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A Study of Bubble Deck Slab

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Abstract—*The role of concrete is very important in the construction field. Some portion of the concrete used in the slab work remains inactive which increases the dead weight. The project cost increases with the increasing use of concrete. As the concrete slab use more concrete than required hence it needs to be optimized. So the inactive portion of the concrete in the slab is replaced by High Density Polyethylene(HDPE) hollow balls. The introduction of void in the slab reduces the self-weight of the slab by 35%.Theadvantages of the bubble deck slab is less energy consumption in production, transport and less emission of exhaust gases in environment. By introducing the gaps, the dead weight of the slab can be reduced and thus the structure can be made cost effective. The plastic waste is recycled in the production of these balls and it provides a great scope for settlement of large amount of plastic waste.*

The technology used in the project is use of high density polyethylene balls, concrete, steel reinforcement, compaction of concrete and flexural test to justify its use.

1. INTRODUCTION

The invention of the new type of hollow core slabs was a breakthrough at the end of 20th century. While concrete has been used for thousands of years, the use of reinforced concrete is usually attributed to Joseph-Louis Lambot in 1848.

The Bubble Deck Slab is the invention of Jorgen Bruenig in 1990's who developed the first biaxial hollow core slab (now known as Bubble Deck in Denmark).

The main obstacle with the concrete construction in case of horizontal slabs, is the high weight, which limits the span. It is the reason for major developments of reinforced concrete. Focus is given in enhancing the span, either by reducing the weight or overcoming the weakness of concrete in tension.

In Bubble Deck slab the main concept is to replace the high weight concrete in the inactive zone by HDPE(high density poly ethylene) balls. This technology can reduce cement and concrete by 30 to 50% as compared to classical slabs. This is a green technology as it also helps in reducing the carbon content emitted by the concrete.

2. MATERIALS REQUIRED

2.1 RECYCLED BALLS

To make it a green technology we use recycled HDPE balls, in this way wastage of plastic is reduced. These plastic balls have a unique property such that they can be reused and recycled after the demolition of structure. The use of plastic balls makes the construction process cost effective.

Fig. 1

2.2 STEEL REINFORCEMENT

High Grade steel of Fe500 and Fe500 is used. Same grade of steel is utilized in top and in bottom steel reinforcement. Reinforcement shall be placed in a manner that will prevent its displacement and balls displacement during the concreting process. The reinforcement is provided in the form of the mesh entrapping plastic balls.

2.3 DIAGONAL GIRDER

The main function of diagonal girder is to keep the hollow balls fixed between the upper and bottom reinforcement. It additionally prevents the displacement of balls. They are also used as shear force reinforcement. It should meet following requirements:

- The Centre-to-Centre-distance of the girder should be a maximum of twice the floor thickness.
- The Centre-to-Centre-distance of two down running or up running diagonals should be a maximum of 2/3 of the floor thickness.
- Every pair of two diagonals, existing of one up running and one down running bar, should be welded with 2 welding points to both the lower and the upper longitudinal bar.

- The welding points with which the diagonals are attached to the lower and upper longitudinal bar should have a resistance per welding point of at least 25% of the flow strength of the diagonal.

Fig. 2

- The distance between the edge of the floor support and the connection of the first diagonal from the floor support with the upper longitudinal bar of the girder should be maximal times the height of the girder.

2.4 TYPES OF BUBBLE DECK

They are majorly categories into three types:

Type 1: Filigree elements

It is a combination of constructed and unconstructed elements. A 60mm thick concrete layer which acts as a part of finished depth as well as formwork is precast. After that bubble and steel reinforcement are attached to it separately on site. The bubbles are then placed in the precast layer and then held in place by a honeycomb of interconnected steel mesh. Further steel may be added as per requirement in the future. This type of Bubble deck is most suitable for projects where the designer has the knowledge of bubble positions and steel mesh layout.

Type 2: Reinforcement Modules

This bubble deck is a reinforcement module in which preassembled sandwich of steel mesh and plastic bubbles are used. They are laid on traditional formwork connected by reinforcement after that the concreting is done by a traditional method. This type of bubble deck slab is most suitable for projects where less space is available since these modules can be placed in the form of stacks one above another.

Type 3: Finished Planks

Bubble deck Type 3 is available in fabricated form such that it consists of plastic spheres, reinforcement mesh and concrete in its finished form. The module is manufactured in the form of plank and is delivered on site ready for use. This type of Plank is best suitable for shorter spans and can be used in limited construction schedules.

2.5 STRUCTURAL PROPERTIES OF BUBBLE DECK SLAB

A. Compressive strength and Flexural capacity of Bubble deck slab is conceptualized to exclude a significant volume of concrete as compared to a solid slab in the central core where the slab is principally un-stressed in flexure. The depth of compressed concrete is usually a small proportion of the slab depth. The concrete between the ball and the surface so there is no reasonable difference between the behaviour of a Bubble Deck and solid slab. The only working rudiments are the steel on the tension side and the outer 'shell' of concrete on the compression side. In terms of flexural strength, the moments of resistance are the same as for solid slab.

B. Durability

The durability of bubble deck slab is not essentially different from ordinary solid slabs. The concrete is standard grade and combined with suitable bar cover provides most control of durability equal with normal standards for solid slabs. When the filigree slabs are manufactured, the reinforcement module and balls are vibrated into the concrete and produce the uniformity of compaction so that a density of surface concrete is produced which is at least as impermeable and durable? Bubble deck slab joints have a chamfer on the inside to assure that concrete surrounds each bar does not allow a direct route to air from the rebar surface. This is mainly a function of the fire resistance but is also relevant to durability.

C. Fire Resistance

The fire resistance of the slab is a complex matter but is chiefly dependent on the ability of the steel to retain enough strength during a fire when it will be heated and lose significant strength as the temperature rises. The temperature of the steel is controlled by the fire and the insulation of the steel from the fire. In a fire, it is likely that the air would escape, and the pressure dissipated. If the standard bubble material is used, the products of burning are relatively benign. In an intense prolonged fire, the ball would melt and eventually char without significance or detectable effect. Fire resistance depends on concrete cover nearly 60-180 minutes. While Bubble deck slabs are not designed to provide thermal insulation due to encapsulation of the air bubbles within the center of the concrete slab Bubble deck achieves between 17% to 39% higher thermal resistance than an equivalent solid slab of the same depth. Bubble deck slabs can therefore make a useful contribution towards the thermal insulation achieved by the overall construction.

Table 1: Comparison between convention slab and bubble deck slab:

TYPE OF SLAB	LOAD (KN)	DEFLECTION (mm)	WEIGHT (Kg)
Conventional slab	260	8.70	321
Continuous Bubble deck	320	9.20	242

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