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BRIDGE DECK EXPANSION DEVICES

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Second Interim Report
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Prepared in cooperation with the
U. S. Department of Transportation
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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 after construction. 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. Onflex joints, Acme strip seal and Delastiflex have also performed well.

Implementation

Staff Bridge Design is aware of the results of this study. Designers in Colorado are informed and using the latest state of the art in each design for new and rehabilitation of structures.

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INTRODUCTION

This interim report documents the evaluation of several promising bridge deck expansion joints and serves as a final report for these experimental features which have been in service for at least three years.

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 and 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 reduce 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.

Thirteen (13) different types of devices have been evaluated in this study. CDH research report 83-11 described the study and the performance of seven types of devices.

Thirteen (13) different systems have been included in the study on 21 structures to seal 128 joints. Table A is a list of the expansion devices. The structure numbers, project numbers, and location where each was placed. The dates submitted, approval for use by the FHWA, the construction date, the date awarded and date completed are also included in Table A. Table B is a list of devices still under evaluation after the

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 Seal (35)	E-17-FU	IR 70-4(73)	46th Avenue Viaduct-WB	11/21/78	12/14/78	12/21/78	9/79
	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	E-17-II	IR 270-6(13)	I 270 E.B. over Brighton &	3/16/83			
CONCRETE END DAMS and ELASTOMERIC STRIP SEAL	E-17-IC	& IR 270-6(14)	York St. over I 270	3/16/83			

TABLE B

EVALUATION OF BRIDGE DECK EXPANSION DEVICES

CATEGORY II STUDY

EXPANSION DEVICE	STRUCTURE NUMBER	PROJECT NUMBER	LOCATION	DATE SUBMITTED	DATE APPROVED	BIDS AWARDS	DATE COMPLETED
ONFLEX 45	E-18-AM	I 76-1(53)	I 76 Lochbuie	9/14/78	10/05/78	1/28/80	6/81
ONFLEX 45&25	E-16-KB	I 76-1(56)	I 76 Wadsworth to Marshall	10/24/78	12/08/78	9/06/79	8/80
GEN STRIP 250	E-16-KC	IR 76-1(61)	I 76 Wadsworth to Marshall	5/22/79	7/12/79	9/06/79	9/81
GEN STRIP 250	E-18-AO	I 76-1(53)	SH 7 to Hudson	9/20/79	10/03/79	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	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	87-01 TOFCU 157-1(1)	47th St. Pky. over Boulder	9/25/80	10/16/80	7/01/82	11/82
ELASTOMERIC Concrete End Dams (Wabocrete)	F-16-JX	BRF 040-4(9)	Colfax Viaduct	1/14/83	2/11/83	4/21/83	7/84
ELASTOMERIC Concrete End Dams (Wabocrete)	E-17-II	IR 270-6(13)	I-270 E.B. over Brighton	3/16/83	4/08/83	11/17/83	6/84
ELASTOMERIC Concrete End Dams (Cevacrete)	E-17-IC	IR 270-6(14)	York St. over I 270	3/16/83	4/08/83	11/17/83	6/84

1983 report. These expansion devices (with the exception of the concrete end dams) are addressed in this report and therefore, evaluation will be completed on them.

The objective 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 important 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. Evaluation and therefore reporting on experimental expansion devices will be completed with the publishing and distribution of the report. Evaluation will continue on elastomeric end dams.

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 joint sites 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 expansions joints since they are a key element in the longevity of the structure.

The following is a discussion of individual devices included in this evaluation. These observations are a summary of field notes and photos taken over a minimum of a three-year evaluation period.

ONFLEX 45 Lochbuie over I-76

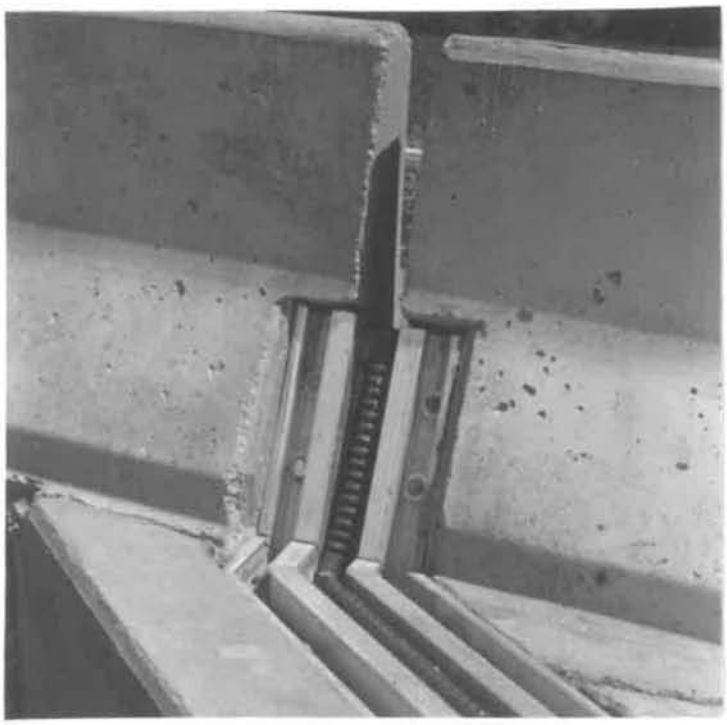
The two ONFLEX 45 seals were placed on structure E-18-AM at Lochbuie in June of 1981 with ease. No particular problems were encountered and the finished structure with joints looked good.

ONFLEX 25 and 45 at Wadsworth

The installation of Onflex 25 and 45 on the northbound Wadsworth to eastbound I-70 went well, all of these Onflex joints were in good condition after construction and were expected to perform well. (see Photos 1 & 2 and Diagram A)

ONFLEX 45 in Place on E-18-AM During Construction

PHOTO #1



Onflex 45 in place on E-16-KB. Both Expansion Joints Looked Good on This Wadsworth Structure.

PHOTO #2

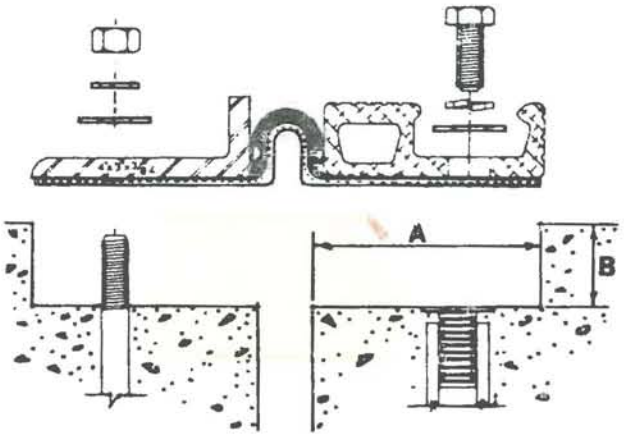


DIAGRAM A
ONFLEX

Workmen Preparing The Expansion Joint on E-16-KC

PHOTO #3

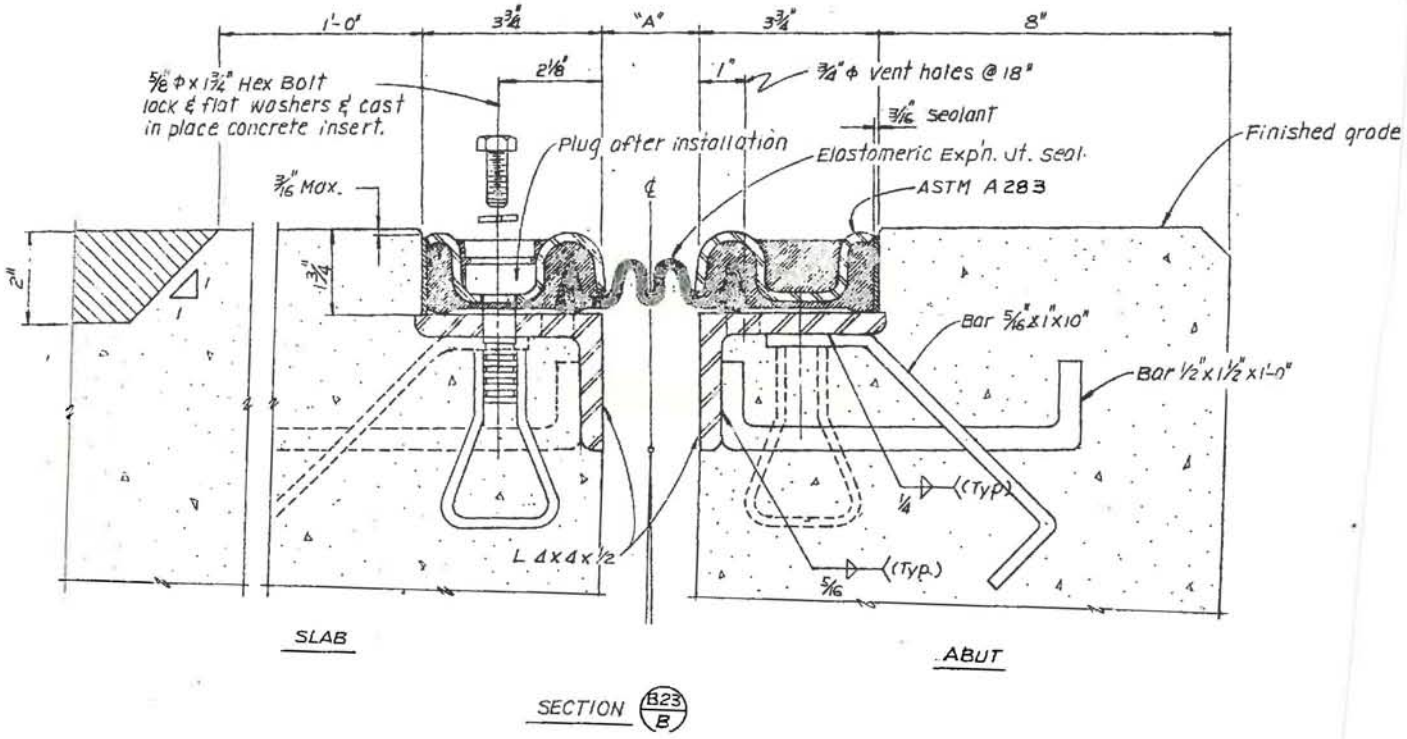


DIAGRAM B
Gen Strip 250

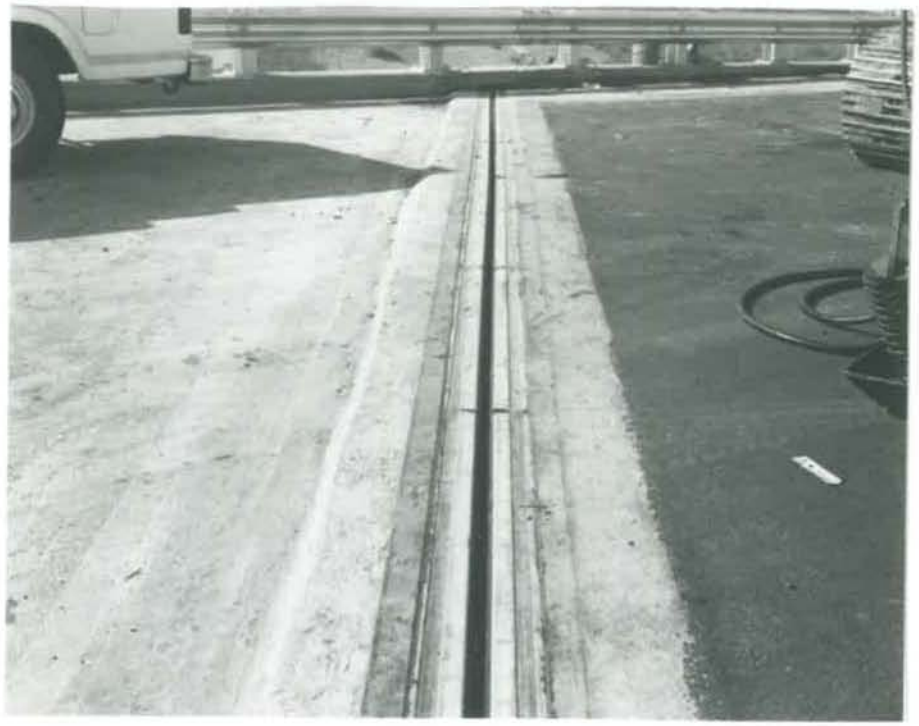
GEN-STRIP 250 Wadsworth to Marshall

After the construction of this structure E-16-KC, there were several places where the expansion joints were slightly higher than the concrete structure or the approach or both. This was a difficult structure to get everything to match with such small or no tolerances. The structure is on a grade, horizontal and vertical curve, super elevated and on a different skew angle at each end.

The Gen-strip 250 listed on Table B for structure E-18-AO on I-76 at State Highway 7 has never been constructed. This experimental expansion joint will be deleted from this list in order to finish this experimental research project.

WABO ALU-STRIP I-76 near Hudson.

The Wabo Alu Strip joints were placed on structure D-18-BN with relative ease. The structure and joints looked good when they were completed (see Photo 4 and Diagram C).



WABO ALU-STRIP On

Structure D-18-BN

PHOTO #4

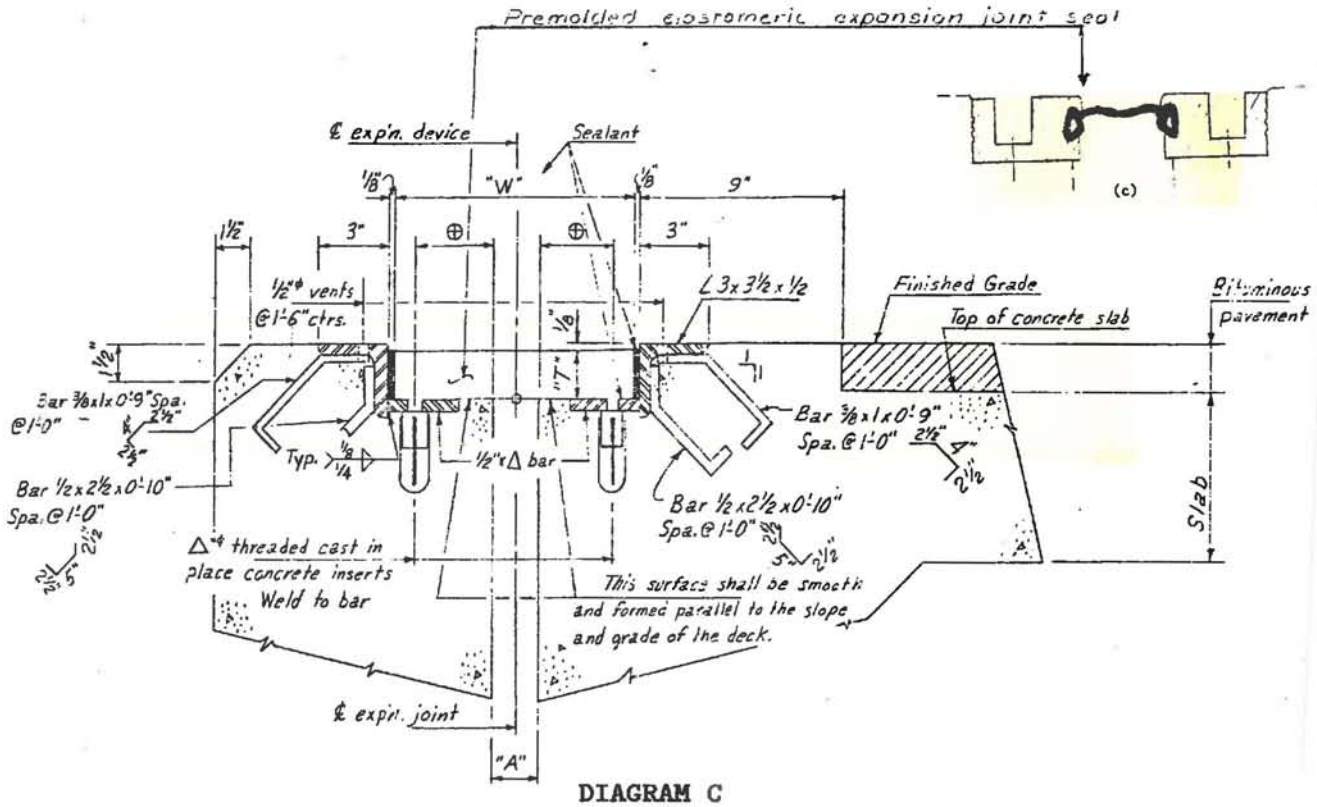


DIAGRAM C
Wabo Alu-Strip

ACME TR 300 56th over Sand Creek.

Acme TR 300 joint seals were placed on structure E-17-MD in the late summer of 1981. A good seal was obtained but members of the research section noticed that the rubber gland was in upside down. Staff Bridge Design offered the opinion that the seal should work either way (see Photo 5 and Diagram D).

ACME TR 300

installed on E-17-MD

PHOTO #5

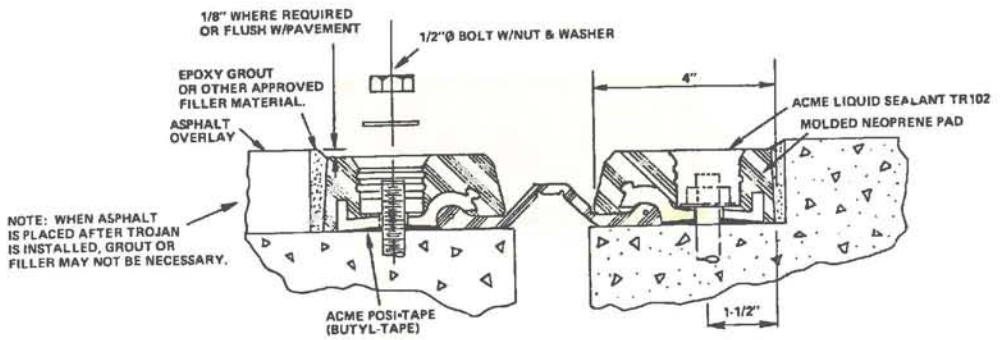
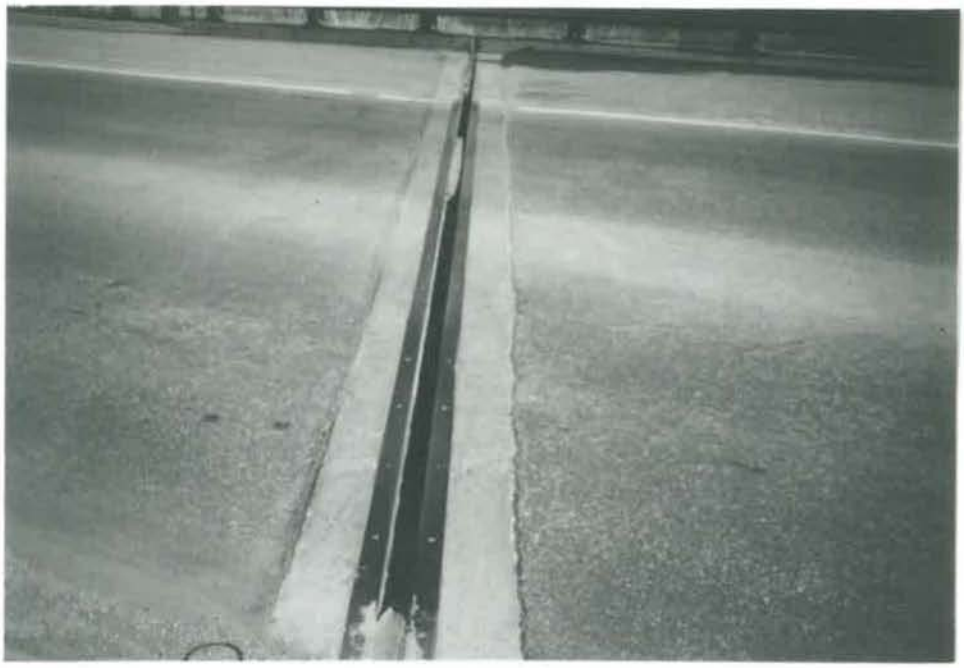


DIAGRAM D
ACME

EVAZOTE 50 47th Street over Boulder Creek.

Evazote was installed on structure D-16-CW in the fall of 1982. One fourth of it, the east half of the north joint, lost ashesion and fell down through the joint within two months. The manufacturer and supplier attributed this adhesion failure to incomplete sand blasting and cleaning of the steel angle iron joint edges. The project engineer suggested that the use of an opened partially used can of epoxy cement, which was used on this section of the joint, could have caused the failure. This particular section of Evazote has failed and been replaced and reinstalled three times by the manufacturer and/or supplier.



Four-Inch Evazote Material Failed Before It Was Opened to Traffic And Twice Since Then

PHOTO #6

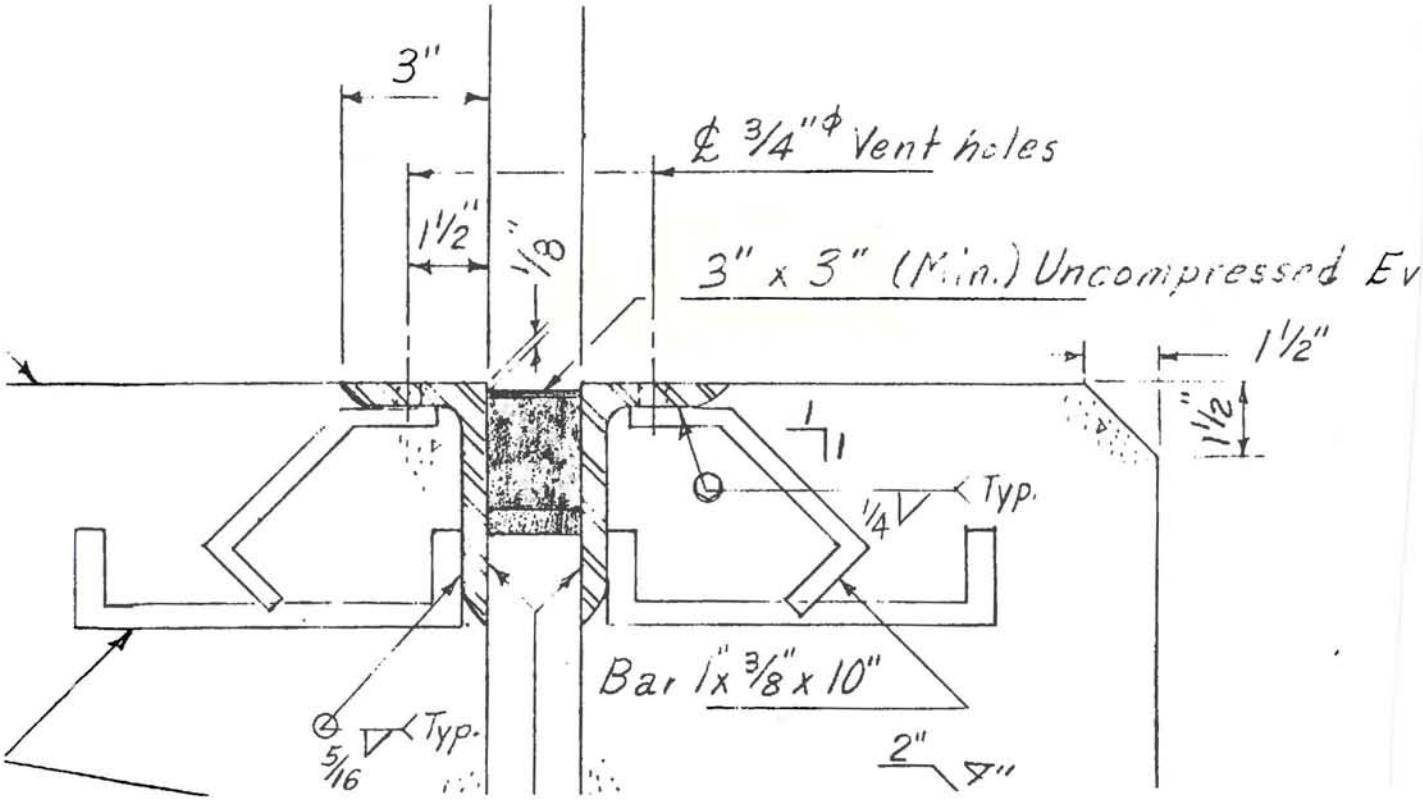


DIAGRAM E
EVAZOTE

PERFORMANCE

Table C is a list of these expansion devices, the structure numbers, cost per lineal foot, leaks and damage.

Maximum and minimum measurements across each joint (the A dimension) were made at temperature extrems during the evaluation period and all were within the design tolerances.

The failure of Evazote is adhesion. The Acme TR 300 gland was punctured as shown in Phote 9, however, this is rare. Most of the other leak failures appear to be between the concrete end dams and the elastomeric or rubber joint material. Repair of a leaky joint is not generally feasible, therefore, replacement is probably the best alternative.

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.

The following photographs show only examples of the failures. All of the expansion joints in Table C, except the ONFLEX on E-16-KB, have many failures.

PHOTO #7

Structure D-18-BN Near Hudson has Leaking Wabo Alu-Strip Joints. Icicles Can Be Seen Hanging From the Joints in Several Places Under the Bridge.

PHOTO #8

Water is Running Down the Abutment Wall After a Rain. This Water Came Through A Gen Strip 250 Joint On Structure No E-16-KC

TABLE C

EVALUATION OF BRIDGE DECK EXPANSION DEVICES

Expansion Device	Structure Number	Cost Per Lin. Ft.	Leaks	Damage	
				Const.	Snow Plow or Traffic
ONFLEX 45	E-18-AM	$170	Yes		
ONFLEX 45 & 25	E-16-KB	130	No		
GEN STRIP 250	E-16-KC	119	yes	yes	yes
GEN STRIP 250	E-18-AO				
WABO ALU-STRIP (Type IV S400)	D-18-BN	180	yes		
ACME TR 300	E-18-MD	230	yes	upside down	yes
EVAZOTE 50 (Grade PO 72 Gray)	D-16-CW		yes	yes	

CONCLUSION AND RECOMMENDATIONS

The most important factor which will ultimately determine the success of an expansion joint is proper installation during construction. All field measurements taken during this study have shown that attachments and anchors are very important in the final alignment and positioning 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. Careful inspection during installation is essential. Most expansion joints can work effectively if they are installed properly, however, the results of this evaluation, which includes only those devices listed in Table C indicates that ONFLEX has performed reasonably well and is also in the lower price range.

The results of the first interim report of this study (CDH-DTP-R-83-11) showed that Compression joint seals, Acme strip seal, Onflex and Delastiflex performed best of that group shown in Table B of that report.

None of these devices can be classified as acceptable or unacceptable. 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.