



ASCE Manuals
and Reports on
Engineering
Practice No. 130

Waterfront Facilities Inspection and Assessment

Waterfront Facility
Inspection Committee

Edited by
Ronald E. Heffron, P.E.



ASCE

Waterfront Facilities Inspection and Assessment

Waterfront Facility Inspection Committee

Edited by
Ronald E. Heffron, P.E.

Sponsored by
Technical Committee on Ports and Harbors of the
Coasts, Oceans, Ports, and Rivers Institute of the
American Society of Civil Engineers

ASCE AMERICAN SOCIETY
OF CIVIL ENGINEERS



COASTS, OCEANS,
PORTS & RIVERS
INSTITUTE

Library of Congress Cataloging-in-Publication Data

Waterfront facilities inspection and assessment / prepared by the Waterfront Facility Inspection Committee of the Technical Committee on Ports and Harbors of the Coasts, Oceans, Ports, and Rivers Institute of the American Society of Civil Engineers ; edited by Ronald E. Heffron, P.E. pages cm. — (ASCE manuals and reports on engineering practice ; no. 130)

Includes bibliographical references and index.

ISBN 978-0-7844-1357-9 (print : alk. paper) — ISBN 978-0-7844-7843-1 (PDF) 1. Harbors—Inspection—United States. 2. Hydraulic structures—Inspection—United States. I. Heffron, Ronald E., editor. II. Coasts, Oceans, Ports and Rivers Institute (American Society of Civil Engineers). Waterfront Facility Inspection Committee.

TC223.W38 2015

627'.24—dc23

2014030884

Published by American Society of Civil Engineers
1801 Alexander Bell Drive
Reston, Virginia, 20191-4382
www.asce.org/bookstore | ascelibrary.org

Any statements expressed in these materials are those of the individual authors and do not necessarily represent the views of ASCE, which takes no responsibility for any statement made herein. No reference made in this publication to any specific method, product, process, or service constitutes or implies an endorsement, recommendation, or warranty thereof by ASCE. The materials are for general information only and do not represent a standard of ASCE, nor are they intended as a reference in purchase specifications, contracts, regulations, statutes, or any other legal document. ASCE makes no representation or warranty of any kind, whether express or implied, concerning the accuracy, completeness, suitability, or utility of any information, apparatus, product, or process discussed in this publication, and assumes no liability therefor. The information contained in these materials should not be used without first securing competent advice with respect to its suitability for any general or specific application. Anyone utilizing such information assumes all liability arising from such use, including but not limited to infringement of any patent or patents.

ASCE and American Society of Civil Engineers—Registered in U.S. Patent and Trademark Office.

Photocopies and permissions. Permission to photocopy or reproduce material from ASCE publications can be requested by sending an e-mail to permissions@asce.org or by locating a title in ASCE's Civil Engineering Database (<http://cedb.asce.org>) or ASCE Library (<http://ascelibrary.org>) and using the "Permissions" link.

Errata: Errata, if any, can be found at <http://dx.doi.org/10.1061/9780784413579>

Copyright © 2015 by the American Society of Civil Engineers.

All Rights Reserved.

ISBN 978-0-7844-1357-9 (print)

ISBN 978-0-7844-7843-1 (PDF)

Manufactured in the United States of America.

22 21 20 19 18 17 16 15 1 2 3 4 5

MANUALS AND REPORTS ON ENGINEERING PRACTICE

(As developed by the ASCE Technical Procedures Committee, July 1930, and revised March 1935, February 1962, and April 1982)

A manual or report in this series consists of an orderly presentation of facts on a particular subject, supplemented by an analysis of limitations and applications of these facts. It contains information useful to the average engineer in his or her everyday work, rather than findings that may be useful only occasionally or rarely. It is not in any sense a "standard," however; nor is it so elementary or so conclusive as to provide a "rule of thumb" for nonengineers.

Furthermore, material in this series, in distinction from a paper (which expresses only one person's observations or opinions), is the work of a committee or group selected to assemble and express information on a specific topic. As often as practicable the committee is under the direction of one or more of the Technical Divisions and Councils, and the product evolved has been subjected to review by the Executive Committee of the Division or Council. As a step in the process of this review, proposed manuscripts are often brought before the members of the Technical Divisions and Councils for comment, which may serve as the basis for improvement. When published, each work shows the names of the committees by which it was compiled and indicates clearly the several processes through which it has passed in review, so that its merit may be definitely understood.

In February 1962 (and revised in April 1982), the Board of Direction voted to establish a series titled "Manuals and Reports on Engineering Practice," to include the Manuals published and authorized to date, future Manuals of Professional Practice, and Reports on Engineering Practice. All such Manual or Report material of the Society would have been refereed in a manner approved by the Board Committee on Publications and would be bound, with applicable discussion, in books similar to past Manuals. Numbering would be consecutive and would be a continuation of present Manual numbers. In some cases of joint committee reports, bypassing of Journal publications may be authorized.

A list of available Manuals of Practice can be found at <http://www.asce.org/bookstore>.

This page intentionally left blank

WATERFRONT FACILITY INSPECTION COMMITTEE

Ronald E. Heffron, P.E., D.PE, *Chairman*

Noah Elwood, *Secretary*

Terry Browne

Bill Bruin

Elizabeth Burkhart

Andrew Cairns

Sean Chapman

Steve Curtis

John Daley

Frank Davidson

Anna Dix

Joshua Johnson

Bryan Jones

Ikaika Kincaid

Shawn Lindmark

Matthew Martinez

Todd Mitchell

Bruce Ostbo

Ralph Petereit

Heath Pope

Kirk Riden

Charlie Roberts

Paul Roberts

Craig Sams

Alberto Sanchez

Shelley Sommerfeld

Tom Spencer

Warren Stewart

Erling Vegsund

BLUE RIBBON REVIEW PANEL

Lee Barco, APM Terminals

Richard Jenkins, Port of Seattle

Angel Lim, Port of Los Angeles

William Stahlman, America's Central Port

Philip Vitale, Naval Facilities Engineering Command

This page intentionally left blank

CONTENTS

PREFACE	xi
1. INTRODUCTION	1
1.1 Intent of the Manual	1
1.2 Importance of Inspections.....	3
1.3 How to Use this Manual	4
1.4 Limitations of Responsibility.....	4
1.5 Significant Changes and Owner’s Responsibilities	5
1.6 Limits of Inspection	6
1.7 Terminology	7
1.8 Organization	8
2. STANDARDS OF PRACTICE	9
2.1 Type and Frequency of Inspections.....	9
2.2 Selection of the Proper Inspection Type	21
2.3 Service Life Modeling: Purpose and Value	21
2.4 Minimum Qualifications of Inspection Personnel.....	26
2.5 Element-Level Damage Rating.....	28
2.6 Overall System Ratings	59
2.7 Recommended Action Guidelines	66
3. SCOPE OF INSPECTION WORK	69
3.1 General.....	69
3.2 Routine Inspections.....	71
3.3 Repair or Upgrade Design Inspections.....	91
3.4 New Construction Inspections	95
3.5 Baseline Inspections	98
3.6 Due Diligence Inspections	100
3.7 Special Inspections	102
3.8 Repair Construction Inspections	102
3.9 Post-Event Inspections.....	104

4. SERVICE LIFE ESTIMATION.....	107
4.1 General.....	107
4.2 Importance of Accurate Estimations	107
4.3 State of the Art.....	108
4.4 Corrosion Zones	109
4.5 Concrete Facilities	109
4.6 Steel Facilities.....	116
4.7 Timber Facilities	124
5. DOCUMENTATION AND REPORTING	127
5.1 General.....	127
5.2 Routine Inspection Report	128
5.3 Documentation	130
6. ADMINISTRATIVE CONSIDERATIONS.....	133
6.1 Agreements	133
6.2 Insurance	134
6.3 Certificates of Insurance.....	138
APPENDIX A. SPECIAL CONSIDERATIONS FOR SPECIFIC STRUCTURE TYPES AND SYSTEMS.....	139
A.1 Introduction	139
A.2 Open-Piled Structures.....	139
A.3 Relieving Platforms.....	156
A.4 Bulkheads and Retaining Walls	158
A.5 Seawalls and Revetments.....	163
A.6 Gravity Block Walls.....	166
A.7 Caissons, Cofferdams, and Cellular Structures	173
A.8 Paving Adjacent to Quaywalls, Bulkheads, and Other Retaining Structures.....	179
A.9 Floating Structures	186
A.10 Mooring Hardware and Fender Systems	192
A.11 Mooring Buoy Systems	203
A.12 Wave Screens and Attenuators	215
A.13 Waterfront Security Barriers.....	219
A.14 Coatings and Cathodic Protection Systems	220
A.15 Marina and Small Craft Harbor Components	226
A.16 Gangways.....	233
A.17 Boat Ramps	237
A.18 Marine Railways.....	239
A.19 Bullrails, Ladders, and Safety Features.....	240
A.20 Crane Rails, Trenching, and Cables	243
A.21 Waterfront Utility Systems	244
A.22 Anchors and Chains	251

APPENDIX B. TYPES AND CAUSES OF DEFECTS	253
B.1 Introduction	253
B.2 Concrete Structures	253
B.3 Steel Structures	271
B.4 Timber Structures	277
B.5 Masonry Structures	283
B.6 Composite Structural Components	288
B.7 Coating and Wrap Systems	290
B.8 Load Isolators and Bearings	292
B.9 Undermining or Scour	294
APPENDIX C. OVERVIEW OF SPECIALIZED TECHNIQUES	297
C.1 Introduction	297
C.2 Infrared Thermography	299
C.3 Ground-Penetrating Radar	301
C.4 Acoustic Emission	304
C.5 Steel Reinforcement Testing	305
C.6 Schmidt Hammer	307
C.7 Impact-Echo Testing	308
C.8 Windsor Probe	309
C.9 Half-Cell Testing Corrosion Survey	309
C.10 Chloride Ion Testing	312
C.11 Material Sampling	313
C.12 Ultrasonic Testing	317
C.13 Liquid Penetrant	320
C.14 Magnetic Particle	322
C.15 Structure Monitoring Systems	325
C.16 Unknown Foundation Investigation	329
C.17 Underwater Acoustic Imaging and Channel Bottom Soundings	331
C.18 Microbial-Induced Corrosion	338
APPENDIX D. INSPECTION NOMENCLATURE	341
D.1 Data Collection Nomenclature	341
D.2 Reporting Nomenclature	342
APPENDIX E. GLOSSARY	347
REFERENCES	367
INDEX	371

This page intentionally left blank

PREFACE

This manual provides guidelines and methodology for conducting engineering inspections and assessments of existing waterfront facilities constructed of materials including concrete, masonry, metals, composites, and wood; and located in near-shore, waterfront, and inland locations exposed to fresh or seawater. It also presents guidelines representing standards of practices, documentation and reporting, and administrative considerations for various inspection types, including routine, structural repair or upgrade design, new construction, baseline, due diligence, special, repair construction, and post-event inspections.

The extensive appendices provide guidelines for special considerations for specific structure types and systems, the types and causes of defects, specialized instruction techniques, inspection nomenclature, and an extensive glossary of key terms.

This page intentionally left blank

CHAPTER 1

INTRODUCTION

1.1 INTENT OF THE MANUAL

The intent of this Manual of Practice is to provide guidelines and methodology for conducting engineering inspections and assessments of existing waterfront facilities constructed of materials including concrete, masonry, metals, composites, and wood; and located in near-shore, waterfront, and inland locations exposed to fresh or seawater. It includes, but is not limited to

- Piers (jetties),
- Wharves (quays),
- Dolphins,
- Bulkheads (quay walls),
- Seawalls,
- Relieving platforms,
- Gravity block walls,
- Caissons and cofferdams,
- Wave screens/attenuators,
- Marinas,
- Boat ramps,
- Marine railways,
- Floating structures,
- Single-point and multi-buoy moorings (SPMs, MBMs, etc.), and
- Slope protection.

The scope of the inspections covered in this manual includes fixed utilities, equipment, mooring hardware, topside paving and drainage, safety features, and appurtenances typically associated with waterfront