International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 07 Issue: 05 | May - 2023 Impact Factor: 8.176 ISSN: 2582-3930

# Investigation on Durability Parameters of Concrete adopting Bubble Deck Technology

**[1]Krupadan Samayya Jangam, [2]Karan Sunil Biswas,, [3]Roshan Laxman Gaikwad**
**[4]Ratan sunil sarkar, [5]Litik bhojendra lilhare, [6]Roshan ramdas jambale, [7]Sanjay bhadke**
[1]*civil engineering department, TGPCET, Nagpur, India*
[2]*civil engineering department, TGPCET, Nagpur, India*
[3]*civil engineering department, TGPCET, Nagpur, India*
[4]*civil engineering department, TGPCET, Nagpur, India*
[5]*civil engineering department, TGPCET, Nagpur, India*
[6]*civil engineering department, TGPCET, Nagpur, India*
[7]*civil engineering department, TGPCET, Nagpur, India*

---***---

**Abstract -** Concrete is being used most widely worldwide and needs to be correctly designed and utilized in RCC structures to sustain the load throughout its life span. people want a longer span of slabs for better appearance and spacing. To get longer spans, we as civil engineers also have to increase the depth of slab due to which it increases the dead weight of concrete which affect the other construction parameters. To minimize the dead load of concrete we are adopting bubble deck technology in which we will use hollow balls which reduces concrete up to certain limit and will reduce the self-weight of the structure. The question may arises by using hollow balls that it may weak the concrete, but we know that concrete is strong in compression but weaker in tension so to counter act this problem we add steel bars in tension zone as steel are strong in tension. We are using hollow balls instead of concrete as there is no need of concrete in a zone of tension where there is need of steel bars. By adopting bubble deck technology we will reduce the use of concrete which reduces the concrete also reduces the cost of concrete which is replaced.

***Key Words***: bubble deck technology, hollow balls, cost reduction, self-weight reduction

## 1. INTRODUCTION

Bubble deck is a method of replacing the concrete of a slab from middle portion of the structure in addition to provide plastic hollow balls (Bubbles) with reinforcement in between them. By adopting this method the self-weight of the concrete get reduced to some greater extent and will be cost efficient. The bubble deck Slab can be used in the roof, ground surface where the insertion of load is less. The hollow spherical ball are fixed and tightened with reinforcement Steel with some spacing between two consecutive balls. This method is having an great impact of consumption of 40 to 50% of material required for construction. The bubble deck slab had been designed and constructed with plastic spherical hollow balls below the neutral axis to eliminate the use of concrete. Thus the bubble deck slab can be reduced the 40-50% concrete than conventional concrete slab. Due to lighter weight of slab it reduces the loads on the columns, walls, foundations and entire part of building. Bubble Deck slab reduces the cost and time of construction. Bubble deck slab requires less expensive equipment and it reduces transportation cost.

## 2. OBJECTIVES OF PAPER

1) The main objective of this study is using hollow Plastic balls i.e. polypropylene balls in the reinforced concrete structure (below the neutral axis rather than whole depth of the section as used in regular bubble deck structure) and its effects.
2) To estimate the amount of concrete saved as a result of spherical balls inserting in to the core of structure.
3) Use of waste plastic material in the form of plastic balls, thereby reducing burning of plastic and harm full environmental pollution.
4) To determine load carrying capacity of bubble deck structure and compare with conventional structure.
5) To study the bending behavior of Conventional structure & bubble deck structure

## 3. LITERATURE REVIEW

**1) Review On Bubble Deck Structures Technology And Their Application vol 8, issue 10, Oct 2019, IJSTR by Samantha Konuri, Dr. T.V.S Varalakshmi.**

The paper "Review on Bubble Deck Structures Technology and Their Application" provides an overview of bubble deck technology and its various applications. The authors describe the construction process of bubble deck structures, which involves creating a void in the concrete slab using plastic spheres, resulting in a lighter and more efficient structure. The paper also discusses the benefits of using bubble deck structures, including reduced material usage, increased spans, improved thermal insulation, and reduced carbon emissions. The authors present case studies of bubble deck structures in various applications, such as residential, commercial, and industrial buildings, and provide a comparison of the construction costs and environmental impact with traditional construction methods.

2) **Performance of Structural Behaviour of Bubble Deck Structure ISSN:2277-3878, Vol7, Issue-6C2, Apr2019 By L. Lakshmikanth, P. Poluraju.**

The paper "Performance of Structural Behaviour of Bubble Deck Structure" examines the structural behaviour of Bubble Deck structures through an experimental study. The study aims to evaluate the performance of the Bubble Deck structure under different loading conditions and compare it with traditional solid slab structures. The authors conducted experiments on two different types of Bubble Deck structures, one with spherical voids and another with elliptical voids. The study involved applying various loadings, including point loads, distributed loads, and concentrated loads, to both Bubble Deck and solid slab structures. The researchers measured the deflection, strain, and stress of the structures under load and compared the results.

3) **Case Study on Bubble Deck Structure with Self-Compacting Concrete 2019 JETIR, Vol 6, issue 3 By Akhand Pratap Singh, Satya Veer Singh.**

The paper "Case Study on Bubble Deck Structure with Self-Compacting Concrete" presents a case study of a Bubble Deck structure constructed using self-compacting concrete (SCC). The study evaluates the feasibility of using SCC in the construction of Bubble Deck structures and examines the structural performance of the structure under different loading conditions. The case study concludes that the use of SCC in Bubble Deck structure construction offers several advantages such as reduced construction time, improved workability, and better quality control. The results indicate that the Bubble Deck structure with SCC performed well under various loading conditions, including live load and earthquake loads. However, the authors caution that careful consideration must be given to the mix design and placement of SCC to ensure its success in construction. The case study suggests that Bubble Deck structures with SSC can be a viable alternative to traditional solid slab structures, offering improved structural performance and faster construction times.

4) **Application of Taguchi Method for the Design of Concrete Mixes IJEAT, ISSN:2249- 8958 By Prince Arulraj, Felix K Regi, Philo Mariya, Merin k Varghese, Abel Antony johns.**

The research paper "Application of Taguchi Method for the Design of Concrete Mixes" by Prince Arulraj, Felix K Regi, Philo Mariya, Merin K Varghese, and Abel Antony Johns describes the use of the Taguchi method for the design of concrete mixes. The Taguchi method is a statistical technique used for optimizing the design of products and processes, and it has been successfully applied in various fields, including engineering.In this study, the authors conducted experiments to investigate the effect of different mix proportions of cement, fine aggregate, coarse aggregate, and water on the compressive strength of concrete. The experiments were designed using the Taguchi method, which allowed the researchers to study the effects of multiple factors simultaneously while minimizing the number of experiments required.

5) **A Review Study on Bubble Deck Structure ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor:6.887 Volume 5 Issue X, October 2017 by Varshney, Nitish Jauhari, Himanshu Bhatt.**

The paper "A Review Study on Bubble Deck Structure" provides a comprehensive review of the Bubble Deck structure system. The Bubble Deck system is a type of slab structure that reduces the amount of concrete required in the construction process. The paper describes the working principle, advantages, and limitations of the Bubble Deck system. Authors analyse the different types of Bubble Deck systems and compare them to traditional slab systems. The review includes information about the design principles, structural analysis, and construction techniques used for Bubble Deck systems. The authors also discuss the importance of careful detailing and proper quality control during construction.

6) **Review on bubble deck with spherical hollow balls, Volume 8, Issue8, August2017, pp.979–987, Article ID : IJCIET_08_08_102 by Ritik Bhowmik, Sourish Mukherjee and Aparna Das.**

The paper "Review on Bubble Deck with Spherical Hollow Balls" provides a comprehensive review of the Bubble Deck structure system that uses spherical hollow balls as void formers. The paper examines the working principle, advantages, and limitations of the Bubble Deck structure system. The authors review the different types of Bubble Deck structures with spherical hollow balls, including their design, construction, and structural behavior. The review highlights the advantages of the Bubble Deck structure system, such as reduced material and labor costs, improved structural performance, and faster construction times. The authors also discuss the importance of careful detailing and proper quality control during construction.

## 4. MATERIALS USED

Cement:- Ordinary Portland cement 43 grade was used. The test were carried out according to the IS 456-2000 Standard.

Fine aggregates:- The river sand is being used as Fine aggregate.

Coarse aggregate:- The Coarse Aggregates of size 20mm is used.

Water:- Potable water is used for mixing and curing 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:- M35 Grade concrete was used for preparing both, the Conventional and Bubble deck cube (size 150mm x 150mm).

Reinforcement bars:- High strength deformed steel bar is used for both main steel and distribution steel.

Hollow balls:- The bubbles are made using high density polypropylene Materials. These are usually made with non- porous 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 100 mm. The bubbles are spherical in shape

## 5. METHODOLOGY

1) Make a mix design of m35 grade.
2) Prepare a conventional concrete cube as well as cubes using polypropylene balls of 50 mm size balls.
3) Test the concrete cubes and compare the compressive strength of conventional cubes with bubble deck cubes .
4) Now make conventional beam as well as bubble deck beam using polypropylene balls.
5) Test the beam for flexural strength and compare the bubble deck beam with conventional beam.
6) Calculate the amount of concrete saved using polypropylene balls.
7) Calculate the amount of reduced self-weight of beam without much affecting its strength parameters.

## 6. MIX DESIGN

### A-1 : STIPULATIONS FOR PROPORTIONING

| | |
|---|---|
| Grade designation | M35 |
| Type of cement | OPC 43 |
| Maximum nominal size of aggregate | 20mm |
| Minimum cement content | 320 kg/m$^3$ |
| Maximum water-cement ratio | 0.45 |
| Workability | 100 mm ( slump ) |
| Exposure condition | severe ( for reinforced cement concrete ) |
| Degree of supervision | good |
| Type of aggregate | angular aggregate |
| Maximum cement content | 450 kg/m$^3$ |

### A-2 : TEST DATA FOR MATERIALS

| | |
|---|---|
| a) Cement used | OPC 43 |
| b) Specific gravity of cement | 3.12 |
| c) Specific gravity of: | |
| I) Coarse aggregate | 2.68 |
| 2) Fine aggregate | 2.34 |

### A–3 : TARGET STRENGTH FOR MIX PRPORTIONING

f'ck =fck + 1.65 S

From Table I , standard deviation, s =5 N/mm$^2$
Therefore, target strength =35 + 1.65 x 5 =43.25 N/mm$^2$

### A·4 : SELECTION OF WATER-CEMENT RATIO

From Table 5 of IS 456, maximum water-cement ratio = 0.45.

It can be reduced since we use admixtures (super plasticizer).

Therefore, adopt water-cement ratio as 0.45 – 0.05 = 0.4

0.40 < 0.45 , hence O.K.

### A-5 : SELECTION OF WATER CONTENT

water content = 186 litre (for 50 mm slump),

Required water content = 197 litre (As per IS – 10262)

For super-plasticizers reduce 20 % water content,

Therefore ,

**WATER CONTENT = 157.6 LITRE**

### A-6 CALCULATION OF CEMENT CONTENT

| | |
|---|---|
| Water-cement ratio Cement content | 0.4 |
| cement content | 157/0.4 = 394 kg/m^3 |
| From Table 5 of IS 456, minimum cement | 320 kg/m3 |
| content for 'severe' exposure condition | |

394 kg/m3 > 320 kg/m3, hence, O.K.

### A·7 PROPORTION OF VOLUME OF COARSE AGGREGATE AND FINE AGGREGATE CONTENT

| | |
|---|---|
| volume of coarse aggregate | 0.62 |
| Volume of fine aggregate content | 1-0.62 = 0.38 |

### A-8 MIX CALCULATIONS

The mix calculations per unit volume of concrete shall be as follows :

| | |
|---|---|
| Volume of concrete (a) | 1 m^3 |
| Volume of cement (b) | Mass of cement / mass density |
| | = 394/ 3.12*1000 |
| | = 0.125 m^3 |
| Volume of water (c) | mass of water / mass density |
| | = 157.6/1*1000 |
| | = 0.1576 m^3 |
| Volume of admixtures (d) | = mass of admixture / mass density |
| | = 1.1% of cement (394) / 1.12*1000 |
| | =0.00386 m^3 |
| Volume of all in aggregate (E) | = [a- (b +c+d )] |
| | =1-(0.125+0.1576+0.00386) |
| | = 0.714 m^3 |
| Mass of coarse aggregate | = E x Volume of coarse aggregate x Specific gravity of coarse aggregate x I000 |
| | = 0.714 x 0.62 x 2.68 x 1000 kg |
| | = 1186 kg |
| Mass of fine aggregate | = E x volume of fine aggregate x Specific gravity of fine aggregate x 1000 |
| | = 0.714 x 0.38 x 2.34 x 1000 |
| | = 635 kg |
| Cement | 394 kg |
| Fine aggregate | 635 kg |
| Coarse aggregate | 1186 kg |

**Mix Proportion : 1 : 1.61 : 3.01**

## 7. QUANTITY ESTIMATION

| PARTICULARS | SIZE(m) | VOLUME( $m^3$) |
|---|---|---|
| **BEAM** | 0.7*0.15*0.15 | 0.01575 |

Sum Of Mix Ratios = 1+ 1.61+3.01 = 5.62

Wet Volume = 1.54 * 0.01575 = 0.024255 $m^3$

| MATERIAL CLACULATION | | | |
|---|---|---|---|
| **PARTICULARS** | **CEMENT** | **SAND** | **AGGREGATE** |
| Required volume = (mix ratio/sum of ratios) X wet volume ($m^3$) | 4.316 X $10^{-3}$ | 6.95 X $10^{-3}$ | 0.013 |
| Density (Kg/ $m^3$) | 1440 | 1600 | 1450 |
| Required weight = volume X density (Kg) | 6.215 | 11.12 | 18.85 |

Total = 36.185 Kg for 0.01575 $m^3$

Water = 6.2208 X 0.4 = 2.488 Kg

Total weight = 36.185 + 2.488 = 38.5 kg

**DENSITY** = 2440 Kg/ $m^3$

| Price calculation | | |
|---|---|---|
| **Particulars** | **Price ( Rupees)** | **summary** |
| **Cement** | 300/50 kg | **3.033 rupees per kg** |
| **Sand** | 1600/1000 kg | |
| **aggregate** | 1500/1000 kg | |
| **concrete** | 3033/1000 kg | |

**Test 2 : Flexural strength of beam**

| particulars | Dimensions (meter) | Types | Volume (V) ( $m^3$ ) | Weight = volume X density (Kg) | Price = weight X 3.033(price per kg of concrete ) (Rupees) |
|---|---|---|---|---|---|
| **BEAM** | 0.7 X 0.15 X 0.15 | conventional beam | 0.01575(V1) | 37.8(W1) | 114.65(P1) |
| | | concrete replaced | $2.62 \times 10^{-3}$ (V2) | 6.288(W2) | 19.07(P2) |
| | | bubble deck beam (only concrete ) | 0.01313(V3) | 31.512(W3) | 95.57(P3) |
| **Polypropylene balls** | 100 mm dia. | Unit = 5 per beam | $2.62 \times 10^{-3}$ | negligible | 2 rupees each = 2 X 5 = 10 RUPEES (P4) |

## 8. REDUCED PARAMETERS

| REDUCED PARAMETERS | | | |
|---|---|---|---|
| | Volume reduced (Kg/ $m^3$ ) | Self-weight reduced (Kg) | Cost reduced (Rupees) |
| **BEAM** | =(V2/V1) X 100<br>**= 16.63 %** | = (W2/W1) X 100<br>**= 16.63 %** | =((P2-P4)/P1) X 100<br>**= 7.9 %** |

## 9. EXPERIMENTAL RESULTS

**Test 1 : Compressive Strength Of Concrete Cubes**

| No. of cubes Casted | Age of concrete (days) | Conventional cube(N/mm^2 | Bubble deck cube (50 mm size) (N/ $mm^2$ ) |
|---|---|---|---|
| 3 | 7 | 23.46 | 20.31 |
| 3 | 14 | 32.5 | 29.8 |
| 3 | 28 | 34.68 | 33.74 |

| Sr. no. | sample | Width (Cms) | Depth (Cms) | Span length | Date of casting | Age of specimen | Load at failure | Fracture position | Flexural strength |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Buuble-deck BEAM | 15 | 15 | 60 | 06-03-2023 | 14 | 65.00 | 19.5 | 11.27 |
| 2 | Conventional BEAM | 15 | 15 | 60 | 06-03-2023 | 14 | 72.00 | 18.5 | 11.84 |
| 3 | Buuble deck BEAM | 15 | 15 | 60 | 06-03-2023 | 28 | 79.42 | 21.2 | 14.12 |
| 4 | Conventional BEAM | 15 | 15 | 60 | 06-03-2023 | 28 | 83.29 | 19.8 | 14.66 |

## 10. CONCLUSION

1) Compressive strength of conventional cube and bubble deck cube are nearly same

2) Flexural strength of conventional beam and bubble deck beam are nearly same.

3) Reduction In Concrete Is Approximately 17 % As Compared To Conventional.

4) Reduction In self-weight of Concrete Is Approximately 17 % As Compared to Conventional.

5) Cost can be reduced up to 8% as compared to conventional.

6) Concrete can be replaced in 1:6 ratios without much loosing strength.

## 11. FUTURE WORK

1) Check the strength variation in bubble deck slab and conventional concrete slab by using polypropylene balls.

## 12. REFERENCES

a) IS 10262 (2009): Guidelines for concrete mix design proportioning.

b) IS 456: 2000 Plain and Reinforced Concrete.

c) Behavioral Analysis of Conventional Slab and Bubble Deck Slab under various Support and Loading Conditions using ANSYS Work bench by Sameer Ali, Mr. Manoj Kumar.

d) Experimental Study on Bubble Deck Beam by Pathan Taha Mehboob Khan1, Pathan Altamash Mehboob Khan2, Bhalerao Aadesh Ashok, Prof. Kaulkhere R.V.

e) Structural Behavior of Bubble Dec k Slab by P. Prabhu Teja, P. Vijay Kumar, S .Anusha. CH. Mounika, Purnachandra Saha.

f) Experimental study on bubble deck slab by Mr. Muhammad Shafiq Mushfiq, Asst. Prof. Shikha Saini and Asst. Prof. Nishant Rajori.

## BIOGRAPHIES

My name is krupadan samayya jangam and I am an undergraduate in bachelor of engineering in civil engineering from TGPCET, Nagpur.