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Manufacturing and Analysis of Gfrp Gratings

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Abstract: *Fiberglass reinforced plastic (FRP) grating is manufactured by combining a resin and fiberglass. That makes it a composite material. Fiberglass grating does not corrode like steel gratings. They are used in corrosive environments. Fiber glass grating is formed using continuous interwoven glass fibers as reinforcement material and epoxy resin as the matrix with continuous solidification through a mould system. The uniform construction provides excellent bi-directional mechanical properties. It is beneficial to all industries whether it be chemical, pharmaceutical, offshore or leisure to name just a few with many applications like platforms, floorings, walkways, trench covers, ramps and cable trough covers. Fiberglass grating is exceptionally slip resistant and the gritted and concave anti-slip grating offers excellent traction in wet and icy conditions. In this work, molded fiber glass gratings are manufactured. Modeling of FRP gratings done by using CATIA and analysis is done by using ANSYS software's and compared with steel and aluminium.*

Keywords: *Molded fiber glass gratings, glass fibers, CATIA, ANSYS.*

I. Introduction

A grating is any regularly spaced collection of essentially identical, parallel, elongated elements. Gratings usually consist of a single set of elongated elements, but can consist of two sets, in which case the second set is usually perpendicular to the first.Fiberglass grating is an integral construction single piece fiberglass roving reinforced with Isopthalic resin typically composed of 60-65% resin by weight and immensely strong continuous glass fibers manufactured by a specially designed process that provides a property of good mechanical and corrosion resistance.Fiberglas Reinforced Plastic (FRP) grating products are widely used in industries. FRP gratings are made up of a combination of a matrix of fiberglass and resin. This makes the gratings a composite material. These gratings are resistant to corrosion, unlike steel gratings. This is the most valuable feature of fiberglass gratings. They can be ideally used in harsh and corrosive environments. Maintenance costs are also lowered by the use of such gratings. FRP gratings offer enormous benefits.
Two of the manufacturing methods of gratings are discussed below:

- Moulded grating process.
- Pultrusion process.

1. Molded grating process.

The manufacture of molded grating is done by the placement of continuous glass fibers, in horizontal and vertical directions in the mould. These glass fibers are wetted with resin thoroughly, layer by layer. After the completion of the weaving process, the mould is subjected to heat, for curing the panel. After curing, the panel is removed from the mould. The top surface of the standard panel would be concave. Processes like post applied grit can be bonded afterwards in the form of a secondary operation. This continuous process leads to the formation of a one piece panel that has outstanding bi-directional strength and corrosion resistance.

2. Pultrusion process:

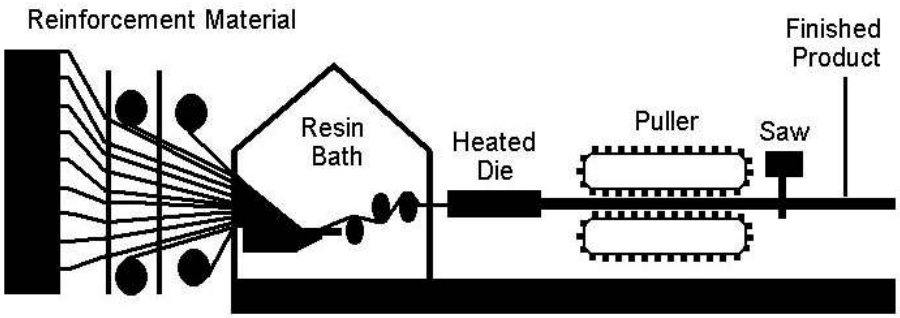


Fig shows schematic diagram of Pultrusion process

II. Literature Review

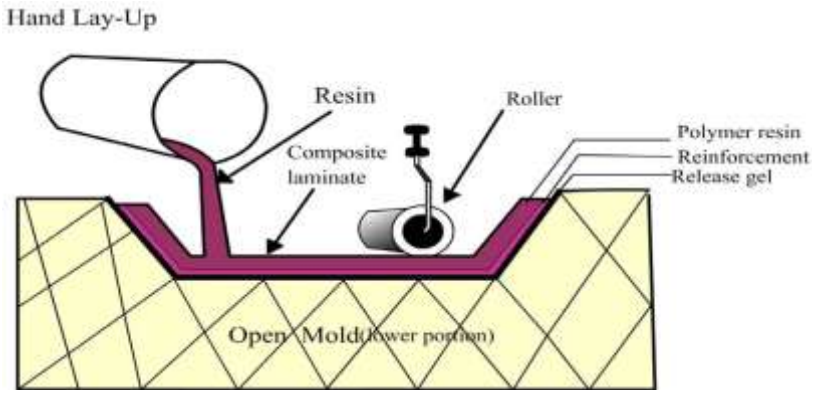
Experimental Test on GFRP Gratings for Mechanical Properties and Chemical Resistance by **B. Devender, A. Purushotham & O. Vasudeva Reddy.**This project explains Fiberglass reinforced plastic (FRP) grating is manufactured by combining a resin and fiberglass. That makes it a composite material. Fiberglass grating does not corrode like steel gratings. They are used in corrosive environments. Fiber glass grating is formed using continuous interwoven glass fibers as reinforcement material and resin as the matrix with continuous solidification through a mould system. The uniform construction provides excellent bi-directional mechanical properties. It is beneficial to all industries whether it be chemical, pharmaceutical, offshore or leisure to name just a few with many applications like platforms, floorings, walkways, trench covers, ramps and cable trough covers. Fiberglass grating is exceptionally slip resistant and the gritted and concave anti-slip grating offers excellent traction in wet and icy conditions. In this work, molded fiber glass gratings are manufactured and subjected to tensile test, chemical resistance, water absorption, flexural test, load bearing test.

Anexperimental investigation on the behavior of molded FRP gratings by **Allan c. Manalo, Lachlan Nicol, Ginghis Maranan, and Mark Jackson**.This project explains, the popularity of fiber reinforced polymer (FRP) grating is slowly gaining momentum as they offer numerous advantages over customary materials for use in platforms and walkways, particularly within harsh and corrosive environments. However, there are still no detailed guidelines relating to the design and use of FRP gratings, making this material at a disadvantage when considered against traditional construction materials. In this paper, an experimental investigation was conducted using full-size moulded FRP gratings to have an understanding on their behavior under three different loading conditions, i.e. line loading at mid span, and concentrated loading applied at mid span and near the support. It was found that the concentrated load regardless of the location of the load application is more critical than the line loading. The FRP gratings under line loading failed at an applied load of around 56kN while the gratings under the concentrated load failed at an applied load of only around 30 KN. The two concentrated loading cases showed very similar failure behavior on which the loading block sank into the grid and crushed the grid under the loading area. On the other hand, the failure of the FRP gratings under a line loading was a major flexural tensile cracking at mid span. From this study, a better understanding on the behavior of molded FRP gratings is gained for their widespread use and application in civil infrastructure particularly in platforms and walkways.

III. Manufacturing of Gfrp Gratings by Handlay Up Method

3.1 Hand layup method:

Hand layup is the simplest process in the low end composite products; require low investment, higher operating skill, and versatile shapes of product that need single high quality surface finish. This method is mainly suitable for thermosetting polymer based composites. Capital and infrastructural requirement is less as compared to other methods. Production rate is less and high volume fraction of reinforcement is difficult to achieve in the processed composites.



The following steps involved in Hand layup method:

- Preparing the mould.
- Applying the gel coat.
- Layup Skin coat.
- Laying fibreglass reinforcement.
- Trim.
- Cure.
- Remove part from mould.
- Finish.

3.2 Materials used for manufacturing of GFRP gratings:

a. Silica powder: 3kg
b. GP resin: 2kg
c. Glass fiber:430gms
d. Epoxy resin: 410gms

3.3 Manufacturing of GFRP gratings by hand layup method:

1. Preparing the mould:

Preparing of mould involves following steps.

- At first, prepare a sample rectangular block made up of wood.

Fig shows rectangular wooden block sample

Fig shows mould to make blocks

- Prepare mould to make the blocks by rectangular wooden block sample.
- Calculate the number of blocks required for 1½ft x 1ft grating.
- Make number of blocks required for preparing of gratings mould by using silica powder and GP resin.

Fig shows silica powder used for preparing of blocks

Fig shows GP resin used for preparing of blocks

Fig shows block made up of silica powder and GP resin

- Preparation of mould for gratings:

1. Base plate of 500x500x12cm made up of plywood is used.
2. Draw the shape the block on the base plate.
3. Place the blocks as per calculated.

Fig shows block made of silica powder and GP resin

Fig shows base plate of plywood

- Mould of grating is an open, heated mould that resembles a large waffle iron.

Fig shows mould prepared by using blocks

2. Applying gel coat:

Gel coat is applied on the surface of the mould of gratings to easy removal of the part after manufacturing of grating. Gel is applied on the surface of the mould before placing of glass fibre weaving.

3. fibre glass weaving:

Glass fibres are placed on the surface of the mould of gratings. The glass fibres are placed alternatively on the surface of the mould in the form of layers. The glass fibres are shown below.

4. applying of Epoxy resin:

Epoxy resin is placed in between of the layers of the fibre glass roving. The resin should be mixed with its hardener thoroughly before applying on the fibre glass roving. The resin is rolled on the layer of fibre glass roving in such a way that no air should be trapped in-between the roving and resin.

5. Curing:

After placing of all glass fibres layers and resin, the mould is subjected to curing. In this process, the mould is cured at room temperature.

6. Remove of part from mould:

After curing of gratings, the final product is removed from mould. Finally the final product is manufactured from Hand layup method.

IV. 3d Modelling of Gfrp Gratings

3d modeling of gratings is done by using CATIA software. CATIA software is one of the cad software used for modeling of components in present days. It is well known for Sheet metal forming and wireframe design.

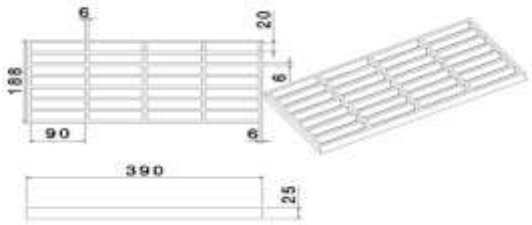


Fig shows Drafting of gratings

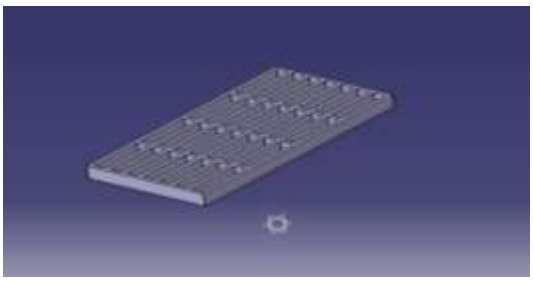


Fig shows isometric view of gratings

V. Structural Analysis of Gfrp Gratings for Eglass/Epoxy Material

Analysis will be done in Ansys 15.0.

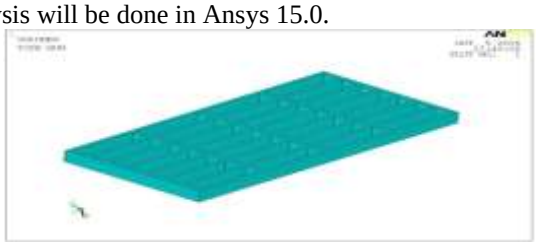


Fig shows infinite model of Gratings

Fig shows finite model of Gratings

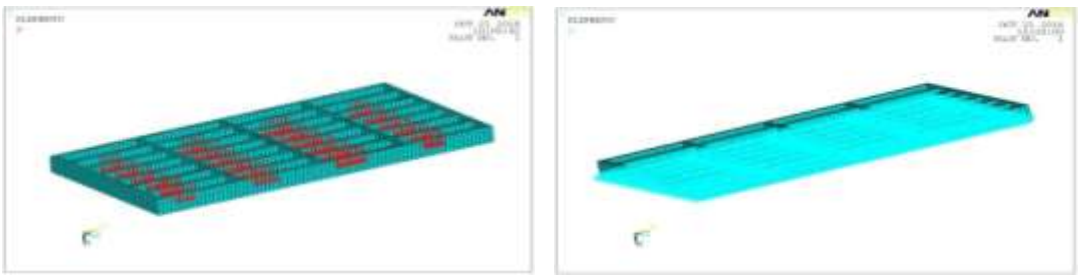


Fig shows boundary and load conditions on Gratings

5.1 Results of Gfrp Gratings:

5.1.1 At load 100 tonnes:

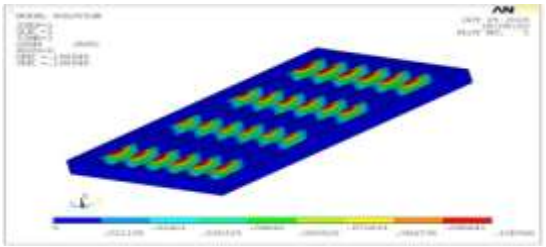


Fig shows Total displacement on the Gratings

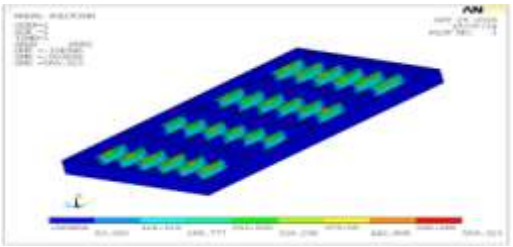


Fig shows Von misses stress observed on the Gratings

5.1.2 At load 150 tonnes:

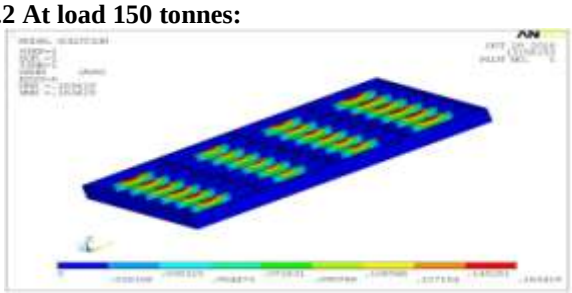


Fig shows total displacement on GFRP gratings

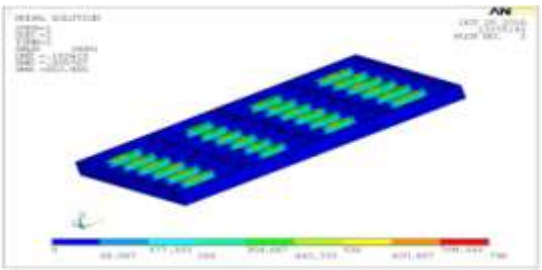


Fig shows von misses stresses on GFRP gratings

5.1.3 At loads 200 tonnes:

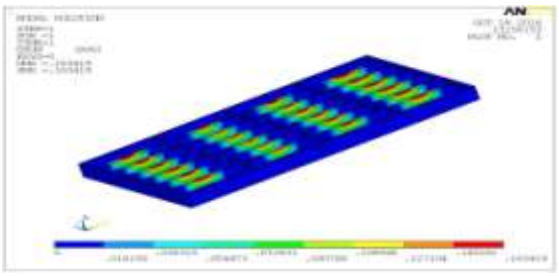


Fig shows total displacement on GFRP gratings

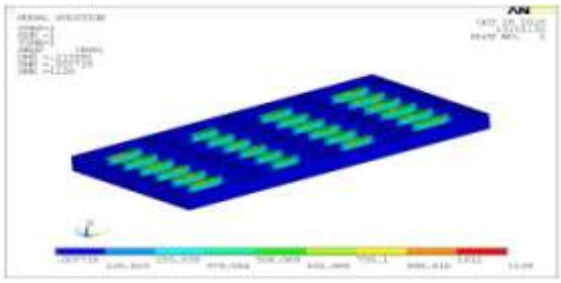


Fig shows von misses stresses on GFRP gratings

5.2 Results of Steel Gratings At 100 Tones:

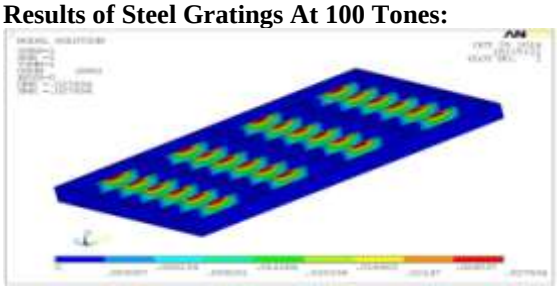


Fig shows total displacement on steel gratings

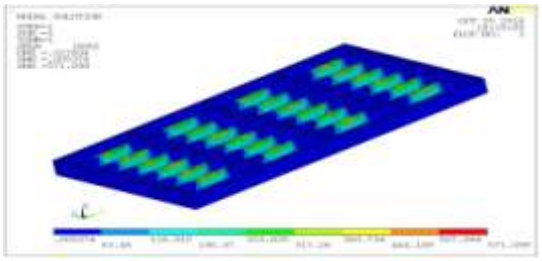


Fig shows von misses stressess on steel gratings

5.3 Results of Aluminium Gratings At 100 Tones Load:

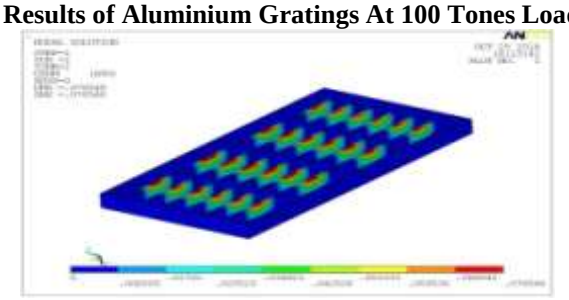


Fig shows total displacement on aluminium gratings

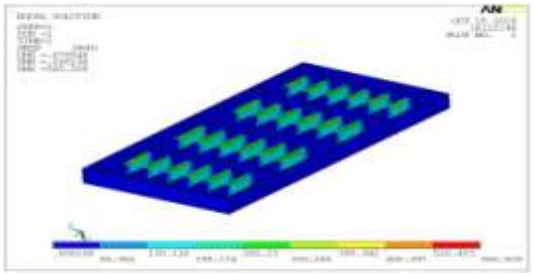


Fig shows von misses stresses on aluminium gratings

S.No	Material	Load	Displacement	Von Misses Stresses
1	Eglass/Epoxy	100	0.10	569.3
2	Eglass/Epoxy	150	0.16	798
3	Eglass/Epoxy	200	0.16	1139
4	Steel	100	0.02	571.0
5	Aluminium	100	0.07	585.5

VI. Conclusions

Glass fibre/Epoxy gratings were manufactured by Hand layup method. These Glass/Epoxy gratings were tested for Flexural stress and shear stress. Then, the 3d modelling of gratings was done by using CATIA software. Static stress analysis was carried on the gratings under maximum load conditions to determine the maximum deflections and stresses developed in each member of grating laminate. The simulation test is performed on gratings made up of three materials (i.e. aluminium, steel and Eglass/Epoxy). The following conclusions are made based on the experimental and simulation studies:

1. The Von misses stress developed in steel and aluminium gratings are greater than the Von misses stress of Eglass/epoxy grating under same load condition. So, GFRP gratings are more advantageous than steel and aluminium gratings.
2. The load carrying capacity of GFRP gratings is more as compared to steel and aluminium gratings.
3. The deformation of GFRP gratings is more as compared to steel and aluminium under same load conditions. GFRP gratings are more flexible than the steel and aluminium gratings.

Acknowldegements

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