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RESEARCH UPDATE

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PERFORMANCE OF EXPERIMENTAL METAL CULVERTS

REFERENCE

Work Plan 81-R-17 Purpose - To compare the performance of various protective systems with each other and with the standard ACCGMP.

HISTORY

In 1981, the Agency prepared plans to include the installation of a 108' x 36", 14 gauge metal culvert composed of experimental materials or treated with protective coatings on the route US7, F019 C/1 project in Sunderland, Vermont. The installation was completed at MM0642±, 5.0 miles south of the route US7 junction with route VT11 in Manchester on October 1, 1981. There were no significant problems encountered during the placement of the 6 segments of culvert on a 2.3% grade.

The six segments listed in order from the outlet to inlet end included the following materials or coatings:

1) Epoxy Bonded, Grade 1, 7 mil minimum average thickness on both sides over black substrate ASTM A366 steel.

2) Galvalume, a 0.6 oz/sf alloy coating (Aluminum, 55%; Zinc, 43.5%; Silicon 1.5%) conforming to AASHTO M289.

3) Beth-Cu-Loy, Type C, a 10 mil polymer coating (PVC plastisol) on both sides over 1 oz/sf galvanized conforming to AASHTO M246.

4) Aluminized Type II, a 1 oz/sf aluminum alloy coating (Aluminum, 96% min; Iron, 3% max; Silicon 0.35% max) conforming to AASHTO M274.

5) CGMP, conforming to the requirements of AASHTO M36.

6) ACCGMP, conforming to the requirements of AASHTO M190 for bituminous coating and AASHTO M246 for precoated galvanized steel.

OBSERVATIONS & COMMENTS

The experimental pipe segments have been inspected in detail at least once every two years since installation. The drainage area consists of wooded mountain slopes free of agricultural or residential development. Water flow generally averaged less than 2" in depth with a maximum flow of 18" estimated. Bed loading has been significant at times with granular material and cobbles up to 10"± found covering the bottom of various sections.

Comments on performance of each system are as follows:

Epoxy Bonded - Segment No. 1 (at outlet)

1981 (at installation). The coating ranged from 6.4 to 10.0 mils with an average of 8.2 mils on the pipe exterior and from 6.9 to 11.0 mils with an average of 8.9 mils on the interior. Some corrosion noted on the pipe invert at the outlet end.

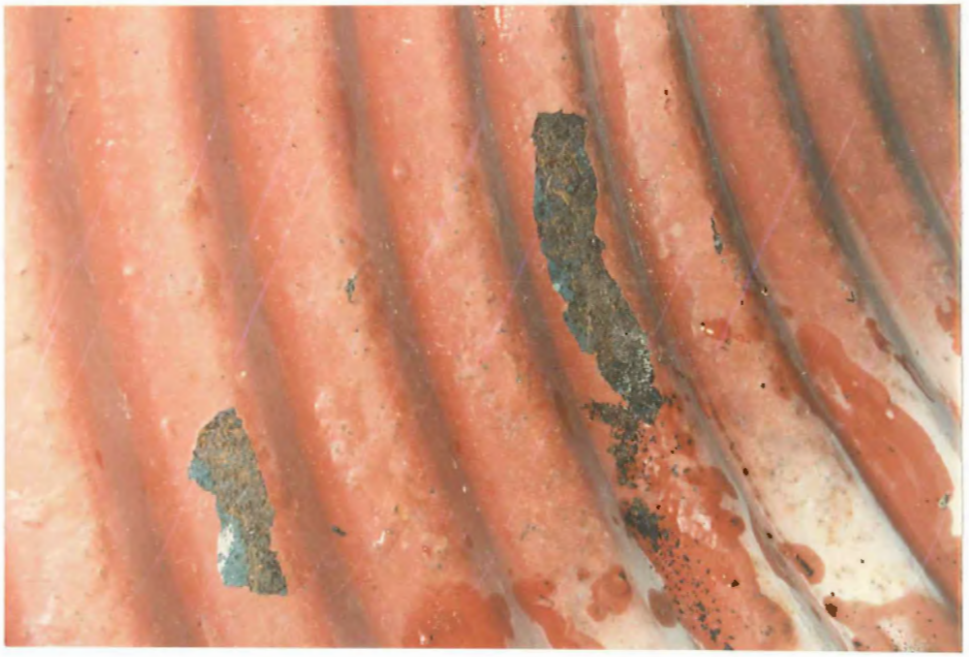
1983 (2 years exposure). Some pitting or abrasion of coating near outlet on upstream side of corrugations and a similar condition has occurred at annular rolled ends.

1984 (3 years exposure). Coating has cracked and flaked off at a location where pipe was dented during placement.

1985 (4 years exposure). Corrosion undercutting and blistering the coating at a few locations.

1987 (6 years exposure). Slight increase in coating failure. Loose coating is brittle.

1988 (7 years exposure). The outlet half of the 20' section has blistering over 50% of the area on the upstream side of the corrugations from the bottom to the midpoint of the pipe. Very little blistering on the downstream side of the corrugations. Removal of the coating from two 1½" x 3" and 5" areas revealed active corrosion was occurring on the underlying steel. Neither this inspection or earlier ones gave any indication that the blistering was preceded by cracks or other breaks in the coating. The upper 10' of pipe had very few blisters visible but the coatings' surface gloss has disappeared.



Note blisters in coating and complete corrosion where the epoxy was removed for inspection

Galvalume - Segment No. 2

1981 (at installation). The coating ranged from 2.8 to 4.1 mils with an average of 3.3 mils on the pipe exterior and from 2.3 to 3.5 mils with an average of 2.9 mils on the interior.

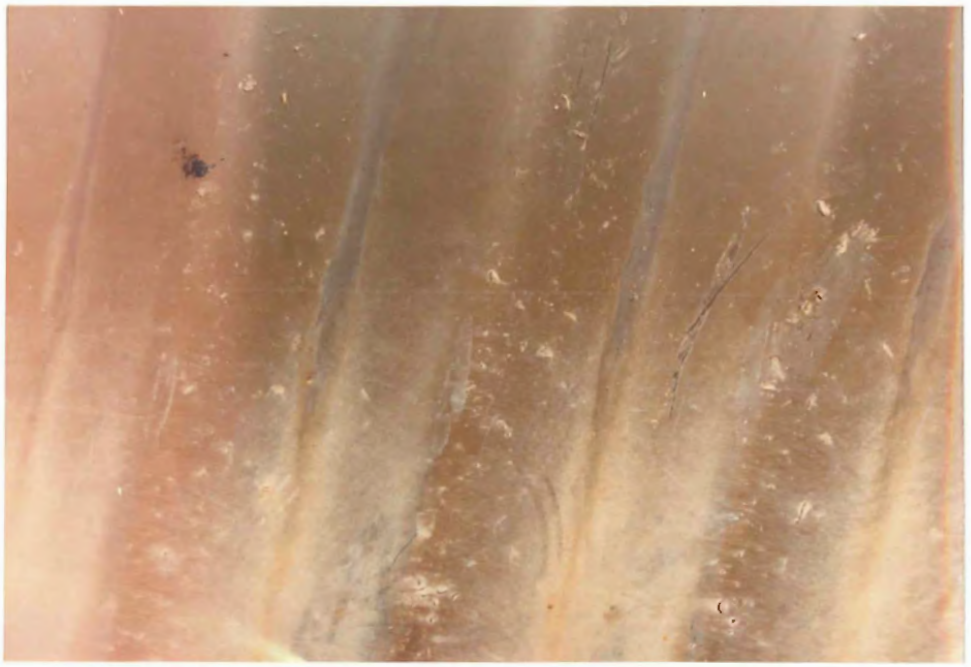
1988 (7 years exposure). This pipe has remained in excellent condition since installation. There is some surface staining within the flow area but no sign of abrasion or corrosion.

Beth-Cu-Loy - Segment No. 3

1981 (at installation). The PVC plastisol coating appeared to be greater than the 10 mils specified by the manufacturer. Actual values could not be obtained with the available thickness gauge.

1984 (3 years exposure). Minor pitting noted in the coating on the upstream side of the corrugations in the area of water flow.

1988 (7 years exposure). Numerous (3 to 6 sq.in.) small chips, nicks, or gouges in the coating with all located on the upstream side of the corrugations up to the midpoint height of the pipe. In some cases the nicks appear to be deep but there is no visible sign of any corrosion present. The coating is still as flexible to fingernail pressure as it was at the time of installation.



Note nicks in coating on up stream side of corrugations

Aluminized Type II - Segment No. 4

1981 (at installation). The coating ranged from 2.5 to 3.0 mils with an average of 2.7 mils on the pipe exterior and from 2.6 to 4.5 mils with and average of 3.7 mils on the interior. Rerolled ends appear to have been recoated (painted) following fabrication.

1984 (3 years exposure). Some rust at welded helical seams.

1985 (4 years exposure). Rusting on increase at welds and occasional corrosive pits visible at widely scattered locations.

1987 (6 years exposure). All welded seams 100% surface rust plus additional spot locations.

1988 (7 years exposure). Spot corrosion visible at random locations averaging a pit per 4 sq.in. Corrosion also present on a ½" wide x 6" to 8" high area in the third corrugation from each seam in the 6 o'clock to 9 o'clock quadrant.

Note band of corrosion plus random spot corrosion

Galvanized - Segment No. 5

1981 (at installation). The galvanizing ranged from 2.1 to 3.1 mils with an average of 2.7 mils on the pipe exterior and from 2.3 to 3.9 mils with an average of 3.6 mils on the interior.

1985 (4 years exposure). Light corrosion occuring below high water line.

1988 (7 years exposure). Corrosion is occuring over the majority of the area within or just above the flow line. Spot corrosion is present from the top center of the pipe to the 5 o'clock position on the bottom 10' to 12' segment.

ACCGMP - Segment No. 6

1984 (3 years exposure). Some asphalt coating missing above the paved invert.

1985 (4 years exposure). 35±% of the asphalt coating has been lost on a 6" high strip above the paved invert in the 6 o'clock to 9 o'clock quadrant.

1988 (7 years exposure). 20±% of the asphalt coating has been lost from the paved invert to the 9 o'clock position but no corrosion is visible within the area.

SUMMARY OF PERFORMANCE

Performance through 7 years of exposure is as follows:

1) Epoxy Bonded - Performance very poor. Corrosion is occuring beneath the coating.

2) Galvalume - Performance very good. No corrosion evident.

3) Beth-Cu-Loy - Performance good. Chips and nicks in coating but no corrosion evident.

4) Aluminized Type II - Performance poor. Corrosion is occuring at various random locations.

5) Galvanized - Performance fair. Corrosion is occuring within, and just above the flow line.

6) ACCGMP - Performance good. Some loss of asphalt coating but no corrosion evident.

Through the present period this field test suggests that the Galvalume, Beth-Cu-Loy and ACCGMP systems will provide the greatest long term service.

FOLLOW-UP

Inspections will continue on this field test installation and additional reports will be prepared as changes in the performance of the systems are identified.

Distribution: A, B, D, E, G, DTA#1