

Guide for the Analysis, Design, and Construction of Elevated Concrete and Composite Steel- Concrete Water Storage Tanks

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Guide for the Analysis, Design, and Construction of Elevated Concrete and Composite Steel-Concrete Water Storage Tanks

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This guide presents recommendations for materials, analysis, design, and construction of concrete-pedestal elevated water storage tanks, including all-concrete and composite tanks. Composite tanks consist of a steel water storage vessel supported on a cylindrical reinforced concrete pedestal.

Concrete-pedestal elevated water storage tanks are structures that present special problems not encountered in typical environmental engineering concrete structures. This guide refers to ACI 350 for design and construction of those components of the pedestal tank in contact with the stored water, and to ACI 308 for design and construction of components not in contact with the stored water. Determination of snow, wind, and seismic loads based on ASCE/SEI 7 is included. These loads conform to the requirements of national building codes that use ASCE/SEI 7 as the basis for environmental loads as well as those of local building codes. Special requirements, based on successful experience, for the unique aspects of loads, analysis, design, and construction of concrete-pedestal tanks are presented.

Keywords: composite tanks; concrete pedestal tanks; earthquake-resistant structures; elevated water tanks; formwork (construction).

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CONTENTS

CHAPTER 1—GENERAL, p. 2

- 1.1—Introduction, p. 2
- 1.2—Scope, p. 2
- 1.3—Construction documents, p. 2
- 1.4—Sample tank photos, p. 3

CHAPTER 2—NOTATION AND DEFINITIONS, p. 5

- 2.1—Notation, p. 5
- 2.2—Definitions, p. 7

CHAPTER 3—MATERIALS, p. 7

- 3.1—Materials common to both composite and concrete tank types, p. 7
- 3.2—Materials specific to composite tanks, p. 8
- 3.3—Materials specific to concrete tanks, p. 8

CHAPTER 4—DESIGN, p. 8

- 4.1—General recommendations common to both composite and concrete tank types, p. 8
- 4.2—Load recommendations common to both composite and concrete tank types, p. 10
- 4.3—Design of components common to both composite and concrete tank types, p. 15
- 4.4—Design of components specific to composite tanks, p. 20
- 4.5—Design of components specific to all-concrete tanks, p. 22

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CHAPTER 5—CONSTRUCTION, p. 24

- 5.1—Construction common to both composite and concrete tank types, p. 24
- 5.2—Construction specific to composite tanks, p. 28
- 5.3—Construction specific to concrete tanks, p. 29

CHAPTER 6—GEOTECHNICAL RECOMMENDATIONS, p. 30

- 6.1—General, p. 30
- 6.2—Foundation depth, p. 30
- 6.3—Settlement limits, p. 30
- 6.4—Shallow foundations, p. 31
- 6.5—Deep foundations, p. 31
- 6.6—Seismic recommendations, p. 32
- 6.7—Special considerations, p. 32

CHAPTER 7—APPURTENANCES AND ACCESSORIES, p. 32

- 7.1—General, p. 32
- 7.2—Pedestal access, p. 32
- 7.3—Ventilation, p. 32
- 7.4—Tank access, p. 34
- 7.5—Rigging devices for steel vessel, p. 35
- 7.6—Above-ground piping, p. 36
- 7.7—Below-ground piping, p. 36
- 7.8—Interior floors within pedestal, p. 37
- 7.9—Electrical and lighting, p. 37

CHAPTER 8—REFERENCES, p. 38

- Authored references, p. 39

APPENDIX A—GUIDE SUPPLEMENT, p. 39

- Preface, p. 39
- A.1—Factored design wind pressures, p. 39
- A.2—Composite steel concrete tank approximate period of vibration derivation, p. 39
- A.3—Pedestal: vertical load capacity derivation, p. 40

CHAPTER 1—GENERAL**1.1—Introduction**

This guide provides recommendations for the design and construction of elevated concrete and composite steel-concrete water storage tanks based on practices used in successful projects. Elevated tanks are used by municipalities and industry for potable water supply and fire protection. Commonly, capacities of elevated concrete and composite steel-concrete water storage tanks range from 500,000 to 3,000,000 gal. (1900 to 11,000 m³). Concrete pedestal heights range from 25 to 200 ft (8 to 60 m), depending on water system requirements and site elevation. The interior of the concrete pedestal may be used for material and equipment storage, office space, and other applications.

Since the 1970s, concrete-pedestal elevated water storage tanks have been constructed in North America with a steel water-containing element and an all-concrete support structure. The generic term “composite elevated tank” is often used to describe tanks of this configuration. A few

all-concrete elevated tanks have been built in the United States throughout the last century, as well as a few elevated prestressed tanks jacked into place. Elevated post-tensioned tanks as detailed in this guide have a long history in Europe, and were introduced to the U.S. market in the 1990s.

All-concrete and composite steel concrete elevated tanks are competitively marketed as complete entities, including design, and are constructed under design-build contracts using proprietary designs, details, and methods of construction. The designs, however, are frequently reviewed by owners and their consulting engineers, or by city or county officials.

Elevated tanks designed and constructed in accordance with the recommendations of this guide are expected to be durable structures that require only routine maintenance. Details of concrete surfaces that promote good drainage and avoid low areas conducive to ponding essentially eliminate the problems associated with cyclic freezing and thawing of fresh concrete in cold climates. The quality of concrete for elevated tanks in this guide meets the requirements for durable concrete as defined in ACI 201.2R. It has adequate strength, a low water-cementitious materials ratio (w/cm), and air entrainment for most exposure. The concrete support structure loads are primarily compressive with little or no cyclic loading with stress reversal.

1.2—Scope

Recommendations supplement the general requirements for reinforced concrete and prestressed concrete design and construction given in ACI 318, ACI 301, ACI 350, and ACI 350.3R. Design and construction recommendations include materials, determination of structural loads, design of concrete elements including foundations, design of concrete or steel tank components, construction requirements, geotechnical requirements, appurtenances, and accessories. Materials, design, fabrication, and construction of the steel vessel of composite steel-concrete tanks are addressed by applicable sections of AWWA D100.

Design and construction recommendations are presented for the types of elevated concrete and composite steel-concrete water storage tanks shown in Fig. 1.2a and 1.2b. The elevated concrete tank consists of a post-tensioned concrete vessel on a cast-in-place concrete pedestal. The composite steel-concrete tank consists of a steel vessel on a cast-in-place concrete pedestal.

This guide may be used in whole or part for other tank configurations; however, the designer should determine the suitability of such use for other configurations and details.

1.3—Construction documents

Construction documents should show all features of the work, including:

- (a) Tank capacity
- (b) Codes and standards used in design
- (c) Design basis and loads used in design
- (d) Size and position of structural components and reinforcement
- (e) Structural details
- (f) Specified concrete compressive strength