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A COMPARATIVE ANALYSIS OF COBIAX - BUBBLE DECK SYSTEM OVER OTHER CONVENTIONAL SLAB SYSTEMS

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Abstract: The construction industry is being revolutionized with growing technology and innovation. Tall structures have considerably reduced the problem of shelter, but are considered highly susceptible to seismic loads and uneconomical. Both the problems are aroused due to the high weight of the building. Of all the structural members in a building slab are considered to be occupying high area and the load of the building is mostly contributed due to slab. The one stop solution in order to achieve less weight of a building which is also environmentally friendly is a Bubble deck slab. This biaxial floor system is incorporated with high density polyethylene hollow spheres, replacing the ineffective concrete in the center of the slab, thus decreasing the dead weight and increasing the efficiency of buildings. The bubble deck slab is a new technique which involves the direct way of linking air and steel. Void form in the middle of slab eliminates 30-50 % of material to be used in the slab which in turn reduces the load on columns, walls and eventually results in smaller foundations.

In the present study the "Bubble deck floor system" is considered and also that is compared with the convensional solid type of slabs (with different plans and bay optimization). Analyzing the structure for various intensity parameters and checking for multiple criteria at each level has become an essential practice. The linear method of Equivalent static analysis is carried over to find out the structural behaviour and that is compared with the convensional method of practice.

Keywords: Tall structures, Seismic loads, Bubble deck slab, biaxial floor system, Polyethylene hollow spheres, convensional solid slabs, Equivalent static analysis.

I. Introduction

The Bubble Deck slab is a revolutionary biaxial concrete floor system developed in Europe in1990s by Jorgen Breuning. The traditional Bubble Deck technology uses spheres made of recycled industrial plastic to create air voids while providing strength through arch action. Reduce construction time, green technology; it gains much of attention from engineers and researchers from the world. So in this consideration the weight of the building is mainly constituted due to the slab. Hence the reduction of slab weight will eventually reduce the complete weight of the building and on this note few of the Europeans scientists felt that reduction of concrete in the slab can be achieved only by reducing the concrete in the tension zone where the use of concrete is minimal or mostly of no use. This idea of reducing the concrete by implementation of bubbles has been revolutionary in the discovery of bubble deck slab system. In the bubble deck slab system, it becomes more important to insert bubbles where its primary function is to create voids but not carrying any load. The construction industry is being revolutionized with growing technology and innovation. The man started to reach sky not in any aero plane, but with the height of the building. Both the problems are aroused due to the high weight of the building. The one stop solution in order to achieve less weight of a building which is also environmentally friendly is a Bubble deck slab. The bubble deck slab system consists of hollow plastic spheres cast inside concrete to create a grid of void forms inside the slab to have a major contribution to the objective of sustainable buildings. This type of slab system could optimize the size of vertical members like walls and columns by lightening the weight of the slabs. According to the manufacturer, the Bubble deck slab can reduce total project costs. The Bubble deck slab floor system can be used for storey floors, roof, floors and ground floor slabs. The principal characteristic is that hollow plastic spheres are incorporated in the floor, Clamped in a factory-made reinforcement structure. This reinforcement structure constitutes at the same time the upper and lower reinforcement of the concrete floor

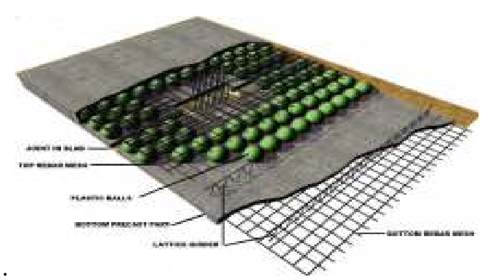

Fig 1: Protype model of Bubble Deck slab

State of art: The bubble deck slab has a unique feature of reducing the concrete in the tension zone of the slab eventually reducing the weight of the slab and in turn reducing the size of the various elements like columns, beams and footings.In a general way the slab was designed only to resist vertical load. In addition, when the span of the building is increasing, deflection of the slab is more

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important. Therefore, the slab thickness is on the increase. Increasing slab thickness makes slabs heavier, and it leads to increased column and base size. Thus, it makes buildings consume more materials such as concrete and steel.

II. Literature Review:

The bubble deck slab system is a revolutionary slab system in the recent technologies. The customary Bubble Deck innovation utilizes circles made of reused modern plastic to make air voids while giving quality through curve activity. In this manner, the Bubble Deck has numerous favorable circumstances as contrast with a conventional solid piece, for example, lower aggregate expense, lessened material utilization, improved basic effectiveness, diminished development time, and is a green innovation. It increases quite a bit of consideration from architects and specialists of the world. The various undiscovered concepts of bubble deck slab system have been a topic of keen interest for various scientists for years. The mechanism of load transfer, shear force, bending moment, deflection, casting, reaction to various loads have been deeply studied by various peopleand put forwarded valuable information regarding it. Literature for the bubble deck slab has various hypotheses and in initial stages its analysis was complex, but with the advent of finite element modelling things became much simpler and understanding the critical parameters became much easier.

The bubble deck patent has been largely adopted from the work of various scientists by the bubble deck company. Their initial research to obtain a better product by the elimination of concrete in the tension zone is though initially questioned, but later got a high accepted worldwide. These deck slab system has created a huge difference in construction of high rise buildings because of their greater spans the weight of the building was always been a topic of concern as the weight of the slab eventually increases the size of the columns and which results in the increase of overall weight and sizes of structural member which result in increasing the weight on the footing. In principle voided biaxial slabs acts like solid slab, U-boot system, consisting of a grid of orthogonal "I" beams, must be calculated as beams. The bubble deck slab system consists of hollow plastic spheres cast into the concrete to create a grid of void forms inside the slab and have a major contribution to the objective of sustainable buildings.

Fig 2: Bubble Deck slab a). Concrete grid frame set; b) slab installed with bubbles; c) c/s view of bubble deck slab

III. Methodology

In the present we have study three different structural systems such as bubble deck system, conventional system and flat slab system these structural systems are applied to the structure which is located near kondagattu a G+5 residential building. For the plan given below, the building is analyzed for gravity, wind and earthquake (linear dynamic analysis) and various internal forces (reactions, bending moment, shear force, axial force of the members (columns) at various levels, joint displacements, base shears, lateral forces in all the cases has to be studied and compared. The analysis is carried out on structural software program **(SAP2000).** In conducting this study a slab of span 8 x 8.5 m is considered for various types of slabs and quantities of steel and concrete are analyzed and estimated. In this initially a conventional 2 way slab of span 8x8.5 m is analyzed in depth fixed on the l/d ratio and based on the safe deflection and for the derived moment are of steel is estimated. In the similar way, flat slab is considered and analyzed as per IS: 456 code and by calculating all the necessary checks for the given moment even considering the punching shear condition steel is provided. The next slab is post tensioned pre-stressed slab of similar dimensions and in here the thickness of the slab is considerably reduced as per the span/50 ratio. In this case the area of steel that is number of tendons and pre stressing are assumed and based on it, the deflection is estimated and when the condition for deflection is satisfied the slab is deemed to be safe. The next and the most important slab system is the topic of interest, i.e. bubble deck slab system. This slab has been analyzed and based on the bubble deck patented work and also been analyzed in SAP. The design guidelines are as per Bubble deck patent where reinforcement is placed both on top and bottom in the form of mesh and bubbles incorporated between them in between lattice girders.

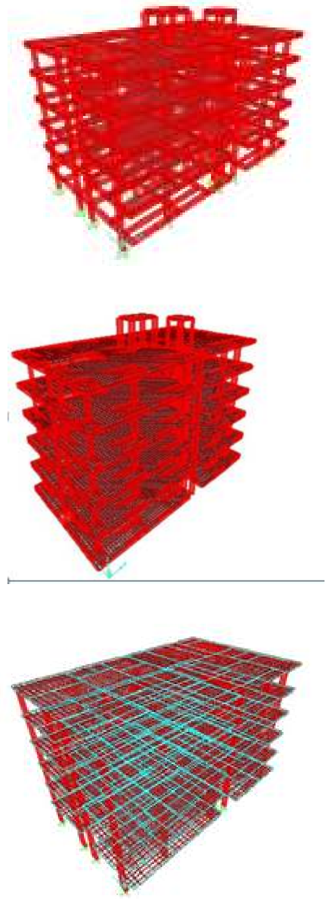

Fig 3: a). Convention slab modle building; b) Flat slab modle building; c) bubble deck slab modle building

IV. Results & Discussion

Base shear is usually a maximum expected lateral force that will occur due to seismic ground motion at the base and in this comparison of a bubble deck slab system with Flat slab system the base shear in a bubble deck slab is reduced by 46.53% and in comparison with conventional two way slab the base shear is reduced to 76% the reason behind this is clearly due to reduction of dead weight from both slabs, columns and elimination of down standing beams.

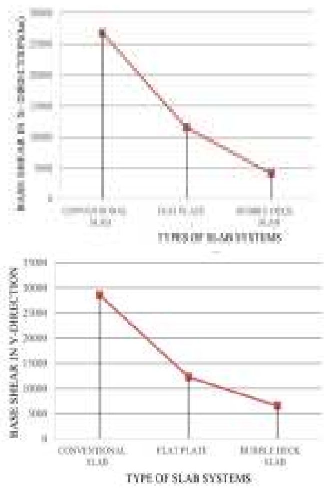

Fig 4: Base shears a) in X – direction; b) in Y – direction

Foundation Reactions: These are the reactions obtained at the base level as I have mentioned in the above that I would consider 4 columns at four different locations.

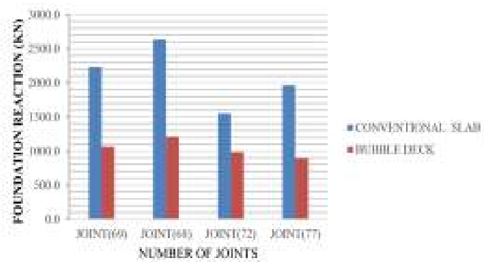

Fig: 5 Reaction at foundation (B.D.S vs Conventional slab)

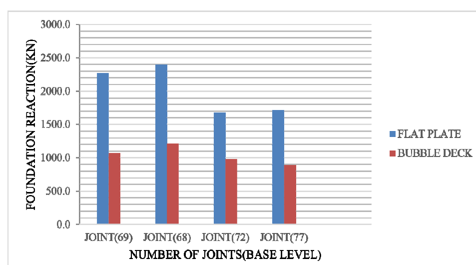

Fig: 6 Reaction at foundation (B.D.S vs Flat slab)

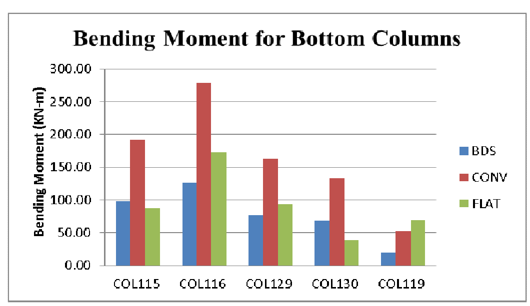

Fig: 7 Bending Moment for bottom columns

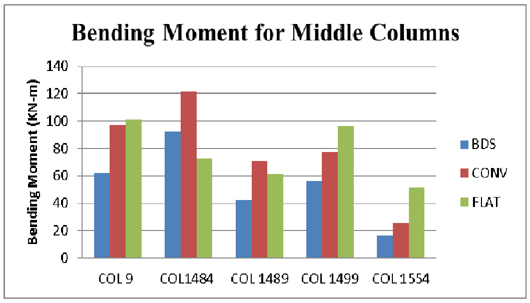

Fig: 8 Bending Moment for middle columns

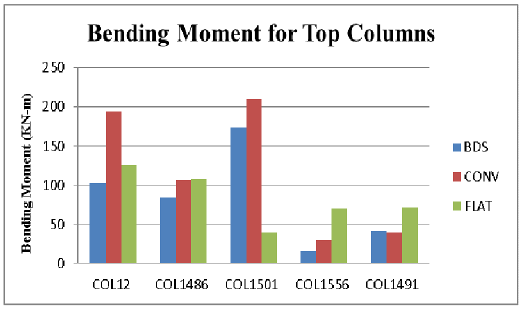

Fig: 9 Bending Moment for top columns

The moment force in the columns is a topic of interest and to some extent this is the key to reduce the sizes of the members and also to understand the behavior of building during the earthquake. The moments which have been carried for calculating the moment is to analyze the reduction of moments in 3 different places that is bottom, middle and top is to understand the behavior of moments at various instants.

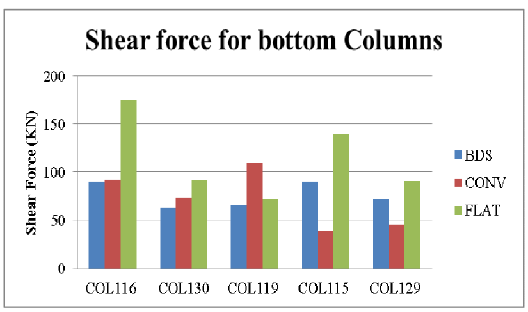

Fig: 10 Shear Force for Bottom columns

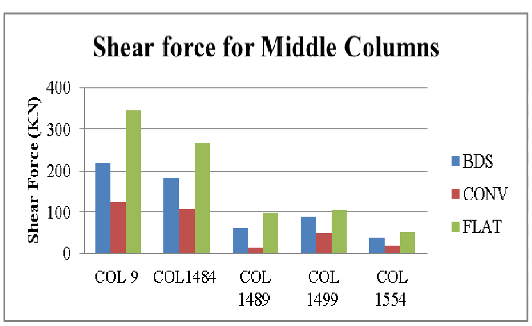

Fig: 11 Shear Force for Middle columns

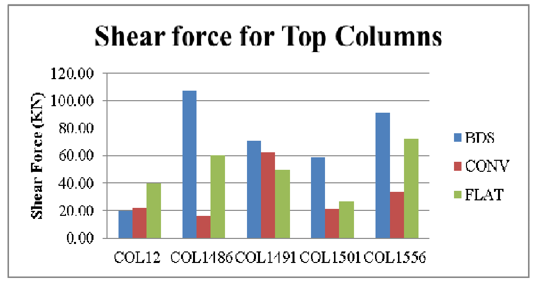

Fig: 12 Shear Force for Top columns

The Shear force in the columns is a topic of interest and to some extent this is the key to increase the shear reinforcement in any member. The sole reason is a bubble deck slab is not incorporated with any beams and the conventional slab has beamed to reduce the shear force and hence in this aspect the bubble deck slab has increased shear force.

Table 1: Quantity of cement in tonne

Sl.No	TYPE	TONNES	BAGS
1	Conventional System	2.09	41 NOS
2	Bubble Deck System	0.62	12 NOS
3	Flat Slab System	0.728	14NOS

Table 2: Quantity of concrete in tonne

SL.NO	TYPE	TONNES
1	Conventional System	16.2
2	Bubble Deck System	4.8
3	Flat Slab System	5.6

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