CONCRETE PRESSURE PIPE

REPAIR GUIDE
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These more-demanding repair procedures require specific materials and/or expertise and so are not described on the ACPPA website. Contact your ACPPA member concrete pressure pipe supplier for full details and support.

Welded Repair
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NOTE: The information presented herein was originally prepared by U.S./Forterra Pressure Pipe. ACPPA gratefully acknowledges their contribution.
INTRODUCTION

Pressure pipe, when properly designed, manufactured and installed, will provide safe, reliable and continuous service under normal and transient conditions. Unfortunately, due to accidents or other unforeseen circumstances, it is sometimes necessary to repair or replace a pipe in the line.

Though durable, this pipe is not designed to withstand impact from a backhoe, jackhammer or an auger. This Repair Guide will provide a course of action to follow should such an event occur.

ACPPA member companies stock repair and replacement clamps, saddles, pipe sections, closures and other materials at many of their manufacturing facilities. The fittings departments can quickly fabricate non-stock repair materials from steel plate inventory.

This Guide describes the most common repair procedures; however, not all repairs are covered. Concrete Pressure Pipe manufacturer’s field representatives have extensive knowledge in repair procedures and can usually offer a practical solution to most situations.

For the best feedback in an emergency, make a record of the types and sizes of pipe in the system. It may also be helpful to provide a sketch showing the location, size and type of pressure pipe. Use the Emergency Repair Questionnaire on page three.

EMERGENCY PHONE NUMBERS

Ameron Water Transmission Group: 909-944-4100 during normal business hours, Pacific time

DECAST, Ltd.: 888-835-7940, anytime

Forterra Pressure Pipe, Canada: 888-497-7371

U.S. Pipe: 972-262-3600 during normal business hours Central time, or 800-445-1534 evenings, weekends, or holidays

Vianini Pipe, Inc.: 908-534-4021 during normal business hours, Eastern time

NOTE

The information in this Repair Guide is descriptive and provided for the benefit of, and consideration by, pipeline owners. This Guide is made available with the understanding that the authors and American Concrete Pressure Pipe Association (ACPPA) are not herewith or herein rendering engineering or any other professional services. This Guide is intended for the use of licensed engineers. As a result of changes in manufacturing processes, technology, and pipeline specifications, information contained in this publication may become outdated. It is the responsibility of the engineer using this material to use independent professional judgment and to update the information to ensure accuracy when dealing with individual repairs. All operations described in this Guide should be performed only by qualified individuals in accordance with the Occupational Safety and Health Act (OSHA) and other regulations, provincial, state and local codes, and recognized safe practices, particularly those related to personal protective equipment and trench and confined space entry. ACPPA disclaims all warranties associated with this Guide or its content. In no event will the authors or ACPPA be liable for any direct, indirect, or consequential damages resulting from the use of this material.
If an emergency repair is needed, please try to answer these questions before calling a Concrete Pressure Pipe manufacturer for assistance.

1. **DO YOU KNOW:**
   - The pipe manufacturer? ______________
   - Job number? ______________
   - Installation date? ______________

2. **WHAT IS THE SIZE AND TYPE OF THE DAMAGED PIPE?**
   - Inside diameter ______________
     - Bar-Wrapped Cylinder Concrete Pipe (AWWA C303, aka “CCP”, “P-303”, “Pretensioned Concrete Cylinder Pipe”, “Concrete Cylinder” or “B-303” pipe)
     - Prestressed Concrete Lined Cylinder Pipe (AWWA C301, aka “L-301” or “SP-5”)
     - Prestressed Concrete Embedded Cylinder Pipe (AWWA C301, aka “E-301” or “SP-12”)
     - Reinforced Concrete Cylinder Pipe (AWWA C300, aka “V-300”, “SP-3”)
     - Reinforced Concrete Noncylinder Pipe (“NC-301”, “SP-1”, “SP-25”, “SP-32” or “ASTM C361”)
     - Prestressed Concrete Noncylinder Pipe (“NC-301”, “SP-23”, “SP-28”, or “SP-31”)
     - Steel Pipe (S-200) (Mortar-coated steel pipe may appear to be concrete pipe.)
     - Reinforced Concrete Pipe (“ASTM C76”, “ASTM C655”, or “AASHTO M170” culvert or storm drain pipe, which can be repaired in the same manner as AWWA C302)

3. If the type of damaged pipe is unknown, what is the outside measured circumference? ______________

4. Does the damaged pipe have an outlet?
   - Outlet size ______________
   - Outlet joint type:
     - CPP bell or spigot joint
     - Flange joint
     - MJ Bell
     - Plain end
     - Other ______________
5. Is the damaged pipe a fitting?
   - Tee/Wye
   - Bend (angle of deflection)
   - Reducer
   - Adapter (type of joints)
   - Other _______________

6. Is the damaged pipe a special piece?
   - Bevel
   - Restrained joint
   - Pipe is double coated, painted, bonded, etc.

7. What is the laying length of the damaged pipe? _______________

8. What is the operating pressure of the line?
   - PSI _______________
   - Feet of Head _______________

9. Can the pipe be depressurized? _______ Drained? _______

10. What is the line's purpose? _______________

11. Type of coating (if steel pipe) _______________

12. What are the dimensions of the damaged area? _______________

13. Do you have clear directions to the site of the damage or to a delivery point? _______________

14. Do you have the name and phone number of the key person to contact? _______________
    If yes, please provide: ________________________________

15. Do you need experienced personnel to assist in the repair? _______________
MAKING A DURABLE REPAIR

Completed repairs on concrete and steel pressure pipe should provide both the strength to contain the pipeline pressure and protection from corrosion.

Pressure containment strength is generally established by assuring adequate gasket compression, by welding, by installing additional circumferential reinforcement on existing pipe or by pipe replacement.

Corrosion protection of the repair is generally provided by coating all exposed steel with a 1" (25 mm) minimum thickness of Portland cement mortar.

If the pipeline being repaired is bonded for monitoring or cathodic protection, the repair steel should also be electrically connected to the pipeline steel.

The proper procedure to repair leaks in damaged pressure pipe depends on the pipe type. The type of pipe determines whether the pipe has a cylinder, the location of the cylinder in the pipe wall and whether the pipe is prestressed.

Cylinder thickness on some types of concrete pressure pipe can be as thin as 18 gauge, (0.05"), and some concrete pressure pipe cylinders were made with higher-strength cold-rolled steel. Only welders with experience on concrete pressure pipe should attempt repairs on pipe with thin cylinders or cylinders of high-strength steel.
TYPES OF CONCRETE PRESSURE PIPES

AWWA C303
Prior to 1970, this pipe was known as American concrete cylinder pipe or P-381. From 1970 to 1995, it was marketed as Concrete Cylinder Pipe or Pretensioned Concrete Cylinder Pipe (P-303). Since 1995, it has been marketed as Bar-Wrapped Pipe or “BWP”. Concrete Cylinder Pipe, or B-303. This pipe is manufactured in diameters ranging from 10” (250 mm) to 72” (1830mm). The bell, spigot, cylinder and spiral reinforcing rod on this pipe are all made of mild steel and can be welded. However, the cylinder for C303 and other types of concrete pressure pipe can be as thin as 16 gauge (0.0598”/1.5 mm), so only welders experienced in making watertight welds on thin steel should attempt welding repairs on concrete pipe cylinders.

NOTE
The bell, spigot, cylinder and spiral reinforcing rod on C303 pipe are all made of mild steel and can be welded.

CAUTION
If the cylinder is 14 gauge (0.0747”/1.9 mm) or thinner, only a welder with experience on concrete pressure pipe should attempt the repair.
AWWA C301

Prestressed Concrete Lined Cylinder Pipe (L-301, also marketed as SP-5) and Prestressed Concrete Embedded Cylinder Pipe (E-301, also marketed as SP-12) are commonly manufactured in the United States and Canada. Lined cylinder prestressed pipe has been manufactured in 16” (400 mm) through 60” (1500 mm) diameters and embedded cylinder prestressed pipe has been manufactured in 24” (600 mm) through 252” (6400 mm) diameters. The bell, spigot and cylinder of these pipe are made of mild steel and the cylinder is usually 16 gauge (0.0598”/1.5 mm) material. The spiral prestressing wire is very high strength steel and cannot be welded. For this reason, repair procedures for these types of pipe usually use circumferential clamps or similar materials which do not require structural support from the prestressing wire.

NOTE

The bell, spigot and cylinder of both types of C301 pipe are made of mild steel and the cylinder is usually 16 gauge (0.0598”/1.5 mm) material.

Repair procedures for C301 pipe use circumferential mild steel clamps or similar materials which do not require structural support from the prestressing wire.
AWWA C300, AWWA C302, AND NON-CYLINDER PRESTRESSED PIPE

There are several other types of concrete pressure pipe which are less commonly or no longer manufactured today but for which there are many miles installed and generally operating with very few problems. These include reinforced concrete cylinder pipe (AWWA C300, sometimes marketed as V-300, SP-3, or Lock Joint Cylinder pipe), reinforced non-cylinder concrete pipe (AWWA C302, sometimes marketed as SP-1, SP-25, or SP-32, depending on the type of joints, or as “C-302” when manufactured by spinning or “V-302” when manufactured by vertical casting the concrete), and prestressed noncylinder pipe (sometimes marketed as “NC-301”, SP-23, SP-28, or SP-31).

AWWA C300 reinforced concrete cylinder pipe was marketed in diameters from 24” through 120”. The pipe bell, spigot, cylinder and reinforcement are made of mild steel. The pipe cylinder is embedded several inches under the outer pipe wall surface.

Non-cylinder C302 and prestressed noncylinder pipe depend on the pipe wall concrete to contain the pipeline pressure. In these pipes, there is no steel cylinder against which a seal may be achieved so in some cases the best repair method is to remove and replace the pipe, often with another type of concrete pressure pipe that has a cylinder. Such a repair requires the existing adjacent pipe to have good joints to which the replacement pipe can be engaged or welded. C302 pipe may have any combination of steel or concrete bells and spigots. Noncylinder prestressed pipe has been made with a variety of steel or concrete belts and spigots, and some was made with double concrete spigots with a fiberglass double-width bell.

NOTE
The bell, spigot, cylinder and reinforcing rod on C300 pipe are all made of mild steel and can be welded.

CAUTION
If the cylinder is 14 gauge (0.0747") or thinner, only a welder with experience on concrete pressure pipe should attempt the repair.
TYPES OF CONCRETE PRESSURE PIPES (Cont.)

AWWA C300, AWWA C302, AND NON-CYLINDER PRESTRESSED PIPE (CONT.)

NOTE
C-302 and V-302 are non-cylinder pipe with smooth exterior surfaces. Holes in these pipe walls can often be sealed by compressing a gasket or rubber pad against the outside of the pipe.

NOTE
Some V-302 and NC-301 pipe have steel bells and spigots which can be welded to seal joint leaks. An alternate style of “V-302” joint has concrete bells with a larger outside diameter than the barrel of the pipe, and concrete spigots.
AWWA C300, AWWA C302, AND NON-CYLINDER PRESTRESSED PIPE (CONT.)

C302 pipe with centrifically-placed concrete was marketed in diameters from 12” through 84”. C302 pipe with vertically-cast concrete pipe was marketed in sizes from 36” through 120”. Noncylinder prestressed was made in 72”, 78”, 96”, 108”, 120”, 216”, and 252” diameters.

NOTE
Other joint configurations have been used for noncylinder prestressed pipe.
CONCRETE PRESSURE PIPE FITTINGS AND MORTAR-COATED STEEL PIPE

Bends, tees, and other concrete pressure pipe fittings are made of welded steel that is lined and coated with wire-reinforced mortar. Fittings can usually be repaired following the applicable steps for repairing AWWA C303 pipe.

When excavated, mortar-coated steel pipe may appear to be concrete pressure pipe. In some areas, both mortar coated steel pipe and bar-wrapped concrete pipe are collectively (and incorrectly) called “concrete cylinder pipe” and/or “steel cylinder pipe.” The pipe can sometimes be identified by a difference in outside diameter between mortar-coated steel pipe and mortar-coated concrete pressure pipe. Mortar-coated steel pipe has wire reinforcement in the middle third of the mortar coating thickness instead of reinforcing bar or prestressing wire being wrapped directly on the cylinder. In diameters smaller than 30”, some mortar-coated steel pipe has been made with cylinders that are 14 gauge (0.0747”) and thinner. Such cylinders require very experienced welders. Larger diameter steel pipe has thicker cylinders that are less likely to be accidentally perforated during welding.

As with concrete pressure pipe fittings, mortar-coated steel pipe can usually be repaired following the applicable steps for repairing AWWA C303 pipe.
# Repair Procedures

## Quick Reference

Typical repair procedures for various types of pipe and conditions are listed here. Some repairs can be made with the pipeline pressurized, provided there is no leak with sufficient water volume or pressure to endanger repair personnel.

Other repairs can be made with the pipeline full but depressurized in order to reduce leakage to a level which will not interfere with the installation of the repair. Where pipe sections must be replaced, the line must be drained.

Any steel used in repairs on electrically bonded pipelines must be made electrically continuous with the pipeline steel and all repair and pipe steel must be properly protected with Portland cement mortar.

Cylinder thickness on some types of concrete pressure pipe can be as thin as 18 gauge, (0.05”), and some concrete pressure pipe cylinders were made with higher-strength cold-rolled steel. Only welders with experience on concrete pressure pipe should attempt repairs on pipe with thin cylinders or cylinders of high-strength steel.

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<td>• Bent joint ring</td>
<td>Heat &amp; reshape or weld on new joint ring</td>
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<tr>
<td>• Larger (&gt;30’/760 mm) pipe with groundwater seeping or gap between bell and spigot</td>
<td>Spigot field adjustment</td>
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<td>• Insufficient joint overlap</td>
<td>Exterior joint weld</td>
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<td>• All diameters</td>
<td>Interior joint weld</td>
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<td>• Larger (&gt;30’/760 mm) diameters</td>
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<tr>
<td>Joint repairs on existing pipe</td>
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<td>• Pipe under low or no pressure</td>
<td>Exterior joint weld</td>
<td>18</td>
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<tr>
<td>• All diameters – slight or no seeping</td>
<td>Interior joint weld</td>
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<tr>
<td>• Larger (&gt;30’/760 mm) diameters</td>
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<td>• (requires draining &amp; access to interior)</td>
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<tr>
<td>• Pipe under operating pressure</td>
<td>Weld-on repair saddle</td>
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<td>Pipe barrel repairs</td>
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<td>• Pipe not under pressure</td>
<td>Welded repair</td>
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<td>• Steel damaged but lining intact</td>
<td>Dry tap</td>
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<td>• Steel and lining damaged</td>
<td>Dry tap or Reinforcing Clamp</td>
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<td>• Hole drilled in pipe barrel</td>
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<td></td>
<td>Cut pipe closure</td>
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* Contact your ACPPA member concrete pressure pipe supplier for full details and support.
## REPAIR PROCEDURES (Cont.)

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<td>• Pipe not under pressure;</td>
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<td>wire damaged but cylinder intact</td>
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<td>Hole drilled in pipe barrel</td>
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<td><strong>EMBEDDED-CYLINDER AWWA C301</strong></td>
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<td>• Pipe not under pressure; steel damaged but lining intact</td>
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* Contact your ACPPA member concrete pressure pipe supplier for full details and support.

**NOTE**
Many of the repair and tapping procedures for steel pressure pipe are the same as for concrete pressure pipe, with a few subtle differences. For more information, please contact ACPPA or your local Concrete Pressure Pipe manufacturer.
MORTAR OR CONCRETE

Repair of Unlaid Pipe or Interior Repairs on Installed Pipe

1. Chip back to sound lining or coating. The borders of the sound material around the repair area should be slightly undercut to key the repair mortar in place. Care must be taken during chipping to avoid nicking any steel, especially any cylinder or prestressing wires.

2. Clean and wet the surface of the repair area. Apply a thick cement slurry to the area to be patched.

3. Ram and compact a stiff mortar into the repair area. The mortar shall be worked under the borders of the surrounding mortar or concrete and under or around any exposed reinforcement or prestressing wire. Wire mesh may be useful for supporting the mortar over large repair areas.

   The surface of the repair mortar shall be shaped to the pipe contour in a manner assuring there is at least ¾” (19 mm) coverage over any pipe steel, (except reinforcing wire or mesh designed to be placed in the middle 1/3 of the mortar).

4. The repair mortar can be one part cement to three parts sand mixed with as little water as possible so the mortar will be very stiff but workable. Repairs made with such mortar should be protected while being cured for 24 hours using intermittent water spray, wet covering, plastic sheet or a curing compound. Any curing compound should be NSF approved for contact with potable water.

   Alternatively, the repair mortar can be a high pH, low chloride, quick set mortar so the repair will harden quickly and require no special curing procedures.

Exterior Repairs on Installed Pipe

Exterior mortar or concrete repairs on installed pipe can be made as outlined above. Alternatively, after the exterior damaged mortar or concrete has been removed and the area of damage cleaned, and inspected to assure cylinder and wire integrity has not been compromised, the pipe exterior can be encased with mortar or concrete. This can be accomplished either by placing a joint wrapper to straddle the repair area and filling the wrapper with mortar, or by backfilling the trench pipe zone in the repair area with concrete or mortar.

All mortar repairs should be protected from freezing until they have cured.
HEAT & RESHAPE OR WELD ON NEW JOINT RING

**Repair Procedure**

1. Joint rings which are misshaped due to being bumped during or after delivery can sometimes be heated and hammered back to essentially their original configuration. Such a repair must only be made: (a) with the approval of the owner’s inspector or representative; and (b) under the supervision of the concrete pressure pipe manufacturer’s field representative.

2. After the bell or spigot is repaired, all broken mortar or concrete around the repair must be removed and replaced.

3. If the joint ring cannot be repaired, a new ring can be provided by the pipe manufacturer to be butt welded to the damaged one.
REPAIR PROCEDURES (Cont.)

SPIGOT FIELD ADJUSTMENT

If the looseness is localized and the gasket is in place, the joint can often be sealed by pounding out the spigot with a sledgehammer.

The rubber gasket forms the watertight seal for concrete pressure pipe. As each pipe is laid, a feeler gauge should be used to check the entire circumference of the new joint to assure the seal exists. If there is no seal, the newly engaged pipe should be removed and replaced with another pipe and the new joint checked. If there is still no seal, it may be necessary to remove and repair the previous pipe.

Joints with an excessive gap between the bell and spigot, however, are sometimes not found until many additional pipes have been laid. Such joints are typically identified by dampness from groundwater infiltration.

Suspected loose joints should be inspected with a feeler gauge after removal or before placement of any interior joint mortar. If the looseness of the joint, as indicated with the feeler gauge check, is extensive or if the gasket is cut, missing, or out of place, the joint should be welded for watertightness. However, if the looseness is localized and the gasket is in place, the joint can often be sealed by pounding out the spigot with a sledgehammer.

If the joint can be sealed by pounding out the spigot, a 3” width of mortar or concrete inside the loose area of the joint should be carefully removed. Caution should be exercised to assure the pipe cylinder is not perforated with a chipping gun or similar tool. After the loose area of the spigot is exposed it can be pressed against the mating bell by hammering on the back of the spigot gasket groove.

Intermittently during hammerings the entire joint circumference should be checked with a feeler gauge. If the looseness in the joint begins to move around the joint circumference, the looseness location can be stabilized by placing short (1/2”+ long) fillet welds between the bell and spigot on each side of the joint looseness.

Such welds must be placed quickly and immediately cooled with damp rags to avoid burning the gasket. After any necessary welds are placed, the hammering should continue until the joint is found to be tight when checked with a feeler gauge or until it is determined the entire joint must be welded to achieve a seal.

After the joint has been sealed the interior pipe mortar or concrete must be repaired.
**SPIGOT FIELD ADJUSTMENT DETAILS**

- **Exposed bell steel**
- **Exposed spigot**
- **Edge of spigot**
- **Edge of concrete over bell**
- **3" of mortar or concrete removed**

**Short (1/2"±) tack welds to stabilize looseness location. Placed only if needed.**

**Hammer on back of spigot gasket groove to seal joint.**

**Length of joint looseness as located with feeler gauge.**

**Remove a 3"± width or mortar or concrete inside loose area of joint.**
REPAIR PROCEDURES (Cont.)

EXTERIOR JOINT WELD

Repair Procedure

1. Remove sufficient exterior mortar or, for C300 pipe, exterior concrete to provide access for complete circumferential weld. Use caution to avoid breaking any prestressing wire or rod reinforcement.

2. Reduce the gap between materials to be welded. This may require the use of a filler rod or bar, or heating and flattening the bell flare, or similar preparation, depending upon the extent of joint overlap.

3. Place a continuous, watertight weld around the entire circumference of the joint.

4. Repair exterior mortar or concrete.

**NOTE**

The weld must be continuous and watertight, so the gasket is not needed. The joint configuration and need for filler material will vary depending on joint overlap.
INTERIOR JOINT WELD

Repair Procedure

1. The line must be dewatered and access to the interior provided. If no entrance is available, a saddle type manhole can be installed.

2. For repairs required during installation due to insufficient joint overlap, the gasket may be left off the spigot since the weld will be continuous and watertight.

3a. To repair joints where the gasket has already been installed, place a fillet weld between the bell and spigot. See Detail A below. The first pass should be fast, “downhill”, and may need to be intermittently cooled with a wet rag to minimize smoke from the gasket. Alternatively or if needed, place a 3/8” (9 mm) mild steel rod around the joint and weld solid.

3b. Alternatively, place the prefabricated, segmented rings as shown in Detail B and weld in place using watertight welds. Weld “downhill” or skip weld as necessary when welding to the pipe bell to prevent smoke from burning gasket. Butt-weld segment ends together.

4. When the weld is completed, clean the interior joint recess and repair the interior concrete and mortar.

5. Examine the adjacent interior joints to assure they do not need to be welded or re-mortared. Where re-mortaring is required, the exterior should be examined and re-mortared if necessary.

NOTE
The weld must be continuous and watertight.
REPAIR PROCEDURES (Cont.)

INTERIOR JOINT WELD, DETAIL B

NOTE
The weld must be continuous and watertight.