

ACI 372R-13

**Guide to Design and Construction
of Circular Wire- and Strand-
Wrapped Prestressed
Concrete Structures**

Reported by ACI Committee 372



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Guide to Design and Construction of Circular Wire- and Strand-Wrapped Prestressed Concrete Structures

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Guide to Design and Construction of Circular Wire- and Strand-Wrapped Prestressed Concrete Structures

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This guide provides recommendations for the design and construction of circular, wrapped, prestressed concrete structures commonly used for liquid or bulk storage. These structures are constructed using thin cylindrical shells of either concrete or shotcrete. Shotcrete and precast concrete core walls incorporate a thin steel diaphragm that serves both as a liquid barrier and vertical reinforcement. Cast-in-place concrete core walls incorporate either vertical prestressing or a steel diaphragm. Recommendations are given for circumferential prestressing achieved by wire or strand wrapping. In wrapping, the wire or strand is fully tensioned before placing it on the structural core wall. Procedures for preventing corrosion of the prestressing elements are emphasized. The design and construction of dome roofs are also covered.

Many recommendations of this guide can also be applied to similar structures containing low-pressure gases, dry materials, chemicals, or other materials capable of creating outward pressures. This guide is not intended for application to nuclear reactor pressure vessels or cryogenic containment structures.

Keywords: circumferential prestressing; dome; footing; joint sealant; prestressed concrete; prestressing steel; shotcrete; wall.

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CHAPTER 1—GENERAL

1.1—Introduction

The design and construction of circular prestressed concrete structures requires specialized engineering knowledge and experience. The recommendations herein reflect over 6 decades of experience in designing and constructing circular prestressed structures. When designed and built with understanding and care, these structures can be expected to serve for well over 50 years without requiring significant maintenance.

1.2—Objective

This guide provides recommendations for the design and construction of circular wire- and strand-wrapped prestressed concrete structures based on practices used in successful projects.

1.3—Scope

The recommendations supplement the general requirements for reinforced concrete and prestressed concrete design and construction given in ACI 350 and ACI 350.5. Design and construction recommendations cover the following elements or components of circular-wrapped prestressed concrete structures:

- a) Floors
 - i) Reinforced concrete
- b) Floor-wall connections
 - i) Hinged
 - ii) Fixed
 - iii) Partially fixed
 - iv) Unrestrained
 - v) Changing restraint
- c) Walls
 - i) Cast-in-place concrete walls with steel diaphragms or vertical prestressing
 - ii) Shotcrete walls with steel diaphragms
 - iii) Precast concrete walls with steel diaphragms
- d) Wall-roof connections
 - i) Hinged
 - ii) Fixed
 - iii) Partially fixed
 - iv) Unrestrained
- e) Roofs
 - i) Concrete dome roofs with a prestressed dome ring, constructed with cast-in-place concrete, shotcrete, or precast concrete
 - ii) Flat concrete roofs
- f) Wall and dome ring prestressing systems
 - i) Circumferential prestressing using wrapped wire or strand systems
 - ii) Vertical prestressing using single or multiple high-strength strands or bars

1.4—Associated structures

Baffle walls and inner storage walls are frequently constructed inside water storage tanks. Baffle walls are used to increase the chlorine retention time of water as it circulates from the tank inlet to the outlet. The configuration and layout of baffle walls vary depending on the tank geometry, flow characteristics, and the desired effectiveness of the chlorination process. The most common baffle wall configurations are straight, C-shaped, or a combination of the two. Baffle walls can be precast or cast-in-place concrete, masonry block, redwood, shotcrete, metal, or fabric.

Inner storage walls are separate storage cells normally used to provide flexibility in a system's water storage capabilities and hydraulics. Inner walls are typically constructed the same as the outer tank walls and are designed for external and internal hydrostatic pressure.

1.5—History and development

Hewett (1923) first applied circumferential prestressing to a concrete water tank using turnbuckles to connect and tension individual steel tie rods. Long-term results were not effective because the steel used was of low yield strength, limiting applied unit tension to approximately 30,000 psi (210 MPa). Shrinkage and creep of the concrete resulted in a rapid and almost total loss of the initial prestressing force. E. Freyssinet was the first to realize the need to use steel of high quality and strength, stressed to relatively high levels, to overcome the adverse effects of concrete creep and shrinkage (Mautner 1936). Freyssinet successfully