

Seismic Design of Piers and Wharves

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American Society of Civil Engineers

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STANDARDS

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The following standards have been issued:

- ANSI/ASCE 1-82 N-725 Guideline for Design and Analysis of Nuclear Safety Related Earth Structures
- ASCE/EWRI 2-06 Measurement of Oxygen Transfer in Clean Water
- ANSI/ASCE 3-91 Standard for the Structural Design of Composite Slabs and ANSI/ASCE 9-91 Standard Practice for the Construction and Inspection of Composite Slabs
- ASCE 4-98 Seismic Analysis of Safety-Related Nuclear Structures
- Building Code Requirements for Masonry Structures (ACI 530-13/ASCE 5-13/TMS 402-13) and Specifications for Masonry Structures (ACI 530.1-13/ASCE 6-13/TMS 602-13)
- ASCE/SEI 7-10 Minimum Design Loads for Buildings and Other Structures
- SEI/ASCE 8-02 Standard Specification for the Design of Cold-Formed Stainless Steel Structural Members
- ANSI/ASCE 9-91 listed with ASCE 3-91
- ASCE 10-97 Design of Latticed Steel Transmission Structures
- SEI/ASCE 11-99 Guideline for Structural Condition Assessment of Existing Buildings
- ASCE/EWRI 12-13 Standard Guidelines for the Design of Urban Subsurface Drainage
- ASCE/EWRI 13-13 Standard Guidelines for the Installation of Urban Subsurface Drainage
- ASCE/EWRI 14-13 Standard Guidelines for the Operation and Maintenance of Urban Subsurface Drainage
- ASCE 15-98 Standard Practice for Direct Design of Buried Precast Concrete Pipe Using Standard Installations (SIDD)
- ASCE 16-95 Standard for Load Resistance Factor Design (LRFD) of Engineered Wood Construction
- ASCE 17-96 Air-Supported Structures
- ASCE 18-96 Standard Guidelines for In-Process Oxygen Transfer Testing
- ASCE 19-10 Structural Applications of Steel Cables for Buildings
- ASCE 20-96 Standard Guidelines for the Design and Installation of Pile Foundations
- ANSI/ASCE/T&DI 21-13 Automated People Mover Standards
- SEI/ASCE 23-97 Specification for Structural Steel Beams with Web Openings
- ASCE/SEI 24-05 Flood Resistant Design and Construction
- ASCE/SEI 25-06 Earthquake-Actuated Automatic Gas Shutoff Devices
- ASCE 26-97 Standard Practice for Design of Buried Precast Concrete Box Sections
- ASCE 27-00 Standard Practice for Direct Design of Precast Concrete Pipe for Jacking in Trenchless Construction
- ASCE 28-00 Standard Practice for Direct Design of Precast Concrete Box Sections for Jacking in Trenchless Construction
- ASCE/SEI/SFPE 29-05 Standard Calculation Methods for Structural Fire Protection
- SEI/ASCE 30-14 Guideline for Condition Assessment of the Building Envelope
- SEI/ASCE 31-03 Seismic Evaluation of Existing Buildings
- SEI/ASCE 32-01 Design and Construction of Frost-Protected Shallow Foundations
- EWRI/ASCE 33-09 Comprehensive Transboundary International Water Quality Management Agreement
- EWRI/ASCE 34-01 Standard Guidelines for Artificial Recharge of Ground Water
- EWRI/ASCE 35-01 Guidelines for Quality Assurance of Installed Fine-Pore Aeration Equipment
- CI/ASCE 36-01 Standard Construction Guidelines for Microtunneling
- SEI/ASCE 37-02 Design Loads on Structures during Construction
- CI/ASCE 38-02 Standard Guideline for the Collection and Depiction of Existing Subsurface Utility Data
- EWRI/ASCE 39-03 Standard Practice for the Design and Operation of Hail Suppression Projects
- ASCE/EWRI 40-03 Regulated Riparian Model Water Code
- ASCE/SEI 41-06 Seismic Rehabilitation of Existing Buildings
- ASCE/EWRI 42-04 Standard Practice for the Design and Operation of Precipitation Enhancement Projects
- ASCE/SEI 43-05 Seismic Design Criteria for Structures, Systems, and Components in Nuclear Facilities
- ASCE/EWRI 44-05 Standard Practice for the Design and Operation of Supercooled Fog Dispersal Projects
- ASCE/EWRI 45-05 Standard Guidelines for the Design of Urban Stormwater Systems
- ASCE/EWRI 46-05 Standard Guidelines for the Installation of Urban Stormwater Systems
- ASCE/EWRI 47-05 Standard Guidelines for the Operation and Maintenance of Urban Stormwater Systems
- ASCE/SEI 48-11 Design of Steel Transmission Pole Structures
- ASCE/SEI 49-12 Wind Tunnel Testing for Buildings and Other Structures
- ASCE/EWRI 50-08 Standard Guideline for Fitting Saturated Hydraulic Conductivity Using Probability Density Functions
- ASCE/EWRI 51-08 Standard Guideline for Calculating the Effective Saturated Hydraulic Conductivity
- ASCE/SEI 52-10 Design of Fiberglass-Reinforced Plastic (FRP) Stacks
- ASCE/G-I 53-10 Compaction Grouting Consensus Guide
- ASCE/EWRI 54-10 Standard Guideline for Geostatistical Estimation and Block-Averaging of Homogeneous and Isotropic Saturated Hydraulic Conductivity
- ASCE/SEI 55-10 Tensile Membrane Structures
- ANSI/ASCE/EWRI 56-10 Guidelines for the Physical Security of Water Utilities
- ANSI/ASCE/EWRI 57-10 Guidelines for the Physical Security of Wastewater/Stormwater Utilities
- ASCE/T&DI/ICPI 58-10 Structural Design of Interlocking Concrete Pavement for Municipal Streets and Roadways
- ASCE/SEI 59-11 Blast Protection of Buildings
- ASCE/EWRI 60-12 Guidelines for Development of Effective Water Sharing Agreement
- ASCE/COPRI 61-14 Seismic Design of Piers and Wharves

PREFACE

This is the first edition of this standard. This standard has been developed by a group of practicing structural engineers, geotechnical engineers, owners, and academics with specific expertise and experience in the marine and waterfront industries. It is intended to reflect the current practice of seismic design of piers and wharves, aspects of which differ considerably from conventional design of buildings or building-like structures. For example, load combinations for piers and wharves are unique and include berthing and mooring loads that may govern the lateral load design in low seismic regions. Geotechnical issues are a prime concern for these types of structures, with pile foundations often penetrating through weak soil layers. Liquefaction, lateral spreading, and ground failures affecting slopes and earth structures are all primary considerations for the analysis and design of piers and wharves. It is often not practical to eliminate these hazards; rather, structures are designed to accommodate permanent ground deformations within specified performance requirements.

This standard contains displacement-based design methods that have become widely used in the industry for more than a decade and have been supported by a number of industry-sponsored testing programs.

This standard is intended to benefit designers and owners by providing a method for considering the economic importance of a structure in addition to meeting life safety requirements. It is also intended to benefit building officials who do not routinely deal with waterfront structures.

Compliance with this standard should not be considered a guarantee that the desired performance goals will be achieved. Variation between the desired performance levels and actual performance should be expected because of the inherent uncertainties in prediction of seismic ground motion, liquefaction, and other seismic effects and because of the inherent uncertainties in levels of workmanship, material strengths, levels of maintenance, structure condition, and other effects.

This standard has been prepared in accordance with recognized engineering principles and should not be used without the user's competent knowledge for a given application. The publication of this standard by ASCE is not intended to warrant that the information contained herein is suitable for any general or specific use, and ASCE takes no position respecting the validity of patent rights. The user is advised that the determination of patent rights or risk of infringement is entirely his or her own responsibility.

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CHAPTER 1

GENERAL

1.1 INTRODUCTION

1.1.1 Purpose The purpose of this standard is to provide minimum requirements for the seismic design of pile-supported piers and wharves.

1.1.2 Scope and Limitations This standard addresses the seismic design of new piers and wharves supported on concrete or steel piles.

This standard does not address the following:

- Structures that are subject to different operational or special regulatory requirements such as offshore platforms or liquefied natural gas (LNG) terminals, or
- Piers or wharves that are accessible to the general public.

This standard does not address all of the aspects of design of sheet pile walls, cellular walls, or similar structures that may be components of a pile-supported pier or wharf.

This standard is intended for use by qualified geotechnical and structural engineers with experience in the marine industry and officials engaged in preparing and administering local codes. This standard is not intended to replace sound engineering knowledge, experience, and judgment.

1.2 DEFINITIONS

The following definitions apply to the provisions of Chapter 1:

PIERS: In this standard, piers are pile-supported platform structures that extend outward perpendicular, or almost perpen-

dicular, from the shore into a body of water and allow water to flow underneath.

WHARVES: In this standard, wharves are pile-supported platform structures that are constructed parallel or almost parallel to the shore.

1.3 DOCUMENT LAYOUT

Chapter 1 presents the purpose, scope, limitations, and layout of this standard. Chapter 2 defines seismic design classifications, performance requirements, and seismic hazard levels. Chapter 3 provides the required steps and criteria for performing a seismic design of a pier or wharf. Chapter 4 introduces the geotechnical considerations required for a seismic design. Chapter 5 presents criteria for force-based design, and Chapter 6 presents those for displacement-based design. Chapter 7 provides provisions for design and detailing. Chapter 8 deals with design considerations for ancillary and nonstructural components. A commentary is provided for each chapter.

1.4 UNITS

Both English and SI units are presented in this document unless noted otherwise.