Steel Fiber Reinforced Concrete Behavior Modelling And Design Springer Transactions In Civil And Environmental Engineering

Sets out basic theory for the behavior of reinforced concrete structural elements and structures in considerable depth. Emphasizes behavior at the ultimate load, and, in particular, aspects of the seismic design of reinforced concrete structures. Based on American practice, but also examines European practice.

The book presents the underlying theories of the different approaches for modeling cracking of concrete and provides a critical survey of the state-of-the-art in computational concrete mechanics. It covers a broad spectrum of topics related to modeling of cracks, including continuum-based and discrete crack models, meso-scale models, advanced discretization strategies to capture evolving cracks based on the concept of finite elements with embedded discontinuities and on the extended finite element method, and extensions to coupled problems such a hygro-mechanical problems as required in computational durability analyses of concrete structures.

This book discusses design aspects of steel fiber-reinforced concrete (SFRC) members, including the behavior of the SFRC and its modeling. It also examines the effect of various parameters governing the response of SFRC members in detail. Unlike other publications available in the form of guidelines, which mainly describe design methods based on experimental results, it describes the basic concepts and principles of designing structural members using SFRC as a structural material, predominantly subjected to flexure and shear. Although applications to special structures, such as bridges, retaining walls, tanks and silos are not specifically covered, the fundamental design concepts remain the same and can easily be extended to these elements. It introduces the principles and related theories for predicting the role of steel fibers in reinforcing concrete members concisely and logically, and presents various material models to predict the response of SFRC members in detail. These are then gradually extended to develop an analytical flexural model for the analysis and design of SFRC members. The lack of such a discussion is a major hindrance to the adoption of SFRC as a structural material in routine design practice. This book helps users appraise the role of fiber as reinforcement in concrete members used alone and/or along with conventional rebars. Applications to singly and doubly reinforced beams and slabs are illustrated with examples, using both SFRC and conventional reinforced concrete as a structural material. The influence of the addition of steel fibers on various mechanical properties of the SFRC members is discussed in detail, which is invaluable in helping designers and engineers create optimum designs. Lastly, it describes the generally accepted methods for specifying the steel fibers at the site along with the SFRC mixing methods, storage and transport and explains in detail methods to validate the adopted design. This book is useful to practicing engineers, researchers, and students.

This volume consists of papers presented at the International Conference on Recent Developments in Fibre Reinforced Cements and Concretes, held at the School of Engineering, University of Wales College of Cardiff, UK, 18-20 September 1989.

Ultra High Performance Concrete (UHPC) is characterized by a very high compressive strength which may reach more than 200 MPa. The behavior of this material under tension and compression actions has been established to be very brittle in nature. Discontinuous fibers (normally steel fibers) are usually added to the UHPC mix to introduce ductility. In order to investigate the beneficial effects of using fiber reinforced UHPC in structural members subjected to torsion, a series of experimental tests on 17 UHPC beams subjected to pure torsion were carried out. The test beams consisted of plain UHPC beams, UHPC beams reinforced with steel fibers only, UHPC reinforced with steel fibers and different combinations of traditional longitudinal and transverse reinforcement. The plain UHPC beams showed very brittle behavior, whereas the UHPC beams with steel fibers only showed a post cracking ductile behavior. The addition of little steel fiber volume (e.g.

0.5 %) to the plain UHPC beams enhanced the ductility. The enhancement at the ultimate capacity amounts to about 20 %. Meanwhile, the steel fibers with 0.9 % by volume showed much enhanced ductility and a maximum enhancement of the torsional carrying capacity up to 32 %. The addition of moderate steel fiber volume (e.g. 0.9 %) to one type of traditional reinforcement (either longitudinal or transverse) accomplished an effective post cracking torsional carrying mechanism. The steel fibers shows a tendency to replace the missing type of traditional reinforcement, however this should be confirmed by more tests and by using higher steel fiber volumes. A series of experimental tests on fiber reinforced UHPC prisms to investigate the post cracking shear strength and stiffness of the used UHPC mix (e.g. M3Q) was conducted. The results of these tests revealed that this fine grained UHPC mix has a weak post cracking shear behavior. The results of these tests were used later in the Finite Element (F.E) model. An analytical model based on the well known thin-walled tube analogy was developed in order to estimate the torsional carrying capacity of beams under pure torsion having different combinations of steel fibers and traditional reinforcement. The comparison between the test and model results showed very good agreement for all cases. A finite element model based on calibrated small scale tests was developed using ATENA F.E. package to predict the full load-deformation behavior of the test beams. The predictions of the model show very good agreement with the test results. The situation of high compressive load transmitted onto limited area of concrete member occurs frequently in a variety of industrial and engineering structures. Hence, numerous investigations have been conducted in the past to study the behavior of concrete under such loading, but mostly of plain and conventionally reinforced concretes. With the increasingly widespread use of steel fibers in the field of structural

application, it is therefore of great interest to investigate the performance of steel fiber reinforced concrete (SFRC) subjected to concentrated load. The objective of the present PhD thesis was to characterize the load-bearing and fracture behavior of SFRC under concentrated loading (i.e. point loading) by means of experimental approach. Based on the experimental results, it can be concluded that the presence of steel fibers substantially improved the load-bearing behavior of concrete under concentrated load and changed the failure mode of concrete from a brittle to a ductile one. The findings acquired here can be used as fundamental information for the composition and optimization of SFRC mixtures, the production of SFRC concrete elements as well as for the constructive design and practical application of SFRC structural members exposed to concentrated load.
Reinforced concrete is a common building material used for blast resistant design. Adding fibers to reinforced concrete enhances the durability and ductility of concrete. This report examines how adding steel fibers to reinforced concrete for blast resistant design is advantageous. An overview of the behavior of blasts and goals of blast resistant design, and advantages of reinforced concrete in blast-resistant design, which include mass and the flexibility in detailing, are included in the blast resistant design section. The common uses for fiber-reinforced concrete, fiber types, and properties of fiber reinforced concrete varying with fiber type and length, and concrete strength are discussed in the fiber-reinforced concrete section. Two studies, Very High-Strength Concrete for Use in Blast-and-Penetration Resistant Structures and Blast Testing of Ultra-High Performance Fiber and FRP-Retrofitted Concrete Slabs, are reviewed. Lastly, the cost, mixing and corrosion limitations of using steel fiber-reinforced concrete are discussed. Reinforced concrete has been shown to be a desirable material choice for blast resistant design.

The first step to designing a blast resistant reinforced concrete structure is to implement proper detailing to ensure that structural failures will be contained in a way that preserves as many lives as possible. To design for the preservation of lives, a list of priorities must be met. Preventing the building from collapse is the first of these priorities. Adding steel fibers to concrete has been shown to enhance the concrete's post-crack behavior, which correlates to this priority. The second priority is reducing flying debris from a blast. Studies have shown that the failure mechanisms of steel fiber reinforced concrete aid in reducing flying debris when compared to conventional reinforced concrete exposed to blast loading. The major design considerations in designing steel fiber reinforced concrete for blast resistant design include: the strength level of the concrete with fiber addition, fiber volume, and fiber shape. As research on this topic progresses, the understanding of these factors and how they affect the strength characteristics of the concrete will increase, and acceptance into the structural design industry through model building codes may be possible.

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High Performance Fiber Reinforced Cement Composites (HPFRCC) represent a class of cement composites whose stress-strain response in tension undergoes strain hardening behaviour accompanied by multiple cracking, leading to a high strain prior to failure. The primary objective of this International Workshop was to provide a compendium of up-to-date information on the most recent developments and research advances in the field of High Performance Fiber Reinforced Cement Composites. Approximately 65 contributions from leading world experts are assembled in these proceedings and provide an authoritative perspective on the subject. Special topics include fresh and hardening state properties; self-compacting mixtures; mechanical behavior under compressive, tensile, and shear loading; structural applications; impact, earthquake and fire resistance; durability issues; ultra-high performance fiber reinforced concrete; and textile reinforced concrete. Target readers: graduate students, researchers, fiber producers, design engineers, material scientists. Advanced cementitious composites can be designed to have outstanding combinations of strength (five to ten times that of conventional concrete) and energy absorption capacity (up to 1000 times that of plain concrete). This second edition brings together in one volume the latest research developments in this rapidly expanding area. The book is split into two parts. The first part is concerned with the mechanics of fibre reinforced brittle matrices and the implications for cementitious systems. In the second part the authors describe the various types of fibre-cement composites, discussing production processes, mechanical and physical properties, durability and applications. Two new chapters have been added, covering fibre specification and structural applications. Fibre Reinforced Cementitious Composites will be of great interest to practitioners involved in modern concrete technology and will also be of use to academics, researchers and graduate students. The EURO-C conference series (Split 1984, Zell am See 1990, Innsbruck 1994, Badgastein 1998, St. Johann im Pongau 2003, Mayrhofen 2006, Schladming 2010, St. Anton am Arlberg 2014, and Bad Hofgastein 2018) brings together researchers and practising engineers concerned with theoretical, algorithmic and validation aspects associated with computational simulations of concrete and concrete structures. Computational Modelling of Concrete Structures reviews and discusses research advancements and the applicability and robustness of methods and models for reliable analysis of complex concrete, reinforced concrete and pre-stressed concrete structures in engineering practice. The contributions cover both computational mechanics and computational modelling aspects of the analysis and design of concrete and concrete structures: Multi-scale cement and concrete research: experiments and modelling Aging concrete: from very early ages to decades-long durability Advances in material modelling of plane concrete Analysis of reinforced concrete structures Steel-concrete interaction, fibre-reinforced concrete, and masonry Dynamic behaviour: from seismic retrofit to impact simulation Computational Modelling of Concrete Structures is of special interest to academics and researchers in computational concrete mechanics, as well as industry experts in complex nonlinear simulations of concrete structures.

Steel fibers have widely been used in the past to reinforce brittle materials in many nonstructural applications such as pavement, tunneling lining, etc. On the basis of numerous previous studies, ACI 318-11 [2011] has recently accepted steel fiber as a minimum shear reinforcement replacement with minimum 0.75% volume fraction for both reinforced concrete and prestressed concrete members. However, not much previous research has talked about the flexural behavior of fiber reinforced concrete (FRC). As per ACI 318-11 for tension-controlled sections, the net tensile strains in the outermost layer of steel, et, should be greater than or equal to 0.005 and for the moment redistribution in continuous beam the section should sufficiently ductile (et [greater or equal to] 0.0075). For this, the sections should have small longitudinal reinforcement ratio which ultimately leads to an inefficient beam section with a large cross-sectional area. In contrast, the use of smaller concrete cross sections can lead to a diminished ductile flexural behavior as well as premature shear failure. In this context, the use of steel fiber reinforced concrete could be a potential solution since fiber can increase both the concrete shear strength and it's usable compressive strains. However limited previous researches on the flexural behavior on SFRC beams are available and most of them are of small scales and concentrated only basically for shear behavior. To the best of our knowledge, the large-scale prestressed fiber reinforced concrete beam specimens have yet to be studied for flexure behavior. In this project, six large scale prestressed concrete beams with or without steel fiber along with some material test were tested. Our experimental investigations indicated that even with inclusion of small percentage volume of fraction of steel fiber (Vf =0.75%) could not only increase the ductility and shear strength of the SFRPC beam but also change the failure pattern by increasing usable strain in concrete and steel. A modification on the limit for c/dt ratio and [phi] factor for design of flexural member given in current

ACI could be proposed which could imply the smaller sections with higher longitudinal reinforcement ratio and less shear reinforcement. could be used. Any standard material test results have to ensure that FRC has, at least, been batched properly and it can give indications of probable performance when used in structures. In the current material testing method suggested by ACI, the third point bending test (ASTM C1609) has an inherent problem in that the coefficients of variations for post cracking strength and residual strength are generally very high on the order of 20%. The direct tensile test can be a more appropriate material. However, it is currently not recommended as standard method in the U.S. Because of it's difficultly in gripping arrangement which will lead to cracking of the specimen at the grips. Both the test methods also require close loop servo controlled machine. The round panel test method (ASTM C1550) requires large size specimen and heavy steel supports prevents performing test in small laboratories. Split cylinder test (ASTM C496), do not necessarily reflect the true properties of the material as the specimen is forced to fail in the line of the application of the load and the test method is also not recommended by ACI for SFRC. In order to improve the material assessment procedure, the double Punch Test (DPT) introduced by Chen in 1970 [Chen, 1970] was extensively evaluated to develop a simple, quick and reliable testing method for SFRC. Various tests were carried out in order to evaluate peak and residual strength, stiffness, strain hardening and softening, toughness and other post crack properties. Our test results indicated that the DPT method could be

immersed as reliable, easier and economical material test method. It could be used to distinguish the peak strength, residual strength, toughness stiffness and crack resistance, of different SFRC mixtures with less scatter results compared to other material test methods.
This volume highlights the latest advances, innovations, and applications in the field of fibre-reinforced concrete (FRC), as presented by scientists and engineers at the RILEM-fib X International Symposium on Fibre Reinforced Concrete (BEFIB), held in Valencia, Spain, on September 20-22, 2021. It discusses a diverse range of topics concerning FRC: technological aspects, nanotechnologies related with FRC, mechanical properties, long-term properties, analytical and numerical models, structural design, codes and standards, quality control, case studies, Textile-Reinforced Concrete, Geopolymers and UHPFRC. After the symposium postponement in 2020, this new volume concludes the publication of the research works and knowledge of FRC in the frame of BEFIB from 2020 to 2021 with the successful celebration of the hybrid symposium BEFIB 2021. The contributions present traditional and new ideas that will open novel research directions and foster multidisciplinary collaboration between different specialists.
Attributes associated with the addition of steel fibers may have significant effects for the unique structural

mechanism of large buried concrete structures such as culverts and bridges. CANDE, software developed under the sponsorship of FHWA in 1976, is recognized as the primary design and analysis tool for buried structures in the United States. Although CANDE models the behavior of reinforced concrete, it does not currently include an option for modeling steel fiber reinforced concrete (SFRC). The reported research focuses on the development of a new material type for CANDE that includes the effects of steel fibers in the concrete. An experimental and analytical approach was used to modify the CANDE finite element program and test the accuracy of the model. The research outcome is new input options to model the behavior of SFRC in the CANDE program needed to accurately predict the structural capabilities of SFRC buried structures.

This book sheds light on the shear behavior of Fiber Reinforced Concrete (FRC) elements, presenting a thorough analysis of the most important studies in the field and highlighting their shortcomings and issues that have been neglected to date. Instead of proposing a new formula, which would add to an already long list, it instead focuses on existing design codes. Based on a comparison of experimental tests, it provides a thorough analysis of these codes, describing both their reliability and weaknesses. Among other issues, the book addresses the influence of flange size on shear, and

the possible inclusion of the flange factor in design formulas. Moreover, it reports in detail on tests performed on beams made of concrete of different compressive strengths, and on fiber reinforcements to study the influence on shear, including size effects. Lastly, the book presents a thorough analysis of FRC hollow core slabs. In fact, although this is an area of great interest in the current research landscape, it remains largely unexplored due to the difficulties encountered in attempting to fit transverse reinforcement in these elements.
The addition of steel fibers to concrete-type materials has been shown to improve many of the engineering properties of those materials. Notable among them is an enhancement in the tensile strength of an otherwise weak and brittle material. Although much is known about the tensile strength of steel-fiber reinforced concrete (SFRC) under one-dimensional state of stress, little is known with regard to the strength behavior under multi-dimensional tension-compression loading. This is attributed to a lack of suitable equipment for simultaneously applying tensile and compressive stresses. The research program described herein is focused on developing such equipment to study the behavior of SFRC under combined loadings. A review of the state-of-the-art research on the tensile strength of SFRC is given and a review of various methods of applying tensile stresses to concrete

specimens is presented. The problem is to be overcome in applying a pure principal tensile stress are discussed.

So far in the twenty-first century, there have been many developments in our understanding of materials' behaviour and in their technology and use. This new edition has been expanded to cover recent developments such as the use of glass as a structural material. It also now examines the contribution that material selection makes to sustainable construction practice, considering the availability of raw materials, production, recycling and reuse, which all contribute to the life cycle assessment of structures. As well as being brought up-to-date with current usage and performance standards, each section now also contains an extra chapter on recycling. Covers the following materials: metals concrete ceramics (including bricks and masonry) polymers fibre composites bituminous materials timber glass. This new edition maintains our familiar and accessible format, starting with fundamental principles and continuing with a section on each of the major groups of materials. It gives you a clear and comprehensive perspective on the whole range of materials used in modern construction. A must have for Civil and Structural engineering students, and for students of architecture, surveying or construction on courses which require an understanding of materials.