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Comparative study of Bubble Deck slab over Conventional slab

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Abstract

As the infrastructure is developing there is need for some changes in construction field, as one cannot rely on same method for a long time as it can have different consequences. The main consequence is the shortage of man power. Also, money matters a lot in construction department along with the machines, equipment and technology in some region is not available, which we want. For these Bubble Deck slab is used as an economical way and the best way to replace the conventional slab in terms of money and material, it also required less time to construct as conventional slab. Bubble Deck is method of eliminating the concrete form middle span and replacing it with high density polyethylene hollow sphere in effective concrete in the center of slab. Thus introducing the gaps, it leads to 30-50% lighter slab which reduces the load on columns, walls and foundations, of course of entire building. The aim of the paper is to discuss the concepts of Bubble Deck slab over the conventional slab and its applications with eco-friendly.

Keywords:-*Bubble deck, Polyethylene balls, Conventional slab.*

1.0 INTRODUCTION

OBJECTIVES

1. Used of hollow HDPE balls made up of waste plastic material in concrete slab.
2. Reduced concrete usage – 1kg recycled plastics replaces 100 kg of concrete.
3. Environmentally green and sustainable – reduced energy & carbon emissions.
4. Reduced dead weight – 35% removed allowing smaller foundation sizes, which result in reduced cost.

2.0 LITERATURE REVIEW

In the 1990's, Jorgen Breuning invented a way to link air space and steel within a voided biaxial concrete slab. The Bubble Deck technology uses spheres which are made up of recycled industrial plastic to create hollow balls having while providing strength through arch action. As a result, this allow hollow slab to act as normal monolithic two ways spanning concrete slab. These bubbles can decrease the dead weight up to 35% and can increase the capacity by almost 100% with the same thickness. As a result Bubble Deck slabs can be lighter, stronger and thinner than regular reinforced concrete slabs.

2.1 999 Hay (Perth, Australia)

Designed by Eames Architect 999 Hay consists of approximately 11,500sqm of commercial office space with highly flexible office floor plates, secure vehicles, proposed restaurant at the ground floor level. 999 Hay is constructed in mid-2015.

Fig.1: 999 Hay

2.2 Student Service Building (Edith Cowan University, Australia)

The new Student Service building at Edith Cowan University is next Architectural feature at the Joonadalup campus. It has been designed by admired Perth architectural firm, JCY Architects and Urban Designers, to create a new, active space for university life. Service building uses 9000sqm of Bubble Deck precast panels. These building has large span of 9 meter with limited deflection permitted.

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Fig.2-The Student Service Building

2.3 Media City (UK):

This $32,000m^2$ building was constructed with great transparency, revealing a huge open atrium. This atrium is the function and the heart of the building. The spaces are formed such that it allow light to spill onto every single place in the building. The flexibility of Bubble Deck also facilitated construction of the soft flowing, organic shapes forming the floors around the central atrium.

Fig.3- Media City, UK

Fig.4 – HDPE Balls

3.0 MATERIALS

3.1 POLYETHYLENE BUBBLES

Polyethylene is also known for modifying natural gas (methane, ethane, propane mix) or from the catalytic cracking of crude oil into gasoline. In a highly purified form, it is piped directly from the refinery to a separate polymerization plant. Here, under the right conditions of temperature, pressure and catalysis, the double bond of the ethylene monomer opens up and many monomers link up to form long chains. In commercial polyethylene, the numbers of monomer repeat units range from 1000-10000. The bubbles are made up of polyethylene they do not react chemically with the concrete or the reinforcement steel. The bubbles are non-porous and possess enough strength and stiffness to carry applied load safely in phases before and during the pouring of site concrete.

3.2 CEMENT

Ordinary Portland cement can be used, it should pass all standards as specified. Cement remained stored for more than 60 days from the date of receipt from the factory shall be rejected.

3.3 COURSE AGGREGATE:

It is hard broken stone of granite or similar stone free from dust and other organic and non-organic matter. We use 20mm & mix aggregate as per the recommendation of IS 10262:2009.

3.4 FINE AGGREGATE:

It is coarse sand consisting of hard sharp and angular grains and shall pass through screen of 4.75 mm square mesh. It should be IS recommended i.e. the fine aggregate should be free from dust, silt and other organic and non-organic matter and size is 4.75mm.

3.5 WATER

The water used should be fresh and free from alkaline and acid matter and it should be potable. Generally drinkable water is used. The PH value of water should not be less than 6. No organic matter should be present in water.

Table.1: As per **IS 10262: 2009** we get the **Ratio** -
Cement: fine aggregate: coarse aggregate
399:656.26: 1242.211: 1.64: 3.11

Sr. no.	Content Quantity	(kg/m^3)
1.	**Cement**	**399**
2.	**Water**	**191.58**
3.	**Fine aggregate**	**656.26**
4.	**Coarse aggregate**	**1242.21**
5.	**Weight density**	**2489.05**

4.0 STRENGTH OF CUBE: –

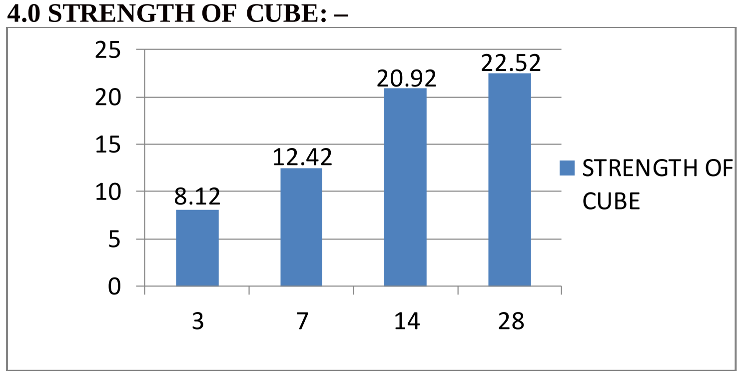

Fig.5 – Strength of cube

5. ESTIMATION OF SLABS

5.1 CONVENTIONAL SLAB:-ESTIMATION OF CONVETIONAL SLAB

1. Steel

Length of bent up bar = L -2xend cover + 2hooks+ one depth

=3230-2x16x8+160

=3.606 m

Weight of bar per m= φ/162

=8²/162

=0.395 kg

Number of bars @ X-direction	**=15 NOS.**
Number of bars @ Y-direction	**=15 NOS.**
Total weight of steel in 3×3 slab	= weight of bars in

X-direction+weight of bars in Y-direction

= (0.395x15x3.606) + (0.95x15x3.606)

=42.74 kg

Cost of steel (TATA STEEL)

Cost per kg= Rs. 44/-42.14 x 44

= Rs. 1879.92/-

2.Mix proportion M20 (1:1.78:2.15)

Volume of concrete = 3x3x0.2

= 1.8 m^3

3.Cement

Volume of cement = [(1.52×1.8) / (1+1.78+2.15)]x1

= 0.554 m^3

Number of bags =0.554×30**=16 NOS.**

Cost of cement =300×16**=Rs.4800/-**

4.Sand

Volume of sand = 0.554×1.78 = 0.986 m^3

For 0.348 brass **= Rs.2227.2/-**

5. Aggregate

Volume of aggregate = 0.554×2.15

=1.191 m^3

Cost of aggregate

For 0.42 brass **= Rs.966/-**

6. Other cost

Head mistry 1	= Rs.1000/-
Mistry 1	= 750/-
Mixer operator 1	= 400/-
Vibrator operator 1	= 400/-
Labor 6	= 1800/-
Water charges	=1000/-
Tools and plants	=1300/-
Total	=6650+850(extra)

=7000/-

7. Summary

Steel	**=1880/-**
Cement	**=4800/-**
Sand	**=2228/-**
Aggregate	**=966/-**
Other	**= 7000/-**
Total	=16794+300

=17094/-

Contractor profit =10%x17094

=1709.4

Total cost for 3x3x0.2 m slab is = 17174+1717.4

=18891.4

=approx. 19000/-

5.2. BUBBLE DECK SLAB: – ESTIMATION OF BUBBLE DECK SLAB

1. Steel

Length of bent up bar	= L -2xend cover + 2hooks+ one depth =3230-2x16x8+160 =3.606 m
Weight of bar per m	= φ/162 = 8²/162
	=0.395 kg
Bottom: –	
Number of bars @ X-direction	=10 NOS.
Number of bars @ Y-direction	=10 NOS.
Top:-	
Number of bars @ X-direction	=10 NOS.
Number of bars @ Y-direction	=10 NOS.
Wt. Of bar per meter	= 0.395 kg.
Top	=3.395x10x3.606
	= 14.243 kg… **X-direction**
	= 3.395x10x3.606
	=14.243 kg… **Y-direction**
Bottom	=3.395x10x3.606
	=14.243… **X-direction**
	= 3.395x10x3.606
	=14.243 kg… **Y-direction**
Total steel	=56.974 kg
Cost per kg Rs 44 /-	= 56.974×44 **=Rs 2506.89/-**

2. Mix proportion M20 (1:1.78:2.15)

Volume of concrete	=3x3x0.2-(5.235×10- 4x841)
	=1.8-0.440
	=1.359 m^3

3.Cement

Volume of cement	=[(1.52×1.359)/ (1+1.78+2.15)]x1
	=0.419 m^3
Number of bags	=0.419×30 =12.57 = approx. 13NOS.
Cost of cement	=300×13 **=Rs.3900/-**

4. Sand

Volume of sand	= 0.419×1.78 =0.265 m^3
For 0.0.093 brass	**= Rs.595/-**

5. Aggregate

Volume of aggregate	= 0.419×2.15 =0.90 m^3
i.e. 0.90/2.83	=0.318 brass

Cost of aggregate	**= Rs.731/-** For 0.318 brass (1 brass=Rs.2300/-)
6. Other cost	
Mistry 1	= 750/-
Mixer operator 1	= 400/-
Vibrator operator 1	= 400/-
Labor 4	= 1200/-
Water charges	=1000/-
Tools and plants	=1300/-
Crane charges	=500/-
Total	**=5550/-**
7. Summary	
Steel	**=2506/-**
Cement	**=3900/-**
Sand	**=595/-**
Aggregate	**=731/-**
Other	**=5550/-**
HDPE balls (900 balls)….2/- each	**=1800/-**
Total	**=15381 = approx. 15400/-**
Contractor profit	**=10%x15400 =1540/-**
Total cost for 3x3x0.2 m slab is	**=15400+1540 =16940/-**

5.3. COST COMPARISON:-

Table 1 – Cost comparison between Conventional and Bubble Deck slab

Sr. no	Description	Cost in Rs.	
		Conventional slab	Bubble Deck Slab
1.	Steel	1880/-	2506/-
2.	Cement	4800/-	3900/-
3.	Sand	2228/-	595/-
4.	Aggregate	966/-	731/-
5.	HDPE Balls	-	1800/-
6.	Other	7000/-	5550/-
	Total	16793/-	15400/-
	Contractor profit 10%	1709.3/-	1540/-
	Grand total	19000/-	16940/-
	Net profit	(1900-16940)/19000×100=10.84%	

6.0 ADVANTAGES AND DISADVANTAGES:-

6.1 ADVANTAGES

1. **STRUCTURAL**

   Due to replacement of inactive concrete with HDPE balls it has -

   (a) Self-weight is less
   (b) Strength is increase
   (c) No need of Beams
   (d) Few columns are required
   (e) Larger span
   (f) Free choice of shape
   (g) Less excavation required
   (h) Less foundation depth

2. CONSTRUCTION
   - Light in **weight** so less equipment is required.
   - **Easy casting** of ducts and pipes in slab.
   - Less work on construction site.
   - **Precast Bubble Deck** are available
   - On site casting is also easy
3. ENGINEERING
   - High resistance against **explosion**.(biaxial flat slab systems and columns)
   - These slabs and columns systems act like an elastic membrane which transfer all the horizontal forces to the vertical structures, which called as **Earthquake resistance**.
4. ENVIRONMENT
   - Less **energy consumption** and material required.
   - Reduction in **emission of CO_2** gas up to 40kg/m^2.
   - **100kg** of concrete is replaced by **1 kg** of plastics.
   - All components used can be **recycled.**
5. ECONOMY
   - There is savings in **materials** used.
   - **Transportation** cost reduced.
   - **Faster** the construction time.
   - Buildings can be more **flexible** and easy for **installations**.

6.2 DISADVANTAGES

- **Bending strength** is same as of conventional slab for same thickness.
- **Deflection** of Bubble Deck slab is 5.88% more than solid slab as the stiffness is reduced to the hollow portion.

7.0 CONCLUSION

- As per our study, we conclude that the **cost** of Bubble Deck is **less** as compare to the conventional slab, with the reduction of **self-weight** up to**50%** as that of conventional slab of same thickness.
- We also conclude that Bubble Deck gives **larger span** with minimum columns which gives large working space area.
- As no beam is needed we are free for **choice of shapes**.
- Cost and time is also saved by this technique as dead load is less so beams, columns and foundation is design for smaller dead loads.
- We also conclude that the volume of concrete required is 25% less than that of conventional slab.
- As these technique is **eco-friendly** and sustainable the emission of CO2 gas is reduced.
- The plasticare used for making balls hence the materials are **recycled**.
- High resistance to explosion and vibrations so it can be used for **Earthquake Resistance**.
- So as the study says the Bubble Deck is more liable than the Conventional slab.

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