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BRIDGE DECK EXPANSION DEVICES

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Interim Report
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16. Abstract

This report documents a study to evaluate promising bridge deck expansion joints with the intent to finding the most maintenance free and water-proof expansion devices for use in Colorado. The evaluation included inspections and measurements during construction and post constructions. The ability of a device to remain water tight is the most important quality used to determine the success of the device. Proper installation during construction is one of the most important factors which will ultimately determine the success of an expansion joint. Neoprene compression joint seals are recommended for future joints whenever possible. On flex joints have also been shown to perform well, however, further evaluations are required before firm recommendations are made.

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INTRODUCTION

This interim report documents a study which was initiated to evaluate various promising bridge deck expansion joints. The final report will be prepared and distributed after sufficient evaluations (at least three years on each device) are made.

Expansion joints have been a major problem in bridge design, construction, and maintenance for many years. Numerous expansion devices used as standards in the past have proved insufficient because of their susceptibility to damage and failure due to snowplows, increased traffic loading, and intrusion of water debris through the joints. Many of these problems were the result of poor design or placement of the expansion device. In areas where deicing chemicals are used to prevent bridge and roadway icing, leakage through joints has caused serious structural damage to concrete bridge seats, piers, abutments, and steel support members.

FHWA Notice N 5140.12 dated April 10, 1978 concerning the final report from the National Experimental and Evaluation Program (NEEP), Project Number 11, gave guidelines for selecting bridge deck expansion devices on Federal-Aid Highways. Using this project as a guide, promising expansion devices were incorporated into the study.

Six types of these devices were included in the original study proposal. The project has been expanded several times to include others as new project plans and devices were developed.

Thirteen (13) different systems have been included in the study on twenty-one structures to seal 128 joints. Table A is a list of the expansion devices. The structure numbers, project numbers, and location where each was or will be placed. The dates submitted, approved for use by the FHWA, the construction date, the date awarded and the date completed are also included in Table A.

TABLE A

EVALUATION OF BRIDGE DECK EXPANSION DEVICES

March 16, 1983

CATEGORY II STUDY

Expansion Device	Structure Number	Project Number	Location	Date Submitted	Date Approved	Bids Awards	Date Completed
Acme Strip Seal	I-17-GU	FCU 083-1(11)	SH 115 to B Street	3/16/78	4/25/78	5/ 4/78	8/79
Delastiflex	F-12-AL	I 70-2(69)	I-70 at Corral Creek	3/ 6/78	4/25/78	5/11/78	9/79
Delastiflex	F-8-Q	I 70-2(79)	I 70 Dotsero to Gypsum	6/ 5/78	8/31/78	3/ 1/79	5/80
Delastiflex	F-8-R	I 70-2(79)	I 70 Dotsero to Gypsum	6/ 5/78	8/31/78	3/ 1/79	5/80
ONFLEX 45	E-18-AM	I 76-1(53)	I 76 Lochbuie	9/14/78	10/ 5/78	2/28/80	6/81
ONFLEX 45	P-5-S	FC 160-2(22)	SH 160 South of Durango	9/14/78	10/ 5/78	11/16/78	10/79
ONFLEX 45 & 25	E-16-KB	I 76-1(56)	I 76 Wadsworth to Marshal	10/24/78	12/ 8/78	9/ 6/79	8/80
GEN STRIP 250	E-16-KC	IR 76-1(61)	I 76 Wadsworth to Marshal	5/22/79	7/12/79	9/ 6/79	9/81
ONFLEX 25(8)	E-17-FX	I 70-4(79)	46th Avenue Viaduct-WB	11/21/78	12/14/78	12/21/78	9/79
ONFLEX 45(6)	E-17-FV	IR 70-4(73)	46th Avenue Viaduct-WB	11/21/78	12/14/78	12/21/78	9/79
Compression Joint	E-17-FU	IR 70-4(73)	46th Avenue Viaduct-WB	11/21/78	12/14/78	12/21/78	9/79
Seal (35)	E-17-FW	IR 70-4(73)	46th Avenue Viaduct-WB	11/21/78	12/14/78	12/21/78	9/79
FEL-PRO	H-17-CQ	I 25-2(132)	I 25 at Perry Park Road	3/16/79	5/ 1/79	9/13/79	8/80
Compression Joint Seal (37)	E-17-FX	I 70-4(82) IR 70-4(80)	46th Avenue Viaduct-EB	9/11/79	10/3/79	1/15/80	7/80
ONFLEX 45(4)	E-17-FX	IR 70-4(80)	46th Avenue Viaduct-EB	9/11/79	10/ 3/79	1/15/80	7/80
WABOFLEX SR2A (2)	E-17-FX	IR 70-4(80)	46th Avenue Viaduct-EB	9/11/79	10/ 3/79	1/15/80	7/80
TRANSFLEX 400A (1)	E-17-FV	IR 70-4(80)	46th Avenue Viaduct-EB	9/11/79	10/ 3/79	1/15/80	7/80
TRANSFLEX 250 (3)	E-17-FV	IR 70-4(80)	46th Avenue Viaduct-EB	9/11/79	10/ 3/79	1/15/80	7/80
	E-17-FW	IR 70-4(80)	46th Avenue Viaduct-EB	9/11/79	10/ 3/79	1/15/80	7/80
	E-17-FX	IR 70-4(80)	46th Avenue Viaduct-EB	9/11/79	10/ 3/79	1/15/80	7/80
GEN STRIP 250	E-18-AO	I 76-1(53)	SH 7 to Hudson	9/20/79	10/ 3/79	3/20/80	
WABO ALU-STRIP TYPE IV S400	D-18-BN	I 76-1(55)	I 76 - SH 7 to Hudson	10/15/79	10/25/79	12/18/80	9/81
ACME TR 300	E-17-MD	CC12-1642-02 87-01	56th Avenue at Sand Creek	3/11/80	3/25/80	8/28/80	7/81
EVAZOTE 50 (Grade-PO 72 Gray)	D-16-CW	TOFCU 157-1(1)	47th St. Pky. over Boulder Cr.	9/25/80	10/16/80	7/ 1/82	11/82
ELASTOMERIC Concrete End Dam	F-16-JX	BRF 040-4(9)	Colfax Viaduct	1/14/83	2/11/83		
ELASTOMERIC CONCRETE END DAMS and ELASTOMERIC STRIP SEAL	E-17-II E-17-IC	IR 270-6(13) & IR 270-6(14)	I 270 E.B. over Brighton & York St. over I 270	3/16/83 3/16/83			

The objectives of the study is to evaluate various types of bridge deck expansion devices with the intent of finding the most maintenance free and waterproof bridge expansion device for use in Colorado.

The evaluation procedures included inspections and measurements during construction and at least twice a year for a minimum of three years. Wear or damage to the expansion device is often sufficient criteria to determine failure. The ability of an expansion device to remain water tight is the most import quality used to determine the success of the device. The underside of these expansion joints was inspected at least once a year during inclement weather to detect any leaks.

This interim report covers the expansion devices listed in Table B which have been evaluated for three years or more. This list of expansion devices will be removed from the list in Table A and the remaining list will continue to be evaluated under this experimental project. Occasional inspections of the devices in Table B are planned at state expense as a general follow up.

INSTALLATION

The installation of expansion joints is probably the most critical factor in long term successful performance. The measurements and layout for forming and preparation of the expansion joints site are very important to facilitate ease of installation, to provide proper expansion - contraction dimensions and to provide a recessed profile which ultimately protects the device from traffic and snow removal equipment. Project engineers and inspectors should see that the details in plans are followed closely and be very critical about expansion joints since they are a key element in the longevity of the structure.

DELASTIFLEX AT DOTSERO

The four Delastiflex joints placed on two structures near Dotsero were exceptionally good installations. The joints were placed and covered with a 1/8" fiber board prior to the paving of the final riding surfaces of the deck and approaches. This fiber board was worn off by traffic and gave good clearance for the entire joint.

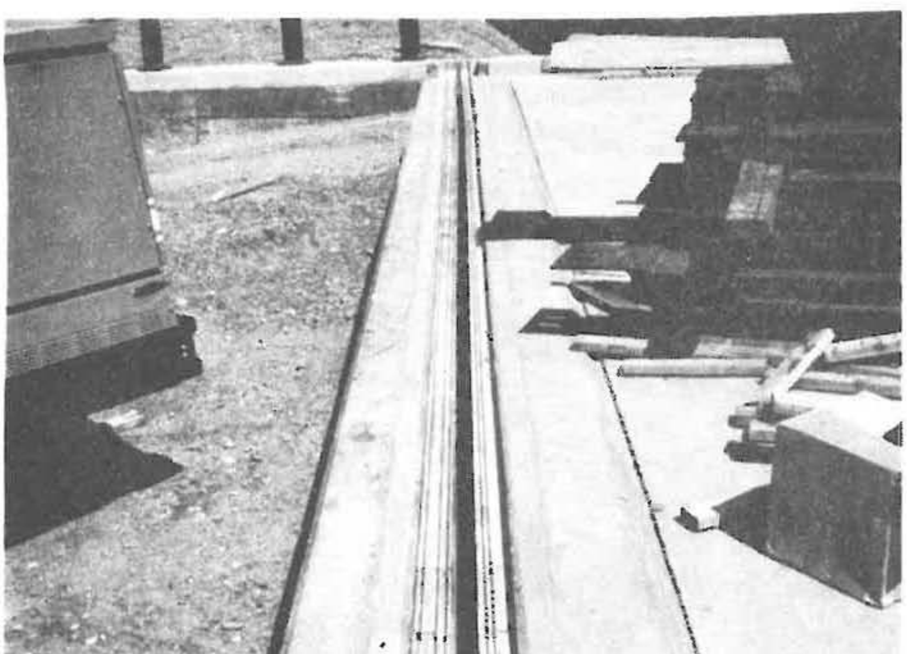


Photo #1
Delastiflex joint
at Dotsero

The aluminum frame
had been installed.

DELASTIFLEX AT CORRAL CREEK

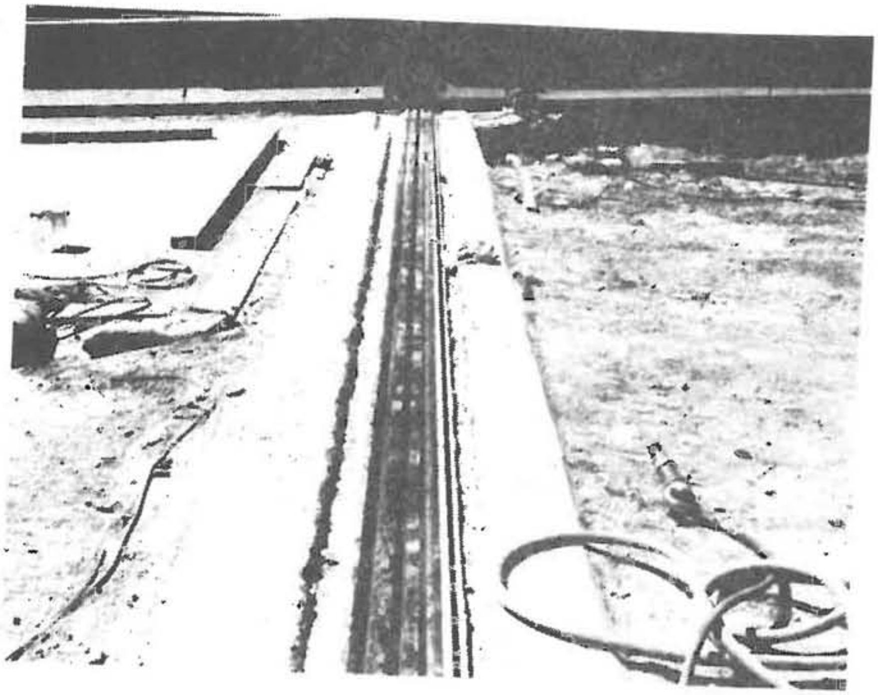


Photo #2

I-70 Over Corral Creek

Delastiflex Expansion Device with Neoprene Installed.

W End Structure F-12-AL

The installation of the delastiflex expansion joint on I-70 over Corral Creek was accomplished without any problems. The finished approach, joint and structure were all on an even grade and had a good appearance.

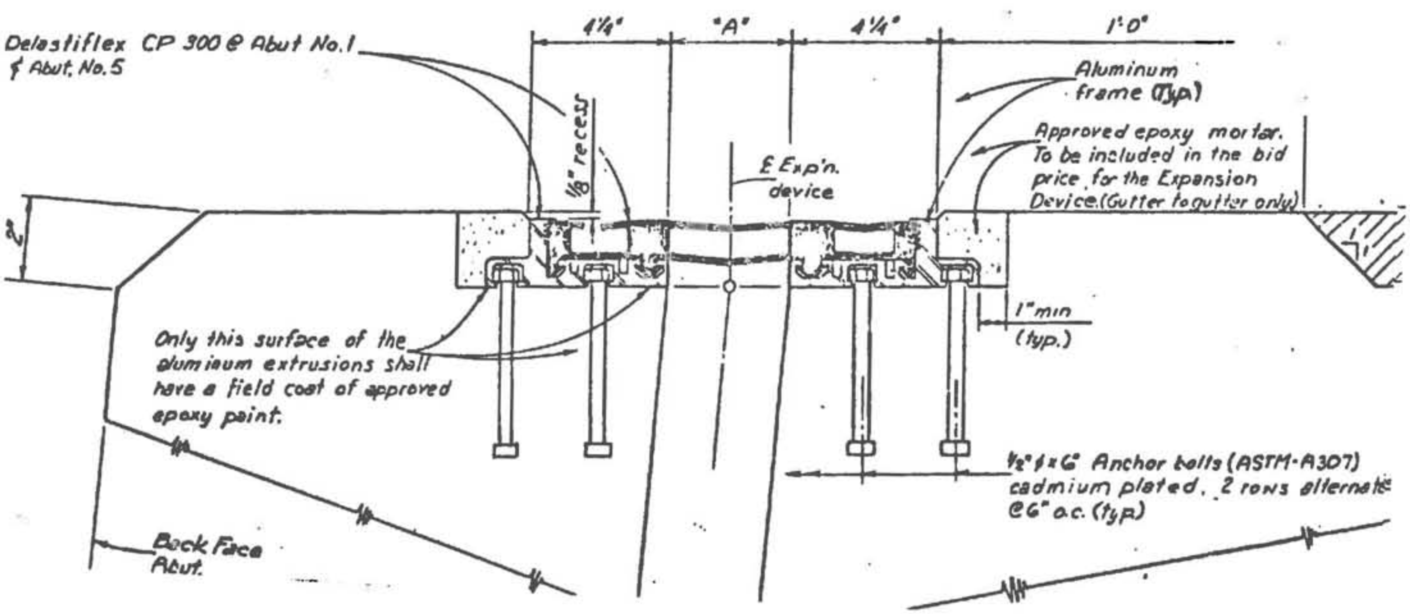


Diagram A

ACME STRIP SEAL

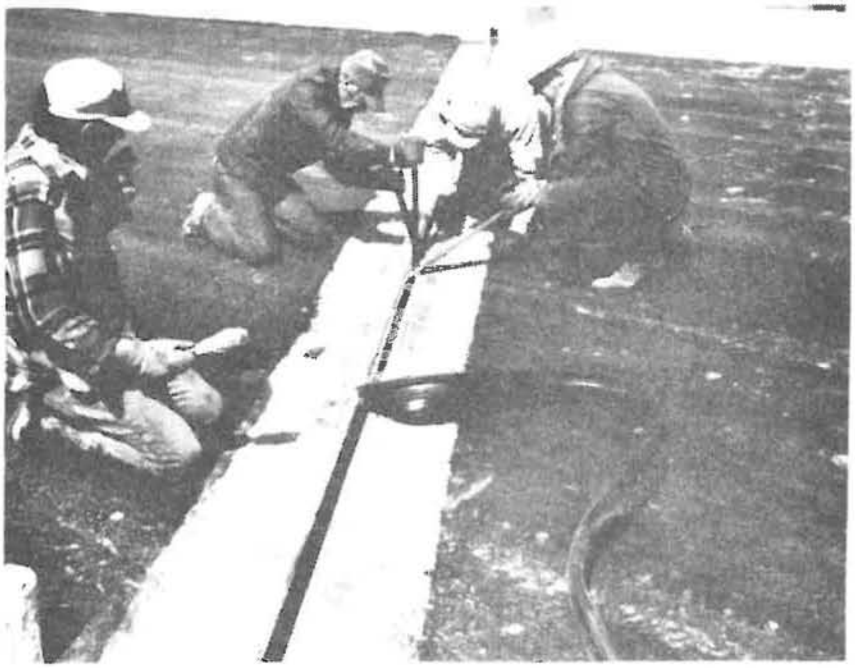


Photo 3

Acme Strip Seal

I-17-GU SH 83, 115 to B Street, Colorado Springs

Rubber extrusion being installed using screwdriver, steel bar and special tool.

There was some form slippage when the deck was poured on I-17-GU in Colorado Springs.

The "A" dimensions were within tolerances, but workmen had some difficulty installing the membrane. The final product was okay and looked good.

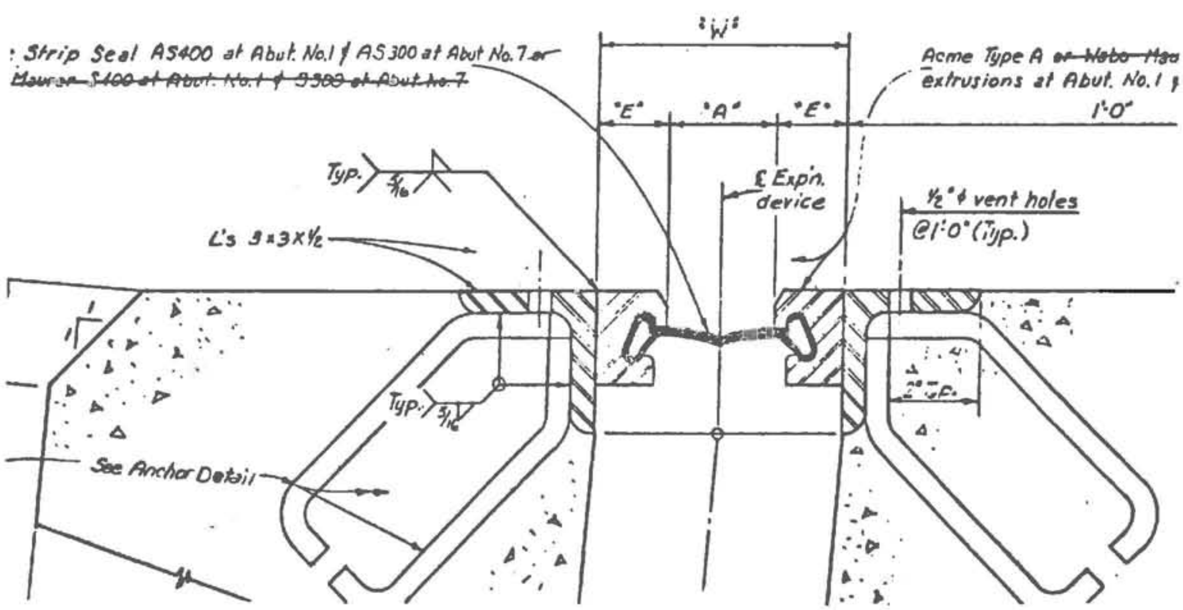
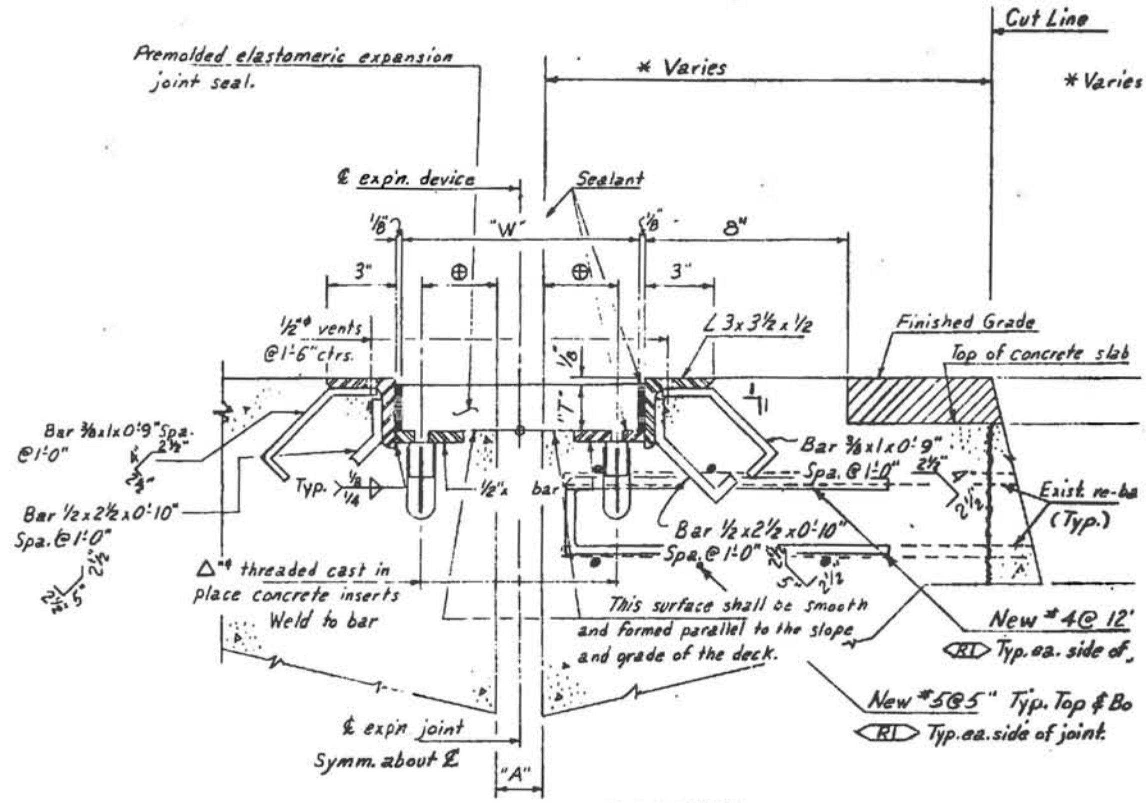


Diagram B



SECTION THRU EXP'N. DEVICE

Diagram C

This general diagram is used for Fel-Pro, Onflex, Waboflex, and Transflex expansion joints. Dimensions are specified for each joint and each type of device on an individual basis.

FEL PRO

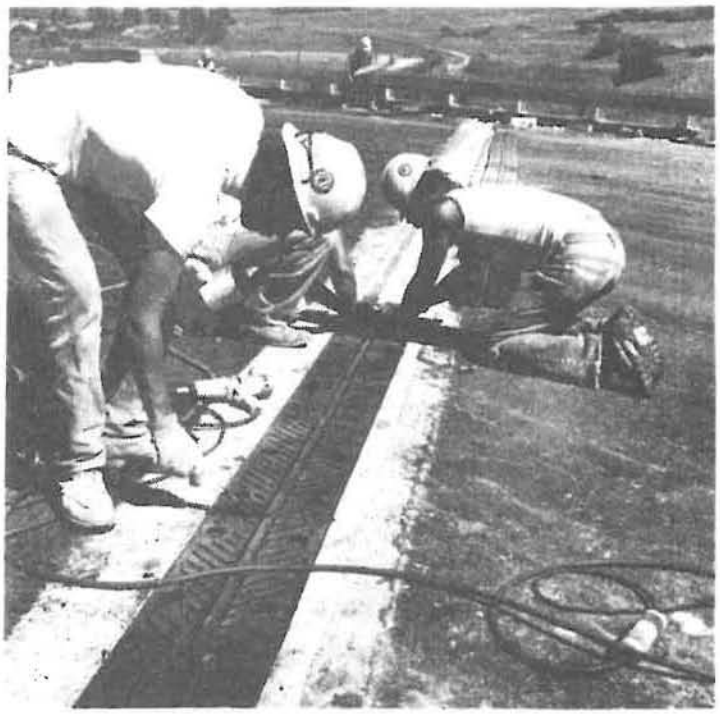


Photo 4

Workmen installing Fel Pro at I-25 over Perry Park Road.

The placement of Fel-Pro was completed with no major problems. The expansion joint was completed at or very near the finished grade and appeared to be okay at the completion of the project.

TRANSFLEX

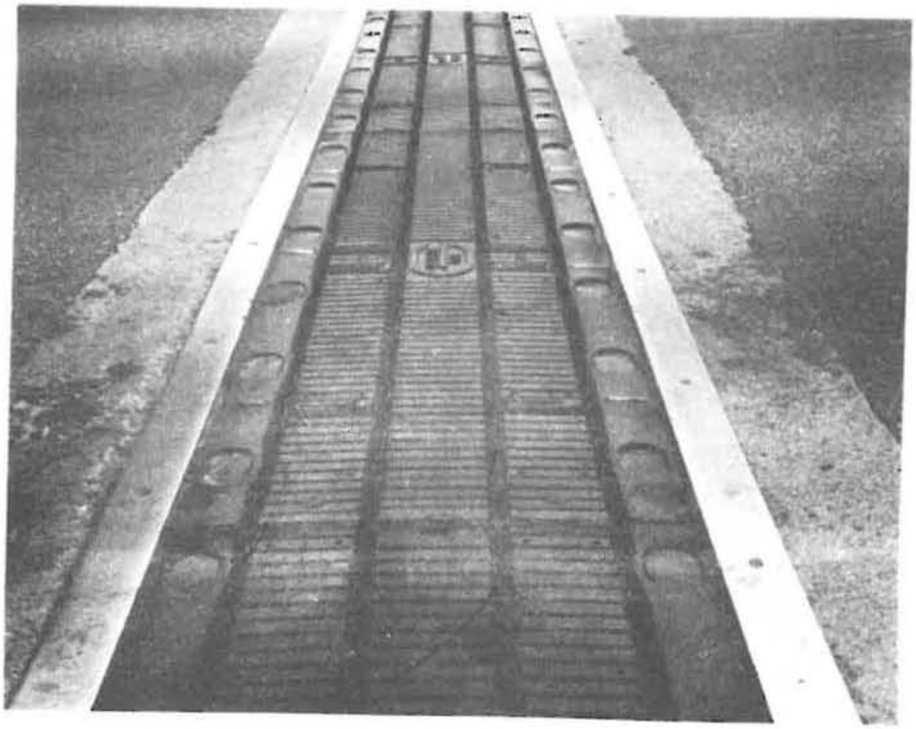


Photo 5

Transflex 400A on I-70 Viaduct.

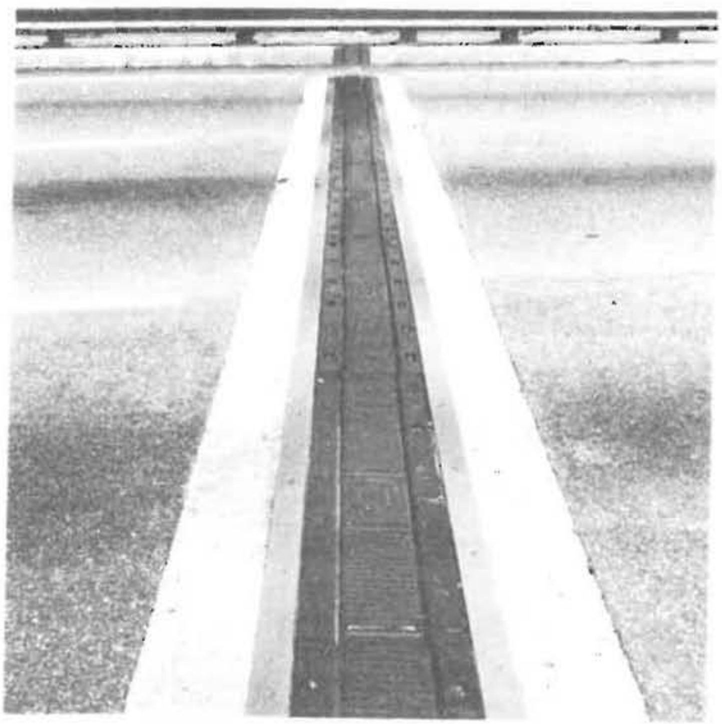


Photo 6

Transflex 250 on I-70 Viaduct

Both sizes of Transflex looked good just after installation, however, the surface was flushed with the finished grade.

WABOFLEX

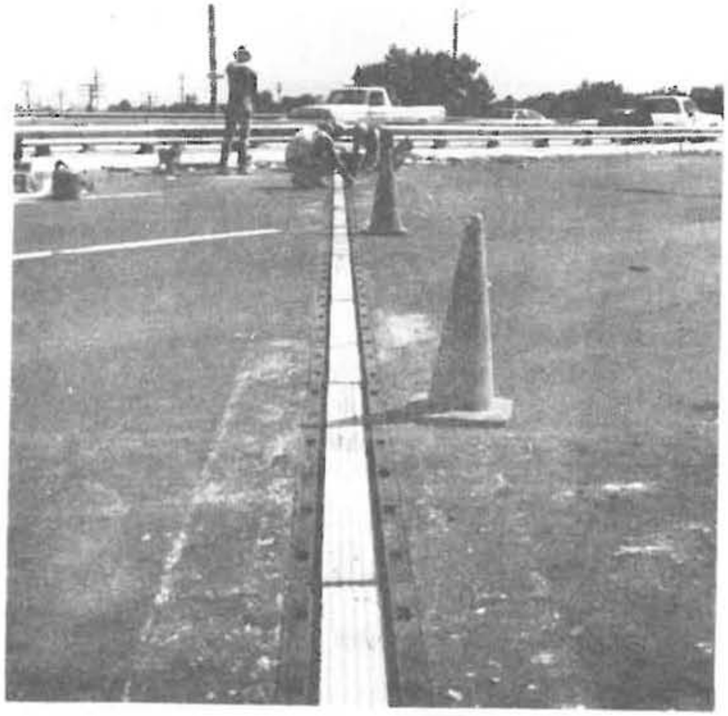


Photo 7

Waboflex SR2A on I-70 Viaduct.

This joint was also finished at the same grade as the finished roadway. Installation went well and the joint looked okay.

ONFLEX

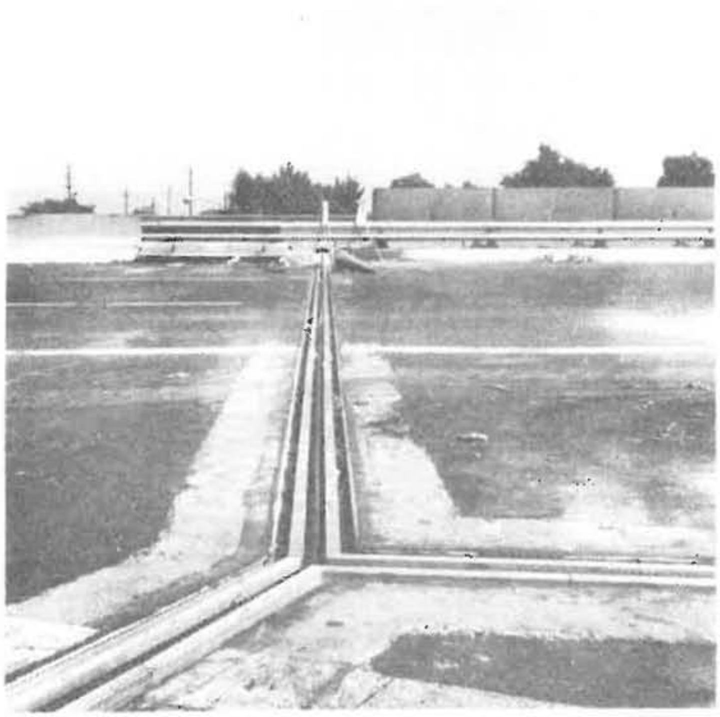


Photo 8

Onflex was placed on several joints on the 46th Avenue Viaduct.

Special Y joints were constructed to accommodate adjoining structures at ramps and railroad overpasses.

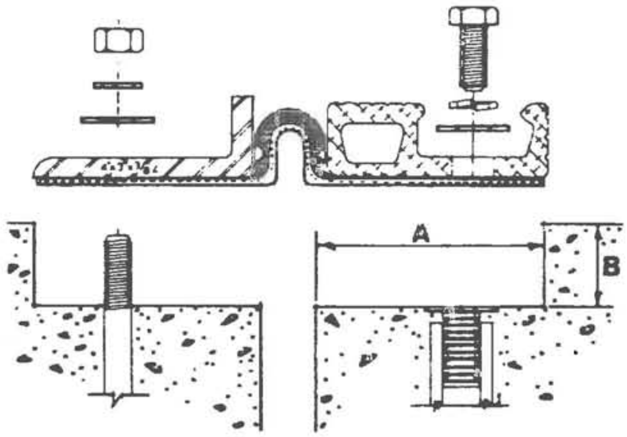


Diagram D
Onflex

The center of the aluminum was damaged by equipment during the installation of Onflex 45 at Durango. There was also a variation of 3/16" in the 'A' dimension across the length of the joint. There has been no subsequent damage and this is not believed to be the cause of subsequent leaks.

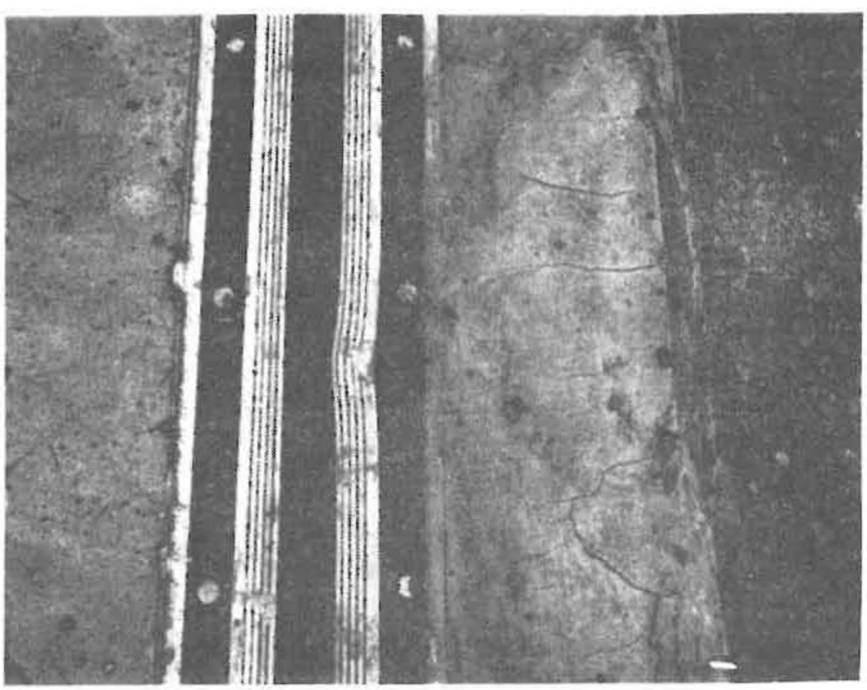


Photo 9

Aluminum damaged on this Onflex expansion joint device at Durango.

NEOPRENE COMPRESSION JOINT SEAL

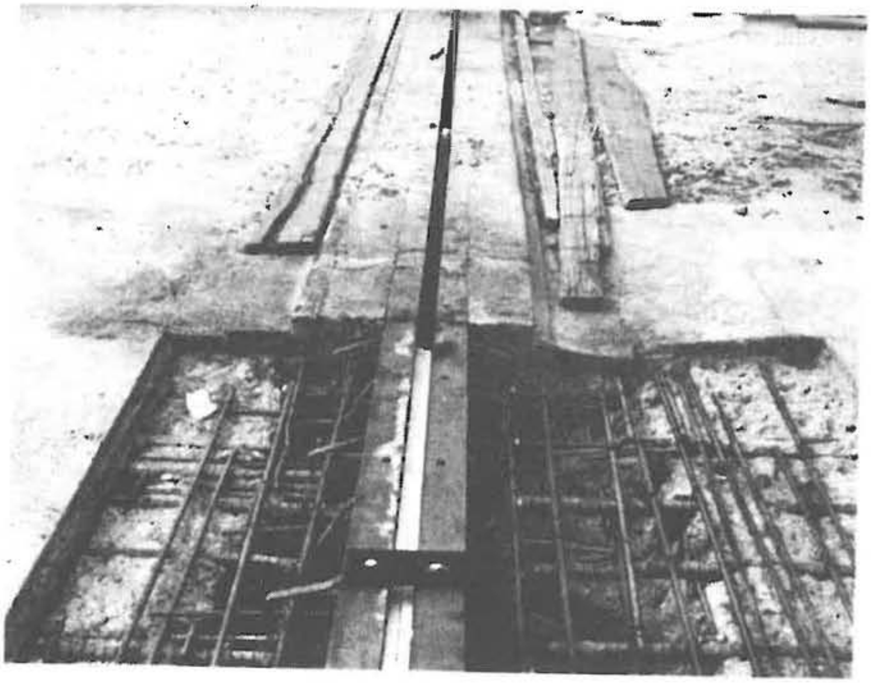


Photo 10

I-70 Viaduct WB Experimental Joint #39

Neoprene Compression joint seal. A metal channel and bolts are used to maintain the proper "A" dimension.

An epoxy glue serves as a lubricant while the neoprene sealer is forced into place. The contractor encountered no problems with most of these joints on the 46th Avenue Viaduct. The metal angle iron parts were installed too close together on three joints and a special order for smaller neoprene strips was made.

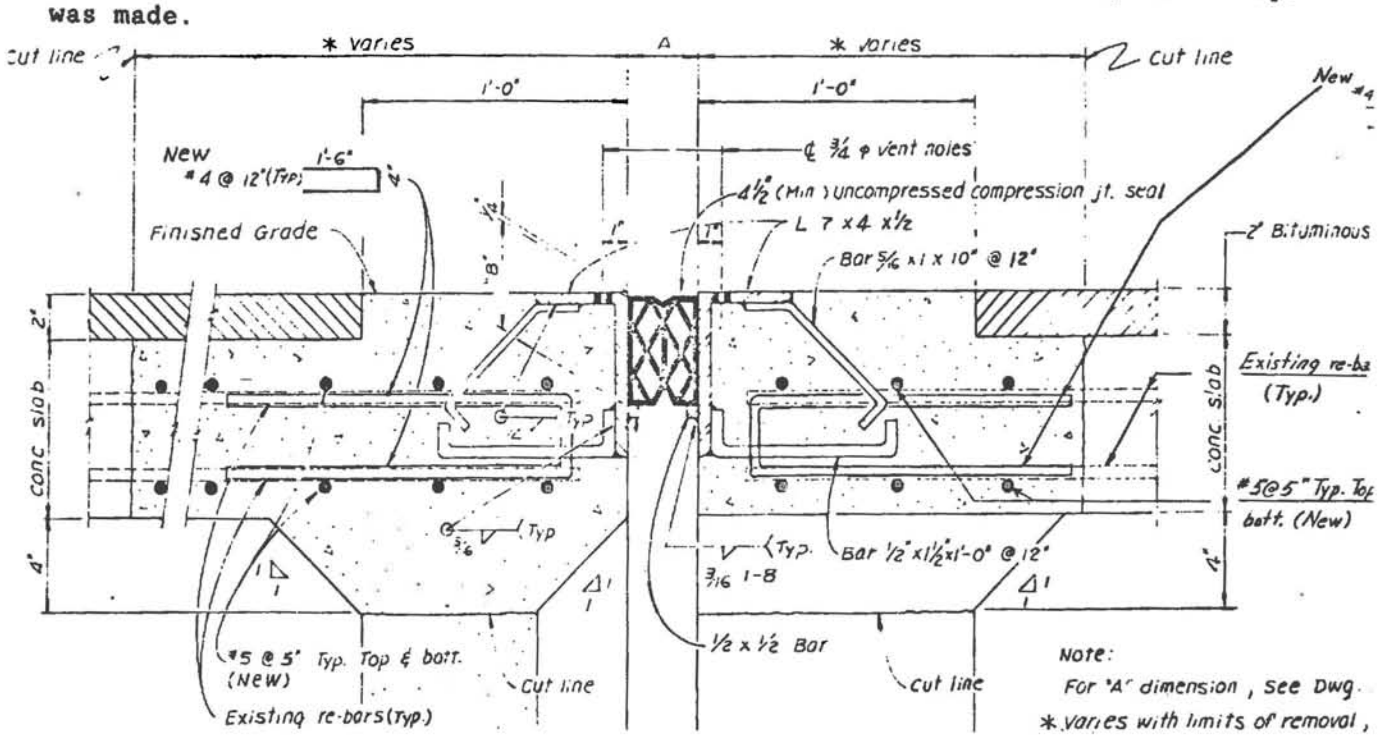


Diagram E

PERFORMANCE

This report deals only with those expansion devices which have been in place for three years or more. Table B is a list of these devices, their locations, cost per lineal foot, leaks, and damage. The major factor in determining the failure of an expansion device is whether it leaks or not. Special efforts were made to inspect the joints during a rainy period to determine leaks. Compression joint seals, which are a standard for comparison, show only a 4% failure of 72 joints on the 46th Avenue Viaduct. Of the various types of expansion devices installed statewide, fifty-eight percent (58%) of the Onflex joints have failed and 50% of both Waboflex and Transflex have failed by this criterion. Both Acme Strip seal joints on one structure have not leaked. The one Fel-Pro joint has been worn by traffic and snow removal equipment. There are several serious leaks in this joint. Delastiflex was used on three structures, one of which shows severe damage and leaks for 335 failure rate. The placement of Delastiflex on the two structures at Dotsero were exceptionally good leading to the positive results. A major observation is that most expansion joints can work effectively if they are properly installed.

Joint installations placed near the same grade as the finished roadway are subject to damage by traffic and snow removal equipment. Heavy traffic volumes, especially when a large percent of the vehicles are using studded snow tires or chains, soon wear the pavement surface to or below the level of the expansion joints. Moderate to heavy damage has been observed in such instances. Severe damage can be expected in high snowfall areas where plows and blades pass over the joints many times a day for more than 150 days a year. This extreme equipment use, high traffic volume, and adverse environment combine to produce the harshest test for any structural component of a highway.

TABLE B

EVALUATION OF BRIDGE DECK EXPANSION DEVICES

CATEGORY II STUDY

Expansion Device	Joints	Location	Cost Per Lin. Ft.	Leaks	Damage Const.	Damage Snow Plow
Acme Strip Seal	(2)	SH 115 to B Street	$123	No		No
Delastiflex	(2)	I-70 at Corral Creek	$ 83	Yes	Yes	Severe
Delastiflex	(2)	I-70 Dotsero to Gypsum	$ 88	No		Light
Delastiflex	(2)	I-70 Dotsero to Gypsum	$ 88	No		No
Onflex 45	(2)	SH 160 So. of Durango	$173	Yes	Yes	No
FEL-PRO	(1)	I-25 at Perry Park Rd.	$200	Yes		Moderate
Compression Joint Seal	(72)	46th Avenue Viaduct	$100	4%		Heavy
Onflex 25	(8)	46th Avenue Viaduct	$200	75%		Light
Onflex 45	(10)	46th Avenue Viaduct	$200	40%		Light
WABOFLEX SR2A	(2)	46th Avenue Viaduct	$220	50%		Heavy
TRANSFLEX	(1)	46th Avenue Viaduct	$220	0		No
TRANSFLEX 250	(3)	46th Avenue Viaduct	$220	66%		Moderate

The longitivity and wear of all these experimental joints can be correlated to installation and high traffic volume and snow removal equipment. Most of the joints evaluated in this report have only been in service for three to four years, yet many have failed. More care and attention to details during installation would save a considerable amount of repair rehabilitation or replacement which is sometimes necessary long before the expected service life on many structures.

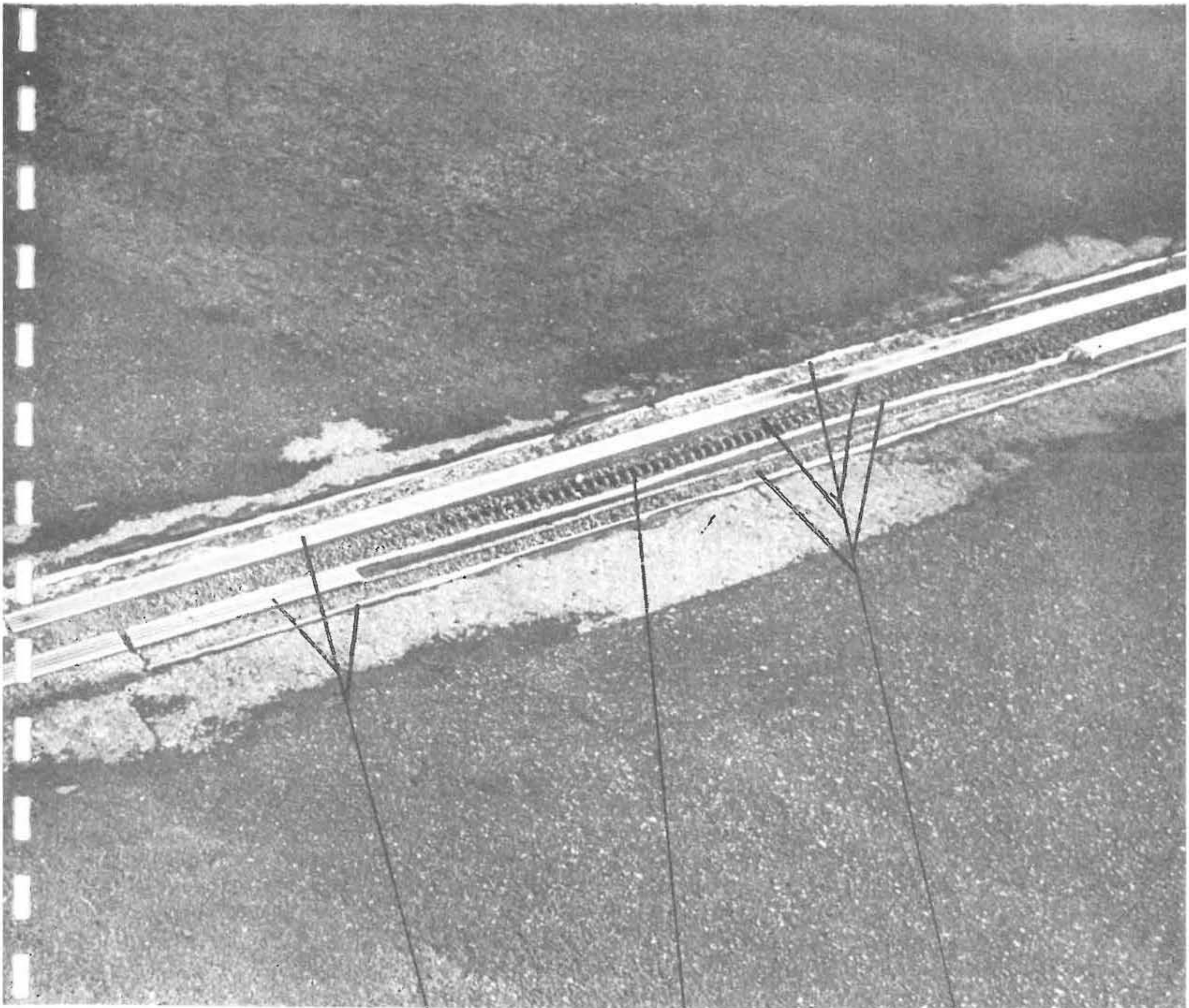


Photo #2, snowplow damage to the aluminum rail of an Onflex 45 joint number 8 on the westbound 46th Avenue Viaduct. This joint now has major leaks during wet weather.

The sand and debris is typical in all recessed parts of all of the experimental expansion joints.

COSTS

It can easily be seen on Table B that Delastiflex and compression joint seal are the least costly and they have also provided the most successful expansion joints of those on this list. The costs were taken from bid tabs which include the materials, labor and other expences for the joints in place on the job.

CONCLUSION AND RECOMMENDATIONS

The most important factor which will ultimately determine the success of an expansion joint is proper installation during construction. All measurements have shown that attachments and anchors are vary important in the final alignment and position of the expansion joint. A finished joint which is recessed 1/8" to 1/4" and has good approach protection will most likely not be damaged by traffic or snow removal equipment. Rigid inspection during installation is essential. Most expansion joints can work effectively if they are installed properly, however, the results of this study, which includes only those expansion joints on the experimental list (Table B) indicates that compression joint seals, acme strips seal, Onflex, and Delastiflex have performed the best.

None of the devices in table B can be classified as acceptable or unacceptable at this time because the cause of failures have not been conclusively proven to be related to installation, snow plow, traffic or simply the failure of the device. CDOH will continue to use compression joint seals where the movements are less than 2" and continuous strip seals such as onflex and acme where movements are less than 4". Even though they don't have a good performance record, Waboflex and Transflex will be used when movements are between 4" and 13" because they are the only products on the market that can be used for these large movements.

Most of the expansion joints on the 46th Avenue Viaduct are not located over abutments or piers, therefore, water and leaking minerals cause very little structural damage to these members.

Four other expansion joints Gen strip, Wabo-Alu Strip, Acme TR300 and Evazote are still under evaluation. Two additional installations of Onflex as well as elastomeric concrete end dams and strip seals are also still under evaluation. A final report will document the results on these items and make further recommendations. Each experimental expansion joint must be evaluated for at least three years. Some of the experimental features listed on Table A have not yet been installed, therefore, a final report will not be written before the summer of 1987.