EVALUATION OF VARIOUS BRIDGE DECK JOINT SEALING SYSTEMS

Progress Report

MICHIGAN
RESEARCH LABORATORY SECTION

MICHIGAN DEPARTMENT OF
STATE HIGHWAYS AND TRANSPORTATION

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F. J. Bashore

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Introduction

This progress report covers the performance of six sealing systems on 64 bridge structures, being a total of 98 joint installations. These systems were installed from 1971 through 1973 and consist of three general types: metal reinforced polychloroprene pads (Figs. 1 through 3); metal supported and anchored polychloroprene extrusions (Figs. 4 through 7); and, modular polychloroprene compression seals (Fig. 8).

General Information

Installation Costs - The cost for each system may vary considerably depending upon the construction firm, and whether it is for new construction or maintenance reconstruction. The following are Michigan's installed costs for the systems under study:

System	Type	Average cost per lin ft, dollars
Transflex (Fig. 1)	200	96
	250	112
Waboflex SR (Fig. 2)	SR2	100
	SR2.5	122
Fel-Span (Fig. 3)	T30	102
	T40	138
Delastiflex (Fig. 5)	DL300	200
Type 190 (Fig. 6)	2	232
Wabo-Maurer Strip Seal (Fig. 7)	SB200	100
Modular Compression (Fig. 8)	Single	150
	Double	200
	Triple	230

De-Icing Operations - Normally, de-icing operations are necessary from 30 to 35 times a year. Each storm may require from one to three applications of de-icing chemicals. Sodium chloride or calcium chloride, either alone or mixed with sand, are used as de-icing agents. The following data represent the total precipitation for 1972. The numbers in the middle column are those assigned to counties, and listed in alphabetical order. These numbers appear as the first two digits in the five-digit portion of each structure number, except for county secondary structures where the first two digits indicate the county (Tables 1 through 7).

Area	Counties In Area	Precipitation, in.
Battle Creek	13	35.46
Detroit	50, 63, 82	31.66
Grand Rapids	03, 41, 70	37.38
Lansing	19, 23	37.38

Problems Encountered with Bridge Joint Systems

The following are the most frequently encountered problems experienced with the systems under study. It should be noted that many of these problems can be attributed to improper installation procedures.

1) Transflex System

   a) Loss of stud hole plugs.
   b) Vertical area between seal and concrete not properly sealed. This may be only a cosmetic problem.
   c) Joints between sections not abutted tightly or properly sealed.
   d) Seal too high making it vulnerable to damage by snow removal equipment.
   e) Seal too low causing a rough and noisy ride.
   f) Misaligned and tilted sections.
   g) Water leakage.

2) Waboflex SR

   a) Sections of seal misaligned vertically and horizontally (Figs. 9 and 10).
   b) Sections not tightly abutted (Fig. 10).

3) Fel-Span System

   a) Joints between seal sections improperly filled (cosmetic in nature).
   b) Some stud holes improperly filled.

4) Delastiflex System

a) Debris intrusion between neoprene seal and aluminum outside frame (Fig. 11).
b) Debris intrusion between neoprene seal extrusions.

The outside frame of the systems installed in 1973 was modified to prevent condition a).

5) Type 190 (Michigan modified Wabo-Maurer)

No problems encountered for the two installations.

6) Wabo-Maurer Strip Seal

The only problem encountered was a poor manufacturer's splice which had partially failed when installed. The splice will be impossible to observe since it is hidden in a sidewalk area.

7) Modular Compression System

a) Uneven degree of compression between seal elements (Fig. 12).
b) Vertical misalignment of steel elements.
c) Uneven depth of compression seals in relation to top of steel elements.

Ratings and Observations

Tables 1 through 7 list the structures and information on the expansion joint devices, including the latest inspection ratings up to July 1, 1975. The following explanations and definitions are given to aid in interpreting the tabulated data.

Joint

Actual Movement - Joint movement based on the difference in joint width measurements at two widely different temperatures and calculated for a temperature range of 150 F.

Model - When defined numerically, it may indicate the amount of movement the system is capable of handling (Example: 'Fel-Span T 30' handles 3 in. of movement). For a modular compression seal system, the number indicates the number of compression seals used.

Ratings

General Appearance - A visual rating of the sealing system (not necessarily an indication of ability to perform).

a) Good: only minor irregularities.
b) Fair: irregularities such as small voids in mastic, slight dirt intrusion, slight misalignment of sections, some missing stud hole plugs, or slight wear due to traffic.
c) Poor: serious irregularities such as excessive wear or damage; joints in material improperly abutted, sealed, or aligned; excessive dirt intrusion; or large voids in mastic.

Joints in System - Joints formed by the abutting of sections in the sealing system.

a) Good: closely abutted, no misalignment, and properly sealed.
b) Fair: closely abutted, some voids in mastic, slight misalignment, or slight dirt intrusion.
c) Poor: not closely abutted, considerable misalignment, major voids in mastic or extensive dirt intrusion.

Intruded Debris - Incompressible materials present between seal and concrete or armor and/or within joints in material.

Leaks - Passage of water through joint area.

a) Slight: moisture visible on underside of joint area but not to extent of dripping.
b) Significant: water observed dripping from joint area.

Traffic Wear - Visible wear due to tires or snow removal equipment.

Ride

1) Quality - smoothness of ride over joint.

a) Good: smooth ride.
b) Fair: slight discomfort.
c) Poor: considerable discomfort.

2) Noise

a) Quiet: little noise generated.
b) Moderate: significant but not excessive noise.
c) Noisy: excessive noise generated.

Summary

The experimental systems provide a more watertight seal than the sliding plate device formerly used for movements greater than 1.8 in. (the maximum movement accommodated by a 4-in. neoprene compression seal).

The following problems have been evident with the metal-reinforced neoprene pad type systems:

1) These systems are produced in 4 or 6-ft sections requiring sealing between them. The Transflex system has a seepage-type leak at most joints between sections. At the time the data were compiled for this report, there was insufficient information on Waboflex installations to comment on them except to state that the same problem is anticipated because the jointing system is similar. The Fel-Span system has an overlap jointing design which has been watertight for the installations inspected to date (Figs. 13 and 14). In many instances, the block-outs formed in the concrete to receive the above types, have been inaccurately constructed, making alignment and joining of these systems very difficult.

2) A major source of leakage has been at the curbline where the systems have been mitered and butt-jointed in the field. The use of mastic-type sealants to waterproof these butt joints has been generally ineffective. Some of the newer installations have shop fabricated curb sections which are performing much better.

3) Damage by snow removal equipment has occurred on all types. Several Transflex systems have had the neoprene removed down to the steel reinforcement (Figs. 15 and 16) and one Waboflex SR system had a section so severely damaged that replacement was required. Some of those severely damaged were placed flush with the deck surface which, no doubt, was a factor affecting the severity of damage. The Fel-Span system has received only superficial damage to date, possibly because there is a thick section of neoprene above the steel reinforcement to absorb shock.

4) All of the metal reinforced neoprene pad systems are held in place by studs anchored into the deck. Therefore, all have stud holes in the pads which must be sealed to protect the studs from corrosion. The Transflex and Waboflex systems have neoprene plugs which are inserted with an adhesive to help hold them in place. A significant number of these have come out. Studs being set too high or too close to the ends of the oblong slot have been contributing factors in causing some of them to come out.

Stud holes in the Fel-Span system are filled with a flexible epoxy which has been generally more effective. An annular groove in the cavity is designed to lock the epoxy in place. Another factor is a greater expanse of neoprene around the cavity, thus decreasing the amount of flexing of the cavity walls under traffic.

The Delastiflex DL installations have shown a tendency to collect debris at the juncture between the neoprene extrusions for all installations and between the neoprene extrusions and the aluminum frame for the older installations before the aluminum side frame was modified to prevent this condition. The collection of debris will be closely watched to determine whether this current cosmetic defect eventually causes any type of failure of the system. In some early installations, leaks developed where the seal tabs had not been fully inserted into the cavities of the supporting aluminum extrusions.

The Delastiflex MT series differs from the above in that a single neoprene extrusion is used and no moving supporting rails are necessary. The neoprene extrusion is installed in the same manner as the DL series with locking tabs which are inserted into aluminum extrusions. There have been no problems noted for the two installations which have been in service less than one year.

The modular neoprene compression seal systems have been relatively trouble free. No damage by snow removal equipment has been noted and leakage has been minimal.

There are two Type 190 (Michigan modified Wabo-Maurer) systems and two Wabo-Maurer Strip Seal installations. There have been no problems reported for these installations.

Recommendations

While all experimental systems are capable of providing a more watertight seal than the sliding plate system, the following recommendations should be considered for future installations.

1) The surface of the recess to which the pad type systems are bolted should be carefully surfaced with epoxy mortar if the as-cast surface is not reasonably perfect. Sand blasting of the recess should precede patching and/or placement of the pads.

2) All pads should be cleaned with solvent and bedded in a flexible epoxy bedding compound. Joining surfaces between pad units should be cleaned with solvent before the specified adhesive or sealant is applied.

3) Pads that are joined with a tongue-and-groove system should be jacked in place so that the joint is under compression as recommended by the manufacturer.

4) The use of rubber plugs to fill stud holes in the pad type systems should be discontinued and flexible epoxy be used instead. The holes should be solvent cleaned before filling.

5) Flexible epoxy or epoxy mortar should be used to fill the groove between the block-out wall and the pad for pad type devices. This would give more protection to the concrete edge and would absorb compressive forces when the device goes into compression.

6) Future installations of modular compression seal systems should incorporate design features which prevent rotation or vertical movement of the I-beams which separate the compression seals. While no damage by snow removal equipment has occurred, there is a real danger that a scraper blade could severely damage systems where these I-beams have risen above the deck surface.

TABLE 1
TRANSFLEX JOINT SYSTEM SURVEY

Bridge						Joint								Ratings							Comments
Number	Spans		Location	ADT	PCV	No.	Skew Angle, deg	Contributing Length, ft	Theoretical Movement, in.	Actual Movement, in.	Model	Date Sealed	Depth, in.	General Appearance	Joints in System	Intruded Debris	Leaks	Traffic Wear	Ride		
	No.	Total Length, ft																	Quality	Noise	
S01-41133	1	134	Rural	---	--	1	0	134	1.67	1.78	200A	1971	+	Fair	Good	None	---	Yes	Good	Quiet	Damage by snow removal equipment
S02-41133	1	134	Rural	---	--	1	0	134	1.67	2.06	200A	1971	+	Poor	Good	None	---	Yes	Good	Mod.	Extensive damage by snow removal equipment
S04-41133	3	177	Rural	---	--	1	53	106	1.32	0.86	200A	1971	0.34	Good	Good	None	---	None	Mod.	Good	
S05-41133	3	187	Rural	---	--	1	55	106	1.32	0.81	200A	1971	0.32	Good	Good	None	---	None	Mod.	Good	
S02-19043	5	472	Rural	2000	10	2	30	150	1.87	1.76	200A	9-72	0.34	Good	Good	None	No	None	Good	Quiet	
						5	30	249	3.11	2.14	400A	9-72	0.34	Good	Good	None	Sign.	None	Good	Quiet	Two leaks
S05-19043	2	253	Rural	25,000	19	2	0	253	3.16	2.02	400A	8-72	0.25	Good	Good	None	Sign.	None	Good	Quiet	Several leaks. Several missing stud hole plugs
S10-63103	2	200	Urban	---	--	2	2	200	2.50	1.65	250	6-72	0.32	Fair	Fair	None	Slight	Yes	Good	Quiet	Excessive spalling, missing stud hole plugs, separation at joints
S11-63103	2	196	Urban	---	--	2	0	197	2.46	1.96	250	5-72	0.62	Good	Fair	None	Sign.	None	Rough	Mod.	Separation at joints causing leaks. Rough ride due to excessive depth.
S12-63103	2	172	Urban	---	--	2	1	172	2.15	1.79	250	11-71	+	Good	Fair	None	Slight	Yes	Good	Quiet	Excessive spalling, separation at joints
S13-63103	2	241	Urban	---	--	2	39	179	2.24	1.81	400A	8-72	0.10	Good	Fair	None	Slight	None	Good	Quiet	Snow removal equipment damage, separation at joints, missing stud hole plugs, poorly sealed between seal and concrete, short section placed with no tongue and groove.
S14-63103	2	172	Urban	---	--	1	0	172	2.15	1.91	250	10-72	0.28	Good	Good	None	Slight	None	Good	Quiet	
S01-50061	2	172	Urban	---	--	1	0	172	2.15	1.99	250	11-72	0.26	Good	Good	None	---	None	Good	Quiet	
S01-70024	2	250	Rural	---	--	1	18	238	2.98	1.75	400A	10-72	0.05	Good	Good	None	---	None	---	---	
S12-03035	1	121	Rural	---	--	1	42	90	1.13	0.67	200A	5-73	0.11	Good	Good	None	---	None	---	---	
S08-03035	1	121	Rural	---	--	1	39	94	1.18	0.81	200A	5-73	0.12	Good	Good	None	---	None	---	---	
S07-63191	4	262	Urban	---	--	2	12	131	1.63	--	200A	9-72	--	Good	Good	None	No	None	---	---	
						4	11	127	1.59	--	200A	9-72	--	Good	Good	None	Sign.	None	---	---	Bad leak at centerline between concrete and steel
S05-63103	5	670	Urban	---	--	2	3	392	4.90	3.70	650	6-72	0.40	Good	Good	None	No	None	---	---	
						5	3	255	3.19	3.54	400A	7-72	0.27	Good	Good	None	No	None	---	---	
S02-41029	3	203	Urban	---	--	3	24	181	2.26	1.41	200	10-72	0.15	Good	Good	None	---	None	---	---	
S22-41029	2	240	Rural	---	--	2	2	240	3.00	1.17	400A	11-72	0.56	Fair	Fair	None	---	None	---	---	
S13-70024	4	279	Rural	---	--	1	24	128	1.60	0.93	200A	4-73	0.15	Good	Good	None	---	None	---	---	
						3	24	128	1.60	1.13	200A	4-73	0.12	Good	Good	None	---	None	---	---	
S11-70024	3	125	Rural	---	--	1	28	111	1.38	1.14	200A	1973	0.21	Good	Good	None	---	None	---	---	
S12-70024	3	130	Rural	---	--	2	42	90	1.13	0.94	200A	5-73	0.32	Good	Good	None	---	None	---	---	
S03-70024	2	258	Rural	---	--	2	18	245	3.07	0.94	400A	6-73	0.16	Good	Good	None	---	None	---	---	
B03-82053	2	124	Urban	19,000	9	1	0	62	0.78	0.14	200A	1972	F	Poor	Poor	None	Slight	Yes	Rough	Noisy	Snow removal equipment damage on some of the joints has caused the following: loss of stud hole plugs, neoprene removed to depth of steel, joint face armour damaged extensively See Figs. 15 and 16.
						2	0	0	0	0.27	200A	1972	+	Fair	Good	None	Slight	Yes	Mod.	Mod.	
						3	0	62	0.78	0.59	200A	1972	+	Poor	Good	None	Slight	Yes	Rough	Noisy	
						4	0	62	0.78	0.17	200A	1972	0.05	Fair	Fair	None	Slight	None	Mod.	Mod.	
						5	0	0	0	0.21	200A	1972	+	Good	Good	None	Slight	None	Good	Quiet	
						6	0	62	0.78	0.20	200A	1972	0.05	Fair	Fair	None	Slight	None	Good	Quiet	

TABLE 1 (Cont.)
TRANSFLEX JOINT SYSTEM SURVEY

Bridge Number	Bridge Spans No.	Bridge Spans Total Length, ft	Bridge Location	Bridge ADT	Bridge PCV	Joint No.	Joint Skew Angle, deg	Joint Contributing Length, ft	Joint Theoretical Movement, in.	Joint Actual Movement, in.	Joint Model	Joint Date Sealed	Joint Depth, in.	Ratings General Appearance	Ratings Joints in System	Ratings Intruded Debris	Ratings Leaks	Ratings Traffic Wear	Ratings Ride Quality	Ratings Ride Noise	Comments
S24-82123	2	228	Urban	---	--	2	21	226	2.82	2.00	250	7-72	0.37	Good	Fair	None	Sign.	None	Good	Quiet	Sections in the material are not tightly butted
S01-82122	3	377	Urban	---	--	2	45	107	1.34	0.88	250	5-72	0.24	Good	Good	None	Slight	Yes	Mod.	Mod.	
						3	45	159	1.99	0.99	250	5-72	0.36	Good	Good	None	Slight	None	Mod.	Mod.	
S19-82122	2	166	Urban	---	--	10	0	165	2.06	1.12	200A	1972	0.22	Good	Good	None	Slight	None	Good	Quiet	
						13	0	165	2.06	1.33	200A	1972	0.12	Good	Good	None	Slight	None	Good	Quiet	
S20-82122	2	239	Urban	---	--	2	6	239	2.99	2.15	250	7-72	0.21	Good	Good	None	Slight	None	Good	Quiet	
S21-82122	2	130	Urban	---	--	2	2	231	2.88	2.21	400A	5-72	0.22	Good	Good	None	Slight	None	Good	Quiet	Snow removal equipment damage has exposed steel
						5	2	231	2.88	1.87	400A	6-72	0.30	Good	Good	None	None	None	Good	Quiet	
						7	2	231	2.88	1.87	400A	5-72	0.25	Good	Good	None	None	None	Good	Quiet	
						8	2	231	2.88	2.05	400A	6-72	0.30	Good	Good	None	None	None	Good	Quiet	
S06-82081	2	234	Urban	58,000	12	2	6	233	2.91	2.24	250	1972	0.05	Fair	Poor	None	Slight	Yes	Good	Quiet	Excessive separation of joints in material, badly spalled
						5	6	233	2.91	2.21	250	1972	0.60	Good	Fair	None	Slight	Yes	Rough	Noisy	
S02-81063	4	354	Urban	53,500	14	2	48	177	2.21	1.70	200A	9-72	0.45	Good	Good	None	Slight	None	Rough	Mod.	
						4	48	177	2.21	1.30	200A	10-72	0.28	Good	Good	None	Slight	None	Rough	Mod.	
S03-41133	2	252	Rural	---	--	1	0	252	3.15	--	400A	1972	0.56	Fair	Fair	None	None	None	Rough	Mod.	
S10-63191	5	399	Rural	---	--	2	2	157	1.96	--	250	10-72	0.14	Good	Fair	None	---	None	Rough	Quiet	
						4	2	242	3.03	--	250	10-72	0.40	Good	Fair	None	---	None	Rough	Quiet	
S02-63191	3	232	Rural	---	--	1	39	156	1.95	--	250	5-73	0.08	Good	Good	None	---	None	Good	Quiet	
S09-63191	5	421	Rural	---	--	2	18	160	2.00	--	250	10-73	0.10	Good	Good	None	---	None	Good	Quiet	
						3	18	240	3.00	--	250	10-73	0.14	Good	Good	None	---	None	Good	Quiet	
S36-82022	4	184	Urban	---	--	1	15	89	1.11	--	200A	----	0.08	Good	Fair	None	---	None	Good	Quiet	
S07-82191	4	193	Rural	---	--	2	7	131	1.64	--	200A	8-72	0.10	Good	Fair	None	---	Yes	Good	Quiet	

TABLE 2
WABOFLEX SR JOINT SYSTEM SURVEY

Bridge Number	Bridge Spans No.	Bridge Spans Total Length, ft	Bridge Location	Bridge ADT	Bridge PCV	Joint No.	Joint Skew Angle, deg	Joint Contributing Length, ft	Joint Theoretical Movement, in.	Joint Actual Movement, in.	Joint Model	Joint Date Sealed	Joint Depth, in.	Ratings General Appearance	Ratings Joints in System	Ratings Intruded Debris	Ratings Leaks	Ratings Traffic Wear	Ratings Ride Quality	Ratings Ride Noise	Comments
S06-03035	2	244	Rural	---	--	2	4	241	3.02	1.40	SR4	11-72	0.24	Fair	Good	None	---	None	---	---	
CS 82-240	3	156	Urban	14,000	8	1	30	94	1.18	0.81	SR2.5	7-73	0.33	Poor	Poor	None	---	Yes	Good	Quiet	Aluminum shows same traffic wear, sections are misaligned horizontally and vertically and are not abutted tightly. See Figs. 9 and 10.

TABLE 3
FEL-SPAN JOINT SYSTEM SURVEY

Bridge						Joint								Ratings							
Number	Spans		Location	ADT	PCV	No.	Skew Angle, deg	Contributing Length, ft	Theoretical Movement, in.	Actual Movement, in.	Model	Date Sealed	Depth, in.	General Appearance	Joints in System	Intruded Debris	Leaks	Traffic Wear	Ride		Comments
	No.	Total Length, ft																	Quality	Noise	
B01-23152	3	269	Rural	3,100	13	1	0	268	3.36	2.32	T30	4-73	0.42	Fair	Poor	None	---	None	Mod.	Mod.	
B01-11016	8	644	Rural	---	--	2	10	252	3.16	--	T40	6-73	0.23	Good	Fair	None	---	None	Good	Quiet	
S08-13082	4	238	Rural	22,600	25	5	1	129	1.61	1.50	T30	8-72	0.50	Good	Good	None	None	None	Rough	Quiet	Poor approach is causing rough ride
S06-13092	4	258	Rural	22,600	25	1	4	128	1.60	1.13	T30	8-72	0.36	Good	Good	None	None	None	Mod.	Quiet	Slight damage by snow removal equipment, performance not affected.
B01-13082	4	275	Rural	22,000	25	7	30	138	1.71	0.95	T30	9-72	0.27	Good	Fair	None	None	None	Good	Quiet	
B01-50021	2	90	Rural	---	--	2	20	80	1.00	--	T30	1973	0.24	Good	Good	---	---	---	Good	Quiet	
S07-80023	4	243	Rural	---	--	1	21	113	1.42	--	T30	1973	0.28	Good	Good	None	None	None	Good	Quiet	

TABLE 4
DELASTIFLEX JOINT SYSTEM SURVEY

Bridge						Joint								Ratings							
Number	Spans		Location	ADT	PCV	No.	Skew Angle, deg	Contributing Length, ft	Theoretical Movement, in.	Actual Movement, in.	Model	Date Sealed	Depth, in.	General Appearance	Joints in System	Intruded Debris	Leaks	Traffic Wear	Ride		Comments
	No.	Total Length, ft																	Quality	Noise	
S04-19022	4	248	Rural	1,600	13	1	17	118	1.48	1.07	DL300	6-73	0.20	Good	Good	None	None	None	Good	Quiet	Damage by snow removal equipment to seal and section of aluminum, See Fig. 17.
S01-13081	4	330	Rural	21,000	25	5	37	130	1.62	1.00	DL300	1972	0.05	Good	Fair	Yes	None	None	Good	Quiet	Joint has been resealed, some dirt intrusion between seal and aluminum frame and in center joint of material.
S09-82112	4	171	Urban	---	--	2	15	82	1.02	1.22	DL300	10-72	F	Fair	Fair	Yes	None	None	Good	Quiet	Dirt intrusion between seal and aluminum. See Figs. 11 and 18.
						4	15	82	1.02	1.56	DL300	10-72	F	Fair	Fair	Yes	None	None	Good	Quiet	
S03-82024	4	237	Urban	---	--	2	5	118	1.48	1.22	DL300	10-72	--	Fair	Fair	Yes	---	None	Good	Mod.	Dirt intrusion between seal and aluminum
S06-13083	4	227	Rural	---	--	1	0	114	1.42	--	MT300	1973	F	Good	None	None	None	None	Good	Quiet	
						2	0	114	1.42	--	MT300	1973	F	Good	None	None	None	None	Good	Quiet	

TABLE 5
MODULAR COMPRESSION JOINT SYSTEMS SURVEY

Bridge						Joint								Ratings							
Number	Spans		Location	ADT	PCV	No.	Skew Angle, deg	Contributing Length, ft	Theoretical Movement, in.	Actual Movement, in.	Model	Date Sealed	Depth, in.	General Appearance	Joints in System	Intruded Debris	Leaks	Traffic Wear	Ride		Comments
	No.	Total Length, ft																	Quality	Noise	
S12-82293	6	694	Rural	---	--	3	25	271	3.39	2.80	Triple	1971	—	Good	None	None	---	None	Rough	Noisy	Center steel rail 0.3 in. higher than edge rails
						5	25	254	3.17	2.46	Triple	1971	--	Good	None	None	---	None	Mod.	Mod.	
S22-82122	4	277	Urban	---	--	2	0	137	1.71	1.27	Double	1972	—	Good	None	None	None	None	Good	Quiet	Uneven compression between neoprene seals.
						4	0	137	1.71	1.15	Double	1972	--	Good	None	None	None	None	Good	Quiet	See Fig. 12.
S23-82122	4	382	Urban	---	--	2	38	203	2.54	1.13	Double	1972	—	Good	None	None	None	None	Good	Quiet	
						4	38	178	2.23	1.53	Double	1972	—	Good	None	None	None	None	Good	Quiet	
S13-82123	4	331	Urban	---	--	2	37	89	1.11	0.87	Single	1971	--	Good	None	None	None	None	Good	Quiet	
						3	37	153	1.91	1.00	Double	1971	--	Good	None	None	None	None	Good	Quiet	Uneven compression between neoprene seals.
						4	37	89	1.11	0.59	Single	1971	--	Good	None	None	None	None	Good	Quiet	Seal is pushed down to 1.45-in. below top of steel in places
S12-82123	4	281	Urban	---	--	2	20	118	1.48	0.94	Double	1971	—	Good	None	None	None	None	Good	Quiet	
						4	20	118	1.48	0.81	Double	1971	--	Good	None	None	Slight	None	Good	Quiet	Leaks at centerline
S14-82123	4	286	Urban	---	--	2	15	143	1.79	1.23	Double	1971	--	Good	None	None	None	None	Good	Quiet	
						4	15	143	1.79	1.26	Double	1971	--	Good	None	None	Sign.	None	Good	Quiet	Bad leak at centerline where longitudinal seal cuts through modular system
S15-82123	4	264	Urban	---	--	2	13	78	0.98	0.75	Single	1971	--	Good	None	None	---	None	Good	Quiet	
						3	13	130	1.63	1.04	Double	1971	--	Good	None	None	---	None	Good	Quiet	
						4	13	75	0.94	0.79	Single	1971	--	Good	None	None	---	None	Good	Quiet	
S16-82123	4	392	Urban	---	--	2	45	141	1.76	1.33	Double	1971	--	Good	None	None	Slight	None	Good	Quiet	
						4	45	141	1.76	1.33	Double	1971	—	Good	None	None	None	None	Good	Quiet	
S17-82123	4	305	Urban	---	--	2	7	153	1.91	1.88	Double	1972	--	Good	None	None	Slight	None	Good	Quiet	
						4	7	150	1.88	1.25	Double	1972	--	Good	None	None	None	None	Good	Quiet	
S18-82123	4	303	Urban	---	--	2	2	150	1.87	1.09	Double	1971	--	Good	None	None	---	None	Good	Quiet	
						4	2	154	1.92	2.08	Double	1971	--	Good	None	None	---	None	Good	Quiet	

TABLE 6
TYPE 190 JOINT SYSTEM SURVEY

Bridge						Joint								Ratings							Comments
Number	Spans		Location	ADT	PCV	No.	Skew Angle, deg	Contributing Length, ft	Theoretical Movement, in.	Actual Movement, in.	Model	Date Sealed	Depth, in.	General Appearance	Joints in System	Intruded Debris	Leaks	Traffic Wear	Ride		
	No.	Total Length, ft																	Quality	Noise	
B05-73051	3	110	Rural	6,000	7	2	0	75	0.93	0.21	190	1972	F	Good	None	None	---	None	Good	Quiet	
						3	0	35	0.44	1.16	190	1972	F	Good	None	None	---	None	Good	Quiet	
B02-70041	7	595	Rural	5,000	7	7	0	96	1.20	1.23	190	1972	F	Good	None	None	---	None	Good	Quiet	

TABLE 7
WABO-MAURER STRIP SEAL JOINT SYSTEM SURVEY

Bridge						Joint								Ratings							Comments
Number	Spans		Location	ADT	PCV	No.	Skew Angle, deg	Contributing Length, ft	Theoretical Movement, in.	Actual Movement, in.	Model	Date Sealed	Depth, in.	General Appearance	Joints in System	Intruded Debris	Leaks	Traffic Wear	Ride		
	No.	Total Length, ft																	Quality	Noise	
S03-70016	4	200	Rural	14,100	8	1	26	90	1.12	1.25	SB200	4-73	F	Good	None	None	---	None	Good	Quiet	
						5	26	90	1.12	1.05	SB200	4-73	F	Good	None	None	---	None	Good	Quiet	

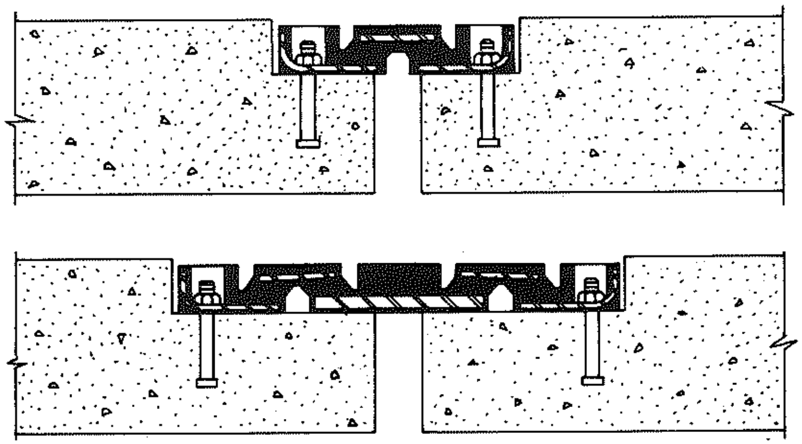

Figure 1. Transflex 200A and 250 (above), Transflex 400A and 650 (below).

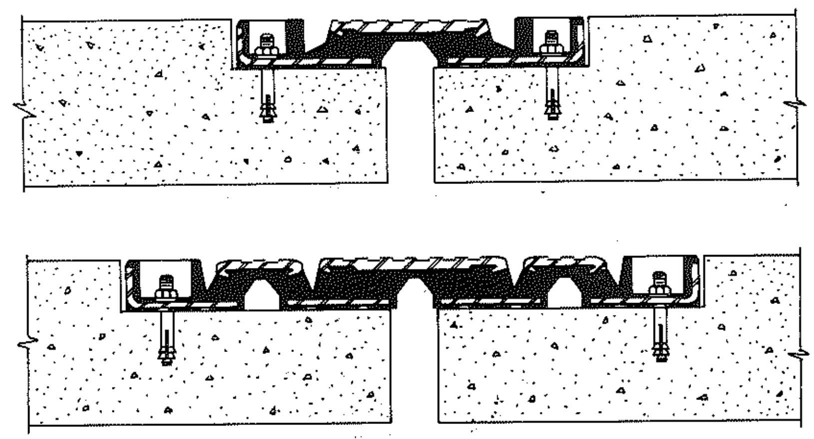

Figure 2. Waboflex SR 2 and SR 2.5 (above), Waboflex SR 4 (below).

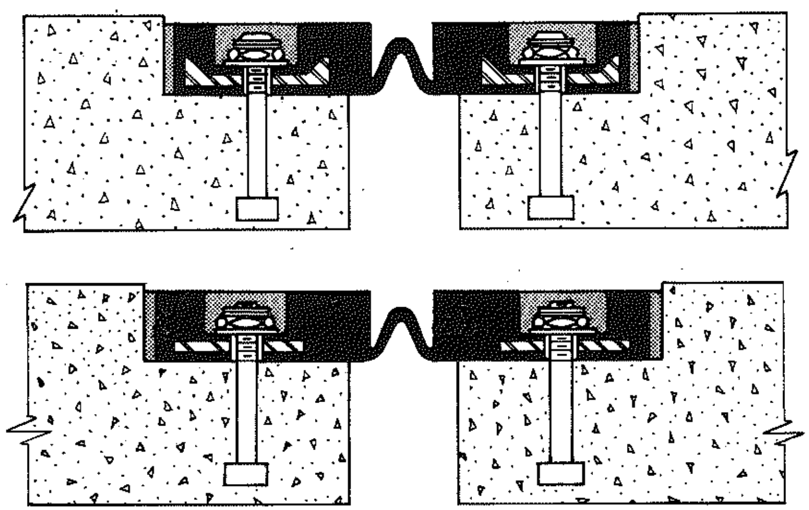

Figure 3. Fel-Span T 20 (above), Fel-Span T 30 and T 40 (below).

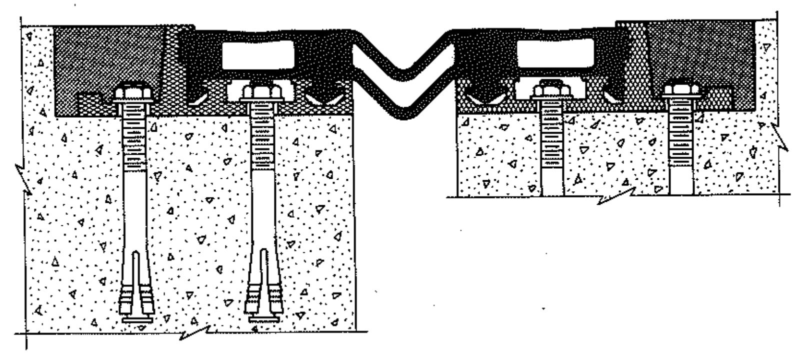

Figure 4. Delastiflex MT 300.

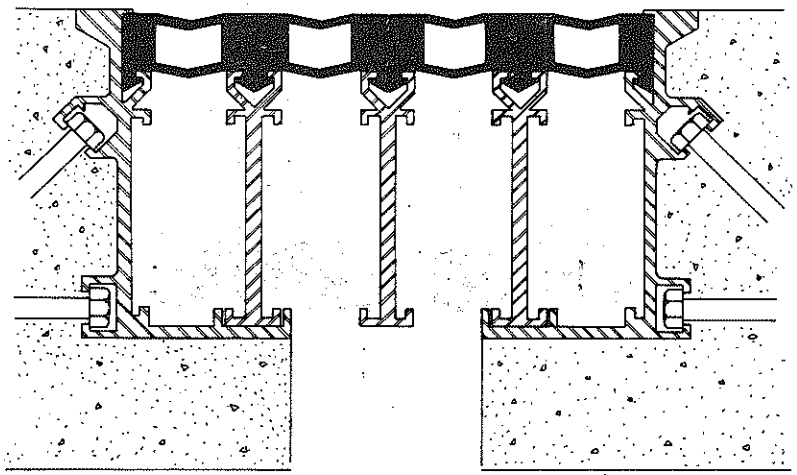

Figure 5. Delastiflex DL 300 (support system for center rail not shown).

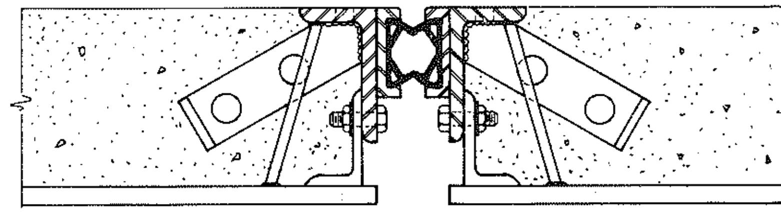

Figure 6. Type 190 (Michigan Modified Wabo-Maurer).

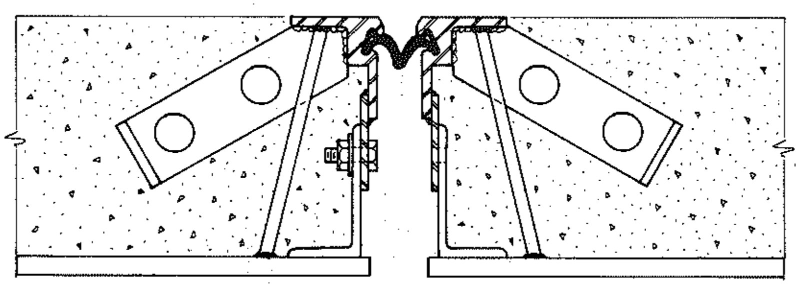

Figure 7. Wabo-Maurer Strip Seal.

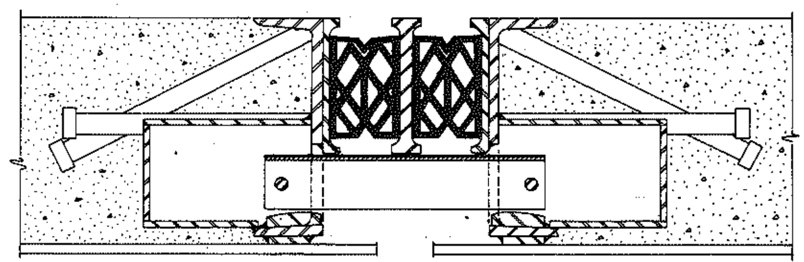

Figure 8. Modular Compression Seal.

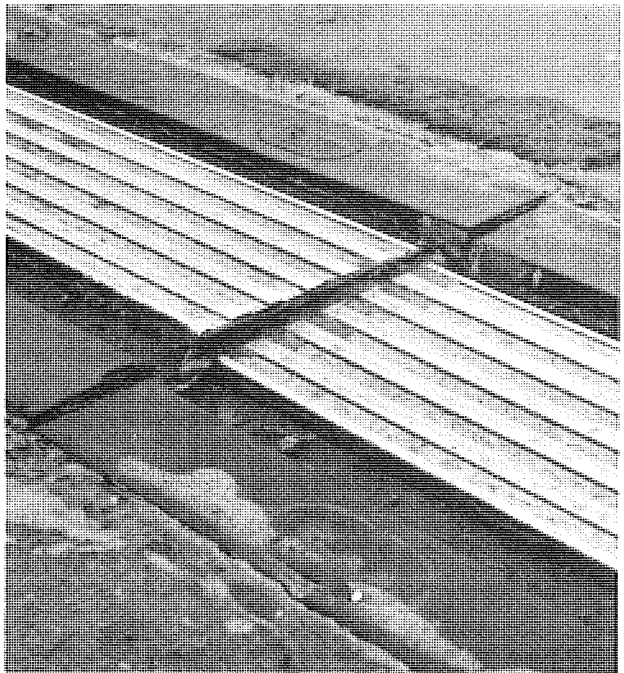

Figure 9. Waboflex SR2.5 (CS 82-240). Vertical misalignment of sections, poor sealing, and wide gap between sections.

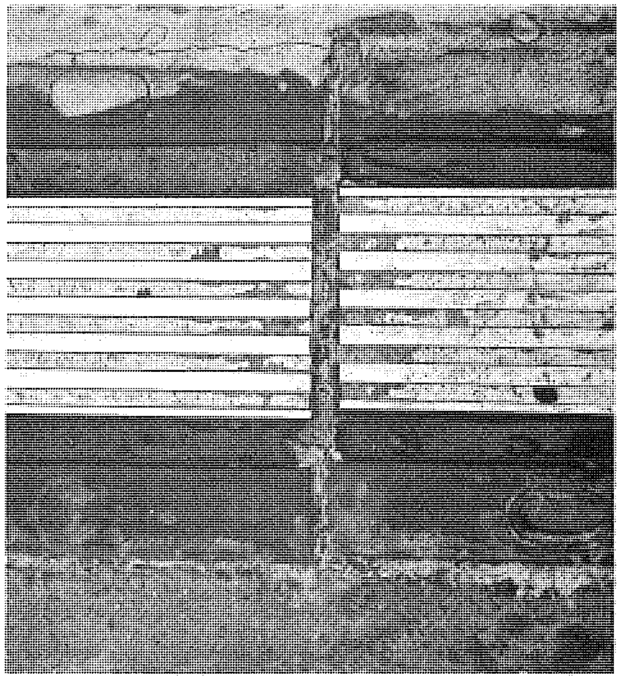

Figure 10. Waboflex SR2.5 (CS 82-240). Horizontal misalignment of sections and not tightly abutted.

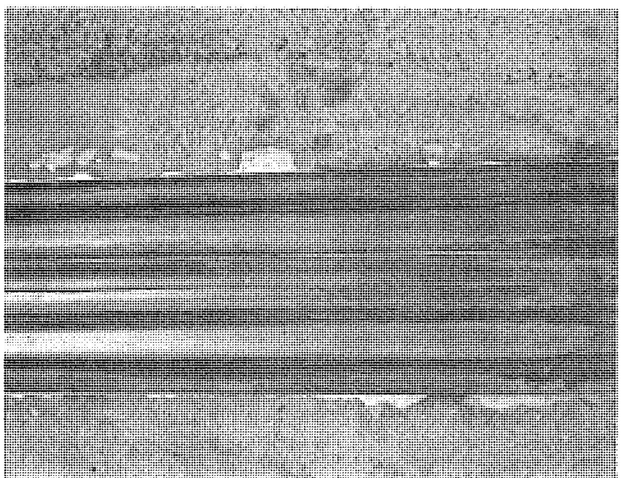

Figure 11. Dirt intrusion between aluminum side rails and neoprene seal elements on an early model of the Delastiflex DL300 system (S09 of 82112).

Figure 12. Modular compression system (S22 of 82122). Uneven degree of compression between neoprene seals.

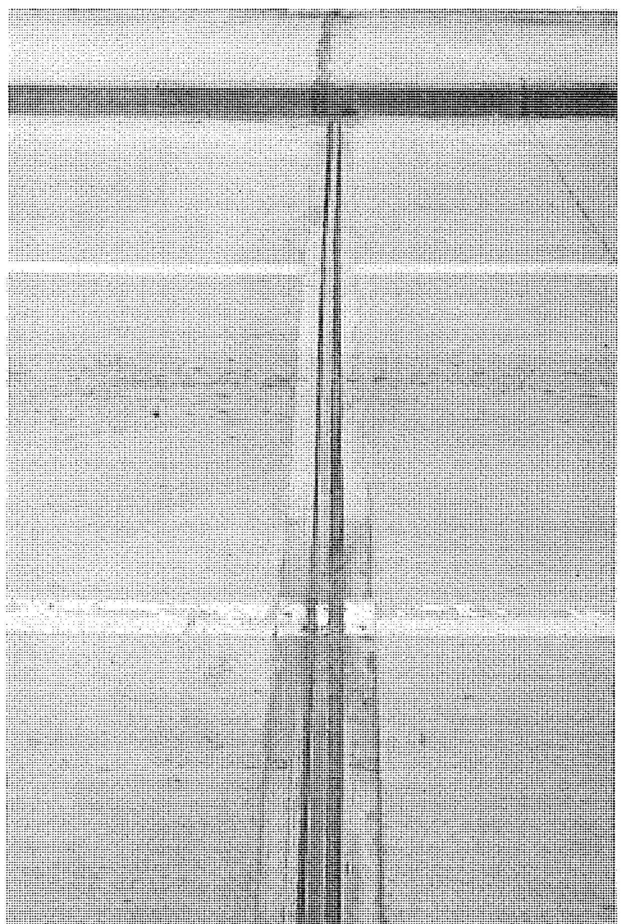

Figure 13. Overlap feature of Fel span design.

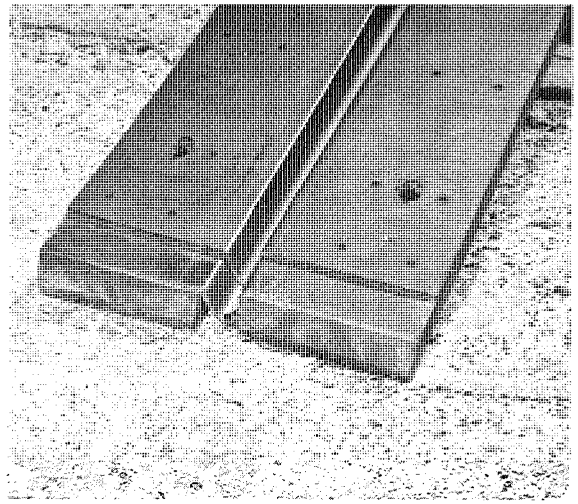

Figure 14. Underside of Fel span seal showing overlap feature.

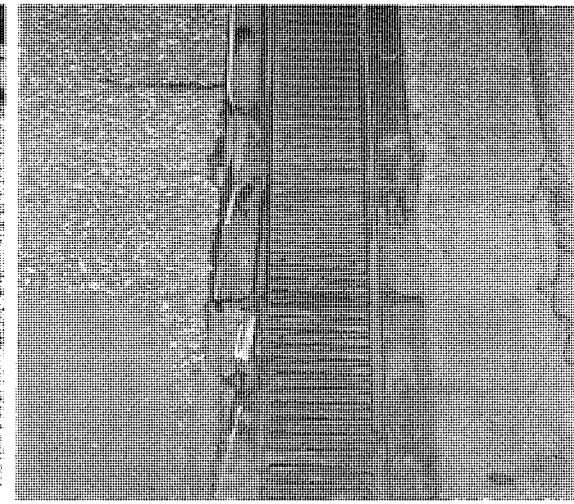

Figure 15. Transflex system (B03 of 82053). Extensive damage by snow removal equipment.

Figure 16. Transflex system (B03 of 82053). Extensive damage by snow removal equipment; note exposed steel.

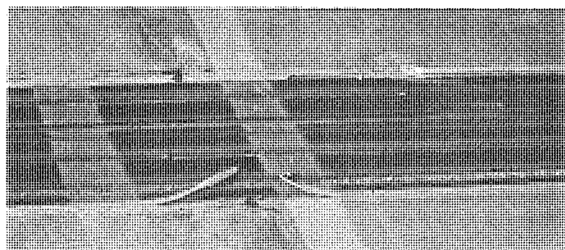

Figure 17. Delastiflex DL300 (S04 of 19022). Extensive snow removal equipment damage to neoprene seal; aluminum frame torn; and concrete spalled.

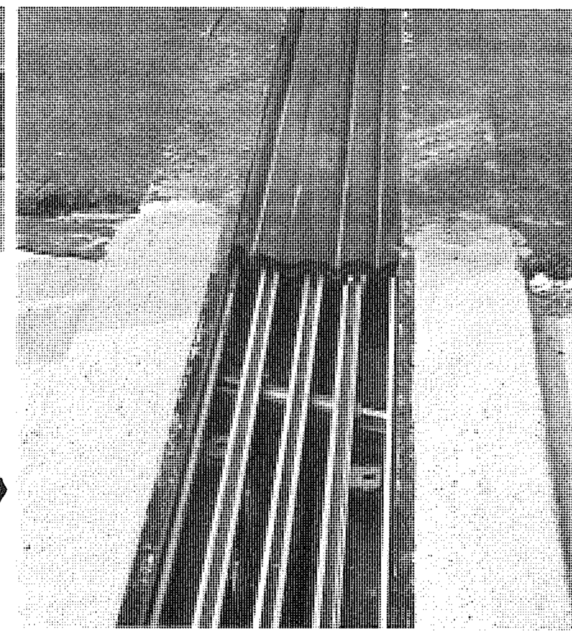

Figure 18. Delastiflex DL300 (S09 of 82112). System under construction; seal installed temporarily to permit traffic while overlay is placed on the rest of the structure.