# OMNI-FLEX PIPE JOINT SEALS

**Final Report**
**December 1996**

**Gary Williams, P.E.**
**Product Evaluation Engineer**

**Research, Development & Technology Transfer**
**Oklahoma Department of Transportation**
**200 N.E. 21st Street, Room 2A2**
**Oklahoma City, Oklahoma 73105**
**(405) 521-2671**
**FAX (405) 521-6528**

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16. ABSTRACT

In June, 1991 The Oklahoma Department of Transportation (ODOT) had 16 Omni-Flex pipe joint seals installed in the joints of a reinforced concrete pipe (RCP) section on ODOT Project ACIR-44-2(326)233 in Tulsa. Individual sections of RCP had diameters of 1.5 m (60 in) and lengths of 2.4 m (8 ft) in the area where the seals were installed. The remainder of the joints between RCP sections on this project were sealed with mastic. Mastic is approved for use on ODOT projects, and is widely used in Oklahoma.

The 16 joints sealed with Omni-Flex seals, and an adjacent 16 joints of the same size RCP, sealed with Mastic, have been monitored since project completion. Monitoring consisted of inspecting the joints from inside the pipe. Neither section has shown any unusual amounts of leakage or other deterioration which could be considered to be related to performance of the joint seals.

Omni-Flex seals have been used on numerous other ODOT projects, where ODOT contractors have been allowed to use them by change order. Results have been satisfactory in all but one case, where unusually large numbers of leaking joints were observed soon after RCP was laid. Pipe where the leakage occurred had diameters of 2.7 m (108 in) and 2.4 m (96 in). It was not clear whether or not performance of the Omni-Flex seals was a factor in causing the leaks.

Based on overall performance of the Omni-Flex devices, ODOT's Research, Development, and Technology Transfer Section recommended their approval as a contractor option, with possible exceptions for large RCP sizes. The Omni-Flex Project Panel approved their use on RCP with diameters of 1.5 m (60 in) and smaller. A specification providing for their use has been included in the "ODOT 1996 Standard Specifications for Highway Construction" published in October, 1996.

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| Unclassified | Unclassified | 26 | |

The contents of this report reflect the views of the author(s) who is responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the views of the Oklahoma Department of Transportation or the Federal Highway Administration. This report does not constitute a standard, specification, or regulation. While trade names may be used in this report, it is not intended as an endorsement of any machine, contractor, process, or product.

# SI (METRIC) CONVERSION FACTORS

## *Approximate Conversions to SI Units*

| Symbol | When you know | Multiply by | To Find | Symbol |
|---|---|---|---|---|
| | **LENGTH** | | | |
| in | inches | 25.40 | millimeters | mm |
| ft | feet | 0.3048 | meters | m |
| yd | yards | 0.9144 | meters | m |
| mi | miles | 1.609 | kilometers | km |
| | **AREA** | | | |
| $in^2$ | square inches | 645.2 | square millimeters | $mm^2$ |
| $ft^2$ | square feet | 0.0929 | square meters | $m^2$ |
| $yd^2$ | square yards | 0.8361 | square meters | $m^2$ |
| ac | acres | 0.4047 | hectares | ha |
| $mi^2$ | square miles | 2.590 | square kilometers | $km^2$ |
| | **VOLUME** | | | |
| fl oz | fluid ounces | 29.57 | milliliters | mL |
| gal | gallons | 3.785 | liters | L |
| $ft^3$ | cubic feet | 0.0283 | cubic meters | $m^3$ |
| $yd^3$ | cubic yards | 0.7645 | cubic meters | $m^3$ |
| | **MASS** | | | |
| oz | ounces | 28.35 | grams | g |
| lb | pounds | 0.4536 | kilograms | kg |
| T | short tons (2000 lb) | 0.907 | megagrams | Mg |
| | **TEMPERATURE (exact)** | | | |
| °F | degrees Fahrenheit | (°F-32)/1.8 | degrees Celsius | °C |
| | **FORCE and PRESSURE or STRESS** | | | |
| lbf | poundforce | 4.448 | Newtons | N |
| $lbf/in^2$ | poundforce per square inch | 6.895 | kilopascals | kPa |

## *Approximate Conversions from SI Units*

| Symbol | When you know | Multiply by | To Find | Symbol |
|---|---|---|---|---|
| | **LENGTH** | | | |
| mm | millimeters | 0.0394 | inches | in |
| m | meters | 3.281 | feet | ft |
| m | meters | 1.094 | yards | yd |
| km | kilometers | 0.6214 | miles | mi |
| | **AREA** | | | |
| $mm^2$ | square millimeters | 0.00155 | square inches | $in^2$ |
| $m^2$ | square meters | 10.764 | square feet | $ft^2$ |
| $m^2$ | square meters | 1.196 | square yards | $yd^2$ |
| ha | hectares | 2.471 | acres | ac |
| $km^2$ | square kilometers | 0.3861 | square miles | $mi^2$ |
| | **VOLUME** | | | |
| mL | milliliters | 0.0338 | fluid ounces | fl oz |
| L | liters | 0.2642 | gallons | gal |
| $m^3$ | cubic meters | 35.315 | cubic feet | $ft^3$ |
| $m^3$ | cubic meters | 1.308 | cubic yards | $yd^3$ |
| | **MASS** | | | |
| g | grams | 0.0353 | ounces | oz |
| kg | kilograms | 2.205 | pounds | lb |
| Mg | megagrams | 1.1023 | short tons (2000 lb) | T |
| | **TEMPERATURE (exact)** | | | |
| °C | degrees Celsius | 9/5+32 | degrees Fahrenheit | °F |
| | **FORCE and PRESSURE or STRESS** | | | |
| N | Newtons | 0.2248 | poundforce | lbf |
| kPa | kilopascals | 0.1450 | poundforce per square inch | $lbf/in^2$ |

# OMNI-FLEX PIPE JOINT SEALS

## Final Report

## December, 1996

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**Oklahoma City, Oklahoma 73105**
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# EXECUTIVE SUMMARY

In June 1991, The Oklahoma Department of Transportation (ODOT) had 16 Omni-Flex pipe joint seals installed in the joints of a reinforced concrete pipe (RCP) section on ODOT Project ACIR-44-2(326)233 in Tulsa. Individual sections of RCP had diameters of 1.5 m (60 in) and lengths of 2.4 m (8 ft) in the area where the seals were installed. The remainder of the joints between RCP sections on this project were sealed with mastic. Mastic is approved for use on ODOT projects and is widely used in Oklahoma.

The 16 joints sealed with Omni-Flex seals and an adjacent 16 joints in the same size RCP, sealed with mastic, have been monitored since project project completion. Monitoring has consisted of inspecting the joints from inside the pipe. Neither the section sealed with Omni-Flex seals or the adjacent section, sealed with mastic, has developed any unusual amounts of leakage or deterioration which could be considered to be related to the performance of the joint seals.

Omni-Flex seals have been used on numerous other ODOT projects, where contractors have been allowed to use them by change order. Results have been satisfactory in all but one case, where unusually large numbers of leaking joints were observed soon after RCP was laid. Pipe where the leakage occurred had diameters of 2.7 m (108 in) and 2.4 m (96 in). The leaks were noted after the pipe had been laid and the trench backfilled. At that point, it was not possible to determine if the leaks were caused by pipe movement related to expansion of the Omni-Flex seals or by other factors.

Based on the overall performance of Omni-Flex pipe joint seals, ODOT's Office of Research recommended their approval as a contractor option, with a possible exception for larger RCP sizes. The Omni-Flex Project Panel approved their use on RCP with diameters of 1.5 m (60 in) and smaller. A specification providing for their use has been included in the "ODOT 1996 Standard Specifications for Highway Construction", published in October, 1996.

# INTRODUCTION

Oklahoma Department of Transportation (ODOT) specifications allow sealing joints in reinforced concrete pipe (RCP) with cold applied mastic, rubber gaskets, or plastic joint filler material. The most commonly used method is sealing with mastic.

Material cost for mastic is low, relative to the other methods, but labor required for application offsets this. Mastic must be applied with a brush or smeared on by hand, using a glove. It is generally applied to the spigot of a bell and spigot joint. Application is difficult on larger pipe sizes and includes the possibility of missing spots along the top and bottom of the pipe where it is difficult to see and reach the entire circumference of the spigot.

Some mastic brands require that primer be applied to both the bell and spigot before application of mastic. This provides more chances to miss spots during application. Mastic adheres to both the bell and the spigot. However, the adhesion force of the mastic to the RCP can be exceeded by water pressure in the pipe where a head of water builds up due to elevation differences. While this is not a common situation, it has occurred on at least one ODOT project. Where this happened, the mastic was "blown out" of the joints by water pressure. Some ODOT construction personnel feel that Omni-Flex joint seals might withstand this type of pressure better than mastic. Omni-Flex pipe joint seals are preformed rubber gaskets which form a compression seal when compressed between pipe sections. Omni-Flex gaskets are available for sealing joints in any standard size round, elliptical, or arch RCP. They are also available for sealing rectangular or square joints on joints between pipe and junction boxes, and joints between box culverts and junction boxes.

# OMNI-FLEX JOINT SEALS

Omni-Flex joint seals are made of closed-cell, blended rubber and polymer material. The base polymer in the seals is a blend of nitrile and vinyl material. Omni-Flex seals meet the chemical resistance requirements of AASHTO M-198. However, AASHTO M-198-75 has two sets of requirements, one for rubber gaskets, and one for gaskets of flexible plastic. Because of their composition of a blended material, Omni-Flex gaskets do not fit under either category, and do not meet either set of requirements.

ASTM D-1056-85, "Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber , Type 2C1" covers the Omni-Flex material. However, requirements of this specification are different (not as stringent) than those of AASHTO M-198, required by ODOT specifications at the time of the evaluation. Because of this, Omni-Flex did not meet ODOT gasket requirements. Also, the manufacturer did not furnish information to show that the Omni-Flex devices could meet the performance aspects of M-198.

Omni-Flex seals are installed by placing them on the spigot of the bell and spigot joint between RCP pipe sections (Figure 1). The following pipe section is then installed by a crane, which lifts it into place, compressing the seal as the sections are connected. For pipe sections up to 1.5m (60 in) in diameter, the Omni-Flex seal moves the last section of pipe slightly as it attempts to expand back to its former shape, further forming a compression seal. This movement can be observed without special equipment. According to the Oklahoma distributor of Omni-Flex seals, the expansion force cannot move larger pipe sections. Figure 2 is a diagram representing a cross-section of Omni-Flex seal during installation. Figure 3 shows an Omni-Flex seal after installation. Different sizes of Omni-Flex seals are used for each standard RCP size. These are listed in a chart, supplied to all customers by the distributor (Appendix A).

The size is printed on each seal to minimize chances of using the wrong size (Figure 4). It would not be possible to put a smaller size on a pipe as they stretch only enough to provide a snug fit. A seal of a size larger than required would leave an amount of slack between the pipe and the seal which should be obvious to the employee installing them.

**Figure 1. Placing Omni-Flex Seal on RCP section.**

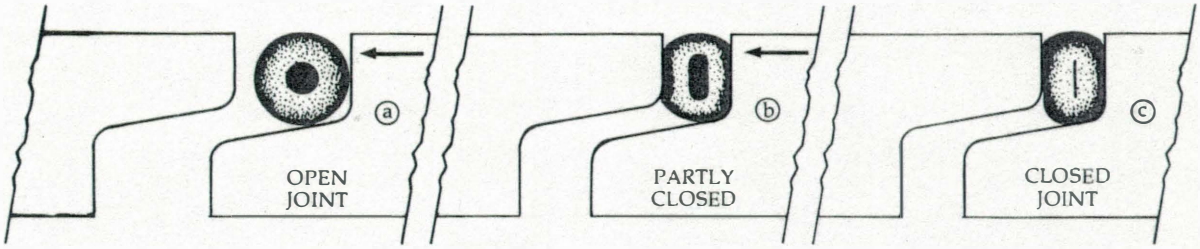



**Figure 2. Diagram of an Omni-Flex Seal During Installation.**

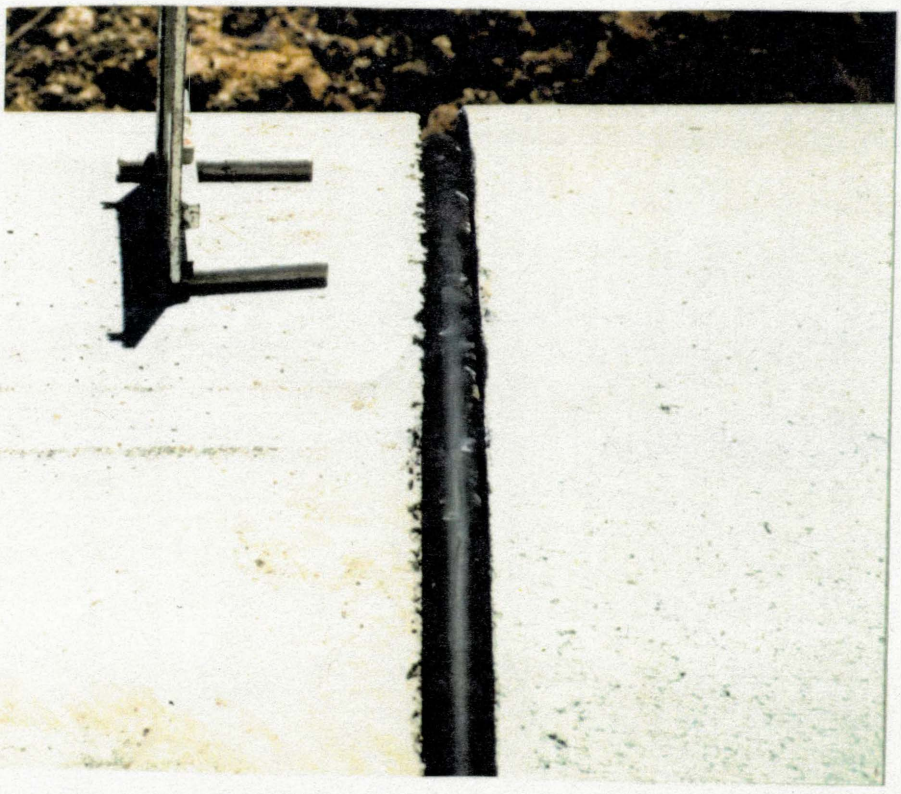


**Figure 3. Omni-Flex Seal During Installation.**

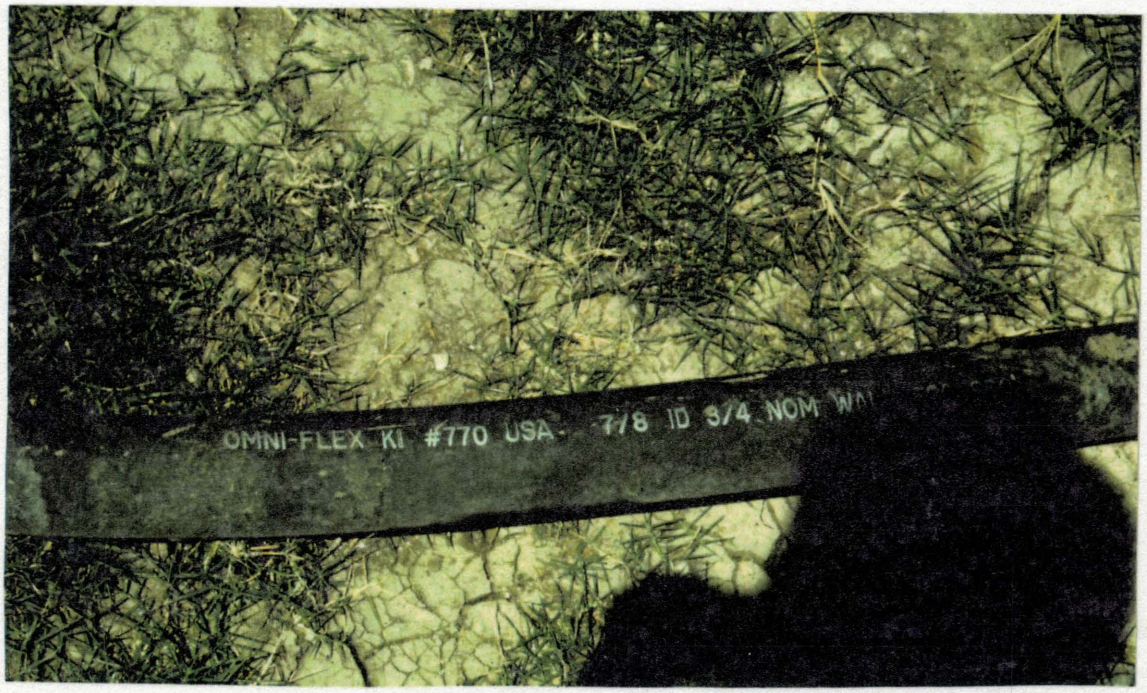



**Figure 4. Standard Markings on Omni-Flex Joint Seals.**

# ODOT EXPERIENCE WITH OMNI-FLEX SEALS

In June, 1991, Omni-Flex seals were installed on 16 joints of 1.5 m (60 in) diameter RCP on ODOT Project ACIR-44-2(326)233, in Tulsa. The rest of the RCP joints on this project were sealed with mastic (Figure 5). Installation of the Omni-Flex seals was observed by the ODOT Hydraulics Engineer. The 16 RCP joints sealed with Omni-Flex seals and 16 joints sealed with mastic have been surveyed at (approximately) six month intervals since installation. Performance of both the joints sealed with Omni-Flex devices and those sealed with mastic has been satisfactory, with no failures or unusual leakage observed.

Omni-Flex seals have been accepted by both Contractors and ODOT field personnel. Many of them prefer using Omni-Flex seals over the other approved alternative sealing methods. The City of Tulsa and several other municipalities allow use of Omni-Flex seals. Some contractors are familiar with Omni-Flex seals and request that they be allowed to use them on ODOT projects. The result is that Omni-Flex seals have been installed on many ODOT projects by change order. In most of these cases, the Research Division has not received notice that the seals were being used.

In March, 1995, the Research Division was notified of a problem on project IM-NHIY-35-3(219)125, an I-35 widening project in Oklahoma City. On this project, joints in 2.4 m (96 in) and 2.7 m (108 in) diameter RCP, which had been sealed with Omni-Flex seals, had developed an unusually large

number of leaks (Figures 6 and 7). The problems were noticed soon after the pipe was laid, and the contractor was still working on the project. Some of the leaks were large enough that corrective action (patching with mortar) had been required of the contractor (Figure 8). ODOT and contractor's personnel agreed that this probably was caused by some sort of movement after the pipe had been laid. Some of the pipe sections did appear to be connected so that the grade was slightly uneven. ODOT field personnel and contractor's employees on the project believed that these problems were caused by pipe sections being moved by the Omni-Flex seals after installation. At that point, (after construction was complete) it was not possible to determine whether the movement was due to expansion of the Omni-Flex seals, movement of pipe sections during backfilling, settlement, or other possible causes.

A meeting at the Oklahoma City Gifford-Hill Plant was arranged to discuss the pipe leakage and try to determine the cause. The Oklahoma Omni-Flex distributor stated that expansion of the seals could not move this size RCP. A demonstration was done where an Omni- Flex gasket was installed between two 2.4 m (96 in) diameter RCP sections, which were then compressed together. No movement of the pipe sections could be seen. The pipe sections used in the demonstration were 2.3 m (7.5 ft) lengths, as were the sections where the problem occurred. The meeting was attended by ODOT construction, materials, and research personnel, the contractor's construction superintendent, and the Omni-Flex distributor.

In March, 1995, after the incident described above, the ODOT Research Division surveyed some other completed projects where joints in the RCP had been sealed with Omni-Flex seals. Pipe on all of these sites checked had uneven grades to some extent (Figure 7), but none had leakage problems of the type that occurred on Project IM-NHIY-3(219)125. The largest size RCP on the other sites surveyed was 1.5 m (60 in ) diameter.

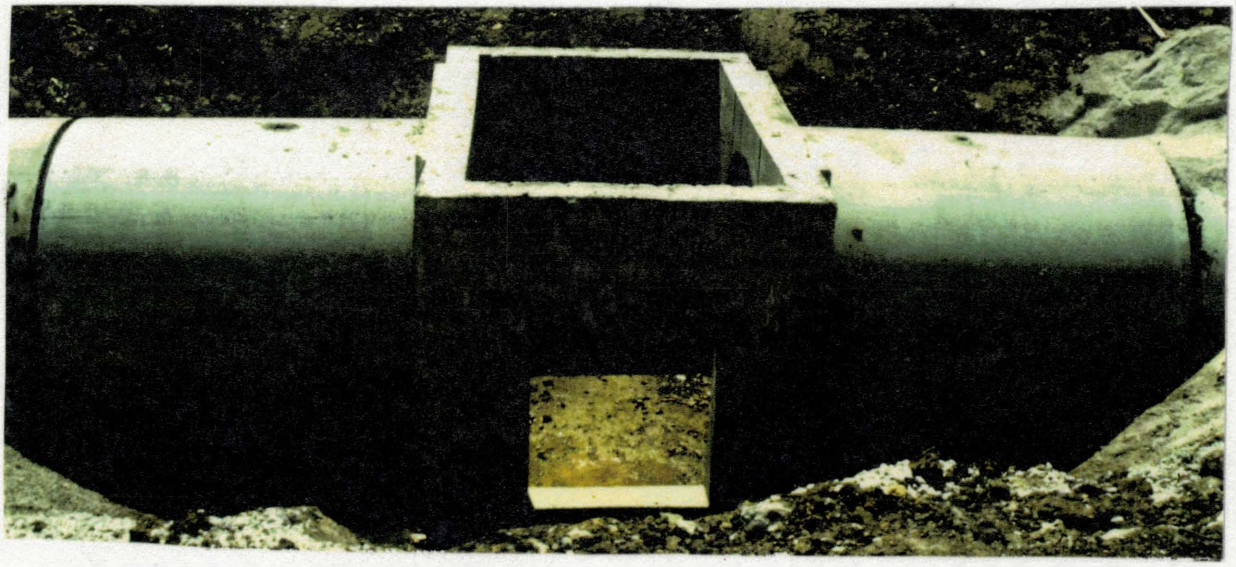


**Figure 5. RCP seals, Omni-Flex Left of Junction Box and Mastic Right of Junction Box.**

**Figure 6. Leaking Joint in 2.4 m (96 in) RCP.**

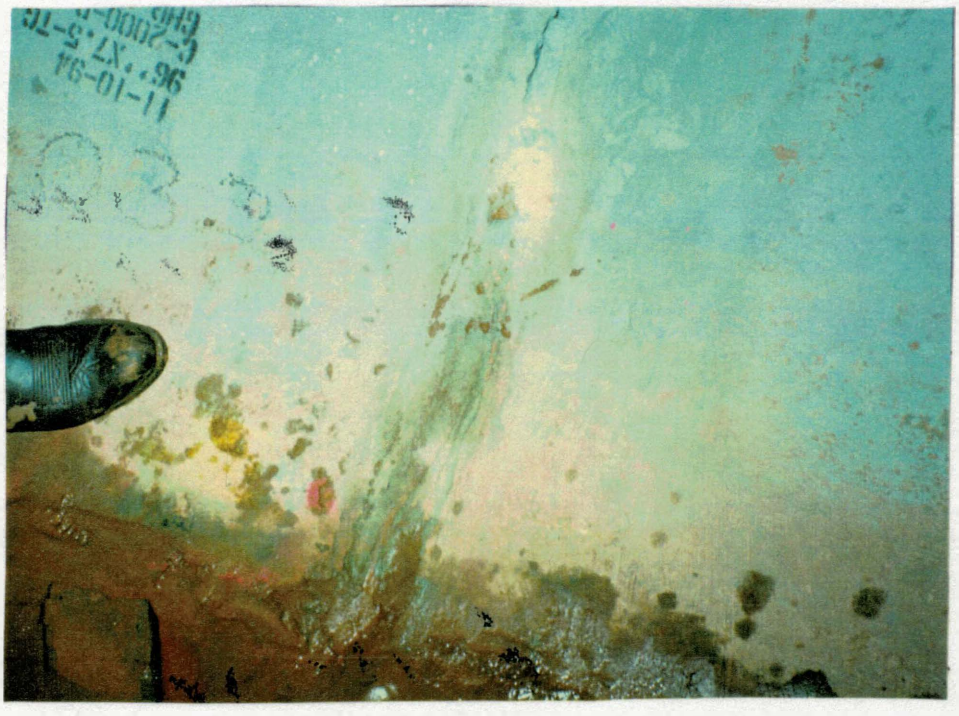


**Figure 7. Water seeping into 2.4 m (96 in) RCP Through Joint Patched with Mortar.**

**Figure 8. RCP Joint Patched With Mortar.**

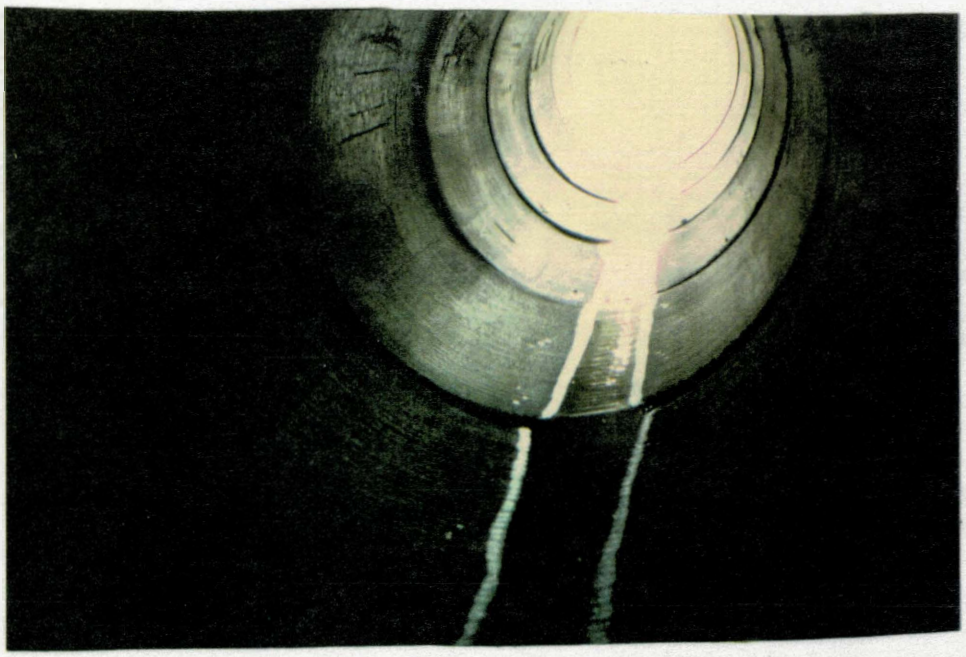


**Figure 9. RCP With Uneven Grade But No Obvious Leaking.**

# CONCLUSIONS

1. Performance of the Omni-Flex joint seals on Project ACIR-44-2(326) has been satisfactory, with no failures or unusual leakage observed. Performance of the mastic sealant used on this project has also been satisfactory. Both the Omni-Flex seals and the mastic sealant observed on this project were used to seal joints in 1.5 m (60 in) diameter RCP.

2. It is not clear whether the leakage on ODOT Project IM-NHIY-3(219)125 was caused by expansion of the Omni-Flex seals or by other causes. ODOT has not used Omni-Flex to seal these sizes of pipe (2.4 m (96 in) and 2.7 m (108 in) diameter) on any other projects reported to the Research Division.

3. At this time, the manufacturer has not provided information showing that Omni-Flex seals meet the performance standards of AASHTO M-198-75.

4. During the Project Panel meeting on implementation, the panel recommended approval of Omni-Flex seals for use on ODOT projects. The seals are to be used only on RCP pipes with diameters of 1.5 m (60 in) or less. Section 726.b.6.3 of "Oklahoma Department of Transportation Standard Specifications for Highway Construction, 1996 Edition" provides for use of this type of seal.

# IMPLEMENTATION

The Omni-Flex Project Panel met February 22, 1996 to discuss implementation. Omni-Flex seals have been used on numerous ODOT projects. However, for each use a change order has been required to allow their use. During the meeting on implementation, it was decided that a specification covering the use of Omni-Flex seals would be written and added to the "Oklahoma Department of Transportation 1996 Standard Specifications for Highway Construction". The specification (Appendix B) has been written and is included in section 726.b.6.3 of the publication named above.

Contractors working on ODOT Projects may now use Omni-Flex seals without requesting and waiting for change orders. This will reduce paperwork for both contractors and ODOT Field personnel. It will also allow contractors to plan for the use of these seals when submitting their original bid, without requesting change orders and waiting for approval.

# APPENDIX A

OMNI-FLEX
SEAL SIZES AND CORRESPONDING
STANDARD RCP SIZES

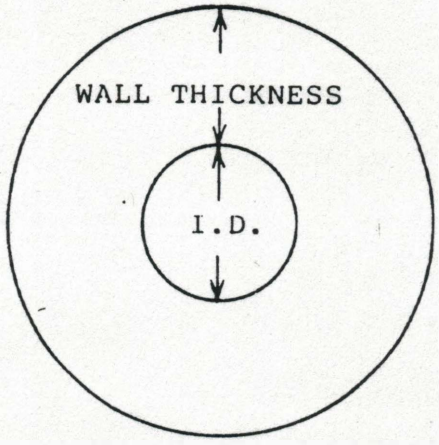
CHANDLER MATERIALS COMPANY
5805 EAST 15th STREET • TULSA, OKLAHOMA 74112
TULSA 836-9151 • PONCA CITY 762-6601 • MUSKOGEE 682-2484

EFFECTIVE DATE JANUARY 15, 1990

MAXIMUM SUGGESTED EXTERIOR JOINT OPENINGS
WHEN USING
OMNI-FLEX JOINT SEALS

| PIPE DIA. | SEAL I.D. | WALL THICKNESS | MAX. OUTSIDE JOINT OPENING | MAX. INSIDE JOINT OPENING |
|---|---|---|---|---|
| 12" | 1/2" | 1/4" | - | - |
| 15" | 3/8" | 3/8" | 3/4" | 5/8" |
| 18" | 1/2" | 3/8" | 7/8" | 3/4" |
| 21" | 3/4" | 3/8" | 1 1/8" | 7/8" |
| 24" | 1/2" | 1/2" | 7/8" | 3/4" |
| 27" | 3/4" | 1/2" | 1 1/4" | 1" |
| 30" | 3/4" | 1/2" | 1 1/4" | 1 1/8" |
| 36" | 1/2" | 3/4" | 1 3/8" | 1 3/8" |
| 42" | 5/8" | 3/4" | 1 1/2" | 1 1/2" |
| 48" | 3/4" | 3/4" | 1 1/2" | 1 1/2" |
| 54" | 7/8" | 3/4" | 1 5/8" | 1 5/8" |

NOTE: WE BELIEVE THAT THE ABOVE PARAMETERS WILL PROVIDE DEPENDABLE RESISTANCE AGAINST JOINT INFILTRATION BY SOILS AND LOW-PRESSURE FLUIDS. TO INCREASE THE FLUID PRESSURE RATING, REDUCE THE MAXIMUM JOINT OPENINGS FROM THOSE SHOWN ABOVE.




FULL SIZE SEAL FOR 48" RCP

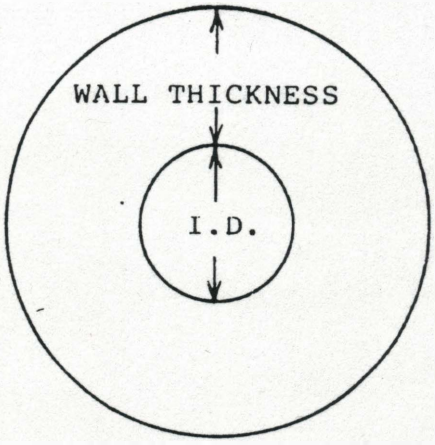
CHANDLER MATERIALS COMPANY
5805 EAST 15th STREET • TULSA, OKLAHOMA 74112
TULSA 836-9151 • PONCA CITY 762-6601 • MUSKOGEE 682-2484

EFFECTIVE DATE JANUARY 15, 1990

MAXIMUM SUGGESTED EXTERIOR JOINT OPENINGS
WHEN USING
OMNI-FLEX JOINT SEALS

| PIPE DIA. | SEAL I.D. | WALL THICKNESS | MAX. OUTSIDE JOINT OPENING | MAX. INSIDE JOINT OPENING |
|---|---|---|---|---|
| 12" | 1/2" | 1/4" | - | - |
| 15" | 3/8" | 3/8" | 3/4" | 5/8" |
| 18" | 1/2" | 3/8" | 7/8" | 3/4" |
| 21" | 3/4" | 3/8" | 1 1/8" | 7/8" |
| 24" | 1/2" | 1/2" | 7/8" | 3/4" |
| 27" | 3/4" | 1/2" | 1 1/4" | 1" |
| 30" | 3/4" | 1/2" | 1 1/4" | 1 1/8" |
| 36" | 1/2" | 3/4" | 1 3/8" | 1 3/8" |
| 42" | 5/8" | 3/4" | 1 1/2" | 1 1/2" |
| 48" | 3/4" | 3/4" | 1 1/2" | 1 1/2" |
| 54" | 7/8" | 3/4" | 1 5/8" | 1 5/8" |

NOTE: WE BELIEVE THAT THE ABOVE PARAMETERS WILL PROVIDE DEPENDABLE RESISTANCE AGAINST JOINT INFILTRATION BY SOILS AND LOW-PRESSURE FLUIDS. TO INCREASE THE FLUID PRESSURE RATING, REDUCE THE MAXIMUM JOINT OPENINGS FROM THOSE SHOWN ABOVE.




FULL SIZE SEAL FOR 48" RCP

CHANDLER MATERIALS COMPANY
5805 EAST 15th STREET • TULSA, OKLAHOMA 74112
TULSA 836-9151 • PONCA CITY 762-6601 • MUSKOGEE 682-2484

EFFECTIVE DATE FEBRUARY 14, 1990

MAXIMUM SUGGESTED EXTERIOR JOINT OPENINGS
WHEN USING
OMNI-FLEX JOINT SEALS

| BOX DIA. | SEAL I.D. | WALL THICKNESS | MAX. OUTSIDE JOINT OPENING | MAX. INSIDE JOINT OPENING |
|---|---|---|---|---|
| 4 X 3 | 5/8" | 3/4" | 1 1/2" | 1 1/2" |
| 4 X 4 | 5/8" | 3/4" | 1 1/2" | 1 1/2" |
| 5 X 3 | 5/8" | 3/4" | 1 1/2" | 1 1/2" |
| 5 X 4 | 5/8" | 3/4" | 1 1/2" | 1 1/2" |
| 5 X 5 | 5/8" | 3/4" | 1 1/2" | 1 1/2" |
| 6 X 3 | 5/8" | 3/4" | 1 1/2" | 1 1/2" |
| 6 X 4 | 5/8" | 3/4" | 1 1/2" | 1 1/2" |
| 6 X 5 | 5/8" | 3/4" | 1 1/2" | 1 1/2" |
| 6 X 6 | 5/8" | 3/4" | 1 1/2" | 1 1/2" |
| 7 X 3 | 3/4" | 3/4" | 1 1/2" | 1 1/2" |
| 7 X 4 | 3/4" | 3/4" | 1 1/2" | 1 1/2" |
| 7 X 5 | 3/4" | 3/4" | 1 1/2" | 1 1/2" |
| 7 X 6 | 3/4" | 3/4" | 1 1/2" | 1 1/2" |
| 7 X 7 | 3/4" | 3/4" | 1 1/2" | 1 1/2" |
| 8 X 3 | 7/8" | 3/4" | 1 5/8" | 1 5/8" |
| 8 X 4 | 7/8" | 3/4" | 1 5/8" | 1 5/8" |
| 8 X 5 | 7/8" | 3/4" | 1 5/8" | 1 5/8" |
| 8 X 6 | 7/8" | 3/4" | 1 5/8" | 1 5/8" |
| 8 X 7 | 7/8" | 3/4" | 1 5/8" | 1 5/8" |
| 8 X 8 | 7/8" | 3/4" | 1 5/8" | 1 5/8" |

# APPENDIX B

STANDARD SPECIFICATIONS FOR
HIGHWAY CONSTRUCTION
OKLAHOMA DEPARTMENT OF TRANSPORTATION
EDITION OF 1988

Support beams required for casting assemblies shall meet the requirements of AASHTO M 183.

"T" handles as shown on standard drawings for locking manhole covers shall be furnished. The minimum shall be two handles for up to and including 20 locking manhole covers and one for every 20 thereafter.

(b) **Special Fabricated Drainage Grates.** Welded steel drainage grates shall meet the material requirements of AASHTO M 183 for the load bearing members. Stiffeners shall be specified by the manufacturer. Welding shall meet all applicable standards as covered in Section 724 and references. Grate units shall be furnished galvanized after fabrication or painted with an inorganic zinc ethyl silicate base primer and vinyl finish coat. Galvanization shall be in accordance with the requirements of AASHTO M 111. Paint shall meet the materials requirements of Subsection 730.04. Cleaning of grate units (for either procedure) and paint application shall be as covered in Subsection 506.04(d) Painting. Only those procedures which apply to grate sized units shall apply, and shop applied paint shall be utilized for both coats.

Pipe for use in fabricated grates shall meet the requirements of ASTM A 53 and be furnished in standard weight, unthreaded mill finish unless otherwise stated. Hydrostatic pressure testing shall be waived. After welding, the grate units shall be thoroughly cleaned and pressure vent holes punched or drilled (only for galvanized units). See Plans for location of vent holes. See paragraph above for paint and painting requirements.

Angle iron and strap iron used for end members or spacers shall meet the requirements of AASHTO M 183 mill-finish.

Butt welded pipe shall be acceptable for use as grate members with the approval of the Engineer.

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**725.06. BRONZE.** Bronze castings shall conform to the requirements of AASHTO M-107 Copper Alloy C91100. Bronze bearings and expansion plates shall conform to the requirements of the Specifications for Rolled Phosphor Bronze Bearings and Expansion Plates for Bridges and Structures, AASHTO M 108 Copper Alloy C51000.

The class of metal shall be shown on the Plans.

## SECTION 726
## DRAINAGE CONDUITS

**726.01. DESCRIPTION.** This section covers the materials requirements for surface and subsurface drainage conduits of the kind specified on the Plans and the requirements of Section 613.

**726.02. MATERIALS.**

(a) **Rigid Conduits.** Materials covered in this Subsection: nonreinforced concrete pipe, drain tile, porous and perforated pipe, reinforced concrete circular, elliptical, and arch pipe; cast (ductile) iron, precast reinforced concrete box sections, manhole sections, inlet boxes, and junction boxes meeting the following requirements:

1. *Concrete and Clay Culverts.*

1.1. **Concrete Sewer, Storm Drain, and Culvert Pipe** shall conform to AASHTO M 86 or M 86M (Metric).





1.2. **Reinforced Concrete Culvert, Storm Drain and Sewer Pipe** shall conform to AASHTO M 170 or M 170M (Metric).

In addition to the Pipe Classes shown in AASHTO M 170, a special design Class IV/V conforming to AASHTO M 170 may also be used. Design criteria for Class IV/V is a midline interpolation between the design criterial shown for Class IV (Table 4) and Class V (Table 5) of AASHTO M 170.

1.3. **Reinforced Concrete Arch Culvert, Storm Drain and Sewer Pipe** shall conform to AASHTO M 206 or M 206M (Metric).

1.4. **Reinforced Concrete Elliptical Culvert, Storm Drain and Sewer Pipe** shall conform to AASHTO M 207 or M 207M (Metric).

1.5. **Reinforced Concrete D-Load Culvert, Storm Drain and Sewer Pipe** shall conform to AASHTO M 242 or M 242M (Metric).

1.6. **Concrete Drain Tile** shall conform to AASHTO M 178 or M 178M (Metric).

1.7. **Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated** shall conform to AASHTO M 65.

1.8. **Clay Drain Tile** shall conform to AASHTO M 179.

2.. *Rigid Metallic Culverts.*

2.1. **Ductile Iron Culvert Pipe** shall conform to AASHTO M 64.

3.. *Precast Sewer Appurtenances and Box Sections for Culverts.*

3.1. **Precast Reinforced Concrete Manhole Sections** shall conform to AASHTO M 199 or M 199M (Metric).

3.2. **Precast Reinforced Concrete Curb Inlet Boxes** shall conform to ODOT approved Designs.

3.3. **Precast Reinforced Concrete Junction Boxes** shall conform to ODOT approved Designs.

3.4. **Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers** shall conform to AASHTO M 259 or M 259M (Metric).

3.5. **Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers With Less Than 2 Feet of Cover Subject to Highway Loadings** shall conform to AASHTO M 273 or M 273M (Metric).

4. *Concrete and Clay Underdrain.*

4.1. **Concrete Sewer, Storm Drain, Culvert Pipe** shall conform to AASHTO M 86 or M 86M (Metric).

4.2. **Concrete Drain Tile** shall conform to AASHTO M 178 or M 178M (Metric).

4.3. **Perforated Concrete Pipe** shall conform to AASHTO M 175 or M 175M (Metric).

4.4. **Porous Concrete Pipe** shall conform to AASHTO M 176 or M 176M (Metric).

4.5. **Vitrified Clay Pipe, Extra Strength, Standard and Perforated** shall conform to AASHTO M 65.

4.6. **Clay Drain Tile** shall conform to AASHTO M 179 or M 179M (Metric).

5. *Pipe Rejection.* Rejection criteria covered herein shall apply to the previously numbered Subsections: 726.02(a) 1.1, 1.2, 1.3, 1.4, 1.5, 1.7, 3.1, 3.2, 3.3, 3.4, 3.5, 4.1, 4.3, and 4.4. A lot of pipe represented by test samples may be rejected for failure to meet any of the requirements of the governing Specifications. Any lot of pipe less than 30 days of age, which meets all requirements except the strength tests, may be retested at a later date when so requested by the manufacturer. Individual sections of pipe may be rejected for failure to meet the Specification requirements of manufacture, and damage acquired in handling, hauling, delivery and installation, with the following exceptions: (1) a single end crack that does not exceed the depth of the joint; (2) damaged ends when chips do not extend more than half of the joint, either from the end of the joint or along the circumference of the pipe, and providing that in the opinion of the Engineer satisfactory permanent patching can be performed during installation.

6. *Joint Filler.* Joint filler for joints in concrete pipe culverts shall meet the requirements of one of the following materials:

6.1. **Cold Applied Mastic Type.** This compound, when applied according to the manufacturer's directions, shall be resilient and adhesive and maintain an effective seal through repeated cycles of expansion and contraction. The material shall comply specifically with the following requirements:

| | Minimum | Maximum |
|---|---|---|
| Specific Gravity 25° C/25° C | 1.290 | 1.350 |
| Pounds Per Gallon | 10.75 | 11.25 |
| Percent Soluble in Trichlorethylene | 45.0 | -- |
| Percent Ash | 50.0 | 55.0 |
| Percent Water by Volume | -- | 0 |
| Penetration (Standard Cone) | | |
| 150 gr., 5 sec., 25° C | 175 | 200 |

**Note:** This joint filler shall not be used for precast concrete boxes.

6.2. **Flexible Watertight Gaskets.** The joint materials shall meet the requirements of AASHTO M 198 and provide a proper fit for a satisfactory seal. When not on the approved list maintained by the Materials Engineer, a type A certification stating the material meets AASHTO M 198 shall be submitted.

(b) **Flexible Conduits.** Materials covered in this Subsection: steel conduits, coated and clad steel conduits, structural plates, aluminum conduits, clad aluminum conduits, and nonmetallic conduits meeting the following requirements:

1. *Steel Conduits-Culverts.*

1.1. **Metallic (Zinc or Aluminum) Coated, Corrugated Steel Culverts and Underdrains** shall conform to AASHTO M 36.

1.1.1. **Sheets for Culverts.** Zinc coated (Galvanized) steel sheets for culverts and underdrains shall conform to AASHTO M 218. Steel sheet, aluminum-coated (type 2) by the hot-dip process for sewer and drainage pipe shall





conform to AASHTO M 274. Aluminum-zinc alloy coated sheet steel for corrugated steel pipe shall conform to AASHTO M 289.

1.1.2. **Types of Culverts.** Culverts shall be type I (Circular) or type II (Arch) shape unless otherwise specified on the Plans.

1.1.3. **Externally Coated or Clad Culverts.**

1.1.3.1. **Bituminous Coated Corrugated Metal Culvert Pipe and Pipe Arches** shall conform to AASHTO M 190. Type A bituminous coating shall be used unless type B, type C, or type D is specified.

1.1.3.2. **Precoated Galvanized Steel Culverts and Underdrains** shall conform to AASHTO M 245 or M 245M (Metric) or steel sheet, metallic-coated and polymer precoated for corrugated steel pipe conforming to AASHTO M 246 or M 246M (Metric).

1.1.3.3. When bituminous coated or mill-precoated galvanized steel culverts are called for, aluminum coated (type 2) steel pipe shall be an equal alternate and paid for under Subsection 613.06(f).

2. *Aluminum Conduits-Culverts.*

2.1. **Corrugated Aluminum Alloy Culverts and Underdrains** shall conform to AASHTO M 196. If bituminous coating is specified it shall by type A coating unless type B or type C coating is specified, meeting the requirements of AASHTO M 190.

2.2. **Clad Aluminum Alloy Sheets for Culverts and Underdrains** shall conform to AASHTO M 197.

3. *Nonmetallic Conduits-Culverts.*

3.1. **Class PS 50 Polyvinyl Chloride (PVC) Pipe** shall conform to AASHTO M 278.

3.2. **Corrugated Polyethylene Pipe,** 12 to 24 inch diameter shall conform to AASHTO M 294.

4. *Steel Conduits-Underdrain.*

4.1. **Metallic (Zinc or Aluminum) Coated Corrugated Steel Culverts and Underdrain** shall conform to AASHTO M 36.

4.1.1. **Sheets for Underdrain** shall conform to AASHTO M 36 (see Subsection (b) 1.1.1.)

4.1.2. **Types.** Underdrain shall be furnished in type III pipe with Class I perforations unless otherwise specified on the Plans. Minimum thickness shall be 0.052 inch for 6 inch diameter and .064 inch for all other diameters.

4.1.3. **Externally Coated or Clad Underdrains.** When called for on the Plans, underdrain shall be furnished clad, meeting the requirements of AASHTO M 245 or M 245M (Metric). Thickness of base metal shall be as shown in 4.1.2.

# APPENDIX C

OKLAHOMA DEPARTMENT OF TRANSPORTATION
1996 STANDARD SPECIFICATIONS
FOR HIGHWAY CONSTRUCTION

In addition to the Pipe Classes shown in AASHTO M 170M, a special design Class IV/V conforming to AASHTO M 170M may also be used. Design criteria for Class IV/V is a midline interpolation between the design criteria shown for Class IV (Table 4) and Class V (Table 5) of AASHTO M 170M.

1.3. ***Reinforced Concrete Arch Culvert, Storm Drain and Sewer Pipe*** shall conform to AASHTO M 206M.

1.4. ***Reinforced Concrete Elliptical Culvert, Storm Drain and Sewer Pipe*** shall conform to AASHTO M 207M.

1.5. ***Reinforced Concrete D-Load Culvert, Storm Drain and Sewer Pipe*** shall conform to AASHTO M 242M.

1.6. ***Concrete Drain Tile*** shall conform to AASHTO M 178M.

1.7. ***Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated*** shall conform to AASHTO M 65.

1.8. ***Clay Drain Tile*** shall conform to AASHTO M 179.

2. ***Rigid Metallic Culverts.***

2.1. ***Ductile Iron Culvert Pipe*** shall conform to AASHTO M 64.

3. ***Precast Sewer Appurtenances and Box Sections for Culverts.***

3.1. ***Precast Reinforced Concrete Manhole Sections*** shall conform to AASHTO M 199M.

3.2. ***Precast Reinforced Concrete Curb Inlet Boxes*** shall conform to ODOT approved Designs.

3.3. ***Precast Reinforced Concrete Junction Boxes*** shall conform to ODOT approved Designs.

3.4. ***Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers*** shall conform to AASHTO M 259M.

3.5. ***Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers With Less Than 600 millimeter of Cover Subject to Highway Loadings*** shall conform to AASHTO M 273M.

4. ***DELETED.***

5. ***Inspection and Acceptance.*** Inspection and acceptance criteria will be as specified unless the manufacturer has established an approved quality control program with the Department.

6. ***Joint Filler.*** Joint filler for joints in concrete pipe culverts shall meet the requirements of one of the following materials:

6.1. ***Cold Applied Mastic Type.*** This compound, when applied according to the manufacturer's directions, shall be resilient and adhesive and maintain an effective seal through repeated cycles of expansion and contraction. The material shall comply specifically with the following requirements:

| | Minimum | Maximum |
|---|---|---|
| Soluble in Trichloroethylene, AASHTO T 44, % | 45.0 | – |
| Ash, AASHTO T 111, % | 15.0 | 55.0 |
| Penetration[a], AASHTO T 49, 150 g., 5 sec., 25°C | 150 | 275 |

[a] Penetration shall be in accordance with AASHTO T 49 except that a penetration cone shall be used in lieu of the standard penetration needle. The cone shall conform to the requirements given in the Standard Method of Test for Cone Penetration of Lubricating Grease (ASTM D 217), except that the interior construction may be modified as desired.

**Note:** This joint filler shall not be used for pipes larger than 1524 millimeter in diameter or for precast concrete boxes.

6.2. ***Flexible Watertight Gaskets.*** The joint materials shall meet the requirements of AASHTO M 198 and provide a proper fit for a satisfactory seal. When not on the approved list maintained by the Materials Engineer, a type A certification stating the material meets AASHTO M 198 shall be submitted.

**Note:** Butyl rubber sealant shall be used for all pipes in excess of 1524 millimeter in diameter.

6.3 ***Flexible Cellular Seals.*** The joint materials shall meet the requirements of ASTM D 1056 "Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber, Type 2C1."

**Note:** This joint material shall be one continuous piece, shall be applied in accordance with the manufacturer's recommendation and shall not be used for pipes larger than 1524 millimeter.

(b) **Flexible Conduits.** Materials covered in this Subsection: steel conduits, coated and clad steel conduits, structural plates, aluminum conduits, clad aluminum conduits, and nonmetallic conduits meeting the following requirements:

1. ***Steel Conduits-Culverts.***

1.1. ***Metallic (Zinc or Aluminum) Coated, Corrugated Steel Culverts*** shall conform to AASHTO M 36.

1.1.1. ***Sheets for Culverts.*** Zinc coated (Galvanized) steel she ts for culverts shall conform to AASHTO M 218. Steel sheet, aluminum-c oated (type 2) by the hot-dip process for sewer and drainage pipe shall conform to AASHTO M 274. Aluminum-zinc alloy coated sheet steel for corrugated steel pipe shall conform to AASHTO M 289.

1.1.2. ***Types of Culverts.*** Culverts shall be type I (Circular) or type II (Arch) shape unless otherwise specified on the Plans.

1.1.3. ***Externally Coated or Clad Culverts.***

1.1.3.1. ***Bituminous Coated Corrugated Metal Culvert Pipe and Pipe Arches*** shall conform to AASHTO M 190. Type A bituminous coating shall be used unless type B, type C, or type D is specified.

1.1.3.2. ***Precoated Corrugated Steel Culverts*** shall conform to AASHTO M 245Mconstructed from polymer coated sheet conforming to AASHTO M 246M, or shall conform to AASHTO M 36M construced from aluminum-coated (type 2) sheet conforming to AASHTO M274..

2. ***Aluminum Conduits-Culverts.***

2.1. ***Corrugated Aluminum Alloy Culverts*** shall conform to AASHTO M 196. If bituminous coating is specified it shall by type A coating unless type B or type C coating is specified, meeting the requirements of AASHTO M 190.

2.2. ***Clad Aluminum Alloy Sheets for Culverts*** shall conform to AASHTO M 197.

3. ***Nonmetallic Condu its-Culverts.***

3.1. ***Class PS 50 Polyvinyl Chloride (PVC) Pipe*** shall conform to AASHTO M 278.

3.2. ***Corrugated Polyethylene Pipe,*** shall conform to AASHTO M 294.

4. ***DELETED.***

5. ***DELETED.***

6. ***Nonmetallic Conduits-Underdrain.***

6.1. ***Polyvinyl Chloride (PVC) Pipe.*** Class PS 50 polyvinyl chloride (PVC) pipe shall conform to AASHTO M 278, or highway underdrain conforming to the requirements of ASTM F 758, Standard Specifications for Smooth-Wall Polyvinyl Chloride (PVC) Plastic Underdrain Systems for Highway, Airport and Similar Drainage with material Specification of ASTM D 1784. This underdrain shall be furnished with a minimum pipe stiffness of 317 kPa (Type PS-46). Corrugated polyvinyl chloride (PVC) pipe shall meet the requirements of ASTM F 949.

6.2. ***Polyethylene Drainage Tubing.***

6.2.1. ***Corrugated Polyethylene Drainage Tubing.*** Corrugated polyethylene drainage tubing shall conform to AASHTO M 252 Type C or CP.

6.2.2. ***Smooth Interior Corrugated Polyethylene Drainage Tubing.*** Smooth wall corrugated polyethylene drainage tubing shall conform to AASHTO M 252 Types S or SP or AASHTO M 294 Type S. The polyethylene pipe shall be manufactured from High Density Polyethylene (HDPE), virgin compounds in accordance with ASTM D 3350, cell class 324420 C.

6.2.3. **Perforations.** When perforations are specified, they shall meet the requirements of Class 2 unless otherwise noted on the Plans.

6.2.4. **Materials Certification, Testing and Acceptance.** Materials certification, testing and acceptance shall be in accordance with the requirements of AASHTO M 252, AASHTO M 294, and the Department's acceptance policy published as: "Procedure for Inspection,