RESEARCH ARTICLE OPEN ACCESS

Development of Fibre Reinforced Geopolymer Concrete Shell (Frgps) Using Abaqus

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ABSTRACT
Compression structures provide an alternate appropriate construction technology which optimises the use of material and natural resources. The funicular shell roof is one such compression structure, which ensures conservation of natural resources by utilising waste materials effectively and optimising the use of expensive steel and cement. Geopolymer concrete is eco-friendly and sustainable which possesses rapid strength gain, elimination of water curing, good mechanical and durability properties. In this point of view, here it has been proposed to form the fibre reinforced Funicular shell using Geopolymer concrete for more practical, economical, sustainable and affordable for the low cost housing system. In the study carried out the finite element analysis of 16mm thickness using geopolymer concrete of 8 M concentrations.

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I. INTRODUCTION

In the Thermal Industry produces a waste called flyash which is simply dumped on the earth, occupies larges areas. The waste water from the Chemical Industries is discharged into the ground which contaminates ground water. By producing Geopolymer Concrete all the above mentioned issues shall be solved by rearranging them. Waste Fly Ash from Thermal Industry + Waste water from Chemical Refineries = Geo polymer concrete. Since Geopolymer concrete doesn't use any cement, the production of cement shall be reduced and hence the pollution of atmosphere by the emission of carbon di oxide shall also be minimized. Shell technology has been enhanced by the development of new materials and prefabrication schemes, and shells of various types and forms have been known to display high potential in the fields of prefabricated shell construction. The funicular shell roofing system consists of doubly curved shells made with materials of good compressive strength such as waste stone pieces and brick tiles and supported on reinforced concrete edge beams. A series of these shells in variable geometric configurations supported on a grid of concrete beams, identical to a coffer slab, provides an attractive roof for small to medium spans.

II. OBJECTIVE

In this project the funicular shells are planned for create a mathematical modelling of funicular shell using a standard finite element software ABAQUS. The analytical results are found the deflection, stress and load carrying capacity. It to develop the funicular shell is economical and sustainable.

III. LITERATURE REVIEW

S. A. Bhalchandra and A. Y. Bhosle(2013) examined that the experimental program to determine mechanical properties of Glass fibre reinforced Geopolymer Concrete .The effects of inclusion of glass fibres on density, compressive strength & flexural strength of hardened geopolymer concrete composite (GPCC) was studied. Glass fibres were added to the mix in 0.01%, 0.02%, 0.03% & 0.04% by volume of concrete. They observed that the density of Geopolymer concrete is similar to that of ordinary Portland cement concrete and the low calcium fly ash based Geopolymer concrete has excellent compressive strength within short period and suitable for structural applications. The Compressive strength and Flexural strength of glass fibre reinforced geopolymer concrete increases with respect to increase in percentage volume fraction of glass fibres and addition of 0.03% volume fraction of glass fibres shows maximum increase in Compressive strength & Flexural strength.

S.Subbiah ilamvazhuthi and G.V.T.Gopalakrishna(2013) examined the mechanical properties of geopolymer concrete with polypropylene fibre. Durability tests were conducted for sulphate and sulphuric acid resistance and the cylinders were durable to chemical environment. The elastic properties of hardened Fibre geopolymer concrete and the behaviour and the strength of Fibre

geopolymer concrete structural members are similar to those observed in the case of Portland cement concrete. The possibility of increased tensile strength and impact resistance offers potential reductions in the weight and thickness of structural components and should also reduce the damage resulting from shipping and handling.

K.N. Lakshmikandhan (2014) with the experimental and analytical investigation, observed that better performance of funicular shell for the span to rise ratio between the 5 and 12.5. Also the reduction of span to rise ratio showed reduction in deflection, reduction in maximum compressive and tensile stress. Also they reported the advantageous of funicular shells for one-way load carrying system for floors and roofs. The developments of the finite element method are readily available for the analysis of shells. The present study planned to use an advanced finite element modeling technique using ABAQUS. Also from this state of art, still there is a scope for the development of configuration and the implementation of sustainability into funicular shell roofs and floors.

L.Krishnan et.al (2014) examined the main limitations of fly ash based geopolymer concrete are slow setting of concrete at ambient temperature and the necessity of heat curing are eliminated by addition of Ground Granulated Blast Furnace Slag (GGBS) powder which shows considerable gain in strength. The Alkaline liquids used in this study for the polymerization process are the solutions of sodium hydroxide (NaoH) and sodium silicate (Na2Sio3).The necessity of heat curing of concrete was eliminated by incorporating GGBS and fly ash in a concrete mix.The strength of geopolymer concrete was increased with increase in percentage of GGBS in a mix

K.N.Lakshmikandhan et.al (2015) examined that the nonlinear finite element analysis on funicular shells. The mathematical nonlinear finite element simulation of funicular shell formation, for the different concentration of geopolymer concrete such as 1M and 2M to the various thickness of 10mm, 15mm and 20mm are carried out using standard finite element software ABAQUS .To systematically experiment the possibility of implementing the two-way shells for the one-way systematic arrangements. Also it is proposed to conduct an experimental investigation for better evaluation of funicular shell. They concluded that the increase in the thickness of the funicular shell showed reduction in deflection and reduction in maximum tensile strain. That the increasing the thickness of funicular shell and concentration of geopolymer concrete to obtain the better performance.

ANALYTICAL MODELLING

The rapid development of computer technology and Finite Element software facilitate the development of advanced three-dimensional finite element models. In the development the shell element was created in the solidworks software.

In solidworks three planes available and select the top plane for creating the part. Using rectangle tool on the Sketch Tools toolbar the required rectangle can be created. The dimension tool on the Sketch Relations toolbar can be used to draw the required dimension.In the extruded command on features tool bars used to extrude the sketch. Then using dome command to create a structures.Then used shell command in the features toolbars to create thickness of structures. The solid work model has been created. The surface geometry is imported in to ABAQUS for the other pre processing effort.

Material Modelling

Concrete has relatively high compressive strength, but significantly lower tensile strength, and is usually reinforced with materials that are strong in tension (often steel). Concrete is a heterogeneous, non-linear and orthotropic material. All concrete structure will crack to some extent, due to shrinkage and tension.

Loading and boundary condition

It represented the displacement and rotation value of the shell. In the boundary condition the two edges are fixed and the boundary values are $u_1u_2u_3$ is zero.

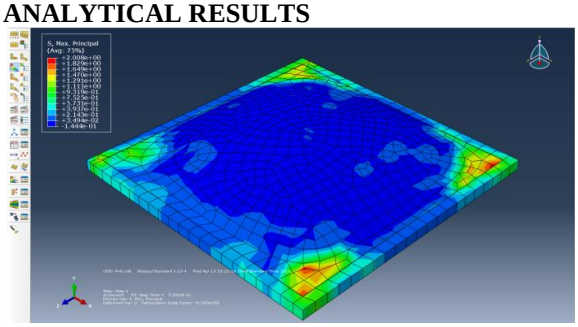
Meshing

To apply a pressure load on the top of the shell model is meshed with 8 noded linear hexahedron elements. The shell part of the model is divided into so called brick elements to obtain a proper stress distribution in the 3D analysis. There several types of brick elements available in ABAQUS.

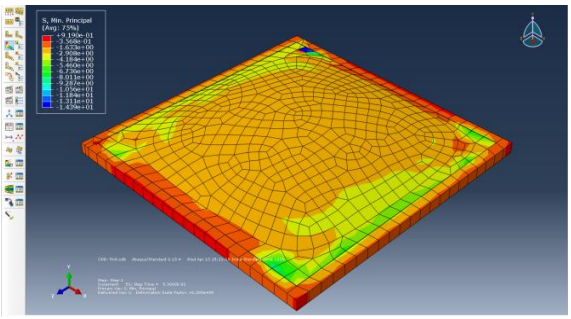
Job

The analysis is started by creating a job from the job manager. The created job is submitted for analysis. The process of analysis is examined with monitor option. After completion of job, the results were seen in visualisation mode. From the visualisation, the maximum deflection, the maximum principle strain and maximum load carrying capacity for the each analysis are observed.

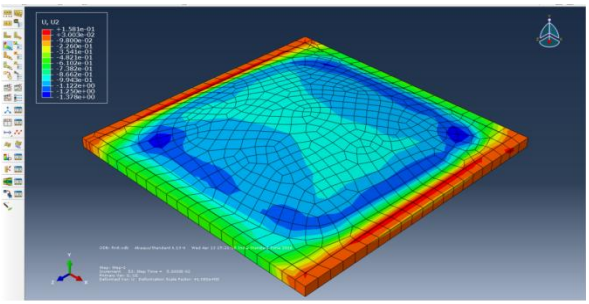
ANALYTICAL RESULTS



Maximum principal stress



Minimum principal stress



Deflection

IV. CONCLUSION

Based on the above results, the following conclusions were arrived.

1. The maximum load acted on the geopolymer shell 15.3 kN and the shell was not damaged.
2. The shell with fibre should have increase the curing period it will give better strength compare to normal shell.
3. The analytical are changed based on material properties.

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