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To study Comparison between Conventional Slab and Bubble Deck Slab

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Abstract: Bubble deck slab is a method of virtually eliminating all concrete from the middle of a floor slab, 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 center of the slab, thus decreasing the dead weight and increasing the efficiency of the floor. 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 deck 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 slab and bubble deck slab are cast with various bubbles arrangement which is continuous arrangement of bubbles within whole slab and two types of alternative bubbles arrangement in the slab. And trying to enhance the increasing strength of that slab. This implies the realization of a monolithic slab element, which will be subjected to static gravitational loadings in order to determine the load carrying capacity of the slab, deformation (deflection), cracking and failing characteristics. The resultant conclusions will be used in defining the failing mechanisms and advantages of the bubble deck slab are highlighted.

Keywords: Bubble Deck slab, conventional slab, HDPE.

I. INTRODUCTION

In a general way, the slab was designed only to resist vertical load. Now a days people recently wants residential environment on which vibration & noise of the slab getting main role. The main moto of concrete construction that is horizontal slab is having large weight which should be limits the span. Due to this major development of the reinforced concrete must focus on developing the span, by reduction in weight or overbear concrete nature weakness in tension. In early stages many attempts had made to manufacture biaxial slab which have hollow cavities to minimize the weight. Many attempts had done before to prepare blocks having light weight material which is polystyrene used on top & bottom reinforcement and other type's grid & waffles slab. All these types only waffle slabs are used in the market. But, the use of waffle slab is limited due to low resistance of shear, fire & local punching. The idea of using many blocks of very light material in slab from same flaws, so that the use of this system had not gained any acceptance and they are only used in a very specific number of projects.

BUBBLE DECK SLAB

It is geometry of Bubble Deck slab which defines by the spheres of specific size, placed in a reinforcement grid for a particular overall deck thickness. Bubble deck slab produces 20% faster floors with beams and limited formwork, which minimize the construction costs by 12% and agrees with 32% minimization in concrete use.

(a) Hollow spherical balls

(b) Hollow elliptical balls

Fig. 1.1 Bubble Deck samples

Technology of Bubble Deck is that which allows for stronger, and often thicker, slabs of concrete that span larger areas, and also gives the opportunity to architecturally design larger cantilevers. Bubble Deck is designed to be an efficient solution to decrease quantity of concrete used in a building's construction, greatly strengthen the overall frame, and better distribute weight of concrete that is actually used.

This technology will be used to manufacture lighter weight bridge deck since a significant portion of the stress applied to a bridge comes from its own self-weight. By using the knowledge collected during behavioural analysis, a modular deck component for pedestrian bridges that is notably lighter but comparable in strength to typical reinforced of concrete sections will be designed. For this investigation, the structural behaviour of Bubble Deck at different conditions will be studied to gain an understanding on this new technique and to compare it to the current slab systems. The difference between solid slab & voided slab of shear resistance. Due to minimizations of concrete volume, the shear resistance gets reduced. The shear capacity should be measured in the range of 72-91% of shear capacity of solid deck.

TYPES OF BALLS

(a) Plastic Balls

(b) Hollow Plastic Balls

(c) Polyurethane Balls

(d) Rubber Balls

(e) Steel Balls

(f) Phenolic Balls

TERMINOLOGIES USED

1. **Conventional slab**: This is a slab with specifications prepared to analyze experimentally with normal concrete of grade M_{30} by adopting conventional methods of design according IS 456:2000 & IS 10262:2009.
2. **Bubble deck slab:** This is a slab with specifications prepared to analyze experimentally with normal concrete of grade M_{30} by using Hollow strong plastic balls (HDPE- High density polyethylene) with the help of design according to DIN 1045 (1988) or DIN 1045 (2001) code (Germen code)

3.2.1 There are three types of bubble deck slab are casted:

a) Continuous bubble deck slab
b) Alternative bubble deck slab (type I)
c) Alternative bubble deck slab (type II)

3.3 PROBLEM STATEMENT

A conventional slab of size 1mx1mx0.125m is casted, Bubble deck slab also casted of size same as conventional slab 1mx1mx0.125m & study of various aspect and structural parameters.

CONVENTIONAL SLAB

3.5.1 Conventional (M_{30}) Concrete Mix Design

The conventional concrete i.e. M_{30} grade concrete is having mix design according to the IS 456:2000 & IS10262:2009 is explained in this section.

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1. Design constant

a) Grade Designation = M_{30}

b) Type of Cement = OPC 53 grade

c) Maximum Nominal Aggregate Size = 20 mm

d) Minimum Cement Content =320 kg/m^3

e) Maximum Water Cement Ratio = 0.45

f) Workability = 50-75 mm (Slump)

g) Exposure Condition = Severe

h) Degree of Supervision = Good

i) Type of Aggregate = Crushed Angular

j) Chemical admixture = No admixture use

2. Test Data for Materials

a) Cement Used Birla super OPC 53 grade

b) Sp. Gravity of Cement = 3.15

c) Sp. Gravity of Water = 1.00

d) Sp. Gravity of Coarse Aggregate = 2.77

e) Sp. Gravity of Fine Aggregate = 2.60

f) Water Absorption of Coarse Aggregate = 1.24%

g) Water Absorption of Fine Aggregate = 2.80%

h) Free (Surface) Moisture of 10 mm Aggregate = nil

i) Free (Surface) Moisture of crushed Sand = nil

3. Target Mean Strength

a) Target Mean Strength = 38.25N/mm^2

b) Characteristic Strength @ 28 days = 30N/mm^2

4. Selection of water cement ratio

a) Maximum Water Cement Ratio =0.45

b) Adopted Water Cement Ratio=0.43

5. Selection of water content

a) Maximum Water content (10262-table-2) =186 Lit.

b) Estimated Water content for 50-75 mm Slump=192 Lit.

6. Selection of cement content

a) Water Cement Ratio=0.43

b) Cement Content (192/0.43)=446.5 kg/m^3

Which is greater than 320 kg/m^3

7. Proportion of volume of coarse Aggregate & Fine Aggregate Content

a) Vol. of C.A. as per table 3 of IS 10262 = 62%

b) Adopted Vol. of coarse Aggregate = 55%

c) Adopted Vol. of Fine Aggregate = 45%

8. Mix Calculations

a) Volume of Concrete in m^3 = 1.00

b) Volume of Cement in m^3 = 0.142

(Mass of Cement) / (Sp. Gravity of Cement) x1000

c) Volume of Water in m^3 = 0.192

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(Mass of Water) / (Sp. Gravity of Water) x1000

d) Volume of All in Aggregate in m^3 = 0.67

e) Volume of Coarse Aggregate in m^3 = 0.55

f) Volume of Fine Aggregate in m^3 = 0.45

9. Mix Calculations

a) Mass of Cement in kg/m^3 = 446.5

b) Mass of Water in kg/m^3 = 192

c) Mass of Fine Aggregate in kg/m^3 = 784

d) Mass of Coarse Aggregate in kg/m^3 = 1021

e) Water Cement Ratio = 0.43

3.6 BUBBLE DECK SLAB

3.6.1 Continuous bubble deck slab (M_{30}) Concrete Mixture Design

1. Design constant

a) Grade Designation = M_{30}

b) Type of Cement = OPC 53 grade

c) Maximum Nominal Aggregate Size = 10 mm

d) Minimum Cement Content =320 kg/m^3

e) Maximum Water Cement Ratio = 0.45

f) Workability = 50-75 mm (Slump)

g) Exposure Condition = Severe

h) Degree of Supervision = Good

i) Type of Aggregate = Crushed Angular

j) Chemical admixture = No admixture use

2. Test Data for Materials

a) Cement Used Birla super OPC 53 grade

b) Sp. Gravity of Cement = 3.15

c) Sp. Gravity of Water = 1.00

d) Sp. Gravity of Coarse Aggregate = 2.77

e) Sp. Gravity of Fine Aggregate = 2.60

f) Water Absorption of Coarse Aggregate = 1.24%

g) Water Absorption of Fine Aggregate = 2.80%

h) Free (Surface) Moisture of 10 mm Aggregate = nil

i) Free (Surface) Moisture of crushed Sand = nil

3. Target Mean Strength

a) Target Mean Strength = 38.25N/mm^2

b) Characteristic Strength @ 28 days = 30N/mm^2

4. Selection of water cement ratio

a) Maximum Water Cement Ratio =0.45

b) Adopted Water Cement Ratio=0.43

5. Selection of water content

a) Maximum Water content (10262-table-2) =208 Lit.

b) Estimated Water content for 50-75 mm Slump=214 Lit.

6. Selection of cement content

a) Water Cement Ratio=0.43

b) Cement Content (214/0.43)=497.67 kg/m^3

Which is greater than 320 kg/m^3

7. Proportion of volume of coarse Aggregate & Fine Aggregate Content

a) Vol. of C.A. as per table 3 of IS 10262 = 62%

b) Adopted Vol. of coarse Aggregate = 55%

c) Adopted Vol. of Fine Aggregate = 45%

8. Mix Calculations

a) Volume of Concrete in m^3 = 1.00

b) Volume of Cement in m^3 = 0.142

(Mass of Cement) / (Sp. Gravity of Cement) x1000

c) Volume of Water in m^3 = 0.214

(Mass of Water) / (Sp. Gravity of Water) x1000

d) Volume of All in Aggregate in m^3 = 0.644

e) Volume of Coarse Aggregate in m^3 = 0.55

f) Volume of Fine Aggregate in m^3 = 0.45

9. Mix Calculations

a) Mass of Cement in kg/m^3 = 497.67

b) Mass of Water in kg/m^3 = 214

c) Mass of Fine Aggregate in kg/m^3 = 753

d) Mass of Coarse Aggregate in kg/m^3 = 981

e) Mass of 10mm Aggregate in kg/m^3 = 981

f) Water Cement Ratio = 0.43

Alternative bubble deck slab (type I) (M_{30}) Concrete Mixture Design

Design of Alternative bubble deck slab (type I)

- In Alternative bubble deck slab (type I) bubbles are arranged in X and Y direction alternatively throughout the slab.
- Reinforcement of alternative bubble deck slab will be same as continuous bubble deck slab.
- In the alternative bubble deck slab we reducing the bubbles volume and increase the concrete volume and analyse the effect on strength.
- The bonding between concrete and bubbles how efficiently effect on slab strength, for that reason alternative bubble deck slab analysed.

Alternative bubble deck slab (type II) (M_{30}) Concrete

Design of Alternative bubble deck slab (type II)

- In Alternative bubble deck slab (type II) bubbles are arranged in anyone of the direction alternatively throughout the slab.
- Reinforcement of alternative bubble deck slabs same as continuous bubble deck slab.
- In the alternative bubble deck slab we reducing the bubbles volume and increase the concrete volume and analyse the effect on strength.
- The bonding between concrete and bubbles how efficiently effect on slab strength, for that reason alternative bubble deck slab is analyse.

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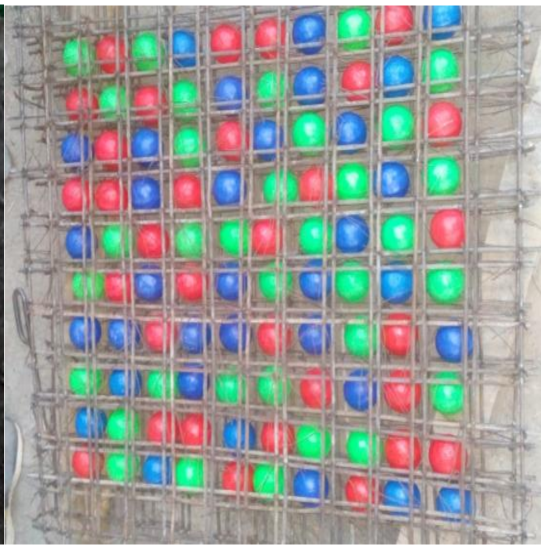
Conventional slab



Reinforcement of continuous bubble deck slab

Crack pattern during testing on slab

cracks on conventional slab

cracks on continuous bubble deck slab

CONCLUSION

- In that experiment found that the bubble deck (continuous) is reduced the concrete volume so that slab of weight ultimately decrease.
- Simultaneously the load on the bubble deck slab (continuous) has also 23% increases as compare to conventional slab.
- But the arrangement of the balls are effect on load carrying capacity of slab, in alternative arrangement of bubbles are 11% & 6% increasing the loaded carrying capacity than conventional slab but less than continuous bubble deck of slab.
- Simultaneously, slab of bubble deck has improve the elasticity property of slab, such as conventional slab is 6% less deflect than bubble deck, and quantity of bubbles in slab also affect on the this elasticity property.
- Weight reduction is the important factor is found in slab of bubble deck. Conventional slabs weight is 33% more than the bubble deck.
- Cost and time saving by using bubbles in slab like weight of slab, concrete volume indirectly load on the beam and walls also decrease/ less so that building foundations is designed for smaller dead loads.
  It is concluded that Load, deflection and weight parameters gives better result for bubble deck slab as compared to conventional slab.

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