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REVIEW PAPER: STUDY ON A COMPARATIVE STUDY OF BUBBLE DECK SLAB AND CONVENTIONAL DECK SLAB

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ABSTRACT

When designing a reinforced concrete structure, a primary design limitation is the span ofthe slab between columns. Designing large spans between columns often requires the use ofsupport beams and/or very thick slabs, thereby increasing the weight of the structure by requiringthe use of large amounts of concrete. Heavier structures are less desirable than lighter structures in seismically active regions because a larger dead load for a building increases the magnitude of inertia forces the structure must resist as large dead load contributes to higher seismic weight. Incorporating support beams can also contribute to larger floor-to-floor heights which consequently increases costs for finish materials and cladding.

A new solution to reduce the weight of concrete structures and increase the spans of two-way reinforced concrete slab systems was developed in the 1990s in Europe and is gaining popularity and acceptance worldwide. Plastic voided slabs provide similar load carrying capacity to traditional flat plate concrete slabs but weigh significantly less. This weight reduction creates many benefits that should be considered by engineers determining the structural system of the building.Plastic voided slabs remove concrete from non-critical areas and replace the removed concrete with hollow plastic void formers while achieving similar load capacity as solid slabs. Voided slab principles have been applied in different applications dating back to the early 1900s.Similary the reduction of concrete in bridge deck modal (light weight Pedestrian Bridge).In this thesis work our main focus on the reduction of concrete of bridge deck. So first we know about different type of parts of the bridge.

I. INTRODUCTION

The BubbleDeck method for the two directions reinforced composite concreteslab with gaps was invented in Denmark, it is licensed and it was conceived to achieve saving of concrete and energy in buildings construction. The composite slabs are made of Bubble Deck type slab elements with spherical gaps, poured in place on transversal and longitudinal directions.

By introducing the gaps leads to a 30 to 50% lighter slab which reduces the loads on the columns, walls and foundations, and of course of the entire building. ”BubbleDeck” slab elements are plates with ribs on two directions made of reinforced concrete or precast concrete with spherical shaped bubble. These slab elements have a bottom and an upper concrete part connected with vertical ribs that go around the gaps .The

reinforcement of the plates is made of two meshes one at the bottom part and one at the upper part that can be tied or welded. The distances between the bars correspond to the dimensions of the bubbles that are to be embodied and the quantity of the reinforcement from the longitudinal and the transversal ribs of the slab. The two mashes are connected after placing the spheres into places in order to form a rigid shell.

The bubbles are made by embodying high density polypropylene in the concrete, arranged according to the project and placed between the reinforcement meshes. The material that are made of don't react chemically with the concrete orthe reinforcement, it has no porosity and has enough rigidity and strength to take over the loads as much as from the pouring of the concrete as from the subsequent phases of this process.

II. OBJECTIVE

The main objective of this study is to investigate the potential use of granite waste in concrete as replacement for coarse aggregate and is to arrive at a suitable mix design for the application of discarded granite waste as a partial replacement of coarse aggregate in concrete; and to test and analyze the workability, density of hardened concrete, compressive and flexural strength, of concrete of grade M30.

III. LITERATURE SURVEY

The bubble deck slab is a revolutionary biaxial concrete floor system developed in Europe. High-density polyethylene hollow spheres replace the ineffective concrete in the centre of the slab ,thus decreasing the dead weight and increasing the efficiency of the floor. These biaxial slabs have many advantages over a conventional solid concrete slab: lower total cost, reduced material use, enhanced structural efficiency, decreased construction time and is a green technology.

Through tests, models and analysis from a variety of institutions,bubbledeck was proven to be superior to the traditional solid concrete slab. The reduced dead load makes the long term response more economical foe the building while offsetting the slightly increased deflection of the slab.However, the shear and punching shear resistance of the bubble deck floor is significantly less than a solid deck since resistance is directly related to the depth of concrete. Design reduction factors have been suggested to compensate for these difference in strength. This system is certified in the Netherlands, the unitedkingdom, Denmark and Germany.

TINA LAI (2009) have studied "Structural behavior of bubble deck slab and their application to lightweight bridge deck" investigated ,after verifying the validity of the prior research through a finite element analysis of an office floor in SAP2000,the bubble deck slab was tested for a pedestrian bridge deck. Bridge design is dominated by the dead weight of the structure and by concentrated stresses from vehicular traffic. This new slab can solve both of these problems by reducing weight with the plastic spheres and by applying it to a pedestrian bridge to limit the high stresses. A set of bridge deck were modeled and analyzed in sap 2000 for this study.

L.V.HAI (2009) Studied "The experimental analysis of bubble deck slab using modified elliptical balls and desisus the new prefabricate construction technology using bubble deck slab" is recently applied in many industrial projects in the world. Bubble deck slab uses hollow spherical ball made by recycled plastic and therefore it is an innovators method of virtually eliminating the concrete part in the middle of conventional slab

which does not contributed to the structural performance. This hence reduce significantly the structural selfweight.in this paper ,the experimental result of bubble deck slab subjected to static loading are presented. The effects of various factors to the behaviors of bubble deck slab are considered, such as the concrete strength, the shape and diameter of plastic balls, the size of reinforcing mesh at top and bottoming order to demonstrate the superiority and advances of mentioned technology, the improving of the plastic ball's shape by using hollow elliptical balls for better load-bearing capacity in Bubble Deck is also presented in details. The research results show the effectiveness and feasibility of the application of Bubble Deck in the construction works Ho Chi Minh City, Vietnam

Vijay Kumar(2010)studied the "Structural Behavior of Bubble Deck Slab" investigated the 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 poly ethylene 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. By introducing the gaps leads to a 30 To50% lighter slab which reduces the loads on the columns, walls and foundations, and of course of the entire building. The advantages are less energy consumption - both in production, transport and carrying out, less emission - exhaust gases from production and transport, especially CO2 .The aim of this paper is to discuss about various properties of Bubble deck slab based on the various studies done abroad. Moment, deflection and stress distributions are verified using Finite Element Method (FEM) in SAP2000.

Corey J Midriff (2013) has studied about "Plastic Voided Slab Systems: Applications and Design investigated the Reinforced concrete slabs are one of the most common components in modern building construction. Reinforced concrete slabs with plastic voids slabs are a new and innovative type of structural, concrete slab system developed to allow for lighter self-weight of the structure while maintaining similar load carrying capacity of a solid slab. Plastic voided slabs are capable of reducing the amount of concrete necessary to construct a building by 30 percent or more. This reduction can be beneficial in terms of financial savings as well as building performance. This report examines a two-way, reinforced concrete slab with plastic voids construction in comparison to traditional flat plate reinforced concrete slab construction. The design processor plastic voided slabs is directly compared with traditional two-way flat plate reinforced concrete slabs through a design comparison of typical bays of 20' by 20' (6m by 6m), 25' by 25'(7.6m by 7.6m), 30' by 30' (9m by 9m) and 35' by 35' (10.7m by 10.7m). The traditional slab design process follows the ACI 318-11 Building Code Requirements for Structural Concrete.

Gilani A, and juntunen (2013) have studied about "Spherical void formers in concrete slabs" investigated the Large span concrete flat-slab systems with internal spherical void formers (SVF) have been used in Europe for over a decade. They are bi-axially reinforced concrete flat-slab systems with a grid of internal spherical void formers. This paper addresses three issues associated with SVF slab systems: their shear resistance, their short-term elastic deflections and their economical value in a South African context. Due to the "loss" (or reduction) of aggregate interlock required for shear resistance in SVFslabs, the design requirements of the reinforced concrete design code are affected. Research at the Technical University of Darmstadt (TUD) in Germany proved a shear resistance reduction factor of 0,55 to be conservative, while research at the University of Pretoria

suggests a greater factor of 0,85 when taking into account the shear capacity of the permanent steel cages that hold the spheres in position in some SVF slab systems.

IV. METHODOLOGY

The method of design and analysis of the bubble deck bridge slab are two types which are elucidated below.

1) DESIGEN AND ANALYSIS IN LABROTARY
2) DESIGEN AND ANALYSIS IN SOFTWARES

4.1 Desigen and Analysis in Laboratary

The design of bubble deck slab in the laboratory consist different steps. The bubble deck slab is the combination of reinforced concrete and PVC balls. The mixer of cement sand and aggregate on the basis of INDIAN STANDARAD (concrete mix proportioning) 10262:2009.

- Step 1 : Dimension of mould of bubble deck slab – 0.66mx0.33mx0.14m

  Volume of mould of bubble deck slab – 0.02772m3
- Step 2: Dimension of Plastic balls (diameter)= 0.0625m

  Radius = 0.031m

  Volume of sphere = $4/3x\pi xr3$

  Volume of sphere of 24 ball =0.0035m3

  Volume of design for mix proportioning = vol. of mould-volume of sphere

  = 0.2772-0.0035

  = 0.02422m3

  Concrete of mix proportion for M25

4.2 Types of Material and Their Shape and Size

For the design of bubble deck slab the main material is the cement sand and aggregate .for the better result we done the test of different type of material

2.2.1 Concrete

4.2.2 HDPE Balls

A linear polymer, High-density polyethylene (HDPE) is prepared from ethylene by a catalytic process. The absence of branching result in a form more closely packed structure with a higher density and somewhat higher chemical resistance then LDPE(low-density polyethylene).HDPE is also somewhat harder and more opaque and it can withstand rather higher temperatures(1200 Celsius for short periods,1100 Celsius continuously).

4.2.3 Preparation of reinforcement mesh

We know that concrete are provided in the bubble deck slab for the compressive zone and the steel bar are provided for the tension zone. The mesh of bar are given below.

Plates-Preparation of mesh Plates -Combination of HDPE Balls with mesh

The size of steel bar vertical direction is 62cm and in the horizontal direction is 24 cm and the spacing between is 6.5cm and the diameter of bar is 8mm.and the diameter of HDPE ball is 6.5cm.the combination of bar and ball are show in fig. are given below.

4.4 Preparation of Concrete

Production of quality concrete requires meticulous care exercised at every stage of manufacture of concrete. It is interesting to note that the ingredients of good concrete and bad concrete are the same. If meticulous care is not exercised, and good rules are not observed, the resultant concrete is going to be of bad quality. With the same material if intense care is taken to exercise control at every stage, it will result in good concrete. Therefore, it is necessary for us to know what are the good rules to be followed in each stage of manufacture of concrete for producing good quality concrete. The various stages of manufacture of concrete are given below.

1. Batching 2. Mixing 3. Transporting
4. Placing 5. Compacting 5. Curing

1.4.1 Batching: The measurement of materials for making concrete is known as batching. There are two methods of batching.

(i) Volume batching (ii) Weigh batching

4.4.1 Volume batching: Volume batching is not a method for proportioning the material because of the difficulty it offers to measure granular material in terms of volume. Volume of moist sand in a loose condition weighs much less than the same volume of dry compacted sand. The amount of solid granular material in a cubic meter is an indefinite quantity. Because of this, for quality concrete material has to be measured by weight only. However, for unimportant concrete or for any small job, concrete may be batched by volume.

4.4.2 Weigh Batching: Strictly speaking, weigh batching is the correct method of measuring the Material. For important concrete, invariably, weigh batching system should be adopted.

Use of weight system in batching, facilitates accuracy, flexibility and simplicity. Different types of weigh batchers are available, the particular type to be used, depends upon the nature of the job. Large weigh batching plants have automatic weighing equipment. The use of this automatic equipment for batching is one of sophistication and requires qualified and experienced engineers.

4.4. 3 Mixing: Thorough mixing of the materials is essential for the production of uniform concrete. The mixing should ensure that the mass becomes homogeneous, uniform in color and consistency. There are two methods adopted for mixing concrete:

(i) Hand mixing
(ii) Machine mixing

1) Hand mixing: Hand mixing is practiced for small scale unimportant concrete works. As the mixing cannot

be thorough and efficient, it is desirable to add 10 per cent more cement for the inferior concrete produced by this method.

2) Machine Mixing: Mixing of concrete is almost invariably carried out by machine, for reinforced concrete work and for medium or large scale mass concrete work. Machine mixing is not only efficient, but also economical, when the quantity of concrete to be produced is large. The fig. of machine mixing are given below.

Plates - Mixing of concrete

Very little is known about the relative mixing efficiencies of the various types of mixers, but some evidences are there to suggest that pan mixers with a revolving star of blades are more efficient. They are specially suitable for stiff and lean mixes, which present difficulties with most other types of mixers, mainly due to sticking of mortar in the drum. The shape of the drum, the angle and size of blades, the angle at which the drum is held, affect the efficiency of mixer. It is seen that tilting drum to some extent is more efficient than non-tilting drum. In non-tilting drum for discharging concrete, a chute is introduced into the drum by operating a lever. The concrete which is being mixed in the drum, falls into the inclined chute and gets discharged out. It is seen that a little more of segregation takes place, when a non-tilting mixer is used. It is observed in practice that, generally, in any type of mixer, even after thorough mixing in the drum, while it is discharged, more of coarse aggregate comes out first and at the end matrix gets discharged. It is necessary that a little bit of re-mixing is essential, after discharged from mixer, on the platform to off-set the effect of segregation caused while concrete is discharged from the mixer.

Mixing Time: Concrete mixers are generally designed to run at a speed of 15 to 20 revolutions per minute. For proper mixing, it is seen that about 25 to 30 revolutions are required in a well-designed mixer. In the site, the normal tendency is to speed up the outturn of concrete by reducing the mixing time. This results in poor quality of concrete.

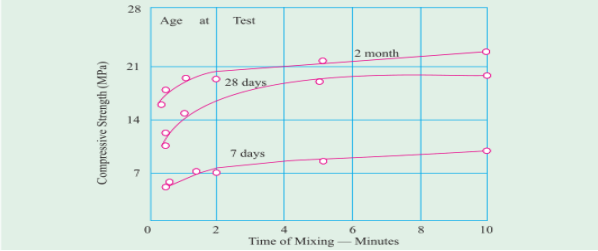

Figure 3.1 The Graph of Mixing time

On the other hand, if the concrete is mixed for a comparatively longer time, it is uneconomical from the point

of view of rate of production of concrete and fuel consumption. Therefore, it is of importance to mix the concrete for such a duration which will accrue optimum benefit.

It is seen from the experiments that the quality of concrete in terms of compressive strength will increase with the increase in the time of mixing, but for mixing time beyond two minutes, the improvement in compressive strength is not very significant. Fig shows the effect of mixing time on strength of concrete. The prepared fresh concrete are shown in fig. are given below.

Plates- Ready Concrete

Teston concrete

Test on concrete are done in accordance with IS: 516-1959 in two stage of concrete:

1) Testing of fresh concrete or wet concrete, and
2) Testing of hardened concrete

Test on fresh concrete are done to determine its workability. These tests are as follows:

1) Slump test
2) Compacting factor test,
3) Vee bee consistency test
4) Flow table test

Slump test: Slump test is the most commonly used method of measuring consistency of concrete which can be employed either in laboratory or at site of work. It is not a suitable method for very wet or very dry concrete. It does not measure all factors contributing to workability, nor is it always representative of the placability of the concrete. However, it is used conveniently as a control test and gives an indication of the uniformity of concrete from batch to batch. Repeated batches of the same mix, brought to the same slump, will have the same water content and water cement ratio; provided the weights of aggregate, cement and admixtures are uniform and aggregate grading is within acceptable limits. Additional information on workability and quality of concrete can be obtained by observing the manner in which concrete slumps. Quality of concrete can also be further assessed by giving a few tapping or blows by tamping rod to the base plate. The deformation shows the characteristics of concrete with respect to tendency for segregation.

The apparatus for conducting the slump test essentially consists of a metallic mould in the

Form of a frustum of a cone having the internal dimensions as under

- Bottom diameter

: 20 cm

- Top diameter : 10 cm
- Height : 30 cm

Slump testing

The result of slump test which are conduct in the lab are given below

Slump difference = height of slum apparatus - height of fresh concrete

= 30cm – 25.5cm

= 4.5

The result shows the medium degree of workability of fresh concrete

Curing Methods

Curing method are divided in to 4 categories

1. Water curing 2. Membrane curing 3. Application of heat 4. Miscellaneous

- Water curing:

This is by far the best method of curing as it satisfied all the requirements of curing namely. Promotion of hydration, elimination of shrinking and absorption of the heat of hydration. It is pointed out that even if the membranes method is adopted, it is desirable that a certain extent of water curing is done before the concrete is covered with membranes. Water curing can be done in the following ways;

a) Immersion
b) Pounding
c) Spraying or fogging
d) Wet covering

The precast concrete item is normally immersed in curing tanks for a certain duration. Pavement slab, roof slab, deck slab etc.are covered under water by making small pounds.verticallyretaining wall or plastered surface or concrete column etc.are cured by spraying water. In some cases, wet covering such as wet gunny bags, hessian cloth, jute matting, straw etc. are wrapped to vertical surface for keeping the concrete wet. For horizontal surfaces saw dust, earth or sand are used as wet covering to keep the concrete in wet condition for a longer time so that the concrete is not unduly dried to prevent hydration. So in my thesis work we use the water curing pounding system. And after 28 days we check the strength of the bubble deck slab as well as the strength of the conventional deck slab system.

Testing of the bubble deck slab and the conventional solid slab

The testing of bubble deck slabs as well as the solid deck slab in the shear failure, flexural failure and check the strength of the slabs on the Universal testing machine

Procedure

1) Adjust the supports along the UTM bed so that they are symmetrically with respect to the length of the bed.

2) Place the slab on the knife-edges on the blocks so as to project equally beyond each knife-edge. See that the load is applied at the centre of the slab.
3) Apply a load and again note the reading.
4) Go on taking reading applying load in steps each time till you have minimum 6 readings. Find the deflection in each time by subtracting the initial *reading.*

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