AP-141

ARMCO Metal Products Division

AP-141

Headquarters Division
Washington, D. C.

June 10, 1964

cc: W. S. Mann
A. J. Mistler
R. E. Smith
H. L. White

corr. file

TO: W. S. Anders

FROM: W. E. Harrison

SUBJECT: Blue Ridge Parkway Culvert Survey

Per my memo of June 4, 1964, attached is copy of article "A Study of Bituminous Coated Corrugated Sheet Metal Culverts" which appeared in 1946 July-Aug.-Sept. issue of Public Roads magazine.

I again suggest that Armco and/or NCSPA take the initiative and re-inspect some of these installations - before we are possibly confronted with reports by BPR which may be detrimental to the industry.

WEH:pap

Attachment

WEH.

G-5958

R E Smith

A STUDY OF BITUMINOUS-COATED CORRUGATED SHEET METAL CULVERTS

BY THE DIVISION OF PHYSICAL RESEARCH, PUBLIC ROADS ADMINISTRATION

Reported by J. Y. Welborn, Associate Highway Engineer, and P. J. Serafin, Assistant Chemical Engineer

IN THE CONSTRUCTION of certain sections on the Blue Ridge parkway during 1936–41, bituminous-coated corrugated sheet metal culverts were installed for the drainage of surface water. Preliminary inspection of these pipe was made by United States naval inspectors at the plants of the fabricators, at which time the erosion test was made. Samples of the pipe were then sent to the Public Roads laboratory, where the asphalt coating and galvanized metal were tested for conformity with the governing specifications.

Since these culvert pipe have been in service from 4 to 9 years it seemed advisable to determine their service behavior. This report covers the field inspection of the pipe in the fall of 1945 and laboratory analyses of the samples taken.

The types of bituminous-coated metal culverts and the sections of road on which they are used are given in table 1.

TABLE 1.—*Types of culvert pipe installed on the Blue Ridge parkway*

Type of culvert pipe	Section	Fabricator	Number of pipe culverts installed	Number of culverts inspected	Date of construction
Galvanized metal coated with asphalt and invert paved with asphalt	2M-1	A	79	26	1938-39
	2U-2	B	67	11	1939-40
Asbestos-bonded metal coated with asphalt and invert paved with asphalt	2M-2	A	38	11	1936-38
	2N-1	A	87	26	1936-38
	2P-2	A	110	31	1937-38
Galvanized metal coated with asphalt and invert paved with metal reinforced asphalt	2N-2	C	69	17	1940-41
	2P-1	C	(1)	7	(1)
	2V-1	C	45	11	1939-40

[1] Section not completed. Construction started in 1940, stopped in 1941.

In order that the reader may distinguish between the types of culvert pipe used on the various sections and have a better understanding of the conditions found during the inspection, brief descriptions of the three general types of bituminous-coated sheet metal pipe are given below.

TYPES OF BITUMINOUS-COATED CORRUGATED SHEET METAL CULVERT PIPE DESCRIBED

Galvanized metal pipe coated with asphalt and with an asphalt pavement.—Galvanized corrugated sheet metal pipe is uniformly coated with asphalt on the outside and the inside. One-fourth of the inside circumference, which forms the bottom of the pipe when installed, is coated with an additional thickness of asphalt such that the corrugations in the pipe are filled and a smooth pavement formed. The specifications required that the thickness of asphalt coating on the inside three-fourths of the circumference should be not less than three-hundredths inch and on the bottom quarter that the thickness should be sufficient to meet the requirements of the erosion test.

Asbestos-bonded metal pipe coated with asphalt and with an asphalt pavement.—In the process of galvanizing the metal sheet for use in the fabrication of this type of culvert pipe a layer of asbestos felt is rolled into the molten spelter coating on one or both sides of the sheet. In the pipe covered by this report the asbestos felt was on only one side of the sheet. On cooling, a portion of the asbestos felt becomes securely embedded in the coating, leaving a mass of fiber on the surface of the sheet. This surface is then primed with a bituminous material after which the sheets are fabricated into corrugated pipe. The asbestos-bonded surface formed the inside of the pipe inspected. As a final step in manufacture the pipe is coated with asphalt and the asphalt pavement formed as for the plain galvanized metal pipe.

It is claimed that the asbestos treatment assures permanent tight adhesion of the asphalt coating, increases the resistance of the asphalt coating to fracture on impact, and tends to cushion pressure caused by water freezing within the pipe.

Galvanized metal pipe coated with asphalt and with a metal reinforced asphalt pavement.—Galvanized corrugated sheet metal is used in the fabrication of this kind of pipe. The outside of the pipe and three-fourths of the inside circumference are uniformly coated with asphalt but the remaining fourth, which forms the bottom of the pipe when installed, is paved with asphalt reinforced with metal.

In fabricating the pavement a layer of asphalt-impregnated felt is placed inside the pipe over the corrugations and over this a sheet of metal, curved to fit the circumference of the pipe, is placed. The felt and the metal plate cover approximately one-fourth of the circumference of the pipe and are the same length as each corrugated section used in fabricating the pipe. The metal reinforcing plate is galvanized sheet iron, perforated on 2-inch centers across the width of the plate and the rows of perforations are spaced so that a row is directly over each valley of the corrugations when the plate is placed in the pipe. The plate is fastened to the pipe by rivets placed on approximately 4-inch centers across each end and one rivet on each edge near the center of the plate. The ends of sheets are lapped approximately 2 inches at each section junction. With the metal reinforcement in place each length of pipe is coated with asphalt. The hot asphalt fills the valleys of the corrugations between the layer of felt and the pipe and an additional thickness of bituminous material is deposited on the surface of the metal plate, thus forming the metal reinforced asphalt pavement. The reinforcing plate in the pipe used on the Blue Ridge parkway had a spelter coating of 0.68 ounce per square foot and was approximately 26 gage.

In November 1939 a sample of bituminous-coated corrugated sheet metal pipe with reinforced asphalt pavement was submitted from section 2V-1 for examination of the paved invert and conformity with the specifications. On examining the invert it was observed that the crests of the corrugations, where the felt made

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TABLE 2.—*Inspection data for asphalt-coated galvanized metal culvert pipe with asphalt paved invert*

Section and station No.	Diameter of pipe	Length of pipe	Gage of metal	End Protection [1]		Grade of invert	Soil condition around culvert	Present flow of water through culvert	Condition of paved invert	Condition of coating inside pipe above invert			Condition of coating on outside of pipe	Condition of exposed metal
				Left	Right					Appearance	Loss	Adhesion		
Section 2M-1:	*Inches*	*Feet*				*Percent*								
18+68	24	126	14	HW	HW	55.8	Damp	None	Cracked, low loss	Checked	Low	Fair		Slightly rusted.
44+00	18	99	16		HW		do	do	Badly cracked	Good		do	(2)	
55+00	18	50	16	DI		2.0	do	do	Checked	Good, some flow		do	(2)	Slightly rusted.
63+73	18	44	16	DI		4.9	do	do	do	Good		do	(2)	
73+96	18	42	16	DI		.2	do	do	Cracked	do		do	(2)	
84+85	24	149	14	HW		36.0	do	do	Good	Good, some flow		do	(2)	
98+84	18	176	14	HW		37.1	do	do	Cracked	Good		do	(2)	
112+05	18	113	16	DI	HW	47.1	do	do	Good	do		do		
124+67	18	39	16	DI	HW	5.7	do	do	Slightly cracked	Good, some flow		do		
141+94	18	50	16	DI		15.0	do	do	Badly cracked, loose	Good		do	(2)	
152+23	18	60	16		DI	6.3	do	Slight	Badly cracked	do		do	(2)	
168+11	18	52	16	HW	DI	17.4	do	None	Good	do		do		
185+73	18	162	14	HW	HW	21.8	do	Slight	Checked	do		do		
204+50	24	83	14	HW	HW	7.1	do	None	Good	Good, some flow		do		
221+50	18	43	16	HW	DI	10.3	do	do	do		Low	do		
243+64	18	42	16		DI	3.3	do	do	Badly cracked, loose	Good		do	(2)	
255+00	18	53	16	DI		1.7	do	do	Cracked		Medium [3]		(2)	Good.
266+00	18	38	16	DI	HW	6.7	do	do	Slightly checked	Good		Fair		
293+78	18	112	16		DI	35.0	do	do	Badly cracked, some loose		Low	do	(2)	
306+47	18	58	16	DI		6.2	do	do	Badly cracked	Good		do	(2)	
328+35	18	78	16	HW	HW	26.9	do	do	Slightly cracked	Checked		do		
351+00	30	218	12	HW		48.9	do	Slight	do	Good, some flow		do	(2)	
356+57	30	182	12	HW		32.5	do	do	Slightly cracked, low loss	do		do	(2)	
375+57	18	144	14	HW		52.0	do	None	Good	Good		do	(2)	
385+28	24	128	14	DI	HW	48.9	do	do	do	do		do		
399+80	18	45	16	DI		15.1	do	do	Badly cracked, some loose	do		do	(2)	
Section 2U-2:														
287+00	18	65	16		HW	39.0	do	Slight	Cracked, loose, high loss [3]	do		Poor	(2)	Slightly rusted.
306+50	24	32	14	HW	DI	12.2	do	do	Cracked, loose, loss [3]	do		do		
326+50	18	40	16		DI	.2	do	do	do	Checked	Low	do	(2)	
343+75	18	56	16		DI	36.6	do	None	Badly cracked, loose	do		do	(2)	
346+90	24	114	14		HW	38.0	do	do	Cracked, loss [3]	Good		do	(2)	
361+00	18	54	16		DI	17.0	do	do	Cracked, loss		Low	do	(2)	
380+00	18	41	16	HW	DI	9.1	do	do	Cracked		do	do		
396+00	18	34	16	HW	DI	4.4	do	Slight	Badly cracked, low loss	Good		do		
419+75	18	46	16	DI	HW	13.6	do	Small	Cracked	do		do		
450+00	18	91	16		HW	46.6	do	None	Cracked, high loss [3]		High [3]	do	(2)	Rusted.
537+95	18	49	16	DI	HW	20.4	do	do	Checked, low loss	Good		do		

[1] HW=Head wall. DI=Drop inlet.
[2] Where exposed, the outside coating was badly checked and brittle. Where covered by fill, coating was badly checked and had very poor adhesion to metal.
[3] Loss was throughout entire length.

TABLE 3.—*Inspection data for asphalt-coated asbestos-bonded metal culvert pipe with asphalt paved invert*

Section and station No.	Diameter of pipe	Length of pipe	Gage of metal	End protection [1]		Grade of invert	Soil condition around culvert	Present flow of water through culvert	Condition of paved invert	Condition of coating inside pipe above invert			Condition of coating on outside of pipe	Condition of exposed metal
				Left	Right					Appearance	Loss	Adhesion		
Section 2M-2:	*Inches*	*Feet*				*Percent*								
425+94	18	67	16		DI	32±	Damp	None	Cracked	Good		Good	(2)	
440+06	18	47	16		HW	1±	do	do	do	Checked		Fair	(2)	
464+00	18	60	16	DI		5±	do	do	do	Good		Good	(2)	
495+44	24	94	14	HW			do	do	do		Low		(2)	
505+19	18	89	16	DI		47±	do	do	Transverse cracks entire length	Good		Good	(2)	Asbestos intact.
514+50	18	43	14	DI		5±	do	do	Slightly cracked	do		do	(2)	
526+65	18	57	16		DI	5±	do	do	Cracked, loose	Checked	Low		(2)	
535+80	18	50	16		HW	8±	do	do	Cracked	Good		Good	(2)	Do.
550+84	18	68	16		HW	9±	do	do	do	do		do	(2)	
578+25	24	44	14	HW		10±	do	do	Cracked entire length	Checked	Low		(2)	
594+45	24	154	14	HW		35±	do	Medium	Cracked	do	do		(2)	Do.
Section 2N-1:														
9+99	18	122	14	HW		19±	do	None	(3)		do		(2)	
20+79	18	49	16	HW		6±	Dry	do	Cracked	Good		Good	(2)	Do.
43+50	18	48	16	DI		3.0	Wet	Slight	Checked, some loose	do		do	(2)	
56+50	18	107	14		HW	34±	Damp	None	Checked	do		do	(2)	
69+36	18	78	16		DI	48±	do	do	do	do		do	(2)	
79+75	18	89	16		HW	38.0	do	do	Badly cracked	do		do	(2)	
90+25	18	52	16		HW	24.1	do	do	Cracked	do		do	(2)	
114+50	18	85	16		DI	44.1	do	do	do	do		do	(2)	
142+29	18	176	16		HW	53.0	Wet	Medium	Cracked at inlet end, some loose	Checked		Poor	(2)	
151+30	24	225	14		HW		Damp	None	Good	Good		Good	(2)	
166+74	18	45	16		DI	7.5	do	do	Cracked, loose	do		do	(2)	
176+45	18	63	16		DI	3.9	do	do	Cracked	do		do	(2)	
194+00	18	85	16		HW		do	do	Badly cracked	do		do	(2)	
207+35	24	81	14		DI	5.4	do	do	Cracked, loose	do		do	(2)	
219+50	18	108	16		HW		do	Slight	do	do		do	(2)	
298+80	18	64	16	DI			do	None	Checked	do		do	(2)	
309+09	18	153	16	DI		57.7–59.5	do	do	Good	do		do	(2)	
317+92	18	67	16	HW		4.1	do	Small	Checked	do		do	(2)	
331+00	18	96	16	HW			do	None	do	do		do	(2)	
341+79	30	140	12	HW			do	do	Checked entire length	do		do	(2)	
354+51	30	74	12	HW		26.4	do	Small	do	Good, some flow		do	(2)	
382+30	18	50	16	DI		17.0	do	None	Checked	Good		do	(2)	
391+24	18	56	16	DI		3.5	do	do	do	do		do	(2)	
401+50	24	46	14	DI		10.5	do	do	do	Good, some flow		do	(2)	
412+49	24	69	14	HW		29.1	do	do	do	Good		do	(2)	
440+75	18	80	16	DI		39.3	do	do	Low loss, spalling	do		do	(2)	Do.

[1] HW=Head wall. DI=Drop inlet.
[2] Where exposed, the outside coating was badly checked and brittle. Where covered by fill, coating was badly checked and had very poor adhesion to metal.
[3] Culvert filled with debris; invert could not be inspected.

TABLE 4.—*Inspection data for asphalt-coated asbestos-bonded metal culvert pipe with asphalt paved invert*

Section and station No.	Diameter of pipe	Length of pipe	Gage of metal	End Protection [1]		Grade of invert	Soil condition around culvert	Present flow of water through culvert	Condition of paved invert	Condition of coating inside pipe above invert			Condition of coating on outside of pipe	Condition of exposed metal
				Left	Right					Appearance	Loss	Adhesion		
Section 2P-2:	*Inches*	*Feet*				*Percent*								
406+39	18	62	16		DI	3.0	Damp	None	Good		Medium	Good	(2)	Asbestos intact.
408+50	18	98	16		DI		do	Small	Badly cracked	Checked	High		(2)	Do.
417+50	18	48	16		HW	3.0	do	None	Cracked	Good		Good	(2)	
428+99	18	55	16		DI	28.1	do	do	Good	do		do	(2)	
449+63	18	42	16		HW	3.0	do	do	do		Low		(2)	
466+50	24	52	14		HW	17.7	do	Slight	Badly cracked, loose [3]	Good		Good	(2)	
477+37	24	46	14		HW	12.3	do	Small	Cracked	do		do	(2)	
501+99	18	58	16		HW	20.4	do	None	do	do		do	(2)	
517+50	18	48	16		HW	2.9	do	do	Good	do		do	(2)	
530+54	18	48	16		HW	3.1	do	do	Checked	do		do	(2)	
544+00	18	78	16		DI	40.0	do	do	Good	do		do	(2)	
567+50	18	46	16		DI	23.7	do	Slight	Badly cracked, loose	do		do	(2)	
587+22	18	46	16		HW	4.2	do	None	Cracked, loose	do		Poor	(2)	
602+50	18	38	16		HW	4.1	do	do	Good [4]	Good [4]			(2)	Badly rusted in invert.
633+95	18	46	16		HW	21.4	do	Medium	Good	Good		Poor	(2)	
642+82	18	36	16		HW	6.1	do	None	Cracked	do		Good	(2)	
654+75	18	75	16		DI	32.6	do	do	Good	do		do	(2)	
664+27	24	72	14		HW	34.7	do	do	Good [4]	Good [4]			(2)	Good.
686+50	30	82	12		HW	30.7	do	do	Good	do	Low		(2)	
696+39	24	40	14		HW	3.4	do	do	Badly cracked	Good		Good	(2)	
710+00	18	76	16		DI	2.8	do	do	do	do		do	(2)	
719+66	30	118	12		HW	31.2	do	do	Good	Good, some flow		do	(2)	
728+90	18	56	16		DI	3.0	do	do	Checked	Good		do	(2)	
739+03	18	36	16		DI	5.2	do	do	Good	do		Poor	(2)	
759+97	30	84	12		HW	19.2	do	Slight	do	Good, some flow		Good	(2)	
767+90	18	78	14		DI	32.5	do	None	do	Good		do	(2)	
796+95	18	103	16		HW	10.0	do	do	Checked	do		do	(2)	
807+25	18	67	16		DI	3.0	do	do	Good	Good, some flow		do	(2)	
816+67	18	89	16		HW		do	do	Checked	Checked		do	(2)	
828+00	18	49	16		DI	28.9	do	do	Cracked	Good		do	(2)	
839+00	18	82	16		DI	43.8	do	do	do	do		do	(2)	

[1] HW=Head wall. DI=Drop inlet.
[2] Where exposed, the outside coating was badly checked and brittle. Where covered by fill, coating was badly checked and had very poor adhesion to metal.
[3] At left end one length of asphalt-coated galvanized metal pipe was used; remainder was asbestos-bonded pipe.
[4] At left end one length of uncoated galvanized pipe was used; remainder was asbestos-bonded pipe and appeared to be in good condition.

TABLE 5.—*Inspection data for asphalt-coated galvanized metal culvert pipe with reinforced asphalt invert*

Section and station No.	Diameter of pipe	Length of pipe	Gage of metal	End protection [1]		Grade of invert	Soil condition around culvert	Present flow of water through culvert	Condition of asphalt coating in invert			Condition of exposed metal reinforcing plate	Condition of coating inside pipe above invert			Condition of coating on outside of pipe
				Left	Right				Appearance	Loss	Adhesion		Appearance	Loss	Adhesion	
Section 2N-2:	*Inches*	*Feet*				*Percent*										
447+75	18	115	16	HW		37.7	Damp	None	Badly broken	Medium	Poor	Loose at ends, some rusting	Good	None	Fair	(2)
462+52	18	72	16	DI		11.1	Wet	Small	do	do	do	Some rusting	do	do	do	(2)
466+53	18	60	16	HW		27.9	Damp	do	Good	None	Fair		do	do	do	(2)
474+50	18	46	16	HW	DI	16.3	do	None	Badly broken	Medium	Poor	Intact, no rusting	Checked	do	do	
485+04	18	43	16	HW	DI	10.0	do	do	Checked	None	Fair		Good	do	do	
490+89	18	100	16		DI	45.0	do	Small	Badly broken	High	Poor	Loose at ends	do	do	do	(2)
504+28	24	79	14		HW	38.9	do	do	do	do	do	Intact, no rusting	do	do	do	(2)
514+63	24	50	14		DI	3.6	do	None	Good	None	do		do	do	do	(2)
533+88	18	61	16	HW	DI	35.6	Wet	do	Cracked	do			do	do	do	
535+75	24	77	14	HW	DI	24.8	do	Medium	Badly broken	Very high	Poor	Loose at ends, slight rusting	do	do	Poor	
537+71	30	70	12	HW	DI	20.4	Damp	Slight	Cracked	Medium	do	Loose at ends, pipe ¼ blocked	do	do	Fair	
544+32	18	57	16		DI	23.5	Wet	Small	Badly broken	do		Loose, badly rusted	do	do	do	(2)
576+28	30	48	12	HW	DI	7.9	Damp	do	Cracked	do		Intact, no rusting	do	do	do	
596+18	30	70	12	HW	HW	28.6	do	do	Good	None			do	do	do	(2)
617+64	30	80	12		DI	50.8	do	do	Badly broken	High	Poor	Loose, turned up at end	do	do	do	(2)
643+57	24	92	14		DI	36.6	do	do	Good	None			do	do	do	(2)
676+50	24	54	14	HW	DI	27.2	do	Large	do	do			do	do	do	
Section 2P-1:																
201+00	18	42	16		HW		Damp	None	Badly broken	Medium		Intact, no rusting	do	do	do	(2)
216+00	18	42	16		HW		do	do	Good	None			do	do	do	(2)
341+20	18	59	16				do	Medium	do	do	Poor		do	do	do	(2)
354+00	18	105					do	Small	do	do			do	do	do	(2)
381+00	30	134	12				do	Medium	Badly broken	High		Intact, no rusting	do	do	do	(2)
392+55	18	123			HW		do	None	(3)				do	do	do	(2)
399+45	18	48	16		HW		do	Slight	Badly broken	Medium		Intact, no rusting	do	do	do	(2)
Section 2V-1:																
140+17	24	104	14		HW	35.1	do	None		Low	Good	Intact, some rusting	do	do	Good	(2)
143+00	18	37	16		DI	4.0	do	do	Cracked	None	do		do	do	do	(2)
153+70	18	95	14		HW	21.7-33.0	do	do		Slight	do	Intact, no rusting	do	do	do	(2)
166+65	18	96	14		DI	66.6	do	do		High		do	do	do	do	(2)
174+35	24	73	14		HW	30.8	do	do		do		Loose, turned up at ends	do	do	do	(2)
191+38	18	49	16		DI	10.0	do	Slight	(3)				do	do	do	(2)
204+50	18	48	16		DI	5.0	do	None	Broken	Medium		Intact, badly rusted	do	do	do	(2)
223+46	24	36	14	DI		7.5	Wet	Medium		High			do	do	Poor	
245+25	18	71	16	HW		14.1-22.0	do	do		do			do	do	do	
262+70	18	93	14	HW		37.5	Damp	None	Checked	None	Poor		do	do	do	
274+38	18	99	14		HW	17.0-19.1	do	Medium		Medium	do		do	do	do	(2)

[1] HW=Head wall. DI=Drop inlet.
[2] Where exposed, the outside coating was badly checked and brittle. Where covered by fill, coating was badly checked and had very poor adhesion to metal.
[3] Outlet end of culvert partially filled and condition of paved invert could not be examined.

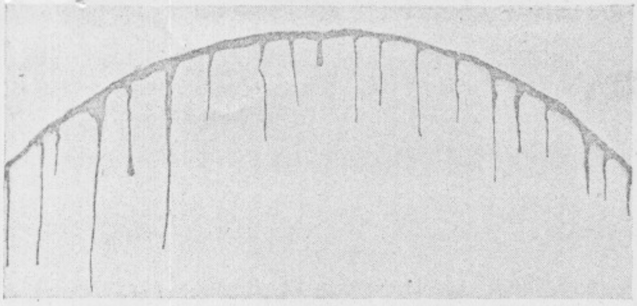

FIGURE 1.—TYPICAL CONDITION OF FLOW FROM CRESTS OF CORRUGATIONS IN THE TOP QUARTER INSIDE THE CULVERT PIPE.

contact, were not coated with asphalt. Also that the underside of the reinforcing plate, which was in contact with the felt, was not uniformly coated. Although the metal plate was perforated the space between the felt and the plate was too small to permit the hot asphalt to completely fill it.

LARGE NUMBER OF FIELD INSTALLATIONS INSPECTED

Because of the large number of culvert pipes it was not considered necessary to inspect all of them. To get a general idea of the condition of the pipes it was planned to inspect every third installation. This plan was not adhered to strictly because of inaccessibility of some of the outlets or because some of the culverts were filled with debris. The plan of inspection was altered in some instances to include culverts of special interest.

A separate report form was used for each culvert inspected to record data pertaining to the type and condition of the installation.

The date of installation, diameter and length of culvert pipe, gage of metal, type of end protection, and grade of the pipe invert were obtained from the records for each section of road. The soil surrounding the culvert was observed only as to its moisture content. The quantity of water flowing through the pipe was noted. Since inspection was made at a relatively dry time of the year the flow was considered continuous if there was water flowing through the pipe when inspected, and the flow was estimated on a comparative basis.

The condition of the paved invert and of the coating above the pavement and on the outside of the pipe was determined. Where there had been a loss of coating either in the paved invert or on the walls of the pipe, the condition of the exposed metal was observed. Drop inlets on many of the culverts made it difficult to make a thorough examination of the coating and pavement of the upper ends. Where possible, inspections were made from both ends or by crawling through the pipe.

DESCRIPTIVE TERM DEFINED

The data from the inspection report for each culvert were tabulated for each project and combined for each of the three general types of bituminous-coated pipe used. The inspection data are given in tables 2, 3, 4, and 5. Explanation of the terms used in these tables is given below.

Good.—Very little or no checking, no cracking, and no apparent loss of asphalt coating.

TABLE 6.—*Summary of conditions of paved inverts and coating on inside walls of all culverts inspected*

Section No.	Total culverts inspected	Number of culverts with paved invert				Number of culverts with inside walls		
		Good	Checked, no loss	Cracked or broken, no loss	Loss of coating	Good	Checked, no loss	Loss of coating
Asphalt-coated galvanized metal pipe with asphalt paved invert:								
2M-1	26	7	4	13	2	21	1	4
2U-2	11	0	0	3	8	6	1	4
Asphalt-coated asbestos-bonded pipe with asphalt paved invert:								
2M-2	11	0	0	11	0	6	1	4
2N-1	[1] 26	2	12	10	1	24	1	1
2P-2	31	15	4	12	0	26	1	4
Asphalt-coated galvanized metal pipe with reinforced asphalt invert:								
2N-2	17	5	1	1	10	16	1	0
2P-1	[1] 7	3	0	0	3	7	0	0
2V-1	[1] 11	0	1	1	8	11	0	0

[1] Outlet end of one culvert was filled; invert was not inspected.

Checked.—Fine hair cracks of insufficient width to permit large infiltration of water and silt. In the asphalt pavement checking usually occurred directly over the crests of the corrugations and often extended the full width of the invert. On the inside walls above the pavement and on the outside of the pipe, checking generally had the pattern of alligator skin.

Cracked.—This term is used to describe the condition of the asphalt pavement and denotes cracks of sufficient width to permit rapid infiltration of water and silt. In some culverts cracks often exceeded one-half inch in width for the full depth of the asphalt pavement. Cracking generally occurred above the crests of the corrugations, although in some pipes there were large longitudinal cracks. In some pipes where the pavement was severely cracked, the infiltration of water and silt had caused a loss of adhesion between the asphalt and the metal with subsequent loosening of pieces of the pavement.

Broken.—This term is used to describe the condition of the asphalt coating on the reinforcing plate (where used) and signifies severe cracking and breaking of the coating into small pieces.

Loss.—In the invert, loss was usually caused by pieces of the asphalt pavement first cracking and then being loosened and dislodged by flowing water.

On the inside walls above the pavement, loss appeared to be due to either erosion, impact, or stripping of the coating from the metal by the action of water.

Adhesion.—Adhesion of the asphalt to the metal was not determined accurately but a comparative indication was obtained by noting the ease with which the coating could be removed with a putty knife.

Flow.—In some culverts a displacement of the asphalt coating by flow was noted. This condition occurred at the top of the pipe and was in the form of strings of asphalt hanging from the crests of the corrugations. Flow is illustrated in figure 1, which shows the coating cut from the corrugations, reassembled, and photographed.

In the two types of pipes where the pavement consisted wholly of asphalt, the most deterioration of the

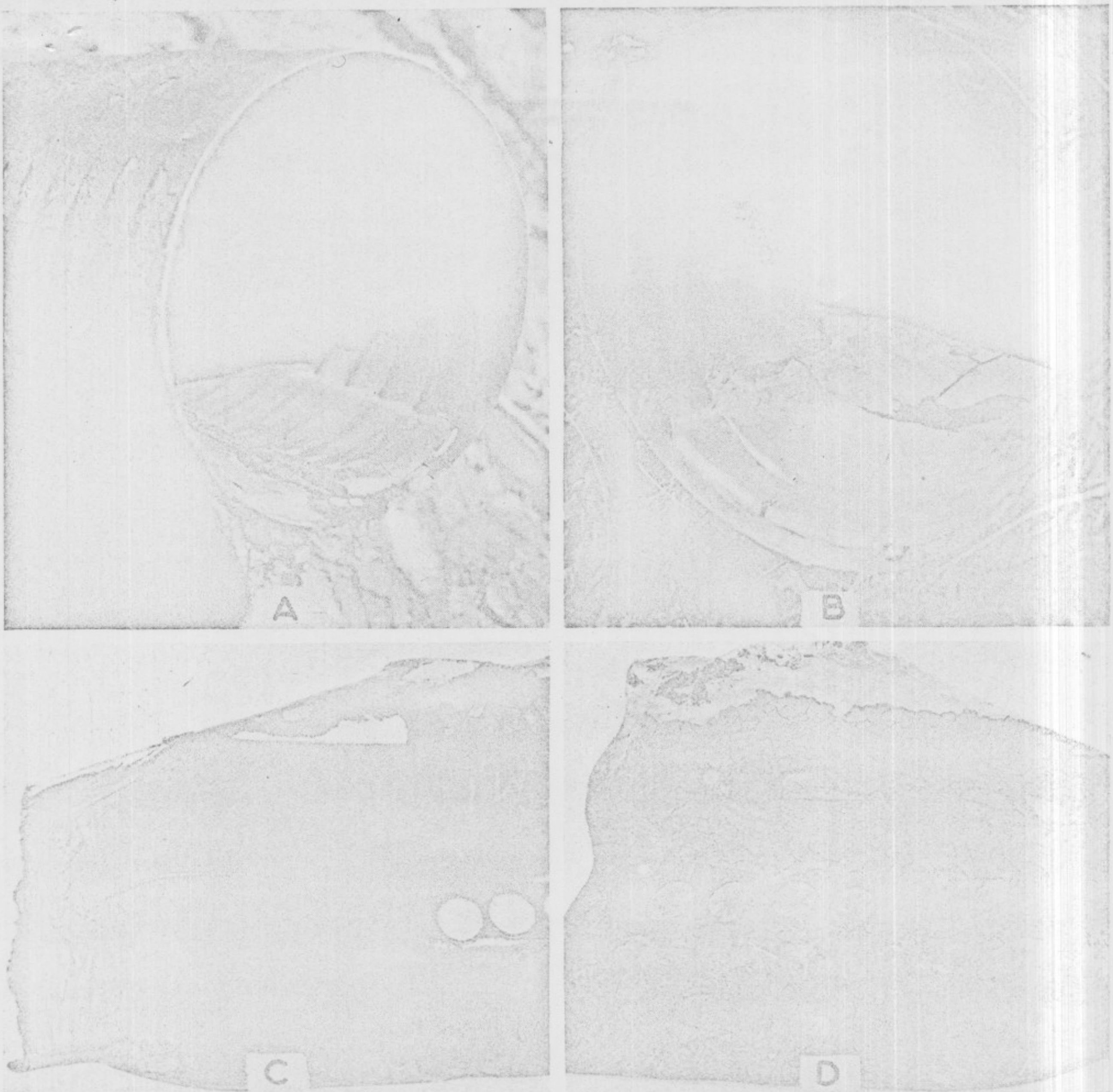

FIGURE 2.—BITUMINOUS-COATED GALVANIZED METAL PIPE: (A) SEVERE LONGITUDINAL CRACKING; (B) CRACKING OF ASPHALT PAVEMENT; (C) INSIDE VIEW OF SAMPLE CUT FROM OUTLET END OF PIPE. CONDITION APPEARS TO BE GOOD BUT ADHESION TEST (ROUND SPOTS) SHOWS LOW ADHESION; AND (D) OUTSIDE OF SAMPLE SHOWN IN (C). THIS PORTION OF THE PIPE WAS IN CONTACT WITH SOIL. TESTS SHOWED POOR ADHESION.

pavement and coating on the inside walls was found to be at the outlet end of the culverts which was more exposed to sunlight and changes in temperature. The condition of the invert, inside and outside coating, and exposed metal given in tables 2, 3, and 4 are for the outlet end except where otherwise indicated. In the culvert pipe with the reinforced asphalt pavement the deterioration of the asphalt coating and metal in the invert was, in general, more uniform throughout the entire length of the pipe. Therefore, these conditions as shown in table 5 apply to the full length of the culvert pipe.

Table 6 gives a summary of the condition of the paved inverts and inside walls by road sections. There follows a discussion of the data on the performance of each type of pipe on the different sections of road.

PLAIN ASPHALT-COATED PIPE

Section 2M-1.—At the time of the inspection the asphalt coating and pavement were considered to be giving adequate protection. No culvert pavements or coatings had failed but conditions were found that may be indicative of future failures. Twenty-six culverts

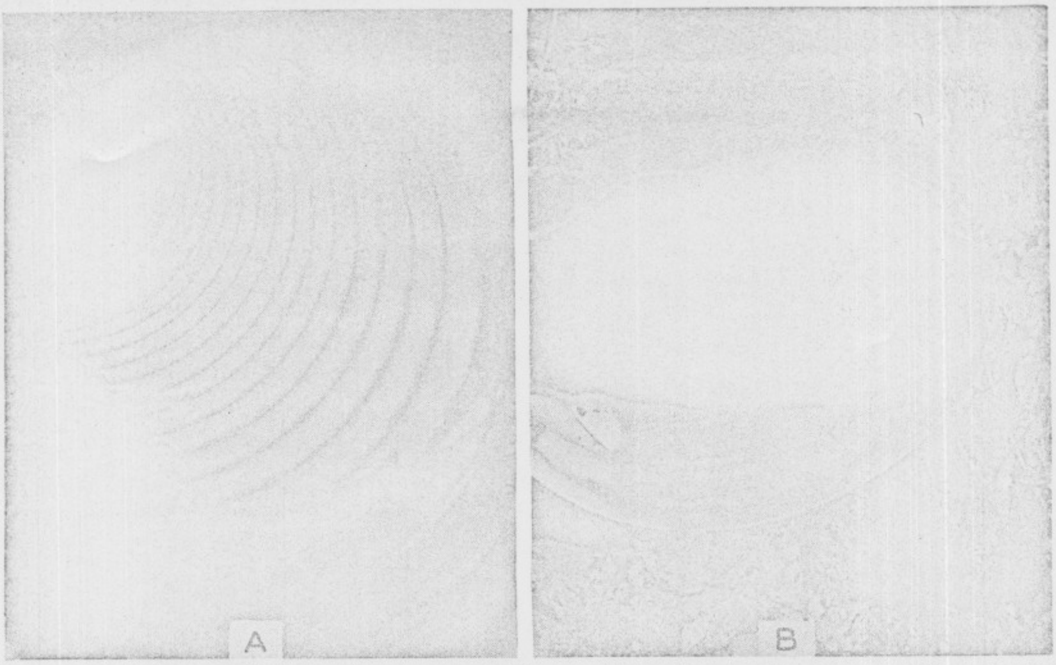

FIGURE 3.—A, ASPHALT COATING STRIPPED FROM WALL BY WATER SURGING THROUGH THE CULVERT ON 47 PERCENT GRADE; B, LOSS OF PAVEMENT FROM SAME CULVERT WITH RUSTING OF EXPOSED METAL.

were inspected. The pavements in 7 culverts were rated good, 4 were checked, 13 were cracked only, and 2 showed sufficient loss of coating to expose the metal. Typical conditions are shown in figure 2.

The coatings on the inside of the pipes above the inverts were generally in good condition but appeared to have only fair adhesion to the metal. In this respect, 21 culverts were rated good, 1 was checked only, and 4 showed some loss of coating.

Section 2U–2.—In general the condition of the culvert pipe installed on section 2U–2 was much worse than on section 2M–1 and for some culverts the coating was not considered to be giving adequate protection to the metal. The adhesion of the asphalt to the metal appeared to be poor. Of the 11 culverts inspected none of the paved inverts was rated as good, 3 were cracked, and 8 had lost some of the coating.

The inside coatings above the inverts also showed more deterioration than on section 2M–1. For 6 of the 11 culverts inspected the coatings were good, 1 was checked only, and 4 showed some loss of coating. One culvert, which had an extremely high loss of coating on the inside walls, is of special interest. This culvert was installed on a 25° skew on a grade of 47 percent with a head wall at the inlet end. It appeared that during heavy rainfall water ran down the gutter and into the pipe at high velocity. It struck the side of the pipe above the pavement at an angle and had stripped a large area of the asphalt coating from the side wall. This condition was repeated on alternate right and left sides of the pipe for a considerable distance down the pipe. Figure 3, A shows the high loss of coating from the inside wall near the inlet. The loss of asphalt coating from the pavement is illustrated in figure 3, B.

BITUMINOUS-COATED ASBESTOS-BONDED PIPE

Bituminous-coated asbestos-bonded metal culvert pipe was used on sections 2M–2, 2N–1, and 2P–2. Although there was considerable checking and cracking of the asphalt pavements near the outlet, all the inverts were giving good service. In comparison with sections 2M–1 and 2U–2 there were fewer cracked areas that were loose or easily removed. Where there was a loss of asphalt the asbestos sheet was generally intact and appeared to give some additional protection to the metal. The coatings on the inside walls above the pavements seemed to have better adhesion to the asbestos-bonded metal than did the asphalt on the plain galvanized metal on section 2M–1. A summary of the condition of the pavements and inside coatings in the culverts where the asbestos-bonded metal was used follows.

Section 2M–2.—Eleven culverts were inspected and all the inverts were found to be cracked but there was no loss of coating. The coating on the inside walls of 6 culverts was rated good, 1 was checked only, and on 4 there was some loss.

Section 2N–1.—Twenty-six culverts were inspected. The paved inverts of 2 were regarded as good, 12 were checked, 10 were cracked, 1 showed some loss of asphalt, and the condition of 1 invert could not be ascertained. The coating on the inside walls of 24 culverts was considered good, 1 showed some checking and 1 some loss of asphalt.

Section 2P–2.—Thirty-one culverts were inspected. The paved inverts in 15 were good, 4 were checked, and 12 were cracked. There was no loss of pavement in any of these pipes. In 26 of the culverts the coating on the inside walls was considered good, 1 was checked only, and 4 had some loss.

Typical conditions of the culvert pipe installed on sections 2M–2 and 2N–1 are shown in figures 4 and 5.

PIPE WITH REINFORCED PAVEMENT

Bituminous-coated corrugated sheet metal culverts with metal reinforced asphalt pavement were installed on sections 2N–2, 2P–1, and 2V–1. Before the inspec-

FIGURE 4.—BITUMINOUS-COATED ASBESTOS-BONDED PIPE SHOWING SEVERE CRACKING OF PAVEMENT AT OUTLET END.

tion some difficulty had been experienced by the maintenance men in keeping some of the culverts on section 2N–2 in serviceable condition due to failure of the inverts. Inspection of the culverts revealed that in some culverts there had been a high loss of coating from the paved invert, exposing the metal reinforcing plate to the action of water and erosion. Subsequent action of water and erosion through the pipes caused the exposed reinforcing plates to loosen and pull away from the rivets holding them to the pipe. Because of the light weight of the reinforcement the loosened ends were turned up and eventually formed blocks within the pipes. This condition usually occurred at the upper end of the section lengths where they were connected by bands.

A summary of the conditions found in culverts where the metal reinforced pavement was used follows.

Section 2N–2.—Of the 17 culverts examined there were 5 in which the pavement was considered good, 2 were checked or cracked only, and in 10 culverts the asphalt was cracked or broken and showed considerable loss. In 6 culverts the exposed metal reinforcing plates were partially turned up, and in 4 culverts they were rusted. The coatings on the insides of the pipes above the pavement were in good condition and appeared to have fair adhesion to the metal.

Section 2P–1.—Since construction of this section had not been completed only 7 culverts were inspected. The paved inverts of 3 were in good condition, 3 were badly broken with some loss of coating, and 1 invert could not be examined. The metal reinforcement in all culverts was in place. The inside walls were in good condition and the coatings appeared to have fair adhesion to the pipe.

Section 2V–1.—Eleven culverts were inspected. Eight had lost coating from the inverts and the exposed plates in 2 of these were rusted. The asphalt coating

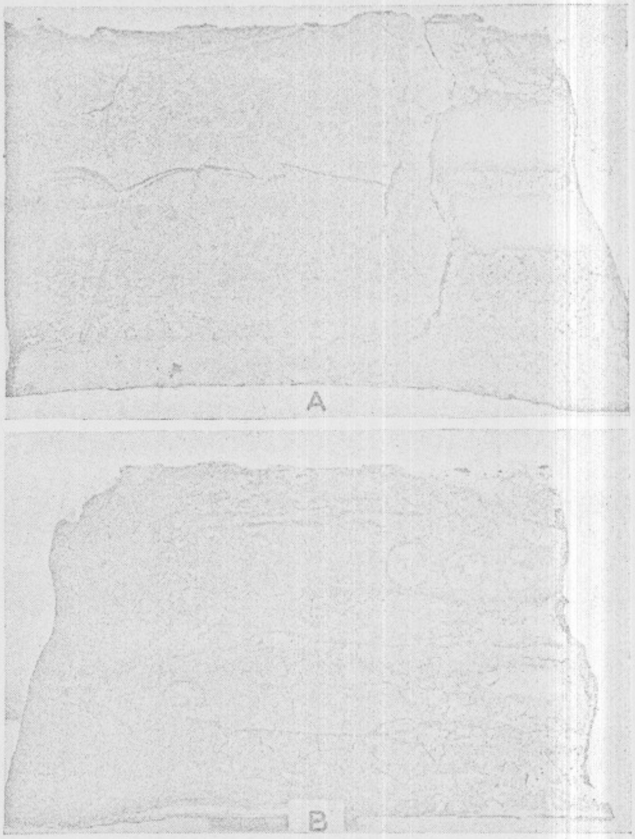

FIGURE 5.—SAMPLE TAKEN FROM OUTLET END OF BITUMINOUS-COATED ASBESTOS-BONDED METAL PIPE. (A) INSIDE SHOWS CRACKED PAVEMENT; (B) OUTSIDE SHOWS GENERAL CONDITION OF COATING WHICH HAS BEEN IN CONTACT WITH SOIL SURROUNDING CULVERT.

in the inverts of 2 culverts was checked or cracked. The metal reinforcing plates appeared to be in place. The condition of the invert of one culvert could not be ascertained. The inside walls of all culverts inspected were in good condition but in some culverts the coating appeared to have better adhesion to the metal than in others.

The conditions of some of the culvert pipe installed on sections 2N–2, 2P–1, and 2V–1 are illustrated by figure 6.

OUTSIDE COATINGS SEVERELY CHECKED

The asphalt coating on the outside of the culvert pipes was found to be in the same general condition on all the sections inspected. Where the outlet ends of the culverts were exposed, the asphalt coating on the outside was hard and severely checked but on most culverts there was good adhesion to the metal. On some culverts there was loss of coating, which appeared to be due to impact of rocks from the slopes above the outlets.

Where it was possible to dig away the cover material and examine the asphalt coating under the fill, it was found to be severely checked and to have very low or no adhesion to the metal. At the time of the inspection the soil surrounding the culverts usually was damp or wet and it is probable that it remains in this condition most of the time.

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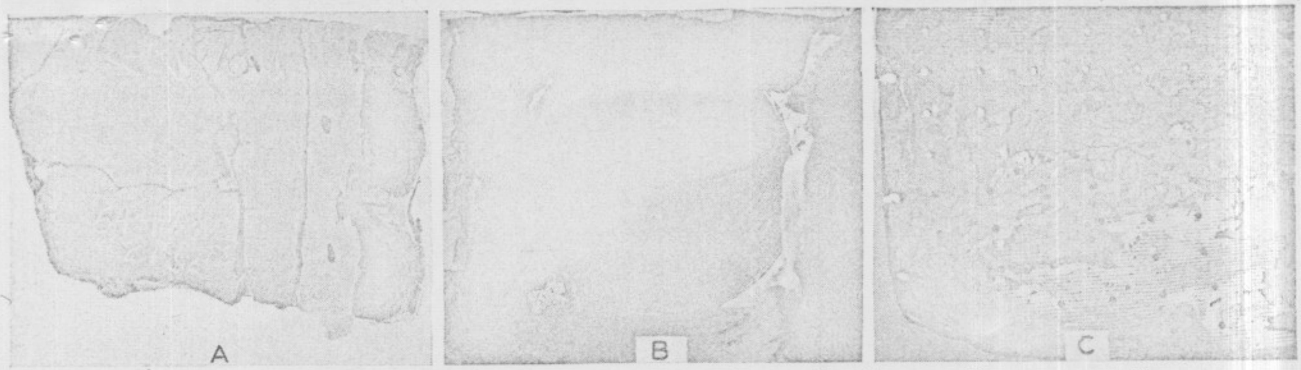


FIGURE 6.—METAL-REINFORCED ASPHALT PAVING. (A) SAMPLE FROM OUTLET END SHOWING LOOSENING OF REINFORCEMENT; (B) COATING ON REINFORCING PLATE BADLY BROKEN WITH SOME LOSS; AND (C) SECTION OF REINFORCING PLATE SHOWING LOSS OF COATING AND RUSTING OF EXPOSED METAL.

LABORATORY TESTS MADE ON FIELD SAMPLES

Samples, representing the three general types of bituminous-coated metal pipe, were cut from the culverts for analysis in the laboratory. Samples of asphalt were also taken from the paved inverts or from the inside walls.

During the construction of Blue Ridge parkway, samples of culvert pipe had been submitted to the laboratory to be tested for conformity with the specifications. Since the only test of asphalt required by these specifications was determination of solubility in carbon disulphide, other characteristics of the asphalt at the time of installing the pipe are not known. Because of this lack of information, a satisfactory comparison between the characteristics of the original asphalt coating and the samples taken at this time cannot be made.

A complete analysis of all asphalt samples was made and the results are shown in table 7. Considering the effects of variations in exposure of the different samples, the average results of tests on samples from the same fabricator of the coated pipe, as shown in table 8, indicate that different asphalts were used by the three fabricators. Analyses of seven typical blown asphalts of the type used or intended for use as pipe coating materials were also made and the test values are given in table 9. These asphalts were submitted either by the fabricator of the bituminous-coated pipe or by the producer of the asphalt. Although the analyses of the field samples given in tables 7 and 8 do not correspond exactly to those of any of the seven typical asphalts, both groups of asphalts are of the same general type.

In 1945 the American Railway Engineering Association[1] issued a specification for bituminous-coated corrugated metal pipe and arches. In this specification a test was proposed for the determination of the adhesion of bituminous coating to metal, the determination to be made on samples taken from the coated pipe, delivered or about to be delivered to the purchaser. To make

[1] Committee Report, American Railway Engineering Association, Bul. 451, February 1945, vol. 46, No. 451, p. 493.

TABLE 7.—*Analyses of samples of asphalt coating taken from culvert pipes*

Section and station No.	Penetration, 100 gm, 5 sec.			Ductility 5 cm. per min. 25° C.	Softening point	Specific gravity, 25°/25° C.	Solubility in CS_2			Bitumen insoluble in 86° B. naphtha	Oliensis test	
	At 15° C.	At 25° C.	At 35° C.				Bitumen	Organic insoluble	Inorganic insoluble		Character of spot	Naphtha-xylene equivalent
Section 2M-1:				*Cm.*	*° C.*		*Percent*	*Percent*	*Percent*	*Percent*		*Percent*
18+68	29	44	64	2.0	98.5	0.999	99.71	0.10	0.19	32.15	Positive	5-10
98+84	31	47	71	2.0	95.5	.999	99.48	.12	.40	30.82	do	10-15
141+94	27	42	64	1.75	96.5	.999	99.67	.10	.23	31.20	do	5-10
152+23	27	41	62	1.75	100.0	1.000	99.73	.21	.06	32.51	do	5-10
204+50	23	35	55	2.0	99.0	1.007	99.08	.19	.73	34.17	do	10-15
Section 2U-2, 306+50	23	36	51	1.75	99.0	.988	99.80	.16	.04	31.82	Negative	
Section 2M-2, 526+65	26	41	61	2.0	97.3	1.003	99.41	.08	.51	32.77	Positive	5-10
Section 2N-1:												
79+75	27	40	60	1.75	98.3	.999	99.82	.13	.05	32.29	do	0-5
166+74	30	45	68	1.75	98.5	1.000	99.72	.12	.16	30.74	do	15-20
207+35	26	40	60	1.75	101.5	1.001	99.35	.16	.49	31.84	do	5-10
Section 2P-2:												
719+66	28	43	63	2.0	99.5	.998	99.68	.15	.17	32.82	do	5-10
466+50	25	40	63	1.75	98.5	1.000	99.66	.11	.23	34.83	do	5-10
587+22	26	39	59	1.75	100.8	.998	99.75	.10	.15	33.36	do	0-5
Section 2N-2:												
447+75	18	26	38	[1]1.5	114.0	1.020	99.12	.37	.51	34.73	do	45-50
474+50	20	34	48	[1]1.0	101.0	1.011	99.64	.17	.19	33.94	do	45-50
504+28	17	27	42	2.25	100.0	1.010	99.55	.21	.24	35.07	do	5-10
535+75	21	29	40	[1]1.5	119.5	1.009	99.30	.19	.51	35.15	do	50-55
544+32	20	31	49	2.25	98.3	1.012	99.73	.11	.16	34.11	do	15-20
617+64	22	33	49	2.5	96.0	1.012	99.72	.15	.13	34.86	do	10-15
Section 2V-1:												
140+17	19	29	44	2.25	101.8	1.012	99.31	.20	.49	34.81	do	15-20
166+65	24	35	51	[1]1.5	109.3	1.013	99.66	.16	.18	32.91	do	45-50
245+25	29	43	62	1.75	101.3	1.009	99.77	.12	.11	31.34	do	40-45
262+70	23	33	47	[1]1.5	109.0	1.011	99.30	.25	.45	33.28	do	45-50

[1] Test specimen broke at smallest cross section.

TABLE 8.—*Average analysis of asphalt coatings used by the fabricators of the coated pipe*

Fabricator	Sections where used	Penetration, 100 gm. 5 sec. at— 15° C.	25° C.	35° C.	Ductility at 25° C.	Softening point	Specific gravity, 25°/25° C.	Bitumen insoluble in 86° B. naphtha	Xylene equivalent
					Cm.	° *C.*		*Percent*	*Percent*
A	2M–1, 2M–2, 2N–1, 2P–2	27	41	63	1.9	98.7	1.000	32.46	[1] 8.3
B	2U–2	23	36	51	1.8	99.0	.988	31.82	0
C	2N–2, 2V–1	21	32	47	1.4	105.0	1.012	34.02	[1] 34.0

[1] Average value of the mean naphtha-xylene equivalent.

TABLE 9.—*Analyses of typical blown asphalts from various sources*

Identification No.	Penetration 100 gm., 5 sec. at— 15° C.	25° C.	35° C.	Ductility 5 cm. per min. 25° C.	Softening point	Specific gravity, 25°/25° C.	Solubility in CS_2: Bitumen	Organic insoluble	Inorganic insoluble	Bitumen insoluble in 86° B. naphtha	Oliensis test: Character of spot	Naphtha-xylene equivalent
				Cm.	° C.		*Percent*	*Percent*	*Percent*	*Percent*		*Percent*
1	21	31	45	2.0	110.0	1.011	99.86	0.14	0	37.16	Positive	12–16
2	32	49	72	2.0	107.2	.981	99.64	.20	.16	33.24	do	0– 4
3	29	45	69	2.3	100.0	1.007	99.86	.14	0	32.32	do	24–28
4	21	35	59	4.0	83.3	1.014	99.74	.26	0	32.62	Negative	
5	19	30	46	2.5	95.0	1.003	99.84	.16	0	33.34	do	
6	23	38	62	3.3	90.6	1.013	99.83	.17	0	33.11	Positive	8–12
7	29	42	61	2.0	97.8	.983	99.89	.11	0	30.34	Negative	

this test, a round brass disk one-half square inch in area is embedded in the asphalt coating and pulled off by applying a load at a uniform rate. The ability of the coating to retain its adherence to the pipe is indicated by the amount of coating remaining on the metal after pulling off the disk. This amount of coating retained by the metal is expressed as a percentage of the total area under the disk. For 100-percent retained coating the asphalt breaks in cohesion and denotes good adhesion, zero percent denotes poor adhesion and values between 100 and zero percent coating retained are proportional between good and poor adhesion.

For some time the Public Roads Administration has been studying the adhesion of bituminous coatings to metal and a test similar to that proposed by the American Railway Engineering Association has been used. In this study not only the amount of coating removed by the adhesion disk is noted but also the load required to pull the disk off is determined. It has been found that the adhesion load may be as significant as the amount of coating retained in evaluating the adhesion of coating materials.

The samples of bituminous-coated metal culverts from the Blue Ridge parkway were tested for adhesion of the asphalt coating to the metal. The results are given in table 10, and include adhesion values for the coating on the outside of the pipe, the inside walls above the pavement, and the coating in the invert. With the exception of the asbestos-bonded metal the adhesion values, as measured by the percentage of coating retained, indicate the asphalt to have little adhesion to the metal for all the samples and for the different areas tested on the same sample. In the tests on asbestos-bonded metal, failures occurred in the asbestos sheet and the coating can be considered as having good adhesion. The adhesion values as measured by the load required to pull the disk off indicate the variable adhesiveness of the asphalt coating not only on different pipes but also on different areas of the same pipe.

As indicated by the values of the adhesion load, the adhesion of the asphalts to the metal was, in general, best in the paved inverts and poorest on the outside walls of the pipe. The adhesion load values for the sample from section 2N–1 are nearly the same for the outside, inside, and the invert, but the latter two values were determined on asbestos-bonded metal and should not be compared with those made on plain galvanized metal. The adhesion values for the sample from section 2N–2 show the asphalt coating to have lower adhesion to the reinforcing plate than to either the outside of the pipe or to the inside of the pipe directly under the reinforcement. The adhesion of the coating to the reinforcing plate from section 2N–2 also was very low. These low values may account for the high loss of coating from the inverts in those culverts having the reinforcing plates.

The asphalt coating from the samples was heated and used to coat various kinds of metal plates. Adhesion tests were made on these coated plates to get some indication of the initial adhesion of the various asphalts to the kind of metal on which they were used in the pipe. The results of these tests are given in table 10.

The adhesion load values for the metal plates coated with the reheated asphalts are in most cases higher than the highest value obtained on the corresponding samples taken from the culverts. The amount of coating retained by the metal also is higher on the recoated galvanized and reinforcing plates than on the corresponding pipe samples. Assuming that the adhesion values for the recoated plates are indicative of the adhesion of the original coating to the pipe, there has been a loss of adhesion while the culverts were in service.

There is no correlation between any of the laboratory tests made on the asphalt coatings from the culvert pipes and the adhesion of these coatings. In the study of the adhesion of pipe coating materials now in progress it has been found that certain characteristics of asphalts may be indicative of their adhesion and should be considered in selecting asphalt to insure high initial adhesion and the retention of that adhesion to the metal after exposure in service.

TABLE 10.—*Results of adhesion tests on pipe samples and on laboratory-coated metal plates using asphalts taken from the pipe samples*

Section number	Station number	Coated pipe samples from culverts				Laboratory-coated plates using asphalts from pipe samples		
		Area tested for adhesion	Type of coated metal	Adhesion load	Coating retained	Type of surface coated	Adhesion load	Coating retained
				Pounds	*Percent*		*Pounds*	*Percent*
2M-1	98+84	Outside	Galvanized	11.4	None	Galvanized	31.4	100
		Inside wall	do	13.8	None			
		Paved invert	do	28.9	None			
2M-1	152+23	Outside	Galvanized	14.9	None	Galvanized	39.2	100
		Paved invert	do	39.5	50			
2M-2	526+65	Outside	Galvanized	9.9	None	Galvanized	42.7	100
		Inside wall	Asbestos-bonded	12.8	(1)	Asbestos-bonded	33.8	(1)
		Paved invert	do	24.3	(1)			
2N-1	207+35	Outside	Galvanized	18.0	None	Galvanized	36.1	100
		Inside wall	Asbestos-bonded	18.9	(1)	Asbestos-bonded	39.8	(1)
		Paved invert	do	18.0	(1)			
2N-2	544+32	Outside	Galvanized	26.8	None	Galvanized	51.6	100
		Paved invert [2]	Reinforcing plate	15.8	10	Reinforcing plate	32.0	20
		Paved invert [3]	Galvanized	38.0	35			
2N-2	535+75	Paved invert [2]	Reinforcing plate	12.0	20			

[1] Asbestos sheet was split by test.
[2] Coating on surface of reinforcing plate.
[3] Coating on corrugated metal under reinforcing plate.

SUMMARY

The data obtained in this study seem to warrant the following summary:

1. In general, the most severe deterioration of the asphalt coating and pavement was found at the outlet ends of the pipes.

2. The amount of flow of water did not seem to bear any consistent relation to the degree of deterioration occurring in the coating and pavement.

3. In general, the slope of the pipe had little influence upon the deterioration of the asphalt coating and pavement.

4. The asphalt coating on the outside of the culvert pipe was usually checked and had very little adhesion to the metal.

5. The metal-reinforced asphalt-paved inverts showed the greatest amount of deterioration under service conditions.

6. The culvert pipes in which asbestos-bonded metal was used appeared to have the greatest resistance to deterioration. Even though there was some loss of asphalt coating the asbestos sheet appeared to give added protection to the metal.

7. The better condition of the asphalt coating on section 2M–1 as compared with that on section 2U–2 seems to indicate that the durability of the coating depends to a considerable degree upon the type of asphalt used.

Because of the limited information available on the durability of bituminous-coated sheet metal culvert pipe and because of the short time the culverts inspected had been in service, it seems advisable to continue periodic inspections of these and other installations.

October 24, 1958

Mr. C. D. Lewis, Manager
Carolina Culvert & Metal Division
Industrial Drive - Salisbury Road
Statesville, North Carolina

Dear Mr. Lewis:

Thanks for your letter and the strip map of the Blue Ridge Parkway. I had the strip map photostated so I now have a print for use whenever one of us can make inspection of the CMP culverts. Enclosed is the original for your file.

I wonder if you or any of your men ever travel around Asheville. If so, curiosity might permit one of them to look at some of these culverts to see how they compare with the original report. Before recommending or permitting an official BPR inspection, I would like to see them myself, but any advance information would be appreciated when available.

Thanks for your invitation to visit you and I shall try to do so when I do get down your way.

Very truly yours,

CORRUGATED METAL PIPE ASSOCIATION

Roy E. Smith
Managing Director

RES:me
Encl.

Carolina Culvert and Metal Division

P. O. Box 389
TELEPHONE TRiangle 2-2471

INDUSTRIAL DRIVE — SALISBURY ROAD
STATESVILLE, NORTH CAROLINA

October 9, 1958

Mr. Roy E. Smith, Managing Director
Corrugated Metal Pipe Association
Suite 785, Marquette Building
140 So. Dearborn
Chicago 3, Illinois

Dear Mr. Smith:

Please excuse my delay in answering your letter of September 24, with reference to the inspection by the BPR in 1945, of the culvert used on the Blue Ridge Parkway. I have been out of town the majority of the time during the past two weeks.

We do not have any facilities here in our small town to make a copy of the strip map that you asked for. Therefore; I am enclosing it with this letter and request that you return it to us after you have had a copy made.

I believe that it would be an excellent idea if Mr. Serafin or Mr. Welborn could make another inspection of these culverts. I would be most happy to participate or cooperate in any way, should they decide to make another inspection.

Should you decide to make a trip down yourself we would be most happy to have you visit our plant and to get acquainted.

I would like to point out that the name of our town is Statesville and not Statesboro.

Yours very truly,

CAROLINA CULVERT & METAL DIVISION

C. D. Lewis

C. D. Lewis, Mgr.

CDL:fp

Lane Pipe Corp.
Bath, N. Y.

Lane-Penncarva Inc.
Bealeton, Va.

Juniata Culvert Co., Inc.
Bedford, Pa.

600 North Third Street
Harrisburg, Pa.

R. T. LANE
PRESIDENT

J. ALAN MYERS
VICE PRESIDENT
ENGINEERING

December 15, 1959

Mr. Roy E. Smith, Managing Director
National Corrugated Metal Pipe Association
Suite 785, Marquette Building
140 South Dearborn Street
Chicago 3, Illinois

Dear Roy:

Please note the attached correspondence with Mr. A. D. Morgan concerning the report "North Carolina Pipe Culvert Investigation, 1944", copy of which we forwarded to you previously. This is for your information and file.

We wish you all the joys which accompany the Christmas Season and ask that the New Year continue to provide Good Health, Good Friends and Good Cheer.

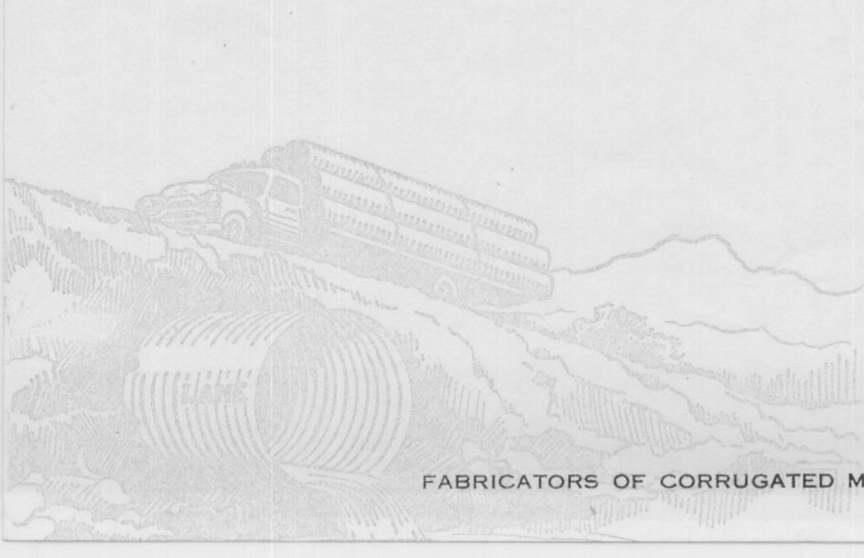
Sincerely,

LANE PIPE CORPORATION

Alan

J. Alan Myers
Vice President

JAM/jlt
Enc.



RECEIVED
DEC 17 1959
CORRUGATED METAL PIPE ...
By ....

FABRICATORS OF CORRUGATED METAL DRAINAGE PRODUCTS

STATE OF NORTH CAROLINA

STATE HIGHWAY COMMISSION

LUTHER H. HODGES, GOVERNOR — J. MELVILLE BROUGHTON, JR., CHAIRMAN

[illegible]

DEPARTMENT OF MATERIALS AND TESTS
[illegible]
STATE MATERIALS ENGINEER

November 5, 1959

Mr. J. Alan Myers
Vice President
Lane Pipe Corporation
600 North Third Street
Harrisburg, Pa.

Dear Mr. Myers:

In reply to your request for permission to reproduce my report "North Carolina Pipe Culvert Investigation, 1944", I shall be very glad to grant your request.

Perhaps you may be interested to know that we have recently made a very limited spot check on our 1944 Investigation and found nothing that would cause us to change our summary and conclusions. You have my permission to quote this statement.

It is good to know that your good friend T. P. De Capiteau is also a good friend of mine.

Very truly yours,

A. D. Morgan
Materials Engineer

ADM:mk

November 3, 1959

Mr. A. H. Morgan
North Carolina State Highway
and Public Works Commission
Highway Building
Raleigh, North Carolina

Dear Mr. Morgan:

Recently I had occasion to have an objective discussion with my good friend T. F. De Capiteau, Republic Steel Corporation, Culvert Division, about the durability of various types of materials used for drainage structures. During that conversation, Mr. De Capiteau showed me your report "North Carolina Pipe Culvert Investigation, 1944."

From time to time Engineers and various specifying agencies specifically request information concerning the durability of the products we fabricate and sell. Comprehensive reports such as the one you prepared on this subject in 1944 are, unfortunately, infrequently made.

If you have no objection, it is requested that permission be granted for us to reproduce the report. It is not our intention to circulate the report in quantity; rather, we would like to be able to discuss the tabulated results from time to time with interested Engineers on an individual basis.

Be assured that if permission to copy the report is granted, the information will be reproduced in total as originally issued by you.

As a member of Highway Research Board Committee D-4, "Culverts and Culvert Pipe," I am vitally interested in subjects such as this since it is felt that practical information resulting from durability studies made in the field unquestionably contributes much toward our better understanding of the economic use, design and application of drainage structures made from all materials.

Your favorable consideration of our request will be sincerely appreciated.

Very truly yours,
LANE PIPE CORPORATION

J. Alan Myers
Vice President

JAM/jlt

ARMCO Metal Products Division

Headquarters Division
Washington, D. C.

June 4, 1964

cc: W. S. Mann
A. J. Mistler
R. E. Smith ← COPY FOR
H. L. White

TO: W. S. Anders

FROM: W. E. Harrison

SUBJECT: Blue Ridge Parkway Culvert Survey

Attached is copy of Roy Smith's memo concerning subject matter which ties into our conversation after our May 13th meeting with Williams.

The BPR library has the 1946 July-Aug-Sept issue of "Public Roads Magazine". I shall brief the article with particular attention to stationing or locations of structures.

If the locations of structures cannot be readily pin pointed from the article I'm sure the Gatlinburg District, BPR, who has maintenance responsibility for this section can supply same.

In my opinion Armco and/or NCSPA had better closely follow both the Blue Ridge Survey and the New York "Analysis of Pipe Culverts".

Our policy should be one of close contact with those agencies performing the investigations.

WEH:pap

Attachment

W. E. Harrison

Form 5958