SEYBOLD Report
ISSN: 1533 - 9211
https://seyboldreport.net/

# EXPERIMENTAL RESEARCH ON THE STRENGTH OF RC BEAM USING CONVENTIONAL CONCRETE AND BUBBLE DECK TECHNOLOGY FOR SUSTAINABLE DEVELOPMENT

**Mr. Sanjay Bhadke** [#1] **Dr Tushar G. Shende** [#2] **Dr. Surendra.R. Kukadapwar** [#3]
#1Research Scholar G. H. Raisoni University, Amravati Maharashtra, India
Email bhadkesanjay4@gmail.com

#2Research Supervisor Associate Professor ,Civil Engineering GH

Raisoni Institute of Engineering and Technology ,Nagpur

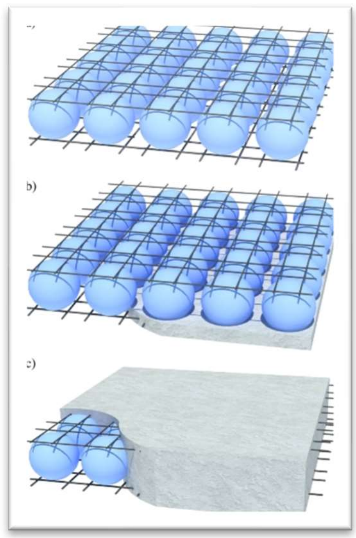
Email tusharshende285.@gmail.com

#3 Research Co-Supervisor HoD ,Civil Engineering Government Polytechnic Nagpur
Email surenkukadapwar.@gmail.com

**Abstract:** A key tectonic component in the construction of houses and buildings is the beam. In essence, the concrete in the centre of the beam, which has no structural value, is removed, considerably reducing the structural dead load. A beam that has spheres of various sizes and shapes in place of its centre is referred to as a bubble beam. The advantages of factory-made materials and components are typically combined with controlled environments, on- and off-site finishing, and the hollow Bubble Deck technology. Numerous advantages are offered, such as reduced total costs, reduced material utilization, increased structural efficiency, quicker construction, and environmental friendliness. In this project, high density polyethylene balls are used in place of the concrete in the beam's middle. The substance most often used globally. This study focuses on the impact of the bubble deck system on the concrete's performance with regard to durability characteristics for structures made of concrete that use bubble deck technology. In order to promote the safe and sustainable use of this cutting-edge technology in the construction sector, the research seeks to give a better knowledge of the long-term durability of bubble deck concrete structures and to identify any possible durability concerns related with its usage.

**1.Primary Introduction:** The horizontal beam is a kind of structural element for buildings that can withstand loads applied to its axis. It initially deflects, then bends. The loads applied to the beam cause reaction forces to be generated at its support points. Shear forces and bending moments are produced inside the beam when all forces acting on it are combined, leading to internal stresses, strains, and deflections. Beams can be recognised by their composition, length, cross-sectional profile, and weight-bearing capacity. Based on how they are supported, beams can be categorized as simply supported, fixed, overhanging, continuous, cantilever, etc. The weight of a beam is passed to surrounding compression structural members, such as columns, walls, or girders, which in turn bear. The building structure is made lighter using the bubble deck technology, which allows for the removal of several columns and beams and overall time savings. Due to its utilization of recycled materials, lower energy consumption, usage of less building materials overall, lower carbon emissions, and lower transportation and crane lifts, bubble deck are more ecologically friendly than conventional concrete construction methods.

**2. Bubble deck Technology:** The most recent technique that lengthens spans to make the depth of the beam lean lowers the self-weight of the beam while preserving the performance of R/f concrete beams is called Hollow Bubble-Deck. The "bubble deck method," a novel construction technique, employs recycled real estate in slabs; by substituting bubbles for portion of the concrete, the structure's self-weight is reduced. When these hollow balls or bubbles are used to fill the spaces in the centre of a beam, the beam's strength is Concrete is the most widely used material worldwide, and RCC projects must be created and constructed correctly to hold the load over the course of their full lives. Customers desire longer slabs for improved aesthetics and space. This method mostly works with intricate, gap-filled, two-directional reinforced concrete slabs. It ensures concrete and energy savings during building construction. This unique, patent-protected technique was created. Air and steel are in close proximity to one another. The bubble deck technique reduces the amount of concrete and cement by 30–50%.The same build-up area significantly decreases carbon emissions when compared to ordinary panels. There is no risk when working since the gaped bubble deck panels are connected.Bubble decks come with a lot of advantages, but they also demand less material, have less effort, cost more, and require lesser expenses. It is also an eco-friendly technology. Punching shear resistance is the last requirement.



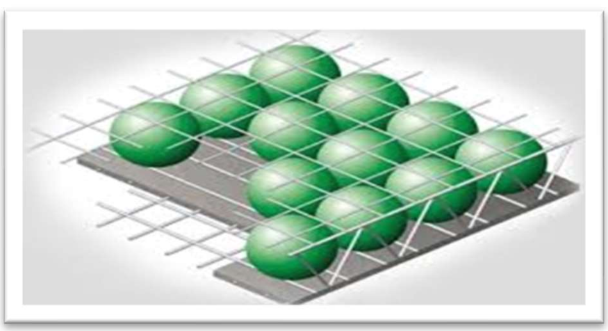


**Fig 1. Polyethylene Hollow Sphere Ball**

## 3. Objectives of Research:

- The usage of a hollow plastic sphere (HDPE, high density polypropylene) in a reinforced concrete structure is the major goal of this test.

- Calculation of the quantity of concrete that can be saved by putting balls inside the structure's core.

- Getting the Bubble Deck framework ready.

- To compare the bubble deck structure's characteristics to those of the traditional construction.

- To examine the flexural strength of the bubble-deck construction to determine its durability.

- Examine the results of incorporating hollow plastic polypropylene balls into a reinforced concrete construction.

## 4. Methodology:

- Create a mix design using grades M 30 and M 35.
- Create a standard concrete cube as well as cubes using 50 mm polypropylene balls.
- Put the concrete cubes to the test and compare their compressive strength to bubble deck cubes.
- Now, using polypropylene balls, construct a conventional beam and a bubble deck beam. Use the balls underneath the slab's and the beam's neutral axis.
- Compare the bubble deck beam and slab with conventional beam and slab by testing the beam for flexural strength and the slab for pulse velocity test and rebound hammer test.
- Calculate how much concrete you can save by utilizing polypropylene balls in step six.
- Calculate the decreased self-weight of the beam and slab without significantly changing their strength values.

## 5. Literature Review:

**Review of Bubble Deck Structures Technology and Their Application by Samantha Konuri and Dr. T.V.S. Varalakshmi, Vol. 8, Issue 10, Oct. 2019.**

An overview of bubble deck technology and its numerous uses is given in the publication "Review on Bubble Deck Structures Technology and Their Application". The authors explain how to build bubble deck constructions, which include employing plastic spheres to make a hole in the concrete slab, resulting in a lighter and more useful structure. The advantages of adopting bubble deck constructions are also covered in the report, including less material use, longer spans, better thermal insulation, and lower carbon emissions. The authors give case studies of bubble deck constructions used in several applications, including residential, commercial, and industrial buildings, and they compare the costs of construction.

**Performance of Structural Behavior of Bubble Deck Structure Vol. 7, No. 6C2, April 2019, ISSN: 2277-3878 by P. Poluraju and L. Lakshmikanth.**

The experimental investigation described in the publication "Performance of Structural Behavior of Bubble Deck Structure" investigates the structural behavior of Bubble Deck constructions. The purpose of the study is to assess the Bubble Deck structure's performance under various loading scenarios and contrast it with more conventional solid slab constructions. Two alternative Bubble Deck constructions, one with spherical voids and the other with elliptical spaces, were used in the studies by the authors. In the investigation, both Bubble Deck and solid slab constructions were subjected to a variety of loadings, such as point loads, dispersed loads, and concentrated loads. The deflection, strain, and stress of the constructions under load were measured by the researchers, and the findings were compared.

**Workbench: Analysis of Conventional Slab and Bubble Deck Slab under Various Support and Loading Conditions by Sameer Ali and Mr. Manoj Kumar.**
The main objective of the study was to perform a behavioral analysis of conventional slab and bubble slab. Both the conventional slab and the slab with a spherical ball in the centre to create voids are evaluated in this comparison study. This research investigated the applicability of traditional slabs vs bubble deck slabs in various locations as distinct components (beam slab, bridge deck slab, etc.). An experiment with a bubble deck slab This study's three primary goals were to compare a bubble deck slab to a conventional slab with a variable b/h ratio and to quantify the amount of concrete that was saved due to the presence of spheres in the slab's core. The aforementioned experiments shown that, despite the bubble deck slabs' reduced load bearing capacity, which rendered them less efficient than conventional slabs, they are nevertheless excellent for slab construction despite the little difference in load bearing capacities between them and conventional slabs. It was advantageous for the bubble deck because the slabs used were between 10.50% and 18% lighter than the typical slab.

**Taguchi Method Application for Concrete Mix Design 2249-8958 Written by Felix K Regi, Philo Mariya, Merin K Varghese, and Abel Antony Johns. Prince Arulraj.**
The application of the Taguchi technique for the design of concrete mixes is discussed in the research article "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. The Taguchi approach is a statistical method that has been effectively utilized in many sectors, including engineering, to optimize the design of goods and processes. Using various mix ratios of cement, fine aggregate, coarse aggregate, and water, the authors of this study performed tests to determine how these mixtures affected the compressive strength of concrete.

**6. Special Materials:**

**Hollow Spherical Balls:** High density polypropylene is used to make bubbles. Typically, they are constructed of a non-porous substance that won't chemically react with the rebar or concrete. The 180mm to 450mm range may be supported by the strength and stiffness of bubbles. The slab's depth might range from 100 mm to 600 mm depending on this. More than 1/9 of the bubble's diameter should separate the bubbles. The bubble may be elliptical or spherical in form.

**Fig 2. Hollow Spherical Balls**

**7. Reinforcement Bar:**

Two meshes, one in the lower section and one in the top half of the panel, which can be knotted or welded, make up the reinforcement. Meshed layers for lateral support and diagonal girders for vertical support of the bubbles are the two forms in which the steel is produced. The spacing between the bars is determined by the size of the bubbles to be employed and the tensile strength of the slab's transverse rib reinforcement. It uses weapons of strength Fe-500 or greater.

**8. Fine Aggregates:**

The grains of the fine aggregate (sand) must be clean, strong, robust, and lasting. Aggregate having a size of 4.75 mm or less is referred to as fine aggregate. The maximum size of a particle is 4.75 mm (3/16 in) and it must be graded down. Anything that might harm concrete or the reinforcement in reinforced concrete construction, such as iron, pyrites, coal, mica, silt, clay, alkali, seashells, organic contaminants, loam, etc., must not be present in the sand. Utilising aggregate that chemically interacts with the alkalis in cement is prohibited. The maximum amount of dangerous substances cannot exceed the limit permitted by the relevant 1.5 Specifications. The amount of silt cannot be more than 8%. Whether it be manufactured, crushed, or natural sand.

**The design criteria taken from IS 10262:2009 are as follows.**

| Sr.No. | Parameter | Data |
|---|---|---|
| 1 | Specific Gravity | 2.34 |
| 2 | Water Absorption | 1.0 |
| 3 | Fineness Modulus | 2.49 |

**Table 1: Design Criteria**

## 9. Concrete Mix Design as per IS Code 10262 -2009:

A certain proportion of cement, sand, coarse aggregate, and water is used to create the heterogeneous, hardened mass known as concrete. The grade varies significantly due to the irregular distribution of the components that go into making concrete. The quantity and ratio in which the components should be blended to create concrete of a specific grade are previously specified in IS 456:2000. The limitation of the regulation is that it only defines material ratios up to grade M25, above which no specific ratio has been approved by industry.In the age of industrial and infrastructural development, a range of high strength concrete that goes far beyond M100 has been created to satisfy the need for high strength concrete and to enhance the general attributes of concrete. The constraints of IS:456 require a fresh approach.

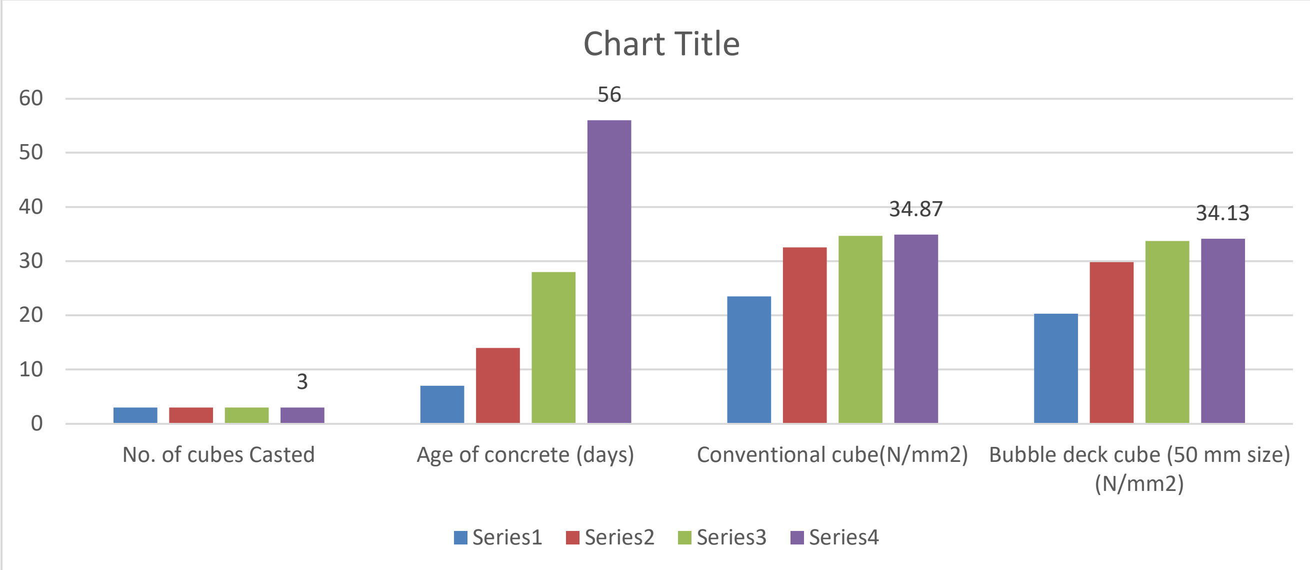
## 10. Test Result:

### Compressive Strength of Concrete of Grade M30

The cube's crash test is determined by this test. By dividing the load applied to the concrete cube at the fracture point by the loaded cube's cross-sectional area (15 x 15 x 15 cm), it is possible to determine the compressive strength of concrete. Concrete samples are tested for their capacity to bear compressive loads using the compressive strength test. A cylindrical or cubical concrete specimen is loaded during the test until it fails or fractures. The compressive strength of the concrete is measured as the highest load that the specimen can support before failing. The compressive strength test findings are used to assess the concrete's quality and make sure it complies with the necessary requirements and standards for strength and durability. Typically, concrete's compressive strength is expressed in mega-Pascals (MPa) or pounds per square inch (psi) units. Concrete’s compressive strength is measured to see whether there have been any changes in strength with the addition of polypropylene balls.

| 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 | 32.50 | 29.8 |
| 3 | 28 | 34.68 | 33.74 |
| 3 | 56 | 34.87 | 34.13 |

**Table 2: Compressive Strength of Cubes**

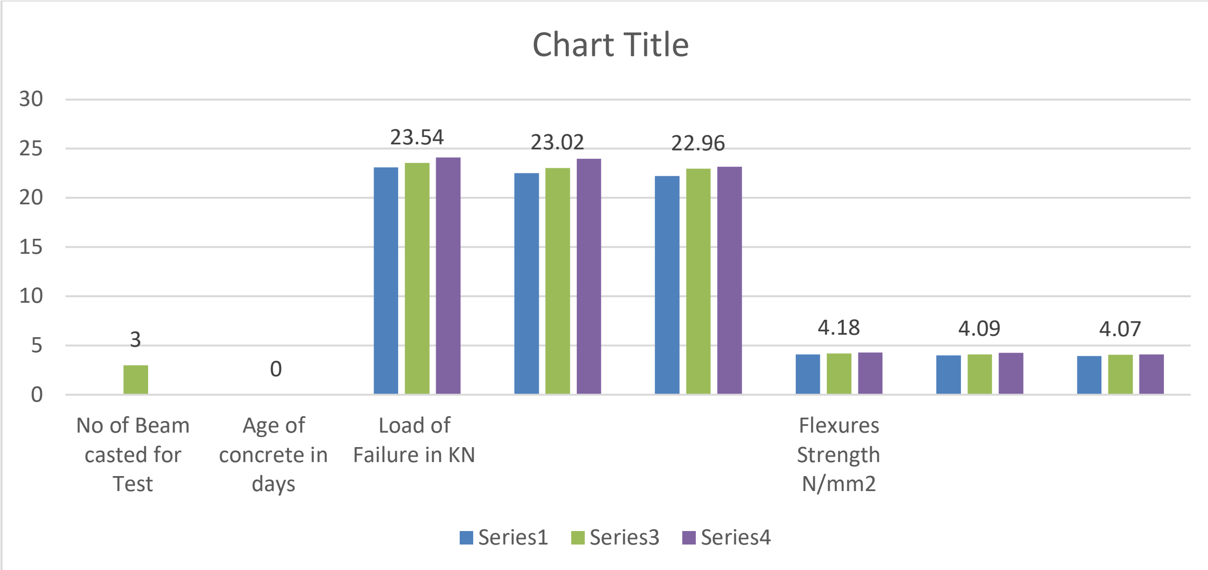



**11. A Screening for Flexure Strength:**

On beams with PP balls, referred to as bubble deck beams and conventional beams, the flexural strength test is conducted. The test is performed at the labs of Becquerel Industries Private Limited, and the results are as follows.

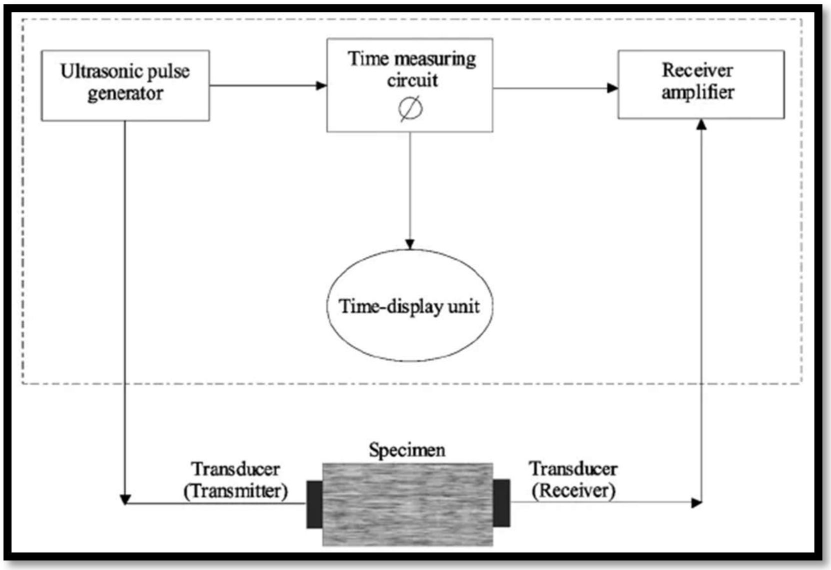
| **No of Beam casted for Test** | **Age of concrete in days** | **Load of Failure in KN** | | | **Flexures Strength N/mm2** | | |
|---|---|---|---|---|---|---|---|
| | | **CC** | **CC** | **CCB** | **CC** | **CC** | **CCB** |
| 03 | Highest days (28) | 23.10 | 22.50 | 22.20 | 4.10 | 4.00 | 3.94 |
| | | 23.54 | 23.02 | 22.96 | 4.18 | 4.09 | 4.07 |
| | | 24.10 | 23.96 | 23.16 | 4.27 | 4.25 | 4.10 |

**Table 3: Flexure Strength of Cubes**




## 12. Test of ultrasonic pulse Velocity:

The ultrasonic pulse velocity test is a non-destructive method of evaluating the quality of the concrete on the project site. In essence, this test gauges how quickly an electrical pulse moves through concrete from a sending transducer to a receiving transducer. The core tenet of the ultrasonic pulse velocity test is that the speed of sound in an object is determined by the square root of the relationship between its density and elastic modulus, or E/P. The material's strength and quality are influenced by its density and elastic properties, respectively. Electrical pulses typically travel between 3 and 5 km/h. The electronic pulse that is created ranges in frequency from 15 kHz to 175 kHz.





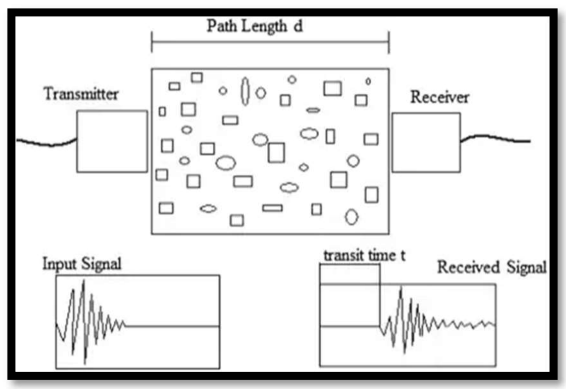



Fig 3. UPV Test Machine Working

| Ultra Sonic Pulse Velocity Km/s | Quality Of Concrete |
|---|---|
| Below 3.0 | Doubtful |
| 3.0 to 3.5 | Medium |
| 3.5 to 4.5 | Good |
| Above 4.5 | Excellent |

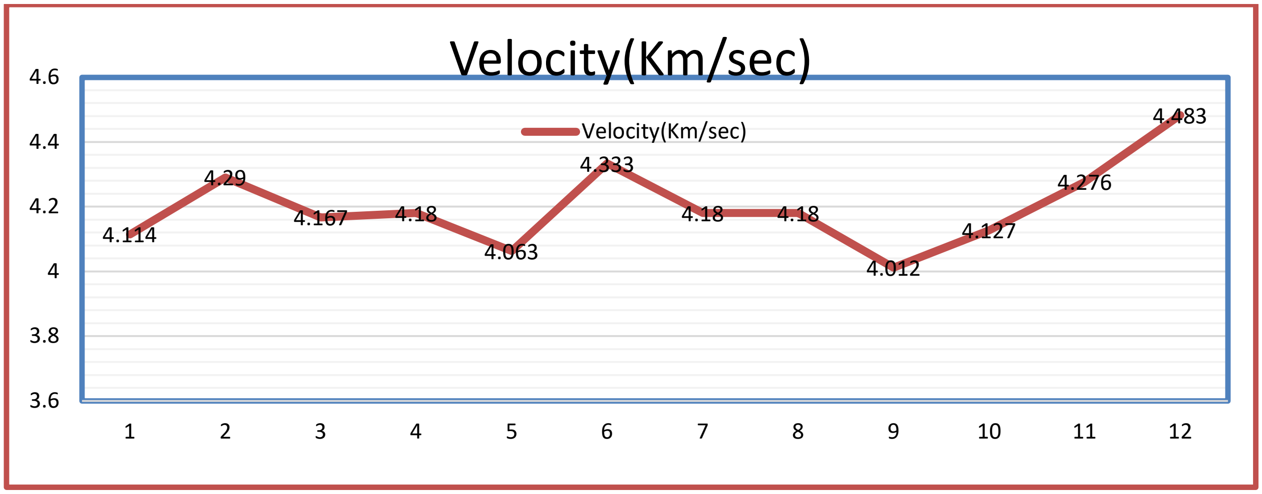
**The following Mesh has been prepared for Ultrasonic Pulse Velocity Test Dimension (1000mm*700mm*130mm size with clear cover included)**

**Bubble deck mesh**

**Test Result of ultrasonic pulse Velocity:**

| Sr. No. | Point ID | Velocity (Km/sec) | Method |
|---|---|---|---|
| 1 | 1 | 4.114 | **Using the Direct Method of Ultrasonic Pulse Velocity.** |
| 2 | 2 | 4.290 | |
| 3 | 3 | 4.167 | |
| 4 | 4 | 4.180 | |
| 5 | 5 | 4.063 | |
| 6 | 6 | 4.333 | |
| 7 | 7 | 4.180 | |
| 8 | 8 | 4.180 | |
| 9 | 9 | 4.012 | |
| 10 | 10 | 4.127 | |
| 11 | 11 | 4.276 | |
| 12 | 12 | 4.483 | |

**Table 4 UPV Test Results**




**Result: Ultrsonic pulse velocity test indicated that the tested specimen having Good Quality of Concrete**

## 13.Rebound Hammer Test:

Rebound Hammer testing is a non-destructive technique that provides a rapid and simple assessment of the compressive strength of concrete. The rebound hammer, often referred to as a Schmidt hammer, is composed of a mass that is moved along a plunger inside a tubular casing by a spring under the control of the plunger. When the plunger of the rebound hammer is forced on the surface of the concrete, a spring-controlled mass with constant energy is made to impact the surface. The amount of rebound, which gauges surface hardness, is measured on a scale. The measurement is called the Rebound Number, often referred to as the Rebound Index. Concrete with low strength and stiffness will absorb more energy and have a lower rebound value.

SEYBOLD Report
ISSN: 1533 - 9211



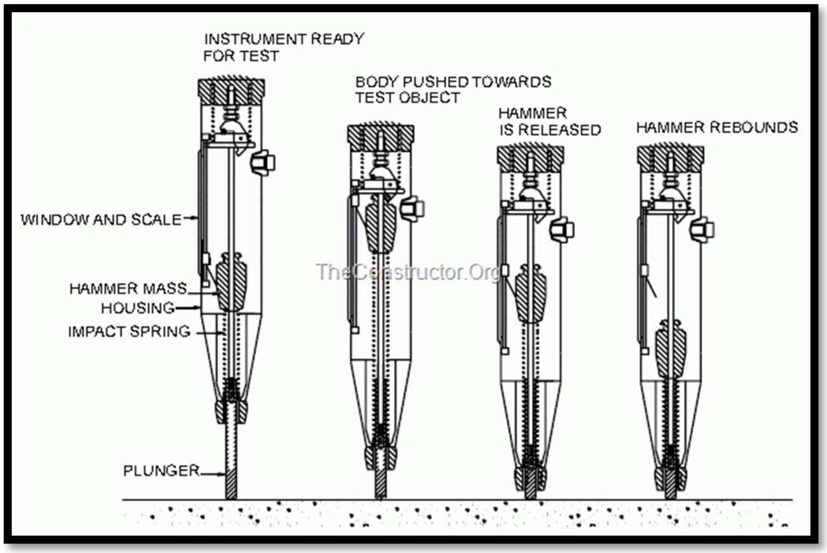
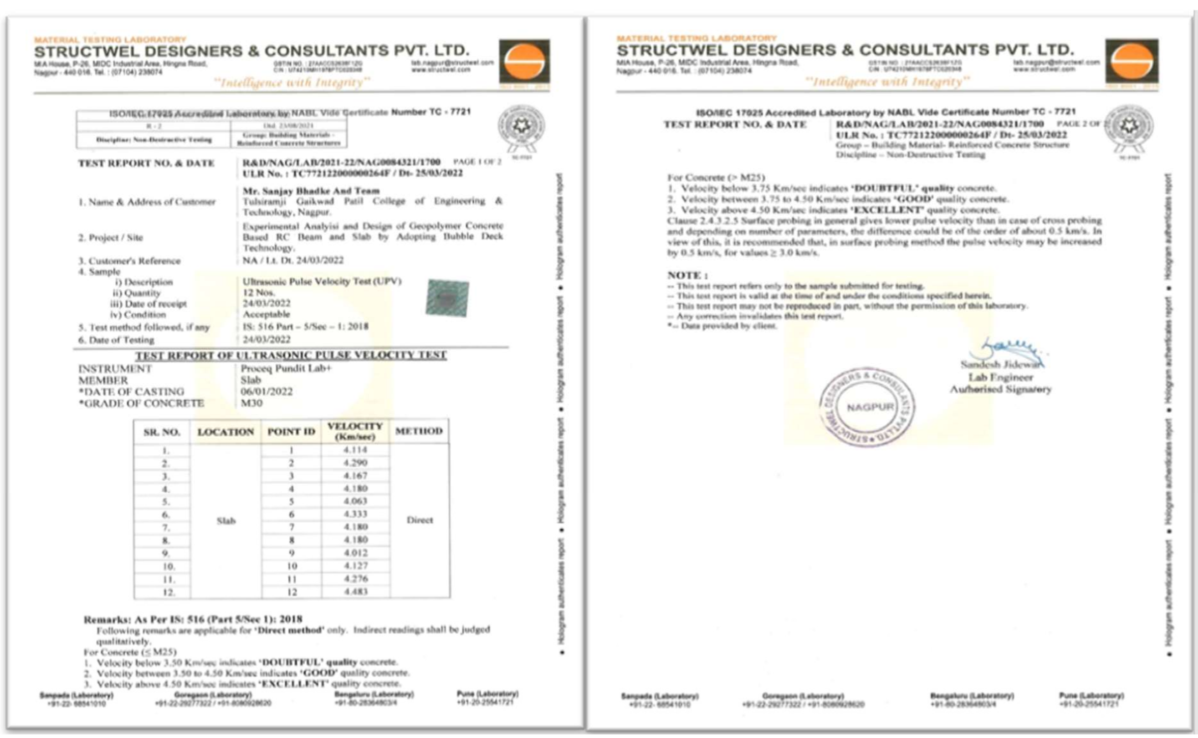



**Fig 4: Rebound Hammer Apparatus**

## 14. Laboratory Test Result:



MATERIAL TESTING LABORATORY
STRUCTWEL DESIGNERS & CONSULTANTS PVT. LTD.
MIA House, P-26, MIDC Industrial Area, Hingna Road, Nagpur - 440 016. Tel. : (07104) 238074
lab.nagpur@structwel.com www.structwel.com
"Intelligence with Integrity"

ISO/IEC 17025 Accredited Laboratory by NABL Vide Certificate Number TC - 7721

| | |
|---|---|
| TEST REPORT NO. & DATE | R&D/NAG/LAB/2021-22/NAG0084321/1700 PAGE 1 OF 2<br>ULR No. : TC772122000000264F / Dt- 25/03/2022 |
| 1. Name & Address of Customer | Mr. Sanjay Bhadke And Team<br>Tulsiramji Gaikwad Patil College of Engineering & Technology, Nagpur. |
| 2. Project / Site | Experimental Analyisi and Design of Geopolymer Concrete Based RC Beam and Slab by Adopting Bubble Deck Technology. |
| 3. Customer's Reference | NA / Lt. Dt. 24/03/2022 |
| 4. Sample | |
| i) Description | Ultrasonic Pulse Velocity Test (UPV) |
| ii) Quantity | 12 Nos. |
| iii) Date of receipt | 24/03/2022 |
| iv) Condition | Acceptable |
| 5. Test method followed, if any | IS: 516 Part – 5/Sec – 1: 2018 |
| 6. Date of Testing | 24/03/2022 |

TEST REPORT OF ULTRASONIC PULSE VELOCITY TEST

| | |
|---|---|
| INSTRUMENT | Proceq Pundit Lab+ |
| MEMBER | Slab |
| *DATE OF CASTING | 06/01/2022 |
| *GRADE OF CONCRETE | M30 |

| SR. NO. | LOCATION | POINT ID | VELOCITY (Km/sec) | METHOD |
|---|---|---|---|---|
| 1. | Slab | 1 | 4.114 | Direct |
| 2. | | 2 | 4.290 | |
| 3. | | 3 | 4.167 | |
| 4. | | 4 | 4.180 | |
| 5. | | 5 | 4.063 | |
| 6. | | 6 | 4.333 | |
| 7. | | 7 | 4.180 | |
| 8. | | 8 | 4.180 | |
| 9. | | 9 | 4.012 | |
| 10. | | 10 | 4.127 | |
| 11. | | 11 | 4.276 | |
| 12. | | 12 | 4.483 | |

**Remarks: As Per IS: 516 (Part 5/Sec 1): 2018**
Following remarks are applicable for '**Direct method**' only. Indirect readings shall be judged qualitatively.
For Concrete (≤ M25)
1. Velocity below 3.50 Km/sec indicates '**DOUBTFUL' quality** concrete.
2. Velocity between 3.50 to 4.50 Km/sec indicates '**GOOD**' quality concrete.
3. Velocity above 4.50 Km/sec indicates '**EXCELLENT**' quality concrete.

Sanpada (Laboratory) Goregaon (Laboratory) Bengaluru (Laboratory) Pune (Laboratory)

MATERIAL TESTING LABORATORY
STRUCTWEL DESIGNERS & CONSULTANTS PVT. LTD.
MIA House, P-26, MIDC Industrial Area, Hingna Road, Nagpur - 440 016. Tel. : (07104) 238074
lab.nagpur@structwel.com www.structwel.com
"Intelligence with Integrity"

ISO/IEC 17025 Accredited Laboratory by NABL Vide Certificate Number TC - 7721
TEST REPORT NO. & DATE R&D/NAG/LAB/2021-22/NAG0084321/1700 PAGE 2 OF 2
ULR No. : TC772122000000264F / Dt- 25/03/2022
Group – Building Material- Reinforced Concrete Structure
Discipline – Non-Destructive Testing

For Concrete (> M25)
1. Velocity below 3.75 Km/sec indicates '**DOUBTFUL' quality** concrete.
2. Velocity between 3.75 to 4.50 Km/sec indicates '**GOOD**' quality concrete.
3. Velocity above 4.50 Km/sec indicates '**EXCELLENT**' quality concrete.

Clause 2.4.3.2.5 Surface probing in general gives lower pulse velocity than in case of cross probing and depending on number of parameters, the difference could be of the order of about 0.5 km/s. In view of this, it is recommended that, in surface probing method the pulse velocity may be increased by 0.5 km/s, for values ≥ 3.0 km/s.

**NOTE :**
-- This test report refers only to the sample submitted for testing.
-- This test report is valid at the time of and under the conditions specified herein.
-- This test report may not be reproduced in part, without the permission of this laboratory.
-- Any correction invalidates this test report.
*-- Data provided by client.

Sandesh Jidewar
Lab Engineer
Authorised Signatory

STRUCTWEL DESIGNERS & CONSULTANTS PVT. LTD. NAGPUR

Sanpada (Laboratory) Goregaon (Laboratory) Bengaluru (Laboratory) Pune (Laboratory)

BECQUEREL INDUSTRIES PVT. LTD.
Testing Laboratory
TC-6382
FORMAT NO. : BIPL/QSFM/7.8/01
ISO / IEC - 17025 ACCREDITED TESTING LABORATORY BY NABL VIDE CERTIFICATE NO. TC-6382

**TEST REPORT**

| | | | |
|---|---|---|---|
| Name of Contractor: | **To the Principal of Tulsiramji Gaikwad-Patil College of Engineering and Technology (TGPCET)** | Page No. | 01 of 06 |
| Address of Customer: | Nagpur | Report No. | BIPL/1446/23 |
| Name of Client | **Nil** | ULR No. | **TC6382230000**01025F |
| Name of Project | **"Investigation on durability parameter of concrete adopting bubble deck technology and its validation "** | Report Date | 05.05.2023 |
| | | Customer Ref No. | Nil |
| Group | Building Material Reinforced Concrete Structure | BIPL Ref No. | SRAF No. 1446/23, Dt-04.05.2023 |
| Discipline | Non-Destructive Testing | Environmental Condition | Satisfactory |
| Dt. of Test Conducted | 04.05.2023 | Temp. | 32.4°C |
| Name of Test | Rebound Hammer (RH), Ultrasonic Pulse Velocity (UPV). | Test Method | As Per IS 516 (Part 5/Sec 4): 2020 & IS: 516 P-5 SEC-1, 2018. |

**1. INTRODUCTION**

Non-Destructive testing of Pole Foundation structure was conducted for project of **"4 Investigation on durability parameter of concrete adopting bubble deck technology and its validation"** and was conducted for **"To the Principal of Tulsiramji Gaikwad-Patil College of Engineering and Technology (TGPCET)"** (Customer). The NDT was intended to determine the strength and quality of the concrete at selected location. Scope of the work included Rebound Hammer (RH), Ultrasonic Pulse Velocity (UPV).

**2. TEST DETAILS**

Tests were conducted on selected point of RCC Slab structure. For every structure, the number and the location of points for testing were directed and guided by costumer officials.

For UPV test Direct measurements were recorded. Rebound Hammer tests were conducted at 10 spots (minimum 25 mm apart) for each point. As per the instruction of engineer in-charge Rebound hammer and UPV were perform at 300mm X 300m grid

CONDITIONS :
1) The results relate only to the items tested / Calibrated
2) The use of report for arbitration, publicity and evidence in legal dispute is forbidden except with prior written consent of B.I.P.L. Test Lab
3) All disputes are subject to Nagpur jurisdiction & Any correction to this report invalidates this report.

Regd. Office : 3, New Trimurti Co-op. Hsg. Society, Ingole Nagar, Wardha Road, Nagpur - 440005, Maharashtra (INDIA)
Cell : +91 - 9822565879, 7410084364 | Email : info@biplndt.com, spectro@biplndt.com | Website : www.biplndt.in | CIN No. - U29268MH2010PTC208424
LAB : A-36, MIDC INDUSTRIAL AREA, BUTIBORI, NAGPUR - 441 122

BECQUEREL INDUSTRIES PVT. LTD.
Testing Laboratory
TC-6382
FORMAT NO. : BIPL/QSFM/7.8/01
ISO / IEC - 17025 ACCREDITED TESTING LABORATORY BY NABL VIDE CERTIFICATE NO. TC-6382

**TEST REPORT**

| | | | |
|---|---|---|---|
| Name Of Customer | **M/s. Krupadan Jangam and Group (Civil Engg.)** | Page No | 01 Of 01 |
| Address Of Customer | T.G.P.C.E.T. Mohgaon, Nagpur. | Report No | BIPL/0911/23 |
| Name Of Agency | Nil | Report Date | 03-04-2023 |
| Name Of Project | Investigation On Durability Parameters Of Concrete Adopting Bubble Deck Technology | Customer Ref. No | Nil |
| Sample Description | **Concrete Beam (M-30 Grade)** | BIPL Ref. No. | SRAF/0911/23 Dtd. 21-03-2023 |
| No. Of Samples | 04 Nos. | Sampled By | Customer |
| Dt. Of Sample Received | 21-03-2023 | Name Of Test | Flexural Strength Test |
| Dt. Of Test Conducted | From 21-03-2023 & 03-04-2023 | Test Method | IS 516 : (Part-1/Sec-1) : 2021 |
| Discipline | Mechanical | Group | Building Materials |

The result of the test conducted on received samples are as follows.

| Sr. No. | SAMPLE IDENTIFICATION | Width (B) cms | Depth (D) cms | Span Length cms | Date Of Casting | Age of Specimen In Days | Load at Failure (P) KN | Fracture Position (A) cms | Flexural Strength $N/mm^2$ |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Bubble Deck | 15 | 15 | 60 | 06-03-2023 | 15 | 65.00 | 19.5 | 11.27 |
| 2 | Conventional | 15 | 15 | 60 | 06-03-2023 | 15 | 72.00 | 18.5 | 11.84 |
| 3 | Bubble Deck | 15 | 15 | 60 | 06-03-2023 | 28 | 79.42 | 21.2 | 14.12 |
| 4 | Conventional | 15 | 15 | 60 | 06-03-2023 | 28 | 83.29 | 19.8 | 14.66 |

Reviewed by
Mr. Akshay Lode
Dy. Technical Manager

For, Becquerel industries pvt. Ltd
Authorised Signatory

End Of Report

CONDITIONS :
1) The results relate only to the items tested / Calibrated
2) The use of report for arbitration, publicity and evidence in legal dispute is forbidden except with prior written consent of B I P L Test Lab
3) All disputes are subject to Nagpur jurisdiction & Any correction to this report invalidates this report.

Regd. Office : 3, New Trimurti Co-op. Hsg. Society, Ingole Nagar, Wardha Road, Nagpur - 440005, Maharashtra (INDIA)
Cell : +91 - 9822565879, 7410084364 | Email : info@biplndt.com, spectro@biplndt.com | Website : www.biplndt.in | CIN No. : U29268MH2010PTC208424
LAB : A-36, MIDC INDUSTRIAL AREA, BUTIBORI, NAGPUR - 441 122

Page: 5 of 06 Report No.: 1446 TC6382230000001025F Date: 05.05.2023

**5. RESULTS**
**Rebound Hammer & UPV Test Results: -**

| Pts | Sr. No. | Location | Point ID | Rebound number Average of 10 Value | Comp. Strength (Mpa) | Measured UPV (m/s) | | | Temp. of concrete | Temperature Correction if >=30°C | Corrected value of UPV (m/s) | Concrete Quality Grading (M≤M25) | Concrete Quality Grading (M>M25) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Direct (A) | Semi-Direct (B) | In-Direct (C) | (°C) | *Deduction 5% value(D) | Direct (A-D) | | |
| Bouble Deck Slab (600 X 600 mm) | | | | | | | | | | | | | |
| 1 | 1 | Deck Slab Surface | 1 | 39 | 34 | 4483 | | | 32.4 | 224 | 4259 | Good | Good |

*Correction applied only where temperatures are between 30- 60°C as per IS 516 PART 5 (Sec 1) Clause no. B-1.4

End of Report

Verified & Approved By
Mr. Rishikesh Khope
(Technical Manager)

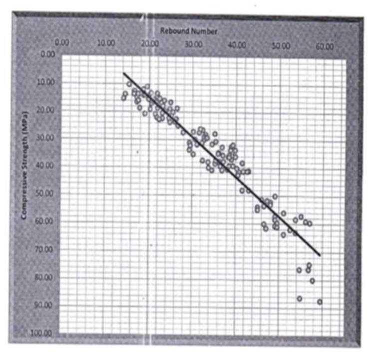
For, Becquerel Industries Pvt. Ltd.
Mr. Jeevan Ghime
(Authorized Signatory)

- The result obtained from site.
- The above result relates only to the location(s) where the test(s) has been conducted.
- Any query regarding report may be reported immediately.

Page: 6 of 06 Report No.: 1446 TC6382230000001025F Date: 05.05.2023

**ANNEXURE**

Strength estimation graph of Rebound Hammer:




## 15. Conclusion and Future Scope

- Conventional and bubble deck cubes have roughly equal compressive strengths.
- The flexural strengths of bubble deck beams and conventional beams are essentially

equal.

- Concrete Has A Reduction Of Around 17% From Conventional.
- Concrete has a self-weight reduction of around 17% compared to conventional.
- Cost savings of up to 8% against conventional methods are possible.
- The strength of concrete may be substituted in 1:6 ratios with little loss.
- Despite these difficulties, research on bubble deck technology has shed light on the potential advantages of this novel building technique. The future of sustainable building may be significantly impacted by bubble deck technology since it offers a variety of benefits in terms of weight reduction, energy efficiency, and design flexibility.
- Future study in this area should concentrate on overcoming the remaining difficulties and restrictions of bubble deck technology, as well as looking into new uses and design options. This can entail more testing and research in the lab, longer-term case studies, and practical applications in various environments and climates. The technological viability, economic viability, and commercial potential of bubble deck technology will ultimately determine its success.

**16. Reference:**


- IS 10262 (2009): Proportioning guidelines for concrete mix designs.
- Plain and reinforced concrete, IS 456: 2000.
- Sameer Ali and Mr. Manoj Kumar's Behavioral Analysis of Conventional Slab and Bubble Deck Slab under Various Support and Loading Conditions Using ANSYS Workbench.
- Pathan Taha Mehboob Khan1, Pathan Altamash Mehboob Khan2, Bhalerao Aadesh Ashok, and Prof. Kaulkhere R.V. conducted an experimental study on a bubble deck beam.
- Bubble Dec k Slab Structural Behavior by P Prabhu Teja, P Vijay Kumar, S Anusha CH. Mounika, and Purnachandra Saha.
- Mr. Muhammad Shafiq Mushfiq, Assistant Professor Shikha Saini, and Assistant Professor Nishant Rajori conducted an experimental investigation on a bubble deck slab.
- Wissam D. Salman, Nazar K. Ali, and Amer M. Ibrahim (June 2019). Flexibility of reinforced materials.
- Pathan Taha Mehboob Khan1, Pathan Altamash Mehboob Khan2, Bhalerao Aadesh Ashok, and Prof. Kaulkhere R.V. conducted an experimental study on a bubble deck beam.
- Bubble Dec k Slab Structural Behaviour by P Prabhu Teja, P Vijay Kumar, S Anusha CH. Mounika, and Purnachandra Saha.
- Mr. Muhammad Shafiq Mushfiq, Assistant Professor Shikha Saini, and Assistant Professor Nishant Rajori conducted an experimental investigation on a bubble deck slab.
- Wissam D. Salman, Nazar K. Ali, and Amer M. Ibrahim (June 2018). "Flexural capacities of reinforced concrete two-way bubble deck slabs of plastic spherical voids", Diyala Journal of Engineering Sciences, ISSN 1999-8716, Vol. 6, No. 2, June 2019.