A REVIEW PAPER ON BUBBLE DECK SLAB DESIGN CONSIDERATION

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Abstract

Abstract- The void slab is a simple concept to remove excess concrete from the expensive parts of the structural slab. It was invented by Jorgan Breuning of Denmark about 20 years ago. It has gained popularity in Europe and Asia. This paper examined several studies conducted on invalid slab systems. All the technical parameters of the invalid slab system in which the authors conducted experimental studies are systematically tabulated in this paper. The realization of the proposed goal includes document work and theoretical work on all the works of several authors on the invalidated slab concept. The conclusion will be used to define failure mechanisms that may be useful in formulating appropriate mathematical models.

Keywords: *Voided slab, Bubble deck, Structural behavior, Punching shear capacity, HDPE, Spherical voided formers.*

INTRODUCTION

This review presents several types of hollow core slab technologies that have appeared over the last 20 years. The voided slab is a reinforced concrete slab that can reduce the amount (volume) of voided concrete. The invention of the hollow slab was in the 1950s. However, it has only been used in one way and must be supported by a beam and / or a fixed wall. The idea was to make a hollow two-axis slab with the same function as a solid slab, but the weight was significantly reduced due to excessive concrete removal.

When building a building, a slab is a very important structural element in creating a space. Slabs are one of the largest members of concrete consumption. The main obstacle to concrete structures is the span of the horizontal slabs, which is limited by their weight. For this reason, the main development of reinforced concrete focuses on reducing the weight of concrete or overcoming the natural weakness of concrete. In general, slabs are designed to withstand only vertical loads. However, as people have become more interested in the residential environment in recent years, the noise and vibration of slabs is becoming increasingly important. The deflection of the slab also increases. Therefore, the slab thickness must increase. Increasing the slab thickness increases the slabs and increases the column and foundation size. As a result, buildings will consume more materials such as concrete and reinforcing steel. A slab system has been proposed to avoid this disadvantage due to the increase in the weight of the slab.

Advantages

Material and Weight Reduction

The main advantage of the Bubble deck slab is that it uses 30-50% less concrete than a regular solid slab. High-density polyethylene (HDPE) bubbles replace inefficient concrete in the center of the section, reducing the dead load of structures by removing unused heavy materials. Decreasing the weight of concrete reduces the need for reinforcement, which reduces structural steel. Overall, the lighter floor slabs reduce the weight of the entire structure because beams, columns, foundations and foundations can be designed for lower loads.

Structural Properties

The self-weight of the slab and its bi-directional spanning action make the load-bearing walls unnecessary. The bubble deck is designed as a flat slab eliminating the need for support beams and girder members. As a result, these features reduce some structural requirements for columns and

foundations. Bubble deck slabs can also be designed and analyzed as standard concrete flat slabs based on strength and ductility studies.

Construction and Time Savings

The bubble deck can be manufactured and transported directly from the factory. Because the field installation is less time-consuming since there is no beam, the formwork is flat as well as the mating of the reinforcement bars is small and the bars can be easily constrained. The time reduction is achieved by the faster erection of the walls, not suitable for innovative flatbed slabs. Because the concrete is less in the slabs, the curing time is shortened and additional time can be saved.

Green Design

The number of owners, designers and engineers who want green alternatives is increasing exponentially. Bubble deck is a suitable solution for lowering the carbon footprint of new buildings. According to the Bubble Deck, 1 kg of recycled plastic replaces 100 kg of concrete. By using less concrete, designers can save up to 40% of the carbon in the slab, which can greatly reduce the downstream of other structural member designs. Carbon emissions from transportation and equipment use will also decrease as material usage decreases. HDPE bubbles can also be recovered from other projects and reused or recycled.

LITERATURE REVIEW

A) Bubble Deck:

In the mid-1990s, **Jorgan Breuning** developed a new system that extended the length between the supports, called the bubble deck system, to guarantee a yarn weight reduction of over 30%. The bubble deck is based on a new patented technology that includes direct methods of connecting air and steel to create a natural cellular structure that works like a solid slab. For the first time, it is a bubble deck with the same performance as a solid slab, but the weight is significantly reduced due to unnecessary concrete removal. In this technique, the ellipsoid is locked between the upper and lower reinforcement mesh to create a natural cell structure that behaves like a solid slab. HDPE hollows are used at the center of the slab to replace unnecessary concrete.

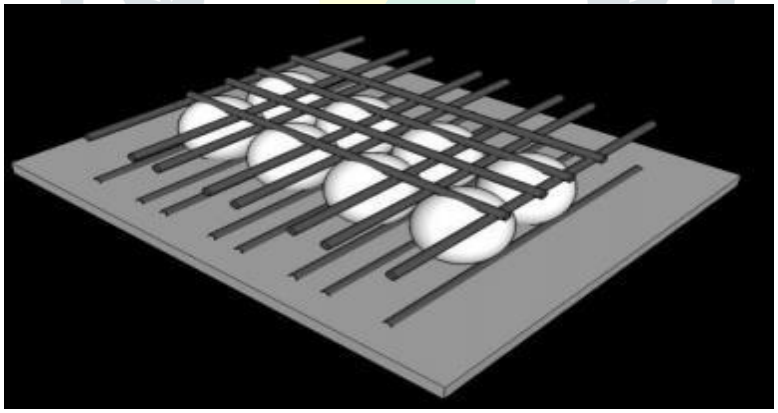

Fig. 1: *3D Section of the Bubble Deck Slab*

In the 1990s, a new system was invented, eliminating the above problems. The so-called Bubble deck technology invented by Jorgen Breuning, locks ellipsoids between the top and bottom reinforcement meshes, thereby creating a natural cell structure, acting like a solid slab. A voided biaxial slab is created with the same capabilities as a solid slab, but with considerably less weight due to the elimination of superfluous concrete.

The bubble deck slab is a biaxial hollow core slab invented in Denmark. This is a way to dramatically reduce the structural quadrature by virtually eliminating all concrete in the middle of a floor slab that does not perform the structural function. Bubble deck slabs are based on a new patented technology that includes direct methods of connecting air and steel. Using a plastic sphere, the pore

shape in the middle of the flat slab eliminates 35% of the slab's own weight, eliminating dead load and short term constraints. Flexible layouts easily adapt to irregular, curved plane configurations. This system allows longer spans, faster and cheaper erection and stall beam removal. According to the manufacturer, the bubble deck slab can reduce the total project cost by up to 3%. Bubble deck slabs are innovative and sustainable new floor systems used as self-supporting concrete floors. The application of the Bubble deck slab floor system in the Netherlands is the world's first application. The bubble deck slab floor system can be used for tiered, roof layer and one-story slabs. The bubble deck slab floor is a flat slab floor, so there are no beams or columns. The main feature is that the hollow plastic spheres are integrated on the floor and are fixed in a factory-built reinforced structure. This reinforced structure simultaneously constructs the top and bottom reinforcement of the concrete floor.

Thin concrete shells, such as spherical reinforced structures and precast slab floors, are supplied to the construction site in factory units up to 3 m wide. They are installed on site and assembled by installing connecting rods and pouring concrete. After the concrete is set, the floor is ready for use. The ratio of the diameter of the plastic sphere to the thickness of the floor can reduce material or concrete consumption by 35% compared to a solid concrete floor of the same thickness. The weight savings achieved in this way result in the bubble deck slab floor being able to provide the required load capacity at smaller thicknesses, which can result in additional benefits and savings of 40-50% of material consumption. Floor construction. This is not the last advantage of a bubble deck slab floor system. Because of the lower weight of the floor system itself, support structures such as pillars and foundations may be less heavy. As a result, total weight or material savings can result in up to 50% of building structures. This type of structure is useful for reducing earthquake damage because the weight of the structure is reduced.

B) Plastic spheres:

Hollow spheres are made from recycled high density polyethylene or HDPE. Figure 2 shows a hollow plastic sphere ready to be shipped to the field. Plastic foam can be used in various sizes
depending on the size of the structure. The main disadvantage of bubbles is that they cannot be stacked. These high density polyethylene bubbles can be lifted and reused or recycled. This contributes to the green character of the bubble deck slab.

Fig. 2: *Plastic Spheres Along With Reinforcement*

Arti Shetkar & Nagesh Hanche (2015): Experimental Studies on Bubble Deck Slab Systems with Elliptical Balls The behavior of published bubble deck slabs is affected by the ratio of bubble diameter to slab thickness, applicability and feasibility of the bubble deck erection. Stiffeners are placed in two meshes that can be welded or welded, one at the bottom and one at the top. The distance between the bars is maintained corresponding to the dimensions of the bubble to be implemented and the amount of stiffener from the longitudinal and transverse ribs of the slab. Bubbles are made using high density polypropylene materials. Bubble diameter is between 180mm and 450mm. According to this, the depth of the slab is 230mm to 600mm. The distance between the bubbles must be greater than 1/9 of the bubble diameter. The nominal diameter of the pores can be 180, 225, 270, 315, or 360 mm. The bubbles may be spherical or elliptical. In this experiment, the applied force is provided from the bottom to the top of the slab opposite to the direction of gravity using a hydraulic jack. Applying this

kind of force makes it easier to record deformation and deformation of concrete and reinforcing bars at the top of the slab. Fault mode appears until a crack is found in the slab. This shows that a better load-carrying capacity in the bubble deck can be achieved using hollow oval balls. Reducing material consumption can shorten overall time and reduce construction costs. In addition, it reduces the weight to 50%, which can make the base size smaller.

Amer M. Ibrahim, Nazar K. Ali, Wissam D. Salman (2013): The flexural capacity of reinforced concrete two - way bubble deck slab of plastic spherical void is presented. The bending behavior of this Bubble Deck slab, such as ultimate load, sag, concrete compressive deformation and crack pattern, was verified, and the 2D bend test was tested using a special loading frame. Six test specimens were used. Two were conventional RC slabs and four were bubble deck slabs with pore diameters of slab thickness ratio (0.51, 0.64 and 0.80). It shows that the crack pattern and the flexural behavior depend on the void diameter to slab thickness ratio. The ultimate load capacity of the bubble deck slab with bubble diameter and slab thickness (0.51 and 0.64) was the same as the solid slab and the bubble diameter to slab thickness (0.80) was about 10% of the final capacity. The slab was simply supported at all corners by four steel beams with hinges on the top to minimize the fixed end moments and other errors due to test stop conditions. This specimen was tested on a 5 point load system using 5 hydraulic jacks and 5 loading plates to meet the actual load conditions.

Harishma K R & Reshmi K N (2015): Effect and possibility of application of foam deck in architecture. Strengthen cost and construction. You can also combine the advantages of the manufactured elements under the controlled conditions and the finished workpiece in the finished floor slab. The steel is made in two forms - the universal mesh layer and the vertical support of the column diagonal beams. At most it reinforced the size of the rider and the lateral rebound of the slab. Rating Fy50 is strange.

Tina Lai (2015): Bubble Deck Slab is an innovative biaxial concrete floor system developed in Europe. These biaxial slabs have many advantages over conventional rigid concrete slabs: reduced total cost, reduced material usage, improved structural efficiency, and reduced construction time and eco-friendly technology. Through testing, modeling and analysis of various institutions, Bubble Deck has proven to be superior to traditional solid concrete slabs. The reduced dead load makes the long- term response to the building economical, offsetting the slightly increased deflection of the slab. However, the shear and punching shear resistance of the Bubble Deck floor is much less than the solid deck because it is directly related to the depth of the concrete. In order to compensate for this difference in strength, design reduction factors have been proposed. This system has been certified in the Netherlands, UK, Denmark and Germany. In this study, the validity of the previous study was verified by finite element analysis of the office floor of the SAP2000, and then the Bubble Deck slab was tested as a pedestrian bridge deck. The bridge design is dominated by the weight of the structure and the intense stresses caused by vehicle traffic. This new slab can solve this problem by reducing weight with plastic spheres and applying high stress to the pedestrian foot. We modeled and analyzed bridge deck sets in SAP2000 for research.

Purnachandra Saha (2014): Bubble Deck Slabs are a way to dramatically reduce the structural quadrature by virtually eliminating all concrete in the middle of a floor slab that does not perform structural functions. High-density polyethylene hollow spheres replaces inefficient concrete in the center of the slab, reducing quadrature and increasing floor efficiency. By introducing spacing, you will have 30-50% lighter slabs that reduce the load on the columns, walls and foundations, and the entire building. The advantage is that the energy consumption of gases, especially CO2, emitted from production, transport and transport, emission reduction, production and transport is low. This paper is based on various studies carried out abroad to analyze the various characteristics of bubble deck slabs we are discussing. Moment, deflection and stress distribution are verified using the SAP2000 Finite Element Method (FEM).

CONCLUSIONS

In the current scenario of the construction industry, there are several types of methods that are more economical, easier to build, and environmentally friendly. Bubble Deck Slab provides economical, easy to build and environmentally friendly technology. Bubble deck Technology is an innovative

system that removes concrete from the center of a secondary support structure, such as a reinforced concrete column or structural wall.

Bubble Deck removes up to 35% of structural concrete. Combined with reduced floor thickness and appearance, smaller bases and pillars, construction costs can be reduced by up to 10%. Compared to the weight of the structure, the Bubble Deck Slab is lighter than the Solid Deck Slab.

The construction layer of the construction industry consists mainly of huge concrete floors, assembled filigree slab floors and hollow core slab floors. This situation has not changed for more than 20 years. However, this innovative bubble-deck slab construction technology has proven to be more efficient than traditional biaxial concrete slabs in office floor systems. Reduces building costs and reduces the building's own weight by nearly 50%. Therefore, a study on various bridge arrangements to determine the validity of bubble deck slabs in bridge construction

In conclusion, we can conclude that Bubble Deck slabs will be constructed in the future, and that research, studies and experiments on the various sizes and slab thicknesses of HDPE Hollow balls are necessary to gain popularity and use of this technology.

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