

Proceedings in Engineering Mechanics
Research, Technology and Education

António J. M. Ferreira
Lucas F. M. da Silva *Editors*

1st International Conference on Mechanics of Solids 2022


Selected Contributions of MS 2022

Proceedings in Engineering Mechanics

Research, Technology and Education

Series Editors

Lucas F. M. da Silva, Faculty of Engineering, University of Porto, PORTO, Portugal

António J. M. Ferreira , Faculty of Engineering, University of Porto, Porto, Portugal

This book series publishes the results of meetings dealing with material properties in engineering and science. It covers a wide range of topics, from the fundamentals of materials mechanics and applications for various industries to aspects of scientific training and career development. The volumes in the series are based typically on primary research materials presented at conferences, workshops, and similar scientific meetings, and represent comprehensive scientific and technical studies.


António J. M. Ferreira · Lucas F. M. da Silva
Editors

1st International Conference on Mechanics of Solids 2022

Selected Contributions of MS 2022

 Springer

Editors

António J. M. Ferreira 
Faculty of Engineering
University of Porto
Porto, Portugal

Lucas F. M. da Silva
Faculty of Engineering
University of Porto
Porto, Portugal

ISSN 2731-0221

ISSN 2731-023X (electronic)

Proceedings in Engineering Mechanics

ISBN 978-3-031-26796-3

ISBN 978-3-031-26797-0 (eBook)

<https://doi.org/10.1007/978-3-031-26797-0>

© The Editor(s) (if applicable) and The Author(s), under exclusive license to Springer Nature Switzerland AG 2023

This work is subject to copyright. All rights are solely and exclusively licensed by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed.

The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

The publisher, the authors, and the editors are safe to assume that the advice and information in this book are believed to be true and accurate at the date of publication. Neither the publisher nor the authors or the editors give a warranty, expressed or implied, with respect to the material contained herein or for any errors or omissions that may have been made. The publisher remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

This Springer imprint is published by the registered company Springer Nature Switzerland AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Preface

This volume of the series *Proceedings in Engineering Mechanics—Research, Technology and Education* contains selected papers presented at the 1st International Conference on Mechanics of Solids MS 2022, held at Faculty of Engineering of the University of Porto (FEUP), Portugal, during 3–4 November 2022.

This conference is held every 2 years. The conference is co-chaired by António Ferreira (University of Porto, Portugal) and Lucas F. M. da Silva (University of Porto, Portugal). The focus is on the mechanics of deformable solids, dynamics of particles and rigid bodies. The conference objective is to disseminate the last developments in the field of solid mechanics in a friendly way.

In order to disseminate the work presented at MS 2022, selected papers were prepared which resulted in the present book. Various topics are covered resulting in 7 chapters dealing with mechanical behavior of materials (first three papers), mechanics of composite materials (one paper), plasticity (one paper), fracture mechanics (one paper) and optimum design methods (last paper). The papers presented here are good examples of the latest trends related to mechanics of solids.

The organizers and editors wish to thank all the authors for their participation and cooperation, which made this volume possible. Finally, I would like to thank the team of Springer-Verlag, especially Dr. Christoph Baumann and Ute Heuser, for the excellent cooperation during the preparation of this volume.

Porto, Portugal
November 2022

Lucas F. M. da Silva
lucas@fe.up.pt

António J. M. Ferreira
ferreira@fe.up.pt

Contents

Mechanical Behaviour of Materials

Effect of Partial Replacement of Cement with Waste Granite Powder and Quartz Powder on the Compressive Strength of Hardened Mortars for Cement Masonry	3
Zuzanna Zofia Woźniak	

Towards Modification of Polyurethane Paint Coatings for Softwood Protection: Preliminary Studies of the Use of Multi Walled Carbon Nanotubes	8
Karolina Brzozowska and Agnieszka Chowaniec-Michalak	

Role of SiC Powder in Reducing the Porosity and Increasing the Carbon Content in Wire Arc Additive Manufacturing of Carbon Steel	17
Masih B. Hesari, Reza Beygi, and Lucas F. M. da Silva	

Mechanics of Composite Materials

Fracture Toughness Analysis of Polymer Concretes Made by Waste Mineral Aggregates and Enhanced with Glass Fibers and Metal Chips	33
Mazaher Salamat-Talab, Sajjad Safaei, Faraz Soltani, Alireza Akhavan-Safar, and Lucas F. M. da Silva	

Plasticity

Effect of Flower Pattern Design on the Springback of High Strength Steel in Cold Roll Forming Process of Pipes	49
Mehdi Karimi Firouzjaei, Hassan Moslemi Naeni, Mohammad Mehdi Kasaei, Behnam Abbaszadeh, and Lucas F. M. da Silva	

Fracture Mechanics

Mixed-Mode I/II Fracture Load Prediction in Cracked Rock Geometries Using the Tangential Stress Contour (TSC) Method 65

Jamal Bidadi, Javad Akbardoost, Mohamad R. M. Aliha,
Hamed Saeidi Googarchin, Alireza Akhavan-Safar,
and Lucas F. M. da Silva

Optimum Design Methods

Investigation of Geometries and Stability for Increasing the Energy Density in Electromechanical Battery Flywheels 93

Daniel Coppede, Marco Antonio de Souza, Fabio da Silva Bortoli,
and Carlos Frajuca

Mechanical Behaviour of Materials



Effect of Partial Replacement of Cement with Waste Granite Powder and Quartz Powder on the Compressive Strength of Hardened Mortars for Cement Masonry

Zuzanna Zofia Woźniak^(✉) 

Wrocław University of Science and Technology, Wybrzeże Wyspiańskiego 27, 50-370 Wrocław, Poland

zuzanna.wozniak@pwr.edu.pl

Abstract. Seven cementitious mortar compositions were investigated. Quartz powder and granite powder were added to mortars as replacement of 5%, 10%, and 15% mass of the cement. 5% replacement of cement with quartz powder has a positive effect on the compressive strength by increasing it. The remaining series achieved a lower strength than the reference series. However, these are acceptable values due to the environmental benefits.

Keywords: Granite powder · Quartz powder · Compressive strength

1 Introduction

Recently, scientists have been focusing on improving the state of the environment due to the emission of carbon dioxide into the atmosphere. Papers published before 2022 claim that the carbon footprint of cement production was 5%. Strune et al. [1] state that this emission is 7%, while Winnefeld et al. [2] say 8%. It can therefore be concluded that carbon dioxide emissions to the atmosphere related to cement production are likely to increase, which may be related to the demand for cement and its increased production. Therefore, the research focused on finding a material that could partially replace cement in masonry mortars. Granite and quartz powder were selected. Granite powder is formed during the processing of granite, which is a widely known decorative material. Granite powder is stored in the form of heaps. Due to the high content of SiO_2 , it can cause silicosis of the lungs for people living in neighboring farms. This material irritates the respiratory tract, weakens the immune system. The second material of choice is quartz powder. Quartz powder is produced by grinding natural quartz sand. Due to the impossibility of reusing some glass waste, quartz powder can be considered as a waste material. It was decided to test one of the most important features of hardened mortars, which is compressive strength.