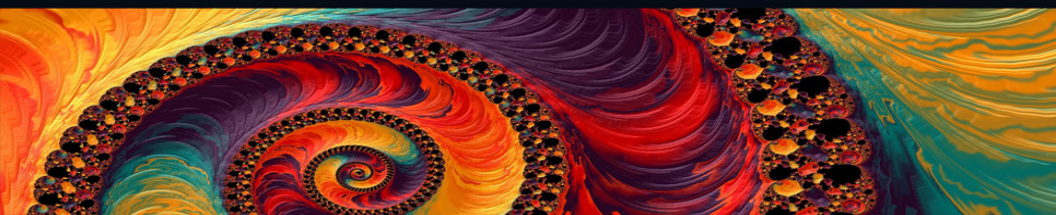


CRC FOCUS



DESIGN GUIDE FOR CONCRETE-FILLED DOUBLE SKIN STEEL TUBULAR STRUCTURES

Lin-Hai Han
Dennis Lam
David A Nethercot



CRC Press
Taylor & Francis Group

Design Guide for Concrete-Filled Double Skin Steel Tubular Structures

This is the first design guide on concrete-filled double skin steel tubular (CFDST) structures. It addresses in particular CFDST structures with plain concrete sandwiched between circular hollow sections and provides the relevant calculation methods and construction provisions for CFDST structures.

CFDST structures inherit the advantages of conventional concrete-filled steel tubular (CFST) structures, including high strength, good ductility and durability, high fire resistance and favorable constructability. Moreover, because of their unique sectional configuration, CFDST structures have been proved to possess lighter weight, higher bending stiffness and better cyclic performance than conventional CFST. Consequently, CFDST can offer reduced concrete consumption and construction costs.

This design guide is for engineers designing electrical grid infrastructures, wind power towers, bridge piers and other structures requiring light self-weight, high bending stiffness and high bearing capacity.



Taylor & Francis

Taylor & Francis Group

<http://taylorandfrancis.com>

Design Guide for Concrete-Filled Double Skin Steel Tubular Structures

Lin-Hai Han
Dennis Lam
David A. Nethercot



CRC Press

Taylor & Francis Group
Boca Raton London New York

CRC Press is an imprint of the
Taylor & Francis Group, an **informa** business

CRC Press
Taylor & Francis Group
6000 Broken Sound Parkway NW, Suite 300
Boca Raton, FL 33487-2742

© 2019 by Taylor & Francis Group, LLC
CRC Press is an imprint of Taylor & Francis Group, an Informa business

No claim to original U.S. Government works

Printed on acid-free paper

International Standard Book Number-13: 978-1-138-34023-7 (Hardback)

This book contains information obtained from authentic and highly regarded sources. Reasonable efforts have been made to publish reliable data and information, but the authors and publisher cannot assume responsibility for the validity of all materials or the consequences of their use. The authors and publishers have attempted to trace the copyright holders of all material reproduced in this publication and apologize to copyright holders if permission to publish in this form has not been obtained. If any copyright material has not been acknowledged please write and let us know so we may rectify in any future reprint.

Except as permitted under U.S. Copyright Law, no part of this book may be reprinted, reproduced, transmitted, or utilized in any form by any electronic, mechanical, or other means, now known or hereafter invented, including photocopying, microfilming, and recording, or in any information storage or retrieval system, without written permission from the publishers.

For permission to photocopy or use material electronically from this work, please access www.copyright.com (<http://www.copyright.com/>) or contact the Copyright Clearance Center, Inc. (CCC), 222 Rosewood Drive, Danvers, MA 01923, 978-750-8400. CCC is a not-for-profit organization that provides licenses and registration for a variety of users. For organizations that have been granted a photocopy license by the CCC, a separate system of payment has been arranged.

Trademark Notice: Product or corporate names may be trademarks or registered trademarks, and are used only for identification and explanation without intent to infringe.

Library of Congress Cataloging-in-Publication Data

Names: Han, Lin-Hai, author. | Lam, Dennis, author. | Nethercot, D. A., author.

Title: Design guide for concrete-filled double skin steel tubular structures / Lin-Hai Han, Dennis Lam and David Nethercot.

Description: First edition. | Boca Raton, FL : CRC Press/Taylor & Francis Group, [2019] | Includes bibliographical references and index.

Identifiers: LCCN 2018027397 (print) | LCCN 2018033839 (ebook) | ISBN 9780429802959 (Adobe PDF) | ISBN 9780429802942 (ePub) | ISBN 9780429802935 (Mobipocket) | ISBN 9781138340237

(hardback : acid-free paper) | ISBN 9780429440410 (ebook)

Subjects: LCSH: Tubular steel structures--Design and construction. | Concrete-filled tubes--Design and construction.

Classification: LCC TA684 (ebook) | LCC TA684 .H337 2019 (print) | DDC 624.1/821--dc23

LC record available at <https://lcn.loc.gov/2018027397>

Visit the Taylor & Francis website at
<http://www.taylorandfrancis.com>

and the CRC Press website at
<http://www.crcpress.com>

Contents

Preface, ix

About the Authors, xi

CHAPTER 1 ■ INTRODUCTION	1
1.1 CONCRETE-FILLED DOUBLE SKIN STEEL TUBES (CFDST)	1
1.2 ABOUT THIS GUIDE	11
1.3 DEFINITIONS	11
1.3.1 Concrete-Filled Double Skin Steel Tubular Structure	11
1.3.2 Hollow Ratio	11
1.3.3 Steel Ratio	11
1.3.4 Nominal Steel Ratio	11
1.3.5 Nominal Confinement Factor	12
1.4 SYMBOLS	12
1.4.1 Design Action and Action Effect	12
1.4.2 Computational Indices	12
1.4.3 Geometric Parameter	14
1.4.4 Computational Coefficients	16

CHAPTER 2 ■ MATERIALS	19
2.1 STEEL	19
2.2 CONCRETE	19
2.3 CONNECTION DEVICES	20
CHAPTER 3 ■ DESIGN OF CFDST COLUMNS	21
3.1 DESIGN PHILOSOPHY	21
3.1.1 General Rules	21
3.1.2 Design Indices	24
3.1.3 Deformation of Structures and Members	25
3.1.4 Anti-Corrosion	25
3.2 CROSS-SECTIONAL RESISTANCE	26
3.3 RESISTANCE OF MEMBERS UNDER AXIAL LOADING	28
3.4 RESISTANCE OF MEMBERS IN COMBINED AXIAL LOADING AND BENDING	33
3.5 LONG-TERM EFFECTS	36
3.6 LOCAL BEARING IN THE CONNECTION AREA	36
3.7 IMPACT	44
3.8 EFFECTS OF CORROSION	45
3.9 LIMITATION AND CALCULATION OF CONCRETE IMPERFECTION	46
CHAPTER 4 ■ JOINTS AND CONNECTIONS	49
4.1 GENERAL DESCRIPTION	49
4.2 JOINTS	50
4.3 FLANGE CONNECTIONS	63
4.4 PLATE CONNECTIONS	63
4.5 COLUMN-FOOT CONNECTIONS	64

CHAPTER 5 ■ FIRE-RESISTANCE DESIGN	67
------------------------------------	----

CHAPTER 6 ■ CONSTRUCTION	73
--------------------------	----

6.1 GENERAL DESCRIPTION	73
6.2 FABRICATION OF TUBULAR MEMBERS	73
6.3 CONCRETE PLACEMENT	74
6.4 QUALITY CHECK	75

REFERENCES, 77

APPENDIX 1: CALCULATION OF THE SHRINKAGE OF
THE SANDWICHED CONCRETE, 79

APPENDIX 2: STABILITY COEFFICIENT OF MEMBERS
UNDER AXIAL COMPRESSION, 83

APPENDIX 3: EXAMPLES FOR THE BEARING
CAPACITY CALCULATION OF CFDST MEMBERS, 107

INDEX, 111



Taylor & Francis

Taylor & Francis Group

<http://taylorandfrancis.com>

Preface

The concrete-filled double skin steel tubular (CFDST) structure is a new type of steel-concrete composite structure. It inherits the advantages of conventional concrete-filled steel tubular (CFST) structures, including high strength, good ductility and durability, high fire resistance and favorable constructability. Moreover, because of its unique sectional configuration, the CFDST structure has been proved to possess higher bending stiffness and better cyclic performance than conventional CFST structures. In addition, the use of CFDST structures could lead to lighter self-weight with less concrete consumption and a reduction of the foundation cost.

This design guide is based on the limit state design philosophy and is fully compliant with all the current Eurocodes. It covers the selection of materials, design of the CFDST structures, design of joints, fire protection requirements and practical construction issues. It will be a valuable guide for practicing engineers who are interested in the design of CFDST structures. Following the principle of sustainable development, the publication of this design guide is expected to exert positive effects on the application of CFDST structures.

Finally, the authors would like to thank and acknowledge the contributions from Mr. You-Xing Hua, Dr. Chao Hou, Dr. Wei Li, Dr. Kan Zhou and Dr. Therese Sheehan in preparation of this design guide.

Lin-Hai Han
Dennis Lam
David A. Nethercot



Taylor & Francis

Taylor & Francis Group

<http://taylorandfrancis.com>

About the Authors

Lin-Hai Han: The research areas of Prof. Han are theoretical and experimental structural performance with particular expertise in steel-concrete composite and mixed structures. He teaches composite and mixed structures, structural fire safety design, disaster and disaster prevention to undergraduates and postgraduates. His research contributions have been recognized by a number of prestigious awards/prizes, including the Distinguished Young Scholar Award from the Natural Science Foundation of China. He served as Head of Department, Department of Civil Engineering, School of Civil Engineering, Tsinghua University from 2010 to 2016. He has been serving as the Associate Dean of the School since 2017. Professor Han was appointed as Professor of Chang Jiang Scholars Program of the Ministry of Education, P.R. China since 2014.

Dennis Lam: Chair of Structural Engineering and the Director of the Centre for Sustainable Environments at the University of Bradford, UK. He was Chief Structural Engineer for the City of Wakefield, UK, and is a fellow of the Institution of Structural Engineers. He is the President of Association of Steel-Concrete Composite Structures. He is also a member of the British Standard Institute and European Committee on Standardization (CEN), which is responsible for the Eurocode 4, and chairs the working group for the revision of the Eurocode 4 (EN1994-1-1).

David A. Nethercot: Former Head of the Department of Civil and Environmental Engineering at Imperial College, London. He was for more than 10 years chairman of the BSI Committee responsible for BS5950 and for UK input into EC3, is a past chairman of IABSE's technical committee, past Deputy Chairman of the Council of the Steel Construction Institute. He is Past President of the IStructE and a former Council Member of the Royal Academy of Engineering, 2008 recipient of the Charles Massonnet prize from the European Convention for Structural Steelwork and received a Gold Medal from the Institution of Structural Engineers in 2009.