



ASTM INTERNATIONAL
Selected Technical Papers

Dimension Stone Use in the Built Environment

STP 1628

Editors:

Steven G. Nagatz
Charles J. Muehlbauer



SELECTED TECHNICAL PAPERS
STP1628

Editors: Steven G. Naggatz and Charles J. Muehlbauer

Dimension Stone Use in the Built Environment

ASTM STOCK #STP1628
DOI: 10.1520/STP1628-EB

Library of Congress Cataloging-in-Publication Data

Names: Naggatz, Steven G., editor. | Muehlbauer, Charles J., editor. | ASTM International.

Title: Dimension stone use in the built environment / Steven G. Naggatz, Charles J. Muehlbauer.

Description: West Conshohocken, PA : ASTM International, 2021. | Series: Selected technical papers ; STP 1628 | Includes bibliographical references. | Summary: "This compilation of Selected Technical Papers, STP1628, Dimension Stone Use in the Built Environment, contains peer-reviewed papers that were presented at a symposium held October 6, 2021, in Atlanta, Georgia, USA. The symposium was sponsored by ASTM International Committee C18 on Dimension Stone"-- Provided by publisher.

Identifiers: LCCN 2021034196 (print) | LCCN 2021034197 (ebook) | ISBN 9780803177024 | ISBN 9780803177031 (ebook)

Subjects: LCSH: Building stones--Congresses. | Building, Stone--Congresses.

Classification: LCC TA426 .D56 2021 (print) | LCC TA426 (ebook) | DDC 691/.2--dc23

LC record available at <https://lcn.loc.gov/2021034196>

LC ebook record available at <https://lcn.loc.gov/2021034197>

ISBN: 978-0-8031-7702-4

ISBN-EB: 978-0-8031-7703-1

Copyright © 2021 ASTM INTERNATIONAL, West Conshohocken, PA. All rights reserved. This material may not be reproduced or copied, in whole or in part, in any printed, mechanical, electronic, film, or other distribution and storage media, without the written consent of the publisher.

Photocopy Rights

Authorization to photocopy items for internal, personal, or educational classroom use, or the internal, personal, or educational classroom use of specific clients, is granted by ASTM International provided that the appropriate fee is paid to the Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01923, Tel: (978) 646-2600; <http://www.copyright.com/>

ASTM International is not responsible, as a body, for the statements and opinions expressed in this publication. ASTM International does not endorse any products represented in this publication.

Peer Review Policy

Each paper published in this volume was evaluated by two peer reviewers and at least one editor. The authors addressed all of the reviewers' comments to the satisfaction of both the technical editor(s) and the ASTM International Committee on Publications.

The quality of the papers in this publication reflects not only the obvious efforts of the authors and the technical editor(s), but also the work of the peer reviewers. In keeping with long-standing publication practices, ASTM International maintains the anonymity of the peer reviewers. The ASTM International Committee on Publications acknowledges with appreciation their dedication and contribution of time and effort on behalf of ASTM International.

Citation of Papers

When citing papers from this publication, the appropriate citation includes the paper authors, "paper title," in *STP title*, book editor(s) (West Conshohocken, PA: ASTM International, year), page range, paper doi, listed in the footnote of the paper. A citation is provided on page one of each paper.

Printed in Hanover, PA
November, 2021

Foreword

THIS COMPILATION OF Selected Technical Papers, STP1628, *Dimension Stone Use in the Built Environment*, contains peer-reviewed papers that were submitted for presentation at a symposium planned for October 18, 2022, in New Orleans, Louisiana, USA. The symposium was sponsored by ASTM International Committee C18 on Dimension Stone.

Symposium Chairs and STP Editors:

Steven G. Naggatz
Wiss, Janney, Elstner Associates, Inc.
Chicago, IL, USA

Charles J. Muehlbauer
Natural Stone Institute
Oberlin, OH, USA

Contents

Overview	vii
Test Methods	
Dimension Stone Water Absorption and Bulk Specific Gravity: An Interlaboratory Study of the Influence of Size, Shape, and Test Methodology on Properties Determination	1
Jacob W. Arnold, Daren S. Kneezel, and Scott Scallorn	
Investigation of Test Specimen Size and Shape on Absorption Measurements of Granite Dimension Stone	40
Maria H. B. O. Frascá and Jorge K. Yamamoto	
Freeze-Thaw Resistance Test Mechanics for Dimension Stone: A Study of the Influence of Variant Wetting Procedures during Exposure Cycling on Mechanically Determined Flexural Strength of Stone	54
Scott D. Scallorn	
Panel Behavior and Attachments	
Improving the Resistance of Lightweight Stone Panels to Fatigue, Fire, and Meteorological Events	71
Giorgio Piccioli De Carolis, Gianluca Galletti, Philip Callant, and Christene Sache	
Evaluation and Avoidance of Stone-Faced Honeycomb Panel Failures	100
Daren S. Kneezel and Jeffrey V. Scarpelli	
Adhesive Attachments: An Examination of Epoxy and Limestone Anchors	122
Joshua D. Freedland and Steven G. Naggatz	

Material Durability

An Investigation of Suspected Salt Crystallization Deterioration of Fine-Grained Limestone Used as Architectural Cladding	139
Lurita McIntosh Blank	

Evaluating the Potential for Limestone Discoloration Using Accelerated Weathering Testing and Petrography	159
Sidney W. Carter, Taryn N. Williams, and Carolyn L. Searls	

A 21st-Century Marble Revival: How Testing and Quality Assurance Can Make Marble a Durable Option for Exterior Cladding	185
Björn Schouenborg, Bent Grelk, David West, and Paola Blasi	

Design and Performance of Paving Systems

Nonuniform Wetting/Drying Behavior of Exterior Granite-Slab Pavers: An Interchange	210
John N. Karras and Evan J. Landis	

A New Methodology for Evaluating the Weathering Durability Performance of Limestone Using WUFI	220
Manfred Kehrer and Michael J. Scheffler	

Structural Evaluation of Mortar or Sand Set Dimension Stone Pavers Using a Probability of Failure Approach	239
Daren S. Kneezel and Michael J. Scheffler	

Overview

This group of Selected Technical Papers (STP) is truly one of a kind. What began with a call for papers in April 2018 and was to have culminated with a symposium in Boston, Massachusetts, on April 1, 2020, was sadly interrupted by a global pandemic. Our thoughts are with our colleagues, friends, and families who have been affected by the COVID-19 health crisis.

Dimension stone has been the focus of two previous STPs: STP1394, *Dimension Stone Cladding: Design, Construction, and Repair* (1999), and STP1499, *Dimension Use in Building Construction* (2007). Dimension stone cladding and paving systems continue to evolve and present challenges to design professionals, owners, and installation, repair, and restoration contractors alike.

This book constitutes the work of 24 authors who have come together to represent the diverse interests of professionals in the dimension stone community. Just as the market for dimension stone touches many continents across the globe, this book brings together authors from North America, South America, Australia, and Europe. Each of these authors is involved with either the design, construction, evaluation, or use of dimension stone, and their work offers a formal exchange of information on the use of dimension stone in the built environment.

The twelve papers presented in this book are organized into four separate broad categories: test methods, panel behavior and attachments, material durability, and design and performance of paving systems.

As is the standard for all STPs, each of the papers presented herein was reviewed by qualified peers at least once, and in most cases twice, prior to acceptance for publication. Consequently, the editors wish to thank a long list of colleagues for their contributions, without which this publication would not have been possible.

In the spirit of all previous symposia and STPs, our acceptance of abstracts for this book was driven by the interest in advancing collective knowledge for use of dimension stone. It is our hope that this publication can be used to advance current construction practices related to dimension stone and fuel the development of new standards in the years to come.

