Strengthening of Concrete Beam by Reinforcing with Geosynthetic Materials

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Abstract
Nowadays, the life period of buildings was very less compared to estimate period. It has many reasons such as in quality building materials and improper planning and so on. Hence the beam was failure within short period because of their Shear and Flexural strength of beam was considerably reduced. This paper reviews that using of Geotextile Fabric and Geogrids in concrete beam. Flexural test are conducted up to failure of concrete beams. An experimental investigation is compare with analytical solution to predict the Flexural strength of concrete beam reinforced with Geotextile Fabric and Geogrids. A total 18 beams, with (150mm × 100mm) rectangular cross section and of span 1200 mm were casted and tested. From totally 18 beams nine were used for 7 Days curing and remaining nine was used for 28 Days curing. In first set of six R.C.C. Under reinforced beams were strengthened with Geogrid in single layer from tension face which is parallel to beam axis subjected to static loading tested until failure. In second set of six R.C.C. Under reinforced beams were externally wrapped with Geotextile fabric. The remaining six beams were used as a control specimen. A Finite Element (FEM) model has been developed using ANSYS 14.5 to analysis beams.The finite elementprogram ANSYS has been used to study the Strengthened behavior of a beam. The concrete was modeled using solid 65 elements. Analysis is carried out by using a computer software program ANSYS with a two dimensional linear 8-noded isoparametric element.

Keywords
Reinforced Cement concrete Beam, Geotextile Fabric, Geogrid, Flexural Strength and ANSYS.

I. Introduction
Geosynthetics is the term used to describe a range of generally polymeric products used to solve civil engineering problems. The term is generally regarded to encompass six main product categories: Geotextiles, Geogrids, Geonets, Geomembranes, Geosynthetics clay liners, Geofoam and Geocomposites.
Geosynthetics are available in a wide range of forms and materials, each to suit a slightly different end use. These products have a wide range of applications and are currently used in many civil, geotechnical, transportation, hydraulic, and private development applications including roads, airfields, railroads, and embankments, retaining structures, reservoirs, canals, dams, erosion control, sediment control, landfill liners, landfill covers, mining, aquaculture and agriculture.

II. Need For The Study
- For strengthening of concrete beam the techniques are typically adopted such as Flexural Strengthening.
- To prevent the depletion of natural resources and enhancing the usage of waste materials has become a challenge to the scientist and engineers.
- The utilization of Geosynthetics in concrete beam will increase the flexure of concrete beam.
- Thus we can minimize the Failure of beam as soon as possible.

III. Materials Used

1. Geotextile
Geotextiles are made from polypropylene, polyester, polyethylene, polyamide (nylon), polyvinyl chloride, and fiber glass. Polypropylene and polyester are the most used material for the geotextiles.

2. Geotextile Types

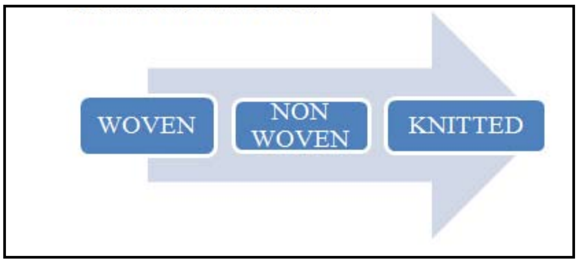

Fig 1 : Geotextile

3. Geogrid
Geogrid is one of the constituent materials classified under geo-synthetics manufactured from the polymers such as polyester, polypropylene, and polyethylene. Uniaxial geogrids are fundamentally used in grade separation appliances for instance steep slope and retaining walls while biaxial geogrids are used in roadways to take vibrations.

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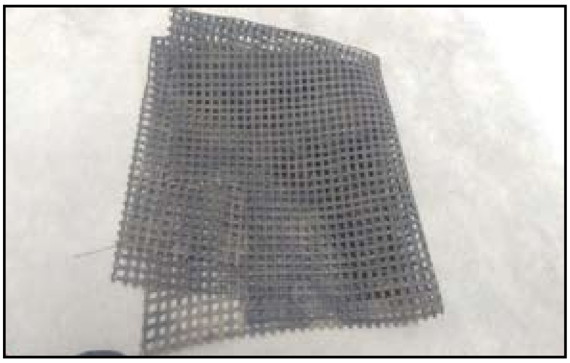

Fig 2 : Geogrid

IV. Literature Review

Aluri Anil Kumar et. al (2015), introduced to be used in concrete columns. This new reinforcement named Geogrid reinforced steel columns (GRSC), is a little satisfactory alternative to the rebar cage used in traditional reinforced concrete, for faster and easier construction. It is structured polymeric material usually made from polyethylene compounds.

BinataDebbarmaet. al (2015) , discussed about out the investigation on strength of fly ash reinforced with woven and non-woven geotextiles in different combinations. Laboratory Direct shear test were conducted on unreinforced and reinforced fly ash. The reinforcement of geotextiles were provided in top and bottom layer, only in middle layer and then top, middle and bottom layer respectively. Reinforced fly ash showed better strength as angle of internal friction value increases.

Ghosh S.Ket. al (2014) , There is a wide scope for innovative and prospective use of jute geotextile followed by the design and engineering of the products, oriented as per the end-user requirements for different geotechnical applications.This will open up newer avenues for Jute, not only as a technical textile, but for the entire Jute Sector as it is environment friendly and its application is effective for protecting environmental degradation.

Musmar.M.Aet. al (2014), this work aims to study the behavior of shallow reinforced concrete beams when subjected to transverse loading, in terms of the resulting distribution of stresses, cracks and load deflection relationship, using finite element analysis utilizing ANSYS software. Solid65 eight nodedisoparametric elements are used to model the concrete. The behavior of concrete material in compression is elasto-plastic work hardening model which is terminated at the onset of crushing.

Shobana.S et. al (2015), illustrated the behavior of concrete beams reinforced with uniaxial and biaxial geogrids. The experimental investigation consists of testing 8 geogrid concrete beams and 2 control beams under two point bending. The two point bending test on geogrid beams reveals that strength of geogrid and number of layers plays a crucial role in enhancing load–deformation behavior and flexural strength. Test results indicate that geogrid can be used as an alternative material for steel in structural members.

Subramani.Tet. al (2015), An analytical and experimental study has been carried out to investigate the behavior of concrete beams bonded with strengthened Glass Fiber- Reinforced Polymer (GFRP) sheets on all sides with different thickness of the plate under loading. The finite element program ANSYS has been used to study the Strengthened behavior of a beam. The analysis has been carried out for the comparison and the study of effect of GFRP. Thebeams modeled in ANSYS for the various conditions.

Subramani.Tet. al (2014) , In this paper the modal parameters of an undamaged beam are monitored and compared with the vibration behaviour of the beam subjected to controlled damaging. Selected stiffness parameters in the finite element model are adjusted in such a way that the computed modal quantities match the measured quantities. FEMtools has been used to establish a damage distribution in beams associated with increasing stress patterns.

Venkatappa.Get. al (1997), the testing required for hydraulic applications is presented in detail. The work is carried out on design of needle punched fabrics for a hydraulic application is described. A case study on use of edge drains for rural roads is presented. The work in progress on nature fiber geotextiles with jute and coir is included.

ZakariaCheMuda. Iret. al (2012) ,aimed to study the flexural strength and deflection behavior of concrete slab casted with oil palm shells (OPS) as aggregates and reinforced with Geogrid. Data from test results shows that increment in oil palm shells content will reduce the flexural strength of slab while increment in amount of Geogrid can increase the flexural strength.

1. Summary Of Litrature Review

Various literatures regarding the utilization of Geotextile Fabric and Geogrids in concrete and similar works are collected and reviewed.

- Flexure failure occurs usually without advanced warning therefore it is desirable that beam fails in flexural.
- These deficiencies occur due to several reasons such as insufficient reinforcement or reduction in steel, due to corrosion, increased due to load and due to construction defects.
- Therefore to reduce or to minimize these deficiencies Geosynthetics materials such as Geotextile Fabric and Geogrids are excellent solution in this situation.
- Structural modeling using Solid 65 finite element utilizing ANSYS software may properly simulate the behavior of concrete beam reinforced with Geotextile Fabric and Geogrids.

V. Mix Design

1. Material Property

Table 1 : Concrete Mix Design

S.No	Concrete Mix Design Quantities	
1	Grade of concrete	M30
2	Type of exposure	Mild
3	Sp. Gravity of cement	3.15
4	Fine Aggregate	2.58
5	Coarse aggregate (20mm)	3.09
6	Maximum Water Cement Ratio	0.45

Table 2 : Result of mix proportions

Cement (kg/m^3)	**Fine aggregate (kg/m^3)**	**Coarse aggregate (kg/m^3)**	**Water (lit/m^3)**
413.3	776.5	1183.3	186
1	1.878	2.863	0.35

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Table 3 : Test Matrix

Cured	Plain Concrete Beam	Flexural Test	
		RCC beam Wrapped with Geotextiles	RCC Beam Reinforced with Geogrid
7 Days	3 Nos	3 Nos	3 Nos
28 Days	3 Nos	3 Nos	3 Nos
TOTAL	18 Beams		

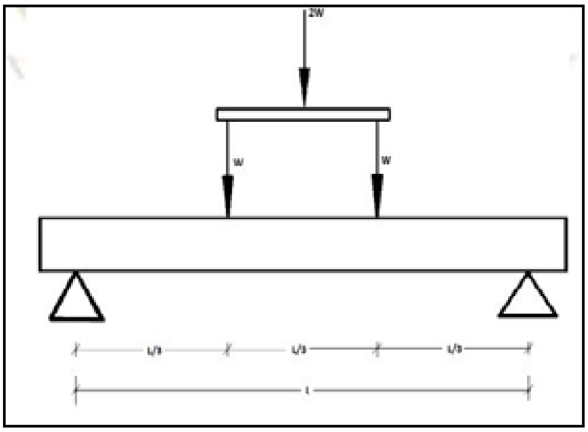

Fig 1 : Two Point Loading System

2. Formwork With Beam Specimen

The reinforcement cages were placed in the moulds and cover between cage and form provided was 25 mm. The concrete was placed into the mould immediately after mixing and well compacted. They are cured in water for 28 days. After 28 days of curing the specimen was dried in air and white washed.

Fig 2Formwork with Beam Specimen

3. External Wrapping By Geotextile

After 28 days of curing the specimen was dried in air. And the specimen was externally wrapped by geotextile mesh.

Fig 3 : External Wrapping by Geotextile

4. Crack Pattern

The reinforced concrete beams are tested with geotextile mesh and geogrid after 7 days of testing and 28days of testing. The minor crack has been observed in the reinforced concrete beam with geotextile mesh and geogrid.The deflection also been lesser compared to the conventional concrete.

Fig 4 : Crack Pattern

5. Reinforcement Details

Tension reinforcement = 2-Nos 10mm dia bar
Compression reinforcement = 2-Nos 10mm dia bar
Stirrups = 8mm dia bar 150mm c/c

Fig 5 Cage of Beam

VI. Experimental Study

For finding the flexural strength of concrete beam using Geotextile Fabric and Geogrids around and inside the beam was found. The ultimate load carrying capacity of beams for 7 days and 28 days curing results as follows.

1. Comparision Of Test Result By Table

Table 1 : Test Result on 7 days curing

Beam	Plain Cement Concrete Beams	Beam Reinforced with Geogrid	Beam wrapped with Geotextile material
	Load in KN		
B-1	25	55	29
B-2	40	58.3	40
B-3	48	60	48
Avg load	**38**	**57.3**	**40**

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Table 2 Test Result on 28 days curing

Beam	Plain Cement Concrete Beams	Beam Reinforced with Geogrid	Beam wrapped with Geotextile material
	Load in KN		
B-1	73	95	78
B-2	59.5	99.3	83
B-3	62	107	89.2
Avg load	**64.8**	100.4	83.4

2. Comparision Of Test Result By Graph

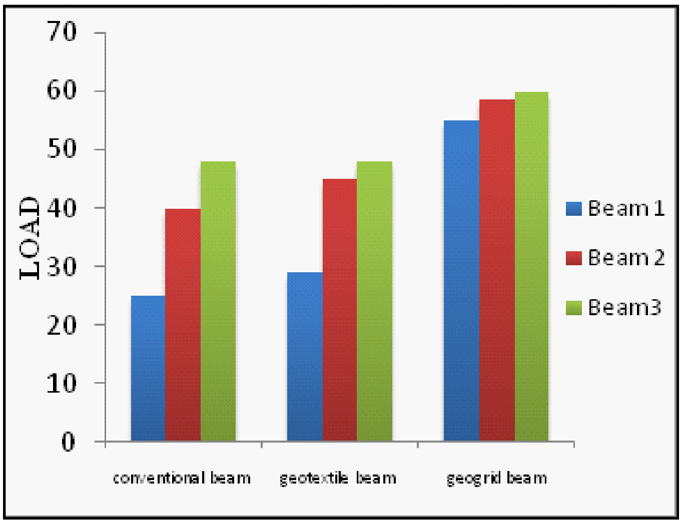

Fig 1.7 : Days Testing Results

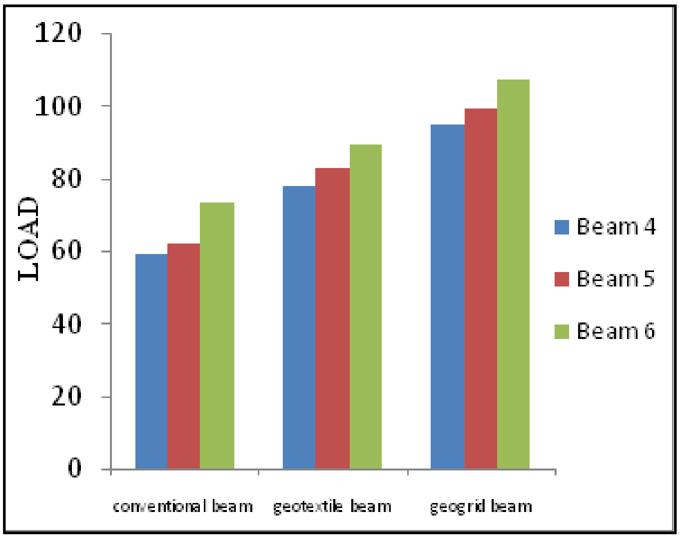

Fig 2.28 : Days Testing Results

VII. Introduction To Ansys

The ANSYS program has many finite element analysis capabilities, ranging from a simple, linear, static analysis to a complex non – linear, transient dynamic analysis.

A typical ANSYS analysis has three distinct steps:

- Building the model.
- Applying loads and obtains the solution.
- Review the results.

1. Typical Project for ANSYS in Civil Engineering

- Industrial buildings, high rise buildings and sport stadiums.
- Seismic calculations
- Nuclear, wind &thermal Power Plant
- Off–shore and marine structures.
- Bridges (concrete, steel, cable, etc).
- Prestressed and nonlinear concrete structures.
- Foundations (slabs, piles, walls, etc).
- Geological and Soil mechanics problems.
- Dams (concrete, earth, etc).
- Cable structures, Special Buildings, etc.
- Quality control, Forensic structural analysis, Project modifications

2. Material Properties

Table 1 : For Concrete

S.No	DESCRIPTIONS	VALUE
1	Young's Modulus	30E11 N/m^2
2	Poisson Ratio	0.2
3	Density	2400 Kg/m^3

Table 2 : For Steel

S.No	DESCRIPTIONS	VALUE
1	Young's Modulus	2E11 N/m^2
2	Poisson Ratio	0.3
3	Density	7850 Kg/m^3

Table 3 : For Geotextile

S.No	DESCRIPTIONS	VALUE
1	Young's Modulus	1.575E9 N/m^2
2	Poisson Ratio	0.45
3	Density	946 Kg/m^3

Table 4 : For Geogrid

S.No	DESCRIPTIONS	VALUE
1	Young's Modulus	1.97E9N/m^2
2	Poisson Ratio	0.3
3	Density	1440 Kg/m^3

VIII. Modeling Of Beams

1. At 7 Days Result

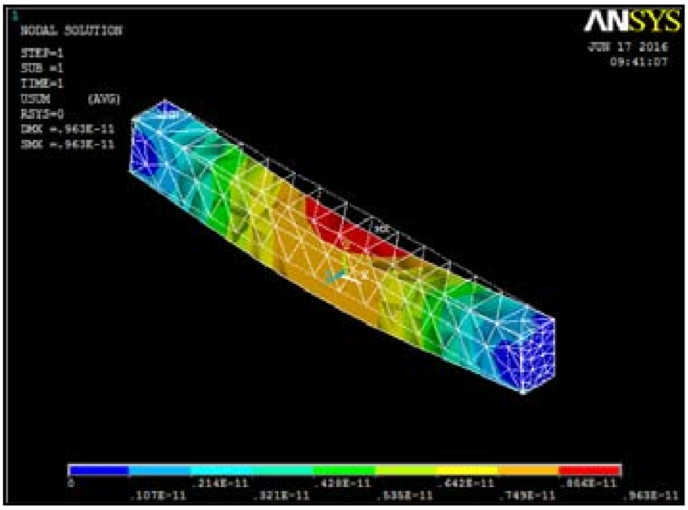

Fig.1: Deflection of Plain cement concrete beam

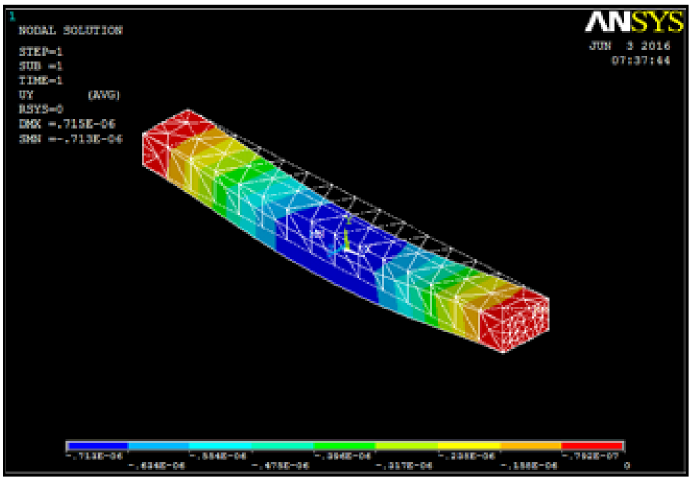

Fig.3 : Deflection of Plain cement concrete beam reinforcedwith Geotextile materials

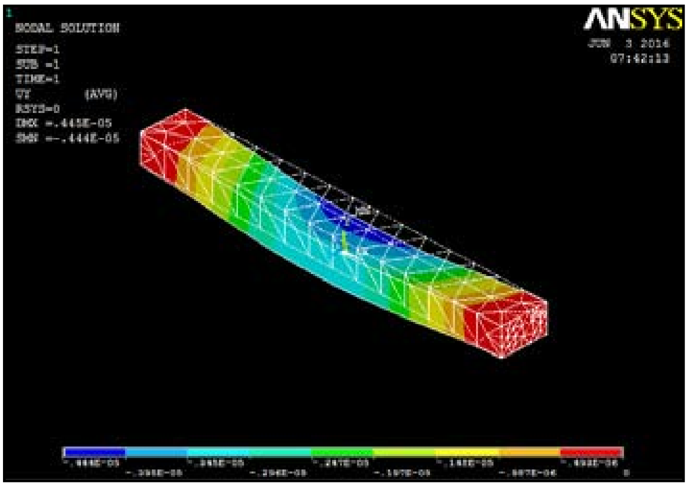

Fig.5 : Deflection of Plain cement concrete beam reinforcedwith Geogrid materials

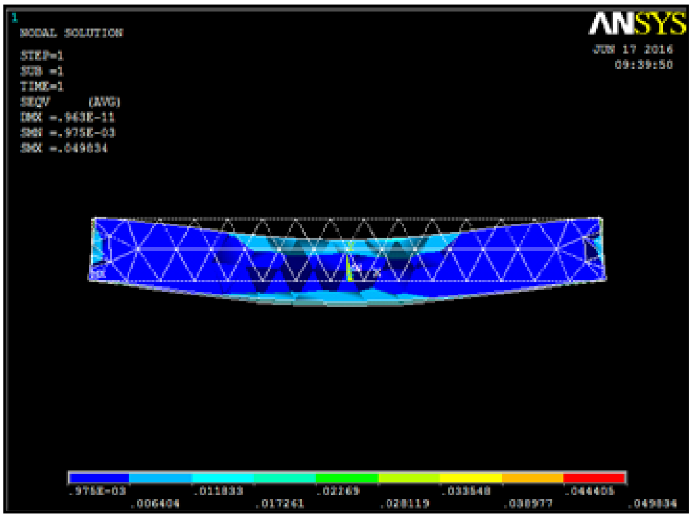

Fig.2 : Von Misses Stress of Plain cement concrete

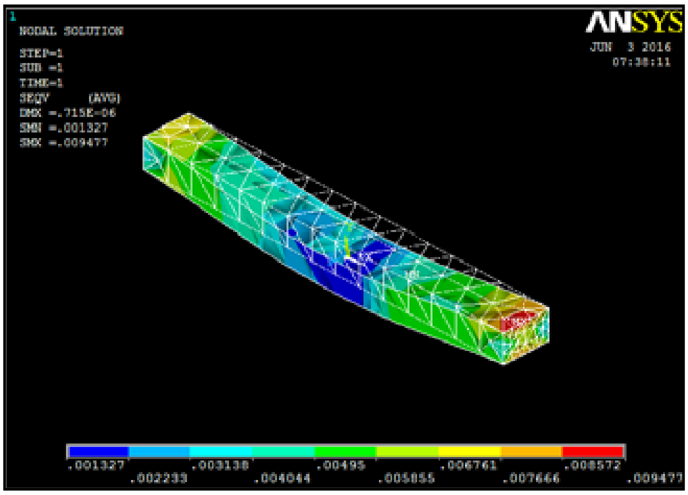

Fig.4 : Von Misses Stress of Plain cement concrete beam Reinforced with Geotextile materials

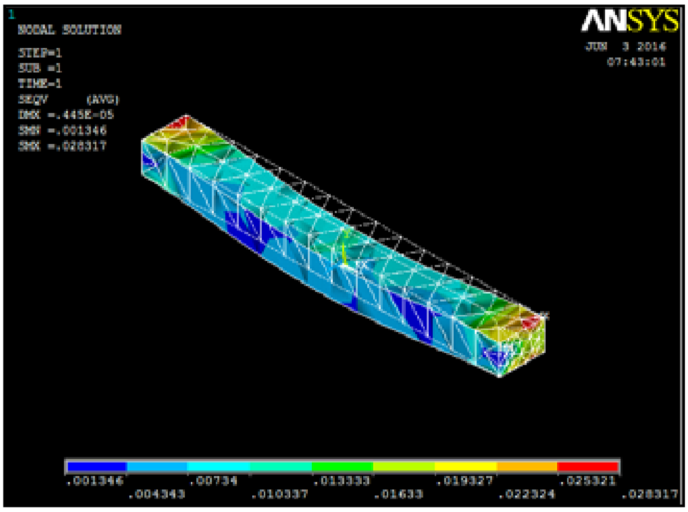

Fig.6 : Von Misses Stress of Plain cement concrete beam Reinforced with Geogrid materials

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2. At 28 Days Result

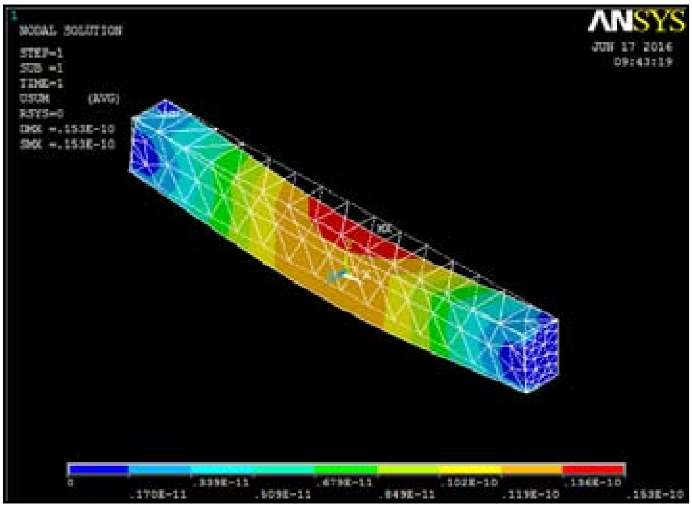

Fig.7 : Deflection of Plain cement concrete beam

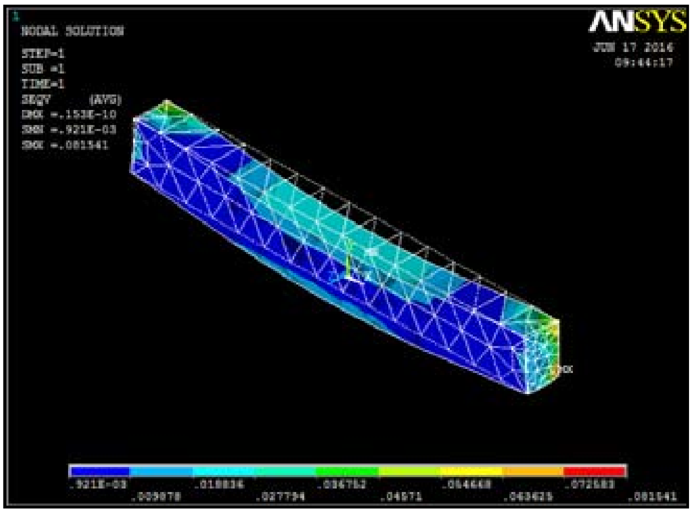

Fig.8 Von Misses Stress of Plain cement concrete beam

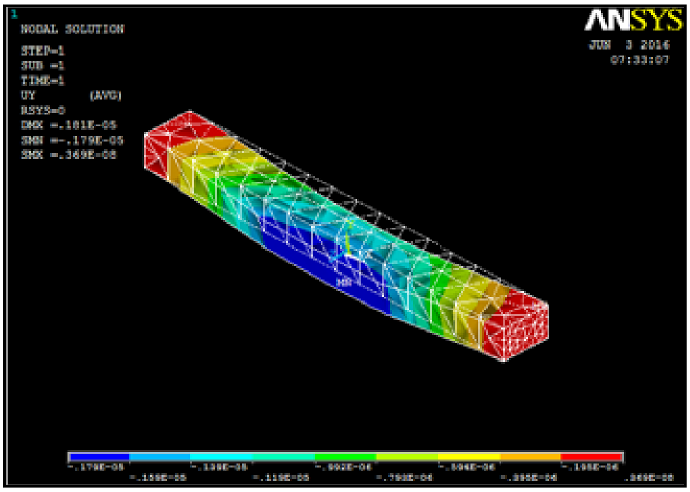

Fig.9 : Deflection of Plain cement concrete beam Reinforced with Geotextile materials

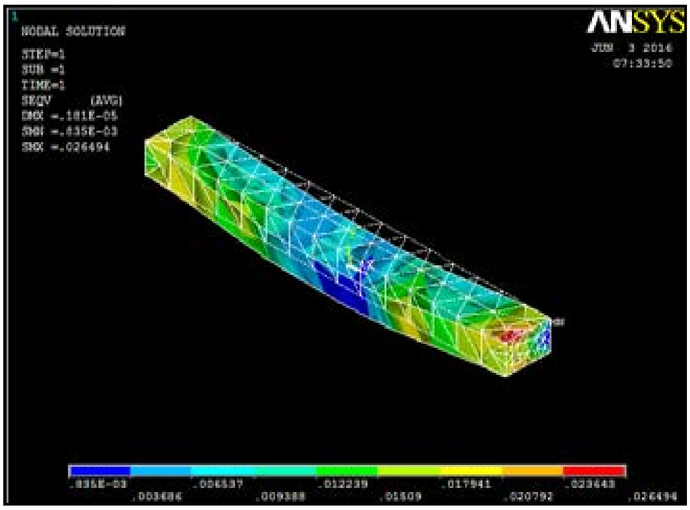

Fig.10 : Von Misses Stress of Plain cement concrete beam Reinforced with Geotextile materials

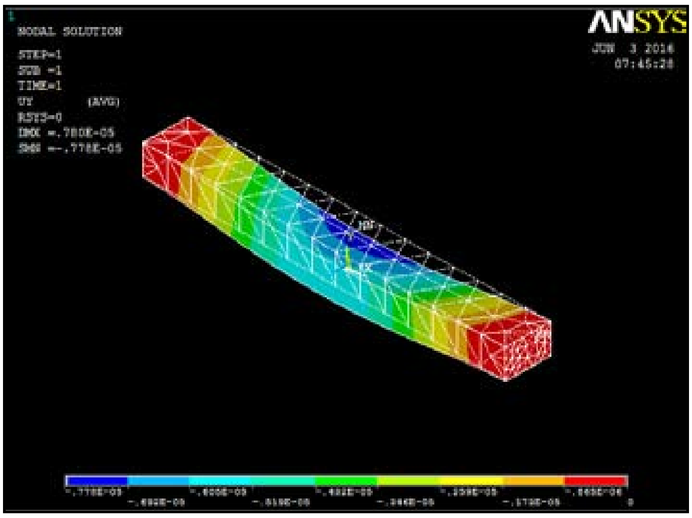

Fig.11 : Deflection of Plain cement concrete beam reinforced with Geogrid materials

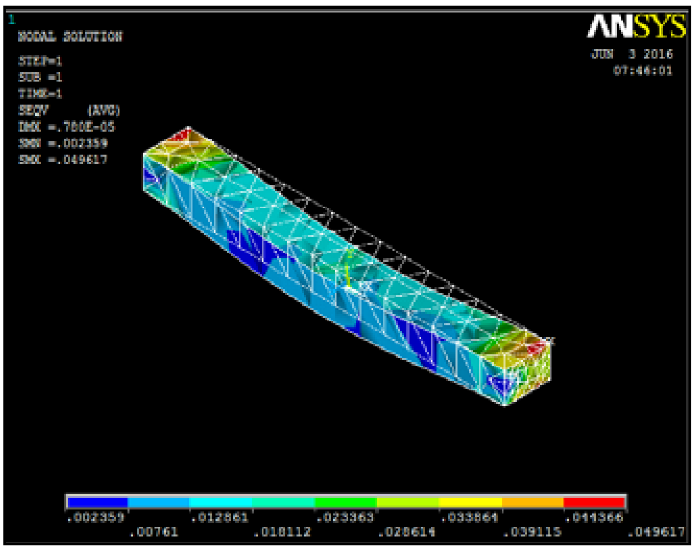

Fig.12 Von Misses Stress of Plain cement concrete beam Reinforced with Geogrid materials

3. Meshing of Reinforced Concrete Beam

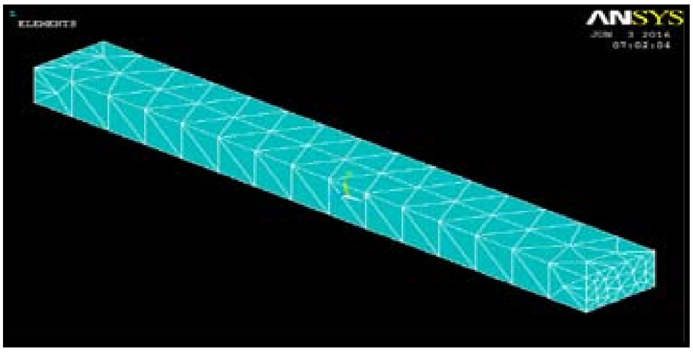

Fig.1 : Meshing of Reinforced concrete beam

4. Loads on Concrete Beam

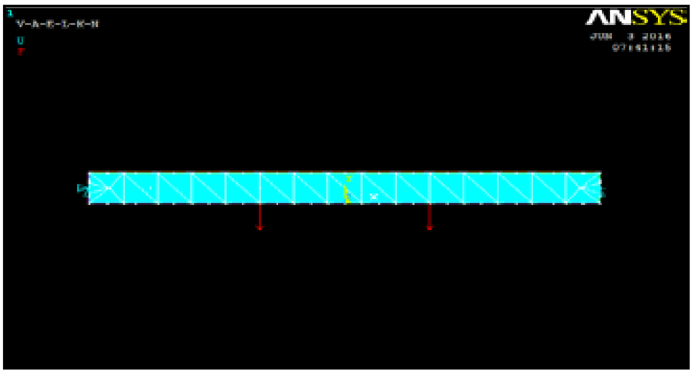

Fig.1 Loads on Concrete Beam

IX. Conclusion

Due to several advantages of Geosynthetics materials used for structural repair and strengthening, the use of Geosynthetics has becoming popular. This paper makes a comparative study between the load carrying capacity of an RCC beam and other beams with Geosynthetics bonded. An experiment study will carry out to study the change in the structural behavior of R.C.C. beams Reinforced with Geosynthetics, to enhance the Flexural capacity of the beams.

- To compute the flexural strength of concrete beam using Geotextile and Geogrid materials given better results compared to the conventional beam.
- The strengthening with Geotextile Fabric and Geogrids around and inside the beam was found more effective in improving the ultimate load carrying capacity of beams.
- In terms of using finite element models to predict the strength of concrete beams, the assignment of appropriate material properties is critical.
- ANSYS is time saving and cost efficient tool that helps in simulation and gives satisfactory results using discrete approach.
- In the comparison cases both experimental and analytical results are varied. Therefore the FEA software ANSYS can use effectively for the beam analysis.

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