



## AMERICAN Linings for Pipe and Fittings

The principal standard covering cement lining is ANSI/AWWA C104/A21.4. This and other standards are referenced throughout this Section either by the full ANSI/AWWA designation or by only the AWWA numbering, such as AWWA C104.

Along with technical and metallurgical advancement in piping materials, research on lining requirements for pipe and fittings has resulted in the development of linings to meet many different service requirements. AMERICAN offers several types of linings, the most common being cement lining. Pipe and fittings furnished by AMERICAN are offered unlined or with linings as follows:

1. Cement Lined per AWWA C104.
2. Asphaltic Lined per AWWA C110, C115 or C151.
3. Fusion-Bonded Epoxy (for 4" -16" Fastite fittings) per AWWAA C116.
4. Special Lining - for unusual service conditions

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### Cement Lining

Cement-mortar lining for ductile iron pipe and ductile and gray iron fittings for water service is in accordance with ANSI/AWWA C104/A21.4.

Cement-lined pipe is also furnished for some sewage service and a number of other applications. In fact, most pipe furnished is cement lined, providing improved flow characteristics and the required protection against internal corrosion. The cement lining is satisfactory for temperatures up to 212°F. If asphaltic seal coat is furnished, the lining is only adequate for temperatures up to 150°F. For other services contact AMERICAN regarding temperature limitations of cement lining.

The first recorded installation of cement-lined gray iron pipe was in 1922 at Charleston, S.C. This lining was developed by the Charleston Commission of Public Works in cooperation with American Cast Iron Pipe Company. Since this beginning, AMERICAN has furnished most of its pipe with cement lining. The lining is applied centrifugally with the speed of rotation designed to produce a smooth waterway surface, minimal voids, yet retaining enough moisture for proper curing. AMERICAN cement-lined pipe and fittings are listed by

ANSI/NSF Standard 61 for potable water contact.

Flow tests on cement-lined pipe under varying service conditions have established that the Hazen-Williams flow coefficient remains as expected at about 140, and flow tests on cement-lined, large-diameter AMERICAN Ductile Iron pipe have confirmed flow coefficients much higher than 140.

#### Handling Cement-Lined Pipe and Fittings

Pipe and fittings with cement lining should be handled with rubber-covered hooks or other type equipment to prevent damage to the cement lining. Bare forklift arms or bare hooks should not be inserted into open ends.

#### Characteristics of Cement Lining

AWWA C104 allows for surface crazing and cracks of a specified nature and magnitude. Occasionally cracks and looseness in linings may occur prior to installation, particularly where pipe is stored for a considerable time. Many years' experience with cementlined pipe and fittings has verified that this condition is not detrimental to the perfor-



mance and effectiveness of the lining. When a cement-lined pipe is placed in service and filled with water, two reactions begin immediately. The first is a gradual elimination of the temperature differential between pipe and lining, thus eliminating any stresses in the lining due to this condition.

Secondly, the lining begins to absorb water into the pores of the cement and into the capillary channels of the calcium silicate gel. The water absorption causes the lining to swell, restoring it to intimate contact with the pipe wall and virtually closing any cracks present in the lining. This swelling process is relatively slow, taking up to several weeks for the lining to be restored to its maximum volume. This process has been demonstrated on a number of occasions to the satisfaction of customers, contractors and engineers by immersing a pipe or fitting in water for one or two weeks.

After a period of exposure to water, not only does the lining tighten against the pipe wall and the cracks close, but finally the surfaces of the cracks actually re-bond. This occurs by a process called autogenous healing.

This phenomenon, long recognized by the cement industry, has been documented by laboratory tests to occur in cement-lined ductile pipe. In one test, a 48" ductile iron pipe with severely cracked cement lining was held half full of water for several months. At the end of that period, the lining both above and below the water surface was found to be tight, with all cracks either healed completely or sealed by the formation of calcium carbonate.

Field inspections of lines that have been in service for many years have verified the laboratory results; cement linings do tighten and heal in service and provide the corrosion protection to the pipe and the high flow coefficients for which they were designed.

### **Field Repair of Damaged Cement Linings**

Cement lining will withstand normal handling; nevertheless, pipe or fittings may be found at times to have damaged linings which need to be repaired before placing in service.

AWWA C104 provides that damaged lining may be repaired, and the following repair procedure is recommended:

1. Cut out the damaged lining to the metal. Square the edges.
2. Thoroughly wet the cut-out area and adjoining lining.
3. With the damaged area cleaned and the adjoining lining wet, spread the mortar (see recommended mix below) evenly over the area to be patched. (See Table No. 11-1, next page, for lining thicknesses.) After the lining has become firm and adheres well to the surface, finish it with a wet 3" or 4" paint brush or similar soft bristle brush.
4. The repaired lining should be kept moist by tying canvas, wet burlap, or other wrap over the ends of the pipe or fitting for at least 24 hours. As an alternative the repaired lining may be seal coated with a cut back type of asphaltic seal coating. This must be sprayed or brushed on within five to 30 minutes after lining. To maintain NSF certification, patch must be made using a NSF certified cement for 4" pipe and larger, or the patch must be topcoated with NSF certified asphalt paint.

### **Recommended Cement Mix**

Cement mix by volume: 3 parts of sand, 2 parts cement.

### **Precautions**

1. Mortar for lining should not be used after it has been mixed for more than one hour.
2. Too rapid a loss of moisture from fresh linings due to hot weather or high wind will prevent proper cure, resulting in the lining being soft and powdery. To prevent this loss of moisture, (a) do not line hot castings and (b) close the ends of the castings with wet burlap.
3. Fresh linings that become frozen will not be serviceable. Avoid lining in freezing weather.



**Cement Lining**  
**ANSI/AWWA C104/A21.4**  
**Thicknesses and Weights**

Table No. 11-1

Size in.	Nominal Pipe Length ft.	Standard Thickness			Double Thickness		
		Minimum Thickness in.	Weight Per Foot lb	Weight Per Length lb	Minimum Thickness in.	Weight Per Foot lb	Weight Per Nominal Length lb
4	18	1/16	.87	17	1/8	1.71	31
6	20	1/16	1.30	26	1/8	2.57	51
8	20	1/16	1.74	35	1/8	3.45	69
10	20	1/16	2.15	43	1/8	4.28	86
12	20	1/16	2.57	51	1/8	5.12	102
14	20	3/32	4.49	90	3/16	8.93	179
16	20	3/32	5.13	103	3/16	10.19	204
18	20	3/32	5.76	115	3/16	11.47	229
20	20	3/32	6.40	128	3/16	12.73	255
24	20	3/32	7.68	154	3/16	15.31	306
30	20	1/8	12.76	255	1/4	25.42	508
36	20	1/8	15.31	306	1/4	30.51	610
42	20	1/8	17.82	356	1/4	35.53	711
48	20	1/8	20.35	407	1/4	40.60	812
54	20	1/8	22.89	458	1/4	45.68	914
60	20	1/8	24.71	494	1/4	49.32	986
64	20	1/8	26.35	527	1/4	52.61	1052

Weights are based on the minimum lining thicknesses for minimum pressure classes of Fastite ductile iron pipe. Actual lengths and weights may differ from above.  
 Linings may taper at the ends.  
 AMERICAN recommends the use of standard thickness cement lining per AWWA C104 for all normal installations.



**This 64" Ductile Iron Fastite Joint water transmission main was furnished with standard cement lining for continuing high flow performance.**