Concrete Pressure Pipe

AWWA MANUAL M9

Third Edition
# Contents

List of Figures, vii  
List of Tables, xi  
Acknowledgments, xiii  

**Chapter 1 Purpose and Scope** ............................................................... 1  

**Chapter 2 Description of Concrete Pressure Pipe** .................................. 3  
- Prestressed Concrete Cylinder Pipe (ANSI/AWWA C301-Type Pipe), 3  
- Reinforced Concrete Cylinder Pipe (ANSI/AWWA C300-Type Pipe), 7  
- Reinforced Concrete Noncylinder Pipe (ANSI/AWWA C302-Type Pipe), 8  
- Concrete Bar-Wrapped Cylinder Pipe (ANSI/AWWA C303-Type Pipe), 10  
- Fittings and Special Pipe, 11  
- Reference, 12  

**Chapter 3 Hydraulics** ............................................................................ 13  
- Flow Formulas, 13  
- Effects of Aging on Carrying Capacity, 20  
- Head Losses, 20  
- Determining an Economical Pipe Diameter, 21  
- Air Entrapment and Release, 25  
- Blowoff Outlets, 25  
- References, 25  

**Chapter 4 Surge Pressure** ...................................................................... 27  
- Equations and Variables, 27  
- Negative Pressures, 30  
- Causes of Surge Pressure, 30  
- Control of Water Hammer, 31  
- References, 32  

**Chapter 5 External Loads** ..................................................................... 33  
- Major Installation Classifications, 33  
- Trench Conduits, 33  
- Embankment Conduits, 37  
- Positive Projection Installations, 37  
- Earth Loads on Large Diameter ANSI/AWWA C303 Pipe, 41
Negative Projection Installations, 42
Induced Trench Installations, 44
Jacked or Tunneled Conduits, 47
Determination of Live Load, 48

References, 56

Chapter 6  Bedding and Backfilling .................................................. 57

Introduction, 57
Rigid Pipe, 57
Semirigid Pipe, 59
Unstable Foundations, 60

References, 61

Chapter 7  Design of Reinforced Concrete Pressure Pipe  ...................... 63

Information Required for Pipe Design, 63
Design Procedure for Rigid Pipe (ANSI/AWWA C300- and C302-Type Pipe), 64
Design Procedure for Semirigid Pipe (ANSI/AWWA C303-Type Pipe), 86

References, 93

Chapter 8  Design of Fittings and Appurtenances.................................. 95

Fittings, 95
Fitting Design, 98
Specials, 117

References, 119

Chapter 9  Design of Thrust Restraints for Buried Pipe......................... 121

Thrust Forces, 121
Hydrostatic Thrust, 121
Thrust Resistance, 123
Thrust Blocks, 124
Joints With Small Deflections, 126
Tied Joints, 132
Design Examples, 141
Combination Thrust-Restraint System, 167
Other Uses for Restraints, 170

References, 171

Chapter 10  Design of Pipe on Piers .................................................... 173

Loads, 173
Chapter 11 Design of Subaqueous Installations

Application, 187
Pipe Design Features, 187
Subaqueous Pipe Details, 190
Installation, 191
Testing, 194

Chapter 12 Design Considerations for Corrosive Environments

History, 195
Inherent Protective Properties, 195
Special Environmental Conditions, 196
Bonding Pipelines, 199
Monitoring for Pipe Corrosion, 205
Cathodic Protection, 213
References, 214

Chapter 13 Transportation of Pipe

Truck Transportation, 215
Rail Transportation, 215
Barge Transportation, 218
Loading Procedures, 218
Delivery and Unloading, 218

Chapter 14 Installation by Trenching or Tunneling—Methods and Equipment

Trenching—General Considerations, 221
Open Trench Construction, 223
Bedding, 226
Pipe Installation—General, 227
Laying the Pipe, 228
Backfilling, 230
Tunnel Installations, 232
Jacking Methods, 233
Chapter 1

Purpose and Scope

The use of concrete pressure pipe for conveying water and other liquids under pressure has dramatically increased in recent years. Its rugged construction and the natural corrosion resistance provided by embedment of the ferrous components in concrete or cement mortar offer the design engineer solutions to a wide range of structural and environmental problems (Figure 1-1).

The manufacture of four basic types of concrete pressure pipe are covered by the following American Water Works Association (AWWA) standards:

- ANSI/AWWA C300 Standard for Reinforced Concrete Pressure Pipe, Steel-Cylinder Type
- ANSI/AWWA C301 Standard for Prestressed Concrete Pressure Pipe, Steel-Cylinder Type

Figure 1-1  A typical installation in rugged terrain
Preparing pipeline project plans and specifications, however, requires many pipe-related decisions that are not covered by the respective AWWA standards.

This manual provides supplemental information to assist engineers and designers in achieving optimum field performance of concrete pressure pipelines. Information and guidelines are provided covering hydraulics, surge pressure, external loads, bedding, and backfilling; designing reinforced concrete pressure pipe, fittings and appurtenances, thrust restraints, pipe on piers, and subaqueous installations; design considerations for corrosive environments; transportation of pipe; trench and tunnel installation; and other pertinent subjects.

The information in this manual is not intended to supersede, nor should be regarded as superseding, any portion of any AWWA standard.

Note: This manual uses US customary units of measurement. Metric equivalents have been added where deemed appropriate.