Analytical Investigation On Composite Slab Subjected To Impact Load By Using Ansys

Sasikumar A.[1]
PG Student[1] , M.E Structural Engineering
Department of Civil Engineering
PSNA College of Engineering and Technology
Dindigul.

Vandhiyan R.[2]
Assistant Professor[2]
Department of Civil Engineering
PSNA College of Engineering and Technology
Dindigul.

***Abstract*—*Concrete has been widely used over many years by military and civil engineers in the design and construction of protective structures to resist impact and explosive loads. Impact is a force or shock applied over a short time period when two or more bodies collide. In this study behavior of RC slab due to impact load is modeled by varying reinforcement pattern and materials in the slab using ANSYS. In addition to conventional reinforcement, GFRP bars and GFRP laminate,composite effect on the slab are also studied. ANSYS mechanical APDL package is used for modeling and analyzing*.**

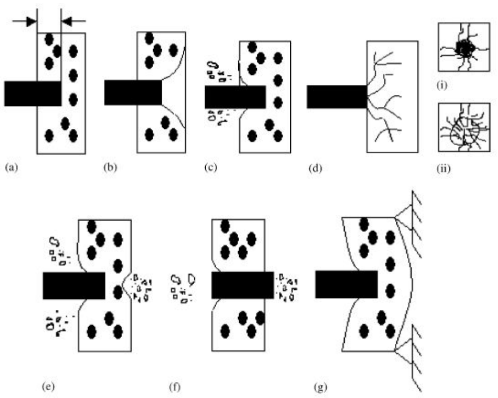
***Keywords*—GFRPbars, GFRP laminates, impact load.**

I INTRODUCTION

Concrete structures subjected to impact by projectiles or shell fragments exhibit responses that differ from those when they are under static loading. When a dynamic loading from blast wave is delivered onto astructure, it produces an instantaneous velocity change momentumis acquired and the structure gains kinetic energy which isconverted to strain energy as the structure deforms. The mostimportant feature of blast resistant construction is that structuralcomponents must possess adequate deformation capacity underextreme overload to dissipate large amounts of energy prior tofailure that is, to permit significant localized damage and simultaneouslypreventing catastrophic collapse. Therefore the materialmust have both adequate ductility and strength. Besides energyabsorption capacity, other crucial factors influencing theperformance of protective materials include scabbing and spallingresistance, multiple-impact resistance, and sensitivity to strainrate.

Impact is a force or shock applied over a short time period when two or more bodies collide .The impact effect depends upon the relative velocity of the bodies to collide each other.

Potential missiles/projectiles include kinetic munitions, vehicle and aircraft crashes, fragments generated by military and terrorist bombing, fragments generated by accidental explosions and other events (e.g., failure of a pressurized vessel, failure of a turbine blade or other high-speed rotating machines),flying objects due to natural forces (tornados, volcano's, meteoroids), etc. These projectiles vary broadly in their shapes and sizes, impact velocities, hardness, rigidities, impact attitude (i.e., obliquity, yaw, tumbling, etc.) and produce a wide spectrum of damage to the target. Impacting missiles can be classified as either hard or soft depending upon whether the missile deformability is small or largely relative to the target deformability. Hard projectile impact results in both local wall damage and in overall dynamic response of the target wall. Local damage consists of spalling of concrete from the front (impacted) face and scabbing of concrete from the rear face of the target together with missile penetration into the target. Overall dynamic response of the target wall consists of flexural deformations. A potential flexural or shear failure will occur if the local strain energy capacity of the wall does not exceed the kinetic energy input to the wall by the striking hard missile.



a) Penetration, (b) Cone cracking, (c) Spalling, (d) Cracks on: (i) Proximal face and (ii) Distal face, (e) Scabbing, (f) Perforation, and (g) Overall target response.

The effects of the impact of a hard projectile on aconcrete target have been studied since mid-1700s mainly due to the continuous interest in designing high-performancemissiles and protective barriers. The recent requirement toaccess the safety of concrete containment vessels for nuclearreactors has also contributed considerably to the currentunderstanding of local impact effects on concrete targets. The initial stiffness of target as well as the ultimate strengthIncreases both in compression and tension. Further, theconcrete-strain capacity increases under dynamic loadingdue to tension stiffening. When a projectile of certain massand velocity hits a concrete target, concrete generally crushedand cracked, and the structure experiences shaking andVibration depending on the relative period of structure andimpact pulse duration.

In this research, the composite slabs are utilized to increase the response of the concrete subjected to impact load in the protective structures by creating composite slab model using ANSYS with variation in reinforcement pattern and materials and applying impact load. And to investigate the behavior of composite slabs using conventional and GFRP bars in concrete due to impact load.

II ANALYTICAL APPROACH

An analytical approach is the use of an appropriate process to break a problem down into the elements necessary to solve it. Each element becomes a smaller and easier problem to solve. Each element becomes a smaller and easier problem to solve which can be achieved by FEM (Finite Element Modelling).This finite element analysis will be carried out by using software ANSYS 16.1.

III ANALYTICAL MODELS

In this analytical approach the concrete slabs are modeled by solid elements to represent the concrete material of size 1mx1mx0.12m. The 10 mm dia reinforcement bars are modeled by using bar elementsfor flexural specimen as shown in figure

I. Compressive strength of concrete, f_{ck} is 20 N/mm^2
II. Tensile yield strength of the reinforcement, f_y is 415 N/mm^2
III. Poisson's ratio for steel and concrete taken as 0.3 & 0.15
IV. Young's modulus of steel, E_s is 2 x 10^5 N/mm^2
V. Young's modulus of concrete, E_c is 22360 N/mm^2

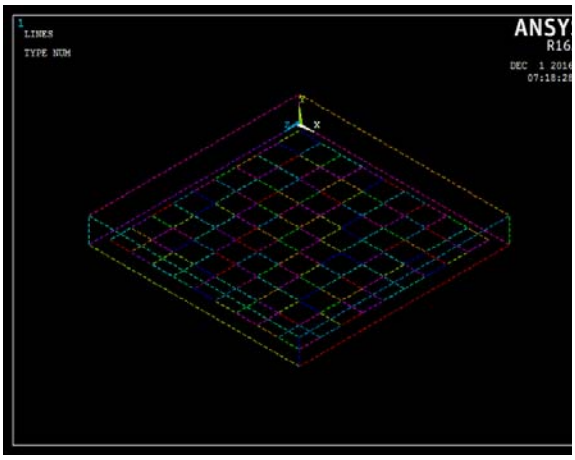


Fig 3.1 Line drawing for reinforcementand slab

In this research various pattern of reinforcement with 100mm and 200mm spacing using conventional steel bars and GFRP bars. GFRP laminates are pasted at the bottom of the slabThe models are meshed with the properties to divide into number of small elements. The concrete elements are meshed by an edge length of 25 mm, whereas steel is meshed with 10mm size

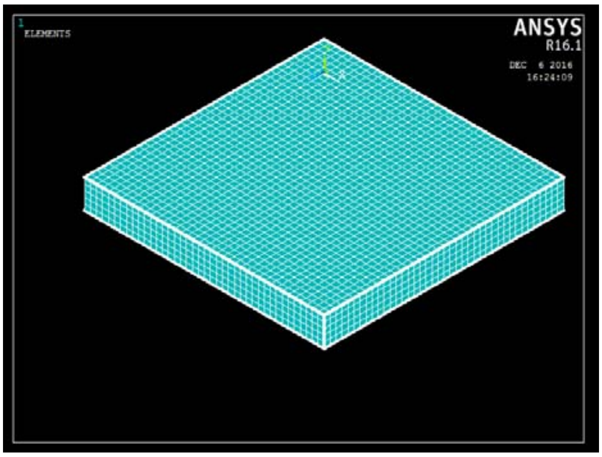


Fig 3.2 Meshed RC slab with reinforcement

Table1 Elements used for model in ANSYS

S.No	**Material**	**Element Base**	**Element Type**
1	Concrete	Solid	Concrete 65
2	Steel	Beam	2 node 188
3	Contact Element	Contact	Contact 165

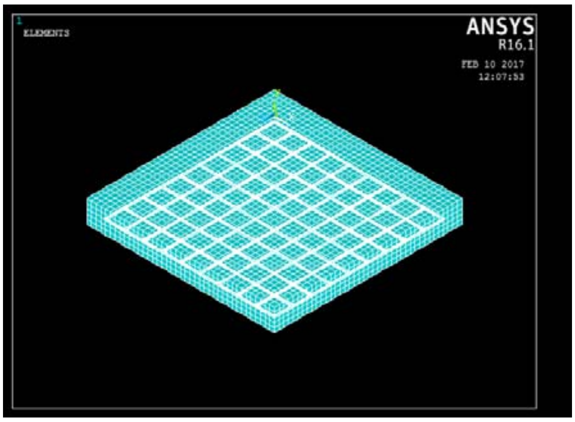


Fig 3.3Reinforcement at 100mm spacing

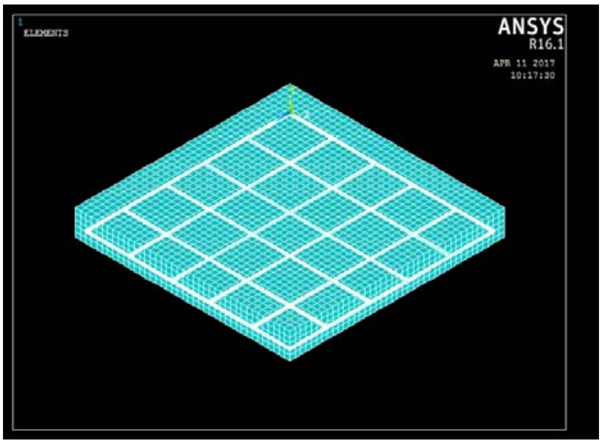


Fig 3.4 Reinforcement with 200mm spacing

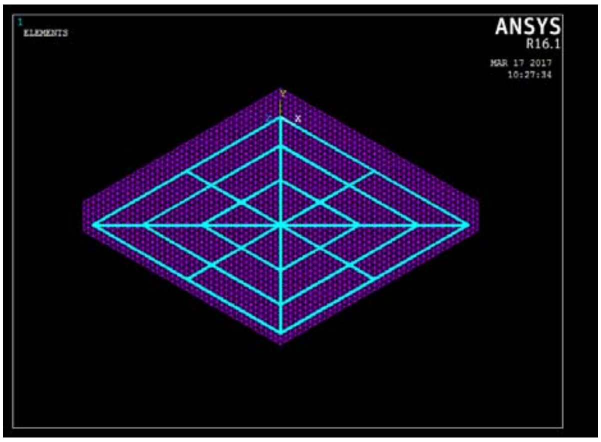


Fig 3.5 Radial reinforcement at 45^{0}angle

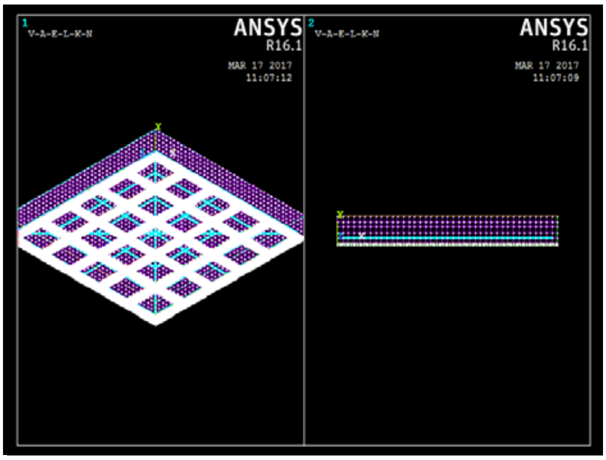


Fig 3.5 Radial reinforcement at 45^{0}angle with GFRP laminates

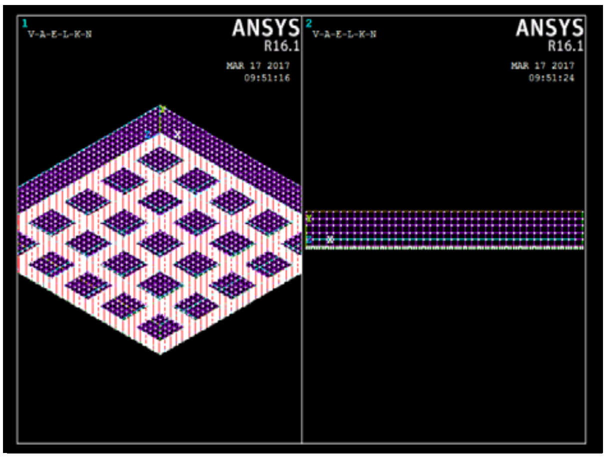


Fig 3.5 Reinforcement at 200 mm spacingwith GFRP laminates

IV ANALYSIS METHOD

The slab modeled as solid element consists of reinforcement as beam elements. It is an element modeled with consideration of tension, compression and bending capabilities. The base of slab is incorporated with boundary condition 100 mm bearings from the edges, which is restrained against all rotations. The horizontal displacement is arrested as shown in figure

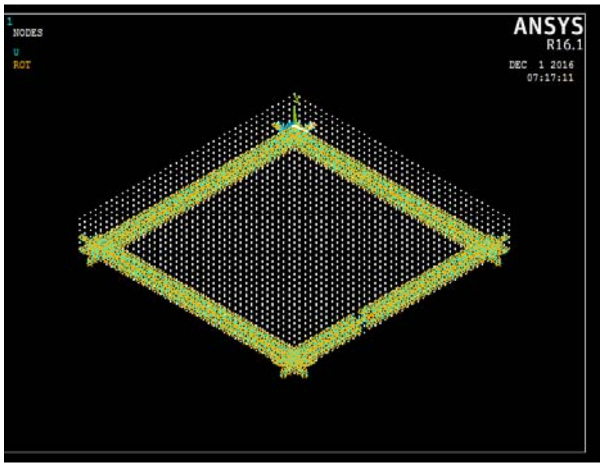


Fig 4.1 Boundary conditions of slab

Load is applied at the center of the slab from 1m height and applied at a central 100mm circumstances by using literatures.

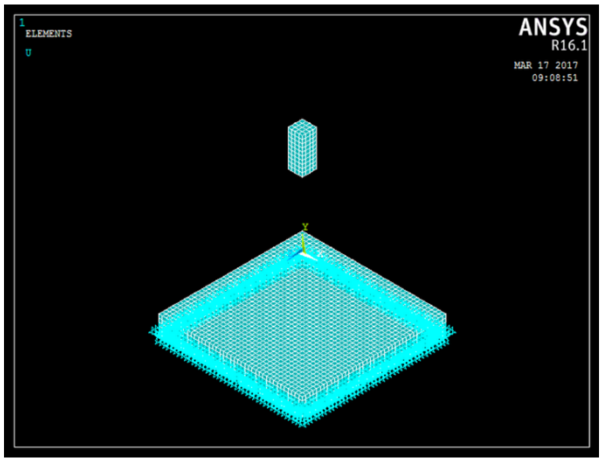


Fig 4.2 Application of load

V ANALYTICAL RESULTS

The model specimens are tested against impact load with various pattern of reinforcement and the deformation at the center is plotted as graph.

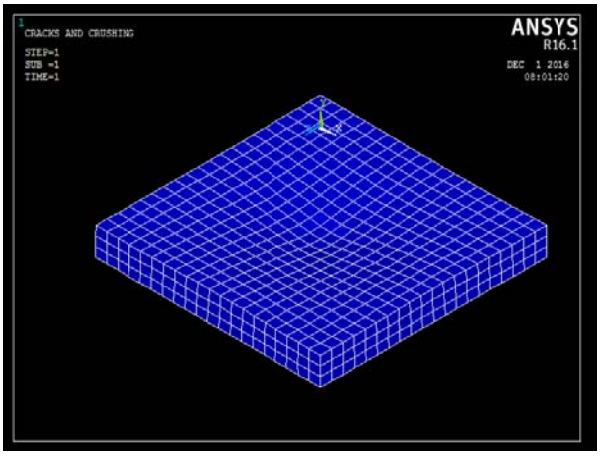


Fig 5.1 Deformation of slab

The crack pattern is noted due to the applied impact load. Incorporating the GFRP bars in the slab reduced deformation due to impact load. by providing the GFRP laminates at the bottom of the slab the cracks and rate of energy absorption is greatly increased and the response of the slab is increased and

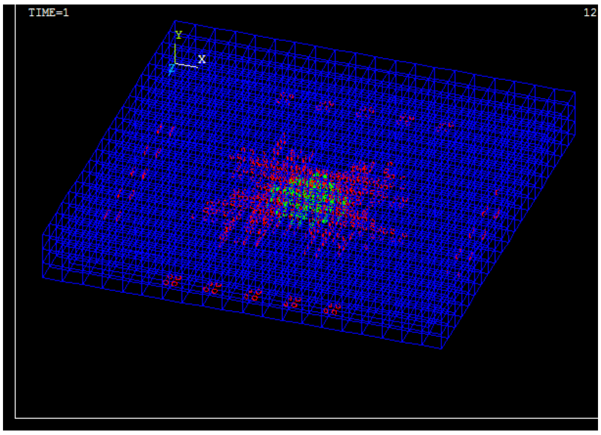


Fig 5.1 Deformation of slab

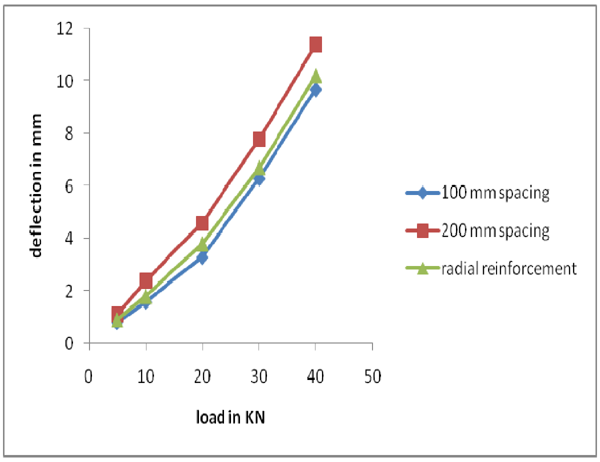


Fig 5.1 Deformation of slab with GFRP laminates

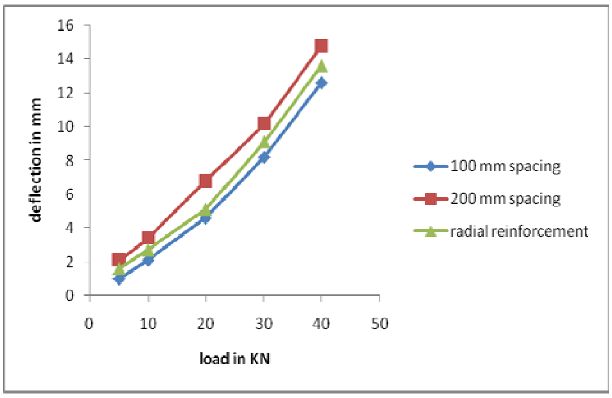


Fig 5.1 Deformation of slab with GFRP bars

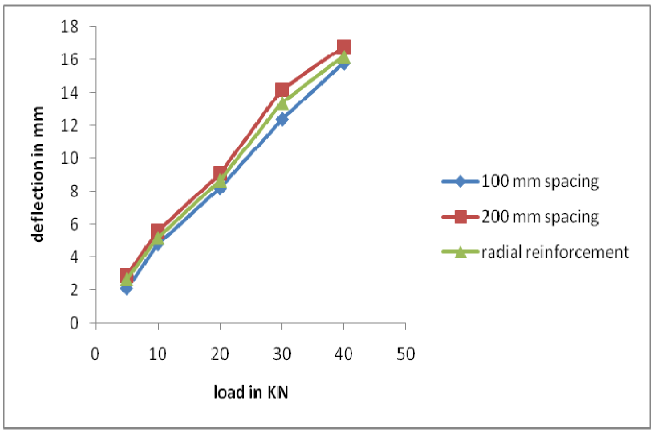


Fig 5.1 Deformation of slab with conventional bars

Deformation of the slab is gradually reduced 10% by adopting GFRP bars on the slab and by applying the GFRP laminates at the bottom of the slab Max deflection of the slab is reduced 20% by applying GFRP laminates

VI CONCLUSION

RC slabs with various reinforcement patterns and materials are tested against under impact loading.analyzing the results the following conclusions have been drawn:

- The deflection in the RC slabs is reduced by 20% when applying GFRP laminates at the bottom of the slab with reinforcement at 100 mm spacing
- By applying the GFRP bars at radial reinforcement the deflection is reduced by 10% than conventional bars.
- By decreasing the spacing the rate of deflection is reduced.

REFERENCES:

1) Dear.J.P, Lee.H, Brown.S.A (2005),'Impact damage processes in composite sheet and sandwich honeycomb materials',International Journal of Impact Engineering,vol.32,pp.130–154.

2) Jing Zhang, Mohamed Maalej and Ser Tong Quek (2007),'Performance of Hybrid-Fiber ECC Blast/Shelter Panels Subjected to Drop Weight Impact' ASCE, vol-19,pp.810-855.

3) Rama Chandra Murthy.A, Palani.G.S and Nagesh R. Iyer (may 2010),'Impact Analysis of Concrete Structural Components' , Defense Science Journal, Vol. 60, pp. 307-319.

4) Shasha Wang, Hoang Thanh Nam Le, Leong HienPoh, HuajunFeng and Min-Hong Zhang(2016), 'Resistance of High-Performance Fiber-Reinforced Cement Composites against High-Velocity Projectile Impact'International Journal of Impact engineering ,vol.4,pp.82-126.

5) SheetalGawas, Itti.S.V (2014), 'Study on Two way RC Slab using ANSYS with and without central opening',IJSETVolume No.3 Issue No.8, pp.1108-1110.

6) SudarsanaRao.H ,Vaishali G. Ghorpade , Ramana.N.V ,K. Gnaneswar(2010),'Response of SIFCON two-way slabs under impact loading' ,International Journal of Impact Engineering, vol.37,pp.452–458.

7) YaghoobFarna A, SoheilMohammadi, MohammadShekarchi(2010) 'Experimental and numerical investigations of low velocity impact behavior of high-performance fiber-reinforced cement based composite', International Journal of Impact Engineering ,vol.37,pp.220–229.

8) Zhang M.H,Shimb.V.P.W , G. Lua, C.W. Chewa (2005),'Resistance of high-strength concrete to projectile impact',International Journal of Impact Engineering,vol.31,pp.825–841.