Pipe Comparisons

AMERICAN Concrete Pressure Pipe ASSOCIATION

Prestressed Concrete Cylinder Pipe (PCCP) vs Steel Pipe

First used in the early 1940's, Prestressed Concrete Cylinder Pipe (PCCP) combines a water tight steel cylinder with structural concrete and high tensile steel wire to produce a high-performance pipe suitable for a wide range of water conveyance applications, such as transmission mains, force mains, reclaimed water, industrial, intake and discharge pipelines. PCCP is used in buried applications, as well as above ground and subaqueous lines. It's cement-rich mortar coating electrochemically protects the steel components from corrosion. Being a rigid pipe, PCCP has a high load carrying capability and can generally be installed without special bedding or backfill procedures.

This document is a comparison between PCCP and steel pipe utilizing information available from industry standards and resources. It is intended to differentiate key performance attributes of the materials to assist specifiers in product selection for water and wastewater pipelines.

ITEM	Prestressed Concrete Cylinder Pipe (PCCP)	Steel Pipe
Pipe Standards	• AWWA C301 – Prestressed Concrete Pressure Pipe, Steel Cylinder Type • AWWA C304 – Design of Prestressed Concrete Cylinder Pipe • AWWA M9 – Concrete Pressure Pipe	• AWWA C200 – Standard for Steel Water Pipe, 6'' and Larger • AWWA C206 - Field Welding of Steel Water Pipe • AWWA C207 – Steel Pipe Flanges • AWWA C208 – Dimension for Fabricated Steel Water Pipe Fittings • AWWA M-11 - Steel Pipe - A Guide for Design and Installation.
Service Life	• Estimated service life of 75 to 105 years. [1]	• Depending on lining, coating and cathodic protection may have estimated service life of 70-100 years. [1]
Pressure and Diameter Ranges	• Typical diameters range from 16" (400mm) through 144" (3600mm) but 156" (3900mm) has been produced. Prestressed concrete cylinder pipe has been designed for operating pressures greater than 400 psi. [2]	• 6" (150mm) through 144" (3600mm) with typical wall thickness limitation of 1" for spirally welded steel pipe. • To ensure satisfactory performance of the pipe, proper bedding and backfilling installation must also be followed to enable pipe deflection to be controlled. [3] • The prudent choice of pipe embedment soil type and the backfill compaction level are the most important factors affecting the performance of the steel pipe-soil system.
Pipe Strength/Stiffness	• Designed as a rigid pipe which allows the use of native materials for embedment providing significant installation savings.	• Steel is a flexible pipe that relies on support from trench embedment material (E') to prevent exceeding deflection limitation of pipe. • Internal stulling is recommended for transport and installation for pipe diameters 24" and larger with diameter to thickness ratios (D/t) greater 120. • Stulling can only be removed after backfill is placed. [3]
Restrained Joints	• Mechanical restraint options utilizing Snap-Ring, Harness clamp, and holdfast joints. • Mechanically restrained joints require very little time for installation and can be unassembled if necessary. • Joints can be welded if required.	• Welded joints are the only retrained joint option for steel pipe. • Temperature control joints are required every 400 to 500 (120 to 150 meters) feet per AWWA M11 Manual.

CONTINUED ON PAGE 2

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External Corrosion Protection	• Integrated cement mortar coating provides protection.	• Requires barrier or dielectric coatings with the addition of corrosion monitoring system and/or supplemental cathodic protection as a means of corrosion protection.
Bedding and Backfill Requirements	• Rigid pipe with no limitation on burial depth. • Pipe is designed to handle burial depth. • Minimal bedding is required, and native soils can be used as bedding material.	• Burial depth limited by backfill type and compaction requirements.
Pipe Design	• The design method is based on combined loading conditions — the most critical type of loading for rigid pipe — and includes surge pressure and live loads.[2]	• Steel thickness design for operation pressure using 50% yield strength of steel. • Handling steel pipe is a factor in design. The design approach can result in a wall thickness calculation that leaves a pipe not stiff enough or without sufficient beam strength to stand alone during installation.
Hydraulics	• Hazen-Williams C Factor = 139.3+2.028d from AWWA M9 Manual for Concrete Pressure Pipe.[1]	• Hazen-Williams C Factor = 140+0.17d for liner in good condition. M11 Manual mentions aggressive C Factor = 130+0.16d in "consideration for long term liner deterioration, slime build-up , etc."[3]
Gasketed Joints	• PCCP utilizes Carnegie joints with fully confined gasket. The compressed volume of the gasket is designed to fill 100% of the recess of the groove when the joint is engaged.	• Rolled groove joint has limited size and pressure range. Spigot of pipe has rolled recess as gasket groove. • Sizing and shape of the rubber gasket and the spigot groove are developed by the manufacturer and are dependent on the configuration of the spigot.[3]
Testable Joints	• Double gasketed joint with test port between gaskets.	• Double welded joint with test port between welds.
Sustainability	• Lower embodied energy.[4] • Easier to install. • Protected from corrosion.	• Higher embodied energy.[4] • More difficult to install. • High energy cost for cathodic protection.

REFERENCES
1 AMERICAN WATER WORKS ASSOCIATION (AWWA) (2015). "BURIED NO LONGER: CONFRONTING AMERICA'S WATER INFRASTRUCTURE CHALLENGE."
2 CONCRETE PRESSURE PIPE AWWA MANUAL M9 – 3RD EDITION, AMERICAN WATER WORKS ASSOCIATION.
3 STEEL PIPE - A GUIDE FOR DESIGN AND INSTALLATION AWWA MANUAL M11 – 5TH EDITION, AMERICAN WATER WORKS ASSOCIATION.
4 JOURNAL OF THE AIR & WASTE MANAGEMENT ASSOCIATION (2016), "COMPARISON OF CARBON FOOTPRINTS OF STEEL VERSUS CONCRETE PIPELINES FOR WATER TRANSMISSION".

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