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A Literature Study on the Performance of Concrete with Geogrids

Aswini A[1], Akash R A[2], O. R. Arun[3], Gokulnath A[4]
[1]*Assistant Professor Department of Civil Engineering Sri ManakulaVinayagar Engineering College Puducherry.*
[2]*Student Department of Civil Engineering Sri ManakulaVinayagar Engineering College Puducherry.*
[3]*Student Department of Civil Engineering Sri ManakulaVinayagar Engineering College Puducherry.*
[4]*Student Department of Civil Engineering Sri ManakulaVinayagar Engineering College Puducherry.*

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ABSTRACT
Reinforced concrete is a versatile and most commonly used construction material. Though concrete specimens have been considered to hold high loads, they are brittle in nature and weak in tension. Experiment have been conducted to improve the strength aspect of the concrete specimens by different possible experiments. Though steel reinforced concrete is by far durable construction material; however, several constrains limit their use such as, physical constrain of placing reinforcing steel bars in thin section, excessive time for construction and concern of steel corrosion. This study taking in consideration the above limitations focuses onstudying the feasibility of using geogridsas potential and secondary reinforcement in the concrete specimens and overlays to provide additional increase to the mechanical property of the specimens.

KEYWORDS— ***Geogrids, FRC, Mechanical property, Durability***

I. INTRODUCTION

Reinforced concrete is a composite material with a mixture of fine aggregate, coarse aggregate and embedded steel bars, plates or fibers induced to increase the strength and the capability to carry loads. RCC is used extensively in construction around the globe. In fact, it has become the most commonly used and preferred construction material. Tough steel reinforced concrete is by far durable construction material; however, several constrains limit their use. Placement of reinforcing bars in thin sections can be difficult due to the provided cover distance, or limitation in space or area in placing the concrete. Main concern to be taken into account is the exasperating damage of steel bars due tocorrosion. Even though RCC is being used extensively for its' durability, still researches are being conducted to increase the strength and durability of the specimens.

Inclusion of geogrids stitched with lesser diameter steel rods may enhance the strength of the specimens and may protect the steel from possible attacks of corrosion when stitched with the main reinforcement. Geogrids also provides flexibility when placing in the concrete specimens. Based on the above-mentioned advantages, this study attempts to study the mechanical properties along with the durability of the concrete specimens embedded with geogrids.

II. OBJECTIVE

- The main objective of this study is to examine the potential benefits of steel stitched geogrids in concrete specimens
- The study focuses on collecting information on the flexural, compression and durability behavior of concrete members reinforced with steel stitched geogrids

III. LITERATURE STUDY

1. Geosynthetics

Geogrids are geosynthetic materials used as reinforcement material in construction works. It can be used in soil reinforcement or used in the reinforcement of retaining walls and even many applications of the material are on its way to being flourished. The high demand and application of geogrids in the construction are due to the fact that it is good in tension and has higher ability to distribute load across a large area.

The geosynthetic material, geogrid, are polymeric products which are formed by means of intersecting grids. Polymeric materials like High-density polyethylene (HDPE) and polypropylene are the main composite of geogrids. These geogrids are formed by material ribs that are intersected by their manufacture in two directions: one is the machine

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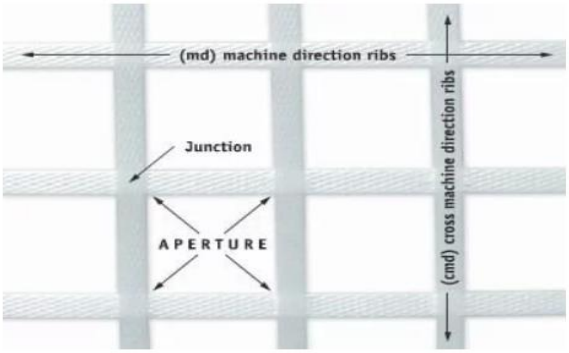
direction (MD), which is conducted in the direction of the manufacturing process. The other direction will be perpendicular to the machine direction ribs, which are called as the cross-machine direction (CMD). These materials form matrix structure materials. The open space, as shown in the figure 1.1, due to the intersection of perpendicular ribs are called as the apertures. This aperture varies from 2.5 to 15 cm based on the longitudinal and transverse arrangement of the ribs. Among different types of the geotextiles, geogrids are considered stiffer. In the case of geogrids, the strength at the junction is considered important because the loads are transmitted from adjacent ribs through these junctions.

FIGURE I
Geogrid formation in machine and cross machine direction



Geogrids are manufactured by two methods,

- Extrusion process
- Weaving process

Extrusion Process

This manufacturing method of geogrids involves extrusion of flat sheet of plastic into the desired configuration. Already set punching pattern is placed over the sheet to make holes for the formation of desired grids.

The punching pattern of holes would result in the formation of so-called apertures. Nest step involves the development of tensile strength, by stretching the material to both longitudinal and transverse direction. A figure representing an extruded geogrid is shown below.

Weaving Process

In this method of geogrid manufacture, single yarn of polyester or polypropylene material undergo either knitting or weaving to form flexible junctions forming apertures. These materials are recommended to have high tenacity, to give the geogrid the final desired property. The product is bought into the market by giving them an additional coating of either bituminous

FIGURE II
Geogrids manufactured by the method of extrusion

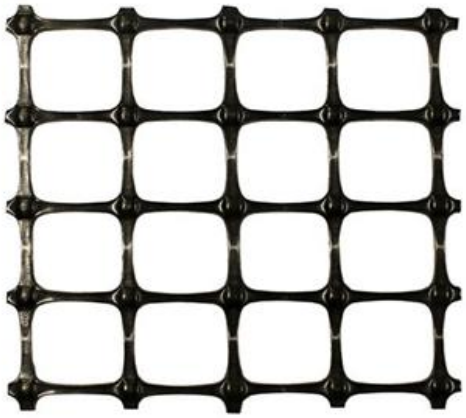


FIGURE III
Geogrids manufactured by the method of weaving

Article Review

P. Maheswar Reddy (2018)., explains that there are two types of geogrid available, the first category geogrids are commonly referred to as punches and drawn geogrids. A sheet of either HDPE or Polypropylene has holes punched into it in a regular pattern and the sheet is then drawn or stretched into finished product. The drawing is done under controlled conditions of temperature and strain rate to avoid the fracture whilst allowing ductile flow of the molecular chain. The second category of geogrid is coated yarn type. These are in fact technical textiles in the form of grids and use bundles of the fibers as the reinforcing component and then coated to provide protection during

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installation and its service. The grid structure is formed by knitting or interviewing the transverse and longitudinal bundles of fiber.

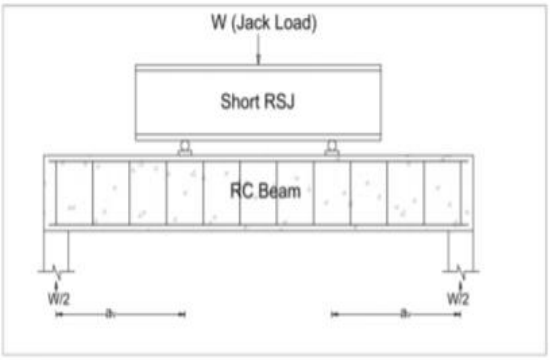
Michael J. Chajes, Cory A. Farshman, et.al., focused on the flexural and shear strengthening of the RC beams using externally applied composite of fibers. The beams, designed to satisfy the ACI ductility requirements (i.e., under reinforced), were internally reinforced with one No. 3 Grade 60 steel bar. Nine beams externally reinforced with composite fabric. In addition to the nine externally reinforced beams, three more were left without external reinforcement and two were reinforced with No. 3 bars. The beams were loaded to failure in four-point bending and results indicated that the external reinforcement can lead to increased flexural capacity, similar to that achieved through additional internal reinforcement.

IV. EXPERIMENTAL PROCEDURE

Article review

XiaoyuMeng, Yin Chi., et.al (2019)., The paper explains that for the Flexural tensile test four-point bending test was carried out to analyse the energy adsorption capacity and crack propagation characteristics of the reinforced pervious concrete beams. The beams were loaded by a hydraulic testing machine with a maximum load capacity of 1500 kN on a four-point loading setup as in figure. The tests were under closed-loop displacement control with a rate of 0.01 mm/s until failure. Vertical displacement was obtained by a vertical displacement sensor. And compressive strength test was carried out on the unreinforced and geogrid reinforced pervious concrete 150 mm cubic specimens. Monotonic loading with a constant rate of 10 kN/s provided by a hydraulic testing machine with a maximum load capacity of 1500 kN was adopted in compression strength test until the specimens failed.

Figure IV
Test setup for RC beam



Ruyan Liu, Kun Wu, et.al., (2019)., explains that to find the compression strength, compression strength test was carried out on the unreinforced and geogrid reinforced concrete cubes of size 150 mm. Monotonic loading with a maximum load capacity of 1500 kN was adopted in compression strength test until the specimens failed.

Peng Liu, Ying Chen, et.al., (2019)., explains that the sulfate solutions with different concentrations (i.e., 1%, 5%, 10% and saturated solution) were prepared, and the concrete specimens were immersed into sulfate solution. In order to ensure the uniformity of sulfate solution, the distance of specimens was set as no less than 2 cm. Then, the sealed solution box was covered with plastic film to prevent the water from evaporation. Finally, the concrete specimens were taken out from sulfate solution and the mechanical properties test were carried out when the erosion age reached to the erosion ages of 2 and 4 months. Moreover, the sulfate solution should be changed once a week. The average value of the measured data of three specimens was used to determine the properties of the concrete specimens.

Load Deflection curve

For a reinforced beam, the load versus vertical displacement can be divided into five stages. (I) Linear elasticity stage, (II) brittle failure stage at peak load, (III) bearing capacity recovery due to the tensile geogrids, (IV) bearing capacity losswhen the cracks propogate upward to the top of the beam and (V) residual strength stage

At stage I, geogrids and the concrete matrix cobines to improve the resistance to brittle failure resulting in the linear increase in the load and deflection. As the load increases cracks emerges from the bottom of the beam. Stage II begins when the concrete attains the peak load and will no longer bear tensile strength. This is where stage III, geogrids plays its role of maintaining the crack propagation as well as the vertical deflection as the load increases and hence the step formation in the load – vertical displacement curve.

V. CONCLUSION

The following conclusion can be drawn from our literature studies:

1. Shape of geogrids and its influence were studied and it gave rise to the idea of stitching the geogrids with 3 mm steel rods
2. Beam specimens consisting of various layers of geogrid were tested for flexural and it turns out as the layer of geogrids increases deflection decreases

3. Sulphate attack test proves to be promising in finding the durability of the specimens
4. Steel fibre up to 2.5% was used in the mix proportion. It proves to add additional strength and minimize crack propagation

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