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An Investigation of the Endurance of RCC Beam Built Utilizing Conventional Concrete and the More Affordable Bubble Deck Technique of Field Building

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Beams are an essential tectonic element in the construction of homes and other structures. By essentially removing the non-structural concrete from the core of the beam, the structural dead load is significantly decreased. A bubble beam is one where the core is replaced with spheres of varying sizes and shapes. Hollow Bubble Deck technology, controlled settings, on- and off-site finishing, factory-made materials and components, and regulated conditions all have advantages. Many benefits are provided, including lower overall costs, less material consumption, improved structural efficiency, quicker construction, and environmental friendliness. In this project, the midsection of the beam is made of high-density polyethylene balls rather than concrete. the information that comes up most frequently.

Keywords: Bubble Beam Technology, Hollow Bubble Deck, Structural Efficiency.

1. Introduction

One type of structural element that deflects first before bending and is utilised in structures that can support weights applied to its axis is the horizontal beam. Reaction forces are produced at the beam's support points by the loads applied to it. When all the forces operating on the beam combine, shear forces and bending moments result in internal stresses, strains, and deflections. The material, length, cross-sectional profile, and weight-bearing capacity of beams can all be used to identify them. Beams can be classified as simply supported, fixed, overhanging, continuous, cantilever, etc. depending on how they are supported. A beam's weight is shared by nearby compression structural elements like walls, girders, and columns, which in turn support the beam

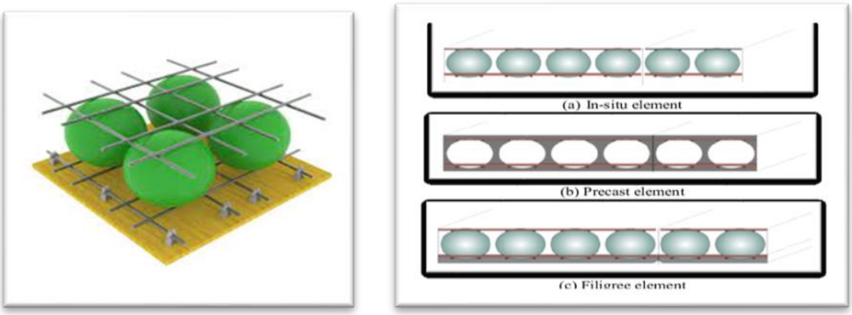

Fig 1. Bubble deck Beam

Bubble Deck Method: The latest method, known as Hollow Bubble-Deck, lowers the beam's self-weight and maintains the performance of R/F concrete beams by lengthening spans to make the beam lean. Known as the "bubble deck method," this creative building technology uses recycled real estate in slabs; to lower the self-weight of the structure, some of the concrete is replaced with bubbles. The beam gets stronger when these empty balls or bubbles are placed inside the core voids. Since concrete is the most widely used material worldwide, RCC constructions need to be correctly designed and built to withstand the load for the duration of their lives. Customers prefer longer slabs since they look better and require more space.

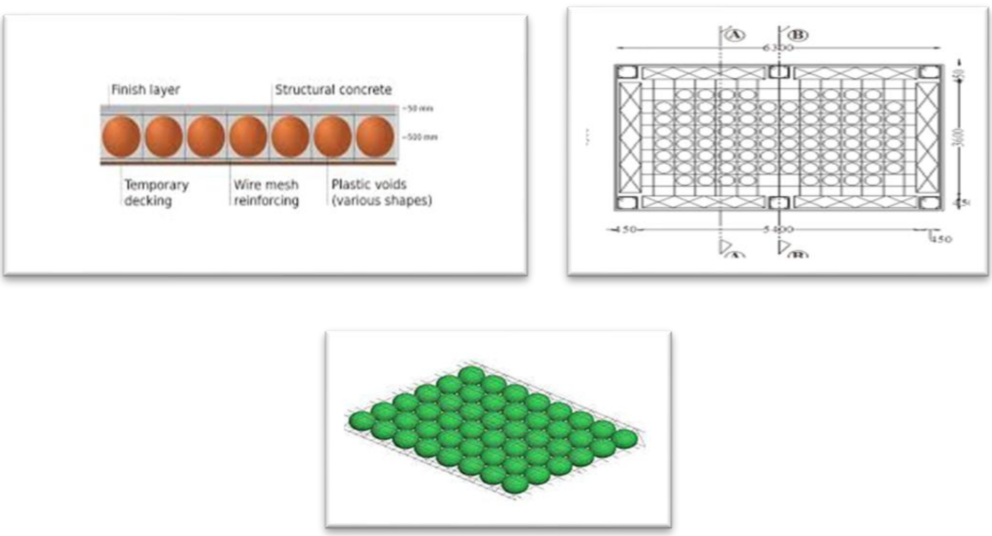

Fig 2. Polyethylene Hollow Sphere Ball

2. Objectives:

- The main objective of this test is to determine if using a hollow plastic sphere composed of high-density polyethylene (HDPE) in reinforced concrete constructions is appropriate..
- A calculation is made to determine how much concrete can be saved by placing balls in the middle of the structure.
- Preparing the Bubble Deck structure.
- To contrast the features of the bubble deck structure with those of the conventional construction.
- To evaluate the bubble-deck construction's flexural strength in order to determine how durable it is.
- Examine the effects of incorporating hollow polypropylene balls into a structure made of reinforced concrete.

3. Methodology:

- Prepare a mixed design with M 30 and M 35 grades.
- Create a standard concrete cube as well as cubes that include 50 mm polypropylene balls.
Compare the concrete cubes' compressive strength to that of the bubble deck cubes by testin g them.
- Next, construct a normal beam and a bubble deck beam out of polypropylene balls. Use the balls below the slab's and the beam's neutral axes.
- Examine the flexural strength of the beam and the outcomes of the pulse velocity an d rebound hammer tests on the slab in order to compare the bubble deck beam and slab to th e traditional beam and slab.
- Determine the amount of concrete that can be saved by using the polypropylene balls in step six.
- Determine the reduced self-weight of the slab and beam without appreciably altering their strength values

Materials used for Experiment:

Hollow Spherical Balls, High density polypropylene is used to make bubbles. Typically, they are composed of a non-porous substance that won't undergo any chemical reactions with the rebar or concrete. The range of 180 to 450 mm may be supported by the strength and stiffness of the bubbles. The slab's depth could range from 100 mm to 600 mm depending on this. There should be more space between the bubbles than 1/9 of their diameter. The bubble may have an elliptical or spherical form.

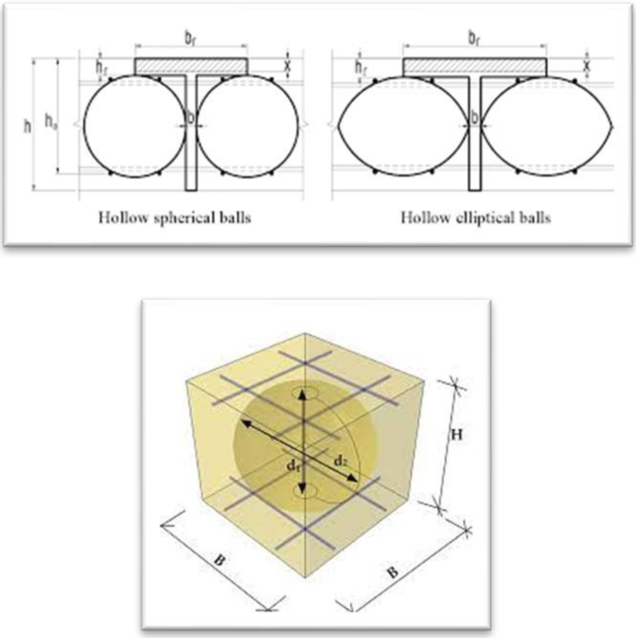

Fig 3. Hollow Spherical Balls

Reinforcement Bar:

The reinforcement consists of two meshes that can be knotted or welded together, one in the upper and one in the lower part of the panel.Two different kinds of steel are made: diagonal girders for the bubbles' vertical support and mesh layers for their lateral support.The size of t he bubbles to be used and the transverse rib reinforcement of the slab's tensile strength dictat e the distance between the bars. It employs weapons with a minimum Fe-500 strength.

Fine Aggregate:

Sand, or fine aggregate, requires grains that are strong, long-lasting, clean, and resilient. Fine aggregate is defined as aggregate that is 4.75 mm or smaller. Filtration is required since the maximum size of the particles is 4.75 mm (3/16 in). Sand cannot contain any of the following materials: iron, pyrites, coal, mica, silt, clay, alkali, seashells, organic pollutants, loam, etc. that could damage concrete or the reinforcing in reinforced concrete construction. It is forbidden to use aggregate that interacts chemically with the cement's alkalis. No more dangerous goods than those allowed by the applicable 1.5 Specifications may be present. There is an 8% maximum silt allowance. Whether the sand is natural, manufactured, or ground into a powder.

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

Sr.No.	Parameter	Data
1	Specific Gravity	2.30
2	Water Absorption	1.0
3	Fineness Modulus	2.48

The specific gravity of an object is the density of that object divided by the density of water. The density of water is 1,000 kilograms per meter cubed. For instance,

Fraction	Specific Gravity	SSD	WA (%)	NMC (%)	DRY	PLANT	BATCH (For 0.038 cum)
Cement (Kg)	3.15	360.00	-	-	360	360	13.68
Water (Kg)	1	136.80	-	-	160	160	6.08
Additive (Kg)		1.62	-	-	1.62	1.62	0.06
Sand (Kg)	2.517	834.00	1.87		819	819	31.1
20 mm (Kg)	2.799	555.96	0.41	0	554	554	21.04
10 mm (Kg)	2.789	679.50	0.59	0	676	676	25.67
Totals		2568	-	-	2568	2568	97.6

Fraction	Specific Gravity	SSD	WA (%)	NMC (%)	DRY	PLANT	BATCH (For 0.038 cum)
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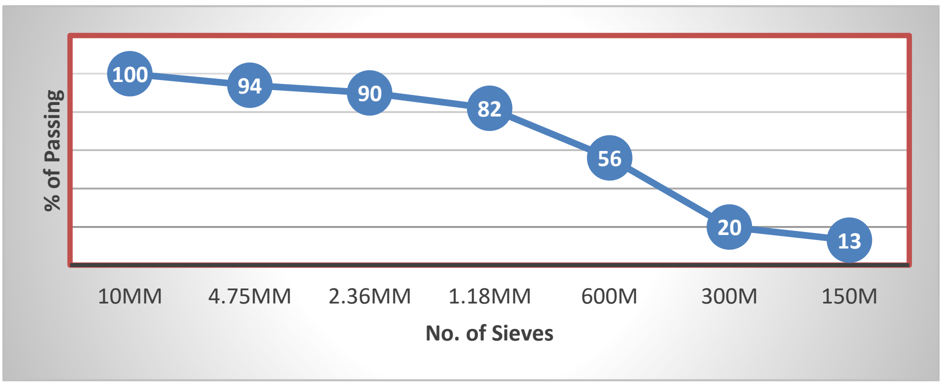
10 mm (Kg)	2.789	679.50	0.59	0	676	676	25.67
Totals		2568	-	-	2568	2568	97.6

Table 1: Design Criteria



Sieve Analysis Results for Fine Aggregate

Coarse Aggregate: Granular, inert, and inorganic materials constitute the definition of aggregates. Stone or solids produced of recycled stone are typically used to make aggregates. Aggregates can be used with cementing agents like Portland or Asphalt cement to create composite materials or concrete, or they can be used alone (in road bases and other types of fill). There is created four times as much concrete with Portland cement as there is Portland cement concrete. It makes sense that a constituent with such a significant mass percentage would have a significant impact on the characteristics of both fresh and hardened products. As shown below, aggregates can be categorized into several classes according to a range of features. Aggregates exhibit a range of physical characteristics.

Coarse aggregate that is firm, dense, and durable without coating must make up a coarse aggregate. Only when specifically noted in the bill of quantities may gravel aggregate be utilized. If not, it will be assumed that the only acceptable coarse material is crushed rock. The aggregate must be devoid of harmful levels of alkali, organic matter, and other undesirable substances.

Sieve no.	Weight retained (g)	Cumulative weight retained (g)	Cumulative weight in %	% of weight pass
40mm	0	0	0	100
20mm	370	370	7.4	92.6
12.5mm	3570	3940	78.8	21.2
10mm	730	4670	93.4	6.6
4.75mm	310	4980	99.6	0.4
Pan	20	5000	100	0

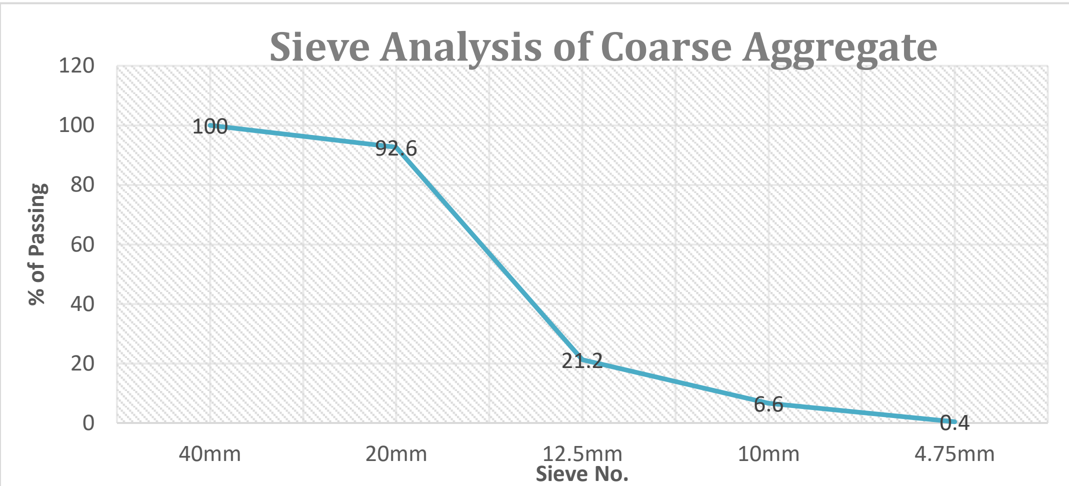
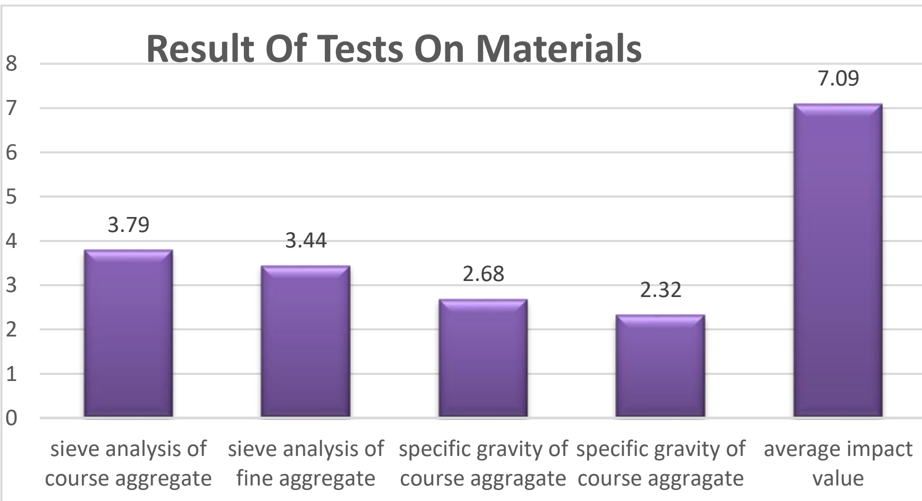


Table 1 (B) Sieve Analysis Results for Coarse Aggregate



Final Result sheet for basic test on materials

Design of Concrete Mix according to IS Code 10262 - 2009:

Concrete is a hardened mass made of a specified amount of water, sand, cement, and coarse aggregate. The grade differs significantly because the chemicals that go into making concrete are not evenly distributed. The proportions and amounts of elements required to make concrete of a specific grade are laid out in IS 456:2000. One drawback of the regulation is that it solely covers material ratios up to grade M25, beyond which no particular ratio has been accepted by the industry. In the era of expanding industries and infrastructure, a form of high strength concrete that greatly surpasses strength. M100 has been manufactured in response to the need for high

M-35 Mix Designs as per IS-10262-2009

Clause IS 456-2000

M-35 CONCRETE MIX DESIGN		
As per IS 10262-2009		
A-1	Stipulations for Proportioning	
1	Grade Designation	M35
2	Type of Cement	PPC 53 grade
3	Maximum Nominal Aggregate Size	20 mm
4	Minimum Cement Content	300 kg/m^3
5	Maximum Water Cement Ratio	0.45
6	Workability	50-75 mm (Slump)
7	Exposure Condition	Moderate
8	Degree of Supervision	Good
9	Type of Aggregate	Crushed Angular Aggregate
10	Maximum Cement Content	450 kg/m^3
11	Chemical Admixture Type	Superplasticiser
A-2	Test Data for Materials	
1	Cement Used	OPC 53 grade
2	Sp. Gravity of Cement	3.16
3	Sp. Gravity of Water	1.00
4	Chemical Admixture	BASF Chemicals
5	Sp. Gravity of 20 mm Aggregate	2.68
	Sp. Gravity of fine Aggregate	2.32
7	Sp. Gravity of Sand	2.2
8	Sieve Analysis of Individual CoarseAggregates	Separate Analysis Done
9	Sieve Analysis of Combined CoarseAggregates	Separate Analysis Done
A-3	Target Strength for Mix Proportioning	
1	Target Average Compressive Strength	43.25 N/mm^2
A-4	Selection of Water Cement Ratio	
1	Maximum Water Cement Ratio	0.45
2	Adopted Water Cement Ratio	0.40
A-5	Selection of Water Content	
1	Maximum Water content (10262-table-2)	186 kg

3	Superplasticizer used	0.5 % by wt. of cement
A-6	Calculation of Cement Content	
1	Water Cement Ratio	0.40
2	Cement Content (186/0.4)	465 kg/m^3
		Which is greater than 320 kg/m^3

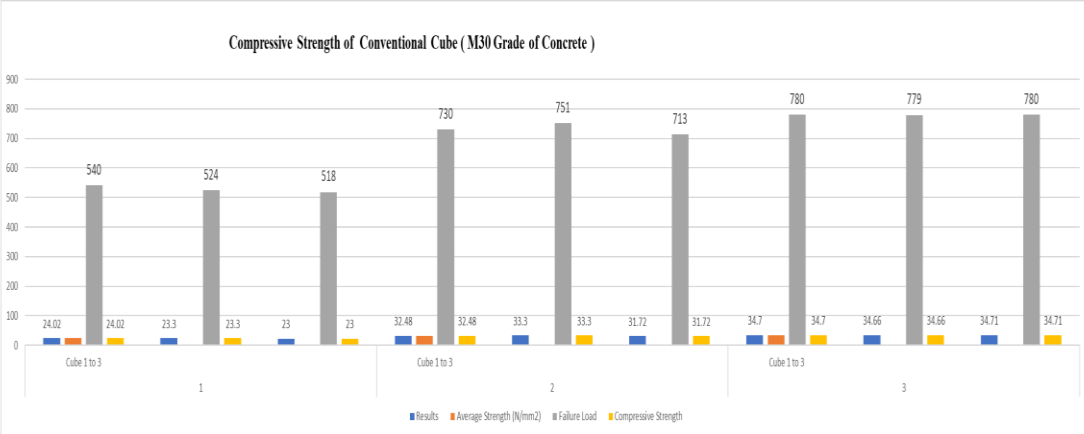
A-7	Proportion of Volume of Coarse Aggregate & Fine Aggregate Content	
1	Vol. of C.A. as per table 3 of IS 10262	62.00%
2	Adopted Vol. of Course Aggregate	63.00%
	Vol of fine aggregate (1-0.62)	38%
A-8	Mix Calculations	
1	Volume of Concrete in m^3	1.00
2	Volume of Cement in m^3	0.172
	(Mass of Cement) / (Sp. Gravity ofCement)x1000	
3	Volume of Water in m^3	0.186
	(Mass of Water) / (Sp. Gravity ofWater)x1000	
4	Volume of Admixture @ 0.5% in m^3	0.00386
	(Mass of Admixture)/(Sp. Gravity of Admixture)x1000	
5	Volume of All in Aggregate in m^3	0.642
A-9	Mix Proportions for One Cum of Concrete	
1	Mass of Cement in kg/m^3	465
2	Mass of Water in kg/m^3	186
3	Mass of Fine Aggregate in kg/m^3	646.49
4	Mass of Coarse Aggregate in kg/m^3	1074.70
5	Mass of Admixture in kg/m^3	1.97
6	Water Cement Ratio	0.4

Test Result:

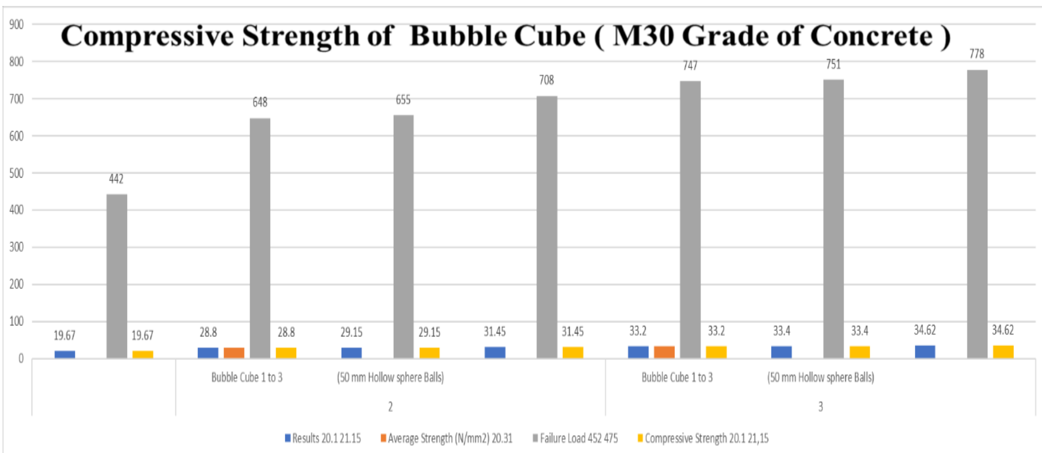
Compressive Strength of Concrete of Grade M30:

The cube's crash test is determined by this test. The force applied to the cube at the fracture point can be divided by the loaded cube's cross-sectional area (15 x 15 x 15 cm) to determine the compressive strength of the concrete. A concrete sample's ability to sustain compressive stresses is ascertained by the compressive strength test. A cylindrical or cubic concrete specimen is loaded until it breaks or fails during the test. The compressive strength of the concrete is determined by taking the highest load that a specimen can support before failing. The compressive strength test findings are used to assess the quality of the concrete and make sure that all standards for strength and durability are satisfied.

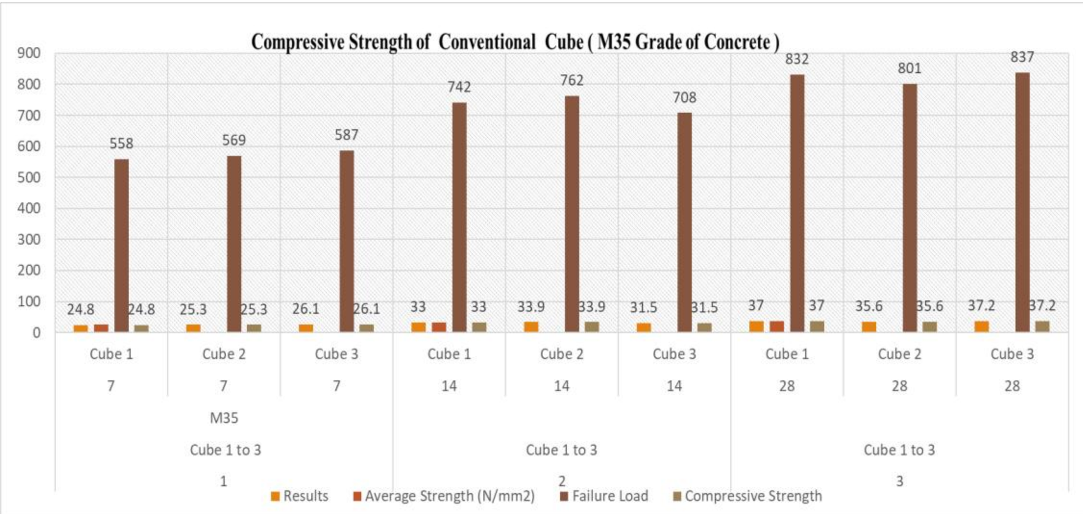
Compressive Strength of Conventional Cube (M30 Grade of Concrete)								
Sr.No.	Sample No	Grade	No of Days	Sample No.	Results	Average Strength (N/mm2)	Failure Load	Compressive Strength
1	Cube 1 to 3	M30	7	Cube 1	24.02	23.45	540	24.02
			7	Cube 2	23.30		524	23.30
			7	Cube 3	23.00		518	23.00
2	Cube 1 to 3		14	Cube 1	32.48	32.50	730	32.48
			14	Cube 2	33.30		751	33.30
			14	Cube 3	31.72		713	31.72
3	Cube 1 to 3		28	Cube 1	34.70	34.68	780	34.70
			28	Cube 2	34.66		779	34.66
			28	Cube 3	34.71		780	34.71



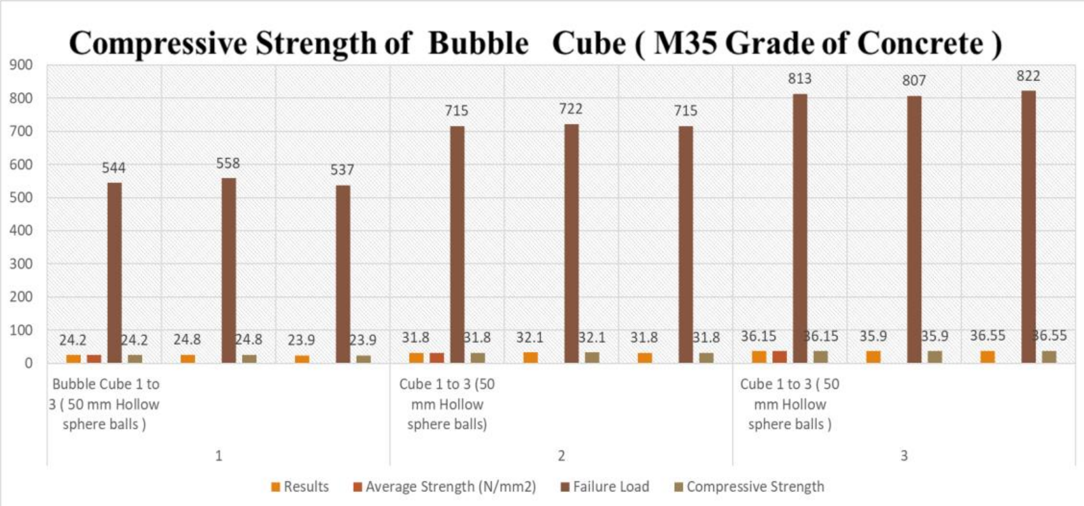
Compressive Strength of Bubble Cube (M30 Grade of Concrete)								
Sr.No.	Sample No	Grade	No of Days	Sample No.	Results	Average Strength (N/mm2)	Failure Load	Compressive Strength
1	Bubble Cube 1 to 3 (50 mm Hollow sphere Balls)	M30	7	Cube 1	20.10	20.31	452	20.10
			7	Cube 2	21.15		475	21,15
			7	Cube 3	19.67		442	19.67
2	Bubble Cube 1 to 3 (50 mm Hollow sphere Balls)		14	Cube 1	28.80	29.8	648	28.80
			14	Cube 2	29.15		655	29.15
			14	Cube 3	31.45		708	31.45
3	Bubble Cube 1 to 3 (50 mm Hollow sphere Balls)		28	Cube 1	33.20	33.74	747	33.20
			28	Cube 2	33.40		751	33.40
			28	Cube 3	34.62		778	34.62



Compressive Strength of Conventional Cube (M35 Grade of Concrete)								
Sr.No.	Sample No	Grade	No of Days	Sample No.	Results	Average Strength (N/mm2)	Failure Load	Compressive Strength
1	Cube 1 to 3	M35	7	Cube 1	24.80	25.4	558	24.80
			7	Cube 2	25.30		569	25.30
			7	Cube 3	26.10		587	26.10
2	Cube 1 to 3		14	Cube 1	33.00	32.8	742	33.00
			14	Cube 2	33.90		762	33.90
			14	Cube 3	31.50		708	31.50
3	Cube 1 to 3		28	Cube 1	37.00	36.6	832	37.00
			28	Cube 2	35.60		801	35.60
			28	Cube 3	37.2		837	37.2



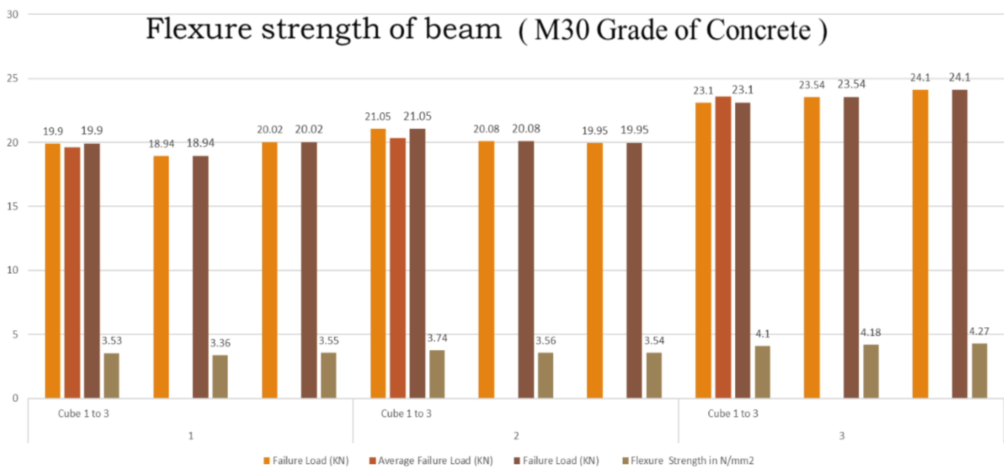
Compressive Strength of Bubble Cube (M35 Grade of Concrete)								
Sr.No.	Sample No	Grade	No of Days	Sample No.	Results	Average Strength (N/mm2)	Failure Load	Compressive Strength
1	Bubble Cube 1 to 3 (50 mm Hollow sphere balls)	M35	7	Cube 1	24.20	24.3	544	24.20
			7	Cube 2	24.80		558	24.80
			7	Cube 3	23.90		537	23.90
2	Cube 1 to 3 (50 mm Hollow sphere balls)		14	Cube 1	31.80	31.9	715	31.80
			14	Cube 2	32.10		722	32.10
			14	Cube 3	31.80		715	31.80
3	Cube 1 to 3 (50 mm Hollow sphere balls)		28	Cube 1	36.15	36.2	813	36.15
			28	Cube 2	35.90		807	35.90
			28	Cube 3	36.55		822	36.55



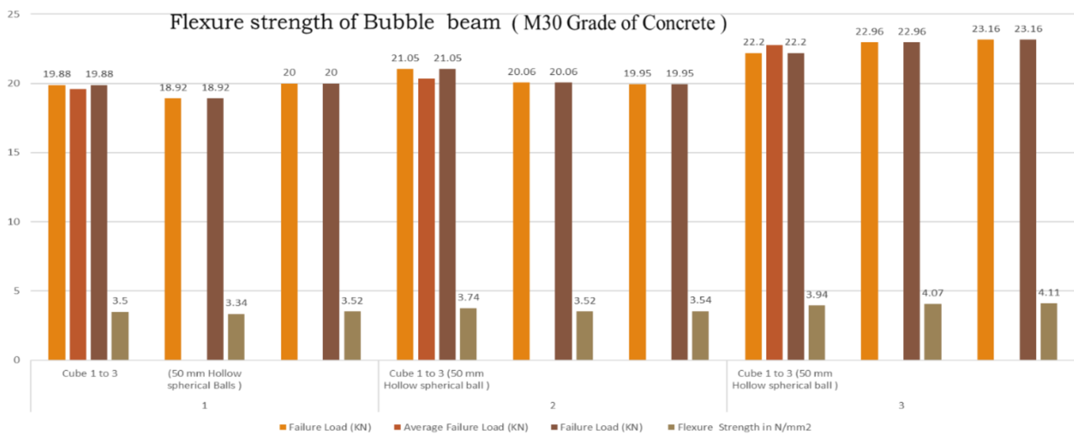
A Screening for Flexure Strength:

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.

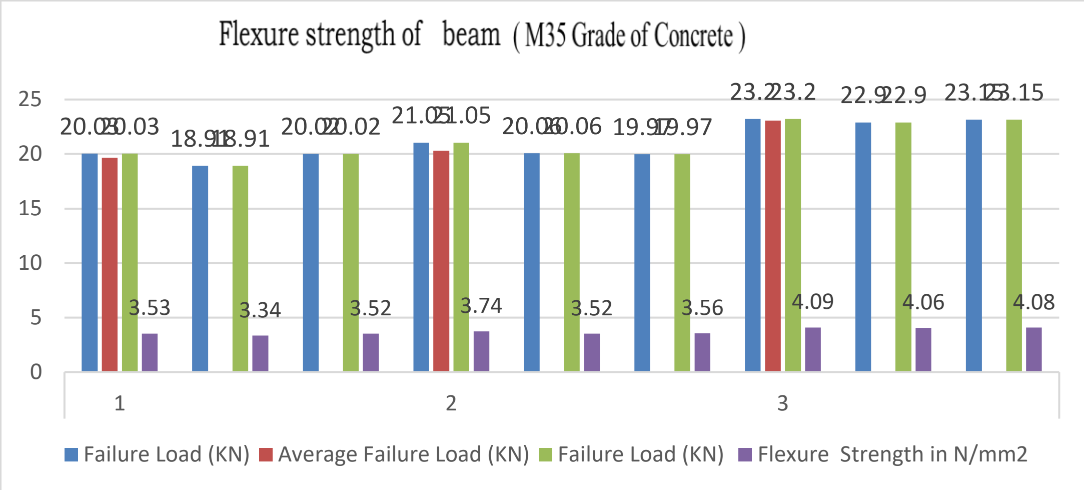
Flexure strength of beam (M30 Grade of Concrete)								
Sr.No.	Sample No	Grade	No of Days	Sample No.	Failure Load (KN)	Average Failure Load (KN)	Failure Load (KN)	Flexure Strength in N/mm2
1	Cube 1 to 3	M30	7	Beam 1	19.90	19.62	19.90	3.53
			7	Beam 2	18.94		18.94	3.36
			7	Beam 3	20.02		20.02	3.55
2	Cube 1 to 3		14	Beam1	21.05	20.36	21.05	3.74
			14	Beam 2	20.08		20.08	3.56
			14	Beam 3	19.95		19.95	3.54
3	Cube 1 to 3		28	Beam 1	23.10	23.58	23.10	4.10
			28	Beam 2	23.54		23.54	4.18
			28	Beam 3	24.10		24.10	4.27



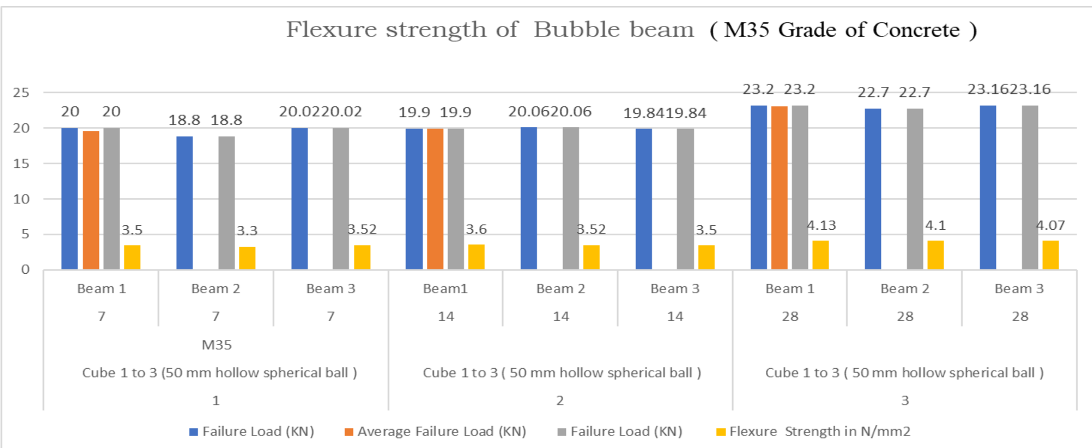
Flexure strength of Bubble beam (M30 Grade of Concrete)								
Sr.No.	Sample No	Grade	No of Days	Sample No.	Failure Load (KN)	Average Failure Load (KN)	Failure Load (KN)	Flexure Strength in N/mm2
1	Cube 1 to 3 (50 mm Hollow spherical Balls)	M30	7	Beam 1	19.88	19.60	19.88	3.50
			7	Beam 2	18.92		18.92	3.34
			7	Beam 3	20.00		20.00	3.52
2	Cube 1 to 3 (50 mm Hollow spherical ball)		14	Beam1	21.05	20.35	21.05	3.74
			14	Beam 2	20.06		20.06	3.52
			14	Beam 3	19.95		19.95	3.54
3	Cube 1 to 3 (50 mm Hollow spherical ball)		28	Beam 1	22.20	22.77	22.20	3.94
			28	Beam 2	22.96		22.96	4.07
			28	Beam 3	23.16		23.16	4.11



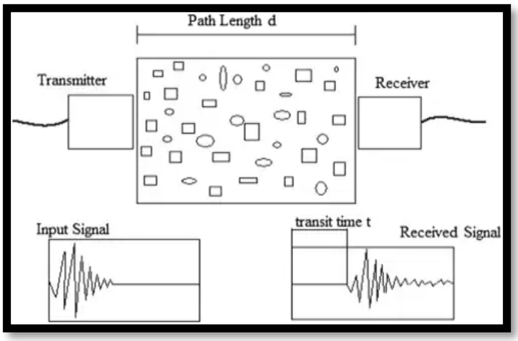
Flexure strength of beam (M35 Grade of Concrete)								
Sr.No.	Sample No	Grade	No of Days	Sample No.	Failure Load (KN)	Average Failure Load (KN)	Failure Load (KN)	Flexure Strength in N/mm2
1	Cube 1 to 3	M35	7	Beam 1	20.03	19.66	20.03	3.53
			7	Beam 2	18.91		18.91	3.34
			7	Beam 3	20.02		20.02	3.52
2	Cube 1 to 3		14	Beam1	21.05	20.3	21.05	3.74
			14	Beam 2	20.06		20.06	3.52
			14	Beam 3	19.97		19.97	3.56
3	Cube 1 to 3		28	Beam 1	23.20	23.08	23.20	4.09
			28	Beam 2	22.90		22.90	4.06
			28	Beam 3	23.15		23.15	4.08

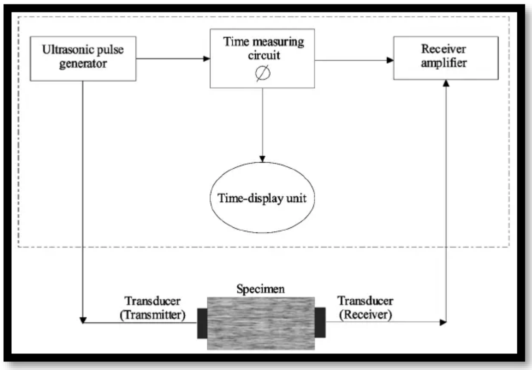


Flexure strength of Bubble beam (M35 Grade of Concrete)								
Sr.No.	Sample No	Grade	No of Days	Sample No.	Failure Load (KN)	Average Failure Load (KN)	Failure Load (KN)	Flexure Strength in N/mm2
1	Cube 1 to 3 (50 mm hollow spherical ball)	M35	7	Beam 1	20.00	19.60	20.00	3.50
			7	Beam 2	18.80		18.80	3.30
			7	Beam 3	20.02		20.02	3.52
2	Cube 1 to 3 (50 mm hollow spherical ball)		14	Beam1	19.90	19.93	19.90	3.60
			14	Beam 2	20.06		20.06	3.52
			14	Beam 3	19.84		19.84	3.50
3	Cube 1 to 3 (50 mm hollow spherical ball)		28	Beam 1	23.18	23.02	23.20	4.11
			28	Beam 2	22.70		22.70	4.10
			28	Beam 3	23.16		23.16	4.07



NDT Technique: Use the ultrasonic pulse velocity test to evaluate the concrete's quality at the project site. In essence, this test calculates the speed at which an electrical pulse passes through concrete from a transmitting transducer to a receiving transducer. The underlying principle of the ultrasonic pulse velocity test is that the square root of the density-elasticity modulus, or E/P, relationship can be used to determine the sound speed of an item. The material's strength and quality are determined by its density and elastic properties, respectively. Electrical pulses typically travel between three and five kilometers per hour. The frequency range of the generated electronic pulse is 15 kHz–175 kHz.





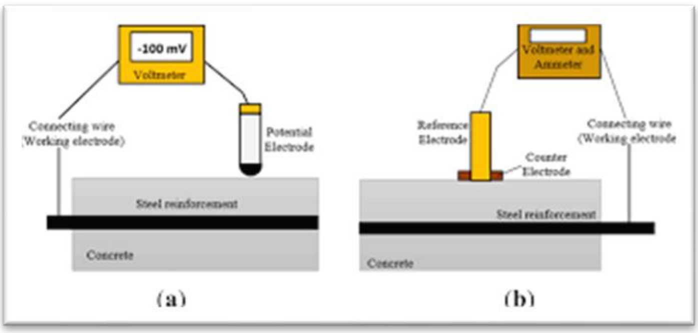


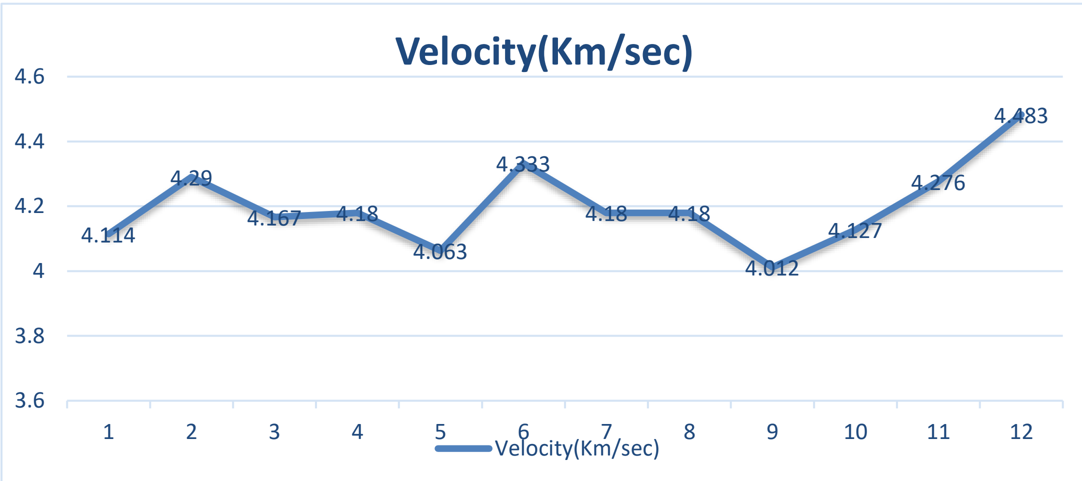
Fig 3. UPV Test Machine Working

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

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. This results indicates the quality of bubble concrete is on Good Levels
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	

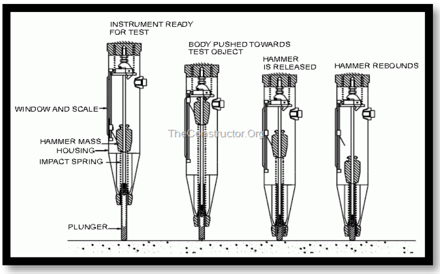
Table: 5 UPV Test Results



Result: Ultrasonic pulse velocity test indicated that the tested specimen with polyethylene ball (HDPE) having Good Quality of Concrete

Rebound Hammer Test on specimen:

The non-destructive rebound hammer test is a quick and simple way to find the compressive strength of concrete. Rebound hammers, also known as Schmidt hammers, consist of a mass that moves along a plunger that is controlled by the plunger, driven by a spring inside a tubular casing. When the plunger of the rebound hammer is pressed against the concrete surface, a spring-controlled mass with continuous energy is produced to impact the surface. A scale is used to measure the amount of rebound in order to evaluate surface hardness. The measurement is called the Rebound Index, or Rebound Number in some contexts. Because it will absorb more energy, concrete with less strength and stiffness will have a lower rebound rating.



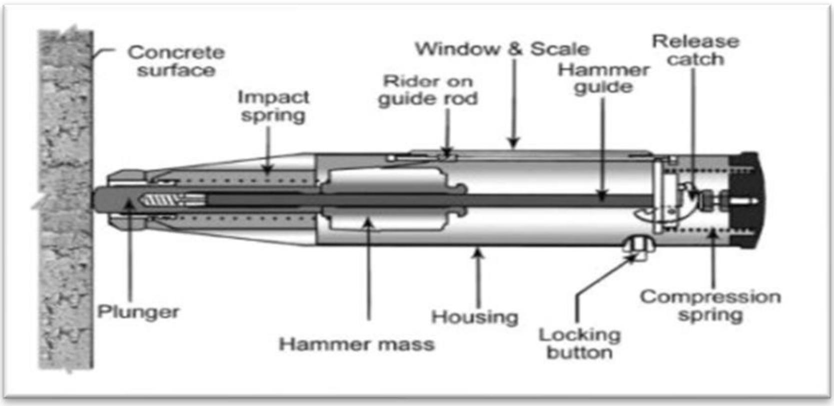
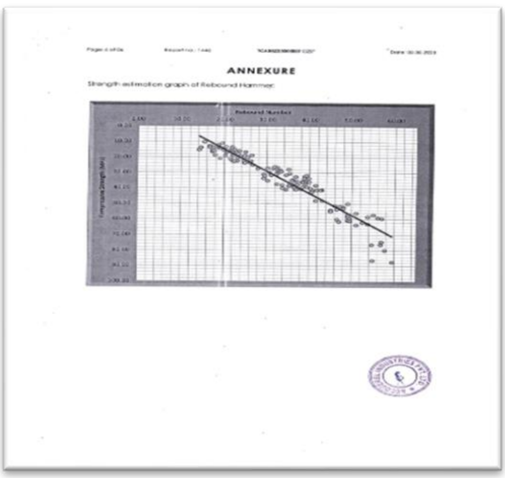


Fig 4: Rebound Hammer Apparatus

Result of Rebound Hammer Test:

The Swiss Hammer, Schmidt Hammer, or Concrete Hammer test are other names for the reb ound hammer test.By evaluating the hardness or elastic qualities of rocks or concrete slabs, t his NDT method can determine how strong they are.


ANNEXURE

Sr. No	Location	Point ID	Rebound, Number Average of 10 Valve	Concrete quality Grading	Temperature of Concrete
01	Deck Slab Surface	01	4482 Numbers	Good Quality	31.4 ^{0}C Concrete thermometer (Digital)

Durability Test on Concrete :

Water Permeability Test

The water permeability test is one of the most crucial methods for evaluating concrete's dura bility.
It measures how well, under pressure, concrete may impede the flow of water.The purpose o f this test is to evaluate the concrete's resistance to water penetration, an important factor in preventing corrosion of the reinforcement and other moistureinduced degradation processes. It usually involves placing a concrete sample under a hydraulic pressure gradient and timing the rate at which water passes through the sample.Lower permeability indicates more resilie nce and resistance to water infiltration
After the test was completed, the value was discovered to be less than 17.

Fig 5 Water Permeability Test

Test Report of Water Penetration of Concrete						Weight of Cube	Weight of Cube	Depth of water penetration
Sr No	ID Mark	Type of Specimen	Length mm	Width mm	Height mm	Before	After	
1	Sample 1	Cube	150.6	150.8	150.4	7.134	7.16	15
2	Sample 2		150.4	150.82	150.56	7.403	7.44	17
3	Sample3		150.42	150.4	150.24	7.43	7.46	13
								(Average) 15

Strength of Split Tensile in Cylindrical Specimen:

An indirect method of assessing the concrete's tensile test is the split tensile test. In this test, a conventional cylindrical specimen is positioned horizontally, and its surface is subjected to radial force, which results in the formation of a vertical crack running the length of the specimen

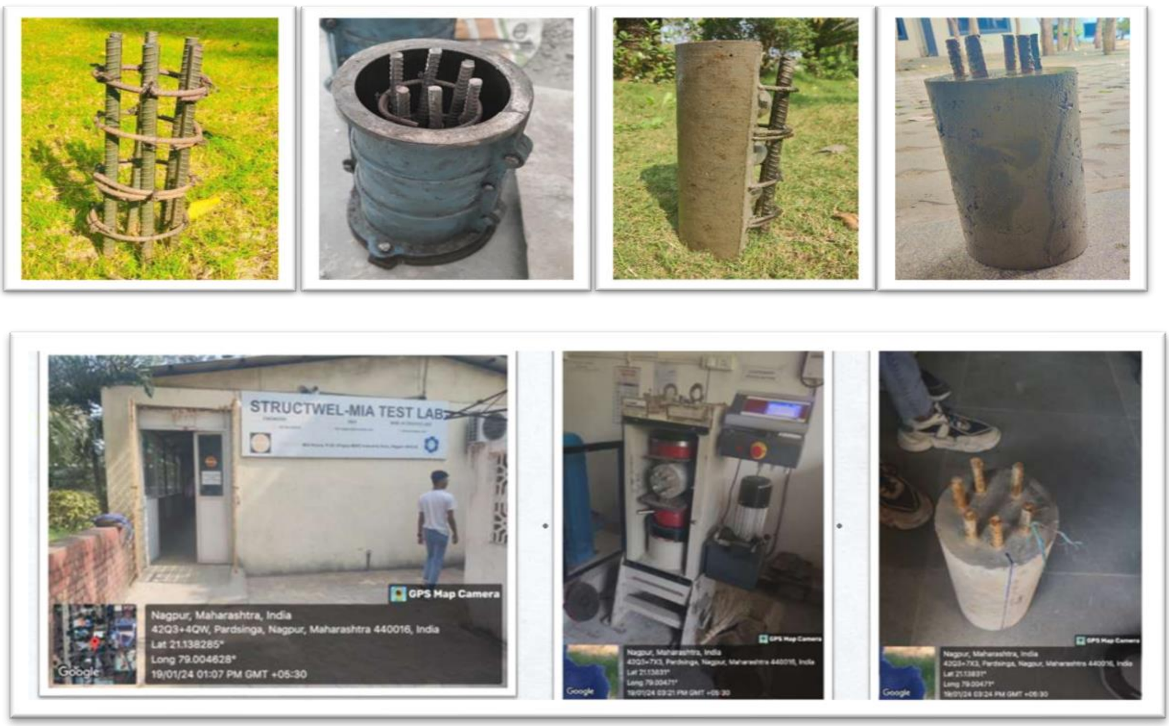
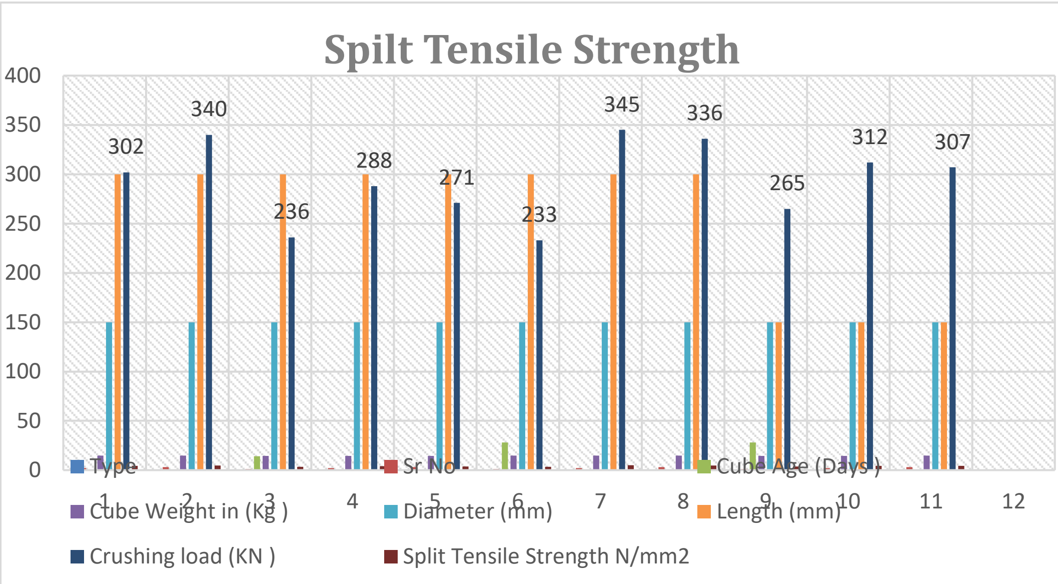


Fig 6 . Split Tensile Strength Result of Column Specimens (As per IS 5816:1999)

Laboratory Result:

Type	Sr No	Cube Age (Days)	Cube Weight in (Kg)	Diameter (mm)	Length (mm)	Crushing load (KN)	Split Tensile Strength N/mm2
Cylinder Specimen (Conventional Concrete)	1	14	14.63	150	300	287	4.06
	2		14.85	150	300	302	4.27
	3		14.72	150	300	340	4.8
Cylinder Specimen (Bubble Concrete)	1	14	14.53	150	300	236	3.34
	2		14.45	150	300	288	4.07
	3		14.53	150	300	271	3.83
Cylinder Specimen (Conventional Concrete)	1	28	14.88	150	300	233	3.3
	2		14.88	150	300	345	4.89
	3		14.595	150	300	336	4.75
Cylinder Specimen (Bubble Concrete)	1	28	14.3	150	150	265	3.74
	2		14.32	150	150	312	4.42
	3		14.67	150	150	307	4.34

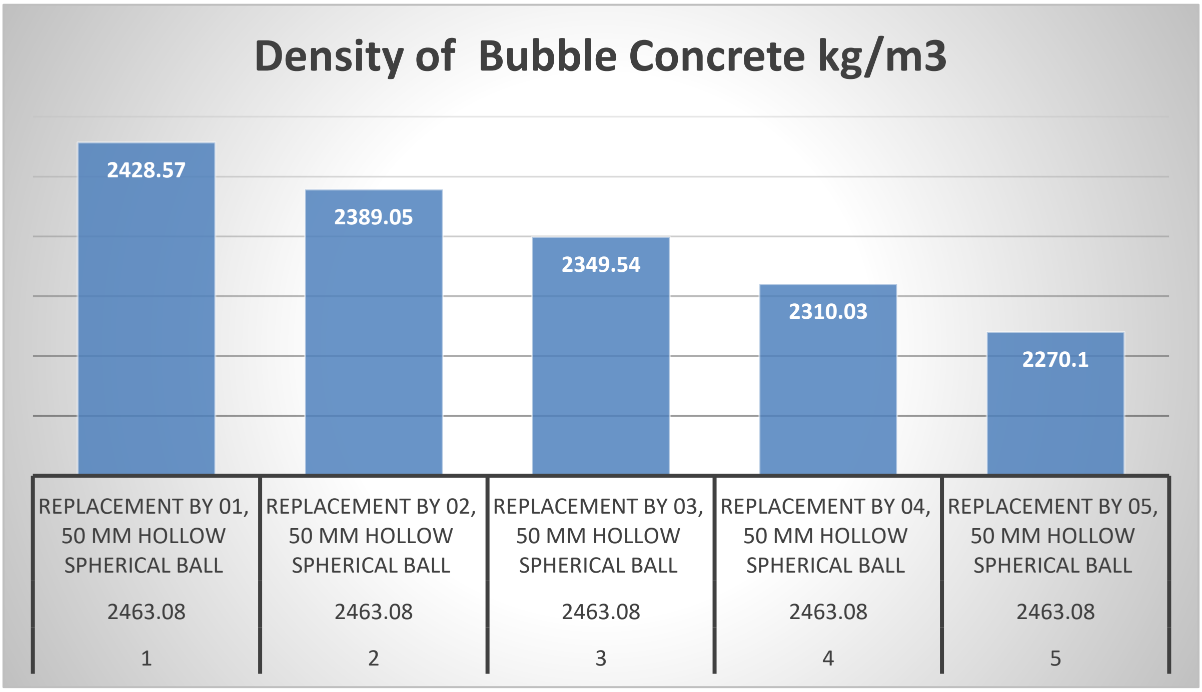


Comparison between Fresh Concrete and Bubble concrete

The density of concrete is important as it affects the compressive strength, durability, water absorption, and permeability of the material.

Sr No	Density of Fresh Concrete	Density of Bubble Concrete	Density of Bubble Concrete
1	2463.08 kg/m3	Replacement by 0,1 50 mm hollow Spherical Ball	2428.57 Kg/m3
2		Replacement by 02, 50 mm hollow Spherical Ball	2389.05 kg/m3
3		Replacement by 03, 50 mm hollow Spherical Ball	2349.54 kg/m3

4		Replacement by 04, 50 mm hollow Spherical Ball	2310.03 kg/m3
5		Replacement by 05, 50 mm hollow Spherical Ball	2270.10 kg/m3



ANALYSIS:

COMPRESSIVE STRENGTH TEST OF CONCRETE

As per the results, we can conclude that the strength parameters vary with very little magnitude. It means we can clearly understand that we can use HDPE balls in concrete projects. We can make cubes and columns using HDPE balls and that will not affect the compressive strength of any concrete structures.

SPLIT TENSILE STRENGTH OF CONCRETE

Price and material calculation of column specimen

PRICE CALCULATION		
Particulars	Price (Rupee)	Summary
Cement	360/50kg	9500/M^3
Sand	6400/M^3	
Aggregate	3600/M^3	
Admixture	150/kg	
Concrete	9500/M^3	

Price Of Materials

Sum of Mix Ratios = 1+1.52+3 = 5.52

Wet Volume = 1.54 X 5.30 X 10^{-3} = 8.16 X $10^{-3}$$m^3$

Material Calculation				
Particulars	Cement	Sand	Aggregate	Admixture
Required volume= (mix ratio/sum of ratio) X wet volume (m^3)	1.478 X 10^{-3}	2.24 X 10^{-3}	4.43 X 10^{-3}	@1.5% of Cement
Density (Kg/ m^3)	1440	1600	1450	
Required weight volume X density (Kg)	2.128	3.59	6.5	0.0312

Material Calculations

Total = 12.25 Kg

Water = 2.128 X 0.4 = 0.8512 Kg

Total weight = 12.25 + 0.8512 = 13.1 Kg

Density = 2400 Kg/ m^3

In table number 8.2.1 we have calculated the price of each material according to the current market price and in table number 8.2.2 we have calculated the required weight of materials that will be required in making one concrete column specimen.

	Analysis				
particulars	Dimensions (meter)	Types	Volume (V) (m^3)	Weight = volume X density (Kg)	Price = weight X 9500 (price per m^3 of concrete) (Rupees)
Column Specimen	150 X 300 mm	Conventional column	5.30 X 10^{-3} (V1)	12.72 (W1)	50.35 (P1)
		Concrete replaced	1.962 X 10^{-4} (V2)	0.47 (W2)	1.9 (P2)
		Bubble Deck Column specimen	5.1 X 10^{-3} (V3)	12.24 (W3)	48.45 (P3)
High-density Polyethylene Balls	50mm Dia	Unit = 3 per column	1.962 X 10^{-4} (V4)	negligible	0.50 rupees each = 0.5 X 3 = 1.5 rupees (P4)

Analysis of Column Specimen

Reduced Parameters			
	Volume reduced (Kg/m^3)	Self-weight reduced (Kg)	Cost reduced (Rupees)
Column	(V2/V1) X 100 = 3.7%	(W2/W1) X 100 = 3.7%	((P2-P4)/P1) X 1000 = 0.71%

Reduced Parameter a of Hollow Balls

As per the results, the bubble deck column specimen and conventional column specimen do not show much greater variation in split tensile strength in table number, By using this technology, we have replaced the concrete by about 3.7% , we didn’t face any major changes in strength. also using this technology, we have reduced self-weight by up to 3.7 %

4. Conclusion and Future Scope

- The Compressive strengths of bubble deck and conventional cubes are almost same
- Conventional beams and bubble deck beams have same flexural strengths.
- Concrete Requires About 19% Less Material Than Conventional. In terms of self-weight reduction, concrete performs roughly 19% better than conventional.
- It is feasible to save costs by as much as 9% when compared to traditional approaches. Concrete strength can be substituted in 1:5 ratios with minimal loss in strength.
- The split tensile strength of bubble columns and conventional columns is almost same
- Prospective research in this domain ought to focus on surmounting the residual challenges and limitations associated with bubble deck technology, in addition to exploring novel applications and design possibilities. More laboratory testing and research, longer-term case studies, and real-world applications in diverse climates and conditions may all be part of this. The success of bubble deck technology will ultimately depend on its technological, economic, and commercial feasibility.

References

1. Guidelines of proportioning concrete mix designs are outlined in IS 10262 (2009).
2. Concrete, both reinforced and plain, IS 456: 2000.
3. Using ANSYS Workbench, Sameer Ali and Mr. Manoj Kumar conducted a behavioral analysis of conventional slabs and bubble deck slabs under various support and load conditions.
4. An experimental investigation was conducted on a bubble deck beam by Pathan Taha Mehboob Khan1, Pathan Altamash Mehboob Khan2, Bhalerao Aadesh Ashok, and Prof. Kaulkhere R.V.
5. P Prabhu Teja, P Vijay Kumar, S Anusha CH. Mounika, and Purnachandra Saha, Bubble Dec k Slab Structural Behavior.
6. Mr. Muhammad Shafiq Mushfiq, Assistant Professor Nishant Rajori, and Assistant Professor Shikha Saini conducted an experimental analysis on a bubble deck slab.
7. Nazar K. Ali, Amer M. Ibrahim, and Wissam D. Salman, June 2019. The adaptability of materials that are reinforced.
8. An experimental investigation on a bubble deck beam was carried out by Pathan Taha Mehboob Khan1, Pathan Altamash Mehboob Khan2, Bhalerao Aadesh Ashok, and Prof. Kaulkhere R.V.
9. P Prabhu Teja, P Vijay Kumar, S Anusha CH. Mounika, and Purnachandra Saha. Bubble Dec k Slab Structural Behavior.
10. Using a bubble deck slab, Mr. Muhammad Shafiq Mushfiq, Assistant Professor Nishant Rajori, and Assistant Professor Shikha Saini carried out an experimental examination.
11. Wissam D. Salman, Amer M. Ibrahim, and Nazar K. Ali (June 2018). "The two-way bubble deck made of reinforced concrete has flexible capacities."
12. Z.C. Steyn, A.J. Babafemi, H. Fataar, R. Combrinck Z.C. Steyn, A.J. Babafemi, H. Fataar, R. Concrete containing waste materials, Vol I Special issue 2017
13. Sankalp K. Sabale, Sandip R. Sule Experimental Study on Bubble Deck Flat Slab (2019)
14. N Kaarthik Krishna, S Sandeep, K M Mini Study on concrete with partial replacement of cement by waste materials IJARTET Vol. II, Special Issue X, March 2017.
15. Prof. J.Shiny A Robustic Analysis on Structural Behaviour

16. of a Bubble Deck Slab over Conventional Deck Slab, IET Vol. 03, No. 02, pp. 19-30. (2017)
17. Rawaid Khan a, Abdul Jabbar a, Irshad Ahmad Reduction in environmental problems using fly ash in concrete ISARET Volume 2 Issue 10. (2018)
18. M. Abdul aleem, P. D. Arumairaj Geopolymer concrete- a Review (2017)
19. B. Singh, Ishwarya G., M. Gupta Geopolymer concrete: A review of some recent developments
20. Study on Geopolymer Concrete Supriya Kulkarni Assistant Professor, Department of Civil Engineering, Gogte Institute of Technology, Belagavi, Karnataka, India (2019)