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Glass Fiber Reinforced Concrete

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Abstract: *The article highlights that glass fiber reinforced concretes (GFRC) can meet the requirements of Smart City better than ordinary concretes. The comprehensive discussion on GFRC composition is presented together with the review of glass fibers' influence on various concrete properties. First of all, because of their bridging abilities, they can limit the width, length, and total area of cracks. Additionally, GFRC are characterized by enhanced tensile, flexural, and splitting strength; impact, abrasion, spalling, fire, and freeze-thaw resistance as well as ductility, toughness, and permeability. All of this positively influences the mechanical behavior, durability, and corrosion resistance of concrete elements. Moreover, decreased thermal conductivity allows for better energy performance from the building's point of view. This results in cheaper structures both in manufacturing and maintaining even though GFRC are more expensive materials. However, mechanical properties enhance as long as sufficient workability and uniform fiber distribution are assured. From the environmental point of view, GFRC are eco-friendlier materials than ordinary concretes since their application can decrease the emission of CO_2 by 17%. The article also describes the GFRC application fields and emphasizes the possibility of the creation of not only structural elements mainly intended for load transferring but also elements accompanying the building process, as well as elements of small architecture that make public spaces more attractive, durable, and safer. Owing to greater design and shaping freedom, GFRC can also better fulfill the needs of habitants of Smart City.*

Keywords: glass fiber reinforced concretes

I. INTRODUCTION

Concrete is the most widely used construction material . In the last fifty five years, there has been significant progress in concrete technology, mainly owing to the revival of the interest in supplementary cementing materials, as well because of the origin of new generation chemical additives for concrete. The concrete without any fiber will develop the cracks due to plastic shrinkage, drying shrinkage and other reasons of changes in volume of concrete.

II. LITERATURE REVIEW

PROF. S. S. PIMPLIKAR

In this paper entitled on "Glass fiber reinforced concrete used in construction "(2011)- GRC is a material made of a cementitious matrix composed of cement, sand, water and admixture, in which short length glass fiber are dispersed. It has been widely used in the construction industry for non – structural elements, like façade panels, piping and channels. GRC offers many advantages, such as being light weight, fire resistance, good appearance and strength. In this study trial test for concrete with glass fiber and without glass fiber are conducted to indicate the differences in compressive strength and flexural strength by using cubes of varying sizes. Varies application of GFRC shown in the study, the experimental test results, techno-economic comparison with other types, as well as the financial calculation presented, indicate the tremendous potential of GFRC as an alternative construction material.

PROF. RAM MEGHE

In this paper entitled on "Glass fiber reinforced concrete & its properties (2013) –GFRC is a recent introduction in the field of civil engineering. So, it has been extensively used in many countries since its introduction in the field two

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decades ago. This product has advantage of being light weight and thereby reducing overall cost of construction, ultimately bringing economy in construction. Steel reinforcement corrosion and structural deterioration in reinforce concrete structures are common and prompted many researchers to seek alternative materials rehabilitation techniques. So, researchers all over the world are attempting to develop high performance concrete using glass fibers and other admixtures in the concrete up to certain extent. In the view of global sustainable scenario, it is imperative that fibers like glass, carbon, aramid and poly-propylene provide very wide improvements in tensile strength, fatigue characteristics, durability, shrinkage characteristics, impact cavitation's, erosion resistance and serviceability of concrete. The present work is only an accumulation of information about GFRC and the research work is already carried out by other researchers.

PROF. M.B. KUMTHEKAR

In this paper entitled on "Strengthening of RCC Cubes and Cylinders-using Different Glass Fiber"(2013)- Worldwide, a great deal of research is currently being conducted concerning the use of fibers reinforced polymer wraps laminates and sheets in the repair and strengthening of reinforced concrete members. Fiber-reinforced polymer application is a very effective way to repair and strengthen structure that has become structurally weak over their life span. FRC repair systems provide an economically

III. AIM OF WORK

- To determine tensile strength of GFRC
- To determine compressive strength of GFRC.
- To determine flexural strength of GFRC.
- To compare strength of GFRC at different percentage of glass fiber
- To determine workability of GFR

Properties of GFRC

- High tensile strength (1700N/mm?).
- Impact Resistance.
- Water resistant.
- Low thermal expansion.
- Less creep with increase with time.
- Light weight
- Resistance to cracks in concrete.
- Resistance to corrosion.
- Improve homogeneity of fresh concrete.
- Improve durability of structur

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Methodology Flowchart:

Performance requirements
↓
Select material
↓
Mix proportions
↓
Workability testing
↓
Casting placement
↓
Curing process
↓
Testing

IV. MATERIAL USED

4.1 Ordinary Portland cement*:*

In this experimental work, Ordinary Portland Cement (OPC) 53 grade conforming to IS: 8112-1989 was used. The cement used was ACC cement from the local distributors. The physical properties of tested cement are given in Table

4.2 CEMENT

Cement is the main component of concrete. The grade of the cement, the form of the cement, the colour, the fineness of the cement, the heat of hydration, and the alkali content of the cement are all important factors to consider when selecting a cement. Ordinary Portland cement, available in grades 33, 43, and 53, is the most commonly used type of cement. The grade results indicate the compressive strength of the cement.

The cement should be very cool and clear of lumps. The cement should be greenish grey in colour and set in a dry location. The cement has a specific gravity of 3.15.

4.3 FINE AGGREGATE

River sand was used as fine aggregate. According to IS: 383-1970 specification sand used confirmed to grading zone -11. Sieve analysis of fine aggregates

4.4 COARSE AGGREGATE

The crushed stone aggregate by local quarry purchased from the supplier. The coarse aggregates used in the experimentation were 20 mm and down size aggregate and tested as per IS: 383-1970 and 2386 – 1963(I, II and III) specifications. Sieve analysis of coarse aggregate

4.5 WATER

Water is the most important aspect of aggregate. And the quality of the concrete is affected by the temperature of the water. Salts and other highly harmful compounds should be removed from the water. Efflorescence occurs in reinforced concrete due to the presence of salt in water. Portable water is used for concrete construction. The strength of the concrete is determined by its water content. A higher water content in the concrete increases its power, whereas a lower water content increases its workability.

4.6 Glass Fiber Reinforced Concrete (GFRC)is a composite material made of Portland cement, fine aggregates, water, chemical admixtures, and alkali-resistant glass fibers. It is used to produce thin, lightweight, and strong concrete products that have high tensile strength and improved durability compared to conventional concrete

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V. RESULT AND DISCUSSION

Compressive strength

In fresh state, concrete is first tested for slump and compaction factor and the results for various samples has been displayed. It was observed that sample of M25 grade concrete with replacement of glass fibers have shown good slump values and compaction factor. The overall results of workability of Glass Fiber Reinforced Concrete with different percentage of Fibers is tabulated bellow

Split Tensile strength

The split tensile strength of GFRC increases with increasing percentage of glass fibers. The percentage increase in tensile strength is maximum at 0.1% of glass fiber for 7 days, 14 days and 28 days curing of GFRC. The percentage increase in tensile strength of M25 7 days GFRC is 26.03%, M25 14 days GFRC is 26.33% and M25 28 days GFRC is 12.09%. For evaluating the split tensile strength, cylindrical specimens of diameter 150mm and length 300mm have to be prepared. Split tensile strength test

FLEXURAL STRENGTH

The flexural strength of GFRC increases with increasing percentage of glass fibers. The percentage increase in flexural strength is maximum at 0.1% of glass fiber for 7 days,14 days and 28 days curing of GFRC. The percentage increase in flexural strength of M25 7 days GFRC is 9.98%, M25 14 days GFRC is 13.94% and M25 28 days GFRC is 20.68%. For evaluating the flexural strength, beam of size 500×100×100mm have to be prepared. Flexural strength test have to be carried out on 3000kN capacity compression testing machine IS 516-1959

SLUMP CONE TEST

In fresh state, concrete is first tested for slump and compaction factor and the results for various samples has been displayed. It was observed that sample of M25 grade concrete with replacement of glass fibers have shown good slump values and compaction factor. The overall results of workability of Glass Fiber Reinforced Concrete with different percentage of Fibers

VI. CONCLUSION

As this composite increases tensile strength it may reduce the area of steel reinforcement required, minimizing the deterioration in marine environment's and hydraulic structures, if any, due to corrosion of steel reinforcements.

There is 20.22% increase in the compressive strength, when 0.1% GFC compared with control mix.

There is 12.09% increase in the split tensile strength, when 0.1% GFC compared with control mix.

There is 31.32% increase in the flexural strength, when 0.1% GFC compared with control mix

In conclusion, Glass Fiber Reinforced Concrete (GFRC) is a highly versatile and durable material that offers numerous advantages in modern construction.

It combines the strength and flexibility of glass fibers with the inherent properties of concrete, leading to a composite material that is lighter, stronger, and more resistant to cracking than traditional concrete.

The use of GFRC enhances the aesthetic appeal of structures due to its ability to be molded into intricate shapes and textures, making it ideal for architectural applications such as facades, cladding, and decorative features.

Additionally, GFRC provides excellent resistance to environmental factors such as corrosion, weathering, and impact, increasing the longevity of structures. Its lightweight nature also makes it easier to handle, reducing transportation and installation costs.

However, while the initial cost of production may be higher compared to conventional concrete, the long-term benefits in terms of durability, maintenance, and performance often justify the investment.

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