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A Review of Comparatively Study between Conventional Slab and Bubble Deck Slab.- Review

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Abstract : ***The aim of this paper is to discuss about various significance of Bubble Deck Slab against Conventional Slab based on the various studies. Reinforced concrete slabs are one of the most common components in modern building construction consuming most of the concrete. Housing all over the world majorly comprises of concrete structures. They provide isolation and thermal comfort to the occupants. Majority of the concrete structures have flooring/roofing of thick concrete to bear the design loads. A bubble deck slab, also known as voided biaxial slab, is one of the latest innovations in the construction sector. A bubble deck slab is constructed by placing high density polyethylene hollow spheres in between the steel reinforcement placed on its top and bottom. Generating 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. The advantages of the bubble deck slab are less energy consumption, less emission - exhaust gases from production and transport, especially CO2. Bubble Deck is a method of eliminating concrete from the conventional flat slab which does not perform any structural function, hence reducing structural dead weight and increasing efficiency of the floor. In the Bubble deck technology reduce the concrete volume by replacing plastic balls which are locally available. This system can be used for roof and ground floor slabs also it does not require beams and column heads. This technology reduces cost of construction. It is a revolutionary method which virtually eliminates all concrete from the middle portion of a floor slab. The structural dead weight is reduced due to the non-performance of any structural function by the middle portion of the slab. High density polypropylene spherical balls replace the in-effective concrete in the center of the slab. Voids in the middle of the slab provide thermal insulation and also leads to 30 to 50% lighter slab. Bubble deck slab allows longer spans between columns supports. In this paper, flexural strength of the slab was determined by two-point load test. 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. The structural behavior of the bubble deck slab has been assessed through flexural strength, shear strength, punching shear, anchoring, crack pattern, fire resistance, creep, crack pattern. From the review of literature, it has been concluded that the bubble deck slabs are more economical and efficient with respect to structural integrity while comparing with conventional slabs.***

Keyword- Bubble Deck Slab, Flexural Strength, Conventional Slab, Hollow Plastic Balls.

I. INTRODUCTION

A concrete slab is a common structural element of modern buildings. Horizontal slabs of steel reinforced concrete are most often used to construct floors and ceilings, exterior paving. 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. A slab is one of the most important structural building elements for distribution of load generated in the structure. The slab is generally of two types, one-way slab, the slab that primarily deflect in one direction are referred to as one-way slabs. And, when slabs are supported by columns arranged generally in rows so that the slabs can deflect in two directions they are usually referred to as two - way slabs. In the concept of bubble deck slab, the recycled spherical hollow blocks are placed

in between the steel reinforcement. This creates voids in the slab and because of which, less concrete is been used during construction of the slab. The main effect of the plastic sphere is to reduce the dead load of the deck by 1/3 in compare to solid slab having same thickness without effecting its deflection behavior & bending strength. The use of spherical balls to fill the voids in the middle of a flat slab eliminates 35% of a slab self-weight compared to solid slab having same thickness without affecting its deflection behavior & bending strength. Bubble deck flat slabs are used in parking decks, commercial buildings, hotels; cinema halls where span between two columns has to be more.

2 LITERATURE REVIEW -

2.1. Rittik Bhowmik , August 2017 -

The aim of this author is to discuss about various significance of Bubble Deck Slab against Conventional Slab based on the various studies. Reinforced concrete slabs are one of the most common components in modern building construction consuming most of the concrete. The main objective of this is to study the practicality in using hollow spherical plastic balls in reinforced concrete slab, which is called as bubble deck slab. To present a procedure for comparison of all parameters between solid conventional slab & bubble deck slab. To study the bending (deflection) behavior of conventional slab & bubble deck slab. To study the behavior of conventional slab & bubble deck slab. The effects of using Hollow plastic ball (HDPE - High Density of polyethylene) in the reinforced concrete slab. It enables reduced foundation sizes since the structural dead-weight is reduced. Concrete usage is significantly reduced; 1kg of recycled plastic replaces 100kg of concrete. It is, therefore, environmentally friendly. The overall result is a significant cost saving of between 2.5% to 10% of total construction costs. Makes the building sound proof comparatively. Helps to achieve much greater fireproof designs compared to using conventional slabs.

2.2. Dr. S. Amaresh Babu -

This concept bubble deck slab has hollow spheres made from recycled plastic placed between two layers or meshes of reinforcement. In this paper, we are going to study two-way slabs and design two ways slabs (both conventional and bubble deck and its types). A bubble deck slab reduces volume of concrete up to 33% in the slab itself and up to 18% reduction in the supporting structural members. This reduction is done by removing the volume of concrete in the center portion where there is no need of concrete structurally. To use hollow polyethylene balls in a slab. To show the procedure of the experiment and a comparison of all parameters between a bubble deck slab and a conventional slab. To estimate concrete volume saved. To study and compare the self-weights of the slabs from the Universal Testing Machine. To study failure or cracking patterns on both the slab types. From this experiment, we can say that the bubble deck slab has a reduced volume of concrete which ultimately decreases the dead load on the slab. Parallelly, the load bearing capacity also increases with respect to a conventional concrete slab. Type of arrangement of bubbles also plays a major role on the load carrying capacity of the slab. In alternative arrangement of the bubbles, there is an increase in the load bearing capacity than the convention slab but less than that of a continuous bubble deck slab. There is also a considerable change in the deflections shown by the bubble deck slabs which are nearer in deflection the conventional slabs. Bubbles in the bubble deck slab improved the elasticity of the slab. A conventional slab deflects less than a bubble deck slab before failure. Based on the deflection, the failure can be estimated, and other preventive measures can be taken. Quantity of bubbles in the slab affects the elasticity property. For a given volume, the compressive strength of a bubble deck slab is higher than the compressive strength of the conventional slab. Bubble deck slabs give greater flexural strength, stiffness and shear force capacity. It was observed that when same quantity of concrete and reinforcement were used, the said structural properties of the slab increased by at least 60% than that of a conventional slab. The economy of construction increased by 40% when compared to a conventional slab.

2.3. L. Lakshmikanth, April 2019 -

In the world, low-cost housings are major leftovers, a big challenge for Civil Engineers and many governments, particularly in the emergent countries of the world like India. The crisis is aggravated by fast escalating population, migration of rural masses into the urban and industrial centres, which demands for the better eminence of existence. Due to this insufficiency of conventional building construction systems, new building systems appeared at the beginning of the 20th century. During 1999 the government has conducted government-sponsored contest on the topic of new habits of constructing buildings. In this contest, the bubble deck technology was accepted and become popular in Europe and around the world as large-scale profit-making construction. In case of filigree elements type of bubble deck slab, the layer of concrete act as both part of the finished slab and also as the formwork bought on site with the bubbles and steel reinforcement separated. Before pouring the concrete temporary stands are used to keep the bubbles in their position, extra steel is also introduced if necessary. The amount of the concrete used in bubble deck slab is 35-50% less than the conventional solid slab. The amount of non-effective reduced concrete is replaced by HDPE hollow spheres leads to the usage of less reinforcement because of the reduction in the dead load from the slab which is more useful for low-cost housing. Reducing self-weight as the positive attributes for encouraging efforts to use voided slabs. This division discusses the idea of creation of voided slab and figures out the historical applications of voided slab. The literature on the bubble deck slab has reviewed. From the literature, it is clear that voided slab is very common in olden days and it is improving day by day and at present bubble deck are effective in load carrying capacity, shear capacity, flexural capacity, fire resistant and moreover we can reduce the weight and increase the span of the slab. Bubble deck slab has not got widespread in India because most of the design is based on the DIN codal provision and lack of BIS codes and specifications regarding the use of technology which is discussed only in IRC SP 64-2005, meant for bridge superstructures. It will come into the competition in India like the pre-stressed concrete, which is using almost all the metro, tall structures, and bridges a lot nowadays but not popular before.

2.4.Shaunak D. Chandekar, Mar 2020 -

A slab is one of the most important structural building elements for distribution of load generated in the structure. The slab is generally of two types, one-way slab, the slab that primarily deflect in one direction are referred to as one-way slabs. And, when slabs are supported by columns arranged generally in rows so that the slabs can deflect in two directions they are usually referred to as two - way slabs. In the concept of bubble deck slab, the recycled spherical hollow blocks are placed in between the steel reinforcement. This creates voids in the slab and because of which, less concrete is been used during construction of the slab. The use of spherical balls to fill the voids in the middle of a flat slab eliminates 35% of a slab self-weight compared to solid slab having same thickness without affecting its deflection behaviour & bending strength. As the conventional slab is generally of two types, one-way and two-way, the bubble deck slab is divided into three types which are Filigree elements, Reinforcement Modules and Finished Plank. In the present situation of the development businesses, we need various sorts of strategies which are increasingly conservative, simple to build and condition amicable. The Bubble Deck Slab is one the innovation which causes us to accomplish the economy, simple to develop and condition neighbourly. Bubble deck technology is the creative framework that eliminates concrete in the mid-section, secondary supporting structure such as beams reinforced concrete columns or structural walls.

2.5. Dr. N.K. Gupta, June-2019 -

In day-to-day life cost of concrete increasing so to overcome this problem plastic balls are used in slabs in place of concrete which does not take any compressive load. When the load acting on the slab is large or clear span between two columns is more, the deflection of the slab is also large. Therefore, thickness of the slab increases. Increasing the slab thickness makes the slabs heavier and will increase column and foundations size. Thus, buildings consume more materials such as concrete and steel reinforcement. Bubble deck flat slabs are used in parking decks, commercial buildings, hotels; cinema halls where span between two columns has to be more. The main objective of this is to study performance of Bubble deck flat slab. To estimate the amount of concrete reduced as result of plastic balls introduction into flat slab. To analyse the results of load vs. deflection. Concrete usage was reduced, reducing material consumption. It led to reduction dead load up to 10.07%. 2. It was observed that deflection of bubble deck flat slab is higher as compared to conventional slab. 3. Ultimate load carrying capacity was reduced in bubble deck flat slab by 11.22%. 4. The bottom cracks are longitudinal as well as diagonal. Most of the cracks are longitudinal and similar in both the cases. 5. Cost was reduced to 13.39% when compared with conventional concrete.

2.6.K.R. Dheepan, 2017 -

In building constructions, slab is one of the largest structural member consuming concrete. Jorgen Bruening in 1990's invented the first biaxial hollow slab (now known as bubble deck slab) in Denmark. Bubble deck offers a more sustainable construction option by using less concrete than traditional concrete floor systems and also contributes less CO2 to the atmosphere in the manufacturing process. It meets sustainability goals through the use of recycled plastic spheres. Even after the building is demolished or renovated in the future, the spheres could be recycled. By virtually eliminating the concrete part in the middle of the conventional slab it leads to 30 to 50% lighter slab which reduces the loads on the columns, walls and foundations, and of course of the entire building. The Bubble Deck concept simplifies the placement of installations like ducts and heating or cooling systems directly in the slab. This enhances the nature of the slim flat slab structure. The tubes can either be placed in the bubble lattice as prefabricated or on site before concreting. Thermal heating or cooling in slab can reduce the substantial energy consumption. The installation of cooling or heating system. From this study, it is understood that when the spacing between the balls increases, the flexural strength of the slab increases irrespective of change in the thickness of the slab. • It is also observed that the flexural strength of the slab in 60mm ball diameter is higher than the flexural strength of slab in 75mm ball diameter for both 20mm and 30mm spacing of the balls. • It is finally concluded that the optimum diameter of the hollow spherical balls that can be used in bubble deck slab for normal purposes is 60mm and the optimum spacing between the balls can be 30mm. • There is a 35 – 50 % reduction in use of concrete which leads to reduction in self weight of slab with same flexural strength of the slab compared to the conventional slab. • Due to the voids in the slab, it has excellent thermal insulation property. Lower total cost, decreased construction time and green technology compared to conventional slab.

3.OBJECTIVE –

To cast conventional slab and bubble deck slab with varying spacing between hollow plastic balls.

1. To find out the load carrying capacity of Bubble Deck Slab.
2. To study the flexural strength of bubble deck slab.
3. To compare the strength characteristics of bubble deck slabs and conventional slab.
4. To estimate the amount of concrete saved by using bubble deck slab.

4. METHODOLOGY –

The various works done are given below –

1. M20 grade concrete is selected.
2. Carryout mix design of M20 concrete.
3. Conventional slab and slabs with varying numbers of hollow balls are casted.
4. Results analysis of conventional slab and bubble deck slabs.

5. MATERIALS USED –

The various materials used for the casting of Conventional slab and Bubble Deck slab are –

- Cement,
- Aggregates,
- Reinforced bars,
- Waste Plastic balls,
- Water

6. PRELIMINARY DESIGN OF SLAB –

The preliminary design of the concrete slab is follows.

5.1. Slab Details –

1. Conventional flat slab: - This is a slab prepared with specifications with normal concrete of M20 grade by adopting conventional methods of design according to IS 456:2000.

2. Bubble deck flat slab: - This is a slab is prepared with specification with normal concrete of grade M20 by using Hollow plastic balls (PVC-Poly vinyl chloride).

Sr. no.	Specimen	Dimension (mm)
1.	Conventional Slab (Cube)	150x150x150
2.	Conventional Slab (Beam)	700x150x150
3.	Bubble Deck Slab (Cube)	150x150x150
4.	Bubble Deck Slab (Beam)	700x150x150

Table 1. Specimen Parameters

5.2. Quantity of Materials Used -

Grade : M20
Types of Cement : OPC 53 grade
Maximum nominal size Aggregates : 20mm
Water Cement ratio : 0.49
Workability : 100mm (slump)
Steel : Fe 500
Exposure condition : Severe (Reinforced concrete)
Degree of Supervision : Good
Type of Aggregate : Crushed angular aggregate

5.3. Quantity of materials for Conventional slab –

Grade of Concrete – M20

Sr. no.	Materials	Quantity
1.	Cement	48 kg
2.	Fine aggregate	71 kg
3.	Coarse aggregate	140 kg
4.	Water	23 lit.

Table 2. Quantity of materials for Conventional slab.

5.4. Quantity of materials for Bubble Deck Slab –

Grade of Concrete – M20

Sr.no.	Materials	Quantity
1.	Cement	46 kg
2.	Fine aggregate	69 kg
3.	Coarse aggregate	138 kg
4.	Water	23 lit.

Table 3. Quantity of materials for Bubble deck slab.

7. TEST ON SLAB SAMPLE CUBE –

6.1. COMPRESSION TEST ON CONVENTIONAL SLAB SAMPLE CUBE –

Compressive strength for 7days-

After curing of cubes for 7 days, the concrete moulds of 150x150x150mm is tested with a compressive tesing machine (CTM). Apply the load gradually without shock and continuously at the rate 140kg/cm2/minute till the samples fails. The results is shown below for M20.

Casting Date – 02/05/2022.

No. of Days after casting – 7days.

Test particulars	Conventional slab			Bubble deck slab		
	1	2	3	1	2	3
Length (mm)	152.04	150.85	150.58	151.14	151.50	150.80
Width (mm)	151.10	151.62	153.14	150.36	143.58	153.84
Height (mm0	151.28	153.42	155.44	154.24	155.04	153.05
Mass (kg)	8.550	8.580	8.720	7.530	7.030	7.770
Maximum load (KN)	384	338	392	204	190	242
Average	371			212		

Table 4. Compressive strength for 7 days.

Compressive strength for 18days-
No. of Days after casting – 18days.

Test particulars	Conventional slab			Bubble deck slab		
	1	2	3	1	2	3
Length (mm)	153.11	151.22	148.55	151.21	153.20	153.34
Width (mm)	149.31	155.28	150.41	151.89	153.26	153.55
Height (mm)	150.60	149.53	154.11	155.35	1553.5	154.21
Mass (kg)	8.3	8.6	8.59	7.86	8.12	7.93
Maximum load (KN)	410	430	460	320	300	280
Average	433			300		

Table 4. Compressive strength for 18 days.

8. TEST ON SLAB SAMPLE BEAM –

The load carrying capacity of the conventional slab and bubble deck slabs with varying number of HDPE balls is found out by conducting flexural strength test using Universal testing machine (UTM) apparatus. It is found that the load carrying capacity of the bubble deck slabs are in same range that of conventional slab.

Flexural strength for 7days-

Test particulars	Conventional slab			Bubble deck slab		
	1	2	3	1	2	3
Length (mm)	699	698	700	700	700	700
Width (mm)	149.80	151.09	151.10	151.16	151.90	153.16
Height (mm)	154.12	151.69	155.69	154.59	153.59	153.10
Load	12.75	13	13.5	5.40	5.95	6.45
Cracks	31.5 (From Right)	29 (From Left)	29 (From Left)	28.9 (From Right)	30.1 (From Right)	31.1 (From Left)

Table 4. Flexural strength for 7 days.

Flexural strength for 18 days-

Test particulars	Conventional slab			Bubble deck slab		
	1	2	3	1	2	3
Length (mm)	700	700	700	700	700	700
Width (mm)	152.56	151.16	151.11	156.46	151.89	150.83
Height (mm)	153.44	154.36	153.10	152.47	151.17	150.15
Load	17.75	17	17.5	8.20	9.35	8.50
Cracks	38 (From Right)	29.6 (From Left)	33 (From Left)	29.7 (From Right)	32.7 (From Right)	36 (From Right)

Table 4. Flexural strength for 18 days.

8. DISCUSSION ON CRACK PATTERN –

Loading of slabs are carried by universal testing machine. As the loading progress cracks are developed on the slabs when the loading reaches the rupture strength of the concrete. As the loading increases intensity of cracking also increases. The cracks pattern developed on all slabs are identified. Cracks pattern of conventional slabs and that of bubble deck slab are shown in fig. 1.

Fig. 1. Cracks developed in Conventional slabs.

Fig. 2. Cracks developed in Bubble deck slabs.

9. CONCLUSIONS –

1. In the present scenario of the construction industries we need different types of methods which are more economical, easy to construct and environment friendly.
2. The Bubble Deck Slab is one the technology which helps us to achieve the economy, easy to construct and environment friendly.
3. Bubble deck Technology is the innovative system that eliminates Concrete in the mid-section, secondary supporting structure such as beams reinforced concrete columns or structural walls.
4. As compared to conventional concrete the weight reduction is about 13% (for 1 m3) which will help in decreasing dead load and hence ultimately will reduce the moments.
5. This will help in a stable structure which will also reduce the initial constructional cost up to 12 %. (For 1 m3).

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