

**SpringerBriefs in Applied Sciences
and Technology**

SpringerBriefs present concise summaries of cutting-edge research and practical applications across a wide spectrum of fields. Featuring compact volumes of 50–125 pages, the series covers a range of content from professional to academic.

Typical publications can be:

- A timely report of state-of-the art methods
- An introduction to or a manual for the application of mathematical or computer techniques
- A bridge between new research results, as published in journal articles
- A snapshot of a hot or emerging topic
- An in-depth case study
- A presentation of core concepts that students must understand in order to make independent contributions

SpringerBriefs are characterized by fast, global electronic dissemination, standard publishing contracts, standardized manuscript preparation and formatting guidelines, and expedited production schedules.

On the one hand, **SpringerBriefs in Applied Sciences and Technology** are devoted to the publication of fundamentals and applications within the different classical engineering disciplines as well as in interdisciplinary fields that recently emerged between these areas. On the other hand, as the boundary separating fundamental research and applied technology is more and more dissolving, this series is particularly open to trans-disciplinary topics between fundamental science and engineering.

Indexed by EI-Compendex, SCOPUS and Springerlink.

More information about this series at <http://www.springer.com/series/8884>

J. M. P. Q. Delgado · Ana Sofia Guimarães
António C. Azevedo · Romilde A. Oliveira
Fernando A. N. Silva · Carlos W. A. P. Sobrinho

Structural Performance of Masonry Elements

Mortar Coating Layers Influence

J. M. P. Q. Delgado
CONSTRUCT-LFC, Faculty of Engineering
University of Porto
Porto, Portugal

Romilde A. Oliveira
Department of Civil Engineering
Catholic University of Pernambuco
Recife, Brazil

Ana Sofia Guimarães
CONSTRUCT-LFC, Faculty of Engineering
University of Porto
Porto, Portugal

Fernando A. N. Silva
Department of Civil Engineering
Catholic University of Pernambuco
Recife, Brazil

António C. Azevedo
CONSTRUCT-LFC, Faculty of Engineering
University of Porto
Porto, Portugal

Carlos W. A. P. Sobrinho
CONSTRUCT-LFC, Faculty of Engineering
University of Porto
Porto, Portugal

ISSN 2191-530X

ISSN 2191-5318 (electronic)

SpringerBriefs in Applied Sciences and Technology

ISBN 978-3-030-03269-2

ISBN 978-3-030-03270-8 (eBook)

<https://doi.org/10.1007/978-3-030-03270-8>

Library of Congress Control Number: 2018959265

© The Author(s), under exclusive license to Springer Nature Switzerland AG 2019

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, express 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

Over the last years, the occurrence of several accidents in the Metropolitan Region of Recife with masonry buildings constructed with non-structural blocks to carry loading beyond its own weight has drawn the attention of the regional and national technical community for the need to establish criteria of research, study, and rehabilitation, within acceptable levels of reliability. Masonry buildings constructed with such a technique are often referred to as resistant masonry buildings.

This book discusses masonry buildings constructed in the state of Pernambuco, Brazil. Topics such as the main features of this construction technique and the peculiarities that affect its structural behaviour are discussed. Technical information about accidents occurred in recent years is also discussed, along with the historical records of the events, followed by indications of the causes for the collapse.

Additionally, this work presents two experimental extensive campaigns with masonry elements in order to analyse the structural performance. First, an experimental study is carried out on running bond 195 red clay prisms, of two and three ceramic blocks, with and without cement mortar coating, subjected to axial compression in order to enhance the capacity of masonry. The prisms were subjected to compressive loading, and all of them had deformation control on each face with a deflectometer, in order to obtain information about the behaviour of the prisms. Secondly, an extensive characterisation of materials and components (more than 500 prisms made with ceramic blocks and concrete blocks) is used in non-structural masonry constructions in the region of Pernambuco, making it one of the most comprehensive research studies on this topic in Brazil. This study conducts an in-depth, numerical, and experimental analysis of the behaviour of the compressive strength of blocks, prisms, and mini-walls that are part of a non-load bearing system, which is often used in the region to carry loads above its own weight.

The main benefit of this book is the extensive experimental results obtained that allowed to identify the contribution of several mortar rendering layers to the load capacity of the tested specimens. The factors that influenced the load capacity of the tested specimens are also discussed.

Porto, Portugal
Porto, Portugal
Porto, Portugal
Recife, Brazil
Recife, Brazil
Porto, Portugal

J. M. P. Q. Delgado
Ana Sofia Guimarães
António C. Azevedo
Romilde A. Oliveira
Fernando A. N. Silva
Carlos W. A. P. Sobrinho

Contents

1	Introduction	1
1.1	Motivation	2
	References	6
2	Physical and Hygrothermal Material Properties	7
2.1	Ceramic Clay Bricks	7
2.1.1	Physical Characteristics	8
2.1.2	Mechanical Characteristics	12
2.2	Sand	12
2.2.1	Fine Aggregate Analyse	12
2.3	Mortar	17
	References	20
3	Influence of Reinforced Mortar Coatings on the Compressive Strength of Masonry Prisms	21
3.1	Materials	21
3.2	Results	24
	References	35
4	Structural Performance of Resistant Masonry Elements	37
4.1	Materials	37
4.1.1	Concrete and Ceramic Blocks	37
4.1.2	Sand and Mortars	37
4.1.3	Steel Mesh and Connectors	39
4.1.4	Prisms	39
4.1.5	Wallets Specimens	40
4.1.6	Steel Mesh and Connector	42
4.2	Results and Discussion	43
4.2.1	Concrete Brick Prisms	46
4.2.2	Wallet Specimens	50

4.2.3	Coating Influence	52
4.2.4	Mortar Coating Mixture Proportion Influence	53
4.2.5	Influence of the Additive	59
4.2.6	Mortar Coating Layer Thickness Influence	59
4.2.7	Influence of Reinforced Mortar Layer with Steel Meshes	64
	References	67
5	Conclusions	69