

# 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/m<sup>3</sup>. 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/m<sup>3</sup>), 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

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

**Recent Advances in Geo-Environmental Engineering, Geomechanics and Geotechnics, and Geohazards** Amjad Kallel,Zeynal Abiddin Erguler,Zhen-Dong Cui,ALi Karrech,Murat Karakus,Pinnaduwa Kulatilake,Sanjay Kumar Shukla,2018-12-31 This edited volume contains the best papers in the geo engineering field accepted for presentation at the 1st Springer Conference of the Arabian Journal of Geosciences Tunisia 2018 In addition it includes 3 keynotes by international experts on the

following topics 1 A new three dimensional rock mass strength criterion 2 New tools and techniques of remote sensing for geologic hazard assessment 3 Land subsidence induced by the engineering environmental effects in Shanghai China The book is useful for readers who would like to get a broad coverage in geo engineering It contains 11 chapters covering the following main areas a Applications in geo environmental engineering including soil remediation b Characterization of geo materials using geological geotechnical and geophysical techniques c Soil improvement applications d Soil behaviour under dynamic loading e Recent studies on expansive soils f Analytical and numerical modelling of various geo structures g Slope stability h Landslides i Subsidence studies and j Recent studies on various other types of geo hazards

*Evaluation of Constructed, Cast-in-place (CIP) Piling Properties*, 2011 *Advanced Condition Monitoring and Fault Diagnosis of Electric Machines* Irfan, Muhammad, 2018-09-14 The reliability of induction motors is a major requirement in many industrial applications It is especially important where an unexpected breakdown might result in the interruption of critical services such as military operations transportation aviation and medical applications *Advanced Condition Monitoring and Fault Diagnosis of Electric Machines* is a collection of innovative research on various issues related to machinery condition monitoring signal processing and conditioning instrumentation and measurements and new trends in condition monitoring It also pays special attention to the fault identification process While highlighting topics including spectral analysis electrical engineering and bearing faults this book is an ideal reference source for electrical engineers mechanical engineers researchers and graduate level students seeking current research on various methods of maintaining machinery

*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

**Structural Health Monitoring (SHM) of Civil Structures** Gangbing Song, Chuji Wang, Bo Wang, 2018-04-20 This book is a printed edition of the Special Issue Structural Health Monitoring SHM of Civil Structures that was published in *Applied Sciences* [Proceedings - American Society for Testing and Materials](#) American Society for Testing and Materials, 1907 Vols 61 66 include technical papers

*Smart Cities and Sustainable Manufacturing* Roshan Raman, Hakan Çalışkan, Zafar Said, 2024-11-28 *Smart Cities and Sustainable Manufacturing Innovations for a Greener Future* explores the intersection of these two essential disciplines underscoring the transformative potential of their integration in sculpting sustainable urban landscapes By providing cutting edge research case studies success stories and practical guidance this book facilitates knowledge sharing and collaboration and inspires stakeholders to implement sustainable and innovative solutions Further it illustrates how integrating smart cities and sustainable manufacturing can contribute to a greener future by investigating the

role of emergent technologies policy frameworks business models and more This essential resource covers a range of topics related to smart cities and sustainable manufacturing including technologies for smart cities such as IoT AI big data analytics and sensor networks sustainable infrastructure design such as green buildings energy efficient transportation systems and renewable energy integration circular economy and waste management strategies sustainable transportation initiatives such as intelligent transportation systems electric mobility solutions and shared mobility services and much more Offers practical frameworks methodologies and tools readers can utilize to implement sustainable practices and drive positive change in their respective domains Features real world case studies from around the globe highlighting successful and less successful examples of smart cities and sustainable manufacturing initiatives and showcasing the outcomes and lessons learned Bridges the gap between different disciplines integrating knowledge from areas such as technology urban planning environmental science and engineering for a holistic understanding of the subject matter Explores future trends and emerging technologies in smart cities and sustainable manufacturing enabling readers to stay ahead of the curve and anticipate upcoming developments

**Cement Standards, Evolution and Trends** SYMPOSIUM ON CEMENT STANDARDS-EVOLUTION AND TRENDS ( 1977 : ST. LOUIS) AUTOR,1978 Non-Destructive Testing of Structures Magdalena Rucka,2021-02-16 The Special Issue Non Destructive Testing of Structures has been proposed to present the recent developments in the field of the diagnostics of structural materials and components in civil and mechanical engineering The papers highlighted in this editorial concern various aspects of non invasive diagnostics including such topics as the condition assessments of civil and mechanical structures and the connections of structural elements the inspection of cultural heritage monuments the testing of structural materials structural health monitoring systems the integration of non destructive testing methods advanced signal processing for the non destructive testing of structures NDT damage detection and damage imaging as well as modeling and numerical analyses for supporting structural health monitoring SHM systems

**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

**Insulation Materials, Testing, and Applications** D. L. McElroy,1990 Proceedings of the symposium held in Bal Harbour Florida December 1987 Rising energy

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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      **Selected Water Resources Abstracts** ,1990      **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      **Recent Advances in Transportation Systems Engineering and Management** M. V. L. R.

Anjaneyulu,M. Harikrishna,Shriniwas S. Arkatkar,A. Veeraragavan,2022-11-10 The book presents the select proceedings of the 8th International Conference on Transportation Systems Engineering and Management CTSEM 2021 The book covers topics pertaining to three broad areas of transportation engineering namely Transportation Planning Traffic Engineering and Pavement Technology The topics covered include transportation and land use urban and regional transportation planning travel behavior modeling travel demand analysis forecasting and management transportation and ICT public transport planning and management freight transport traffic flow modeling and management highway design and maintenance capacity and level of service traffic crashes and safety ITS and applications non motorized transportation transportation economics and policy road and parking pricing pedestrian facilities and safety road asset management pavement materials and characterization pavement design and construction pavement evaluation and management transportation infrastructure financing innovative trends in transportation systems sustainable transportation smart cities resilience of transportation systems and environmental and ecological aspects This book will be useful for the students researchers and the professionals in the area of civil engineering especially transportation and traffic engineering      **Mechanics of Structures and**

**Materials XXIV** Hong Hao,Chunwei Zhang,2019-08-08 Mechanics of Structures and Materials Advancements and Challenges is a collection of peer reviewed papers presented at the 24th Australasian Conference on the Mechanics of Structures and Materials ACMSM24 Curtin University Perth Western Australia 6 9 December 2016 The contributions from academics researchers and practising engineers from Australasian Asia pacific region and around the world cover a wide range of topics including Structural mechanics Computational mechanics Reinforced and prestressed concrete structures Steel structures Composite structures Civil engineering materials Fire engineering Coastal and offshore structures Dynamic analysis of structures Structural health monitoring and damage identification Structural reliability analysis and design

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the most popular sizes for sandcrete blocks are 450mm x 225mm x 225mm and 450mm x 150mm x 225mm sandcrete blocks can also be rectangular and solid or hollow the nigerian industrial standards nis 87 2007 defined two types of blocks 1 type a load bearing blocks and 2 type b non load see more

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