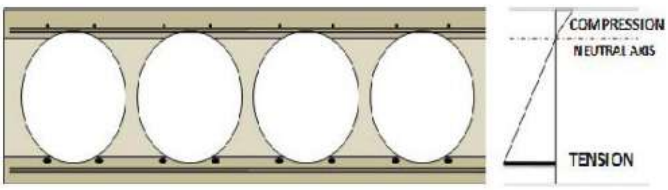

Fig 1. Stress diagram of bubble deck slab [2]

According to study Bubble Deck Slab can reduce three percent (3%) of total construction cost. Bubble deck slab is a new innovative and sustainable floor system to be used as a self-supporting concrete floor. The Bubble deck slab floor system can be used for storey floors, roof floors and ground floor slabs. The ratio of the diameter of the plastic spheres to the thickness of the floor is such that a 35 % saving is achieved on the material or concrete consumption for the floor in comparison with a solid concrete floor of the same thickness.

2. Literature Review

Prabhu Teja and P Vijay Kumar (2012) studied about the durability of Bubble deck slab and is explained on the basis of creep and shrinkage. A Bubble deck element with two spherical hollows was compared with a solid concrete block of the same dimension and of the same concrete grade. They conclude the difference between the shrinkage strains of Bubble deck slab and solid concrete block was measured. The results show that Bubble deck element has a negligible larger marginal shrinkage strain than a solid slab with equivalent dimensions, under the same exposure to environmental conditions. The influence of carbonation shrinkage can be neglected in the design of concrete structures with Bubble deck system, because only a small part of the concrete cross-section is exposed to this kind of shrinkage.

Gilani A, and juntunen (2013) have studied about "Spherical void formers in concrete slabs" investigated the Large span concrete flat-slab systems with internal spherical void formers (SVF) have been used in Europe for over a decade. They are bi-axially reinforced concrete flat-slab systems with a grid of internal spherical void formers. This paper addresses three issues associated with SVF slab systems: their shear resistance, their short-term elastic deflections and their economic value in a South African context. Due to the "loss" (or reduction) of aggregate interlock required for shear resistance in SVF slabs, the design requirements of the reinforced concrete design code are affected. Research at the Technical University of Darmstadt (TUD) in Germany proved a shear resistance reduction factor of 0,55 to be conservative, while research at the University of Pretoria suggests a greater factor of 0,85 when taking into account the shear capacity of the permanent steel cages that hold the spheres in position in some SVF slab systems.

Arati Shetkar & Nagesh Hanche (2015) Presented experimental study on bubble deck slab system with elliptical balls, the behavior of bubble deck slabs is influenced by the ratio of bubble diameter to the thickness, the effectiveness and feasibility of the application of bubble deck in the construction. The reinforcements are placed as two meshes, one at the bottom part and one at the upper part that can be tied or welded the distance between the bars are kept corresponding 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 the slab. Bubble diameter varies between 180mm to 450mm. Depending on this; the slab depth is 230mm to 600mm. The distance between bubbles must be greater than $1/9^{th}$ of bubble diameter. The nominal diameter of the gaps may be of: 180, 225, 270, 315 or 360mm. The bubbles may be of spherical or ellipsoidal in shape. In this experiment, the applied force is provided from the bottom to the top of the slab, which is opposite to the direction of gravity using hydraulic jack. By applying that kind of force, it is easier to record the strain and deformation concrete and rebar from the top side of the slab. Until the cracks are found in the slabs and the failure modes are appeared. It shows the better load bearing capacity of Bubble Deck can be achieved using hollow elliptical balls.

Mr. Muhammad Shafiq Mushfiq, PG Student, Asst. Prof. Shikha Saini and Asst. Prof. Nishant Rajoria (2017) did a numerical and experimental Study on Bubble Deck Slab with the sole aim of reducing the concrete in the centre of the slab by using HDPE balls. Plastic hollow spheres balls were used to replace the in-effective concrete in the centre of the slab, thus decreasing the dead weight and increasing the efficiency of the floor and to enhance the performance of the bubble deck slab in moderate and severe seismic susceptibility areas. The conventional slab and the bubble deck slab with different B/H ratio were subjected to loads. The load, stress, deformation was measured. The conventional slab when subjected to a load of 424 kN, showed displacement of 12.26 mm. The bubble deck slab with 0.6 B/H ratio was subjected to a load of 350 kN and showed displacement of 12.65 mm. On the other hand, the bubble deck slab with 0.8 B/H ratio was subjected to a load of 398.2 kN and showed displacement of 13.3 mm. The bubble deck slab carried less weight but are very much satisfactory in slab construction considering the negligible difference in load bearing capacity between them and the conventional. It is however interesting to note a weight reduction of 10.55% & 17% in the bubble deck slabs compared to the conventional slab which is an added advantage for the bubble deck slabs especially in structures where load is an issue.

Fig.NO. 5: conventional slab placed on UT

Fig. No. 6: conventional slab on UTM after testing

Fig. No. 7: BD2 on UTM

Fig. No. 8: BD2 fail after testing

3. CONCLUSION

The literature on Bubble Deck Slab has reviewed. From this literature we can conclude that Bubble Deck Slab is good in load carrying capacity, it reduces 30% self-weight, and most important it reduces the construction cost by replacing central inactive concrete with HDPE (High Density Polyethylene) balls. The only issue we may face is, if the load acts between two consecutive HDPE balls sudden failure may occur as it can be defined as weaker zone of Bubble Deck Slab.

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