BEHAVIOUR OF CONCRETE COLUMNS BY USING BIAXIAL GEOGRID ENCASEMENT

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Abstract: A new reinforced system is 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. Geogrids are an alternative tool in transportation and civil construction. They allow engineers to build where it otherwise would not be possible or would be cost prohibitive using traditional material. It is structured polymeric material usually made from polyethylene compounds. To extend the use of geogrid in civil engineering as a structural component in concrete in axial load member, with the strength comparison to traditional rebar system and geogrid encased system was done. Test results have shown that the axial load carrying capacity of specimens reinforced with two different cases geogrid encased columns. The geogrid reinforced steel columns are given strength 5 percent less strength with compare to traditional rebar system by using geogrid (50kN/m tensile strength).Axial load-displacement relations for the test column and stresses in member was observed in Finite element analysis (ANSYS12.0).

Keywords: Reinforced Concrete (RC), Geogrid reinforced steel columns (GRSC)

I. INTRODUCTION

Reinforced concrete (RC) has been used in construction of different structures for centuries. Reinforced concrete is defined as concrete which is a mixture of cement, sand, gravel, water, and some optional other admixtures, combined with a reinforcement system, which is usually steel. Concrete is strong in compression but weak in tension, therefore may result in cracking and failure under large tensile stresses. Steel has high tensile capacity and can be used in areas with high tensile stresses to compensate for the low tensile strength of concrete.

The combination of concrete, a relatively cheap material with high compressive strength, and steel, a material with high tensile strength, has made reinforced concrete a popular construction material for structural and non-structural members. Historically, steel in the form of rebar has been used as longitudinal and transverse reinforcement. Other forms of steel reinforcement systems, such as tubular and composite sections have been introduced in recent decades.

Reinforced concrete columns are used to transfer the load of the structure to its foundations. These are reinforced by means of main longitudinal bars to resist compression and/or bending and transverse steel (ties) to resist the bursting forces.

II. EXPERIMENTAL PROGRAM

The three types of specimens were constructed and tested up to failure monotonic axial load. The strength and displacement and effect of reinforcement with rebar and polypropylene geogrid strength of the column were investigated. The results from traditional rebar, GRSC and GRC specimen with different amount of transverse and longitudinal steel were compared. The specimens were 700mm high and had 230mm X 230mm cross-sections with 40 mm clear cover the reinforcement .The specimen specification are provided in Table 1.

The characteristic concrete compressive strength for tested specimen M20 grade concrete was used. Table 2 illustrates the mixture properties as well as the concrete mechanical properties for the tested specimens. The used polypropylene and high density polyethylene geo grid with opening size (25x25) mm with tensile strength 50kN/m.

Group	Column Designation	Column specimens dimension			Slenderness Ration h/D
		L (mm)	B (mm)	H (mm)	
C1	Traditional Rebar Columns	230	230	700	3.04
C2	Geogrid Reinforced Steel Columns	230	230	700	3.04
C3	Geogrid Reinforced Columns	230	230	700	3.04

Table 1: Details of tested column specimen

Grade	W/C	Cement (Kg/m^3)	Fine Aggregate (Kg/m^3)	Coarse Aggregate (Kg/m^3)
M20	0.5	360	586.8	1195.2

Table 2: Mixture properties of concrete M20 (1:1.63:3.32)

III. ANALYTICAL MODELLING

The finite element model in ANSYS (SAS 2003) there are multiple tasks that have to be completed for the model to run properly. Models can be created using command prompt line input or the Graphical User Interface (GUI). For this model, the GUI was utilized to create the model. This section describes the different tasks and entries into used to create the FE calibration model.

Material Type	ANSYS Element
Concrete	Solid65
Steel Reinforcement & geogrid	Link8

Table 3: Element Type for Working Model

Material Model Number	Element Type	Material Properties	
		Linear isotropic	
1	Solid65	EX	22360
		PRXY	0.2
2	Link 8	EX	200000
		PRXY	0.3
3	Link 8	EX	2500
		PRXY	0.18

Table 4: Material Models for the Calibration Model

Modelling:

The concrete column with rebar and geogrid were modeled as volumes. Since a quarter of the beam is modeled, the model is700mm long with a cross section of 230x230mm.

Meshing:

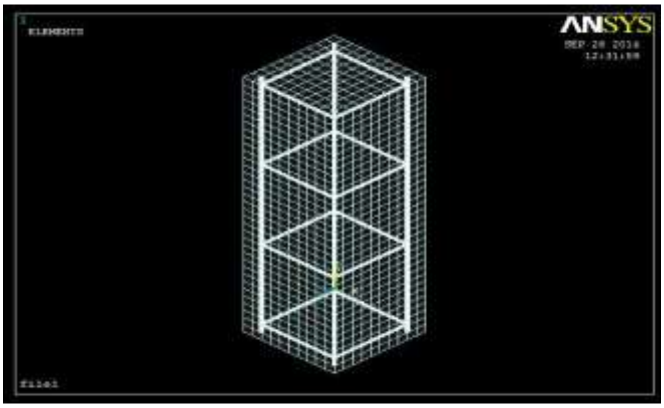


Figure 1: Meshing of the concrete and rebar

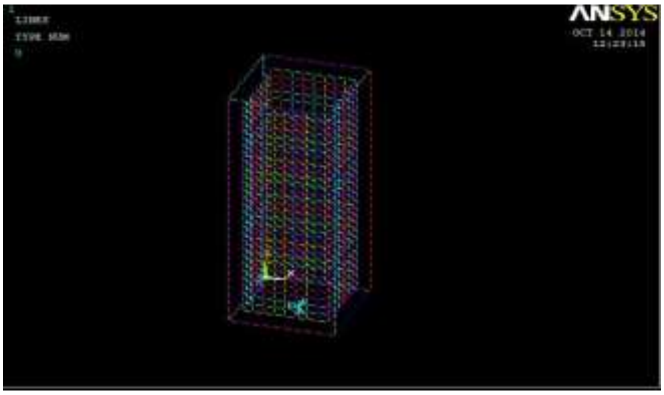


Figure 2: Meshing of concrete and geogrid material

Loads and Boundary Conditions:

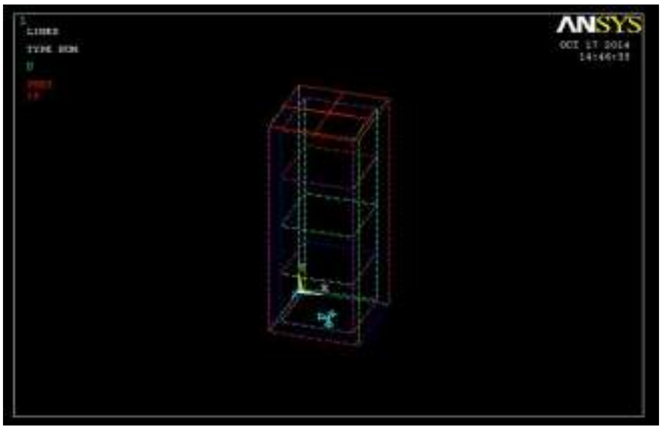


Figure 3: Boundary conditions for plane of symmetry

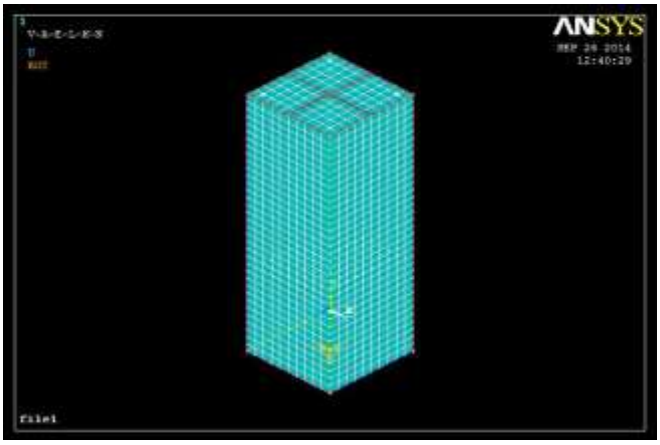


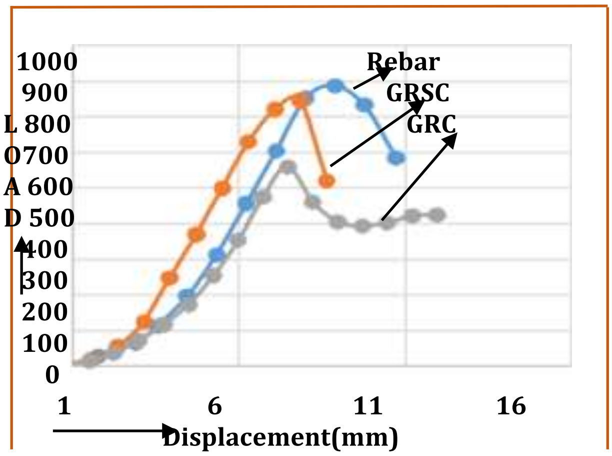
Figure 4: Boundary condition and pressure direction

IV. RESULTS AND DISCUSSIONS

The all three types specimens Traditional rebar column (C1),Geogrid reinforced steel column (C2) and Geogrid reinforced column (C3) was very different in strength see Table. A representative axial load-displacement is measured; typically the specimens behaved elastically without cracking until the peak strength was almost reached .Suddenly the axial strength dropped about 1/2 of the peak strength.

Group	Column Designation	Column specimens dimension			1ST Cracking (KN)	Peak Strength(KN)	Displacement(mm)
		L (mm)	B (mm)	H (mm)			
C 1	Traditional Rebar Columns	230	230	700	560	799.8	8.9
C 2	Geogrid Reinforced Steel Columns	230	230	700	520	750.6	7.84
C 3	Geogrid Reinforced Columns	230	230	700	515	500.2	7.47

Table 5: Measured load-displacement value



Graph 1: Load Vs Displacement Curve

Tested Specimens:

Rebar Column **GRSC** **GRC**

Figure 5: Specimens

Specimen Type	Analytical Study					
	Stress			Stress at the interface		
	Longitudinal Bar	Ties	Geo grid	Longitudinal Bar	Ties	Geogrid
TRC	82.47 (comp)	25.8	……	17.48	14.33	…….
GRSC	78.58 (comp)	…….	3.22	15.82	…….	13.67
GRC	11.4 (comp)	……	3.22	10.71	………	10.20

Table 6: Stress value from analytical study

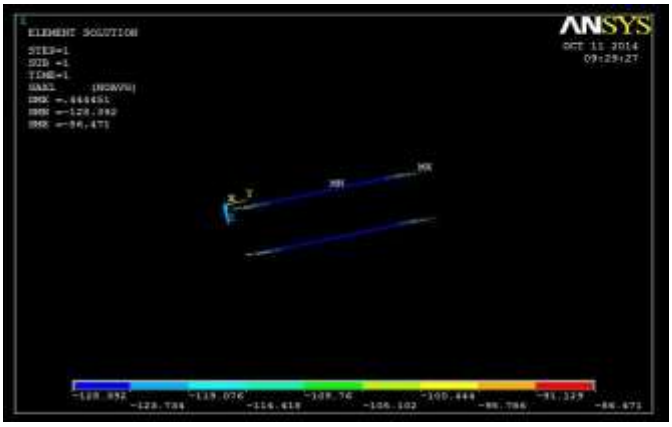


Figure 6: Stress in steel bar (C1) model

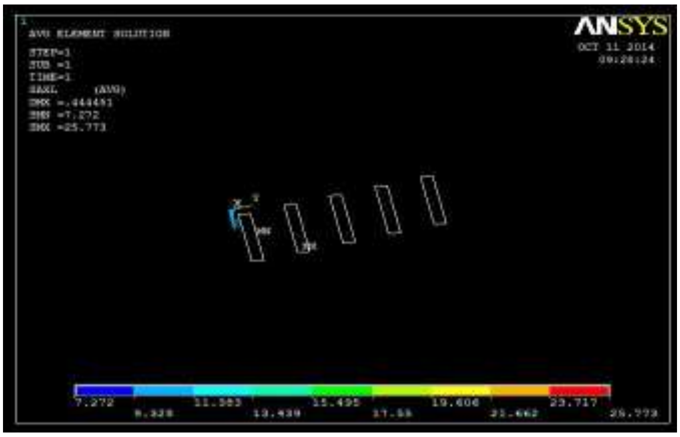


Figure 7: Stress in steel ties (C1) model

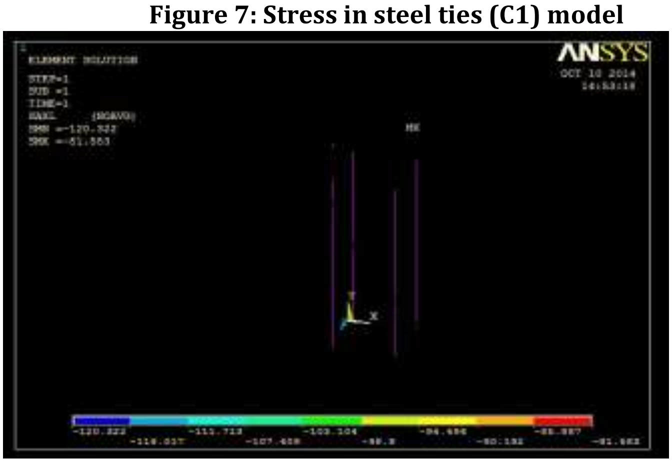


Figure 8: Stress in steel bar (C2) model

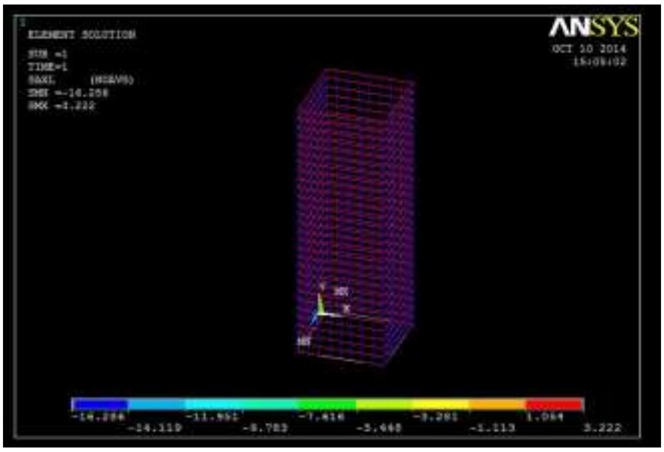


Figure 9: Stress in geogrid (C2) model

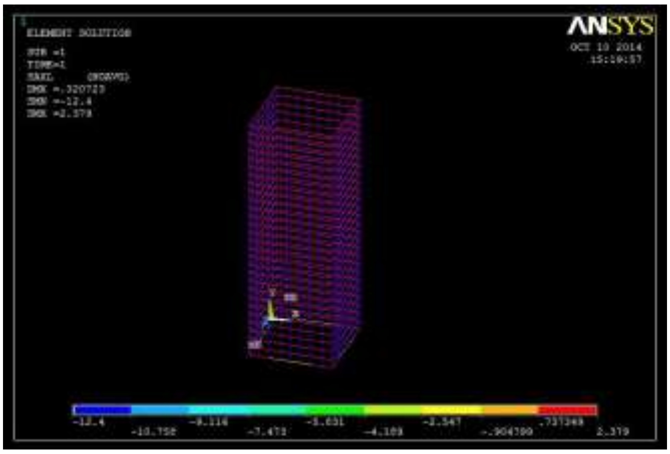


Figure 10: Stress in geogrid (C3) model

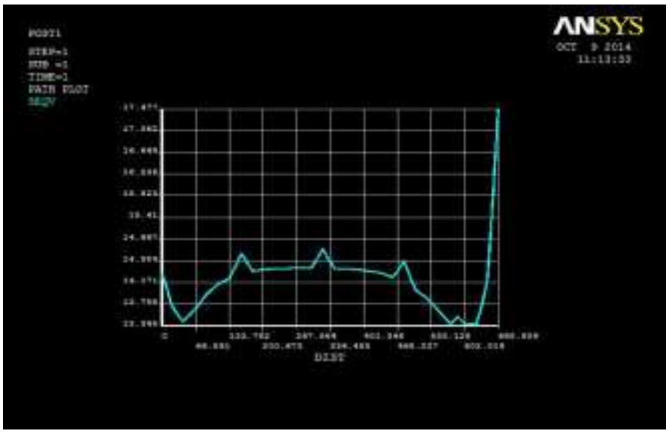


Figure 11: Stress at interface in (C1) model longitudinal rebar

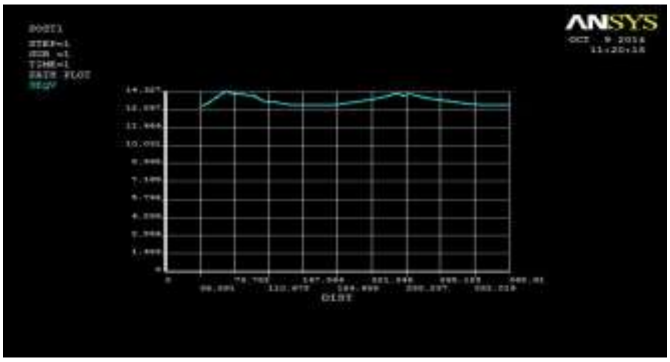


Figure 12: Stress at interface in (C1) model rebar lateral ties

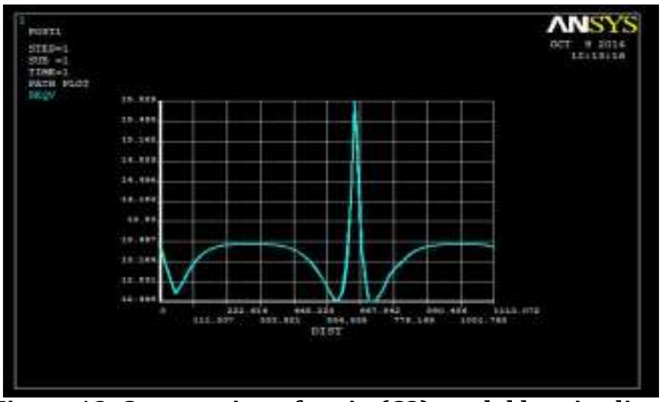


Figure 13: Stress at interface in (C2) model longitudinal rebar

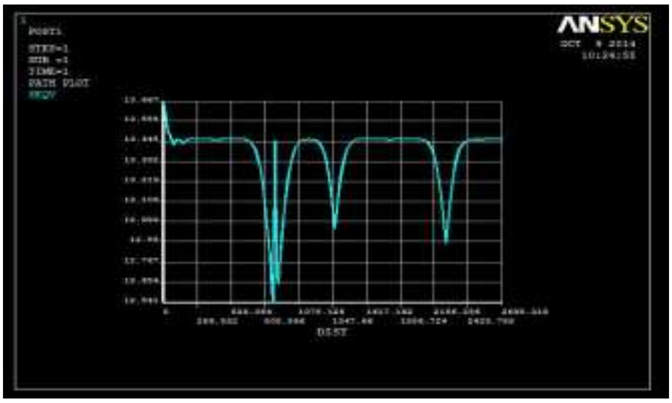


Figure 14: Stress at interface in (C2) model geogrid lateral direction

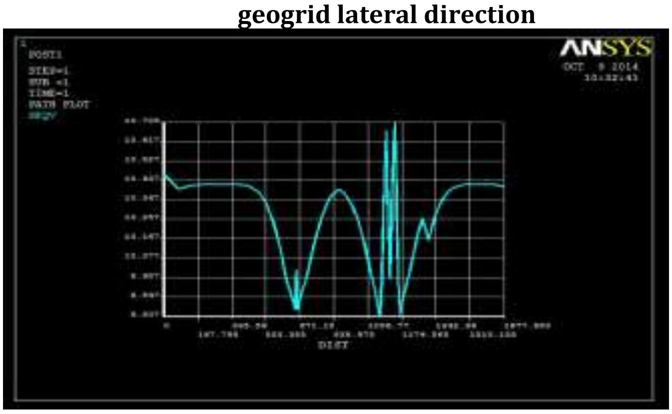


Figure 15: Stress at interface in (C3) model geogrid longitudinal direction

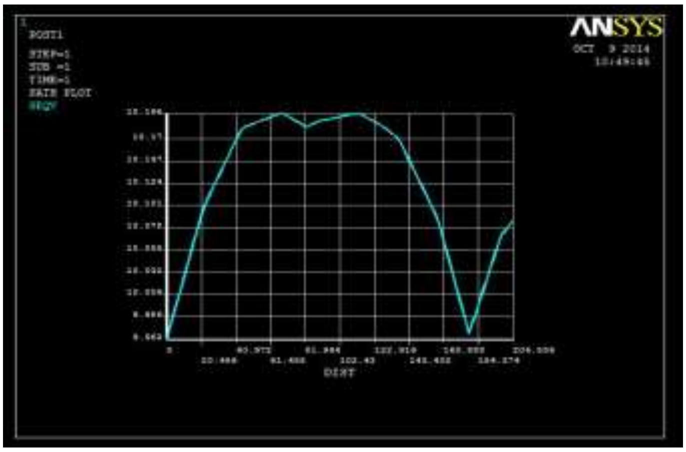


Figure 16: Stress at interface in (C3) model geogrid lateral direction

V. CONCLUSIONS

From the experimental and practical investigations carried out in the study, the following major findings can be arrived at

1. A new geogrid reinforcement termed GRSC is proposed for longitudinal reinforced members GRSC is an anticipated to be an alternative to the existing reinforcement systems and lower construction cost as it eliminates the labour cost associated with cutting, bending and tying reinforcing ties.
2. The columns with rebar gives the better confinement than the geogrid, this may be due to low tensile and compressive strength of geogrid.
3. The test results shows that the load carrying capacity of columns with geogrid and longitudinal steel reinforcement is 5% less than the load carrying capacity with traditional rebar reinforcement, so the GRSC shows a little reduction of its strength.
4. The strength reduction of two models GRSC and GRC compared with traditional rebar specimens give 5% and 29% respectively.
5. From FEM analysis it is observed that the failure stresses at the interface in traditional system with GRSC and GRC systems was compared, and found that the stresses in traditional reinforcement is more.
6. A result of analytical work, the stresses developed steel in traditional rebar column - 86.47N/mm^2 (compression),Geogrid reinforced steel columns-81.53N/mm^2(compression) and geogrid reinforced columns-2.37N/mm^2(tension) respectively. From the above result can conclude that compression stress in GRCS is more compared to GRS.
7. This research shows that in second case with increasing the tensile strength of geogrid grade, the confinement of the concrete compressive strength of the column specimen will increase.

From the experimental and analytical analysis it was observed that geogrid is a better replacement of steel ties.

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