

EXPERIMENTAL FEATURES PROJECTS

Category 2

EXPERIMENTAL DECK JOINT SEALS

FINAL REPORT

OREGON DEPARTMENT OF TRANSPORTATION  
HIGHWAY DIVISION  
Research Section

February, 1977

## EXPERIMENTAL DECK JOINT SEALS

### Final Report

#### Introduction

The problems resulting from the failure to obtain durable watertight bridge deck joint seals prompted the Oregon State Highway Division in 1970 to participate in Project 11 of the National Experimental and Evaluation Program. This project was initiated to evaluate both proprietary and nonproprietary deck joint seals on a nationwide basis. Thirty-six states agreed to participate in this study, which promised to save maintenance costs of repairing bridge bearings and other structural elements due to non-functioning deck joint seals. Preventing the loss of esthetics because of unsightly water stains increased the appeal of this study.

In Oregon, the study of bridge deck joint seals consisted of semi-annual inspections of a select group of seals by regional bridge inspectors. These inspections were scheduled for times of extreme weather conditions. The joint seals selected for examination varied from nonproprietary single cell units to elaborate proprietary modular and reinforced molded units.

The single cell seals commonly used in Oregon to accommodate joint openings of 5/8" to 3-3/8" (and joint movements from 0 to 1-3/4") are shown on the drawing "Standard Expansion Joint Details" which is included in this report. These seals were normally supplied by Acme Highway Product Company and the D. S. Brown Company. The Wabo-Maurer "strip-seal" manufactured by Watson Bowman Associates Inc., has also been used for similar joint movements.

When moderate to large deck joint movements were anticipated, multiple unit modular seals and the proprietary Transflex joint seal were used. The areas of joint seal performance appraised during the inspections included: (1) degree of watertightness, (2) effects of traffic and debris on seal durability, and (3) the ability of the seal to provide a smooth quiet ride. A summary of the latest joint seal inspection reports is included in this report.

Additional benefits gained from this inspection program were the repair of minor seal defects by maintenance forces and the early discovery of uncalculated creep of post-tensioned concrete box girder bridges.

#### Observations and Comments

The performance of almost all joint seals inspected during this study was unsatisfactory for one or more reasons. The inspection of single cell seals has shown them to provide a smooth, quiet ride but not a watertight barrier. Leakage has mostly been attributed to debris in the joint causing the displacement of the seal. This destroyed the bond between the seal and the deck and allowed moisture to pass. Generally this damage has occurred in the wheel tracks, but this was not always the case.

Additional leakage was found in joint seal splices and particularly at angle points. Failure to provide adequate termination dams at curbs and at the edge of decks has also resulted in noticeable leakage problems.

The report of joints being filled with debris during each inspection indicated the joint seals were not self-cleaning. The serviceability of many seals would be improved if joints were cleaned by maintenance forces on a periodic basis.

The Wabo-Maurer strip seal which consists of a single neoprene element inserted into a wedge grip extruded steel frame has been rated very satisfactory in providing a watertight seal and a smooth quiet ride.

Several deficiencies have been reported in multiple unit, modular type joint seals. Of the 10 systems inspected, 5 were reported to be leaking. Some of the leakage was blamed on tilting spacer I-bars while debris was cited as the cause for other leakage.

Excessive noise was recorded on 4 sealing systems because of loose spacer I-bars striking the support bar because of wheel induced movement. On an 8 cell modular unit, a hold-down system was installed to eliminate a serious noise problem. This system consisted of a number of rods which were attached to the I-bars at several locations. These rods were bolted through a flat steel spring and channel. The channel was fastened to a transverse steel end beam. The hold-down system greatly reduced the level of noise but it required periodic maintenance.

The proprietary Wabo-Modular Systems have had favorable inspection reports on two projects. Several joints were reported damaged on one project because the actual joint width exceeded the calculated width due to unanticipated prestressed concrete creep. Other modular seals on the same project have functioned well in spite of the joint being full of roadway debris. The Wabo-Modular System has generally provided a smooth, quiet ride as well.

The performance of Transflex joint seals has been rated unsatisfactory at almost all installations for several different reasons. In two cases the joint seals have been damaged by snowplow blades because of poor installation. At another site several Transflex joints on twin structures became loose due to poor construction practices. On the latter project an asphalt concrete wearing surface of variable thickness required an epoxy concrete seat to accomodate the 1-9/16" deep joint seal. "Red Head" concrete anchor bolts were placed in holes drilled into the epoxy concrete for anchorage. Unfortunately, the anchor bolts failed to provide an adequate hold-down which caused the seal to fail. Damage was caused to the adjacent asphalt concrete as well.

The major disadvantage of the Transflex joint is the requirement that a smooth seat be provided on which to set the joint at a desired slope and grade. Epoxy concrete seats which have been used to shim the joint seals have been found to be permeable and to allow water to seep under the seal. Recommendations to improve the performance of the Transflex joint seal include: (1) using a Kwik-Bolt or similar anchor, (2) locating the seal splices outside of the wheel tracks, and (3) carefully protecting the epoxy concrete seat areas with a membrane material.

The advantages of using the Transflex joint seal are: (1) it provides a paving dam against which the wearing surface can be placed directly, (2) the seal is not adversely affected by roadway debris, and (3) this seal generally provides a smooth, quiet ride. Two other similar type joint seals are currently marketed under the trade names of Fel Span and Wabo Flex but no appraisals of these joint seals have been made to date in Oregon.

In addition to inspecting watertight joints, open joints with finger plates were also examined on three structures. These joints allowed water to flow through the joint but provisions were made to control its discharge. In two cases continuous troughs fabricated from 6 gauge galvanized metal were attached to the bottom of the deck below the joints. Water which entered the trough was channeled to a discharge pipe. In two other cases, 6 gauge galvanized metal sheets served to deflect the water going through the joints away from the bridge bearings and into concrete troughs. Both of these systems have been reported to be functioning very well.

Although no specific bid items were received for the various deck joint seals, inquiries of approximate costs were made. Single cell joint seals including armored corners and labor were in the range of \$100 per linear foot as compared to the multiple seal modular and molded reinforced units which range from \$350 to \$550 per linear foot installed.

Present joint seal policy in Oregon allows the continued use of the single cell joint seal for small thermal deck movements. Steps are being taken however to encourage the development of a maintenance cleaning program for bridge deck joints which would reduce seal failures. The Wabo-Maurer strip seals are also being used, especially where large amounts of sanding material is expected.

For large thermal deck movements, the proprietary multiple unit modular seal systems such as the Wabo-Modular System are being specified because of satisfactory past performance.

The "Transflex" type joint seals are now being used mainly on resurfacing and stage construction projects where field joint splicing is necessary. Attention to proper installation practices has been stressed to ensure satisfactory performance.

Bridge Deck Joint Seals Final Summary

STRUCTURE	LOCATION	TYPE OF SEAL	REMARKS
Union Jct. Int. EB. #9635A Hwy. #6	Bent 5	Finger Plate with deflector	Smooth quiet ride - joint is working well.
	Bent 2	Finger Plate with trough	Smooth quiet ride - joint is working well.
Union Jct. Int. WB. #9635 Hwy. #6	Bent 1	Single Seal	Smooth quiet ride - joint leaks slightly at right gutter.
	Bent 5	Finger Plate with deflector	Smooth quiet ride - joint is working well.
Willamette River Bridge (West Linn) #9403 Hwy. #64	Pier 3	Transflex 400	Smooth slightly noisy ride - joint seal leaks.
	Pier 6	Multiple Seal 8 Units	Smooth noisy ride - no leakage. A series of hold-down springs have been installed in an attempt to reduce the noise of the spacer bars. Springs require frequent maintenance.
Eagle Creek Viaduct #9382 Hwy. #2	Bent 8	Finger Plate with trough	Smooth quiet ride - joint is working well.
O'xing UPRR & NB Hwy. #28 (Frazier St.) #9535 Hwy. #8	Near Bent 2	Multiple Seal 2 Units	Smooth quiet ride - joint leaks at end of seal.
	Near Bent 3	Single Seal	Smooth quiet ride - joint leaks at end of seal.

Bridge Deck Joint Seals Final Summary

STRUCTURE	LOCATION	TYPE OF SEAL	REMARKS
Wallowa Lake Int. WB. #9632 Hwy. #6	Bent 1	Single Seal	Smooth quiet ride - joint leaks slightly at left gutter.
	Bent 3	Multiple Seal 2 Units	Smooth quiet ride - joint leaks slightly at left gutter.
Wallowa Lake Int. EB. #9632A Hwy. #6	Bent 1	Single Unit	Smooth quiet ride - joint leaks slightly at right gutter.
	Bent 3	Multiple Seal 2 Units	Smooth quiet ride - joint leaks slightly at right gutter.
U'xing McAlister Lane #9634 Hwy. #6	Abutment 1	Transflex 200A	Due to an unanticipated amount of bridge shortening, the anchor bolts holding the transflex seals have been either cut or have broken.
	Abutment 2	Transflex 200A	Same as above.
Meacham O'xing EB. #8498E Hwy. #6	Bent 2	Transflex 150A	Smooth quiet ride - joint leaks as water seeps under seal through epoxy paving dam and seat. There is some cracking of the caulking compound at the splices.
	Bent 3	Transflex 150A	Same as Bent 2 except joint damaged by snow plow.
	Bent 4	Transflex 150A	Smooth quiet ride - joint leaks as water seeps under seal through epoxy paving dam and seat. There is some cracking of the caulking compound at the splices.
	Bent 5	Transflex 150A	Same as Bent 4 except joint damaged by snow plow.

Bridge Deck Joint Seals Final Summary

STRUCTURE	LOCATION	TYPE OF SEAL	REMARKS
Meacham O'xing WB. #8498W Hwy. #6	Bent 2	Transflex 150A	Smooth quiet ride - joint leaks as water seeps under seal through epoxy paving dam and seat. There is some cracking of the caulking compound at the splices.
	Bent 3	Transflex 150A	Rough noisy ride - joint leaks as seal has been damaged due to failure of anchor bolts. AC is breaking up at the joints as seal moves.
	Bent 4	Transflex 150A	Smooth quiet ride - joint leaks as water seeps under seal through epoxy paving dam and seat. Anchor bolts are loose in two sections and there is some separation at splices.
	Bent 5	Transflex 150A	Smooth quiet ride - joint leaks as water seeps under seal through epoxy paving dam and seat. Anchor bolts are loose in one section and there is some separation at splices.
O'xing Great Northern RR #9692 Hwy. #4	Bent 1	Single Seal	Smooth quiet ride. There is minor leakage along 70% of the joint due to debris.
U'xing Riverside Drive #9693 Hwy. #4	Bent 1	Multiple Seal 2 Units	Smooth quiet ride. Minor leakage in wheel tracks due to debris.
Siletz River Bridge #9906 Hwy. #9	Abutment 1	Transflex 400A	Smooth quiet ride - no leakage.
	Abutment 2	Transflex 400A	Slightly noisy and slightly rough ride - no leakage.
Snake River Bridge #4412A Hwy. #450	Pier 4	Wabo Maurer SB-400	Smooth quiet ride - no leakage.

Bridge Deck Joint Seals Final Summary

STRUCTURE	LOCATION	TYPE OF SEAL	REMARKS
Campbell St. Int. #9515 Hwy. #6	Bent 2	Single Seal Type F	Smooth quiet ride - joints leaks quite badly due to seal being displaced by debris.
	Bent 3	Single Seal Type F	Smooth quiet ride - no leakage on fixed end.
Campbell St. Int. #9515A Hwy. #6	Bent 2	Single Seal Type F	Smooth quiet ride - joint leaks quite badly due to seal being displaced by debris.
	Bent 3	Single Seal Type F	Smooth quiet ride - no leakage on fixed end.
U'xing Cove Ave. #9633 Hwy. #6	Bent 2	Single Seal Type F	Smooth quiet ride - joint leaks due to opening exceeding maximum allowable width during cold weather.
	Bent 4	Single Seal Type F	Same as Bent 2.
S. Santiam River Bridge (Sanderson) #1771A Hwy. #211	Pier 2	Wabo Maurer D-520 - 2 Units	Smooth quiet ride - no leakage.
	Pier 5	Wabo Maurer D-260 - Single	Smooth quiet ride - no leakage.
	Pier 8	Single Seal Type F	Smooth quiet ride - no leakage.

Bridge Deck Joint Seals Final Summary

STRUCTURE	LOCATION	TYPE OF SEAL	REMARKS
Willamette River Bridge at Albany #9806 Hwy. #31.	Abutment 2	Single Seal	Smooth quiet ride - joint is full of sanding material but is not leaking.
	Pier 7	Multiple Seal Triple Unit	Smooth slightly noisy ride caused by deflecting I-bars - joint is full of sanding material but is not leaking.
U'xing Johnson Rd. #9736 Hwy. #64	Bent 2	Multiple Seal 2 Units	Smooth quiet ride - no leakage.
	Bent 4	Multiple Seal 2 Units	Smooth quiet ride - no leakage.
Tualatin River Bridge NB. #9737 Hwy. #64	Bent 4	Multiple Seal 2 Units	Smooth slightly noisy ride - joint leaks due to being displaced by debris.
Tualatin River Bridge SB. #9737A Hwy. #64	Bent 4	Multiple Seal 2 Units	Smooth slightly noisy ride - joint leaks due to being displaced by debris.
O'xing Hwy. 1 #9743B Hwy. #64	Bent 5	Multiple Seal 3 Units	Smooth slightly noisy ride - no leakage.
U'xing Sunset Avenue #9723 Hwy. #64	Abutment 1	Single Seal	Smooth quiet ride - slight joint leakage at angle point in sidewalk.
	Abutment 2	Single Seal	Same as Abutment 1.

STRUCTURE	LOCATION	TYPE OF SEAL	REMARKS
1st to 7th Viaduct #9600 Hwy. #227	30' ahead of Bent L3	Wabo Maurer 3 Seals	Smooth quiet ride - joint leaks.*(1)
	15' back of Bent WN5 (WN4-5)	Wabo Maurer 2 Seals	Smooth quiet ride - no leakage. (1)
	15' back of Bent WN5 (6th on - WN5)	Wabo Maurer Single Seal	Smooth quiet ride - no leakage. (1)
	15' back of Bent JF5 (JF4-5)	Wabo Maurer Single Seal	Smooth quiet ride - joint leaks.*(1)
	15' back of Bent JF5 (6th off - JF5)	Wabo Maurer 2 Seals	Smooth quiet ride - joint leaks.*(1)
	20" back of Bent WN7 (WN6-7)	Wabo Maurer Single Seal	Smooth quiet ride - no leakage. (1)
	20' back of Bent JF7 (JF6-7)	Wabo Maurer Single Seal	Smooth quiet ride - no leakage. (1)
	30' ahead of Bent JF9 (JF8-9)	Wabo Maurer 2 Seals	Smooth quiet ride - joint leaks.*(1)
	30' ahead of Bent WN9 (WN8-9)	Wabo Maurer 2 Seals	Smooth quiet ride - joint leaks.*(1)

\* Some leakage occurred when excessive creep opened the joints beyond their calculated width.  
 (1) All joints are full of sanding material.

Bridge Deck Joint Seals Final Summary

STRUCTURE	LOCATION	TYPE OF SEAL	REMARKS
O'xing 92nd Ave. #9711 Hwy. #64	Bent 1	Wabo Maurer D-260 - Single	Smooth quiet ride - no leakage.
	Bent 4	Wabo Maurer D-260 - Single	Same as Bent 1.
O'xing 92nd Ave. #9711A Hwy. #64	Bent 1	Wabo Maurer D-260 - Single	Smooth quiet ride - no leakage.
	Bent 4	Wabo Maurer D-260 - Single	Same as Bent 1.
Goshen O'xing #6836A Hwy. #1	Bent 5	Transflex 150A	Smooth quiet ride - joint leaks at seal splice and under seal due to porous epoxy seat.
Grande Ronde River and Ore Dell O'xing #8431A Hwy. #66	Bent 1	Single Seal	Smooth quiet ride - joint leaks due to being depressed by debris.
	Bent 4	Single Seal	Smooth quiet ride - joint leaks due to being depressed by debris.



**DIMENSIONS FOR ALTERNATE 1 BRIDGE SEAL**

TYPE	WIDTH	DEPTH	THICKNESS
B	1 1/2" ± 0.05"	2 1/2" ± 0.02"	1/4" ± 0.01"
C	2" ± 0.05"	2 1/2" ± 0.02"	1/4" ± 0.01"
D	2 1/2" ± 0.05"	2 1/2" ± 0.02"	1/4" ± 0.01"
E	3" ± 0.05"	2 1/2" ± 0.02"	1/4" ± 0.01"
F	4" ± 0.05"	2 1/2" ± 0.02"	1/4" ± 0.01"

**DIMENSIONS FOR ALTERNATE 2 BRIDGE SEAL**

TYPE	WIDTH	DEPTH	THICKNESS
B	1 1/2" ± 0.05"	2 1/2" ± 0.02"	1/4" ± 0.01"
C	2" ± 0.05"	2 1/2" ± 0.02"	1/4" ± 0.01"
D	2 1/2" ± 0.05"	2 1/2" ± 0.02"	1/4" ± 0.01"
E	3" ± 0.05"	2 1/2" ± 0.02"	1/4" ± 0.01"
F	4" ± 0.05"	2 1/2" ± 0.02"	1/4" ± 0.01"

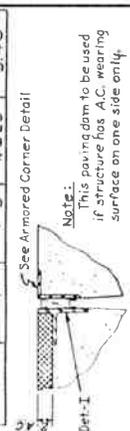
**DIMENSIONS FOR ALTERNATE 3 BRIDGE SEAL**

TYPE	WIDTH	DEPTH	THICKNESS
B	1 1/2" ± 0.05"	2 1/2" ± 0.02"	1/4" ± 0.01"
C	2" ± 0.05"	2 1/2" ± 0.02"	1/4" ± 0.01"
D	2 1/2" ± 0.05"	2 1/2" ± 0.02"	1/4" ± 0.01"
E	3" ± 0.05"	2 1/2" ± 0.02"	1/4" ± 0.01"
F	4" ± 0.05"	2 1/2" ± 0.02"	1/4" ± 0.01"

**NOTE:**  
 1. Minimum dimension: Force shall not exceed 50 lbs per linear inch.  
 2. Maximum dimension: Force shall not exceed 10 lbs per linear inch.  
 3. Web Shell tolerance not needed as Force-Deflection criterion assures compliance within parameter of Movement Category.

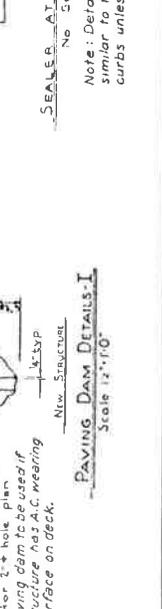
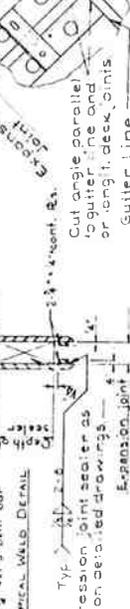
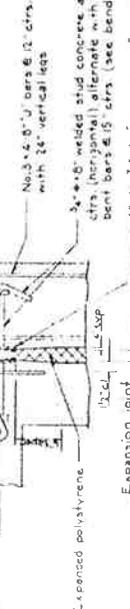
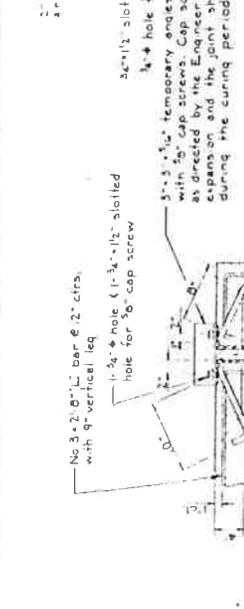
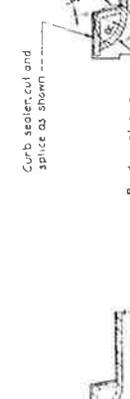
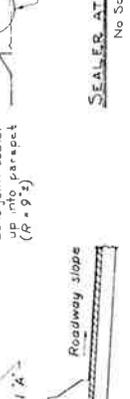
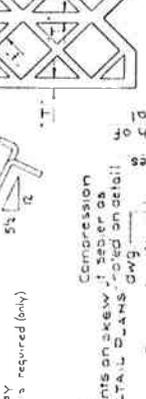
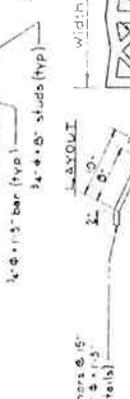
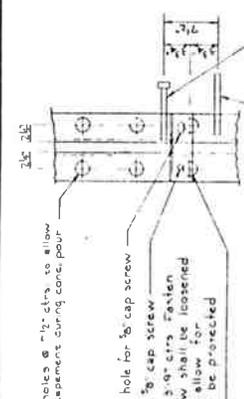
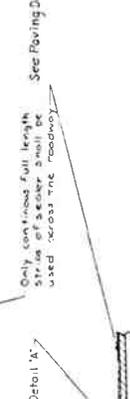
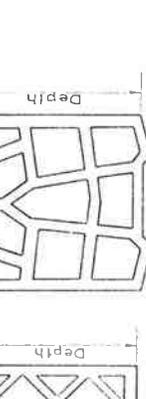
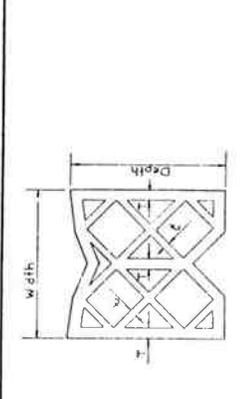
**DIMENSIONS FOR ALTERNATE 3 BRIDGE SEAL**

TYPE	SEAL SIZE	DEPTH	MINIMUM MAXIMUM
B	1 1/2"	2 1/2"	1.487"
C	2"	2 1/2"	1.70"
D	2 1/2"	2 1/2"	1.92"
E	3"	2 1/2"	2.15"
F	4"	2 1/2"	2.40"



**PAVING DAM DETAILS-II**

DATE	REVISION	BY	CHKD
10/20/50	1	W. J. ...	...
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**NOTE:**  
 1. All steel to be A.S.T.M. Specification A-36.  
 2. Expansion joint sealers as shown on detailed drawings.  
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 88. Expansion joint sealers as shown on detailed drawings.  
 89. Expansion joint sealers as shown on detailed drawings.  
 90. Expansion joint sealers as shown on detailed drawings.  
 91. Expansion joint sealers as shown on detailed drawings.  
 92. Expansion joint sealers as shown on detailed drawings.  
 93. Expansion joint sealers as shown on detailed drawings.  
 94. Expansion joint sealers as shown on detailed drawings.  
 95. Expansion joint sealers as shown on detailed drawings.  
 96. Expansion joint sealers as shown on detailed drawings.  
 97. Expansion joint sealers as shown on detailed drawings.  
 98. Expansion joint sealers as shown on detailed drawings.  
 99. Expansion joint sealers as shown on detailed drawings.  
 100. Expansion joint sealers as shown on detailed drawings.