

# Structural Behavior of Hybrid Fiber Reinforced Concrete Elements

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**Abstract**— This paper labels the study of hybrid fiber reinforced concrete specimen's structural behavior elements. Fibers influenced on the hybrid reinforced specimens structural characteristics are analyzed. Samples having various fiber-volume fractions will be explored. Structural characteristics investigates test like compressive strength, flexural strength and tensile strength. The incorporation of Steel and Polyester (Recron 35) fiber varies from range 0.1 to 1% volume fraction. From the results obtained the concrete specimens made with 0.5 % possess high structural behavior compared to other specimens made. The results attained is also equated with the predictable specimens of beam and beam-column joint.

**Index Terms**— Beam-column joints, Hybrid fiber reinforced, Polyester, Recron 35

## 1 INTRODUCTION

Concrete is generally delivered and widely used than all other as a construction material,. Concrete strength varies with the preparations and the incorporations of the material involved in the manufacturing, like Plain concrete possesses a very less tensile strength and little resistance to cracking [1,2]. In addition with these the microstructural study like internal micro cracks are characteristically present in the concrete if the concrete possess low strength and improper arrangements. Such micro cracks lead to the propagation of poor tensile strength which, in the long run leading to fragile fracture of the concrete. The mandatory reason for incorporating the fibers include it reduces the air voids reasonably, in addition with the reduction of water voids. Creep resistance can be attained with the incorporation of graphite and glass fibers. [3,4,5].

Modulus of elasticity of fiber plays a major role in fiber reinforced concrete for efficient stress transfer. Fibers like steel, carbon and glass gives high modulus and stiffness. This the major reason for selecting the Steel fiber in this project. The sequential factor also plays vital role in incorporating the fiber is volume of fibers. The higher addition more than the optimum would result in segregation and harshness in the concrete specimens. [6, 7]. Aspect ratio of fibers remains the constant reason for the selection of quantity of fibers, where it differs based on the properties and nature of concrete. The optimum aspect ratio is 75 where it exceeds the concrete attains certain less toughness and strength.

Orientation of fibers plays some roles in the toughness and strength attained in FRC. From the study the fibers arranged parallel to the applied load attains quite high results when compared to orientations done random and perpendicular to the load. The orientation continued with the size and shape of the fiber imply in the applications like steel fibers round in shape available as reinforcement.

Thus from the above conditions the steel fiber proposed to use is crimped round steel fiber and is purchased from Bakul castings. The Recron 35 fibers are purchased from Reliance Regional Office in Bangalore.

Besides, steel reinforcement is espoused to overcome high theoretically tensile stresses and shear stresses at critical location in concrete member. When the root analysis of this most cases induce that micro cracks development should be suppressed with the method of additional of additives or filler materials which significantly increase the strength of concrete, which in turn produce concrete with homogenous tensile properties [9]. The expansion of strands was gotten as an answer for create concrete in perspective on expanding its elastic and flexural quality, custom of fastener that could join Portland concrete in the holding with concrete frameworks. [13, 14, 15]. 'Fiber strengthened cement' (FRC) is made up with concrete, different sizes of aggregate, which coordinate with discrete, irregular filaments. Filaments are most regularly spasmodic, arbitrarily dispersed all through the concretes frameworks. [16,17]

## 2 Materials and Methods

### 2.1 Cement

OPC 53 grade was adapted to the concrete cube making process. The properties of Cement like consistency, Initial setting time, last setting time and fineness modulus are tried for the examples and the outcomes are given beneath.

Properties	Obtained value
Specific gravity	3.15
Consistency	30.5%
Finess	2.0%
Initial setting time	95 min
Final setting time	600 min

TABLE 1- PROPERTIES OF CEMENT

### 2.2 Fine aggregate

The river sand available in the nearby area was taken for casting the test specimens. The properties of river sand are studies with the reference of BIS 2386-1963, the obtained results are shown below in table .

# Flexural Behavior Of Hybrid Fiber Reinforced Concrete Beams

**Shamsher Bahadur Singh, Madappa V.  
R. Sivasubramanian, Himanshu Chawla**

## **Flexural Behavior Of Hybrid Fiber Reinforced Concrete Beams:**

Fiber Reinforced Composites Kuruvilla Joseph, Kristiina Oksman, George Gejo, Runcy Wilson, Saritha Appukuttan, 2021-03-20 Polymer based fibre reinforced composites FRC s have now come out as a major class of structural materials being used or regarded as substituent s for metals in several critical components in space automotive and other industries marine and sports goods owing to their low density strength weight ratio and fatigue strength FRC s have several commercial as well as industrial applications ranging from aircraft space automotive sporting goods marine and infrastructure The above mentioned applications of FRC s clearly reveal that FRC s have the potential to be used in a broad range of different engineering fields with the added advantages of low density and resistance to corrosion compared to conventional metallic and ceramic composites However for scientists researchers R D s to fabricate FRC s with such potential there should be careful and precise design followed by suitable process development based on properties like mechanical physical and thermal that are unique to each application Hence the last few decades have witnessed considerable research on fibre reinforced composites Fibre Reinforced Composites Constituents Compatibility Perspectives and Applications presents a widespread all inclusive review on fibre reinforced composites ranging from the different types of processing techniques to chemical modification of the fibre surface to enhance the interfacial adhesion between the matrix and fibre and the structure property relationship It illustrates how high value composites can be produced by efficient and sustainable processing methods by selecting different constituents fibres and resins Researchers in academia working in composites and accompanying areas materials characterisation and industrial manufacturers who need information on composite constituents and how they relate to each other for a certain application will find the book extremely useful when they need to make decisions about materials selection for their products Focuses on the different types of FRC s that are currently available e g from polymeric matrices to metallic and ceramic matrices from carbon fibre to different types of natural fibres and from short to long fibre reinforced their processing techniques characterization of different properties and how to improve the interfacial adhesion between an incompatible fibre and matrix and their applications Looks at crisis areas such as how to incorporate incompatible fibres and matrices together e g Non polar polypropylene matrix is not compatible with that of polar natural fibres and hence suitable surface modifications are required to make them compatible with each other along with low cost processing methods low density and high strength Uncovers clarifications to both elementary and practical problems related to the fabrication of FRCs Schematic representations depicting the interaction between different fibre types and matrices will be provided in some chapters **Advanced Concretes and Their Structural Applications-Volume II** Zhigang Zhang, Cong Zhang, Dong Zhang, Jialuo He, 2023-07-10 Reinforced Concrete Design with FRP Composites Hota V.S. GangaRao, Narendra Taly, P. V. Vijay, 2006-11-20 Although the use of composites has increased in many industrial commercial medical and defense applications there is a lack of technical literature that

examines composites in conjunction with concrete construction Fulfilling the need for a comprehensive explicit guide Reinforced Concrete Design with FRP Composites presents specific informat

**Current Trends in Civil Engineering and Engineering Sciences 2024, Vol 2** Mahdi Karkush,Deepankar Choudhury,Mohammed Fattah,2024-11-15 This book contains selected articles from the fourth International Conference on Geotechnical Engineering Iraq 2024 ICGE 2024 held on April 17 18 2024 at at Warith Al Anbiyaa University Karbala Iraq This proceeding discusses the latest research and studies in geotechnical engineering and all related topics in different fields such as civil engineering environmental engineering and architectural engineering This book gives participants from both academics and industry a great chance to learn about recent developments in Geotechnical engineering fields

**Fiber Reinforced Polymeric Materials and Sustainable Structures** Shamsher Bahadur Singh,Muthukumar Gopalathnam,Venkatesh Kumar R. Kodur,Vasant A. Matsagar,2023-03-01 This book deals with the introduction of various kinds of advanced composite materials such as carbon fiber reinforced polymer CFRP glass fiber reinforced polymer GFRP aramid fiber reinforced polymer AFRP and basalt fiber reinforced polymer BFRP This book covers the advantages and disadvantages of these advanced composite materials The primary advantages such as high specific strength and stiffness of advance composite materials result in lighter and durable structures On the other hand its linear elastic behavior till failure has been highlighted as the main disadvantage for their structural applications This book also highlights the various forms in which the FRP components are tailored and stacked up to optimize its strength and stiffness to deliver the high performance structural as well as non structural components in its real life application The various forms in which FRP materials are developed are described such as uni directional cross ply angle ply hybrid and functionally graded composites In addition various forms in which these materials stacked and bonded to fabricate the various structural and non structural components are described Most importantly techniques to extract plant based cellulosic fibers and its application to fabricate the various forms of sustainable composite products are described In addition development of nano particle enforced cellulosic fibers for sustainable industrial products has also been presented Furthermore the use of advanced composites and natural fiber based composites has been demonstrated for repair rehabilitation and retrofitting of deficient structural systems Moreover the comprehensive overview of the state of the art research on the test methods for material characterization at room and elevated temperature is presented which will be of high interest to scientists researchers students and engineers working in the fields of composite materials such as FRPs and other forms of composites such as fiber reinforced concrete FRC This book is also helpful for undergraduate masters and most importantly Ph D research scholars for developing their fundamental understanding on advanced composite materials and their applications in construction as well as industrial sectors

Emerging Trends of Advanced Composite Materials in Structural Applications Shamsher Bahadur Singh,Madappa V. R. Sivasubramanian,Himanshu Chawla,2021-06-01 This book introduces different advanced composite materials used in construction of civil engineering infrastructures It reflects the

latest manufacturing processes and applications in the civil structures This book also includes test cases and its validation with finite element method using computer software Moreover the book also deals with design methodology of advanced composite materials based on different applications The comprehensive overview of the state of the art research on the composite materials presented herein is of interest to scientists researchers students and engineers and practitioners in general working in area of innovative composite materials and structures This book is also helpful for Ph D research scholars for developing their fundamental understanding on advanced materials and it is also appropriate for master and undergraduate level courses on composite materials

**Sustainable Fiber Reinforced Cementitious Composites for Construction and Building Materials** Li Li,Mehran Khan,Xi Jiang,Pshtiwan Shakor,Yangyang Zhang,2023-07-26

Proceedings of the Canadian Society for Civil Engineering Annual Conference 2023, Volume 11 Serge Desjardins,Gérard J. Poitras,Ashraf El Damatty,Ahmed Elshaer,2024-09-25 This book comprises the proceedings of the Annual Conference of the Canadian Society for Civil Engineering 2023 The contents of this volume focus on the specialty track in structural engineering with topics on bridge design FRP concrete structures innovation in structural engineering seismic analysis and design wind load on structures masonry structures structural optimization machine learning and AI in structural engineering and wood and timber structures among others This volume will prove a valuable resource for researchers and professionals

*Emerging Trends in Composite Structures* Md. Abdul Mannan,R. Sathyanathan,N. Umamaheswari,Hemant S. Chore,2023-12-01 This book presents the select proceedings of International Conference on Civil Engineering Innovative Development in Engineering Advances ICC IDEA 2023 This book covers the latest research in the areas of structural engineering and health monitoring steel and composite structure bridge and tunnel engineering earthquake engineering disaster management and coastal and harbor engineering The book is useful for researchers and professionals in related fields of civil engineering

**Advances in Design and Implementation of Cementitious Backfills (ADICB)** Erol Yilmaz,Shuai Cao,Di Wu,2022-10-05 **Advanced Concretes and Their Structural Applications** Zhigang Zhang,Xijun Shi,Fangying Wang,Qian Zhang,2022-09-23 **10th International Conference on FRP Composites in Civil Engineering** Alper Ilki,Medine Ispir,Pinar Inci,2021-11-26

This volume highlights the latest advances innovations and applications in the field of FRP composites and structures as presented by leading international researchers and engineers at the 10th International Conference on Fibre Reinforced Polymer FRP Composites in Civil Engineering CICE held in Istanbul Turkey on December 8 10 2021 It covers a diverse range of topics such as All FRP structures Bond and interfacial stresses Concrete filled FRP tubular members Concrete structures reinforced or pre stressed with FRP Confinement Design issues guidelines Durability and long term performance Fire impact and blast loading FRP as internal reinforcement Hybrid structures of FRP and other materials Materials and products Seismic retrofit of structures Strengthening of concrete steel masonry and timber structures and Testing The contributions which were selected by means of a rigorous international peer

review process present a wealth of exciting ideas that will open novel research directions and foster multidisciplinary collaboration among different specialists

*Advanced Concretes and Their Structural Applications, Volume III* Zhigang Zhang, Yao Ding, Jialuo He, Yang Zou, Pengfei Men, 2025-01-30 Construction materials play a critical role in building modern infrastructures that stand the test of time In recent decades novel advanced construction materials have emerged such as high performance smart concrete fiber reinforced concrete high ductility concrete high strength concrete etc However construction materials are still expected to achieve higher performances and functionalities in response to the ever increasing demand of more durable sustainable resilient energy efficient infrastructures in modern society Further research on the application of these advanced construction materials at structural and infrastructural scale is necessary to fully demonstrate the benefits of these advanced construction technologies

**FRP Composites in Civil Engineering - CICE 2004** R. Seracino, 2004-12-15 The range of fibre reinforced polymer FRP applications in new construction and in the retrofitting of existing civil engineering infrastructure is continuing to grow worldwide Furthermore this progress is being matched by advancing research into all aspects of analysis and design The Second International Conference on FRP Composites in Applications of Mathematics in Science and Technology Bui Thanh Hung, M. Sekar, Ayhan ESI, R. Senthil Kumar, 2025-04-29 The Conference dealt with one of the most important problems faced in International development in Pure Mathematics and Applied mathematics development in engineering such as Cryptography Cyber Security Network Operations Research Heat Equation and so forth The aim of the conference was to provide a platform for researchers engineers academicians as well as industrial professionals to present their research results and development activities in Pure and Applied Mathematics and its applied technology It provided opportunities for the delegates to exchange new ideas and application experiences to establish business or research relations and to find global partners for future collaboration

*Fibre Reinforced Concrete: Improvements and Innovations* Pedro Serna, Aitor Llano-Torre, José R. Martí-Vargas, Juan Navarro-Gregori, 2020-11-05 This volume highlights the latest advances innovations and applications in the field of fibre reinforced concrete FRC and discusses a diverse range of topics concerning FRC rheology and early age properties mechanical properties codes and standards long term properties durability analytical and numerical models quality control structural and Industrial applications smart FRC s nanotechnologies related to FRC textile reinforced concrete structural design and UHPFRC The contributions present improved traditional and new ideas that will open novel research directions and foster multidisciplinary collaboration between different specialists Although the symposium was postponed the book gathers peer reviewed papers selected in 2020 for the RILEM fib International Symposium on Fibre Reinforced Concrete BEFIB

*Latest Developments in Civil Engineering* Krishna Kant Pathak, J. M. S. J. Bandara, Ramakant Agrawal, 2023-10-02 This book comprises select proceedings of the International Conference on Recent Advances in Civil Engineering RACE 2022 The contents of this book focus on the recent advancements and innovations in the field of civil engineering and various

related areas such as design and development of new sustainable and smart building materials performance analysis and simulation of steel structures design and performance optimization of concrete structures structural engineering geotechnical engineering water resources engineering and hydraulics transportation and bridge engineering building services design surveying and remote sensing engineering management and renewable energy This book serves as a useful reference to researchers and professionals in the field of civil engineering *Sustainable Innovations in Construction Management* Osman Gencel,M. Balasubramanian,T. Palanisamy,2023-11-20 This book presents the select proceedings of International Conference on Civil Engineering Innovative Development in Engineering Advances ICC IDEA 2023 This book covers the latest research in the areas of construction engineering and management urban planning and design building energy conservation and green architecture materials science and engineering innovation in construction materials and information technology in civil engineering The book is useful for researchers and professionals in civil engineering

**Beton Kalender 2017** Konrad Bergmeister, Frank Fingerloos, Johann-Dietrich Wörner, 2016-12-08 Beton unterliegt einem Wandel der Anforderungen und entwickelt selbst Innovationskraft mit Auswirkungen auf Gestaltung bis hin zur Baustellenlogistik Die Entwicklung von hochfesten ultrahochfesten und selbstverdichtenden Betonen die gestiegenen Qualitätsanforderungen und die zu erwartende Knappheit natürlicher Gesteinsressourcen setzen neue Anforderungsmaßstäbe an Entwurfskonzepte Die Anforderungen an die Dauerhaftigkeit von Beton zielen insbesondere auf eine gute Homogenität und auf eine relativ hohe Dichte Dieses Ziel kann nur im Zusammenwirken von Konstruktion Statik Herstellung Transport Förderung Verarbeitung und Nachbehandlung erreicht werden Die Anforderungen an die Wirtschaftlichkeit von Betontragwerken können durch Optimierung von Prozessen und Automatisierung in der Baustellenlogistik erfüllt werden der Bauablauf im Jahr 2017 unterscheidet sich erheblich von Baustellen vor 50 oder gar 100 Jahren Immer höher erzielbare Festigkeiten ermöglichen schlankere Bauteile Auch die Gestaltbarkeit von Tragwerken wird vielseitiger diese erfordert aber gleichzeitig eine leichte Verarbeitbarkeit Vor diesem Hintergrund enthält der Beton Kalender 2017 eine Reihe von Beiträgen über Betonherstellung aktuelle Produkterweiterungen sowie verschiedene Anwendungen von Spezialbetonen und deren Qualitätssicherung sowie erstmalig über die bautechnische Anwendung von tragenden Kunststoffbauteilen Außerdem wurde der aktuelle Wissensstand über Spannbeton aufgearbeitet In bewährter Weise werden aktuelle europäische und nationale Normen in konsolidierten Kurzfassungen fortgeführt Der Beton Kalender 2017 ist eine besondere Fundgrube für Ingenieure in Planungsbüros und in der Bauindustrie **Advances in Structural Mechanics and Applications** José António Fonseca de Oliveira Correia, Satyabrata Choudhury, Subhrajit Dutta, 2022-07-14 The proceedings of the conference is going to benefit the researchers academicians students and professionals in getting enlightened on latest technologies on structural mechanics structure and infrastructure engineering Further work on practical applications of developed scientific methodologies to civil structural engineering will make the proceedings more interesting and useful to practicing engineers and structural

designers



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## **Table of Contents Flexural Behavior Of Hybrid Fiber Reinforced Concrete Beams**

1. Understanding the eBook Flexural Behavior Of Hybrid Fiber Reinforced Concrete Beams
  - The Rise of Digital Reading Flexural Behavior Of Hybrid Fiber Reinforced Concrete Beams
  - Advantages of eBooks Over Traditional Books
2. Identifying Flexural Behavior Of Hybrid Fiber Reinforced Concrete Beams
  - Exploring Different Genres
  - Considering Fiction vs. Non-Fiction
  - Determining Your Reading Goals
3. Choosing the Right eBook Platform
  - Popular eBook Platforms
  - Features to Look for in an Flexural Behavior Of Hybrid Fiber Reinforced Concrete Beams
  - User-Friendly Interface

4. Exploring eBook Recommendations from Flexural Behavior Of Hybrid Fiber Reinforced Concrete Beams
  - Personalized Recommendations
  - Flexural Behavior Of Hybrid Fiber Reinforced Concrete Beams User Reviews and Ratings
  - Flexural Behavior Of Hybrid Fiber Reinforced Concrete Beams and Bestseller Lists
5. Accessing Flexural Behavior Of Hybrid Fiber Reinforced Concrete Beams Free and Paid eBooks
  - Flexural Behavior Of Hybrid Fiber Reinforced Concrete Beams Public Domain eBooks
  - Flexural Behavior Of Hybrid Fiber Reinforced Concrete Beams eBook Subscription Services
  - Flexural Behavior Of Hybrid Fiber Reinforced Concrete Beams Budget-Friendly Options
6. Navigating Flexural Behavior Of Hybrid Fiber Reinforced Concrete Beams eBook Formats
  - ePub, PDF, MOBI, and More
  - Flexural Behavior Of Hybrid Fiber Reinforced Concrete Beams Compatibility with Devices
  - Flexural Behavior Of Hybrid Fiber Reinforced Concrete Beams Enhanced eBook Features
7. Enhancing Your Reading Experience
  - Adjustable Fonts and Text Sizes of Flexural Behavior Of Hybrid Fiber Reinforced Concrete Beams
  - Highlighting and Note-Taking Flexural Behavior Of Hybrid Fiber Reinforced Concrete Beams
  - Interactive Elements Flexural Behavior Of Hybrid Fiber Reinforced Concrete Beams
8. Staying Engaged with Flexural Behavior Of Hybrid Fiber Reinforced Concrete Beams
  - Joining Online Reading Communities
  - Participating in Virtual Book Clubs
  - Following Authors and Publishers Flexural Behavior Of Hybrid Fiber Reinforced Concrete Beams
9. Balancing eBooks and Physical Books Flexural Behavior Of Hybrid Fiber Reinforced Concrete Beams
  - Benefits of a Digital Library
  - Creating a Diverse Reading Collection Flexural Behavior Of Hybrid Fiber Reinforced Concrete Beams
10. Overcoming Reading Challenges
  - Dealing with Digital Eye Strain
  - Minimizing Distractions
  - Managing Screen Time
11. Cultivating a Reading Routine Flexural Behavior Of Hybrid Fiber Reinforced Concrete Beams
  - Setting Reading Goals Flexural Behavior Of Hybrid Fiber Reinforced Concrete Beams
  - Carving Out Dedicated Reading Time

12. Sourcing Reliable Information of Flexural Behavior Of Hybrid Fiber Reinforced Concrete Beams
  - Fact-Checking eBook Content of Flexural Behavior Of Hybrid Fiber Reinforced Concrete Beams
  - Distinguishing Credible Sources
13. Promoting Lifelong Learning
  - Utilizing eBooks for Skill Development
  - Exploring Educational eBooks
14. Embracing eBook Trends
  - Integration of Multimedia Elements
  - Interactive and Gamified eBooks

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