

Analysis of bubble deck slab using different materials

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Abstract:-- Reinforced concrete slab is an essential component of the structure. Various parameters such as span, depth and reinforcement are designed as per standard codes. Due to large amount of concrete used to cast these slabs, dead weight also increases. Heavier structures are less desirable as compared to lighter structures as it involves larger costs, time and labour. An alternative to this type of conventional slab is a bubble deck slab which introduces bubbles made up of various materials which reduce the overall weight of the slab. Various studies have shown that the weight of the bubble deck slab reduces by approximately 35% as compared to the self weight of the conventional reinforced concrete slab. In this study conventional slab was compared with bubble deck slab made up of various materials using finite element analysis on ANSYS Workbench 14.0. Total deformation for conventional reinforced concrete slab and bubble slabs made up of glass reinforced polymer fibres, carbon reinforced polymer fibres and epoxy were analysed and compared. This study showed that different values of total deformation was obtained for bubble deck made up of materials like carbon reinforced polymer fibres, glass reinforced polymer fibres, epoxy and conventional reinforced concrete slab.

key words: bubble deck slab, carbon reinforced polymer fibre, glass reinforced polymer fibre, epoxy

I. INTRODUCTION

It is a known fact that concrete is strong in compression but weak in tension, hence when talking about a solid reinforced concrete slab, the concrete above neutral axis is in compression and the concrete below neutral axis is in tension. This indicates that the concrete used in the tension is waste and it also increases the overall dead load of the structures. This additional dead load can be reduced by removing the unused concrete. An alternative to this conventional reinforced concrete slab is the bubble deck slab. These are characterised by the presence of voids in the form of bubbles within the slab. The concept of bubble slab involves placing hollow recycled plastics shapes or other materials in the form of spheres between the two layers of rebar in the middle of concrete slab. Introduction of these bubbles in the slab will decrease the dead load of the slab and therefore a higher allowable span can be obtained. This reduced dead load will in turn reduce the size of column and foundation while designing. There are a lot of advantages of using bubble slab such as it reduces the additional weight of concrete, larger spans can be cast on site, there is less wastage of concrete, less energy is consumed in terms of labours, transportation and crane lifting. Various studies have been done on the structural behaviour of bubble deck slab and various parameters have also been calculated for the same. In the present study a comparison between the structural behaviour of conventional reinforced concrete slab and bubble deck slab made of different materials such as carbon reinforced polymer fibres, glass reinforced polymer fibres

and epoxy has been done. The basic aim was to compare the total deformation of all the generated models analytically using ANSYS Workbench.

METHODOLOGY:

In the present study four models have been generated using ANSYS Workbench. The dimensions of all the slab models were kept same with the same loading conditions and supports. The analysis has been done using finite element analysis.

Material properties of concrete:

Density	2300	kg/m ³
Young's Modulus	30000000000	Pa
Poisson ratio	0.18	
Bulk Modulus	15625000000	Pa
Shear Modulus	12712000000	Pa

Material properties of structural steel:

Density	7850	kg/m ³
Young's Modulus	2×10^{11}	Pa
Poisson Ratio	0.3	
Bulk Modulus	1.667×10^{11}	Pa
Shear Modulus	7.6923×10^{10}	Pa

Specific Heat	434	$\text{J kg}^{-1} \text{C}^{-1}$
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Material properties of carbon reinforced polymer fibres:

Density	1500	kg/m^3
Young's Modulus	5.5×10^{11}	Pa
Poisson Ratio	0.23	
Bulk Modulus	3.3951×10^{10}	Pa
Shear Modulus	2.2358×10^{10}	Pa

Material properties of glass reinforced polymer fibres:

Density	2500	kg/m^3
Young's Modulus	7.3×10^{10}	Pa
Poisson Ratio	0.22	
Bulk Modulus	4.3425×10^{10}	Pa
Shear Modulus	2.9918×10^{10}	Pa

Material properties of epoxy:

Density	1570	kg/m^3
Young's Modulus	1.2×10^{11}	Pa
Poisson Ratio	0.25	
Bulk Modulus	8×10^{10}	Pa
Shear Modulus	4.8×10^{10}	Pa

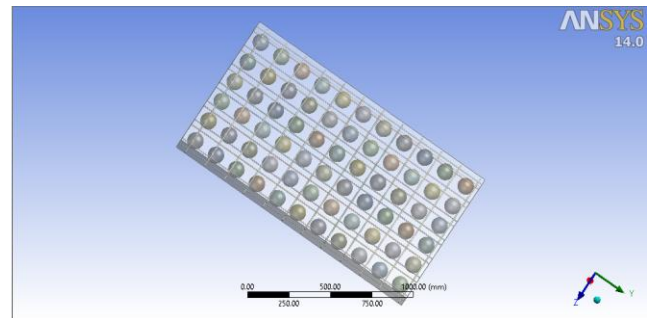
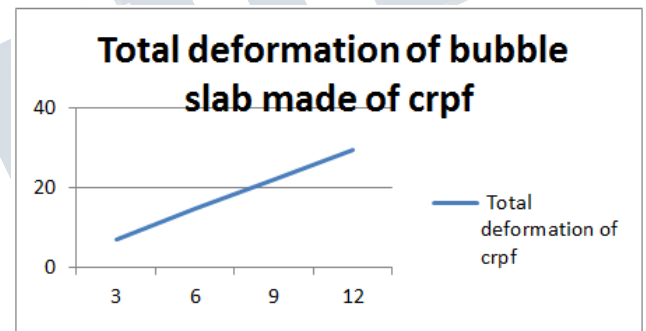


Figure showing the top view of the bubble deck slab.

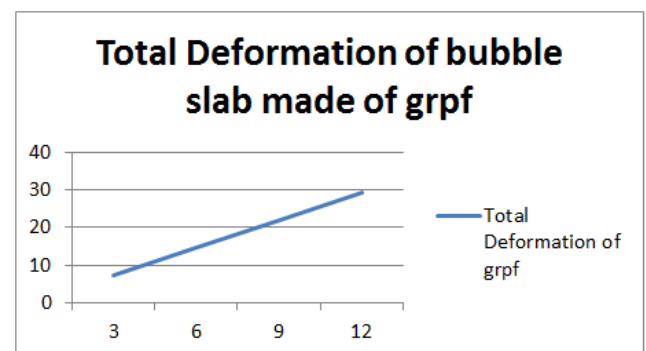
RESULTS AND CONCLUSIONS:

1. Total deformation in bubble deck slab made of carbon reinforced polymer fibre was 1.241% more as compared to conventional concrete slab.



Load vs total deformation graph of bubble slab made of carbon reinforced polymer fibre

2. Total deformation in bubble deck slab made of glass reinforced polymer fibre was 0.405% more as compared to conventional reinforced concrete slab.



Load vs total deformation graph of bubble slab made of glass reinforced polymer fibre

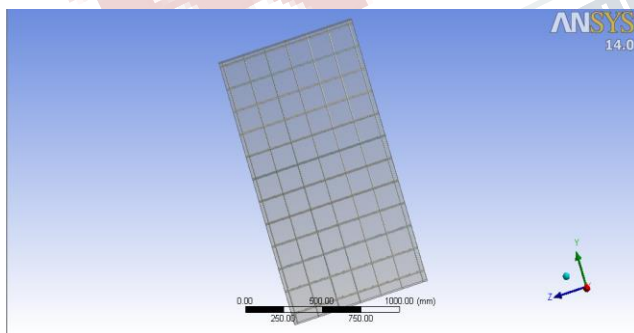
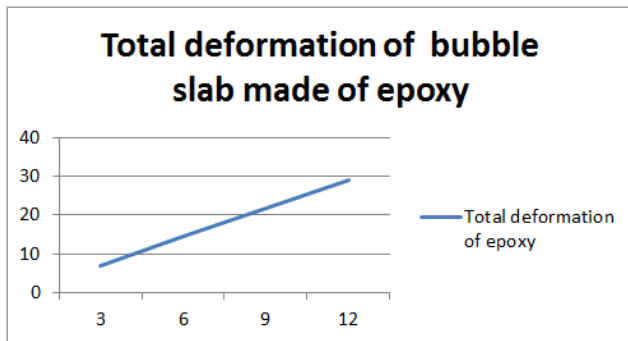
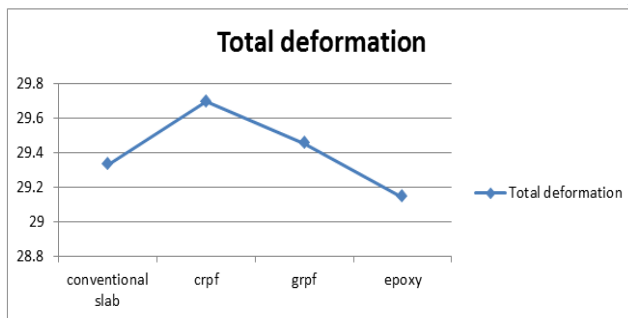


Figure showing the top view of conventional reinforced slab.

3. Total deformation in bubble deck slab made of epoxy was 0.634% less as compared to conventional reinforced concrete slab.



Load vs total deformation graph of bubble slab made of epoxy



Graph showing the variation of total deformation for slabs made up of different materials

4. Since there was not much difference between the total deformation of the conventional reinforced concrete slab and the bubble deck slab, hence conventional reinforced concrete could be replaced by bubble deck slab.

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