Structural Behaviour of Voided Beam

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Abstract— Bubble beam is a method of virtually eliminating all concrete from the middle of a beam, which is not performing any structural function, thereby dramatically reducing structural dead weight. High density polyethylene hollow spheres replace the in-effective concrete in the beam, thus decreasing the dead weight. The advantages are less energy consumption, both in production, transport and carrying out, less emission - exhaust gases from production and transport, especially CO2 and reduce the material, the load, lower the cost and it is also a green technology. In the bubble beam technology reduce the concrete volume by replacing the spherical bubbles, these are locally available which is called as PEPSI balls, these balls are made up of HDPE (High Density polyethylene). In this experimental program conventional beam and bubble beam are cast with various bubbles arrangement which is continuous arrangement of bubbles within whole beam and two types of alternative bubbles arrangement in the beam. And trying to enhance the increasing strength of that beam but shear capacity of concrete Decreases when bubbles are added. There is a remarkable Decrease in load carrying capacity upto first crack appears.

Keywords: Voided Beam, CO2, HDPE (High Density polyethylene)

I. INTRODUCTION

The main objective of the project is to study Shear Stress & Bending Stress of Bubblel Reinforced Concrete Beams with Web Reinforcement. For this study the available data clustered according to number of bubble. The shear strength results obtained are compared with the existing results in literature.

A. Background:

Concrete has better resistance in compression while steel has more resistance in tension. Conventional concrete has limited ductility, impact and abrasion resistance and little resistance to cracking. A qood concrete must possess high strength and low permeability. Hence, alternative Composite materials are gaining popularity because of ductility and strain hardening. Addition of bubbles decreases the units.

B. Effects of bubble in Concrete:

The capability of durable structure to resist weathering action, chemical attack, abrasion and other degradation processes during its service life with the minimal maintenance is equally important as the capacity of a structure to resist the loads applied on it. Bubble effects on various properties of concrete in fresh and hardened state such as l compressive strength, tensile strength, flexural strength, workability, bond strength, fracture properties, creep strain, impact and chloride penetration. Various types of hollow, spherical bubbles are available. Typically, they may be added to concrete at rate of about 0.9 kg/m. Their primary role is to modify the properties of fresh concrete.

Their ability to reduce bleed and segregation assists in maintaining the original water/cement ratio of the surface mortar, which can lead to improvements in the surface layer there by increasing resistance to abrasion. Bubble may be effective in distributing impact stresses and providing some enhancement to frost resistance. They have also been shown to reduce the spalling of concrete in a fire. Bubbles s are also used in sprayed concrete, to improve the initial properties and to reduce sloughing and rebound

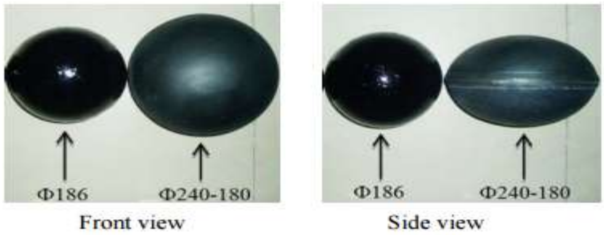

Fig. 1.1: Different types of Bubble

C. Development of bubble:

Bubble vary in types, geometry, properties and availability in construction industry. Most common types of bubbles are hollow spherical bubble, elliptical bubble. These usages may alter in concrete for different applications. The bubble are selected from their properties like, effectiveness, cost and availability. Among the various types of bubble are most widely used in the concrete industry, slab and beams.

D. Role of Bubble:

Cracks play an important role as they change concrete structures into permeable elements and consequently with a high risk of corrosion. Cracks not only reduce the quality of concrete and make it aesthetically unacceptable but also make structures out of service. If these cracks do not exceed a certain width, they are neither harmful to a structure nor to its serviceability. It is important to reduce the crack width and this can be achieved by adding bubble to concrete.

Thus addition of bubble in cement concrete matrix bridges these cracks and restrains them from further opening. In order to achieve more deflection in the beam, additional forces and energies are required to pull out or fracture the bubble. This process, apart from preserving the integrity of concrete, improves the load-carrying capacity of structural member beyond cracking.

E. Properties of hollow bubbles:

The bubble are made using high density polypropylene materials. Polypropylene is one of the cheapest and abundantly available polymers. These are usually made with nonporous mtrl that does not react are to be used and the quantity of reinforcement from transverse ribs of the beam. Bubble are resistant to most chemical attacks. Its melting point is high about 162 degree centigrade. There is a sterically regular atomic arrangement in the polymer molecule and high crystallinity. Due to regular structure, it is known as isotactic polypropylene. Chemical inertness makes the bubble resistant to most chemicals. Any chemical that will not attack the concrete constituents will have no effect on the ball either. On contact with more aggressive chemicals, the concrete will always deteriorate first. The water demand is nil for hollow bubbles.

F. Advantages of hollow bubble:

1) fast and perfect mixable bubble and high performance and crack resistance
2) Optimize costs with lower bubble dosages
3) hollow spherical ball reinforced concrete improving the toughness of concrete
4) Improve ductility
5) Improve structural strength
6) Improve impact and abrasion resistance
7) Non-magnetic
8) Rustproof
9) Alkaliproof
10) Safe and easy to use

G. Features and Benefits:

- Alternate system to welded wire reinforcement for secondary reinforcing in concrete
- Inhibits and controls the formation of intrinsic cracking in concrete
- Reinforces against impact forces
- Reinforces against the effect of shattering forcess
- Reinforces against material loss from abrading forces
- Reinforces against water migration
- Provides improved durability
- Imparts toughness to hardened concrete
- Reduces plastic shrinkage and settlement cracking
- Provides residual strength

H. Discussion on Shear

The main obstacle to the shear problem is the large number of parameters involved, some of which may not be known. Therefore, for some time, researchers have concentrated on the internal mechanism of shear failure. The shear failure of reinforced concrete beams without web reinforcement is a distinctive case of failure which depends on various parameters such as shear span to effective depth ratio (a/d), longitudinal tension steel ratio (ρ), aggregate type, strength of concrete f_{ck}, type of loading, and support conditions, etc. Most of the researchers concluded that failure mode is strongly dependent on the shear span to depth ratios (a/d).The usual arrangement for investigating shear failure is that of a beam subjected to symmetrically placed two equal concentrated loads ‘P’ at distance ‘a’ (shear span) from the supports. It has the advantage of combining two different test conditions, viz, pure bending, that is, no shear force is present between the two loads P, and constant shear force in the two end regions or shear spans.

The failure of beam considered in shear is induced by cracks outside the central section of the beam. Though the bending moment is maximum in the central section, the cause of failure of the beam considered is due to shear force in the end region of the beam where the cracks appeared causing failure. It is to be noted that in the central section there is no shear force present (pure bending). Hence it is felt that the shear force, or the shear stress, must be responsible for such a failure.

I. Objectives:

1) To study the behaviour of properties of voided beam
2) To study the static behaviour of Bubble
3) To analyze change in ultimate load carrying capacity for RC Beam

1) Methodology with respect to each objective is briefly given below:

a) To study the behaviour of properties of voided beam

The identify various properties such as flexural strength, deflection, shear strength, sound insulation, ductility, fire resistance etc.

b) To study the static behavior of Bubble

To check the beam in such a way that, whether it is safe for deflection or not. For this for given loading and for a given cross-sectional dimensions along with steel quantity, apply a check for deflection. And hence, for deciding the beam is safe or not as per IS 456

c) To analyze change in ultimate load carrying capacity for RC Beam

By reducing the quantity of concrete i.e. curtailment of concrete from mid-span up to support causing increase in the load carrying capacity. It does not affect the strength of beam. But strength can be increased by providing the plastic bubbles in proper position. For this, skilled work is very importance

II. EXPERIMENTAL PROGRAM

A. Introduction

In this chapter we are going to calculate the experimental shear strength value by loading the 8 different beams on FTM (Flexural Testing Machine) with a different no of bubbles.

Section 3.2 gives the brief information of experimental program, Section 3.3 gives the details of Test Materials, & Section 3.4 gives the detail information of mix design nominal mix M20, Section 3.5 gives the detail information of specimen details, Section 3.6 gives the detail information of test procedures. Section 3.7 Different Models to predict shear capacity

B. Experimental Program

Two different numbers of bubbles reinforced concrete beams were casted and tested, under two-point loading varying the different number of reinforced from 2-3. The test specimens are divided into two series. Each series consisted of different number of bubbles with stirrups.

C. Test Materials

1) Cement:

Ordinary Portland cement whose 28-day compressive strength was 53Mpa used.

2) Fine Aggregate:

Natural River sand confirming with specific gravity is 2.65 and fineness modulus 2.33 was used.

3) Coarse Aggregate:

Crushed Coarse aggregate of 20mm and 10 mm procured from local crusher grading with
specific gravity is 2.63 was used.

4) Water:

Portable water free from any harmful amounts of oils, alkalis, sugars, salts and organic materials was used for proportioning and curing of concrete.

5) Reinforcement:

The longitudinal reinforcements used were high-yield strength deformed bars of 12 mm diameter. The stirrups were made from mild steel bars with 8 mm diameter. The yield strength of steel reinforcements used in this experimental program was determined by performing the standard tensile test on the three specimens of each bar. The average proof stress at 0.2 % strain of 12 mm φ bars was 437 N/mm2 and that of 8 mm φ bars was 415 N/mm2

6) Hollow bubbles:

The bubbles (Fig.) are made using high density polypropylene materials. These are usually made with nonporous material that does not react are to be used and the quantity of reinforcement from transverse ribs of the slab.

D. Mix Design M 20

Mix design based on the experimental results of the concrete ingredients. The mix design based on Indian Standard Recommended Method of Concrete Mix Design of IS 10262-2009.Thus, mix design of M-20 grade concrete is carried out as per the procedure given below,

Design Stipulations:

1) Characteristics compressive strength required in the field at 28 days=55.70 N/mm2.
2) Maximum size of aggregate =20 mm (angular)
3) Degree of quality control-Good
4) Type of exposure-Mild
5) Specific gravity of
   Cement =3.15
   Coarse Aggregate (20 mm down): 2.78
   Coarse Aggregate (10mm down): 2.89
   Fine Aggregate: 2.73
6) Free moisture
   Nil in C.A
   Nil in F.A
7) Water absorption-
   Coarse Aggregate (20 mm down) : 0.55%
   Coarse Aggregate (10mm down) :1%
8) Fineness Modulus
   C.A. = 7.3%
   F.A =2.9%
9) Compaction Factor = 0.85

Step 1:
Target mean strength:
=20+ (1.6x4)
= 26.60 N/mm2

Step2:
Selection of Water-Cement Ratio:
From Table 5 of IS 456,
Maximum water cement Ratio = 0.50
Based on experience, adopt water-cement ratio as 0.4
0.48 < 0.50
Hence OK.

Step 3:Selection water
maximum water content = 186 litre (for 25 to 50 mm Slump range) for 20mm
aggregate.
Estimate water content for 75mm slump
=186 + (6/100) x186 = 197 litre
As Superplasticizer is used, the water content can reduced up to 9 percent and above,
Hence, the arrived water content = 197 x 0.91 = 180 litres

Step 4:
Calculation of Cement Content
Water-cement ratio = 0.48
Cement content = 180/ 0.48
=375 kg/m3From Table 5 of IS 456, minimum cement content for
MODERATE‘ condition = 300 kg/m3
375 Kg/m3> 300 Kg/m3 ,Hence, OK.

Step5 :
Proportion of Volume of Coarse Aggregate and Fine Aggregate Content
From Table 3, volume of the coarse aggregate to 20 mm size aggregate and fine
aggregate ZONE 1 for water cement ratio of 0.50 = 0.60
For hand placing no reduced volume Therefore,
Volume of coarse aggregate = 0.004 + 0.6 = 0.6
Volume of fine aggregate = 1.00-0.6 = 0.40

Step6 :
Mix Calculations :
The mix calculation per unit volume of concrete shall beas follows:

1) Volume of concrete = 1m3
2) Volume of cement = (mass of cement /sp. Gravity of cement) x1000 = 0.11m3
3) Volume of water = (mass of water/ sp. Gravity of water) x(1/10000)

= 180/1000
= 0.180m3

4) Volume of chemical = (mass of admixture/sp. Gravity ofadmixture) x (1/1000)

Admixture (superplasticizer @ = (3.75/1.26) x (1/1000)
1% by mass of cementitious = 0.003m3 Material)

5) Volume of all aggregates = { a – (b + c + d) }
= 0.698 m3
6) Mass of coarse aggregate (20 down)
= e x Volume x Speciic gravity x 1000
= 0.698 x 0.39 x 2.89 x 1000
= 757Kg
7) Mass of coarse aggregate (10 down)
= 0.698 x 0.21 x 2.89 x 1000
= 424 kg
8) Mass of fine aggregate (sand)
= 0.698 x 0.4 x 2.73 x 1000
=762kg

Step7:
Mix proportions for trial number 1:
Cement = 375 kg/m3
Water =180 kg/m3
Fine aggregates =762 kg/m3
course aggregates=424 kg/m3

Step8:
Material Required for beam-
Size of beam to be tested
=0.70×0.15×0.15

=0.01575m3

Number of beam to be tested =3
Volume of 3 beam = 3×0.01575m3
= 0.04725m3.

1) Mix design of concrete

IS method of mix design is used for mix design of M-20grade of concrete. The quantity of ingredient materials and mix proportions as per design is given in table

Materials	Proportion by Weight	Weight in Kg/m3
Cement	1	375
FA	2.03	762
CA	3.14	1181
W/C	0.48	180

Table 3.4.1: Quantity of Materials per Cubic Meter of Concrete

E. Detailing of Reinforcement:

In case of reinforced concrete beams, same arrangement is made for flexural and shear reinforcement

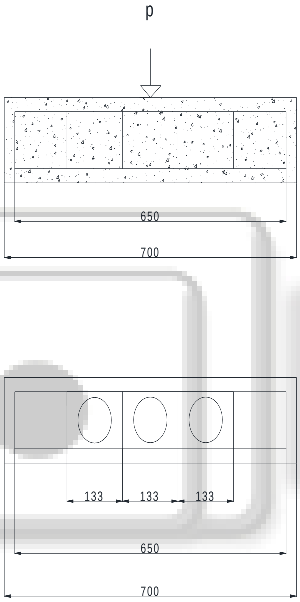

Fig. 2.2: Detailing of reinforcement top and bottom steel.

F. Form Work:

Size of the form work is 150mmX 150mmX 700mm

Fig. 2.2: Form work

G. Preparations of specimen-

1) Measurement of ingredients:

All cement, sand and coarse aggregate respectively are measured with Digital balance. The water is measured with measuring cylinder of capacity 1 liter and measuring jars of 5 and 10 litres.

2) Preparation of surface before placing concrete:

It is very essential to prepare a proper base or place before placing the concrete mix in order to develop proper bond between the base and fresh concrete. Before placing concrete, the different types of bases should be prepared as below.

3) Mixing of concrete:

The ingredients were thoroughly mixed over a G.I.sheet. The sand, cement and aggregate were measured accurately and were mixed in dry state for normal concrete. The dry concrete mix was then thoroughly and uniformly mixed till uniform and homogeneous. Sufficient quantity of pure water added slowly till proper mixing of cement, sand and aggregate.

4) Transportation of concrete:

The process of carrying the concrete mix from the place of its mixing to final position of deposition is called as transportation of concrete. The time factor is very important in case of transportation of concrete. The concrete mix should be transported as quickly as possible.

5) Importance of transportation:

The concrete mix should carry from its mixing place to final position of placement in a very short time. It will minimize the loss of water by evaporation. It will also not allow the concrete to become stiff. The mix can be transported manually by using iron-pans, wheel barrows, etc. The concrete mix required at lower levels is transported by chutes.

6) Placing of concrete & Bubble:

The fresh concrete was placed in the moulds by trowel and then placed bubble. Beams are constructing to using the steel, 8mm bars are used to main reinforcement & stirrups. First we constructing the 8 conventional beam & then in other 8 beams placing the bubble at given size. Two bubbles & three bubbles are placing in Four-four beams simultaneously at given spacing of the stirrups in steel reinforcement. Spacing of the stirrups & bubble in steel reinforcement at shown in fig. 3.1 & Fig. 3.2. It was ensured that the representative volume was filled evenly in all the specimens to avoid segregation, accumulation of aggregates etc. While placing concretes & bubble, the compaction in vertical position was given to avoid gaps in moulds.

7) Compaction of concrete:

Moulds are cleaned and oiled from inside for smooth de-moulding. Concrete is mixed thoroughly and placed in the mould in three layers with bubble and compacted by electrically operated needle vibrator for beam specimens and table vibrator with suitable fixing frame for cubes and cylinders. It is vibrated till concrete woes out of mould. The vibration is continued till cement slurry just ooze out on surface of moulds. Care is taken of cement slurry not to spill over, due to vibration and segregation. The process of consolidating concrete mix after placing it in position is called as compaction of concrete. The object of compaction is to remove air from the concrete and to give maximum density to the concrete. Presence of more air voids will reduce the strength. It also ensures an intimate contact between the concrete and the surfaces of reinforcing steel and other embedded parts of the structure. During the process of compaction it is important to note that the reinforcement should not be disturbed and the forms should not be damaged or displaced. If the compaction is not uniform, the concrete becomes porous, non-homogeneous and attains less strength. The mix to be used should have adequate workability for placing without any difficulty and in order to obtain maximum density. The mix should also not be too wet, as it would otherwise cause segregation, lower density, and excessive laitance at the top.

8) Importance of compaction:

A considerable amount of air is entrapped in concrete along with the partial segregation of aggregates during the manufacture of concrete. It lowers the quality of concrete by making it porous and non-homogeneous.

9) Compaction methods:

It is very important to decide whether to use a workable mix with hand or a stiffer mix with vibration before considering the method of compaction. It has been determined that a better surface with less blow holes is obtained for workable concrete

The compaction methods are classified as follows:

1) Hand compaction:

Hand compaction method is adopted for pavements, narrow and deep members. Compaction must be uniform and concrete must reach to the corners of the formwork. Excessive compaction is not good because it will try to push the aggregates at the bottom thus bringing the mortar at the surface. Iron rods and rammers are used for the hand compaction. Mass concrete is compacted in successive layers of thickness not exceeding 30 cm by tamping with light rammers or templates. Iron rods are used for compacting reinforced concrete work in layers not exceeding 15 cm in thickness.

Hand compaction is further classified as follows:

- Ramming
- Rodding
- Tamping

2) Finishing of Concrete:

After removing from vibrating table, the moulds were kept on ground for finishing and covering up for any leftover position. The concrete is worked with trowel to give uniform surface Care is taken not to add any extra cement, water or cement mortar for achieving good surface finish. The additional concrete is chopped off from top surface of the mould for avoiding over sizes etc. Identification marks are given on the specimens by embossing over the surface after initial drying.The operations adopted for obtaining a true, uniform concrete surface are called as finishing operations.

Concrete mix should be spread in such a way that no segregation takes place. Only designing the mix properly can ensure this. The results of finishing are good if the slump is about 5 cm. The choice of concrete finish depends upon the ultimate use of the completed job and the desired effect.

3) Importance of finishing:

Finishing is very important from engineering point of view. The importance of finishing is to keep the concrete surfaces free from undulations. Many concrete structures have an unsatisfactory appearance after exposure for some time. Some of the surfaces, which were quite pleasing when new, have weathered badly. The surface of concrete cannot be made pleasing to the eye as many unsightly features result from cracks, carelessly constructed and badly placed construction joints, patching or honey-combed or damaged areas, poor formwork and lack of sufficient cover to reinforcement.

4) Finishing operations:

Following are the operations adopted for finishing of concrete surface.

1) Screeding,
2) Floating, and
3) Trowelling.

5) De-moulding of specimens:

The plain cement concrete specimens are demoulded after 24 hours of casting wet concrete and kept in water tank for curing and kept for water curing at 28days.

6) Curing of test concrete beam :

The specimens were demoulded after 24 hours of casting and immediately stored in the curing tank for continuous curing. M-20 grade plain cement concrete is cured in curing tank for 28 days. The process of hardening the concrete mixes by keeping its surface moist for a certain period after compaction and finishing is called curing of concrete.

Curing is one of the important factors for obtaining better strength. The concrete hardens because of the chemical reaction between water and cement, i.e. hydration. The chemical action that accompanies the setting of concrete is dependent on the presence of water. Although there is sufficient water at the time of mixing yet it is necessary to ensure that the water is retained to enable the chemical action to continue till the concrete is fully hardened. Properties of concrete such as strength, durability, and wear resistance, water-tightness and volume stability improve with the passage of time. If the loss due to evaporation is more from newly placed concrete, the hydration process will stop and concrete will shrink thus creating tensile stresses at the drying surface. The development of these stresses will result into the formation of plastic shrinkage cracks.

7) Importance of curing:

The importance of curing of concrete is to improve its properties such as water-tightness, wear resistance, strength, volume stability and durability. The table 5.3 shows the effect of curing period on strength.

Objects of curing:

Following are the objects of curing.

1) Maintaining the process of hydration by preventing the loss of water by evaporation.
2) To reduce the shrinkage of concrete.

3) To preserve the properties of concrete.

H. Quality of good concrete

1) Bleeding and segregation

Bleeding is a form of segregation where some of the water in the concrete tends to rise to the surface of the freshly placed material. This arises due to the inability of the solid components of the concrete to hold all of the mixing water when they settle downwards (water being the lightest of all the mix constituents). Bleeding of the water continues until the cement paste has stiffened enough to end the sedimentation process.

If the bleed water is remixed during the finishing of the top surface, a weak top surface will result. To avoid this, the finishing operations can be delayed until the bleed water has evaporated. Conversely, if evaporation of the surface water is faster than the rate of bleed, plastic shrinkage cracking may occur.

Cement types can influence bleeding capacity, increased proportions of, for example, cement combinations containing gabs, leading to an increase in the time for bleeding continue due to a longer setting time. The presence of an adequate proportion of very fine aggregate (smaller than 150µm) reduces bleeding. Similarly polypropylene micro-fibres are known to reduce bleeding.

In more severe cases, segregation of aggregates can also occur, with the heavier coarse particles moving towards the bottom of the concrete, leaving a cement sand paste layer on the top surface.

Excessive working of a concrete prone to bleeding can prolong bleeding and encourage further aggregate settlement.

2) Workability of concrete:

The behavior of green or fresh concrete from mixing up to compaction depends mainly on the property called "workability of concrete". Workability of concrete is a term which consists of the following four partial properties of concrete namely, mixability, transportability, mouldability and compatibility. In general terms, workability represents the amount of work which is to be done to compact the compact the concrete in a given mould. The desired workability for a particular mix depends upon the type compaction adopted and the complicated nature of reinforcement used in reinforced concrete.

I. Details of test beams for tests on hardened concrete

The Beam Dimensions of each test are as under:
Beam: 150 mm x 150 mm x 700 mm
Beam specimens were used to determine shear stress & Bending stress.

Shear & Bending stress of Beams are determined at 28 days using flexural testing machine (FTM) of capacity 2000 KN. Flexural testing machine (FTM) of capacity 250 KN was used to determine the shear strength of beams.

J. Experimental setup:

The beams are tested in the loading frame of the "Structural Engineering" Laboratory. The testing procedure for the all the specimen is same. The two-point loading arrangement is used for testing of beams. two-point loading is conveniently provided by the arrangement shown in Figure The load is transmitted through a load cell on to a spreader beam. The spreader beam is installed on rollers seated. The test member is supported on roller bearings acting on similar spreader plates. The specimen is placed over the two steel rollers bearing leaving 50 mm from the ends of the beam. The remaining 600 mm part goes under two Point load is placed on the center of the mid span of the beam.

K. Specimen details

Tests were carried out on 16 beams, simply supported under two points loading. All the beams had different cross section of 150mm x 150mm x700 illustrated in Fig . The length of beam was 700mm. All the beams were provided with 8 mm diameter HYSD bars as longitudinal reinforcement to avoid any possible failure by flexure and the grade of concrete.

L. Test Procedure & Results

All the 16 beams are tested one by one. All of them are tested in the above arrangement. The gradual increase in load and the deformation in the dial gauge reading are taken throughout the test. The load at which the first visible crack is developed is recorded as cracking load. Then the load is applied till the ultimate failure of the beam. The deflections at midpoint of each span are taken for all beams with and are recorded with respect to increase of load. The beams were tested under two point loading. The test specimen was simply supported on rigid supports. Two-point loads were applied through a rigid spread beam. Figure shows the experimental setup for beams. On flexural testing machine the beam is loaded as shown in figure and the experiment is carried out and calculations are done. The table 3.11.1 gives the geometric properties of experimental beam.

Sr. No.	Member	Length	width	Height	No.of bar	No.of Ball	Load	Fb	Fv
1	2-s	700	150	150	4		87	18.044	
2	2-s	700	150	150	4		86	17.83	
3	2-b	700	150	150	4	2	74	15.348	
4	2-b	700	150	150	4	2	65	13.48	
5	3-s	700	150	150	4		77	15.97	
6	3-s	700	150	150	4		95	19	
7	3-b	700	150	150	4	3	77	15.9	
8	3-b	700	150	150	4	3	82	17	
9	2-s	700	150	150	4		107		3.71
10	2-s	700	150	150	4		200		4.44

11	2-b	700	150	150	4	2	156		3.46
12	2-b	700	150	150	4	2	180		4
13	3-s	700	150	150	4		200		4.44
14	3-s	700	150	150	4		215		4.77
15	3-b	700	150	150	4	3	153		3.4
16	3-b	700	150	150	4	3	150		3.33

Table 3.12.1: Geometric Properties of Experimental Beams

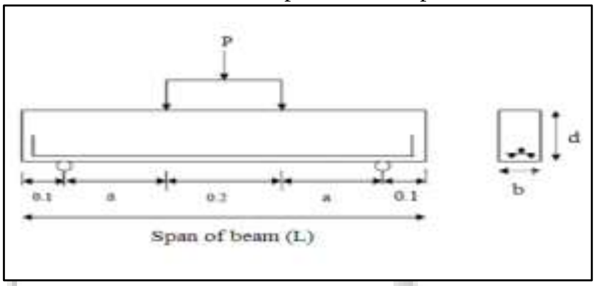

Fig. 3.4: Details of test beam

Fig. 3.5: Details of test beams with arrangement of loads and supports on FTM

The load and deflections were monitored for every 5 seconds. The load that produced the diagonal crack and the ultimate shear crack were recorded. Crack patterns were marked on the beam. The average response of two beams tested in a series, was taken as the representative response of the corresponding series. The test set up is presented in figure.

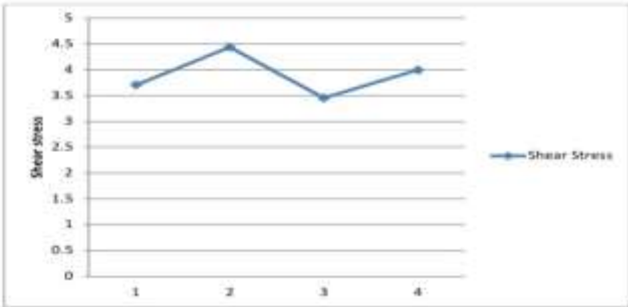

Fig. 3: 6shear stress comparison with conventional beam and two bubble beam

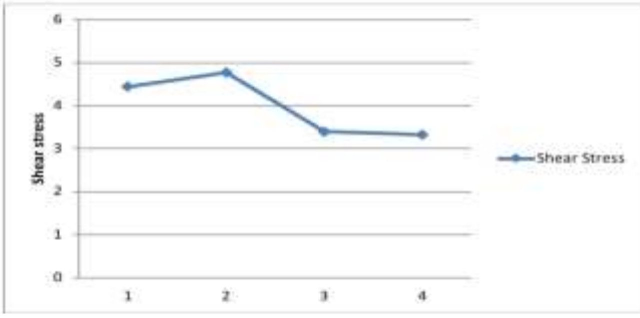

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Fig. 3.7: Shear stress comparison with conventional & three bubble beam

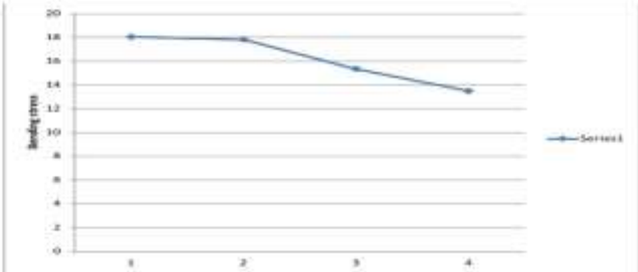

Fig. 3.8: Bending stress comparison with conventional beam and two bubble beam:

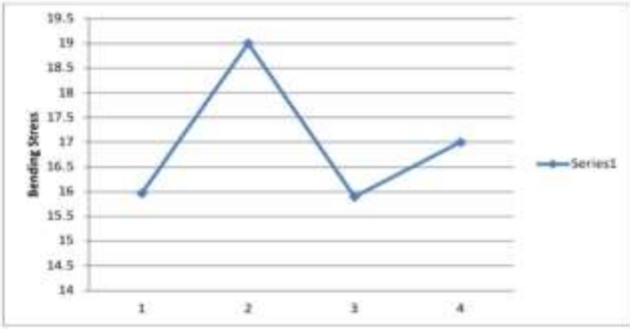

Fig. 3.9: Bending stress comparison with conventional beam and three bubble beam:

Beam No.	No.of Balls	Shear Stress	Bending Stress	Comparision with Conventional Beam		Remark
				Shear Stress	Bending Stress	
1	-			3.71		
2	-			4.44		
3	2	3.46				
4	2	4				
5	-			4.44		
6	-			4.77		
7	3	3.4				
8	3	3.33				
9	-				18.044	
10	-				17.83	
11	2		15.34			
12	2		13.48			
13	-				15.97	
14	-				19	
15	3		15.9			
16	3		17			

Table 3.11.2: Comparision of Experimental Results

III. CONCLUSION

Shear tests on Bubble beams with stirrups have been carried out. The results show, by adding 2&3 Number of balls, a moderate decrease of the shear capacity is achieved and a more ductile shear failure mode than the failure mode of the conventional concrete beams is observed.

1) The addition of a 2 balls in beam, then decreasing the shear stress As compare to solid beams shear stress.
2) The addition of a 3 balls in beam, then decreasing the shear stress As compare to solid beams shear stress.
3) The addition of a 2 balls in beam, then decreasing the Bending stress As compare to solid beams Bending stress.
4) The addition of a 3 balls in beam, then decreasing the Bending stress As compare to solid beams Bending stress.
5) The shear capacity of concrete Decreases when bubbles are added.There is a remarkable Decrease in load carrying capacity upto first crack appears.

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