# LABORATORY EVALUATION OF TYPE 190 PREFORMED NEOPRENE JOINT SEAL AND LUBRICANT ADHESIVES IN SKEWED BRIDGE JOINTS



MICHIGAN HIGHWAY RESEARCH LABORATORY SECTION

MICHIGAN DEPARTMENT OF STATE HIGHWAYS

# LABORATORY EVALUATION OF TYPE 190 PREFORMED NEOPRENE JOINT SEAL AND LUBRICANT ADHESIVES IN SKEWED BRIDGE JOINTS

F. J. Bashore

Research Laboratory Section
Testing and Research Division
Research Project 72 TI-88
Research Report No. R-839


Lansing, November 1972

A laboratory evaluation of the type 190 preformed neoprene joint seal was requested by M. Rothstein, Engineer of Design, in a memorandum to Max N. Clyde, dated February 8, 1972. Specific properties to be studied were; performance in skews up to 45 degrees, and the effect of different lubricant-adhesives.

At the time this project was initiated it was thought that the laboratory evaluation would be completed by May 1, 1972. However, the material which had been delivered to the Maintenance Division was not suitable for use in their field installations and therefore not suitable for our laboratory evaluations. Obvious deficiencies were poor quality factory splices and insufficient height, thereby not fitting the steel extrusions properly. Complete testing in accordance with the MDSH Standard Specifications revealed other deficiencies which are shown in Table 1.

No valid laboratory work could be initiated until the second shipment was received by the Maintenance Division in May. This material was furnished in the lengths needed for field installation with no splices, and while it did not meet the height requirements in effect at the time the original order was placed, it met the requirements of later specification revisions. Physical properties compared to the requirements of the MDSH Standard Specification were very good except for compression recovery at 14 degrees which was four percentage points below specification requirements. Perhaps the compression-recovery requirements should be reduced for this design since there are no internal webs (except in the corners) to assist in recovery. Physical properties obtained from tests run on samples from both shipments are shown in Table 1.

The equipment used to evaluate the seal in skew, and also to study different lubricant-adhesives, consisted of a neoprene seal fatigue tester with adjustable skew angle and length of stroke, powered by the moving crosshead of an Instron Universal Tester (Fig. 1). Since the maximum stroke of the fatigue tester was less than the total movement capability of the seal (maximum extension to maximum compression), the Instron tester and attaching cable were adjusted to cycle the seal from an initial compressed width of 2.66 in. to maximum extension and then readjusted to cycle from width to maximum compression. The speed used was approximately one cycle per minute. The initial compressed seal width of 2.66 in. corresponds to the theoretical 60 F initial placement width.

Specimens were prepared by applying a liberal amount of lubricant-adhesive to 15-1/2 in. lengths of steel extrusions and mounting 9-in. lengths of seal. Wood spacers and C-clamps were used to hold the specimens at the theoretical 60 F spacing (2.66 in. width) for a three-day cure before cycling was started (Fig. 2).

The first specimen mounted with the standard specification lubricant-adhesive (25 percent neoprene solids in toluene) was set at a 45-degree skew and cycled from the initial 2.66 in. width to a 3.84 in. width. This figure was derived from the Watson-Bowman Associates recommendation that the maximum longitudinal deformation to either side be limited to 1.18 in. The seal started to pull out of the steel extrusion after about 850 cycles (Fig. 3).

The second specimen mounted with a urethane lubricant-adhesive was cycled as above for 2,000 cycles with no failure except for a tear in a corner web which had been initiated by a small nick in the end. Because of this failure, the ends of the rest of the specimens were buffed to remove all blemishes caused by sawing.

It was observed that considerable stress is placed upon the leading corners of the seal when in skewed tension and it was thought that a simple holding clip could be designed to insure that pull-out would not be initiated. The clips designed and used in subsequent fatigue tests are shown in Figure 4. The test clips were aluminum for ease of fabrication but steel should be used in the field to prevent bi-metallic corrosion.

The clips used for the test work were held in place by bolting to the steel extrusions. The first models were found to be thicker than necessary thereby restricting maximum closure. These were progressively thinned to eliminate excess bulk. The final model was designed for simple installation without need for mechanical fastening. The clip is shaped to be inserted into the end of the steel extrusion and would be held in place by the lubricant-adhesive.

The third specimen was mounted with urethane lubricant-adhesive and aged three days before cycling. The thinner clips were then installed and cycling from the initial 2.66 in. width to an extension of 3.84 in. was begun. After 3,000 cycles a careful examination showed no failure. Cycling from the initial 2.66 in. width to a seal width of 1.48 in., representing a maximum closure for 3,000 cycles was performed without failure.

The above specimen was next set to cycle at a 55-degree skew from an initial 2.66 in. width to a maximum extension of 3.49 in. (1.18 in. longitudinal deformation). Cycling was discontinued after 2,000 cycles without failure (Fig. 5).

The last investigation concerned the feasibility of using a grease instead of a lubricant-adhesive in skewed installations to eliminate the longitudinal stresses in the seal.

A test specimen was mounted using ordinary gun grease (in actual practice a grease compatible with neoprene such as a silicone grease would have to be used) and cycled at a 45-degree skew. Longitudinal stresses were eliminated but it was evident that stops would have to be installed to prevent the seal from progressively working out of the steel extrusions endwise.

Another consideration was the question of ease of removing the seal by downward pressure when at maximum extension which might happen in the field when debris is present on top of the seal. Resistance to pull-out was measured by applying a vertical force at the center of the seal with the Instron Universal Tester using a 1 by 3-in. pressure foot. Only 34 psi was required for the grease mounted specimen while the urethane mounted specimen required 141 psi to initiate pull-out.

## Conclusions and Recommendations

1. Tests showed that by mounting the seal with grease, longitudinal stresses were eliminated but that the large decrease in resistance to pull-out would make its use inadvisable.

2. We recommend that the high solids (70 percent) one-component urethane lubricant-adhesive be used instead of the currently specified low solids (25 percent) neoprene polymer in toluene for the following reasons:

a) The urethane maintains it's lubricity up to 4 hours compared to a few minutes for the currently used material; thus providing ample time for application of the lubricant-adhesive, installation of the seal, and compression to the 60 F setting for shop assembled systems.

b) The higher solids urethane does a much better job of filling any voids between the seal and the steel extrusions which is especially important if the seal is slightly undersize.

3. Our tests indicate that this seal will perform in skewed joints of 45 degrees or more by following the Watson-Bowman Associates recommendation that no more than 1.18 in. of longitudinal deformation to either side be permitted.

In addition we would recommend that for joints skewed 30 degrees or more, all seal ends be buffed to remove nicks or blemishes caused by sawing and that clips similar to those used in our test work be installed on the leading edges.

TABLE 1
PHYSICAL PROPERTIES OF TYPE 190 BRIDGE SEAL

| Property | First Shipment | Second Shipment | Specification |
|---|---|---|---|
| Composition | GRS rubber | neoprene | neoprene |
| Tensile Strength, psi | 2,020 | 2,230 | 2,000 min |
| Elongation at Break, percent | 285 | 335 | 250 min |
| Hardness, Type A Durometer | 64 | 57 | 60±5 |
| Oven aging, 70 hr @ 212F | | | |
| Tensile strength change, % | -8.7 | 0.2 | 20 max |
| Elongation change, % | -43.6 | -10.4 | 20 max |
| Hardness, points change | 13 | 3 | 0-10 |
| Oil Swell, 70 hr @ 212 F., ASTM oil 3, weight change, % | 54 | 3 | 45 max |
| Ozone resistance, 70 hr @ 104 F, 20% strain, 300 pphm | no cracks | no cracks | no cracks |
| Compression recovery, 50% deflection, % of original width | | | |
| 70 hr @ 212 F | 65 | 85 | 85 min |
| 70 hr @ 14 F | 85 | 84 | 88 min |
| 22 hr @ -20 F | 71 | 83 | 83 min |
| Width, in. | 3.653 avg | 3.898 avg | 3.750 nominal |
| Depth, in. | 3.528 avg | 3.649 avg | 3.656-3.719* (3.625-3.656)** |

* Jan. 1972 specification
** March 1972 specification

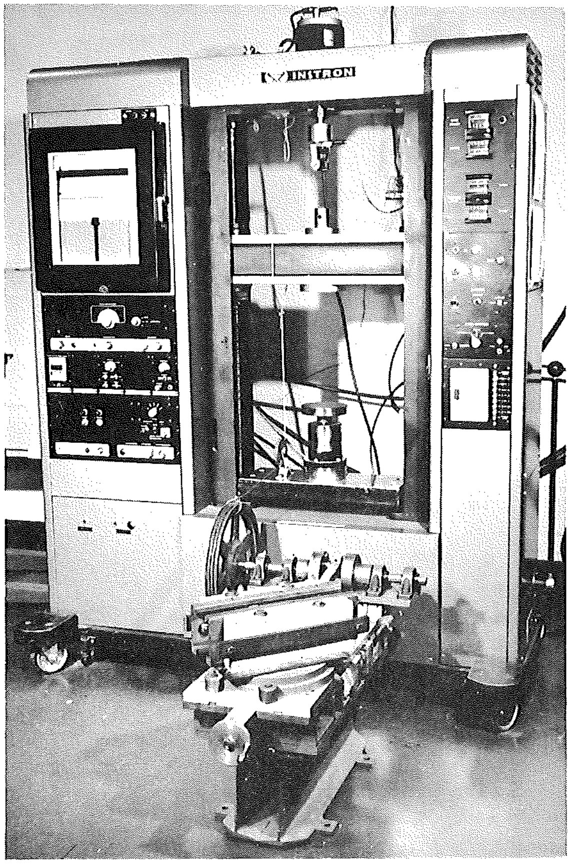


Figure 1. Instron Universal Tester and fatigue tester set up to automatically cycle seal in tension or compression.

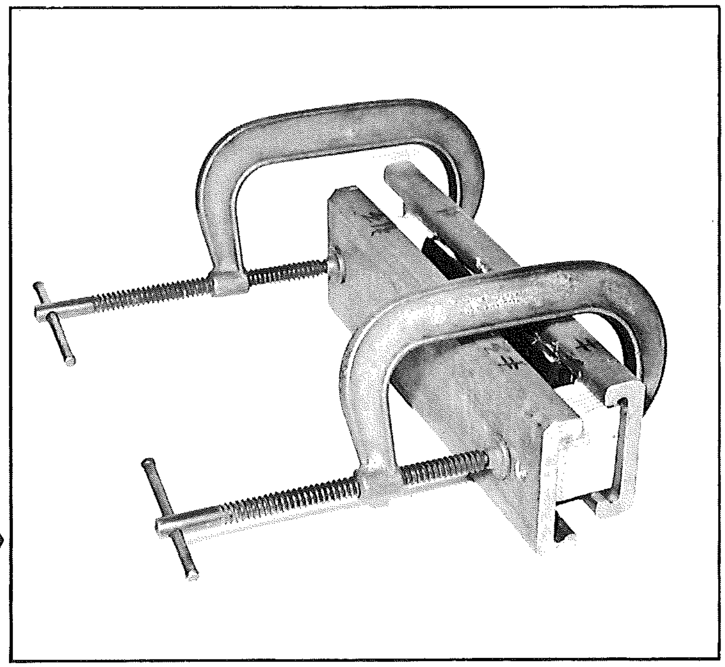

Figure 2. Mounted seal specimen clamped at theoretical 60 F spacing during 3-day cure of lubricant-adhesive.

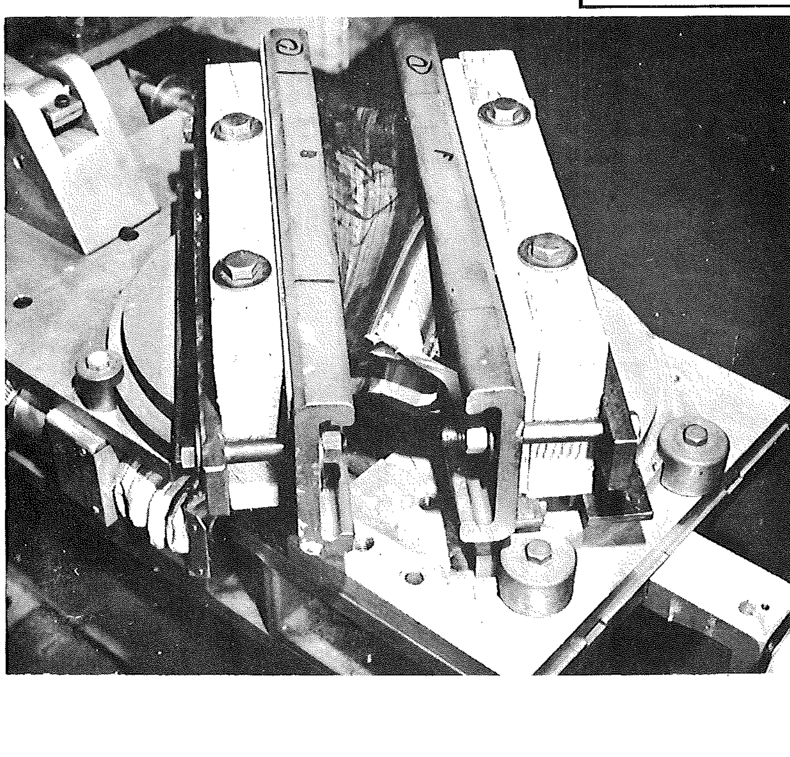

Figure 3. Seal mounted with standard specification lubricant-adhesive started to pull out of steel extrusions after 850 cycles in tension.

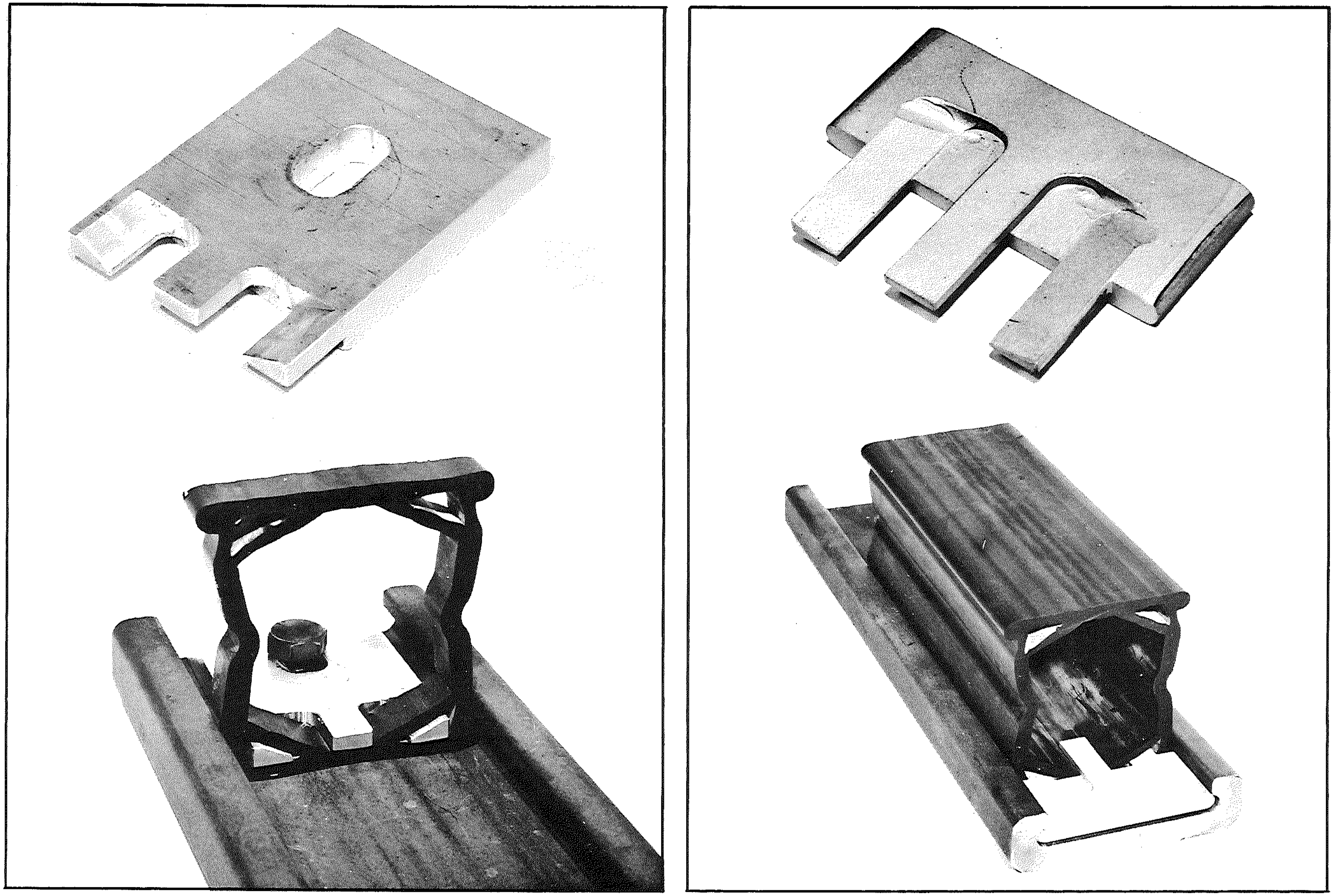

Figure 4. Clips designed to prevent pull-out of seal when in skewed tension. First model on left, final model on right.

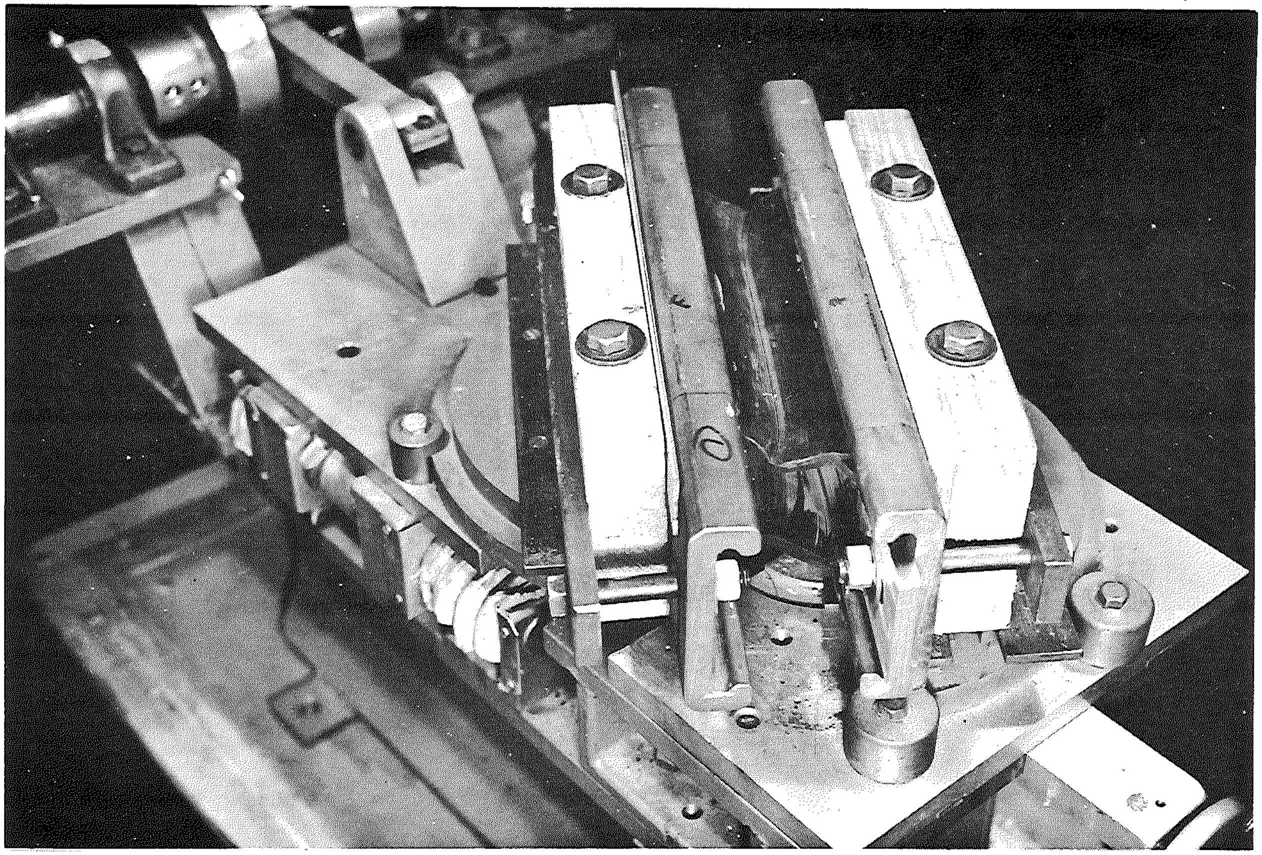

Figure 5. Seal after 3,000 extensions at a 45-degree skew and 2,000 extensions at a 55-degree skew.