Comparative Studies of Conventional Slab and Bubble Deck Slab Based on Stiffness and Economy

Nagashree B[1] Sachin Hokrane[2] Soumajit Saha[3]
[1]Assistant Professor [2,3]U.G Student
[1,2,3]Department of Civil Engineering
[1]MSRIT, Bangalore [2,3]MS Ramaiah Institute of Technology, Autonomous institute, affiliated to VTU, Bangalore, Karnataka

Abstract— Bubble Deck is a revolutionary method of virtually eliminating concrete from neutral axis of conventional slab, which does not perform any structural function, thereby dramatically reducing structural dead weight by linking air and steel directly. Bubble Deck slab uses hollow spherical or elliptical balls made by recycled plastic. A Bubble Deck slab has a two-dimensional arrangement of voids within the slabs to reduce self-weight.
Key feature of the project is to carry out the design each slab and compare them in terms of which includes stiffness and economy. We will compare these characteristics for better selection of the roof system suitable for proposing for particular project. Through this project we will be able to achieve adequacy on certain parameters like stiffness and economy.

Key words: Stiffness and Economy, Conventional Slab

I. INTRODUCTION

Bubble Deck is a biaxial technology that increases span lengths and makes floors thinner by reducing the weight while maintaining the performance of reinforced concrete slabs A construction method by eliminating concrete from the neutral axis of a floor slab that is structurally not performing, as a result dramatically reducing in dead weight. Hollow biaxial slabs, also known as biaxial voided slabs, are reinforced concrete slabs in which voids allow to reduce the amount (volume) of concrete. The main disadvantage of concrete constructions, in case of horizontal slabs, is the high weight which limits the span. For this reason, basic research in the field of reinforced concrete structures have focused on enhancing the span, either by reducing the weight or overcoming concrete's natural weakness in tension. Due to the prefabrication, these are inexpensive, and reduce building time, but can be used only in one-way spanning constructions, and must be supported by beams and/or fixed walls. The slab has been especially popular in countries where the emphasis of home construction has been on precast concrete, including Northern Europe and socialist countries of Eastern Europe. Precast concrete popularity is linked with low-seismic zones and more economical constructions because of fast building assembly, lower self-weight (less material), etc.

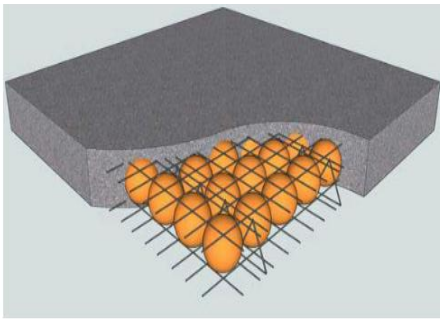

Fig. 1: BUBBLE DECK SLAB

II. MATERIALS AND CONSTRUCTION

The materials which are used for the experimental procedure are as follows;

A. Cement

Cement is the most important binding ingredient which determines the fresh & hardened properties of concrete. Ordinary Portland cement of 43 grade (sp gravity-3.5) confirming to IS 12269-1987 is used in this experimental program.

B. Fine aggregate

The aggregates which are passing through 4.75mm size IS sieve and contains only that much of coarse grained materials are permitted by the specifications are generalized as fine aggregates. Fine aggregates confirming to zone II passing through 4.75mm IS sieve (sp gravity - 2.52) is used in this experimental programe.

C. Coarse aggregate

The aggregates which are retained on 4.75mm size IS sieve and contains only finer materials are generalized as coarse aggregates. Coarse aggregate passing through 12mm sieve and retained on 10mm sieve (sp gravity - 2.63) are used in this experimental programme.

D. Steel

The steel is fabricated in two form- meshed layers for lateral support and diagonal girders for vertical support of the balls.

E. Plastic spheres

The plastic spheres are the hollow balls which are made of plastic materials.

III. METHODOLOGY

Basic tests on cement, coarse aggregate and fine aggregate were conducted. Using the results of basic tests, mix design for M_{20} grade of concrete and Fe415 grade of steel for a slab of 1m x1 m was made using IS 10262-2009.Then the design

for conventional slab was made using IS 456-2000.In order to determine fresh properties of concrete slump test and hardened properties of concrete, Cube Compression, Split tensile and flexural test on prisms was conducted. Further the conventional slab and bubble deck slab (1mX1m) with balls of different diameter of 70mm and 60mm was casted. Test was conducted for the casted slab for curing periods of 7 days and 14 days. The graph for load versus deflection was obtained. The ultimate load of the conventional slab and bubble deck slabs were recorded from the graphs. The deflections at ultimate slabs were also recorded. The stiffness of the slabs were calculated from the graph.
Stiffness = (Load/Deflection)

Amount of concrete used for the casting of all the three slabs was calculated using the methods of estimation and costing. Comparison of volume of concrete used for bubble deck slab and conventional slab.

IV. EXPERIMENTAL ANALYSIS

Fig. 2: Finishing of conventional slab

Fig. 3: Casting of Bubble deck slab of 70mm void size

Fig. 4: Casting of Bubble deck slab of 60mm void size

Fig. 5: Arrangment of loading

Fig. 6: Cracks developed in the slabs after failure

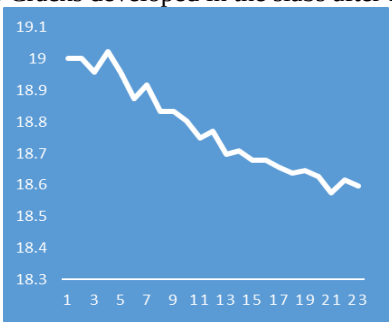

Fig. 7: Stiffness curves for conventional slab

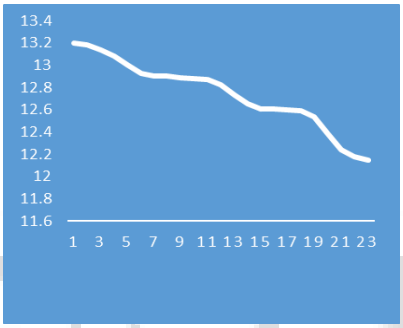

Fig. 8: Stiffness curves bubble deck slab (70mm dia)

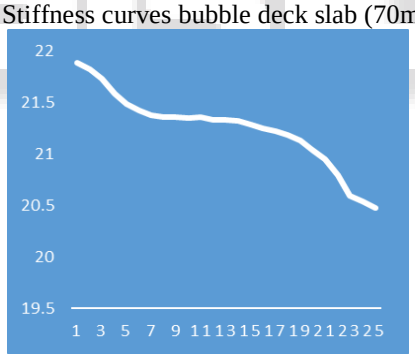

Fig. 9: Stiffness curves bubble deck slab (60mm dia)

Type of slabs	Stiffness (KN/mm2)
conventional	17.30
Bubble deck 70mm void	13.18
Bubble deck 60mm void	21.42

Table 1:

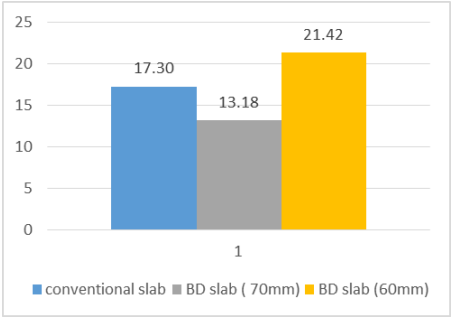

Fig. 10: Bar graphs for comparison of stiffness for ultimate loads of the three slabs

Sl no	Type of slab	Total amount (concrete and reinforcement)	Percentage reduction in cost of concrete
1	Conventional slab	10910	-
2	Bubble deck slab (70mm dia)	9969	9.41%
3	Bubble deck slab (60mm dia)	9500	14.10%

Table 2: Cost estimation of for conventional and bubble deck slabs

V. CONCLUSIONS

- The stiffness of bubble deck slab with smaller dia balls (60mm) was found to be greater than that of 70mm dia balls slab and conventional slab.
- About 14% of money can be saved by using bubble deck slab of 60mm diameter and 9.41% by 70mm diameter.
- The volume of concrete for60mm balls was found to be more economical.
- This concludes that the bubble deck slab of 60mm diameter is more effective in terms of strength, stiffness and economy compared to conventional slab.

REFERENCES

[1] IS 456 – 2000 (For slab design)
[2] IS 10262-2009 (For mix design)
[3] "Concrete Reinforcing Steel Institute".Structures: The Sum of their parts. 2008.15April 2010 s
[4] "DR.B.C.Punmia,A.K.Jain",Soil Mechanics & Foundations,16th Edition 2005
[5] "Ashok Kumar Jain",Reinforced Concrete,6th Edition,2002.
[6] "Bubble deck design and detailing,BubbleDeck Voided Flat Slab Solutions- Technical Manual and Documents (2007).
[7] "BubbleDeck Slab properties " Bubble Deck Voided Flat Slab Solutions- Technical Manual and Documents (2006).
[8] " BubbleDeck-UK". "Lighter Flat Slab Structures with Bubble Deck." (2006).

