Tendon-Prestressed Concrete Water Tanks

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Committee Personnel

The AWWA Standards Committee on Concrete Water Tanks, Tendon-Type Prestressed, which reviewed and approved this standard, had the following personnel at the time of approval:

Lawrence Thomas, Chair

General Interest Members

R.T. Bates, Bates Engineering Inc., Lakewood, Colo. (AWWA)
C.A. Close, Bonita, Calif. (AWWA)
D.E. Gruel, San Diego, Calif. (AWWA)
T.P. Kenyon, McLaughlin-Rincon Ltd., Denver, Colo. (AWWA)
T.J. McCandless, * Standards Engineer Liaison, AWWA, Denver, Colo. (AWWA)
L.E. Thomas, Baxter & Woodman Inc., Crystal Lake, Ill. (AWWA)
T.R. Volz, URS Corporation, Denver, Colo. (AWWA)
M.L. Wetzel, Dufresne-Henry Inc., Westford, Mass. (AWWA)

Producer Members

R.H. Allen, APT Systems Inc., Commerce City, Colo. (AWWA)
R.R. Imper, Morse Brothers Inc., Sunriver, Ore. (AWWA)
A.M. James, Arthur M. James Engineering, Portland, Ore. (AWWA)
T.L. Neff, Post-Tensioning Institute, Phoenix, Ariz. (AWWA)
B.A. Zavitz, Tindall Concrete of Georgia Inc., Conley, Ga. (PTI)

User Members

D.J. Elmer, Indianapolis Water Company, Indianapolis, Ind. (AWWA)
K.L. Hill, Las Vegas, Nev. (AWWA)
W.J. Horst, Montgomery County Sanitary, Engineering Department, Kettering, Ohio (AWWA)
R.F. Miller, † Indianapolis, Ind. (AWWA)

* Liaison, nonvoting
† Alternate
All AWWA standards follow the general format indicated subsequently. Some variations from this format may be found in a particular standard.

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Foreword

This foreword is for information only and is not part of ANSI/AWWA D115.

I. Introduction.

I.A. Background. The New England Water Works Association (NEWWA) established a committee in 1958 to prepare a standard for the design and construction of circular prestressed concrete water storage tanks. The committee submitted a suggested specification covering wire-wound prestressed concrete tanks to NEWWA in October 1962 as a guide to those water utility people who wished to consider the use of these tanks.

The American Concrete Institute (ACI*) Committee 344 concluded eight years of committee work with a report titled “Design and Construction of Circular Prestressed Concrete Structures,” published in the ACI Journal in September 1970. This report referred to both wire-wound and tendon tanks. After publication of its first report in 1970, ACI Committee 344 could not reach a consensus on a combined report covering both wire-wound and tendon tanks. In 1985 the ACI Committee was divided into two subcommittees and “interim” reports were completed in 1988 for both types of tanks. ACI did not publish these interim reports but made copies available until a consensus could be reached on a recombin ed report. However, a consensus could not be reached and in the spring of 1994 ACI Committee 344 was divided into two separate committees, ACI 372 and ACI 373.

I.B. History. In the December 1972 issue of AWWA Journal, circular prestressed concrete water containment structures were discussed in four articles. As a result of these articles and continued discussion on the subject, a standards committee was authorized by the AWWA Standards Council on June 20, 1974, to develop an AWWA standard on circular prestressed concrete water tanks. The AWWA Standards Committee on Circular Prestressed-Concrete Water Tanks held its first meeting June 19, 1974.

After many meetings and the presentation of many differing viewpoints, this committee decided to defer work on a standard for tendon tanks and to concentrate only on a standard for wire-wound tanks. ANSI/AWWA D110-86, Standard for Wire-Wound Prestressed Concrete Tanks, was published in 1986.

*ACI International, 38800 Country Club Drive, Farmington Hills, MI 48331.
In 1988 the AWWA Standards Council authorized the formation of a new standards committee to develop a standard for tendon-type prestressed concrete tanks, with the assigned task of developing a standard for the safe, efficient use of tendon stressing techniques for design and construction of tanks. Subsequently this new AWWA standards committee was formed and held its first meeting on June 21, 1989, under its first chair, Ib Falk Jorgensen.

The first edition of this standard was published in 1996 and incorporated applicable work of ACI and the AWWA standards committee, which developed ANSI/AWWA D110-86. It contained requirements and recommendations, specifically for potable water containment structures prestressed with bonded circumferential tendons.

This second edition is expanded to include tendon prestressed tanks of rectangular and other shapes, as well as circular. It was approved on Feb. 12, 2006.

I.C. Acceptance. In May 1985, the US Environmental Protection Agency (USEPA) entered into a cooperative agreement with a consortium led by NSF International (NSF) to develop voluntary third-party consensus standards and a certification program for direct and indirect drinking water additives. Other members of the consortium included the American Water Works Association Research Foundation (AwwaRF), the Conference of State Health and Environmental Managers (COSHEM). The American Water Works Association (AWWA), and the Association of State Drinking Water Administrators (ASDWA) joined later.

In the United States, authority to regulate products for use in, or in contact with, drinking water rests with individual states. Local agencies may choose to impose requirements more stringent than those required by the state. To evaluate the health effects of products and drinking water additives from such products, state and local agencies may use various references, including

2. Specific policies of the state or local agency.
3. Two standards developed under the direction of NSF, NSF†/ANSI‡ 60, Drinking Water Treatment Chemicals—Health Effects, and NSF/ANSI 61, Drinking Water System Components—Health Effects.

*Persons outside the United States should contact the appropriate authority having jurisdiction.
†NSF International, 789 North Dixboro Rd., Ann Arbor, MI 48105.
‡American National Standards Institute, 25 West 43rd Street, Fourth Floor, New York, NY 10036.
4. Other references, including AWWA standards, *Food Chemicals Codex, Water Chemicals Codex*, and other standards considered appropriate by the state or local agency.

Various certification organizations may be involved in certifying products in accordance with NSF/ANSI 61. Individual states or local agencies have authority to accept or accredit certification organizations within their jurisdiction. Accreditation of certification organizations may vary from jurisdiction to jurisdiction. Annex A “Toxicology Review and Evaluation Procedures” to NSF/ANSI 61 does not stipulate a maximum allowable level (MAL) of a contaminant for substances not regulated by a USEPA final maximum contaminant level (MCL). The MALs of an unspecified list of “unregulated contaminants” are based on toxicity testing guidelines (noncarcinogens) and risk characterization methodology (carcinogens). Use of Annex A procedures may not always be identical, depending on the certifier.

ANSI/AWWA D115 does not address additives requirements. Thus, users of this standard should consult the appropriate state or local agency having jurisdiction in order to

1. Determine additives requirements, including applicable standards.
2. Determine the status of certifications by parties offering to certify products for contact with, or treatment of, drinking water.
3. Determine current information on product certification.

II. Special Issues.

II.A. General. This standard reflects a committee consensus of industry practice concerning the design, detailing, and construction of prestressed concrete water tanks that employ horizontal prestressing tendons, placed either internally or on the wall's surface. Recommended criteria and guidelines are presented to assist engineers in design and construction of both cast-in-place and precast concrete tanks using tendon prestressing, based on the specific detailed experience of the committee members. Engineering principles are tied to existing codes where applicable. Design and construction of prestressed-concrete water tanks is complex, requiring a wide range of special knowledge and experience. This standard represents a sharing of information on the unique aspects of analysis and construction that are encountered in these types of structures.

*Both publications available from National Academy of Sciences, 500 Fifth Street, NW, Washington, DC 20001.*
II.B. **Site-specific Conditions.** Because of the wide range of site specific environments, foundation conditions, loadings, and construction conditions throughout North America, this standard should not be expected to universally apply or to produce a cost-effective and maintenance-free structure in every situation. In adapting this standard to obtain the structure’s expected service life for the actual conditions that are anticipated, the purchaser and the designer of the tank are advised to carefully study factors affecting the structure.

II.C. **Use of Horizontal Unbonded Tendons.** The owner must rely on the judgement of the project engineer to determine if the use of bonded or unbonded tendons is in the owner’s best interest, taking into account the unique design and site conditions of each tank.

III. **Use of This Standard.** It is the responsibility of the user of an AWWA standard to determine that the products described in that standard are suitable for use in the particular application being considered.

III.A. **Purchaser Options and Alternatives.** It is not the purpose of this standard either to define or recommend contractual relationships or to stipulate contractual obligations, both of which are the responsibility of the purchaser. Generally, purchasers may solicit competitive bids for tendon-prestressed concrete tanks by one of two alternative methods.

Under the first method, a qualified engineer is retained by the purchaser to design the structure and prepare construction drawings, specifications, and other contract documents. Competitive bids are then solicited from constructors and suppliers for construction of the tank. In this standard, these are referred to as *purchaser-furnished designs.*

Under the second method, the purchaser prepares performance specifications which require bidding constructors to prepare detailed project designs and specifications and construct the tank according to the approved design. In this standard, these are referred to as *design–construct projects.*

While the division of information that must be covered in the purchaser’s specifications for execution of each project type differs substantially, depending on who is responsible for the tank design, the information that must be supplied by the purchaser to successfully apply this standard is essentially the same.

ANSI/AWWA D115 does not address matters related to site selection and property acquisition. It has been assumed that the purchaser will have conducted sufficient background work in the form of studies, predesign surveys, subsurface...
investigations, and preliminary design work to establish the desired tank site, volume, operating water depth, and elevations. It is also assumed the purchaser will have acquired the property, easements, and rights-of-way necessary for construction of the tank structure and associated pipelines connecting it to the system. Finally, it has been assumed that the purchaser will accomplish and/or provide the following as necessary or appropriate:

1. Whether compliance with NSF/ANSI 61, Drinking Water System Components—Health Effects, is required, in addition to the requirements of the Safe Drinking Water Act.
2. The site on which the tank is to be built, with adequate space to permit the constructor to erect the structure using customary methods.
3. A predesign site survey and preparation of a site plan showing existing topography, property lines, approximate tank centerline location, setback, encumbrances, details of special construction features, and extent of final site grading.
4. A site geotechnical survey and foundation report, including logs of borings and test pits, and other pertinent soil and geological information, construction criteria for any backfill that may be necessary at a particular site, and foundation design criteria prepared by a professional engineer specializing in soil mechanics, including allowable bearing loads, anticipated total and differential settlements, and the seismic soil profile type.
5. Structure loading conditions, including but not limited to snow, wind, seismic, hydrostatic uplift and other live loads, depending on the tank's intended use; the amount of earth cover over the tank, if any; the height of backfill against the tank wall, if any; and any other special loading conditions that are anticipated or special criteria on which the tank design is to be based. If, for example, the tank is located in a high-intensity earthquake area and must continue to serve without damage, the purchaser may specify an importance factor for earthquake design as described in Sec. 4.3.1 or provide design values for the horizontal acceleration and for the spectrum velocity.
6. A groundwater drainage and collection system plan.
7. Delivery of electric power and water service to the site.
8. Details of other federal, state, local, and provincial requirements (Sec. 2.1).

III.A.1. Information Required for Use of This Standard. The items which follow are either required information or alternative options in the standard that should
be considered and covered in the purchase documents, unless the purchaser intends that the choice for a particular option be left to the tank designer's discretion.

1. The standard used, that is ANSI/AWWA D115, Tendon-Prestressed Concrete Water Tanks.
2. The required tank capacity and either the plan dimensions or operating water depth.
3. The size, material, location, details, cover depths, and limits of responsibility of pipe connections.
4. The required elevation of the overflow weir and freeboard requirements.
5. The size, material, arrangement and location of the overflow pipe.
6. Finish grade relative to the tank foundation. (Are the tank walls to be completely exposed, partially buried, or completely buried?)
7. Aboveground exterior concrete coatings or additional shotcrete cover, if required (Sec. 2.12.1 and Sec. 5.4.3).
8. Below-grade concrete coatings, if required (Sec. 2.12.2).
9. Design loading conditions (Sec. 3.3.1, Sec. 3.3.2, Sec. 3.3.3, and Sec. 3.3.4).
10. Type of roof structure required: flat with column supports or domed (Sec. 3.8, Sec. 3.9, and Sec. 3.10).
11. Freeze protection requirements (Sec. 3.12).
12. Tank Appurtenances required:
   a. Whether a removable silt stop is required.
   b. Arrangement of inlet–outlet piping, including cover depths (Sec. 3.13.1).
   c. Whether baffles are required (Sec. 3.13.1).
   d. Encasement of piping beneath the floor slab (Sec. 3.13.1.3).
   e. Design rates of inflow and outflow for design of overflow and vent systems (Sec. 3.13.2.1 and 3.13.3.2).
   f. Tank drain line (Sec. 3.13.2.3).
   g. Water level gauge or pressure sensor (Sec. 3.13.2.4).
   h. Required roof openings and hatches (Sec. 3.13.3).
   i. Roof ventilator requirements (Sec. 3.13.3.2).
   j. Access ladder and stair requirements (Sec. 3.13.4).
13. Details of other federal, state, local, and provincial requirements (Sec. 2.1).
14. Seismic Importance Factor (Table 1) (Sec. 4.1).
15. Seismic Soil Profile Coefficient (Table 3) from geotechnical foundation survey provided by the purchaser (Sec. 4.1).

This is a preview of "AWWA D115-06". Click here to purchase the full version from the ANSI store.
IV. Modification of Standard. Any modification of the provisions, definitions, or terminology in this standard must be provided by the purchaser.

V. Major Revisions. The second edition of this standard incorporates the following major revisions:

1. The Standard ANSI/AWWA D115 title is changed from “Circular Prestressed Concrete Water Tanks With Circumferential Tendons” to “Tendon-Prestressed Concrete Water Tanks.”

2. The scope of the standard is expanded to include rectangular and other non-circular shapes as may be applicable (oblong, rectangular with rounded corners, etc.) and to allow the use of unbonded tendons as provided for in this standard.

3. Section 1 references have been updated.

4. Section 2 material standards are updated for cement grout, aggregates, admixtures, reinforcement, sheathing, bearing pads, and shrinkage compensating grout.

5. Section 3 design standards are updated for wall footings, floors, walls, vertical reinforcement, construction joints, and concrete and shotcrete cover.

6. Section 4 seismic design calculations are removed from the standard and replaced with references to appropriate ACI on Standards.

7. Section 5 construction procedures are updated for tendon ducts, grouting, and shotcreting.

VI. Comments. If you have any comments or questions about this standard, please call the AWWA Volunteer & Technical Support Group, at 303.794.7711, FAX at 303.794.7603, write to the group at 6666 West Quincy Avenue, Denver, CO 80235-3098, or e-mail standards@awwa.org.
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Tendon-Prestressed
Concrete Water Tanks

SECTION 1: GENERAL

Sec. 1.1 Scope

This standard describes current and recommended practice for the design, construction, and field observations of concrete tanks using tendons for prestressing. This standard applies to containment structures for use with potable water, raw water, or wastewater.

Sec. 1.2 Definitions

The following definitions shall apply in this standard:

1. **Core wall**: That portion of a concrete wall that is horizontally prestressed.

2. **Epoxy bonding agent**: An epoxy used in repair processes to bond fresh, plastic concrete mix, mortar, or epoxy mortar to hardened concrete.

3. **Epoxy mortar**: An epoxy mix used for repair of concrete.

4. **Horizontal wall joints**: Connection between the tank's core wall and its foundation or floor slab or roof or dome. Types of joints may be generally defined as shown in Figures 2 and 3.