

EVALUATION OF MECHANICAL PROPERTIES OF CONCRETE

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Abstract

This paper investigates the impact of pre-washed aggregates, and pozzolanic cement replacements on the limit strengths and elastic properties of concrete during the hardening process. The static and dynamic Young's moduli; and compressive and tensile strengths have been measured during the first 28 days of maturity on different concrete mixes: (a) various fly ash and silica fume replacement ratios; (b) washed and unwashed aggregates with various fly ash replacement ratios. The strength prediction models described in the Eurocode-2 have been fitted to the experimental results. A modification of the Eurocode-2 equations is suggested, incorporating the linear combination of the mix-design variables as model factors. Finally, the proposed model is used to quantify the impact of the mix-design variables on the aforementioned mechanical properties. The results indicate minor influence of Silica Fume and Fly Ash replacements on the 28 days Young's moduli, contrasting with significant negative effects of pre-washed aggregates on the Young's moduli and limit strengths.

Keywords: Filler content, Fly Ash, Silica Fume, Strength, Young's modulus.

1 Introduction

The elastic properties of concrete play a critical role in the design of reinforced concrete structures, and are highly influenced by the concrete composition.

Aggregate coatings (film of fine material adhered to the aggregate surface) can have a different mineralogical composition from the parent rock, depending on the nature of the aggregate (Galloway, 2006). Coatings can be composed of clay, calcium carbonates or silt; which have negative impacts on the hardened concrete mechanical properties by interacting with the cement paste (Quiroga and Fowler, 2004). Washing the aggregates is an effective strategy to eliminate such coatings and may present economic and technical benefits for concrete production (Muñoz et al., 2005). Nevertheless, former studies suggest that the effects of aggregate coatings on the fracture behaviour of concrete are more pronounced on round aggregates than crushed ones, as the aggregate-paste bond strength is more sensible to surface texture than surface coatings (Rocco and Elices, 2009).

Fly Ash (FA), either siliceous (class F) or high-lime (class C), is widely used as cement replacement and reports substantial benefits to the long-term mechanical properties and durability of hardened concrete (Neville and Brooks, 2010). Class F Fly Ash (FFA) increases the compressive (F_{ck}) and tensile strength (F_{ctk}) as well as the Static Elastic Modulus (E_{ck}) at 28 days on High Strength Concrete (HSC) mixes, with cement contents between 400-500kg/m³. Similar effects are expected on normal strength concrete. The optimum FFA replacement ratios are found at 10% (Haque and Kayali, 1998). Whereas, increases on F_{ck} , F_{ctk} are barely found on the long-term (over 90 days) for higher cement replacement ratios (40-50%) (Siddique, 2004).

Silica Fume (SF) is also widely used as cement replacement in concrete, and SF replacement ratios in the range of 10-20% improve the long-term mechanical properties of concrete (Siddique, 2011). Several studies have proved the benefits of SF as cement replacement (SF replacement ratio 10-15%) when used in HSC (cement content 400-500kg/m³), compressive, tensile strengths and

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Non-destructive Testing and Evaluation of Civil Engineering Structures Jean-Paul Balayssac,Vincent Garnier,2017-11-22 The non destructive evaluation of civil engineering structures in reinforced concrete is becoming an increasingly important issue in this field of engineering This book proposes innovative ways to deal with this problem through the characterization of concrete durability indicators by the use of non destructive techniques It presents the description of the various non destructive techniques and their combination for the evaluation of indicators The processing of data issued from the combination of NDE methods is also illustrated through examples of data fusion methods The identification of conversion models linking observables obtained from non destructive measurements to concrete durability indicators as well as the consideration of different sources of variability in the assessment process are also described An analysis of in situ applications is carried out in order to highlight the practical aspects of the methodology At the end of the book the authors provide a methodological guide detailing the proposed non destructive evaluation methodology of concrete indicators Presents the latest developments performed in the community of NDT on different aspects Provides a methodology developed in laboratory and transferred onsite for the evaluation of concrete properties which are not usually addressed by NDT methods Includes the use of data fusion for merging the measurements provided by several NDT methods Includes examples of current and potential applications

Nondestructive Testing of Materials and Structures Oral Büyüköztürk,Mehmet Ali Taşdemir,2012-09-14 Condition assessment and characterization of materials and structures by means of nondestructive testing NDT methods is a priority need around the world to meet the challenges associated with the durability maintenance rehabilitation retrofitting renewal and health monitoring of new and existing infrastructures including historic monuments Numerous NDT methods that make use of certain components of the electromagnetic and acoustic spectrum are currently in use to this effect with various levels of success and there is an intensive worldwide research effort aimed at improving the existing methods and developing new ones The knowledge and information compiled in this book captures the current state of the art in NDT methods and their application to civil and other engineering materials and structures Critical reviews and advanced interdisciplinary discussions by world renowned researchers point to the capabilities and limitations of the currently used NDT methods and shed light on current and future research directions to overcome the challenges in their development and practical use In this respect the contents of this book will equally benefit practicing engineers and researchers who take part in characterization assessment and health monitoring of materials and structures

Non-Destructive Techniques for the Evaluation of Structures and Infrastructure Belén Riveiro,Mercedes Solla,2016-04-04 This book provides an overview and up to date synthesis of the most commonly used non destructive technologies for the reverse engineering of built infrastructure facilities These technologies tackle both the geometric and radiometric characterization of built structures and thus validated technologies such as laser scanning

photogrammetry and Technologies for Sustainable Buildings and Infrastructure B. R. Jayalekshmi, K. S. Nanjunda Rao, G. S. Pavan, 2024-09-19 This book presents select proceedings of the International Conference on Sustainable Infrastructure Innovations Challenges and Opportunities 2023 SIIOC 2023 The topics covered include behavior of masonry and RC buildings under earthquakes performance of concrete bricks and blocks manufactured with non organic industrial wastes bamboo for construction composites for construction and finite element simulations on buildings and special structures The book presents various facets of experiments to characterize the properties of construction materials and intricacies involved in performing finite element simulations to assess the behavior of buildings under seismic and wind loading conditions The book serves as a resource material for budding researchers and industry professionals interested in developing solutions for sustainable building habitats

Reliability, Safety and Hazard Assessment for Risk-Based Technologies Prabhakar V. Varde, Raghu V. Prakash, Gopika Vinod, 2019-08-30 This volume presents selected papers from the International Conference on Reliability Safety and Hazard It presents the latest developments in reliability engineering and probabilistic safety assessment and brings together contributions from a diverse international community and covers all aspects of safety reliability and hazard assessment across a host of interdisciplinary applications This book will be of interest to researchers in both academia and the industry

Measuring, Monitoring and Modeling Concrete Properties Maria S. Konsta-Gdoutos, 2007-09-23 This state of the art volume covers the latest and future trends in measuring monitoring and modeling the properties of cement based materials The book contains 94 papers and presents the latest research work of renowned experts It acts as a survey of the most up to date research in the field

Proceedings - American Society for Testing and Materials American Society for Testing and Materials, 1906 Vols 61 66 include technical papers

Advanced Concretes and Their Structural Applications-Volume II Zhigang Zhang, Cong Zhang, Dong Zhang, Jialuo He, 2023-07-10

Mechanical Properties of Cementitious Materials at Microscale Ya Wei, Siming Liang, Weikang Kong, 2022-11-14 This book provides information on characterizing the microstructure and mechanical properties of cementitious materials at microscale Specifically with the intention to provide the methods of preparing the samples for the micro scale mechanical testing to address the techniques for measuring and analyzing the elastic modulus the stiffness and the fracture toughness of cementitious materials at micro scale by instrumented indentation to describe a method for measuring and interpreting creep behavior of cementitious materials at micro scale and to demonstrate the homogenization method for obtaining the mechanical properties of cementitious materials across scales The information in this book is helpful to a wide readership in the field of civil engineering and materials science working with cementitious materials and other composite materials

Contract Report S. Waterways Experiment Station (U.S.), 1976

Life-Cycle of Structures and Infrastructure Systems Fabio Biondini, Dan M. Frangopol, 2023-06-28 Life Cycle of Structures and Infrastructure Systems collects the lectures and papers presented at IALCCE 2023 The Eighth International Symposium on Life Cycle Civil Engineering held at

Politecnico di Milano Milan Italy 2 6 July 2023 This Open Access Book contains the full papers of 514 contributions including the Fazlur R Khan Plenary Lecture nine Keynote Lectures and 504 technical papers from 45 countries The papers cover recent advances and cutting edge research in the field of life cycle civil engineering including emerging concepts and innovative applications related to life cycle design assessment inspection monitoring repair maintenance rehabilitation and management of structures and infrastructure systems under uncertainty Major topics covered include life cycle safety reliability risk resilience and sustainability life cycle damaging processes life cycle design and assessment life cycle inspection and monitoring life cycle maintenance and management life cycle performance of special structures life cycle cost of structures and infrastructure systems and life cycle oriented computational tools among others This Open Access Book provides an up to date overview of the field of life cycle civil engineering and significant contributions to the process of making more rational decisions to mitigate the life cycle risk and improve the life cycle reliability resilience and sustainability of structures and infrastructure systems exposed to multiple natural and human made hazards in a changing climate It will serve as a valuable reference to all concerned with life cycle of civil engineering systems including students researchers practitioners consultants contractors decision makers and representatives of managing bodies and public authorities from all branches of civil engineering

Application of Waste Materials in Lightweight Aggregates Franus Małgorzata, 2023-11-27 Application of Waste Materials in Lightweight Aggregates presents the current state of knowledge on aggregates production methods their characteristics current standards and legal regulations In addition the book briefly discusses the issue of the presence of different types of waste in the environment including municipal agricultural energy and mining industries their characteristics and uses for the production of lightweight aggregates This book serves as a source of academic information on the course and conditions of using various waste treatment processes for academics engineers professionals and students interested in environmental engineering as well as for companies dealing with recycling and disposal of waste **Advanced**

Techniques for Testing of Cement-Based Materials Marijana Serdar, Ivan Gabrijel, Dirk Schlicke, Stéphanie Staquet, Miguel Azenha, 2020-02-18 The book examines advanced non standardized techniques that have been developed for determining different properties of cement paste mortar and concrete and provides state of the art information on methods for monitoring hydration induced changes in cement based materials CBMs These methods are often nondestructive and allow quasi continuous monitoring covering the time span from placement of the material to formation of a fully hardened cement composite The book also presents various applications of acoustic emission for characterizing fresh concrete recent developments in ultrasonic methods for characterizing CBMs since placement application of ambient response methods for measuring elastic modulus methods for determining deformational characteristics of CBMs since setting and methods for in situ measurements of stresses in concrete elements during hardening Bridge Evaluation and Analysis National Research Council (U.S.). Highway Research Board, 1973 *Non-Destructive Testing of Structures* Magdalena Rucka, 2021-02-16 The

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Reinforced Cementitious Composites for Construction and Building Materials Li Li,Mehran Khan,Xi Jiang,Pshtiwan Shakor,Yangyang Zhang,2023-07-26 Sustainable Development of Water and Environment Han-Yong Jeon,2023-10-24 This book aims to offer new scientific concept in the field of water and environment The main purpose of this book is to exchange some of the latest research findings and educational information on the water and environment in order to take important measures to protect water resources and the environment for future generations in accordance with the principles of sustainable development The book welcomes all related research and review papers and hopes ICSDWE can positively impact our world and provide a better future for all including the improvement to the quality of life **Book Catalog of the Library and Information Services Division: Shelf List catalog** Environmental Science Information Center. Library and Information Services Division,1977 **Book catalog of the Library and Information Services Division** Environmental Science Information Center. Library and Information Services Division,1977 *Publication Index 1969-1972* National Research Council (U.S.). Highway Research Board,1973

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