International Journal Of

Recent Scientific Research

ISSN: 0976-3031

Volume: 7(6) June -2016

AN EXPERIMENTAL STUDY ON TWO WAY BUBBLE DECK SLAB WITH SPHERICAL HOLLOW BALLS

Bhagyashri G. Bhade and S.M Barelikar

THE OFFICIAL PUBLICATION OF
INTERNATIONAL JOURNAL OF RECENT SCIENTIFIC RESEARCH (IJRSR)
http://www.recentscientific.com/ recentscientific@gmail.com

ISSN: 0976-3031

Available Online at http://www.recentscientific.com

International Journal of Recent Scientific Research
Vol. 7, Issue, 6, pp. 11621-11626, June, 2016

International Journal of Recent Scientific Research

Research Article

AN EXPERIMENTAL STUDY ON TWO WAY BUBBLE DECK SLAB WITH SPHERICAL HOLLOW BALLS

Bhagyashri G. Bhade[1] and S.M Barelikar[2]

Department JSPM's Imperial College of Engineering & Research, Wagholi, Pune

ARTICLE INFO

Article History:

Received 05th March, 2016
Received in revised form 21st April, 2016
Accepted 06th May, 2016
Published online 28th June, 2016

Key Words:

Bubble deck, alternative bubble deck, deflection

ABSTRACT

Bubble deck slab is a method of virtually eliminating all concrete from the middle of a floor slab, which is not performing any structural function, thereby dramatically reducing structural dead weight. High density polyethylene hollow spheres replace the in-effective concrete in the centre of the slab, thus decreasing the dead weight and increasing the efficiency of the floor. The advantages are less energy consumption - both in production, transport and carrying out, less emission - exhaust gases from production and transport, especially CO2 and reduce the material, the load, lower the cost and it is also a green technology.

In the bubble deck technology reduce the concrete volume by replacing the spherical bubbles, these are locally available which is called as PEPSI balls, these balls are made up of HDPE (High Density polyethylene). In this experimental program conventional slab and bubble deck slab are cast with various bubbles arrangement which is continuous arrangement of bubbles within whole slab and two types of alternative bubbles arrangement in the slab. And trying to enhance the increasing strength of that slab. This implies the realization of a monolithic slab element, which will be subjected to static gravitational loadings in order to determine the deformation (deflection), cracking and failing characteristics. The resultant conclusions will be used in defining the failing mechanisms.

Copyright © Bhagyashri G. Bhade and S.M Barelikar., 2016, this is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution and reproduction in any medium, provided the original work is properly cited.

INTRODUCTION

In building constructions, the slab is a very important structural member to make a space and it is one of the largest member consuming concrete. A slab being the essential part of the structure has to be effectively designed and utilized. It tends to use more concrete than requirement, hence has to be optimized. When the load acting on the slab is large or clear span between columns is more, the deflection of the slab is also more. Therefore the slab thickness is on increasing. Increasing the slab thickness makes the slabs heavier because of self-weight of slab also increase, and will increase column and foundations size. Thus, it makes buildings consuming more materials such as concrete and steel reinforcement.

The new prefabricated construction technology using Bubble Deck slab is recently applied in many industrial projects in the world. Bubble Deck slab uses hollow balls made by recycled plastic and therefore it is an innovatory method of eliminating the concrete part in the middle of conventional slab which does not contribute to the structural performance. Bubble Deck is a two-way spanning hollow deck in which recycled plastic bubbles serve the purpose of eliminating non-structural concrete, thereby reducing structural dead weight, void formers in the middle of a flat slab eliminates 25% of a slabs self-weight.

Hollow spherical balls Hollow elliptical balls

Fig 1 Bubble Deck samples

**Corresponding author: Bhagyashri G. Bhade*
Department JSPM's Imperial College of Engineering & Research, Wagholi, Pune

Bubble Deck Slab

It is the geometry of the Bubble Deck slab is defined by the spheres of a certain size, placed in a precise modular grid for a particular overall deck thickness. Bubble deck that it produces floors 20% faster with less formwork and beams, reduces construction costs by 10% and agrees with the 35% reduction in concrete use.

Objectives

1. The main objective of this study is to practically using hollow spherical plastic balls in reinforced concrete slab which is called as bubble deck slab.
2. To present a procedure for comparison of all parameters between solid conventional slab & bubble deck slab.
3. The structure is generally designed, using the conventional design methods for solid floor slabs & bubble deck slab.
4. To study the bending (deflection) behavior of conventional slab & bubble deck slab.
5. To study the behavior of conventional slab& bubble deck slab.
6. The main objective of this study is using Hollow plastic ball (HDPE- High Density of polyethylene) in the reinforced concrete slab and its effects.

LITERATURE REVIEW

Brief review of literature relevant to the study is presented below-

Arati Shetkar & Nagesh Hanche (2015): Presented experimental Study on Bubble Deck Slab System with Elliptical Balls, the behaviour of Bubble Deck slabs is influenced by the ratio of bubble diameter to slab 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. The bubbles are made using high density polypropylene materials. 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 1/9th of bubble diameter. The nominal diameter of the gaps may be of: 180, 225, 270, 315 or 360 mm. 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 of 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 in Bubble Deck can be achieved using the hollow elliptical balls, Reducing material consumption made it possible to make the construction time faster, to reduce the overall costs. Besides that, it has led to reduce deadweight up to 50%, which allow creating foundation sizes smaller.

Harishma K R & Reshmi K N (2015): It shows the effectiveness and feasibility of the application of Bubble Deck in the construction. It proves a wide range of cost and construction benefits. It also proves combines the benefits of factory-manufactured elements in controlled conditions along with on-site completion with the final monolith concrete, resulting in a completed floor slab.

Steel is fabricated in two forms - the meshed layers for lateral support and diagonal girders for vertical support of the bubbles. The distance between the bars are corresponding to the dimensions of the bubbles that are to be used and the quantity of reinforcement from transverse ribs of the slab. Grade Fy50 strength or higher is used.

All the Bubble Deck versions come in 3 forms

1. Filigree elements (Type A)-A concrete layer that acts as both the formwork and part of the finished depth is precast and brought on site with the bubbles and steel reinforcement unattached. The bubbles are then supported by temporary stands on top of the precast layer and held in place by a honeycomb of interconnected steel mesh.
2. Reinforcement modules (Type B)-consists of a pre-assembled sandwich of steel mesh and plastic bubbles, or bubble lattice. These components are brought to the site, laid on traditional formwork, connected with any additional shear or edge reinforcement, and then concreted in 2 stages to the full slab depth by traditional methods.
3. Finished planks (Type C)-It is a shop fabricated module that includes the plastic spheres, reinforcement mesh, and concrete in its form. This module is manufactured to the final depth in the form of a plank and is brought to site. According to the tests carried out in various countries as per ISO 140-4:1998, ISO-7:1998, ISO 717-1:1997 by measuring impact and airborne sound.

Amer M. Ibrahim, Nazar K. Ali, Wissam D. Salman (2013): Presented flexural capacities of reinforced concrete two-way bubble deck slabs of plastic spherical voids. It has been verified the flexural behaviour of this Bubble Deck slab such as ultimate load, deflection, concrete compressive strain and crack pattern, two-dimensional flexural tests were tested by using special loading frame. In that six test of specimens were used. Two were a conventional RC slab and four were Bubble Deck slabs having void diameter to slab thickness ratios of (0.51, 0.64 and 0.80). It shown that the crack pattern and flexural behaviour depend on the void diameter to slab thickness ratio. The ultimate load capacities for Bubble Deck slabs having bubble diameter to slab thickness of (0.°1 and 0.64) were the same of solid slabs, while when bubble diameter to slab thickness of (0.80) the ultimate capacities were reduced by about (10%). The slab was simply supported at all edges by four steel beams which had a hinge in the upper surface to minimize fixed end moment and other errors from support condition during the test. This Specimens were tested under a five-point load system using a five hydraulic jack and a five loading plate to satisfy the actual loading condition.

MATERIALS AND METHODOLOGY

Materials

Cement

Ordinary Portland cement 53 grade was used.
The test were carried out according to the IS 456-2000 standard.

Aggregate

Fine aggregates

Those fractions from 4.75 mm to 150 micron are termed as fine aggregate. The river sand and crushed Sand is being used as fine aggregate conforming to the requirements of IS: 383.

Coarse aggregate

The fractions from 10 mm to 4.75 mm are used as coarse aggregate. The Coarse Aggregates from 10 mm are used conforming to IS: 383 is being use.

Water

Potable water is used for mixing and curing as per IS 456:2000. From durability consideration water cement ratio should be restricted as in case of normal concrete and it should preferably be less than 0.45.

Concrete

The concrete used for joint filling in the Bubble Deck floor system. Usually conventional concrete is used, for the casting of bubble deck slab. The nominal maximum size of the aggregate is the function of thickness of the slab. The size should be less than12mm. M30 Grade should be used.

Reinforcement bars

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 by binding wire. The distance between the bars is corresponding to the dimensions of the bubbles that are to be used in the slab. Grade Fy500 strength is used.

Hollow bubbles

The bubbles are made using high density polyethylene materials. These are usually made with nonporous material that does not react chemically with the concrete or reinforcement bars. The bubbles have enough strength and stiffness to support safely the applied loads in the phases before and during concrete pouring. The diameter of bubble is 62 mm and the distance between bubbles is 12 mm. The bubbles are spherical in shape.

METHODOLOGY

1. **Conventional slab**: This is a slab with specifications prepared to analyze experimentally with normal concrete of grade M30 by adopting conventional methods of design according to IS 456:2000 & IS 10262:2009.
2. **Bubble deck slab**: This is a slab with specifications prepared to analyze experimentally with normal concrete of grade M30 by using Hollow strong plastic balls (HDPE- High density polyethylene) with the help of design according to modified DIN 1045 (1988) or DIN 1045 (2001) code (German code).

Types of slab casted

Conventional slab

Bubble deck (continuous arrangement of bubble)

Alternative bubble deck slab (type I)

Alternative bubble deck slab (type II)

A. Prepared the conventional slab normal M30 grade of concrete & design of the reinforcement according to IS Code 456-2000 & IS 10262:2009 & analyses it.
B. In the Bubble deck slab firstly prepared the design of continuous bubble deck slab using DIN 1045 (1988) or DIN 1045 (2001) code (German code) and analyses it.
C. After the preparing continuous bubble deck slab, prepared the design alternative bubble deck slab using, DIN 1045 (1988) or DIN 1045 (2001) code, (German code) codes and analyses it.
D. In the alternative bubble deck slab preparing the different arrangement of the bubbles which is alternative bubble deck slab (type I) & (type II).
E. Casted the conventional slab & bubble deck slab with hollow strong plastic balls i.e. HDPE (High density polyethylene balls).
F. After casted these slabs was put in curing tank for 28 days. Take Testing after 28 days on conventional slab & bubble deck slab.
G. Take results of conventional slab and bubble deck slab. Compare the experimental results of conventional slab and bubble deck slab.
H. Conclusion by deciding the best featured slab of both conventional slab and bubble deck slab

Conventional slab

The conventional concrete i.e. M30 grade concrete is having mix design according to the IS 456:2000 & IS10262:2009 is explained in this section.

Continuous Bubble deck

In that slab continuous arrangement of bubbles are placed. In the bubble deck slab only 10mm aggregates are used. Alternative spacing for bubbles and distance between two bubbles are 62mm and 12mm respectively. In that slab bubbles volume are large than the alternative bubble deck.

Alternative bubble deck slab (type I & II)

- Reinforcement of alternative bubble deck slab is same as continuous bubble deck slab.
- In the alternative bubble deck slab we reducing the bubbles volume and increase the concrete volume and analyse the effect of strength.
- The bonding between concrete and bubbles how efficiently effect on slab strength, for that reason alternative bubble deck slab is analyse.
- In that alternative bubble deck slab (type II) the arrangement of bubbles are different than the alternative bubble deck slab (type I) and analysis in perspective of strength, as shown in fig. 6&7.

Experimental Procedure

Conventional slab

The conventional slab is prepare of the M30 grade of concrete in the form work it's dimension is1mx1mx0.125m.Cover block is used for maintain the cover. Requirement of reinforcement is 4 crank bar longitudinal, 4 crank bar lateral, and 4 distribution bar of four sides of slab.

Diameter of that reinforcement is 8mm @ 240mm c/c spacing. Total length of bars is 960mm, straight portion of that bar length is about 810mm and crank portion of bar length is about 150mm and Crank bar bent is about 45^0, as shown in fig. 2.

Fig 2 Reinforcement of conventional slab

Continuous Bubble deck

The reinforcement mesh is placed both side of the bubbles and bubbles are arrange in continuous manner. Requirement of reinforcement is only straight shape of bar in the slab as per the design. Reinforcement is 6mm @ 62mm c/c spacing and 6mm @ 12mm c/c spacing also provided in alternative manner. Total length of bars is 960mm. In the bubble deck slab only 10mm aggregate is used because 12mm alternative spacing is provided. Reinforcement mesh is placed in the formwork and maintains the cover by cover block, as shown in fig. 3, 4 &5.

Fig 3 Reinforcement of bubble deck slab

Alternative bubble deck slab (type I)

The reinforcement mesh is placed both side of the bubble and bubbles are placed in alternative manner. Requirement of reinforcement is only straight shape of bar in the slab. Reinforcement is 6mm @ 62mm c/c spacing and 6mm @ 12mm c/c spacing also provided in alternative manner. Total length of bars is 960mm.Reinforcement is properly bind by binding wire. in the bubble deck slab only 10mm aggregate is used because 12mm alternative is provided. Reinforcement mesh is placed in the formwork and maintains the cover by cover block, as shown in fig. 6.

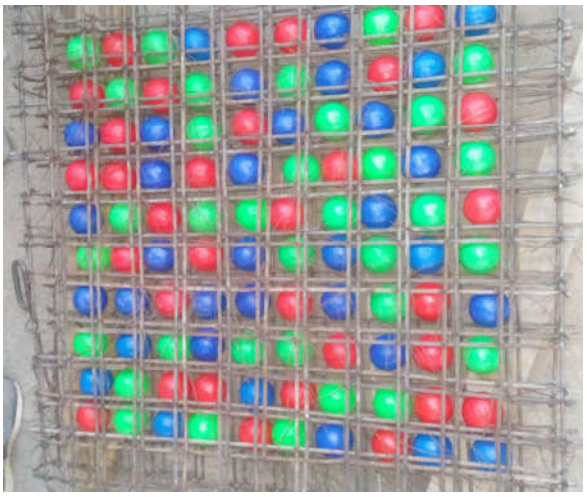


Fig 4 Reinforcement of continuous bubble deck slab

Fig 5 Reinforcement of continuous bubble deck slab

Fig 6 Reinforcement of Alternative bubble deck slab (type I)

Alternative bubble deck slab (type II)

The reinforcement mesh is placed both side of the bubble and bubbles are placed in alternative manner (type2). Requirement of reinforcement is only straight shape of bar in the slab. Reinforcement is 6mm @ 62mm c/c spacing and 6mm @ 12mm c/c spacing also provided in alternative manner. Total length of bars is 960mm.Reinforcement is properly bind by binding wire. in the bubble deck slab only, as shown in fig. 7.

Fig 7 Reinforcement of Alternative bubble deck slab (type II)

Testing Procedure

The tested slabs were simply supported and loaded with a single-point load. The slabs have been tested at ages of (28) days. The slab specimens were placed on the testing machine and adjusted the centreline, supports, point load and dial gauge were in their correct or best locations. At the end of each load increment, observations and measurements were recorded for the mid-span deflection and crack development and propagation on the slab surface.

The deflection of the specimens was measured at their mid-span beneath the lower face of the tested slabs. When the slab reached advanced stage of loading, smaller increments were applied until failure, where the load indicator stopped recording anymore and the deflections increased very fast without any increase in applied load.

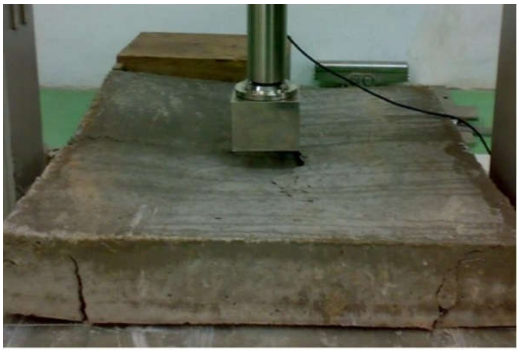


Fig 8 testing on slab

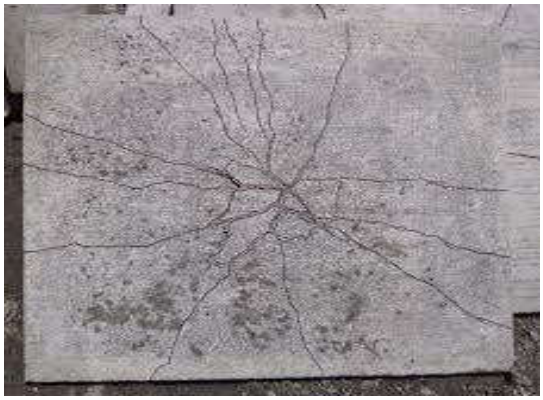


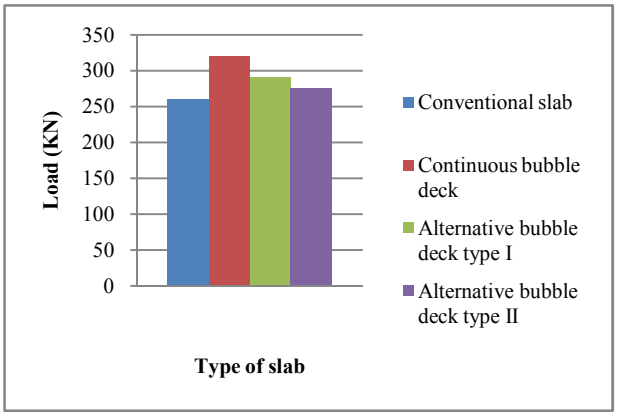
Fig 9 crack pattern during testing on slab

RESULTS AND DISSCUSSION

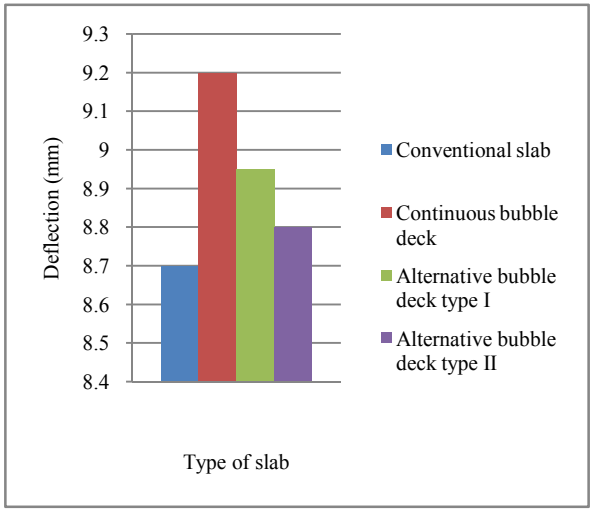
Results on the slab

Table 1 shows the load, deflection, weight of the slab

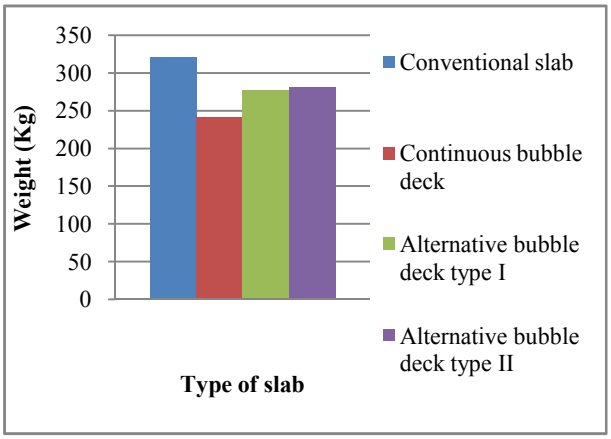
Type of slab	Load (KN)	Deflection (mm)	Weight (kg)
Conventional Slab	260	8.70	321
Continuous Bubble deck	320	9.20	242
Alternative bubble deck type I	290	8.95	278
Alternative bubble deck type II	275	8.80	281



Graph 1 shows the load carrying capacity on the slab



Graph 2 shows the Deflection behavior on the slab



Graph 3 shows the weight of the slab

DISCUSSION

In that experiment found that the bubble deck (continuous) is reduced the volume of concrete so that weight of slab ultimately decrease. Simultaneously the load carrying capacity has also increase as compare to conventional slab. But the arrangement of the bubbles are effect on the load carrying capacity of the slab, in alternative arrangement of bubbles are increase the load carrying capacity than conventional slab but less than continuous bubble deck slab.

Simultaneously, bubble deck slab has improve the elasticity property of slab, such as conventional slab is less deflect than bubble deck slab, and quantity of bubbles in slab also affect on the this elasticity property.

Weight reduction is the important factor is found in bubble deck slab. Weight of the conventional slab is more than the bubble deck slab.

CONCLUSION

A. Weight reduction is 25% compared to solid slab.
B. The bubble deck technology is environmentally green and sustainable; avoiding the cement production allows reducing global CO2 emissions.
C. In comparative of conventional slab the volume of concrete in bubble deck (continuous) are less required, that is 25% approximately.
D. In bubble deck slab volume of concrete is reduced, so that the weight of slab is decrease, comparative to Conventional slab.
E. Cost and time saving by using bubbles in the slab like weight of slab, concrete volume indirectly load on the beam and walls also decrease/ less so that building foundations can be designed for smaller dead loads.

References

1. Arati Shetkarand & Nagesh Hanche an Experimental Study On bubble deck slab system with elliptical balls, NCRIET-2015 &Indian J.Sci.Res. 12(1):021-027, 2015.
2. Harishma K.R and Reshmi K N A study on Bubble Deck slab, *International Journal of Advanced Research Trends in Engineering and Technology* (IJARTET) Vol. II, Special Issue X, March 2015.
3. Subramanian K and Bhuvaneshwari P Finite Element Analysis of Voided Slab with High Density Polypropylene Void Formers *International Journal of Chem Tech Research*, CODEN (USA): IJCRGG ISSN: 0974-4290, Vol.8, No.2, pp. 746-753, 2015.
4. Saifee Bhagat, Dr. K. B. Parikh Comparative Study of Voided Flat Plate Slab and Solid Flat Plate Slab, ISSN 2278 – 0211, Vol. 3 Issue 3, March, 2014.
5. Shaimaa Tariq Sakin Punching Shear in Voided Slab, ISSN 2224-5790 , ISSN 2225-0514 , Vol.6, No.10, 2014.
6. Saifee Bhagat and Dr. K. B. Parikh Parametric Study of R.C.C Voided and Solid Flat Plate Slab using SAP 2000, IOSR *Journal of Mechanical and Civil Engineering* (IOSR-JMCE), e-ISSN: 2278-1684,p-ISSN: 2320-334X, Volume 11, Issue 2 Ver. VI (Mar-Apr. 2014), PP 12-16.
7. A. Churakov Biaxial hollow slab with innovative types of voids, Saint-Petersburg Polytechnical University, 29 Polytechnicheskayast. St. Petersburg, 195251, Russia, ISSN 2304-6295.6 (21) 2014. 70-88.
8. Amer M. Ibrahim, Nazar K. Ali, Wissam D. Salman "Flexural capacities of reinforced concrete two-way bubble deck slabs of plastic spherical voids" *Diyala Journal of Engineering Sciences*, ISSN 1999-8716, Vol. 06, No. 02, June 2013.
9. L. R. terec, M. A. Terec The bubbledeck floor system: a brief presentation, CS I, INCD URBAN-INCERC Branch of Cluj-Napoca, CONSTRUCȚII – No. 2 / 2013.
10. Wesley N. Mascarenhas Viscoelastic Analysis of Biaxial Hollow Deck Balls, *International Journal of Computer Aided Engineering*, ISSN: 1071-2317, Vol.23, Issue.1,© recent science publications archives, January 2013.

****

How to cite this article:

Bhagyashri G. Bhade and S.M Barelikar.2016, AN Experimental Study on Two Way Bubble Deck SLAB With Spherical Hollow Balls. *Int J Recent Sci Res.* 7(6), pp. 11621-11626.

TSSN 0976-3031