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# Study of GFRG column strengthened with steel fiber

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**Abstract**

This paper presents the formulation of an alternate light weight mix to be used in the GFRG columns of M20 grade concrete by partial replacement of cement with phosphogypsum and thereby conducting experimental investigations to obtain the optimum combination. The GFRG column used in this study is of 230mmx120mmx800mm. The experiment is carried out for GFRG columns infilled with 1.5% of steel fibers and is compared to the column with steel rod. This paper presents a study of the axial behaviour of GFRG columns with steel fiber. The experimental study indicated that the columns with steel fiber increases ultimate axial load compared to the column with steel rod.

**Keywords:** GFRG column, Hooked end Steel fiber, Ultimate load, Axial behaviour.

## Introduction

Glass fiber reinforced gypsum (GFRG) panel is a green product .They are made with modified gypsum plaster and reinforced with cut glass fibers. Although its main application is in the construction of walls, it can also be used in floor and roof slabs in combination with the reinforced concrete. The panels contain cavities that maybe filled with concrete and reinforced with steel bars to impart additional strength and provide ductility. Phosphogypsum is a by-product of fertilizer industries, requiring large disposal areas. The effective disposal of phosphogypsum is done by the manufacture of Glass Fiber Reinforced Gypsum (GFRG) panel. In this study phosphogysum was used in partial replacement of cement. Steel fiber reinforced concrete (SFRC), a relatively new engineering material, can be used to enhance the fatigue strength of reinforced concrete. Steel fiber reinforced concrete has been developed through extensive research for over half a century. The use of steel fiber reinforced concrete can improve the strength and ductility of columns by delaying cover spalling and improving core confinement. The addition of fibers to concrete improves post cracking resistance leading to enhanced strain capacity, toughness, and damage tolerance. The use of steel fibers has advantages over transverse reinforcement, namely less labour cost and shorter construction time, because steel fibers can be added automatically during the mixing process. Hooked fibers perform better than straight and crimped steel fibers. The mechanical properties of steel fiber reinforced concrete are influenced by the type of fiber, aspect ratio, amount of fiber, strength of matrix, size, shape and method of specimen preparation and size of aggregate.

## Methodology

In the present research, GFRG columns of size 230mmx120mmx800mm with steel rod and GFRG column with 1.5% of hooked end steel fiber of concrete were casted using M20 mix. The specifications of these fibers are presented in Table 1 and steel fibers are shown in Fig 1. Test setup has shown in Fig.2. Columns were casted with design mix ratio of 1:2.39:2.55 with w/c ratio 0.5. Phosphogysum was used in partial replacement of cement and optimum percentage obtained is 10. The experiment is carried out for GFRG columns infilled with 1.5% of steel fibers and is compared to the

column with steel rod. The columns were then tested after 28 days water curing. Prepared specimen after casting is shown in Fig 3.

Table 1 : Physical Properties of Steel Fiber

| Sl No. | Properties | Magnitude |
|---|---|---|
| 1 | Diameter | 0.6mm |
| 2 | Length | 30mm |
| 3 | Aspect ratio | 50 |
| 4 | Tensile strength | 1000MPa |

Fig. 1: Steel fiber

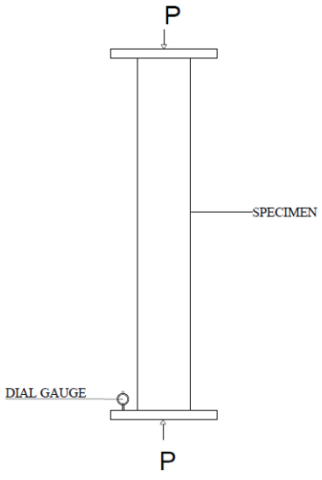


Fig. 2: Schematic Setup for Testing

Fig. 3: Specimen after casting

**Results**

The failure modes of GFRG columns with steel rod and columns with steel fiber are shown in fig 4 and fig 5 respectively.

Fig. 4: Failure of column with steel rod

Fig.5: Failure of column with 1.5% SF

The failure modes were found to be crippling for both the columns. It was also observed that initiation of steel fiber increases the load carrying capacity and decreases the deformation.

**Discussion**

The ultimate loading carrying capacity of GFRG column with steel rod was obtained as 424 kN. The ultimate load

carrying capacity of columns with steel fiber was obtained as 463 kN, which is higher than that of column with steel rod.

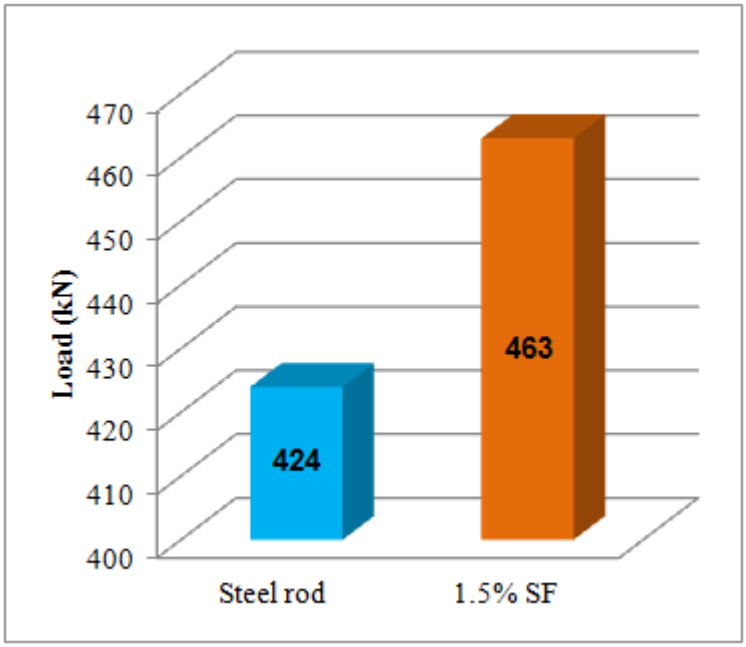


Fig. 6 : Ultimate Load Carrying Capacity

**Conclusions**

The research work included the testing of GFRG columns with steel rod and column with steel fiber. Based on research, the following conclusions may be drawn.

a) The optimum percentage of phosphogypsum was found to be 10%.
b) M20 mix with optimum percentage of phosphogypsum was found to be 3.2% stronger than control mix in terms of compressive strength.
c) Columns with 1.5 % of SF shows an increase of 10% in ultimate load carrying capacity when compared with ultimate load carrying capacity steel rod columns.
d) GFRG columns with steel rod shows a deflection of 10.8mm and the columns with 1.5 % of SF shows a deflection of 7.2 mm. This means that deflection was reduced due to the use of steel fiber.

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