International Journal of Advanced Technology in Engineering and Science
Vol. No.5, Issue No. 03, March 2017
www.ijates.com
ijates
ISSN 2348 - 7550

STUDY ON A COMPARATIVE STUDY OF BUBBLE DECK SLAB AND CONVENTIONAL DECK SLAB

Mr. Devyanshu Jain[1], Miss. Nidhi Gupta[2]

[1]*Department of Civil Engineering, RKDF Institute of Science & Technology (India)*

[2] *Head of Department of Civil Engineering, RKDF Institute of Science & Technology (India)*

ABSTRACT

When designing a reinforced concrete structure, a primary design limitation is the span ofthe slab between columns. Designing large spans between columns often requires the use ofsupport beams and/or very thick slabs, thereby increasing the weight of the structure by requiringthe use of large amounts of concrete. Heavier structures are less desirable than lighter structures in seismically active regions 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.

A new solution to reduce the weight of concrete structures and increase the spans of two-way reinforced concrete slab systems was developed in the 1990s in Europe and is gaining popularity and acceptance worldwide. Plastic voided slabs provide similar load carrying capacity to traditional flat plate concrete slabs but weigh significantly less. This weight reduction creates many benefits that should be considered by engineers determining the structural system of the building.Plastic voided slabs remove concrete from non-critical areas and replace the removed concrete with hollow plastic void formers while achieving similar load capacity as solid slabs. Voided slab principles have been applied in different applications dating back to the early 1900s.Similary the reduction of concrete in bridge deck modal (light weight Pedestrian Bridge).In this thesis work our main focus on the reduction of concrete of bridge deck. So first we know about different type of parts of the bridge.

I. INTRODUCTION

The BubbleDeck method for the two directions reinforced composite concreteslab with gaps was invented in Denmark, it is licensed and it was conceived to achieve saving of concrete and energy in buildings construction. The composite slabs are made of Bubble Deck type slab elements with spherical gaps, poured in place on transversal and longitudinal directions.

By introducing the gaps leads to a 30 to 50% lighter slab which reduces the loads on the columns, walls and foundations, and of course of the entire building. ”BubbleDeck” slab elements are plates with ribs on two directions made of reinforced concrete or precast concrete with spherical shaped bubble. These slab elements have a bottom and an upper concrete part connected with vertical ribs that go around the gaps .The reinforcement of the plates is made of two meshes one at the bottom part and one at the upper part that can be tied or welded. The distances between the bars correspond 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. The two mashes are connected after placing the spheres into places in order to form a rigid shell.

The bubbles are made by embodying high density polypropylene in the concrete, arranged according to the project and placed between the reinforcement meshes. The material that are made of don't react chemically with the concrete orthe reinforcement, it has no porosity and has enough rigidity and strength to take over the loads as much as from the pouring of the concrete as from the subsequent phases of this process.

Objective:-The main objective of this study is to investigate the potential use of granite waste in concrete as replacement for coarse aggregate and is to arrive at a suitable mix design for the application of discarded granite waste as a partial replacement of coarse aggregate in concrete; and to test and analyze the workability, density of hardened concrete, compressive and flexural strength, of concrete of grade M30.

II. METHODOLOGY

The method of design and analysis of the bubble deck bridge slab are two types which are elucidated below.

1) DESIGEN AND ANALYSIS IN LABROTARY
2) DESIGEN AND ANALYSIS IN SOFTWARES

1.1 DESIGEN AND ANALYSIS IN LABORATARY

The design of bubble deck slab in the laboratory consist different steps. The bubble deck slab is the combination of reinforced concrete and PVC balls. The mixer of cement sand and aggregate on the basis of INDIAN STANDARAD (concrete mix proportioning) 10262:2009.

Step 1 : Dimension of mould of bubble deck slab – 0.66mx0.33mx0.14m

Volume of mould of bubble deck slab – 0.02772m3

Step 2: Dimension of Plastic balls (diameter)= 0.0625m

Radius = 0.031m

Volume of sphere = 4/3xπxr3

Volume of sphere of 24 ball =0.0035m3

Volume of design for mix proportioning = vol. of mould-volume of sphere

= 0.2772-0.0035

= 0.02422m3

Concrete of mix proportion for M25

2.2 TYPES OF MATERIAL AND THEIR SHAPE AND SIZE

For the design of bubble deck slab the main material is the cement sand and aggregate .for the better result we done the test of different type of material

2.2.1 Concrete

2.2.2 HDPE Balls

A linear polymer, High-density polyethylene (HDPE) is prepared from ethylene by a catalytic process. The absence of branching result in a form more closely packed structure with a higher density and somewhat higher chemical resistance then LDPE(low-density polyethylene).HDPE is also somewhat harder and more opaque and it can withstand rather higher temperatures(1200 Celsius for short periods,1100 Celsius continuously).

2.2.3 Preparation of reinforcement mesh

We know that concrete are provided in the bubble deck slab for the compressive zone and the steel bar are provided for the tension zone. The mesh of bar are given below.

Plates - Preparation of mesh

The size of steel bar vertical direction is 62cm and in the horizontal direction is 24 cm and the spacing between is 6.5cm and the diameter of bar is 8mm.and the diameter of HDPE ball is 6.5cm.the combination of bar and ball are show in fig. are given below.

2.3 combination of HDPE ball with mesh

THE FINITE ELEMENT METHOD
(DESIGEN AND ANALYSIS IN SOFTWARES)

III. INTRODUCTION

Engineering use a wide range of tools and techniques to ensure that the design they create are safe. However accidents sometimes happen and when they do, companies need to know if a product failed because the design was inadequate or if there is another cause, such as an user error. But they have to ensure that the product works well under a wide range of condition, and try to avoid to the maximum a failure produced by any cause. One important tool to achieve this is the finite element method.

"The finite element method is one of the most powerful numerical techniques ever devised for solving differential (and integral) equation of initial and boundary-value problem in geometrically complicated region" (Reddy,1988).There is some data that cannot be ignored when analyzing an element by the finite element method. This input data is to define the domain, the boundary and initial condition and also the physical properties. After knowing this data, if the analysis is done carefully, it will give the satisfactory result.it can be said that the process to do this analysis is very methodical and that it is why is so popular, because that makes it easier to apply. "The finite element analysis of a problem is so systematic that it can be divided into a set of logical steps that can be implemented on a digital computer and can be utilized to solve a wide range of problems by merely changing the data input to the computer program"(Reddy 1988)

The finite element analysis can be done for one, two and three-dimensional problems. But generally, the easier problems are those including one and two dimensions, and those can be solved without the aid of computer, because even if they give a lot of equation, if they are handled with care, an exact result can be achieved. But if the analysis requires three-dimensional tools, then it would be a lot more complicated, because it will involve a lot of equation that are very difficult to solve without having an errors. That is why engineers have developed software that can perform these analysis by computer, making everything easier. These software can make analysis of one, two and three dimensional problems with a very good accuracy.

A basic thing to understand how finite element works is to know that it divides the whole element into a finite number of small elements. "The domain of the problem is viewed as a collection of nonintersecting simple sub domains, calledfiniteelement. The subdivision of a domain into elements is termed finite element discretization. The collection of the elements is called the finite element mesh of the domain." (Reddy, 1988). The advantage of dividing a big element into small ones is that it allows that every small element has a simpler shape, which leads to a good approximation for the analysis. Another advantage is that at every node (the intersection of the boundaries) arises an interplant polynomial, which allows an accurate result at a specific point. Before the finite element method, engineers and physicians used a method that involved the use of differential equations, which is known as the finite difference method.

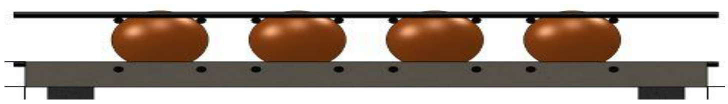
The Purpose of FEA

- **Analytical Solution**

- Stress analysis for trusses, beams, and other simple structures are carried out based on dramatic simplification and idealization.
- mass concentrated at the center of gravity
- beam simplified as a line segment (same cross-section)
- Design is based on the calculation results of the idealized structure & a large safety factor (1.5-3) given by experience

4.3 Bridge Deck Model

The bridge deck model was designed and analysis by the software in finite element analysis in the static analysis and the dynamic analysis of the solid slab as well as the bubble deck slab. In order to fully understand the previous research conducted on the bubble deck, further analysis was performed to compare the response of this new type of slab and conventional solid slab. A 3D solid slab and bubble deck slab were constructed in the ANYSIS 2000 with the entire dimension as in use in the laboratory. Each solid slab finite element model has approximately 8,100 elements. A 3D rendering of the solid slab with the column supports is displayed in figure7.2 .The solid slab was generated as a thick shell of pure concrete while the Bubble deck slab was designed as a layered shell. For simplicity in the Bubble deck model, a rectangular layer of HDPE was sandwiched in between two layers of standard concrete on top and bottom (see in figure 7.2) for the simplified Bubble deck slab layers as used in the analysis. Both model were subjected to a 100 KN load in addition to their own self weight for the static and dynamic design.(See in figure 7.3) and the cross section and isometric view of bubble deck slab are shown in the figure 7.1.and all the dimension of the bubble deck slab are given in the table



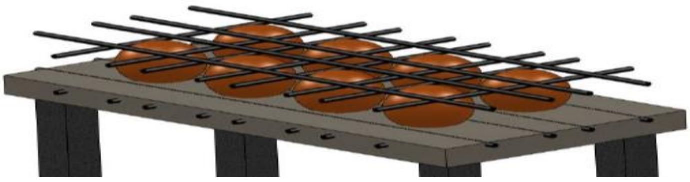


Figure 4.1 3d Modeling and cross section of bubble deck slab

The material properties used are typical for standard concrete and HDPE in the India. See figure for the single module in AYSIS 2000, Table 7.1 for module dimension and the table 7.2 for the property used in the models.

Table - Dimension of Bubble deck slab

Dimension of bubble deck slab	
Bubble diameter	6.50cm
Depth	14cm
Width	30cm
Upper concrete thickness	3.75cm
Lower concrete thickness	3.75cm

Table – Material Property

Material	Compressive strength (kN/m2)	Young Modulus (kN/m2)	Possinos Ratio (kN/m2)	Thermal Expansion	Density (kN/m2)
Concrete	25,000	2.48E+07	0.16	5.5E-6	25
HDPE	30,000	8.00E+05	0.42	2.0E-5	10.01

The ANYSIS 2000 models of bubble deck slab consist the approximately 7500 element. See figure 4.1 for design of the bubble deck bridge models, and analyzed for static response

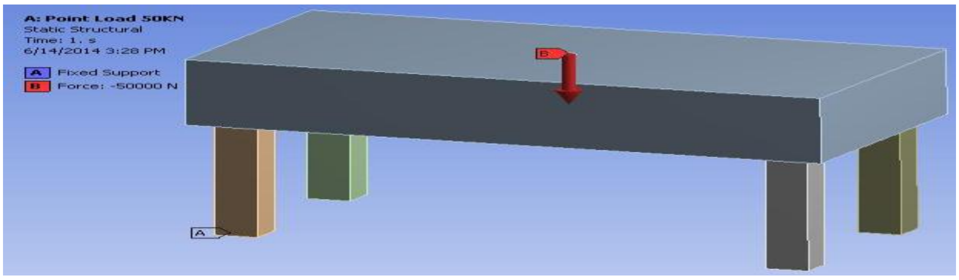
STATIC METHOD: A Static analysis calculates the effect of steady loading condition on a structure, while loading conditions on a structure, while ignoring inertia and damping effects, such as those caused by Time-Varying loads. A static analysis can, however, include steady Inertia loads(such as gravity and rotational velocity), and time – varying loads that can be approximated as static equivalent load (such as the equivalent wind and seismic loads commonly defined in many building codes).

Static method determine the displacements, stresses, strain and forces in structure or components caused by load that do not induce significant inertia and damping effects. Steady loading and response conditions are assumed; that is the load and the structure's response are assumed to vary slowly with respects to time.

The type of loading that can be applied in static analysis include:

- Externally applied forces and pressure
- Steady –state inertial force (such as gravity or rotational velocity)
- Imposed displacements
- Temperature(for thermal strain)

In my thesis work the type of loading that can be applied in bubble deck slab and the conventional deck slab is externally applied force in different types. Like point load (50kn).in both the slab which is simply supported which are designed in the ANYSIS and compare the maximum stress and maximum deformation in both the slab. Which are given below Figure 4.3 shoes the model of conventional solid deck.



Analysis Result

Static response

The maximum internal stresses and forces in the bubble deck model exceeded those of the solid slab. The maximum moment and internal stress of the Bubble deck was 64% higher then the solid deck.

Observation of bubble deck slab:

Slab dimension: length = 660mm, Width = 330mm, Depth = 14cm

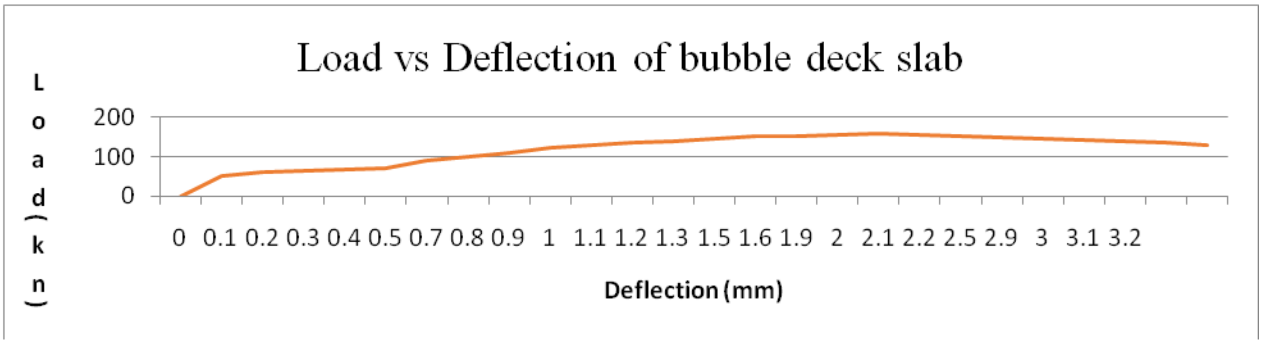


Figure - Load vs. Deflection of Bubble Deck Slab

3.10.5 RESULT:

1. Maximum shear load is taken by the bubble deck slab is observed to be 157.6kn
2. Crack have been observed at load of 60 kn. are shown in figure no


Plates-Crack Pattern in Bubble Deck Slab

V. CONCLUSION

Shear strength of any concrete slab is chiefly dependent on the effective mass of concrete. Due to the inclusion of plastic bubbles, the shear resistance of a bubble deck slab is greatly reduced compared to a solid slab (as shown in the graph) .From theoretical models, the shear strength of the voided slab was determine to be 60-80% of a solid slab with the same depth. Therefore, a reduction factor of 0.6 is to be applied to the shear capacity of all bubble deck slabs. Since shear is also major concern for the design of solid slabs, several groups have performed test on the shear capacity of Bubble deck slab in various situation.

REFERENCES

[1.] Essentials of BRIDGE ENGINEERING (Six edition) by D.JOHNSON VICTOR Former professor of civil engineering Indian Institute of technology Madras, Chennai.

Codes

[1.] IS 5640:1970 Method of test for determining aggregates impact value of soft coarse aggregates

[2.] IS 10262:2009 Concrete Mix Proportioning-Guidelines

Technical Reports

[1.] Wang, K., Jansen, D.C., and Shah, S., "Permeability study of cracked concrete," Cement and Concrete Research, Vol.27, No.3, 1997, pp. 381-393.

[2.] Sergiu Cal in, CiprianAsavoaie and N. Florea, "Issues for achieving an experimental model" Bul. Inst. Polit. lai, t. LV (LIX), f. 3, 2009.

[3.] Martina Schnellenbach-Held and KarstenPfeffer,"Punching behavior ofbiaxial hollow slabs" Cement and Concrete Composites, Volume 24,Issue 6, Pages 551-556, December 2002

[4.] SergiuCalin and CiprianAsavoaie, "Method for Bubble deck slabconcrete slab with gaps", The BuletinulInstitutuluiPolitehnic din lai,LV (LTX), f. 2,2009.

[5.] Sergiu Cal in, C.Mugurel, G.Dascalu, C.Asavoaie, "Computational simulation for concrete slab with spherical gaps", Proceedings of The 8-th International Symposium, Concepts in Civil Engineering, Ed.SocietatiiAcademice "Matei-TeiuBotez", 2010, pp. 154-161.

[6.] Kim, Y. Y., Fischer, G., and Li, V. (2004). "Performance of bridge decklink slab designed with ductile engineered cementations composite."ACI Structure Journal. 101(6), 792–801.

[7.] Gastal F.P.S.L. (1987). "Instantaneous and time-dependent response andstrength of joint less bridge beams."Ph.D. dissertation, NorthCarolinaState Univ., Dept. of Civil Eng., Raleigh, NC

[8.] Kim, Y.Y., Fischer, G. and Li, V.C., "Performance of Bridge Deck Link SlabsDesigned with Ductile ECC," Submitted, ACI Journal, 2003.

[9.] Oesterle, R.G. et al., Jointless and Integral Abutment Bridges – Summary Report,Final Report to Federal Highway Administration, Washington D.C., 1999.

Patents

[1.] Tina Lai "Structural behavior of bubble deck slab and their applications to lightweight bridge decks" M.Tech thesis, MIT, 2009.

Websites

[1.] BubbleDeck voided Flat Slab Solutions- Technical Manual andDocuments, Version: 5, Issue 1, BubbleDeck UK, White Lodge,Wellington Road, St Savior, JERSEY, C.1., 2008, Available:

[2.] www.BubbleDeck-UK.com