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An Experimental Study on Increasing Strength, and Durability of Concrete by Using Fiber Reinforced Polymer Composites Such as Steel Fiber Elements, Glass Fiber Elements and Textile Reinforcement

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***Abstract*: Concrete elements are one of the most significant integral parts of any embedded construction work. As the constituents for preparation of concrete, is usually easily available, along with the economically beneficial aspect, concrete has been extensively in use for years now. Over time, the advanced construction has developed a tendency of working on escalating the strength, durability of concrete to fulfill the stipulation of contemporary structural requirements. Adding fibers to concrete results in assorted properties to the concrete, significantly contrasting from conventional concrete, depending upon the 'volume of fraction' of fibers added to it and its variety or orientation. The main motive of this study is to analyze the outcome of adding fibers (Glass fibers, textile fibers, and Steel fuse elements) to the concrete and collate the strength, durability factors respectively due to the experimental addition.**

***Keywords*: Fiber reinforced concrete, steel fiber, glass fiber elements, textile reinforced concrete, strength and durability studies, advantage of using fiber reinforced concrete, outcome of adding fibers to concrete.**

1. Introduction

Concrete is the one of the most extensively used substances usually prepared by using easily available ingredients. With time, correspond to the development in the construction industry, the requirement for the concrete to increase it's strength, durability has also increased along with the economic benefits.

To enhance the quality and performance of concrete, experiments of adding various components in the preparation has been done such as; Fly Ash, Glass fiber, Coconut fiber etc.

Adding up admixtures to concrete is mainly to acquire more setting, hardening, as well as escalating the rate of hydration of cement. The major fiber elements which are commonly in use are glass, textile, wood, steel etc.

The main motive of this paper is to run comparative tests on fiber reinforced concrete as well concrete without fiber elements in it, in terms of their respective strength, durability and present it as a report on different advantageous mechanical property enhancement due to the experimental addition of fibers in concrete compared to the conventional option.

2. Advantages of Fiber Reinforced Concrete

- Concrete when mixed with suitable fibers, may contribute in the increment of Strength, toughness and ductility.
- Fiber reinforced concrete is said to offer more tensile strength than the conventional one.
- Fiber added concrete enhances the durability as well as provides improved resistance against freezing and thawing.
- Fortifying concrete with fibers increases the fatigue strength.
- Adding admixtures to concrete helps in achieving more setting, hardening, and advancing the rate of hydration of cement.

John-Han Lee, Baiksoon-Choo and Ensoo Choi have presented their work on experiment-based study of examination on of the impact of strength and flexural capacity of fiber reinforced concrete. The volume fractions of 0.25, 0.375 and 0.5% were designed along with concrete of compressive strength 25, 35 and 45 MPa for the examination. The stress strain relationship along with the deflection property were evaluated as well as the first peak and post cracking strength and energy absorption capacity correspond to the variance factor in the fiber volume fraction and concrete strength. The result concluded equivalent flexural strength ratio, evaluated from the first peak strength and energy absorption capacity and their increment with the increase in fiber volume fraction and decreases with the increment in concrete strength. The impact of concrete strength and fiber content ratio were evaluated on a reinforced concrete floor slab. The ultimate flexural capacity requirement also demands a consideration of the influence of

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the content ratio of steel fiber as well as the strength of cement composite matrix.

Steel Reinforced Concrete:

Steel elements are known to resist rupture more effectively than concrete, thus using steel elements in the preparation of concrete may enhance the strengthening quality significantly greater than the conventional one.

Fig. 1. Steel reinforcement

Shireesha et. al, has worked on Experimental evaluation on the basis of using steel fiber reinforced concrete. M40 grade was taken and steel fiber of ratio 80 was added to it. It showed that the compressive strength increment was from 821% and 6-12% for 7and 28 days, Split tensile strength increment from 14-36% and 15-39% for 7 and 28 days.

Bhawukverma et. al, has worked on usage of steel fiber reinforced concrete over conventional concrete for using in underground tunneling. His research work focused on the fact that in case of underground tunnel work demands very strong support system which can be satisfied by using steel fiber reinforced concrete. Adding steel fibers in concrete can provide comparatively greater strength when compared to conventional concrete.

Soulioti et. al, has studied the impacts of Fiber Geometry and Volume Fraction on the Flexural Behavior of Steel-Fiber Reinforced Concrete. The flexural strength and compressive strength were calculated and collated with conventional concrete. The impact of fiber on mechanical properties of concrete was also estimated.

Raghunath and K. Suguna has worked on the potency of steel fiber concrete to increase the flexural capacity of HSC. Four beams of length 3m and cross-sectional area of 150mm* 250 mm were taken for the test. Three distinguished values of volume fraction were considered, i.e., 0.5%, 1% and 1.5%. Loading frame of 250 KN capacities was taken for the test. The result shows that SRFC can display an increased value of strength, ductility and toughness to resist failure.

Vikrant S. Valragade and kavita S. Kene has worked on effect of using steel fiber reinforcement in concrete in terms of performance of concrete. Steel fiber reinforced concrete usually utilized in long lasting sustainable concrete structures. This study presents a review of using new type of concrete and their beneficial aspect compared to the conventional concrete.

Textile Reinforced Concrete:

The system of adding textile materials in concrete can enhance the mechanical behavior of concrete. Textile reinforced concretes are not that heavy-weighted hence may lessen up the difficulty in transportation. Textile reinforced concrete can provide better corrosion resistance compared to the conventional one.

Fig. 2. Textile reinforcement

Michael Raupach and Cynthia Morales Cruz has worked with textile reinforced concrete and its various usages i.e, repairing of existing structures, in light weight pedestrian bridges or in self supported construction work. It may also get used in increasing the strength of structures repairing work in sewage plants, heating units with carbon reinforcement and furniture production. The advantageous part of textile reinforced concrete having high tensile strength and non-corrosive nature along with being light weight reduces cost for pre fabrication as well as also helps with resources conservation. TRC also environment friendly as it produces less

amount of CO2. If cracking occurs, the distribution is comparatively thinner which allows it to create durable and water resistant surface suitable for the repairing work. This study concludes the advantageous and challenging factors of working with TRC focusing on advanced construction industry and its prospect. Few case studies of new buildings made with TRC, repairing work of building structures were included as reference.

Van Doan Truong and Dong Jo Kim, have presented a review paper on understanding tensile behavior and test procedures of textile reinforced composites. The parameters of tensile strength with respect to tensile stress strain nature and the influence factors were discussed. Method of performing tensile tests on TRCC were evaluated as well as loading mechanics and load transmission mechanism along with measurement and geometry of test specimens. Mainly Bi-linear or Tri-linear tensile stress-strain behaviors were focused on. The requirement for standard test method to study tensile stress strain behavior for TRCC was suggested.

Glass Reinforced Concrete:

Glass element has high alkali resistibility, therefore adding glass fibers to concrete may enhance the long-term durability of concrete. Over 30 years glass has been used in constructional elements, preferably in paneling work, piping work, embellished form work, exterior building façade. Glass reinforced concretes are also economical as the installation part is quick and cost effective.

Fig. 3. Glass reinforcement

İskender, Muhammet & Karasu, Bekir. have worked on Glass Fiber Reinforced Concrete (GFRC) and the economic benefits of using it, instead of plain concrete. In the 1940's, potential of glass as a construction material was realized and zirconium dioxide started getting mixed in 1960's for harsh alkali conditions. To increase durability of components, new generation of glass fibers were introduced to the up-gradation process. Scientific studies and tests on the GFRC have shown the conclusion that the physical and mechanical properties of the GFRC change depending on the quality of the materials and the accuracy of the production methods. As technology advances, it can be expected to build structural units using GFRC in low-cost budget.

E. Arunakanthi and J. D. Chaitanya Kumar has worked on the effect of adding glass fibers and steel fibers in the concrete. Reduction of the loss of the causalities because of fire related mishaps has also been focused on. FRC was added by 1%, 2%, and 3% respectively to M20 graded concrete. The percentage wise increment in compressive strength, split tensile strength and flexural strength for the test specimens for the duration of 28 days has been observed.

Dinesh Kumar and V. S. Sethuraman has done research work on uses of glass fiber concrete with structural element such as, cube cylinder and beam. To determine the strength and durability, M20 grade of concrete was taken and GFRC was added to it to evaluate the characteristics of the new concrete and its strength and durable properties. GRFC variation was noticed to be in the range of 0-1% by mass of the concrete.

Prasad Bishetti, Ameersohel, Basavannevva N, Suhas M, Veergangadhar A., has started working on GFRC and its various usages in non-structural elements such as façade panel work, pipeline work and channeling etc. the research work focuses on various benefits that GFRC has to offer, i.e, reduction of dead load, resistance against fire, better tensile strength and being light in weight etc. comparative tests have been done on conventional concrete and concrete with glass fiber to state the difference between both in terms of compressive strength, flexural strength and split tensile strength by taking various cube, beams and cylindrical elements.

3. Conclusion

Using fibers in concrete can have various future prospects including economic benefits, enhancing mechanical properties and transportation management. Apart from that it may also show a new direction in replacing conventional elements with different components which may not only enhance the required advancement in structural element but can also contribute to the environmental factor.

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