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“Review Work of Experimental Study on Using Fiber Reinforced Concrete”

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I. RELEVANCE OF TOPIC :

To the use of steel fiber reinforcements to improve the performance of reinforced concrete (RC) members in shear and tension has been extensively researched. Many studies have demonstrated that the inclusion of steel fiber reinforcements in concrete significantly enhances the tensile, flexural and shear capacity improves the ductile and post-cracking behavior and increases the energy absorption properties. The various investigations conducted in reported that the inclusion of fiber reinforcements in reinforced concrete beams significantly improves the shear capacity. The presence of steel fiber reinforcement in concrete enhances shear resistance by resisting and redistributing inclined tensile stresses along the diagonal cracks, improves post cracking resistance capacity and reduces the diagonal crack width and spacing. The reduction in the crack spacing suggests that the inclusion of steel fibers could result in a possible reduction or elimination of the size effect in beams without stirrups, where shear capacity decreases with increasing beam effective depth.

The use of steel fibers to improve the properties of concrete has been a topic of many studies. Recent studies indicate that the addition of steel fibers greatly increases the resistance of concrete to crack propagation.Fiber reinforced concrete can be regarded as an improved type of concrete with higher tensile strength and post-cracking ductility. Both of these characteristics favorably influence the behavior of fiber concrete beams under combined loadings. One such combination of loadings is axial compression, bending, and torsion.

The stirrups are used as transverse reinforcement in regular RC beams to prevent premature shear failure, which is sudden, brittle, and may lead to catastrophic consequences. In the case of premature failure, the beam fails before reaching its full flexural strength. Thus the traditional beams are reinforced with steel stirrups. The labor cost for reinforcement installation makes the use of stirrups expensive.Moreover the closely spaced stirrups could be difficult for concrete casting, which might lead to voids inthe concrete and poor bond between the reinforcement and concrete. Therefore, steel fibers can be an alternative solution to steel stirrups in RC beams. The orientation of steel fibers is random in concrete, which offers more shear resistance and improves ductility. It is already recognized that steel fibers significantly improve post-cracking tensile resistance and toughness in concrete. Moreover, steel fibers also help to delay the widening of microcracks which eventually reduce crack width due to service loadings. Besides these advantages, steel fibers also improve concrete compressive strength, crack resistance, performance under dynamic loadings, elastic modulus, durability, fatigue life, resistance to impact and abrasion, resistance to freezing-and-thawing cycles, shrinkage, expansion, thermal behavior, erosion, and fire resistance. The use of steel fibers helps improve the post-cracking behavior, which enhances the ductility in the concrete matrix. The bond failure at the fiber interfaces requires successive pull-out of the fibers, which needs a large amount of energy.

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II. LITERATURE REVIEW:

The following researchers have carried out the study related to the dissertation topic.

Oladimeji B. Olalusi and Panagiotis Spyridis (2020)

Shear failure is a brittle and undesirable mode of failure in reinforced concrete structures. Many of the existing shear design equations for steel fiber reinforced concrete (SFRC) beams include significant uncertainty due to the failure in accurately predicting the true shear capacity. Given these, adequate quantification and description of model uncertainties considering the systematic variation in the model prediction and measured shear capacity is crucial for reliability-based investigation. Reliability analysis must account for model uncertainties in order to predict the probability of failure under prescribed limit states. This study focuses on the quantification and description of model uncertainty related to the current shear resistance predictive models for SFRC beams without shear reinforcement.

Muyasser M. Jomaa'h, Saad R. Ahmed, Baraa T. Kamel Ibraheem J. Karim (2020) Based on the present study, it is concluded that the fabrication of a slender reinforced concrete beams with different shape and sizes of the opening is a complex problem. This requires anintensive study to figure out the suitable design and ingredients to obtain a high shear strength RCBs to overcome lack of such high strength composite with openings. The most substantial conclusions of the implemented study can be summarized as follows. The fabricated RCBsshow a significant improvement regarding load-deflection behavior compared to the most recent works; The openings cause a reduction in load capacity approaches 32% as an average for the examined samples of RCB.

Chris G. Karayannis, Parthena-Maria K. Kosmidou and Constantin E. Chalioris (2018)

Innovative reinforcement as fiber-reinforced polymer (FRP) bars has been proposed as alternative for the substitution of the traditional steel bars in reinforced concrete (RC) structures. Although the advantages of this polymer reinforcement have long been recognised, the predominantly elastic response, the reduced bond capacity under repeated load and the low ductility of RC members with FRP bars restricted its wide application in construction so far. In this work, the behavior of seven slender concrete beams reinforced with carbon-FRP barsunder increasing static loading is experimentally investigated. Load capacities, deflections, pre- cracking and after-cracking stiffness, sudden local drops of strength, failure modes, and cracking propagation have been presented and commented. Special attention has been given in the bond conditions of the anchorage lengths of the tensile carbon-FRP bars. The application oflocal confinement conditions along the anchorage lengths of the carbon-FRP bars in some specimens seems to influence their cracking behavior. Nevertheless, more research is required in this direction**.**

Guray Arslan, Riza Secer Orkun Keskin, Semih Ulusoy (2017)

The use of steel fibers in reinforced concrete (RC) structural members aims at the improvement of mechanical properties of such members. This study focuses on shear strength characteristics of steel fiber reinforced concrete (SFRC) beams without stirrups. Test specimens consisting of three RC and ten SFRC beams without stirrups have been tested under three-point loading in order to investigate the effects of fiber content and shear span-to- -effective depth ratio on the shear strength. Furthermore, an equation developed previously for predicting the ultimate shear strength of SFRC beams without stirrups is proposed to predict the diagonal cracking strength of SFRC beams without stirrups.

Xiliang Ninga, Yining Dinga, Fasheng Zhangb, Yulin Zhangc

Seven full-scale steel fiber reinforced self-consolidating concrete (SFRSCC) beams were tested to study the effects of macro steel fibers on the flexural behaviors of reinforced self-consolidating concrete beams. The major test variables are fiber contents and longitudinal reinforcement ratios. The ultimate load, midspan deflections, steel reinforcement strains, crack width and crack spacing were investigated. The enhanced ultimate flexural capacity and reduced midspan deflection due to the addition of steel fibers were observed. With the increasing of fiber contents, the strain in longitudinal reinforcement, crack width and crack spacing decreased significantly. The possibility of using steel fibers for partial replacement of the conventional longitudinal reinforcement is estimated, which is meaningful for extending the structural application of SFRSCC. A method incorporating fiber contribution to the post-cracking tensile strength of concrete in the flexural analysis of SFRSCC beam is also suggested. Comparisons are made between the suggested model and the fib Model Code 2010 model with experimental data. The results showed that the suggested model can estimate ultimate flexural capacity accurately.

Guray Arslan(2013)

In the last four decades, many equations have been proposed to estimate the shear strength of Steel Fiber Reinforced Concrete (SFRC) beams. However, in terms of accuracy and uniformity of the prediction, there is considerable diversity between existing test results and researchers' predictions. In this study, by using the basic principle of mechanics and considering the slenderness effect of SFRC beams without stirrups, a new design expression is proposed for the shear strength of SFRC beams. The proposed equation and researchers' predictions are compared to the test results of 170 SFRC beams without stirrups. It is found that the proposed equation shows good agreement with regard to the existing test results.

Karen E. Caballero-Morrison, J.L. Bonet , Juan Navarro-Gregori, Pedro Serna-Ros(2012) Structural engineers usually limit the use of HSC columns to seismic active zones because of their brittle behavior in comparison with NSC, even though it presents advantages both in terms of mechanics and durability. A possible solution to improve the ductile behavior of HSC columns is the use of transverse reinforcement and steel fibers simultaneously. In addition, the use of HSC makes the design of more slender columns possible, with the consequent increase of second-order effects. However, there are few experimental tests on columns of medium slenderness (between 5 and 10) subjected to cyclic loads including or excluding steel fibers. This article presents experimental research work on the behavior of slender columns subjected to combined constant compression and cyclic lateral loads. Fifteen tests were carried out in order to study the behavior of such elements. The following variables were studied: concrete strength, slenderness, axial load level, transverse reinforcement ratio, and volumetric steel-fiber ratio. The maximum load and deformation capacity of the columns were analyzed. The fact that the inclusion of steel fibers into the concrete mixture increases the deformation capacity was verified. Moreover, a minimum transverse reinforcement is required in order to improve the effectiveness of the steel fibers with no significant decrease in the carrying capacity under cyclic loading. The inclusion of steel fibers in HSC can ensure similar ductility values to those of NSC. It was shown that slenderness influences the deformation capacity.

Narawit Hemstapat, Kazumasa Okubo and Junichiro Niwa

The objective of this research is to propose a simple and accurate prediction method for the shear capacity of reinforced concrete beams with steel fiber (RSF beams). Steel fiber reinforced concrete (SFRC) is being widely used nowadays, with the steel fibers added to the concrete to improve the tensile resistance. First, this research aims to investigate the material properties of SFRC in various concrete compressive strengths, shapes of steel fiber and volume fractions of steel fiber. In order to evaluate the shear capacity, several material properties, such as tension softening curves and fracture energy were investigated in the material tests. Second, four-point bending tests of RSF beams were conducted in order to investigate the shear capacity and diagonal crack pattern. Eight RSF beams with various concrete compressive strengths, volume fractions of steel fiber and stirrup ratios were fabricated and tested. The results revealed that the concrete compressive strength and steel fiber significantly affect the shear capacity of RSF beams.

Samer Sabry F, Mehanny Gendy, Ashraf Ayoub

In this paper, two fibre-based beam elements with enhanced capabilities to consider large displacements and rotations of slender reinforced concrete members are developed. Fibre beam elements were comprehensively used before to model the behaviour of different structural systems with great accuracy. To upsurge the use of the fibre beam elements in modelling complex reinforced concrete (RC) systems such as slender walls and columns, the elements are improved by including the second order effect. Available research from the literature related to large displacements focused mainly on modelling steel and composite members due to the limitations in their material model behaviour. Conversely, the newly developed elements introduced in this paper can precisely model RC members by accounting for their more complex nonlinear material behaviour under reversed cyclic loads. The first element is formulated using a displacement formulation, while the second element is basedon a mixed approach that is computationally more complicated but numerically more efficient. Further, the adopted concrete constitutive law accounts for the effect of compression post-peak softening as well as tension stiffening and degradation under cyclic loads. Several correlation studies are presented to highlight the efficiency of the new elements in modelling slender RC structures.

Xiangguo Wuab , Thomas HK Kangc , Yang Lin , Hyeon-Jong Hwangd

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As a structural and constructional element, a thin-walled U-shaped precast permanent form consisting of High Performance Fiber-Reinforced Cementitious Composites (HPFRCC) and steel wire mesh is considered. Prior to casting, transverse steel threaded bars are installed, as well as longitudinal reinforcing bars, connecting two sides of the U-shaped form for shear transfer between the precast and in-filled concrete sections and for fresh concrete pressure resistance. The present study investigated the effect of precast U-shaped HPFRCC section on the shear strength of the composite beams. As parameters for full-scale three-point bending tests, the type or materials of precast section, spacing of shear reinforcement, and shear span- to-depth ratio were considered. The test results showed that the precast U-shaped HPFRCC permanent form increased the shear contributions of in-filled concrete and shear reinforcement in the composite beam substantially. From the experimental and analytical assessment, the coefficients related to the composite action between precast HPFRCC and in- filled concrete sections, shear reinforcement along diagonal cracks, and shear span-to-depth ratio were proposed, which were applied to a previous shear strength model for the simplified shear design of proposed precast U-shaped HPFRCC-in filled concrete composite beams.

MATERIALS :

The materials used are cement, coarse aggregate sand as fine aggregate, water and steel fibres

• Cement: Ordinary Portland cement of 53 Grade

• Fine Aggregate (sand): Locally available zone II sand with specific gravity 2.6 confirming with code book IS 393-1970.

• Coarse Aggregate: Crushed stone of 10mm size having specific gravity 2.76 confirming code book IS 393-
1970.

• Water: Potable water for Experiments.

• Steel Fibers: In this Experiment Hook tain steel fibers are used with different aspect ratios 50, 60 and 67
having lengths 35, 30 and 20mm with diameter 0.7, 0.5 and 0.4.

• Glass Fiber: It is the material made from extremely fine fibres of glass. It is a light weight, extremely strong
and robust material. There are distinctive sorts of fibre however in these we have taken E-glass fibre to show
better resistance and a very good insulation to electricity.

III. RESULTS AND DISCUSSION

In this present work M20 grade of concrete is selected for the proportions of 1:1.96:2.63 and water cement ratio of 0.45 and various studies are conducted to observe the responses. In addition to general ingredients steel and glass fibers are added of percentages 0, 0.5,1,2 and 3.

Effect of Compressive Strength in FRC

The compressive strength results are tabulated in table.1. The graph is plotted on X- axis the percentage
addition of FRC and on Y-axis compressive strength in Fig.1. The graph is a non-linear.

Table 1 **Compressive strength of FRC**

COMPRESSIVE STRENGTH (N/mm2)			
Sr. No	**%** Of Addition	Steel Fiber	Glass Fiber
1	0	22.56	22.56
2	0.5	24.06	27.06
3	1	26.00	28.46
4	2	27.66	26.98
5	3	28.15	26.10

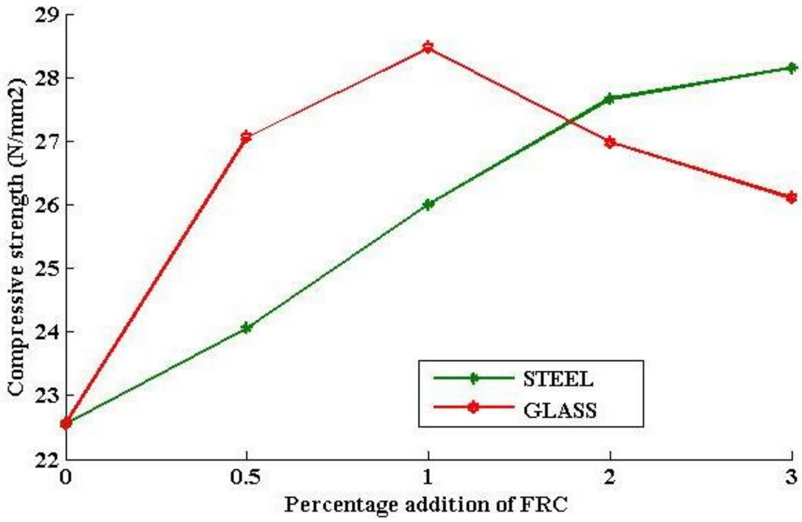

Figure 1 **Effect of compressive strength**

Effect of Flexural Strength in FRC

The Flexural strength results are tabulated in table.2. The graph is plotted on X- axis the percentage addition **of FRC and on Y-axis Flexural strength in Fig.2. The graph is a non-linear.**

Table 2 **Flexural strength of FRC**

FLEXURAL STRENGTH (N/mm2)			
Sr. No	% of addition	Steel fiber	Glass fiber
1	0	3.73	3.73
2	0.5	3.9	2.45
3	1	4.4	2.94
4	2	4.75	2.6
5	3	5.20	2.45

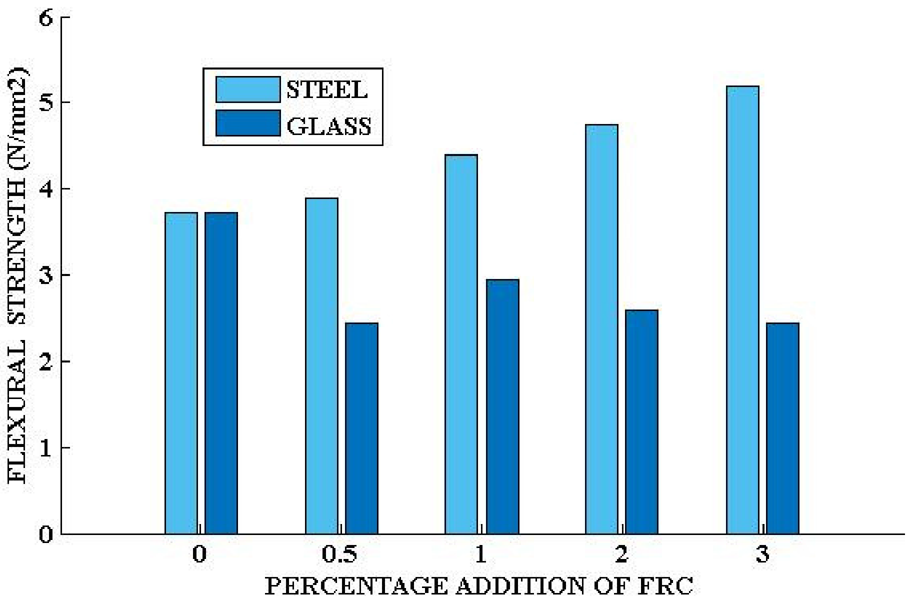

Figure 2 **Effect of Flexural strength**

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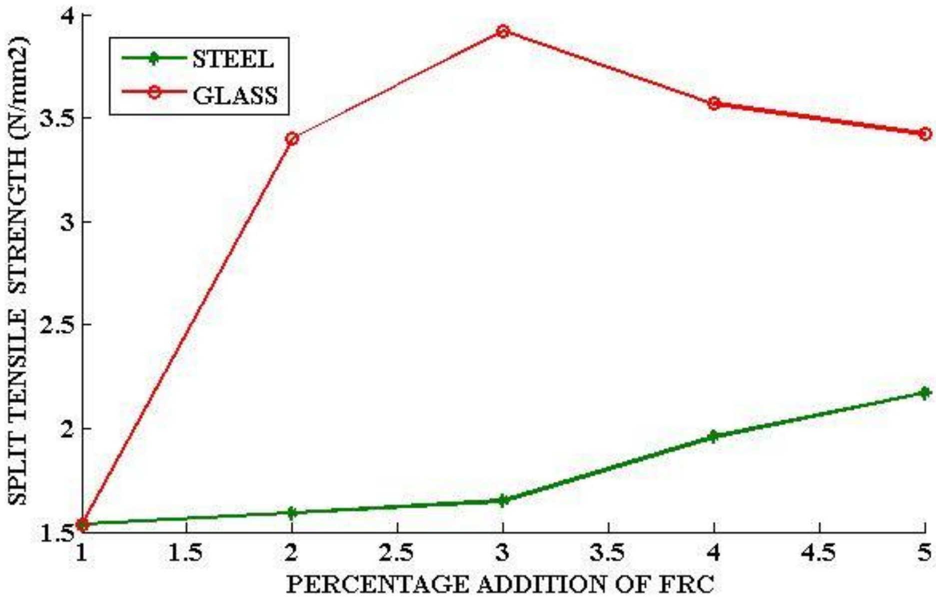
Effect of Split Tensile Strength in FRC

The Split tensile strength results are tabulated in table.3. The graph is plotted on X- axis the percentage addition of FRC and on Y-axis Split tensile strength in Fig.3. The graph is a non-linear.

Table 3 **Split tensile strength of FRC**

SPLIT TENSILE STRENGTH (N/mm2)			
Sr. No	% of addition	Steel fiber	Glass fiber
1	0	1.535	1.535
2	0.5	1.59	3.4
3	1	1.65	3.92
4	2	1.96	3.57
5	3	2.17	3.42



OBJECTIVES

The main objective of this investigation is to conduct an experimental study on strength of RCC Beams with hybrid fibers.

i) To evaluate compressive strength of concrete cube with fibers and without fibers.

ii) To compare the flexural strength of concrete cube with fibers and without fibers.

iii) To compare the cost effectiveness concrete cube with fibers and without fibers for both conventional and non-conventional.

RESEARCH METHODOLOGY:

Above study will be done with experimental approach.

The grade of concrete to be used is M20, and grade of steel is Fe 500. Steel fiber are used in the range of 0%to 1.5% and glass fibers in the range of 0% to 0.3% by volumetric fraction of concrete. Optimized mix of Steel fiber and glass fibers are used in casting of cubes. The cubes will be cured for 28 days. Then results is taken.

EXPECTED DATE OF COMPLETION:

It is expected to complete the work by 28 days.

REFERENCES: -

[1]. Chris G. Karayannis, Parthena-Maria K. Kosmidou and Constantin E. Chalioris; Reinforced Concrete and Seismic Design of Structures Laboratory, Civil Engineering Department, School of Engineering, Democritus University of Thrace, Xanthi 67100, Greece; karayan@civil.duth.gr, pkosmido@civil.duth.gr.

[2]. Guray Arslan, Riza Secer Orkun Keskin, Semih Ulusoy "An experimental study on the shear strength of SFRC beams without stirrups" Yildiz Technical University, Department of Civil Engineering, Istanbul, Turkey.

[3]. Xiliang Ninga, Yining Dinga, Fasheng Zhangb, Yulin Zhangc "Experimental Study and Prediction Model for Flexural Behaviour of Reinforced SCC Beam Containing Steel Fibers" a State Key Laboratory of Coastal and Offshore Engineering, Dalian University of Technology, Dalian 116023, China.

[4]. Guray Arslan "Shear Strength of Steel Fiber Reinforced Concrete (SFRC) Slender Beam" Received June 21, 2012/Revised 1st: October 8, 2012, 2nd: December 18, 2012/Accepted May 12, 2013.

[5]. Karen E.Caballero Morrison,J.L Bonet,Juan Navarro-Gregori, Pedro Serna-Ros"An experimental study of steel fiber-reinforced high-strength concrete slender columns under cyclic loading" Instituto de Ciencia y Tecnología del Hormigón, Universitat Politècnica de València, Camino de Vera s/n, 46022 Valencia, Spain

[6]. Oladimeji B. Olalusi, and Panagiotis Spyridis "Probabilistic Studies on the Shear Strength of Slender Steel Fiber Reinforced Concrete Structures" Structural Engineering & Computational Mechanics Group (SECM), Department of Civil Engineering, University of KwaZulu-Natal, Durban 4041, South Africa 2 Faculty of Architecture and Civil Engineering, Technical University of Dortmund, 44227 Dortmund.

[7]. Muyasser M. Jomaah, Saad R. Ahmed, Baraa T. Kamel Ibraheem J. KarimFlexural "Behavior of Slender Reinforced Concrete Beams" Civil Department, College of Engineering, Tikrit University, Iraq

[8]. Nasr E. Nasr Structural Engineering Department, Faculty of Engineering/ Ain-Shams University, Cairo, Egypt Corresponding Author: Nasr E. NasIOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) e-ISSN: 2278-1684p-ISSN: 2320- 334X, Volume 16, Issue 1 Ser. II (Jan. - Feb. 2019), PP 72-82 www.iosrjournals.org.

[9]. Smith, K. N., and Vantsiotis, A. S., "Shear Strength of Deep Beams," ACIJOURNAL, Proceedings V. 79, No. 3, May-June 1982, pp.

[10]. Ma, K., Qi, T., Liu, H., & Wang, H. (2018). Shear behavior of hybrid fiber reinforced concrete beams. Materials, 11(10), 202.

[11]. Indian Standard Institutions, Indian Standard Code of Practice for Concrete Mix Proportioning Guidelines (Second Revision) IS 10262: 2019.

[12]. Indian Standard Institutions, Indian Standard Code of Practice for Plain and Reinforced Concrete I.S. 456-2000 (fourth revision).

Books:

[13]. Design Of Reinforced Concrete Structures (IS 456- 2000) N. Krishna Raju

[14]. Design Of RCC Structural Elements (RCC Volume-1) S.S. Bhavikatti