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Study on Behaviour of Steel Fiber with Biaxial Geogrid Confined Concrete

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Abstract: Concrete is a heterogeneous mixture. The behaviour of concrete in addition of any relevant materials needs proper investigations. The steel fibres in concrete enhance the shear capacity of concrete members and Biaxial Geo-grids in Concrete enhance the tensile capacity of concrete members. The concrete is very poor in tension as well as in shear but strong in compression. The main aim of the study is to investigate the tensile and flexural behaviour of Biaxial Geo-grid with and without steel fibres and compared with regular conventional specimens. In this study Compression test on cubes, Split tensile test on cylinders and Flexure test on prisms with one point loading were performed with the 0.5%, 1% , 1.5% volume fraction of hooked fibres with Biaxial Geo-grids into consideration. The experimental tests with the Biaxial Geo-grid and 1.5% volume fraction of hooked steel fibres showed significant improvement in all strengthening aspects. Further this study helps to know the possibility of Biaxial Geo-grid and steel fibres as substitute for tensile and shear reinforcement.
Keywords: Steel fibres, Biaxial Geo-grids, Concrete, Flexure, Shear, Reinforcement

I. INTRODUCTION

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. The conventional method of increasing tensile and shear capacity in a concrete member is to provide reinforcements at the location of plastic hinges and in tensile zones. The concrete members with hooked steel fibres showed a better shear enhancing properties under loads. The Beam confined with Geo-grids and steel fibres showed better flexural strength, stiffness degradation, Energy dissipation capacity, displacement ductility and ultimate load with its corresponding deflection [1, 2]. The experimental programme with different types of Geo-grids showed the better confinement with enhanced strength in concrete members. Several tests results confirms the benefits of the Geo-grids as evidenced from the load-deflection response in terms of post behaviour, crack-mouth opening and failure mode [3,4]. The present objective of the research paper is to understand the basic structural strength properties of concrete members at different age of 7, 15 and 28 days with different volume fraction of hooked steel fibres confined with Biaxial Geo-grids.

II. EXPERIMENTAL INVESTIGATION

A. Material Specifications

The specimens were casted using a mix proportion of 1:1.5:3 in Ordinary Portland Cement (OPC) of Grade53 maintaining a Water-Cement (W/C) ratio of 0.5. Hooked end steel fibre with a specification of 30 mm length, 0.50 mm diameter has an aspect ratio of 60, has a nominal tensile strength of 1000 N/mm2 is used to prepare steel fibre reinforced concrete having a constant volume fraction of 0.5%, 1% and 1.5%. The Strata Bi-Axial geo-grid used in this study has a tensile strength of 100 kN/m in both the direction. For flexure testing on Prism the same constant volume fraction of 0.5%, 1% and 1.5% is used along with strata biaxial Geo-grids at tension zone of the prism.

Fig. 1. (a) Hooked end steel fibre; (b) Bi-axial Geo- grid

B. Compression and split tension specimens

To evaluate the attainment of compression strength for conventional concrete, cubes were casted and tested after curing. The characteristic compression strength of the cube after 28 days of curing is 48.5 N/mm2. To differentiate the synergetic effect of grid confinement with conventional and SFRC under compression and tension, three different configurations on the cylindrical specimen (150Φ × 300 mm) were casted and tested after 28 days of curing. In order to prepare the grid confined specimens, geo-grid was made in tubular form bounded and tied with nominal steel wires which are placed in a cylindrical mould as shown in Fig. 2 after that concrete is laid. The details of the configuration for all cylindrical specimens were tabulated in Table I.

Fig. 2. (a) Tubular form; (b) Inserting the tubular form inside the cylindrical mould.

TABLE I

DETAILS OF CYLINDRICAL AND CUBE SPECIMENS

Specimen	% of steel fibre	Remarks
C1	-	Conventional
C2	-	Geo-grid
C3	0.5%	Geo-grid with steel fibre
C4	1%	Geo-grid with steel fibre
C5	1.5%	Geo-grid with steel fibre

C. Prism Specimens

The flexure strength criteria is performed with 100mm*100mm*500mm prisms respectively. The Geo-grids were placed in layers at 25 mm above the soffit of prism in layers. The steel fibre reinforced concrete having a constant volume fraction of 0.5%, 1%, 1.5% with Geo-grid were casted and tested after 28 days of curing. In order to prepare the grid confined specimens, geo-grid was made in Layer form shown in Fig. 3 after that concrete is laid. The details of the configuration for all Prism specimens were tabulated in Table II.

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Fig. 3. (a) Layer form; (b) Cubes and Prisms.

TABLE II
DETAILS OF PRISM SPECIMEN

Specimen	% of steel fibre	Remarks
P1	-	Conventional
P2	-	Geo-grid
P3	0.5%	Geo-grid with steel fibre
P4	1%	Geo-grid with steel fibre
P5	1.5%	Geo-grid with steel fibre

III. RESULTS AND DISCUSSIONS

A. *Compression Behaviour of Cube specimens.*

The details of the specimens tabulated in Table. 1 is tested using a Compression Testing Machine (CTM) with a capacity of 200 tons. The ultimate load of the specimen is obtained after 7, 14 and 28 days of curing. The compressive strength criteria are studied with by 150mm*150mm*150 mm cube specimens. The results from the study were plotted in the form of bar chart as shown in Fig. 4. The rate of variation in compression strength for C5 specimen is higher than the other specimens. However after 28 days of curing the compression strength of C4 and C5 specimens were almost comparable.

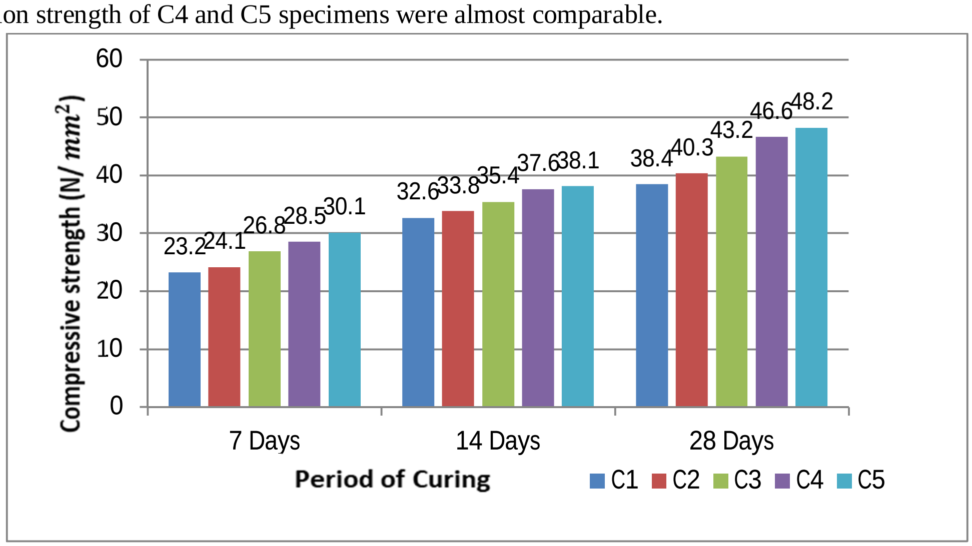

Fig. 4. Compression strength of the Cube specimen

B. *Split Tensile Behaviour of Cylindrical Specimen*

The rate of variation in split tensile strength of C5 specimen is higher than the other specimens. This signifies that the SFRC in C5 specimen along with geo-grid confinement has a major role on the ultimate tensile strength of the specimen.

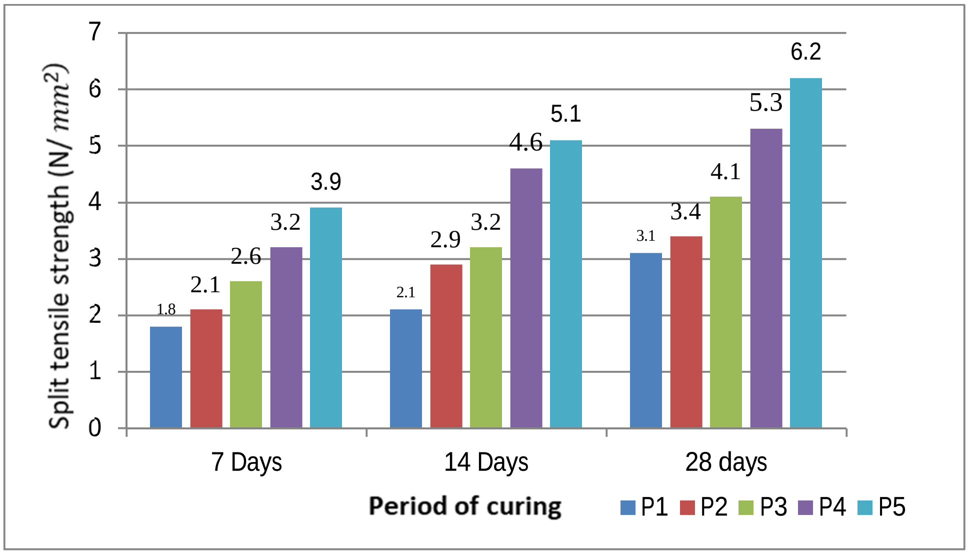

Fig. 5. Split Tensile strength of the cylindrical specimen

C. Flexure Behaviour of Prism Specimens

The flexural strength of the concrete helps to find the behavior of prisms under Bending. The one-point flexure test is conducted to determine the failure load of each specimen. The details of the specimens tabulated in Table. 2 are tested using a Universal Testing Machine (UTM) with a capacity of 40 tons. The ultimate load of the specimen is obtained after 7, 14 and 28 days of curing. The flexural strength criteria are performed with 100mm*100mm*500mm prism specimens. The results from the study were plotted in the form of bar chart as shown in Fig. 6. The rate of variation in Flexural strength for P5 specimen is higher than the other specimens. However after 28 days of curing the compression strength of P4 and P5 specimens were almost comparable.

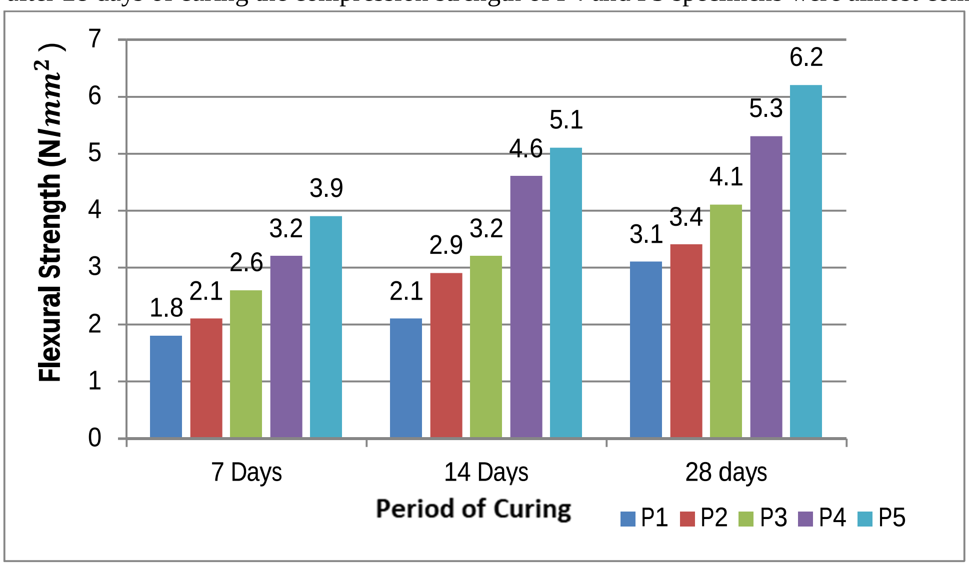

Fig. 6. Flexural strength of the Prism specimen

IV. CONCLUSION

An experimental investigation has been carried out to study the behavior of plain cement concrete and with different volume fractions of steel fiber reinforced with Strata Geo-grid. From flexure tests it has been found out that geogrids can take tensile forces when these are kept in plain cement concrete prisms. The total experimental investigation can be summarized as follows.

A. The failure in Geogrid concrete prisms due to initial failure of Geogrids in specimens.
B. The compressive strength at full age of concrete get significant rise compared with controlled specimens.
C. The flexure strength also shows the significant increment with 1.5% volume fractions of steel fibers with Strata Geo-grids.

V. ACKNOWLEDGMENT

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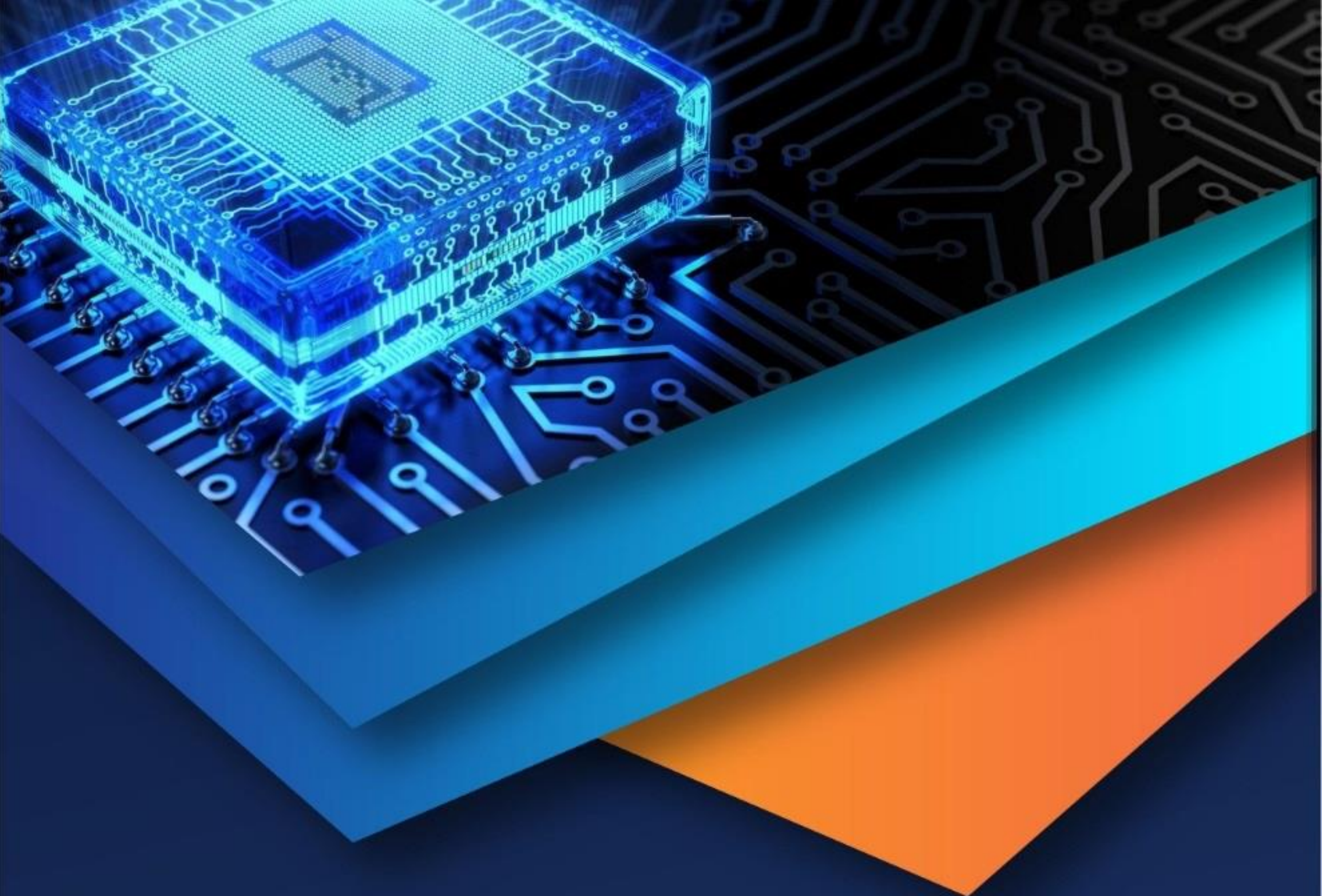

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