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Theoretical Modeling of Hollow Deck Slab with Hexagonal Reinforcement and Nano-Concrete

Shivraj G. Malge[1], Chandrakant B. POL[2]

[1]PG Student, Dept. of Civil Engineering, Walchand College of Engineering, Sangli, Maharashtra[2]Assistant Professor, Walchand College of Engineering, Sangli, Maharashtra

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Abstract - *The slab is profoundly influential structural member to generate space which is one of the largest components engrossing concrete. The invention of the hollow slab was in 1950's. The thought was to make an empty biaxial piece with similar capacities as a strong slab, however with significantly a lesser amount of weight because of the disposal of overabundance concrete. It is established on the unproved gathering method that is the association of air and steel bars (network).In this research, an innovative type of hollow deck slab is introduced with hexagonal reinforcement, nano-concrete and thermocol foam as infill material. This methodology stays away from the impediments in empty center chunks, absence of primary honesty, rigidity and absence of compositional conceivable outcomes which creates the approaches to decrease the heaviness of the structure. It is utilized to diminish the measure of cement utilized in a structure, extraordinarily fortify the general casing and convey the heaviness of substantial that is really utilized. This innovation decreases cost of development. In these analytical verdicts assessment between conventional slab and hollow deck slab with hexagonal reinforcement is done. In ANSYS software, by providing flexural point loading in the hollow deck slab and in conventional slab; the model is analyzed. Next to; the appraisal has been prepared for hollow deck Slab with the conventional slab over the stresses and deformation. From the judgment of these outcomes, hollow deck slab provides improved enactment than that of the conventional slab.*

***Key Words*: Hollow deck slab, conventional slab, hexagonal reinforcement, thermocol, etc.**

1. INTRODUCTION

Concrete is often used in slab construction. It results in concrete loss since the load moves from the structure just to the column part of the slab and not to the rest of the slab. So, by applying hollow deck technology, you may reduce the significant heaviness in the slab's centre. In everyday life cost of concrete expanding so to conquer this issue here, foam material is utilized to supplant the incapable concrete in the slab's centre, likewise decreasing the additional weight and growing the capability of the floor. Right when the load circling back to the part is colossal or clear reach between two segments is more, the deformity of the section is similarly gigantic. Hence, thickness of the chunk gets expansions in plan. Extending the chunk thickness makes the areas heavier and will construct segment and balance in bigger size. Consequently, structures eat up more materials, for instance, cement and steel support. Lightweight foam material replaces the incapable concrete in center of section in this way withdrawing extra weight expanding the effectiveness of floor.

The wished-for effort conveys to decrease the general identity load of section or to lessen the general lifeless weight of the chunk. Here, this hollow floor slab is planned according to Indian stipulation by utilizing thermocol foam which lessens the expense of the undertaking. At long last, a correlation for hollow deck slab with regular section over its load carrying limit and deflection has been established. As of the evaluation of these results, , the hollow deck slab outperforms the regular section. Hollow deck slabs are used in stopping decks, business structures, lodgings; film corridors where range between two sections should be more. Here, the schematic portrayal of hollow deck slab with hexagonal reinforcement utilizing foam as infill is displayed in Fig 1.

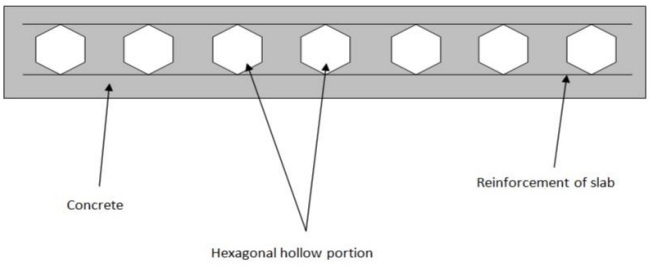

Fig -1: Cross Sectional representation of hollow deck slab with hexagonal reinforcement.

1.1 Objective of the proposed work

The objective of this work is to develop theoretical modelingof Hexagonal Reinforced Nano-concrete slab and

compare the performance with conventional concrete slab using ANSYS workbench 19.2

2. LITERATURE REVIEW

Maha Habeeb et al (2020) in this paper, they zeroed in on the main issue in section; a punching shear. He zeroed in on most well-known fortifying strategy; work of shear support. To lessen dead heap of section, lightweight total concrete just as the bubble deck innovation were utilized in this examination. To examine impact of shear support, three mathematically and precisely comparable pieces were casted with various shear support type (share, inclined bar and stud) and ready for testing. In Parallel, for correlation reason, a control example with no shear support was utilized. The outcomes showed that the slanted shear support has the best influence on section conduct, between the three kinds of support that were received in the test work.

Sankalp K. Sabale (2019) this paper offers an examination on the properties and benefits of Bubble Deck level piece framework. In corresponding with; offers an examination on characteristics and advantages of bubble deck level chunk framework. Bubble Deck is a technique for killing cement from the ordinary piece which doesn't play out any underlying capacity, henceforth decreasing primary extra weight alongside expanding proficiency of the floor. In corresponding with not needing shafts and segment heads, this agenda can be consumed for gable and ground flooring sections (slabs). Substantial volume is dense by replacements of plastic balls in this bubble deck innovation. This innovation decreases cost of development alongside time. In this writing, an experimental investigation of connection between ordinary level section and bubble deck level chunk is exhausted.

L. Lakshmikanth et al (2019) in this paper a careful review of the underlying conduct of bubble deck section is introduced. By lessening the heaviness of the piece by disposing of cement, which is fundamentally latent in the interlocking of total for shear obstruction. Alongside, staying substantial go about as pressure block for flexural obstruction. With this prestigious innovation, bigger ranges with less plan burdens to the segments and footings without compromising flexural strength of the piece with least diversions are feasible. To know the primary conduct under broad stacking, scientific and test concentrates on bubble deck pieces have been introduced in this article. The bubble deck section is checked for different primary properties like flexural strength, shear strength, punching shear, securing, break design, imperviousness to fire, creep, break design.

Namdev Rajguru et al (2017) in this paper, contemplates have been made to show the halfway substitution of concrete by Nano silica powder (1%, 1.5%, 2%) by the heaviness of concrete. After that relative examination had been made of compressive strength of cement with expansion of Nano silica and without expansion of Nano silica. To diminish the ecological contamination by decrease of CO2 discharge in environment, nano silica is utilized in concrete. This article additionally shows substantial penetrability improvement.

Mani M et al (2017) presently a day, in all development fields, nanotechnology is one of most dynamic examination regions with wide applications. An examination is completed in this paper about Nano materials utilized; like nano silica, nanoTio2, and carbon nano-tubes which are less than 500 nano meter. Nano silica has heat transfer property while nano Tio2 has heat transfer just as has UV assimilation characteristic. When contrasted with customary substantial solidness and strength execution is expanded by the expansion of nano silica.

P.Vasanthi et al (2017) in this paper, an exhibit is done appearance that substantial containing nano particles have expanded strength, sturdiness and decrease of pores because of the pore filling properties of the nano materials. Life expectancy of the structure can be expanded utilizing nano materials. CO2 discharge is expanded because of use of concrete in enormous amount. Concrete having high compressive strength can be created by nano silica materials. In equal, high usefulness will be furnished with decreased water concrete proportion.

3. MATERIALS

Here, Hollow Deck is made out of three principle materials-support steel, thermocol and nano concrete.

3.1 Thermocol froth

Thermocol or Expanded Polystyrene (EPS) is a limiting component embraced to shield costly items. Thermocol is a plastic which is completely recyclable just as it has a high worth to recyclers. Thus, rather utilizing HDPE balls to make piece empty, here, thermocol is utilized to make the empty segments in section. It doesn't respond synthetically with the substantial or support bars. The froth has sufficient strength and solidness to help securely the applied burdens in the stages previously and all through concrete drizzling.

3.2 Concrete

The substantial utilized in the section should be of least grade 20. Generally ordinary cement is utilized for the making of empty deck piece in any case, here nano substantial material is utilized by utilizing nano-graphene and nano-silica material. Cement of M20

grade is utilized for customary chunk and M20 grade of nano-concrete is utilized for empty deck piece. The profundity of the piece is about 135mm.

3.3 NANO CONCRETE

Nano-concrete is a substantial delivered by filling pores in customary cement by particles of size under 500nm. At the point when cement is diminished to nano level there properties are extraordinarily impacted. In this examination we will utilize graphene and nano silica as nano added substances. Past investigations show that expansion of graphene and nano silica works on the compressive strength just as rigidity of cement. It additionally builds the young's modulus of cement.

3.3.1 Nano Silica

Research facility tests show that Nano silica particles can be acquired by sol-gel measure from the hydrolysis of tetra ethoxysilane in ethanol with utilization of smelling salts as impetus. Molecule size of nano silica can be represented by utilization of liquor as dissolvable and changing response temperature.

Table1: Characteristics of Nano-silica

Characteristics	Value
1. Density	2.7
2. PH	3.7-4.7
3. SiO2 Content	>99.8% by wt.

2.6.2 Graphene

Graphene has had extremely flimsy layer of carbon, has a higher SSA, high Young's modulus of versatility, higher warm conductivity and more prominent electrical conductivity. These properties make graphene significant nanomaterial in utilizations of supported cement.

Graphene can be characterized as single film of carbon molecules coordinated in a hexagonal grid. Graphene is central structure block for graphite materials, everything being equal. Graphene Nano particles are the extraction of carbon, which works on the strength of cement.

Table-2: Characteristics of Graphene

Characteristics	Value
1.Specific Gravity	1.9
2. Test	Test less
3. Odor	Odor less
4. Color	Black

3. METHODOLOGY

3.1 Conventional Slab

This is a piece ready with details with typical cement of M20 grade by receiving traditional strategies for configuration as indicated by IS 456:2000 with measurements 1mX1mX0.135m. Cover of 25mm is given. The underlying advance is laying the support for increment the elasticity of the design. The support is given as lattice comprise of 7 no. of 8mm and 6mm bars with dispersing 157mm focus to focus in the two ways.

3.2 Hollow Deck Slab

This is a section is ready with IS 456:2000 determination just as with German code DIN 1045. Nano-concrete of grade M20 is utilized alongside utilizing froth as infill material for empty segment with section measurements as 1mX1mX0.135m.. The underlying advance is laying the support for increment the rigidity of the design. The support is given as lattice comprise of 7 no. of 8mm and 6mm bars with dividing 157mm focus to focus in the two ways. The empty hexagonal built up segments are set on base concrete according to design. 49 no. of hexagons having side 40mm and distance between two balls is 157mm focus to focus.

4. NUMERICAL INVESTIGATION

In this part, the primary conduct and strength of Hollow deck chunk and Conventional piece are examined utilizing limited component bundle ANSYS. The limited component strategy is broadly used to examine the conduct of the design, for example, shear strength, Equivalent stress, and extreme burden, and crack outline, avoidance at mid bit of chunk for both hollow deck piece and for Conventional section. The FEA is the discretization of the primary part in to limited number of component by fanciful line or by surface. The interconnected component may have distinctive size and shape and associated at limited number of focuses called nodes. The test boundaries included sizes of hexagonal empty segments, section thickness, width of the chunk are feed into ANSYS.

4.1 Numerical Modelling

The size of the slab is 1000mm x1000mm x 135mm. The support subtleties and model is drawn utilizing AUTO CAD programming for both hollow deck slab and for ordinary chunk and afterward it sent out to ANSYS Workbench19.2 as 3D strong items with indistinguishable math. The Hollow deck slab and ordinary section are discretized utilizing tetrahedral component type and it as 4 nodes and every node as 6 degrees of freedom for concrete, steel support and for thermocol; it is reasonable for both hollow deck chunk and for customary slab. Essentially support conditions were accommodated

hollow deck section and for traditional slab. Single point load is applied for the space of about 300mm x300mm over the top part of the section. A pivotally compressive load was applied on the top surface of chunk with dislodging control. The explanation for utilizing point load was to contemplate the conduct of section in prohibitive shear, and the sort of disappointment related with it. The redirection of a slab was determined at focus. The load was applied on a gradual technique and the investigation is done.

4.2 Numerical Investigation for Hollow Deck Slab

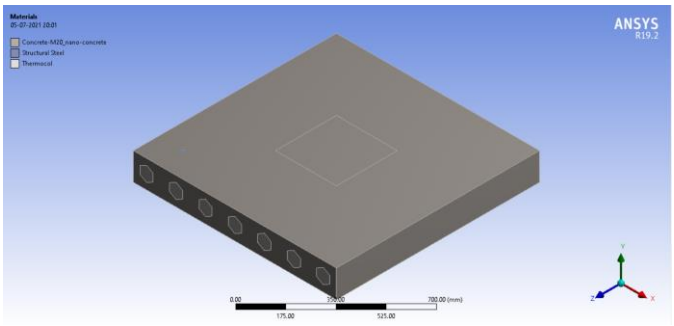

Fig -2: Modeling of hollow deck slab

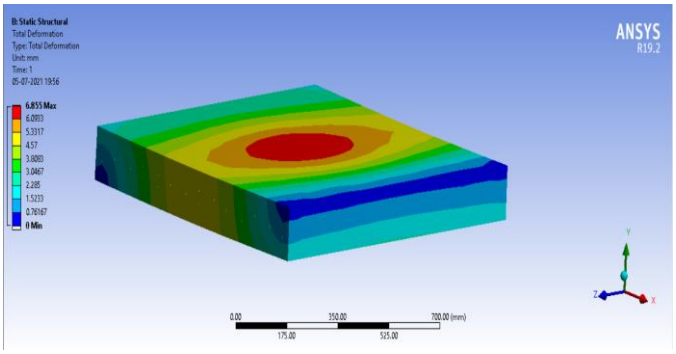

Fig -3: Deformation of hollow deck slab

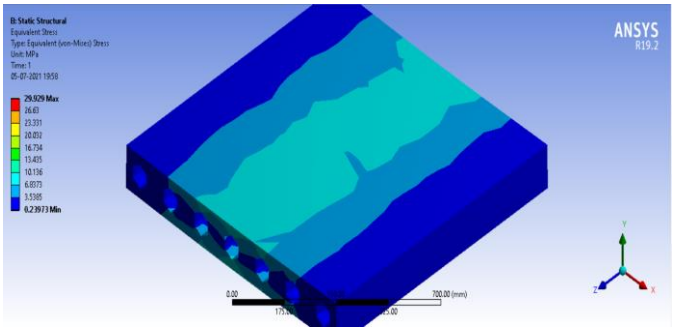

Fig -4: Equivalent stress for hollow deck slab

4.3 Numerical Investigation for Conventional Slab

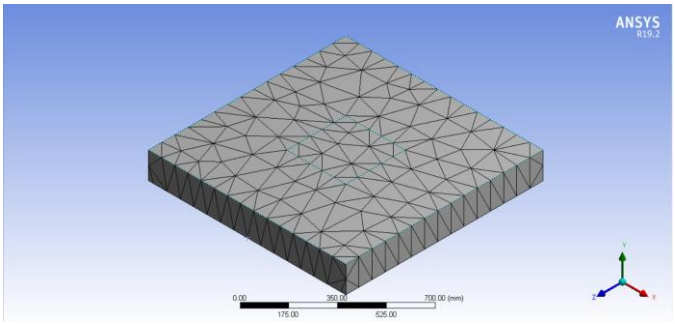

Fig -5: Mesh modeling of conventional slab

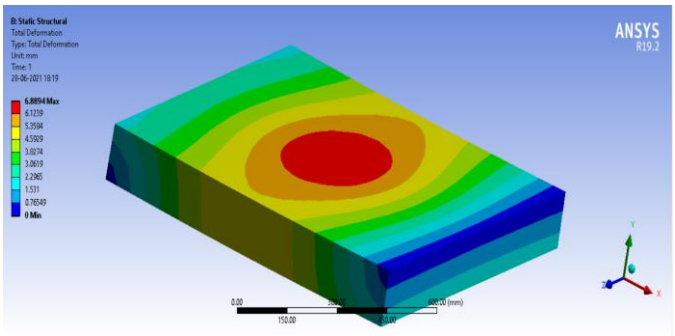

Fig -6: Deformation of conventional slab

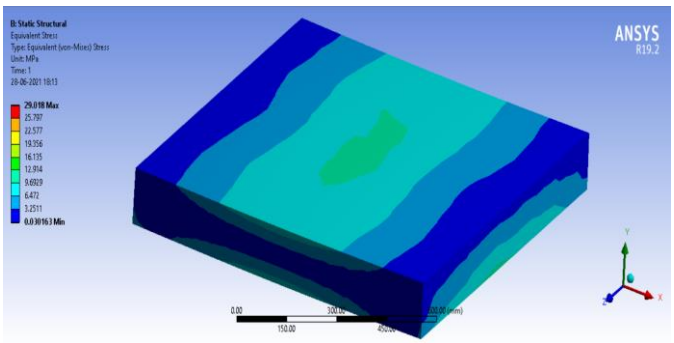

Fig -7: Equivalent stress for conventional slab

5. RESULT

In this section the mathematical and test aftereffects of Conventional slab and Hollow Deck piece were deciphered. Finite Element Analysis (FEA) was completed by utilizing the FEA programming ANSYS to contemplate primary conduct on the section. The pieces of traditional and Hollow deck slab are situated to single point load. A definitive load, stress, distortion were estimated analytically. For this reason, the two slabs are systematically read for various load esteems going from 0KN to 300KN with 25 KN increment. The hollow deck section can withstand practically 100% of stress when contrasted and customary slab. Trivial dissimilarity

occurs in the deformation when associated to conventional slab.

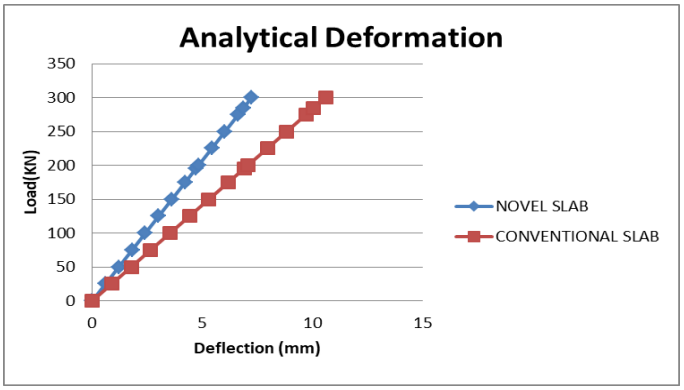

Fig -8: Comparison between slabs on the basis on analytical deformation

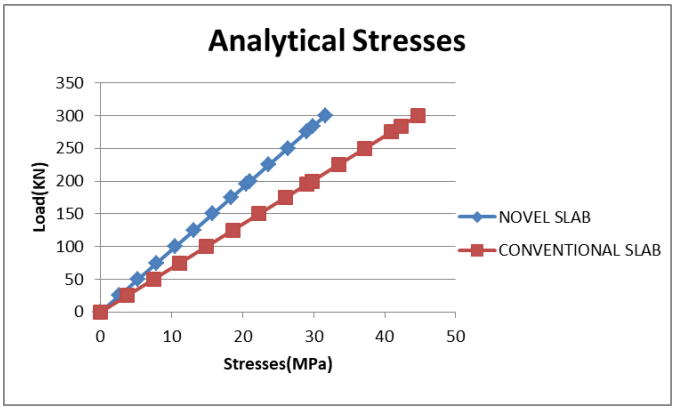

Fig -9: Comparison between slabs on the basis on analytical stresses

7. CONCLUSIONS

The test was conducted to evaluate the structural performance of the Conventional slab and Hollow deck slab. The finite element analysis was conveyed by using ANSYS software to study the ultimate load conveying capability, stresses and deflection. Based on the numerical and analytical studies the following conclusions were made. Hollow deck slab gives much improved performance than the conventional slab but slight variation was found in numerical investigation. The numerical results shows the hollow deck slab can withstand 145.64% of load carrying capability when associated to conventional slab. From these results it is observed that the Hollow Deck Slab is enrich in stress standards and its weight than that of Traditional slab. The stress and deformation outcomes were appraised and equated the hollow deck slab alongside conventional slab were observed using finite element analysis. This detailed investigation has proven that the Hollow Deck concept is more efficient than a conventional concrete slab in all aspects. The finite element analysis of models of the slabs also verified the prior analysis and experiments.

Upon the concise investigation of the bridge deck slab shows that it don't follows the workplace section of the models which was made with similar general boundaries. Be that as it may, the exhibition of the hollow slab isn't recommendable in a pedestrian bridge deck. So it requires further examinations on bridge designs to utterly decide the plausibility of hollow deck slab in a bridge deck.

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