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Study on the effect of Biaxial Geo-Grid on Fiber Reinforced Concrete

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Abstract – *An experimental investigation has been carried out for the use of Biaxial geogrid in fiber reinforced concrete. This paper focused to study the mechanical properties of geogrid and steel fiber in concrete. The main aim of the study is to investigate the tensile and flexural behavior of Biaxial geogrid with and without steel fibers and compared with conventional specimens. In this study compression test on cube, split tensile test on cylinder and flexural test on beams were conducted. Experimental results shows that geogrid can be an effective alternative material to confine concrete as compared to conventional confining technique. This study helps to know the possibility of biaxial geogrid and steel fibers as substitute for reinforcement in concrete.*

Key Words: Steel fibers, Biaxial geogrid, Concrete, Flexure, Reinforcement,

1.INTRODUCTION

Nowadays, the life period of buildings are very less compared to estimate period. It has many reasons such as in quality of building materials and improper planning and so on. Hence beams fail within short period due to reduction in strength shear and flexural strength of beam. Concrete structures are brittle materials very strong in compression and weak in tension. The behaviour of concrete members under tensile and flexural loads can be controlled by adding reinforcements. Generally steel reinforcements are provided to control failure of concrete member. Steel is a material having high tensile strength and ductility but it loses its properties when it exposed to environment because of corrosion. From the economical point of view steel is costly as well as production of steel emits high carbon gases to environment causes pollution

Geosynthetics is the term used to describe a range of generally polymeric products used to solve civil engineering problems. 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 fields such as 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.

A study was conducted by Siva Chidambaram in 2014 to find the confining effect of Uniaxial geo-grid on the mechanical properties of concrete specimens with and without steel fibers under compression and flexure. The geo-grid along with steel fibers is able to reverse the failure mechanism from sudden brittle failure to ductile without significant loss of strength and there is a significant improvement in the flexure tension behavior of beam specimens observed after placing a single layer of geo-grid at the tension side of beam specimens [1]. From the experimental and analytical analysis of the paper by Lekshmi Suku (2017) , it is observed that geogrid is a better replacement of steel ties[2]. A paper written by Itani (2016) discussed about the use of geo-grid reinforcement for enhancing the performance of concrete overlays. His study investigated the use of geo-grids as main reinforcement in thin concrete overlays. The geo-grid reinforcement adds a substantial post-cracking ductility where reinforced samples showed an increase in strength after cracking as well as larger deformations[3]. Turan (2018) studied about the Confinement Effect of Geo-grid and Conventional Shear Reinforcement Bars Subjected to Corrosion. The low elastic modulus of the geo-grid material, combined with the concrete not contributing sufficient deformation, produces brittle fractures in the RC beams and causes the longitudinal bars to remain within the elastic limits. [4]

2. EXPERIMENTAL PROGRAM

2.1 Test Specimens

Cube and Cylindrical specimens confined with geo-grid of size 150 mm, 150 mm × 300 mm are tested for direct compression and split tension. Geo-grid is shaped into a tubular form and inserted in the cylindrical mould before the concrete lay.

Beam specimens of size of 100 × 100 × 500 mm are tested to examine the effect of geo-grid on the flexural strength of specimens. In preparation of beam specimens with geo-grid, firstly the cover concrete is laid in the mould before placing the layer of geo-grid on the cover concrete. Details of the specimens are listed in Table 1.

Table -1: Details of Specimens

Sl. No.	MIX ID	Description
1	CS_{0}	Conventional concrete mix
2	$CS_{0.5}$	Concrete mix with 0.5% steel
3	CS_{1}	Concrete mix with 1% steel fibers
4	$CS_{1.5}$	Concrete mix with 1.5% steel
5	CS_{2}	Concrete mix with 2% steel fibers
6	$CS_{0}G$	Geogrid confined specimen
7	$CS_{1.5}G$	Geogrid confined with 1.5% steel

2.2 Material Properties

A concrete mix of M25 was used in this study. The specimen were casted in ordinar Portland cement (OPC) of Grad 53. Manufactured sand as fine aggregate and well graed crushed coarse aggregate having 20mm maximum size. Hooked end steel fibers with a specification of 30mm length, 0.50mm diameter has an asect ratio of 60 and density of 7850kg/m^3. The steel fibers were distributed randomly into the concrete mixtures and the percentages were 0%, 0.5% and 1% to the volume of concrete. The strata Bi-Axial geogrid used in this study has a tensile strength of 40kN/m in both direction aspect ratio of 60

2.3 Specimen Preparation

Cube and Cylindrical specimens confined with geo-grid of size 150 mm, 150 mm × 300 mm are tested for direct compression and split tension. Geo-grid is shaped into a tubular form and inserted in the cylindrical mould before the concrete lay as shown in fig. 1

Beam specimens of size of 100 × 100 × 500 mm are tested to examine the effect of geo-grid on the flexural strength of specimens. In preparation of beam specimens with geo-grid, firstly the cover concrete is laid in the mould before placing the layer of geo-grid on the cover concrete as shown in fig. 2

Fig -1: Geogrid placing on cylinder

Fig -2: Geogrid placing on beam

2.4 Test Setup

All the specimens were tested under Universal Testing Machine. The cube compressive strength test was done to obtain the compressive strength behaviour of the concrete specimens. Cube compressive strength,Spilt tensile strength at 7, 14 and 28 days were found out using compression testing machine as recommended by the Indian Standard [21]. The compressive strength was determined by dividing the failure load by the cross-sectional area of the cube and is expressed in N/mm2. Split tensile strength is calculated using

$$T_{sp} = \frac{2P}{\pi DL} \quad (1)$$

Where T_{sp} = Split tensile strength (N/mm^2) ,P = Applied load (N) ,D = Diameter of the specimen (mm) ,L = Length of the specimen (mm).

The two point load test is used for the present study. The beam specimens were placed on the supporting rollers and load was applied at a continuous increasing rate without shock. Load at failure was recorded. flexural strength is given by the equation 2

$$f_b = \frac{Pl}{bd^2} \quad (2)$$

Where fb = Modulus of rupture, P = Maximum load applied to the specimen in kg, l = Length of span in cm , a = Crack distance in cm, b = Width of the specimen in cm, d = Depth of the specimen in cm

Fig -3: Experimental Test Setup

3. RESULTS AND DISCUSSIONS

3.1 Compressive strength

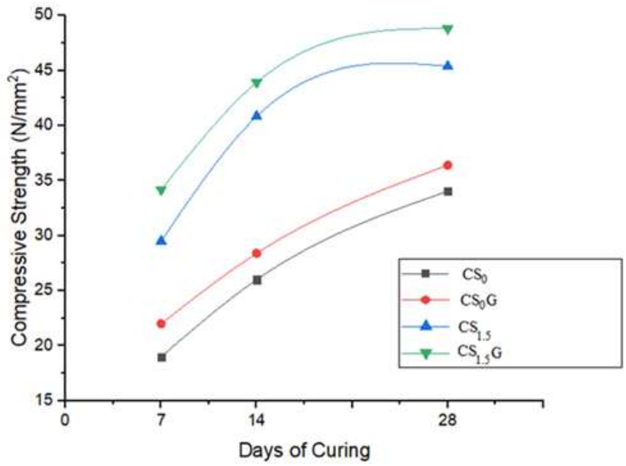


Chart -1: Graph showing compressive strength results of CS_0, $CS_{1.5}$, CS_0G, $CS_{1.5}G$

(a)

Chart 1 shows the effect of concrete type on the compressive strength versus days of curing .. From the Fig. 5.1, for 28 days of curing the average compressive strength of conventional specimen is 34.04 MPa. The average compressive strength of steel fibers reinforced specimen is increased by 30% but that of Geo-grid reinforced specimen) is increased only by 6%. hence geogrid is not much helpful in increasing the strength and stiffness of specimen. But the post peak behaviour of geogrid is considerably improved than the conventional concrete specimen. The combined effect of steel fibers with geo-grid confinement increases the compressive strength up to 36%.

3.2 Split strength strength

Chart 2 shows the effect of concrete type on the split tensile strength versus days of curing. Splitting failure takes place immediately after achieving its ultimate strength, while the presence of steel fiber in specimen permits the specimen to elongate in lateral direction without sudden loss in strength. The tensile strength of the geogrid confined specimen is 37% higher than that of the conventional concrete. The split tensile strength of steel fiber reinforced specimen is increased by 48.5% of that of conventional concrete and only 7% than that of geogrid confined concrete . The presence of steel fiber acts as an effective bridge across the cracks and supports in increasing the split tensile strength and stiffness of specimen with the geogrid confinement. The composite action of steel fiber and geogrid confinement increases the split tensile strength is increased by 40 to 50% as compared with the individual material effect.

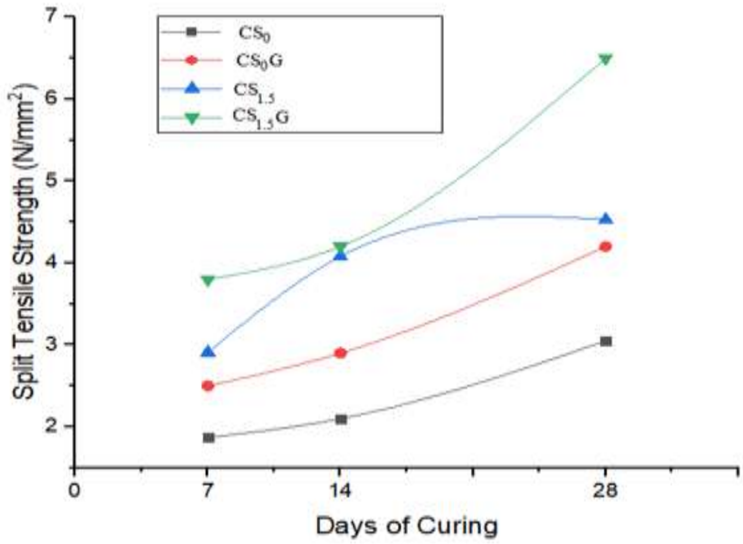
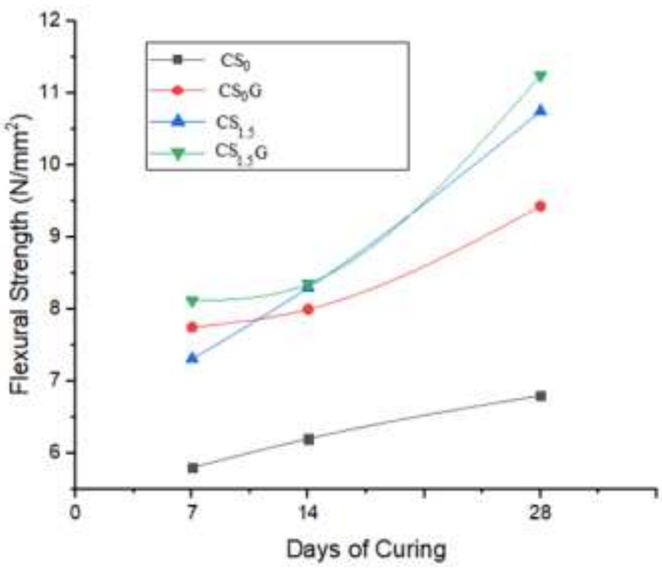


Chart-2: Graph showing split tensile strength results of CS_0, $CS_{1.5}$, CS_0G, $CS_{1.5}G$

3.3 Flexural strength



(c)

Chart -3: Graph showing flexural strength results of CS_0, $CS_{1.5}$, CS_0G, $CS_{1.5}G$

Chart 3 shows the effect of concrete type on the flexural strength versus days of curing The conventional plain concrete beam specimen fails completely in brittle mode with a maximum strength of 6.8Mpa. The 28 day flexural strength of geogrid specimen is 38% more than that of conventional beam . A significant increase in flexural strength is observed in geogrid confined specimen as compared to the conventional specimen. These specimens have also undergone the lesser cracking with no sudden spalling of cover concrete as compared to other specimens. The 28 day flexural strength of fiber reinforced beam is 58% more than that of conventional beam and 14% more than that of geogrid confined specimen . The presence of steel fibers in concrete increase the aggregate interlock property and restricts the embedded geogrid to slip hence it helps to resist the crack. Hence the geogrid can be efficacious in transfering tensile stress across the crack and can act like continuous fibers in bridging the crack.

4. CONCLUSIONS

Specimens were tested for finding out the compression strength , flexural strength and tensile strength and results were obtained. Some important observation as follows;

- The Geogrid confined specimen has not much effect in improving the compressive strength of concrete.
- The combined effect of steel fibers with geo-grid confinement increases the compressive strength up to 36%.
- The composite action of steel fiber and geogrid confinement increases the split tensile strength is increased by 40 to 50% as compared with the individual material effect.
- A significant increase in flexural strength is observed in geogrid confined specimen as compared to the conventional specimen.
- The geogrid can be efficacious in transfering tensile stress across the crack and can act like continuous fibers in bridging the crack.

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