KENTUCKY DEPARTMENT OF HIGHWAYS

RESEARCH REPORT

INVESTIGATION OF USE OF PREFORMED, COMPRESSED NEOPRENE SEALS IN JOINTS OF CONCRETE BRIDGE DECKS
KYHPR-65-35, HPR-1(3), Part II

by
Dennis L. Willaman
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July 1968

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Lexington

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MEMO TO: A. O. Neiser, State Highway Engineer
Chairman, Research Committee

DATE: November 21, 1968

SUBJECT: Research Report; "... Preformed, Compressed Neoprene Seals in Joints of Concrete Bridge Decks;" HPR-1(3), Part II, KYHPR 65-35

The report submitted herewith is slightly belated. July was the date of the re-draft, and we chose not to update the context thereafter. Mr. Willaman, who prepared the original draft has entered military service.

This report is rather general in respect to both joints and seals. Unfortunately, there are implications in the report which support the often-expressed viewpoint that "it is impossible to seal joints properly". Objectively speaking, we have illustrated several "defects" related to design, construction of joints, and installation of seals -- which, if overcome, would undoubtedly assure improved performance of the sealing material. The AE-2 armored-edge style of joint appears to give superior performance. I may mention that the defect illustrated in Figures 41 and 42 has been corrected somewhat by depressing the seal more along a diagonal line through the curb (cf. Drawing G 353F, appended).

Special Provision No. 37-A, which was in effect when the report was compiled has since been redacted and issued as No. 37-B (April 5, 1968). A copy is included here for convenient reference.

Respectfully submitted,

Jas. H. Havens

Jas. H. Havens
Director of Research

JHH:em
Attachments
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W. B. Drake, Assistant State Highway Engineer
J. T. Anderson, Projects Management Engineer
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KENTUCKY DEPARTMENT OF HIGHWAYS

SPECIAL PROVISION NO. 37-B
PREFORMED COMPRESSION JOINT SEALS

This Special Provision shall be applicable to individual projects only when so indicated on the plans, in the proposal, or in the bidding invitation.

I. DESCRIPTION

This work includes the preparation of the joint faces and edges, furnishing and installing of preformed elastomeric compression joint seals of the sizes and shapes as specified or approved, and furnishing and applying an approved lubricant; all in accordance with this special provision.

The seal shall be installed by means of an approved machine except as otherwise provided herein.

Unless otherwise specified on the plans or in the proposal, preformed compression joint seals will not be permitted in pavement joints.

II. MATERIALS

A. Seals. The seals shall be preformed; shall be manufactured from elastic polychloroprene material; shall be compatible with concrete; and shall be resistant to abrasion, oxidation, oils, gasoline, salt, and other materials that may be spilled on or applied to the surface. Factory splicing shall be held to a minimum. The seals shall be accurately marked by the fabricator at 1-foot intervals.

The seals shall be of a design and cross-section so as to be substantially solid when fully compressed. The seals shall also be designed so that, when compressed, the center portion of the top surfaces will not extend upward.

The size, shape, and dimensional tolerances of the seals shall be as indicated on the standard drawings or on the plans, or as otherwise permitted by the plans. Seals of other configurations, but having equal widths and sealing characteristics, may be used when approved by the Department.

Each lot of the joint seal shall be identified with manufacturer's name or trade mark and shall be accompanied by the manufacturer's affidavit attesting conformance with this special provision. The term "lot" shall mean all seals of the same size and cross-section contained in one shipment.

The seals shall comply with the requirements given in Table I as determined by tests on actual seals. All test specimens will be cut from samples of the preformed joint seal.

Specimens for hardness testing will be buffed in accordance with ASTM D 15 and a sufficient number of plys of the seal material will be utilized to obtain the proper thickness for testing.

B. Lubricant. Lubricants used to facilitate the installation of the joint seals shall be compatible with the seals and the concrete and shall meet with the approval of the Engineer.

C. Sampling and Testing. If the material has not been pretested and approved, one sample of each size and cross-section shall be taken from each lot and submitted to the Laboratory for testing. A 10-foot length of seal shall constitute a sample and each sample shall be cut from one end of any roll selected at random. The samples shall be subjected to the tests listed in Table I and the

TABLE I

Properties	Requirements	Test Methods
Tensile Strength, psi., min...........................	2000	ASTM D 412*
Elongation at Break, % min............................	250	ASTM D 412*
Hardness, Type A Durometer............................	55 ± 5	ASTM D 2240*
Oven Aging, 70 hrs. @ 212° F..........................		ASTM D 573* (Except testing
Tensile strength, % change, max.....................	-30	apparatus may be that used
Elongation, % change, max...........................	-40	for other high temperature
Hardness, points change, max........................	+10	tests as specified herein.)
Ozone Resistance......................................		ASTM D 1149
20% strain, 300 pphm in air, 70 hrs. @ 104° F........	No Cracks	
(Wipe with solvent to remove surface contamination)		
High Temperature Recovery**...........................		Refer to II-C-1
70 hrs. @ 212° F., under 50% deflection, % min.......	85	
Low Temperature Recovery..............................		Refer to II-C-1
72 hrs. @ +14° F., under 50% deflection, % min.......	87	
Low Temperature Recovery..............................		Refer to II-C-1
22 hrs. @ -20° F., under 50% deflection, % min.......	82	
Weight Change in Oil..................................		Refer to II-C-2
22 hrs. @ 212° F. in ASTM Oil No. 3, % max..........	45	

* When it is not possible to obtain the standard size specimen from a sample, a test specimen shall be obtained as near the size of the standard specimen as possible.

**Web adhesion or cracking of specimens shall be cause for rejection.

test procedures shall follow the ASTM methods designated, except for the procedures hereinafter specified.

1. High and Low Temperature Recovery Tests.

a. Apparatus. The testing apparatus shall consist of the following items:

(1) Compression Clamp. A compression clamp consists of two or more flat steel plates known as a Method "B" ASTM compression set clamp (ASTM D-395); or a vise having parallel plates on jaws; or any basic device by which uniform compression can be applied to a specimen. The device should be capable of accepting a 5-inch long specimen.

(2) Steel Spacers. If compression clamps are used, steel spacer bars will be required to allow proper spacing of the steel plates.

(3) Air Oven. Any well designed, uniformly heated, standard circulating air oven may be used. The oven shall be provided with proper temperature control to maintain the specified temperature within a permissible variation of ± 2° F.

(4) Low Temperature Box. This apparatus may be any refrigerated box capable of maintaining a temperature variation of ± 2° F. on temperature settings within the range of +20° F. to -20° F.

(5) Dial Gage - Vernier Caliper - Micrometer. A dial gage, vernier caliper, or micrometer graduated in thousandths of an inch shall be used for measurements.

b. Test Specimens. Specimens cut from samples of fabricated seals shall be approximately 5 inches long.

c. Test Procedure.

(1) The outside surfaces of the seal shall be lightly dusted with talc to prevent sticking to the steel compression plates.

(2) Deflect the test specimen between parallel plates to 50 per cent of original top width. Width measurement shall be taken in the center of the 5-inch length and the point of the measurement shall be marked. Prior to compression, the specimen shall be placed in a horizontal position in such a manner that the plane between the lip tips is perpendicular to the compression plates. As the specimen is being compressed, care shall be exercised to insure that the "V" section or the top of the specimen folds so that it projects inward towards the inner web section.

(3) High Temperature. Expose the clamp assembly and compressed specimen in an oven for the time and at the temperature specified. Do not pre-heat the clamp assembly. When the oven aging period is complete, remove the clamp assembly and unclamp the test specimen immediately. Cool the test specimen at room temperature (73° F. ± 4°) on a wooden surface for one hour before measuring the heat aged recovery width. The measurement shall be made at the marked location at which the original width was determined.

(4) Low Temperature. All internal surfaces shall be dusted with talc to prevent web adhesion due to ice crystal formation. Expose the clamp assembly and compressed specimen in the low temperature box for the time and at the temperature specified. When each cold aging period is complete, unclamp the test specimen at the test temperature; allow it to recover in a free state at the test temperature for one hour. At this point, measure the recovery width at the test temperature. These measurements shall be made at the marked location at which the original width was determined.

d. Calculations. Calculate the recovery for each test, which is expressed as a percentage of the original width, as follows:

$$\text{Per Cent Recovery} = \frac{\text{Recovered width}}{\text{Original width}} \times 100$$

2. Weight Change in Petroleum Oil.

a. Apparatus.

(1) Air Oven. Any well designed, uniformly heated, standard circulating air oven may be used. The oven shall be provided with proper temperature control to maintain the specified temperature within a permissible variation of ± 2° F.

(2) Scale. A scale capable of weighing to the nearest tenth of a gram shall be used.

(3) Test Liquid. A petroleum based oil such as ASTM Oil No. 3 (ASTM D-471) shall be used.

(4) Miscellaneous. Pyrex beakers, tongs, filter paper, acetone.

b. Test Specimens. Specimens cut from samples of fabricated seals shall be approximately 3 inches long.

c. Test Procedure.

(1) Weigh each test specimen in air to the nearest tenth of a gram (W_1). Place in a Pyrex beaker containing sufficient test oil, at the specified test temperature, to fully cover the samples throughout the test period. Two specimens shall be tested. They may be placed in the same beaker, but must be separated by large glass balls or beads. The beaker shall be loosely covered with aluminum foil.

(2) The beaker assembly shall be placed in the oven and conditioned for 22 hours at 212° F. ± 2°.

(3) After the immersion period has been completed, remove the test specimens from the hot oil and cool the test specimens to room temperature by transferring them to a cool clean portion of the test liquid for 30 to 60 minutes. Then dip the specimens quickly into acetone to remove surface test oil, blot lightly with filter paper, and immediately determine weight of each specimen (W_2).

d. Calculations. Calculate the change in weight as follows:

$$\text{Change in weight, per cent} = \frac{W_2 - W_1}{W_1} \times 100$$

Where: W_1 = initial weight of specimen in grams
W_2 = weight of specimen in grams after immersion.

D. Approval. The seals accepted for use shall be those approved by the Department on evidence of their compliance with test requirements as hereinbefore specified under paragraph A.

Acceptance shall be made on the basis of one of the following procedures to be designated by the Department.

(1) Approval by the Laboratory from the results of tests made on samples furnished by the Contractor; or

(2) Approval by the Department on evidence that the materials have been tested by a recognized laboratory and found to comply with all requirements. Two certified copies of the test report from the laboratory are required by the Department; or

(3) Approval by the Department upon certification by the manufacturer, furnished by the Contractor, stating that the materials are identical in composition with those previously approved.

When the seals are to be tested by the Laboratory, the Contractor shall provide the Engineer with samples at least 3 weeks prior to the anticipated date of installation.

If a seal is approved on the basis of tests performed by a recognized laboratory, such laboratory shall be one approved by the Department to perform such tests.

III. CONSTRUCTION METHODS

All joints, whether sawed or formed, shall be true to alignment and shall have vertical faces. Each joint shall be uniform in width throughout its length.

Construction joints and contraction joints to be sealed by this method shall conform to the details shown on the Standard Drawings or plans.

Joints that are to be sawed shall not be sawed until the concrete has hardened to the extent that tearing and ravelling will not occur, but as soon thereafter as deemed necessary by the Engineer to preclude random cracking.

Expansion joints to be sealed by this method shall be formed and shall be constructed in accordance with the details shown on the Standard Drawings or plans.

If a joint, as constructed, has a width in excess of the specified width, the seal for that joint shall be of such width that the ratio of the seal width to the joint width will be 1.60 or greater as required by the Engineer.

All joints to be sealed shall be free of cracked or spalled concrete. Cracked areas shall be chipped back to sound concrete and repaired with an approved epoxy resin compound or other materials approved by the Department.

The faces of all joints to be sealed shall be cleaned of laitance, oils, greases, dirt, free water, and other foreign matter immediately prior to the installation of the seal. The method of cleaning shall be as directed by the Engineer as deemed necessary to satisfactorily clean the joints.

The seals shall be installed in the properly prepared joint by a machine designed specially for installing joint seals. Any seal that is damaged during installation shall be removed and replaced with an undamaged seal. Any seal that is improperly positioned in the joint shall be removed and reinstalled at the proper elevation. Installation of seals by hand methods will be permitted only in areas that are inaccessible to the machine, unless written permission is obtained from the Engineer to install all seals by hand methods.

Prior to placement, the seals shall be cut to the lengths of the joints or as much longer as is needed for proper installation. Each seal shall be measured before and after installing as a check against stretch. Any installed seal that shows more than 5 per cent stretch shall be removed and reinstalled.

The seals may be installed immediately after the removal of the curing cover. The seals shall be installed securely and shall be free from any objectionable curling or twisting in the joint groove. A lubricant shall be used to facilitate the installation and shall cover both sides of the seal over the full area in contact with the sides of the concrete joint. The lubricant may be applied to the faces of the joint or the seal, or both. The seals shall be installed in a highly compressed state and the top of the seals shall be below the level of the roadway surface to the depth indicated on the Standard Drawings or plans. The seal shall be in one piece, without field or factory splicing, for the full length of each of the transverse joints.

When specified for longitudinal joints, the seals shall be installed in practical lengths without field splicing.

IV. MEASUREMENT AND PAYMENT

No direct payment will be made for sawing or forming and the preparation of the joint, or for the furnishing and the installation of the seals. The cost of all materials, labor, equipment, and supplies required for this work shall be included in the price bid for the various items incorporated in the work.

APPROVED April 5, 1968

A. O. Neiser

A. O. NEISER
STATE HIGHWAY ENGINEER

Research Report

INVESTIGATION OF USE OF PREFORMED, COMPRESSED NEOPRENE SEALS IN JOINTS OF CONCRETE BRIDGE DECKS
KYHPR-65-35, HPR-1(3), Part II

by
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Division of Research
DEPARTMENT OF HIGHWAYS
Commonwealth of Kentucky

in cooperation with the
U.S. Department of Transportation
Federal Highway Administration
Bureau of Public Roads

July 1968

INTRODUCTION

Progressive deterioration and staining of concrete bridge substructures and erosion of abutments may, in many instances, be attributed to the leakage of bridge deck joints. The primary difficulty in maintaining a properly sealed joint is the continual expansion and contraction of the bridge spans. Joint seals, of course, must remain in contact with both faces of the disjointed sections and remain flexible at all temperatures encountered.

A study was initiated by the Division of Research for the specific purpose of evaluating the performance of preformed, compressed neoprene seals and to compare the performance of these seals with the performance of conventional joint sealers. This report is based on a field inspection of sealed joints in numerous Kentucky bridges, and the conclusions are derived from the observed performance of formed, sawed, or armored-edge joints sealed with conventional or neoprene seals. Between 1963 and 1965, neoprene seals were installed in one Lexington bridge, two Louisville bridges, and most of the Central Kentucky (Bluegrass) Parkway bridges. These seals, therefore, had been in service from two to three years at the time of field inspections.

It was observed that formed and sawed joints inevitably spall thereby making it difficult for any sealant to adequately seal the joints. Armored-edge joints, when sealed with neoprene seals, were observed to provide the best combination to perform the intended function of joint and seal. The added expense of such an installation may be justified from the standpoint of reduced maintenance costs.

JOINTS

Joints in concrete bridge decks are necessary to allow for the thermal expansion and contraction of the slabs. Theoretically, the coefficient of linear expansion and contraction for reinforced concrete is approximately 0.000006/°F. If the average annual change in temperature in Kentucky were assumed to be 100°F, the theoretical change in joint width would be 0.36 inch for a bridge slab 50 feet in length. A graph showing the theoretical change in joint width for various lengths of slabs in Kentucky bridges is shown in Figure 1. It has been noted that actual length changes are somewhat less than theoretical, and this curve is also shown in Figure 1.

Joints may generally be classified into three basic groups: 1) construction, 2) contraction, and 3) expansion. Construction joints are placed at points of ending and beginning of construction for provision of a smooth transition between pours. In extreme emergencies, a construction joint may be used in a concrete bridge deck.

Contraction joints (Figure 2) are normally used in portland cement concrete pavements and are occassionally used in concrete bridge slabs. These narrower joints serve to control shrinkage cracking and may either be transverse or skewed cuts sawed into the slab to a depth of 1/6th the total slab thickness or to a depth equal to the size of the largest aggregate used in the concrete, whichever is greater. Upon curing, concrete shrinks and cracks, and the cut provides a weakened section wherein the shrinkage crack may naturally develop. The exact time to saw joints depends upon the type of aggregate, the curing method, the cement factor, and other variables. Sawing should proceed as soon as possible with as little raveling of the joint edges as possible. With proper care, sawed joints will be straight and of uniform depth and width. The edges of sawed joints frequently chip and spall and due to the size and nature of the joint, repairs would be tedious and costly and therefore not attempted.

Expansion joints provide the necessary space for expansion of the reinforced concrete slab during hot weather. These joints are necessary in bridge decks and bridge approaches. Even though some decks contain sawed contraction joints, it has been found that they must also contain expansion joints. Six types of expansion joints normally used in Kentucky are:

1. formed concrete joint (Figure 3 and Standard Drawing G 351, Appendix),
2. AE-1 and AE-2 armored-edge joints (Figures 4 and 5 and Standard Drawings AE-1 and AE-2, Appendix),
3. ED-1 and ED-2 expansion dams (Figures 6, 7, and 8 and Standard Drawings ED-1 and ED-2, Appendix),
4. neoprene expansion dam (Figure 9),
5. aluminum expansion dam (Figure 10), and
6. finger dam (Figure 11).

A formed joint is used to provide a 1/2-, 3/4-, 1-1/4- or 1-5/8-inch joint. The formed joint (Figure 3) is created by positioning premolded joint-filler material (meeting the requirements of Standard Drawings G 351 and G 354C, Appendix) at the location of the joint and placing concrete around it (Figures 12 and 13). A copper or plastic waterstop (Figure 14) is frequently used to aid in sealing and to add support to the filler. In many instances, the premolded material is warped, twisted, and pulled out of alignment (Figures 15 and 16) during concrete placement. Edging tools are often used in an attempt to restore alignment after the paver has passed over the filler. Cracks may form at the joint edges during the curing period (Figure 17) thereby necessitating elaborate repairs to restore the joint (Figure 18). The ideal formed joint is vertical, straight, and of uniform width. However, because of installation difficulties, a large number of formed joints are crooked and vary in width. Variations in width and alignment may be abrupt (Figure 19) or change gradually from one end of the joint to the other. Besides having variable widths, the joints inevitably become spalled. Repairing formed joints is also a tedious and costly operation. Spalled formed joints are repaired only in extreme situations. Armored-edge AE-1 and AE-2 joints (Figures 4 and 5) are improvements of formed joints and their edges do not spall. Armored-edge joints are usually constructed to 1-inch widths but may be constructed as narrow as 1/2 inch and as wide as 1-5/8inches. Joint filler is used to fill the lower portion of the joint and the armored edges form the top portion which is later sealed. The armored edges provide a symmetrical joint which is required for use with certain types of seals. The AE-2 joint is an improvement of the AE-l joint since it provides a seat to support the seals at an appropriate elevation.

Other types of non-spalling joints are the ED-1 and ED-2 expansion dams (Figures 6 and 7). These joints are used to provide up to four inches of width for expansion. Figure 8 shows the ED-2 joint in position before the deck concrete was placed. Metal bars were spot welded on the top of the joint to maintain the joint at the desired width. The bars were removed after the concrete cured. The ED-2 joint is intended to be sealed with an adhesive sealant whereas the ED-1 joint required no sealant.

The neoprene expansion dam (Figure 9) has been developed for sealing and bridging one- to four-inch joints. The joint is bolted on each side after the deck concrete has been placed and cured. The neoprene expansion dam has a honeycombed structure which is reinforced with steel plates. As the concrete expands and contracts, the neoprene will compress and stretch to maintain a sealed joint.

The aluminum expansion dam (Figure 10) is another type of sealed joint which will also bridge and seal a wide expansion space. The joint is similar to the ED-1 and ED-2 joints, except movement of the dam takes place on both sides of the joint.

The finger dam (Figure 11) is used for wide expansion joints up to 12 inches or more placed in the longer bridges. Such joints are not sealed and therefore require little or no maintenance.

In summary, the sawed and formed joints will eventually spall Figures 20 and 21). Spalling is difficult to correct and renders the joint difficult to seal. The AE-2 joint is an improvement on the AE-l joint and provides a maintenance free 1/2-inch to 1-5/8-inch joint. The ED-l, ED-2, neoprene, and aluminum expansion dams provide from 1 to 4 inches of expansion space and the finger dam provides up to 12 inches or more of expansion space. The expansion dams should not require maintenance.

SEALANTS

A joint may be structurally sound; however, in the event it is not adequately sealed, it may cause deterioration and staining of the bridge substructure. Improperly sealed joints allow structurally and aesthetically destructive liquids, such as salt water from de-icing practices, to leak through and soak into the substructures. Liquids that seep into the slab interior and the pier caps require more time to dry than liquids remaining on the slab surface. The extended period of saturation may lead to scaling (Figures 22, 23, and 24), unsightly streaking (Figures 25, 26, and 27), and leaching (Figure 28). In addition to deterioration of concrete, a leaking joint may cause erosion of the earth fill at the abutment (Figures 29 and 30).

The prime difficulty of a sealant filling the gap created by the joint is to expand as the joint widens. If a seal functions properly, it will remain in contact with the joint faces and remain flexible at all temperatures.

Sealants may be classified as either adhesive or compressive materials. Adhesive sealants are applied in the liquid state and upon cooling or drying become a viscoelastic material. These sealants adhere to the joint faces and expand or contract with the changes in joint width. Adhesive materials utilized by the Department are oil-asphalt, hot-poured, and cold-applied crack and joint sealing compounds. These materials are used in formed joints, sawed joints, and ED-2 expansion dams.

Installation of adhesive type sealants is a simple operation. Oil-asphalt and hot-poured materials are heated and then poured into the joint (Figure 31). Cold-applied materials are mixed cold and then poured into the joint.

The initial application of the adhesive sealants will completely seal any joint. Adhesive sealants, however, have been noted to fail after one or more years of service. Failure may be attributed to deteriorating effects of weathering and to stress relaxation of the material. Weathering of an adhesive sealant may oxidize the material and destroy its adhesive and cohesive properties (Figure 32a and b). The oxidized seals may then crack and separate from the joint faces (Figures 33, 34, and 35). Stress relaxation of an adhesive seal may cause an imbalance of the sealant. This imbalance may create an uneven distribution of tensile stresses, thereby inducing possible failure planes. Extrusion (Figure 31c) of the seal may cause uneven distribution of the sealant on the joint faces, and failure may eventually develop at the deficient face. Intrusion or entrapment (Figures 32d and 36) may concentrate tensile stresses in the thin section thereby causing a possible failure plane. An imbalance of sealant may also develop as shown in Figure 32e and f and may eventually cause an intrusion or extrusion failure.

Adhesive seals generally must be replaced annually in order to maintain an adequately sealed joint. Joints should be cleaned thoroughly prior to adding a new sealant. Maintenance work on seals is often deferred due to a lack of time and money required to replace the adhesive seals.

Compressive-type sealants may be squeezed and forced into the joint or, in the case of the neoprene expansion dam, the seal may be bolted into position. Compressive seals may expand as the joint widens and compress as it narrows and remain in contact with the faces.

Preformed, compressed neoprene seals are extruded from elastic polychloroprene material. This material is ideal for joint seals in that it has a high degree of recovery and is resistant to weathering, sunlight, aging, water absorption, oil, gasoline, and penetration by debris. Typical cross-section details of preformed seals used in Kentucky are shown on Standard Drawing G353E, and material and installation requirements are contained in Special Provision 37-A, both of which are contained in the Appendix.

To install preformed neoprene seals, the seals must be compressed and forced into the joint and special equipment (Figures 37, 38, and 39) has been developed for use in the operation. A lubricant-adhesive consisting of liquid neoprene is applied to the sides of the seal and oftentimes to the joint faces prior to insertion. The lubricant-adhesive aids in the insertion of the seal and creates a bond between the seal and joint faces. This bond helps prevent the seal from moving vertically; however the adhesive is not of sufficient strength to place the seals in tension as the joints open significantly.

Installation of the seal in the curb and plinth presents a problem because the seal's rigidity makes bending difficult. Three 90° bends are required at each curb and plinth, and a skewed bridge joint requires an additional longitudinal bend at each curb (Figure 40). No tool is available for installation of the seal at such points.

One of the most common installation abuses is excessive stretching of the seal during installation. Stretching reduces the cross-sectional area of the seal and makes installation easier, but with time, the seal may creep out of the joint (Figure 41) or tear (Figures 42 and 43). Stretching should be limited to 5 percent and factory or field splices should not be premitted in bridge joints.

Properly installed preformed neoprene seals may prevent water from leaking through the joint but may allow ponded water, caused by saturated debris or puddling, to soak through the joint. If the seal is seated at an elevation lower than 1/4 inch below the deck surface (Figures 44 and 45), the joint will trap water which may eventually soak into the joint. Neoprene seals in sawed joints are most often placed too close to the surface. The seal may be torn out of the joints by traffic (Figures 46 and 47) under such circumstances.

Formed joints present sealing problems since the constructed widths may vary from joint to joint and also from point to point within the same joint. Recommended seal widths are 1/6th inch wider than the constructed joint width plus the anticipated annual change in width. Some seals have been observed as being too narrow to seal the joint in some areas (Figure 48) but sufficiently large to seal other areas (Figure 49). Spalling may also decrease the effectiveness of the compression seal (Figures 50, 51, and 52) in formed and sawed joints. Spalling of some joints has been of sufficient depth to expose the bottom of the preformed seal (Figure 51).

Preformed neoprene seals have been utilized in AE-1 armored- edge joints with relatively good success. The proper width seal installed 1/4th inch below the surface in a joint of uniform width performs satisfactorily and prevents leakage. If the seal should be pushed downward in the joint such that water and debris become trapped, water has been observed to leak through the joint in these areas. Observations of recent installation of the AE-2 armored-edge joint indicate that the steel step will support the seal at the proper elevation so water and debris cannot become trapped.

CONCLUSIONS AND RECOMMENDATIONS

Liquids which seep through deck joints are quite detrimental to the structure and appearance of the bridge. To prevent liquids from seeping through the joint, a compatible combination of joint and sealant must be used. For the combination to function properly, the joint must not spall, and the sealant must remain in contact with the joint faces and remain pliable and resilient at all temperatures.

Formed or sawed joints have not proven satisfactory in combination with any type of sealant since they inevitably spall. The ED-2 expansion dam does not spall and will provide an effective joint. The sealant that must be utilized with this type of joint will not endure and the joint has always been observed to leak. Uniform width, good alignment, and elimination of spalling associated with armored-edge joints has led to this type being considered as the most suitable presently available.

Adhesive sealants which are used in conjunction with copper and plastic waterstops are in many instances only partially effective in preventing the flow and seepage of water through the joints. After one year of service, loss of adhesion, development of brittleness, and impregnation of rock particles are associated with these sealants, thereby for use in any type of joint.

Elimination of these undesirable physical characteristics has been achieved with compressed neoprene (polychloroprene) rubber seals, but satisfactory performance has not always been obtained. Improper installation and use in variable width and irregularly aligned joints are the primary causes of unsatisfactory service. Use of neoprene seals in sawed or formed joints has not proven satisfactory and the additional cost of neoprene seals is not justified for use in such joints. On the other hand, indications are that neoprene seals will perform the intended functions in armored-edge joints, and the increased cost of this type of joint and seal may be justified from the standpoint of reduced maintenance. AE-2 armored-edge joints sealed with preformed neoprene are expected to be the best combination since the seal is supported at the proper elevation at all times by the ledge on the joint faces.

Formed joints should be eliminated entirely from future construction and where design warrants, sawed joints (1/4-inch maximum width) sealed with adhesive sealants should be used only when other designs are not applicable. AE-2 armored-edge joints properly sealed with the preformed neoprene seals should be used in all other instances.

APPENDIX

INSTALLATIONS OF
COMPRESSED NEOPRENE SEALS IN KENTUCKY

County	Road Description	Date of Installation	Type Joint
Fayette	Newtown Pike over New Circle Road	1964	AE-1
Jefferson	I 264 over US 60	1963	Formed
Jefferson	I 64, 3rd Street to Preston Street	1965	Sawed
Jefferson	Clark Memorial Bridge over Ohio River	1968	AE-1,AE-2, Sawed
Hart	I 65 over Green River	1965	Sawed
Lee	Ky 52 over Kentucky River		Formed
Woodford	BG Parkway over US 60, Sta. 3973+77	1965	AE-1
Woodford	Huntertown Road over BG Parkway, Sta. 3893+12	1965	Formed
Woodford	Ky 33 over BG Parkway, Sta. 3821+40	1965	Formed
Woodford	McCowans Ferry Road over BG Parkway,Sta. 3686+43	1965	Formed
Woodford	BG Parkway over Kentucky River, Sta. 3483+13	1965	AE-1,Formed
Anderson	US 127 over BG Parkway, Sta. 3265+17	1965	Sawed
Anderson	BG Parkway over Southern R.R., Sta. 3224+24	1965	Formed
Anderson	Johnson Road over BG Parkway, Sta. 3198+40	1965	Formed
Mercer	BG Parkway over Salt River, Sta. 3133+18	1965	Formed
Mercer	BG Parkway over Cheese Lick Road, Sta. 2898+70	1964	Formed
Anderson	Duggansville Road over BG Parkway, Sta. 2885+00	1964	Formed
Anderson	Cardwell Road over BG Parkway, Sta. 2836+77	1964	Formed
Anderson	Hoophole Road over BG Parkway, Sta. 2785+04	1964	Formed
Anderson	Ky 53 over BG Parkway, Sta. 2685+86	1965	Formed
Anderson	Sea Roadover BG Parkway, Sta. 2616+34	1965	Formed
Washington	Sulphur Creek Road over BG Parkway, Sta. 2461+50	1964	Formed
Washington	BG Parkway over Chaplin River, Sta. 2316+29	1965	Sawed
Washington	BG Parkway over Chaplin River Sta. 2167+65	1965	Sawed
Nelson	Ky 458 over BG Parkway, Sta. 2081+77	1965	Formed
Nelson	Milton Brown Road over BG Parkway, Sta. 1736+00	1965	Formed
Nelson	Stringtown-Beech Fork Rd.over BG Pkwy,Sta.1628+00	1965	Formed
Nelson	BG Parkway over L & N R.R., Sta. 1543+91	1965	Formed
Nelson	Ky 605 over BG Parkway, Sta. 1513+40	1964	Formed
Nelson	US 150 over BG Parkway,Sta. 1391+02	1965	Formed
Nelson	BG Parkway over Cross Road No.2, Sta. 1337+00	1965	Formed
Nelson	Ky 49 over BG Parkway, Sta. 1273+90	1965	Formed
Nelson	BG Parkway over Beech Fork River, Sta. 1236+00	1965	Formed
Nelson	US 31-E over BG Parkway, Sta. 1178+96	1964	Formed
Nelson	BG Parkway over Beech Fork River, Sta. 1028+90	1964	Formed
Nelson	BG Parkway over Beech Fork River, Sta. 736+95	1965	Formed
Nelson	BG Parkway over Ky 52, Sta. 606+58	1965	Formed
Nelson	BG Parkway over Rolling Fork River, Sta. 579+65	1965	Formed
Jefferson	I 71 and I 264 Interchange	1967	AE-2
Jefferson	Jefferson Freeway over I 71	1967	Sawed
Jefferson	Springdale Road over I 71, Sta. 239+56	1967	Sawed
Jefferson	I 71 over Blankenbaker Lane, Sta. 518+60	1967	AE-2
Oldham	Ky 146 over I 71, Sta. 705+62	1967	AE-2
Oldham	I 71, Sta. 936+36	1967	Sawed
Oldham	Ky 53 over I 71, Sta. 937+51	1967	Sawed
Carroll	I 71 over Mill Creek Road Sta. 1869+43	1967	AE-2
Carroll	I 71 over Mill Creek Road Sta. 1871+21	1967	AE-2
Carroll	Ky 389 over I 71, Sta. 2052+50	1967	AE-2
Carroll	I 71 over Kentucky River, Sta. 2115+85	1967	AE-1
Carroll	I 71 over US 227, Sta. 2133+25	1967	AE-2
Carroll	Ky 36 over I 71, Sta. 2363+87	1967	AE-2
Gallatin	I 71 over Ky 35, Sta. 2765+33	1967	Formed
Gallatin	US 127 over I 71, Sta. 3020+00	1967	AE-1
Gallatin	I 71 over Tapering Point Road, Sta. 3112+71	1967	AE-1
Gallatin	I 71 over Little Sugar Road, Sta. 3217+50	1967	AE-1
Gallatin	I 71 over Roberts Road, Sta. 3303+00	1967	AE-1
Gallatin	I 71, Sta. 3412+85	1967	Sawed
Gallatin	Baker Road over I 71, Sta. 3443+00	1967	AE-2
Boone	Ky 14 over I 71, Sta. 3563+93	1967	AE-2,Sawed
Boone	Ky 1292 over I 71, Sta. 3778+58	1967	AE-2
Boone	I 71 over I 75, Sta. 3805+67	1967	AE-2

OTHER EXPERIMENTAL INSTALLATIONS OF JOINTS AND SEALS IN KENTUCKY

Neoprene expansion dam; Clark Memorial Bridge, Jefferson County, MP 56-8118-7, installed 1967.

Aluminum expansion dam; Clark Memorial Bridge, Jefferson County, MP 56-8118-7, installed 1967.

Preformed, compressed neoprene seals in sawed concrete pavement joints; Eastern Kentucky Parkway, Powell County, EK 1-9, installed October 1962.

Preformed, cast-in-place neoprene seals in concrete pavement joints; US 127, Campbell County, F 367(10), installed November 1948.

Concrete pavement joint devices involving bress inserts and air chambers; US 421, Fayette County, FA 326-CS, installed 1938.

Cold-mastic joint filler for concrete pavements; US 42, Gallatin County, FI 197(6), installed summer 1952.

Cold-mastic joint filler for concrete pavements; US 68, Fayette County, F 369(4)24(3), installed 1947.

Aluminum load-transfer devices for concrete pavement joints; US 60, Shelby County, FI 117(22), installed fall 1950.

Aluminum load-transfer devices for concrete pavement joints; US 45 By-pass, McCracken County, U 586, installed September, 1949.

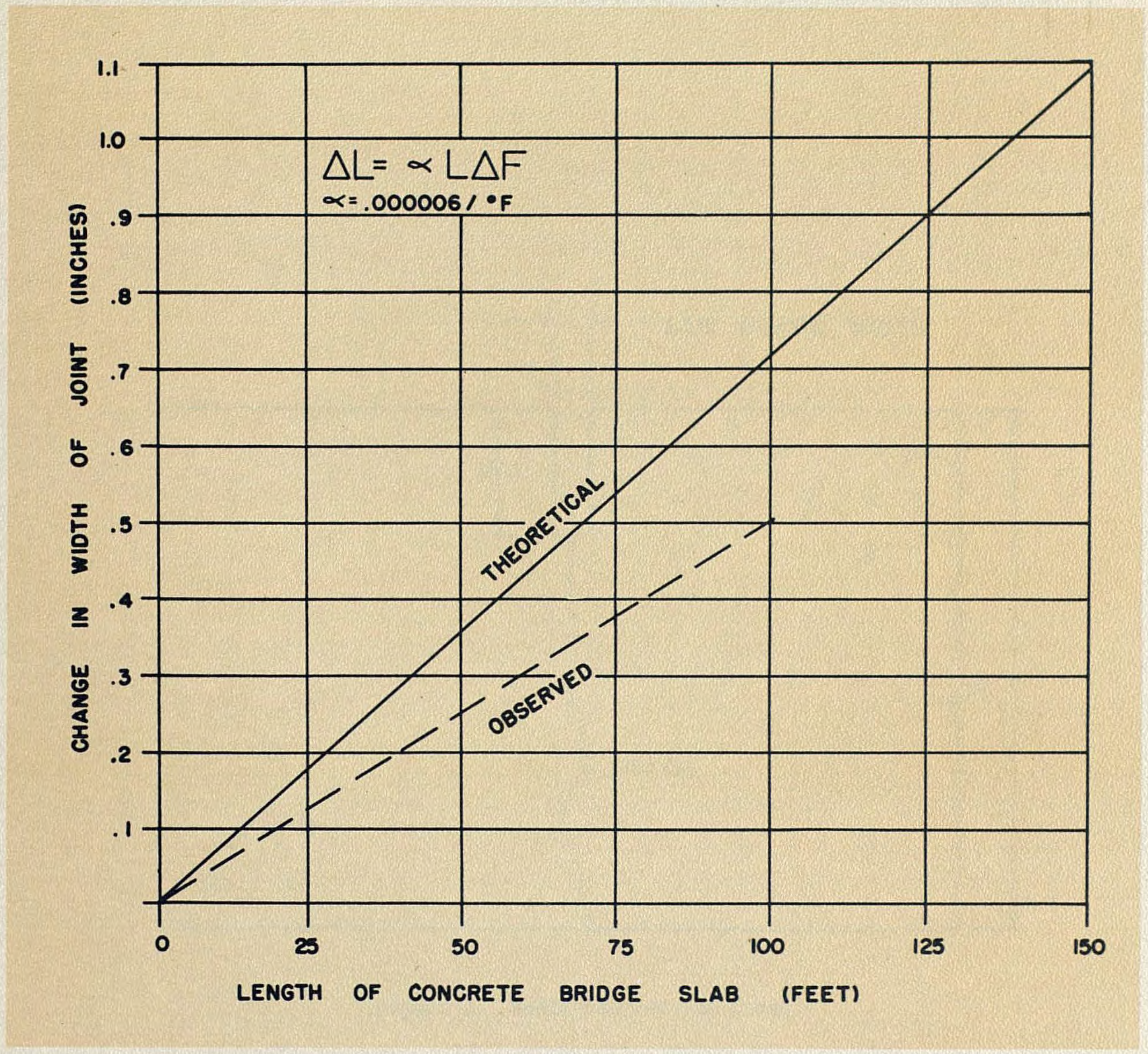


Figure 1. Change in Width of Joint for Varying Lengths of Concrete Slab Assuming 100°F Temperature Variation (Tons, Egons, "Factors in Joint Seal Design," Record No. 80, Highway Research Board, 1965).

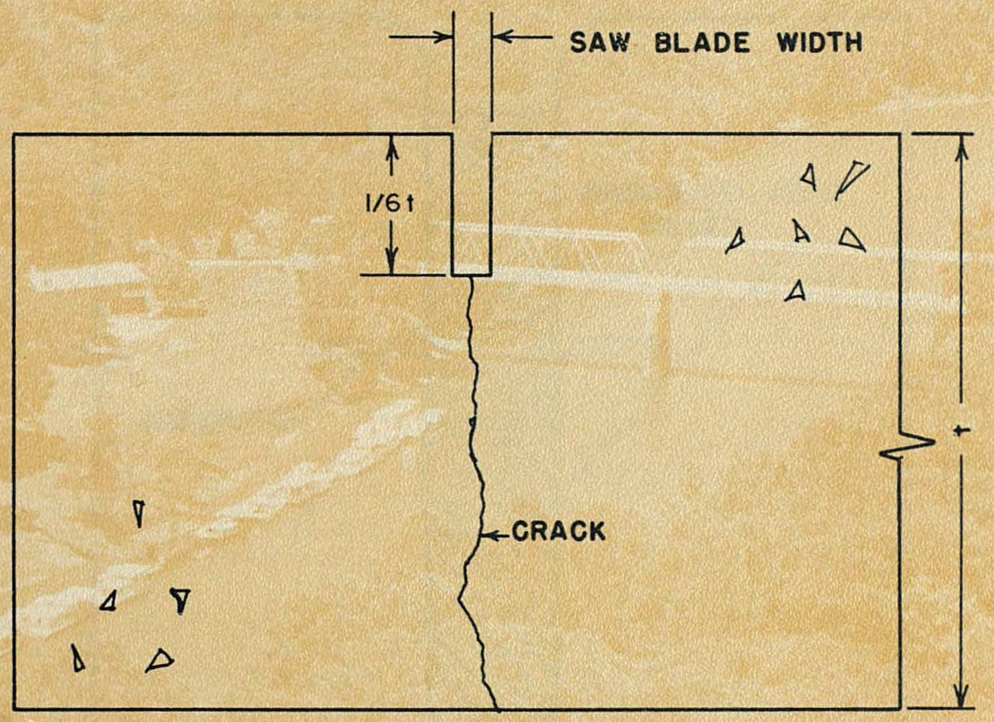


Figure 2. Sawed Contraction Joint.

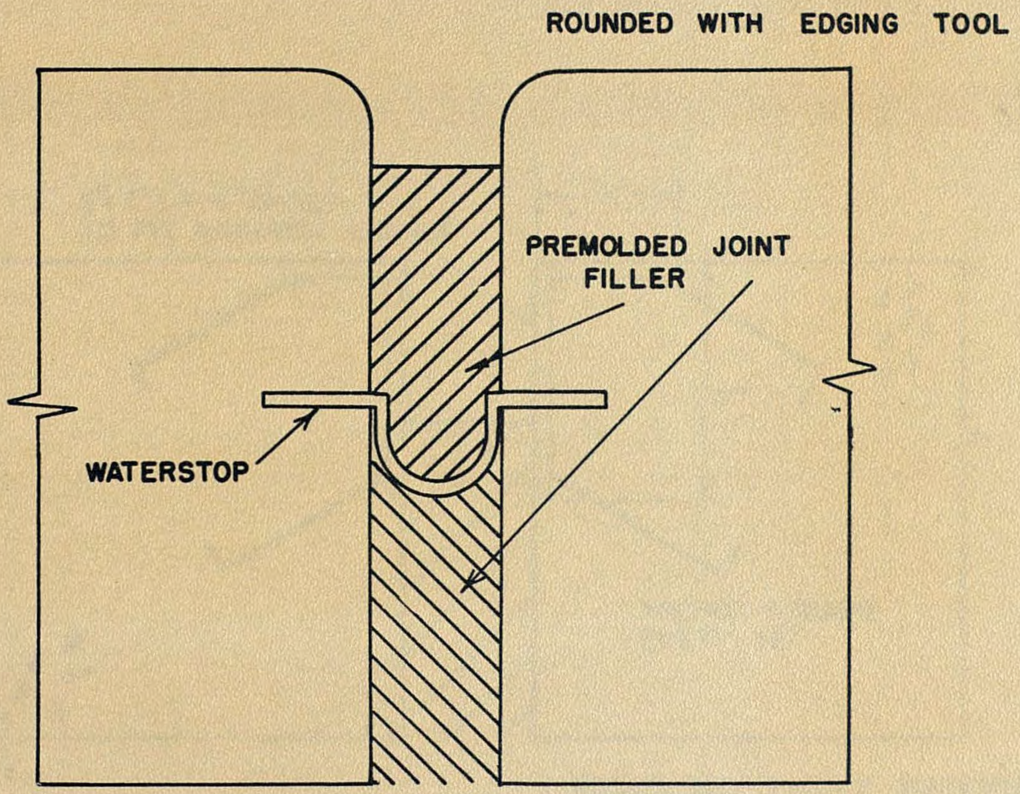


Figure 3. Formed Joint with Waterstop to Support Premolded Filler.

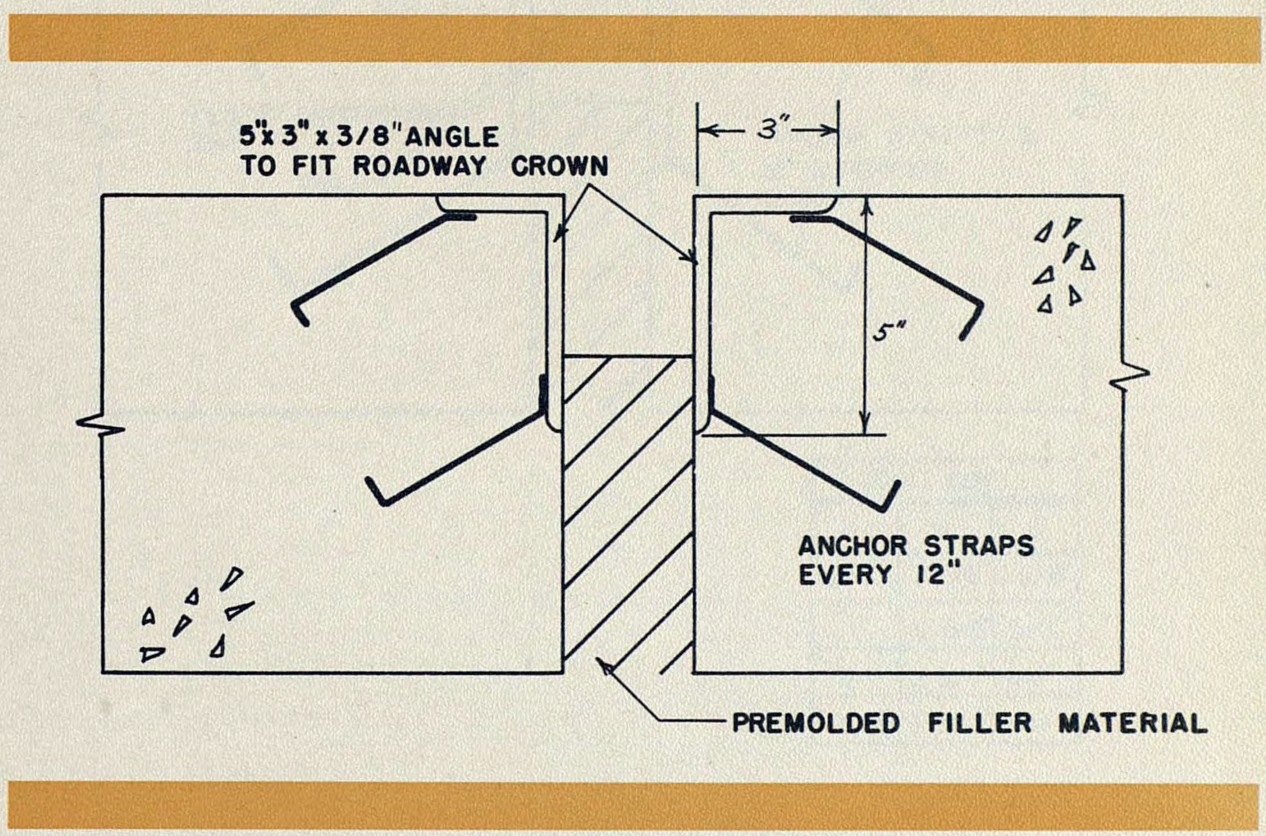
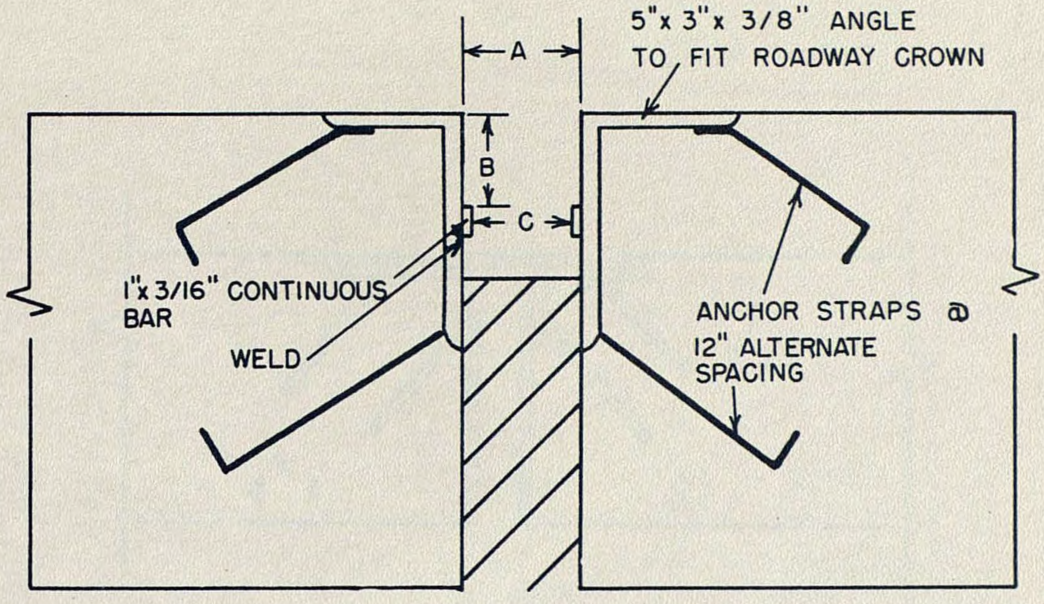


Figure 4. AE-1 Armored-Edge Joint.



JOINT SIZE		
A	B	C
3/4"	1 7/8"	3/8"
1"	2 5/8"	5/8"
1 1/4"	2 3/4"	7/8"
1 5/8"	3 3/8"	1 1/4"

Figure 5. AE-2 Armored-Edge Joint (Note seat provided for preformed, compressed neoprene seal).

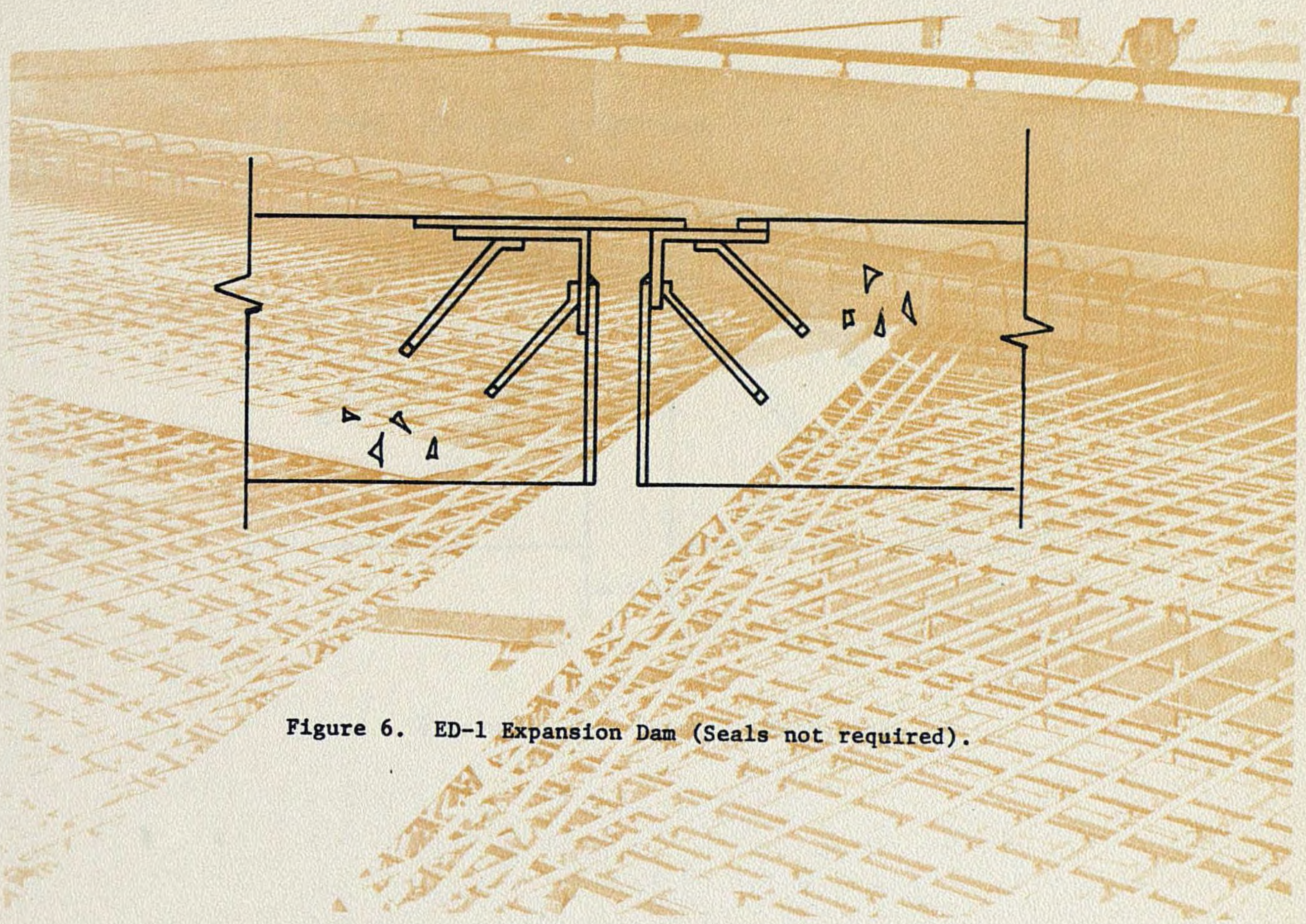


Figure 6. ED-1 Expansion Dam (Seals not required).

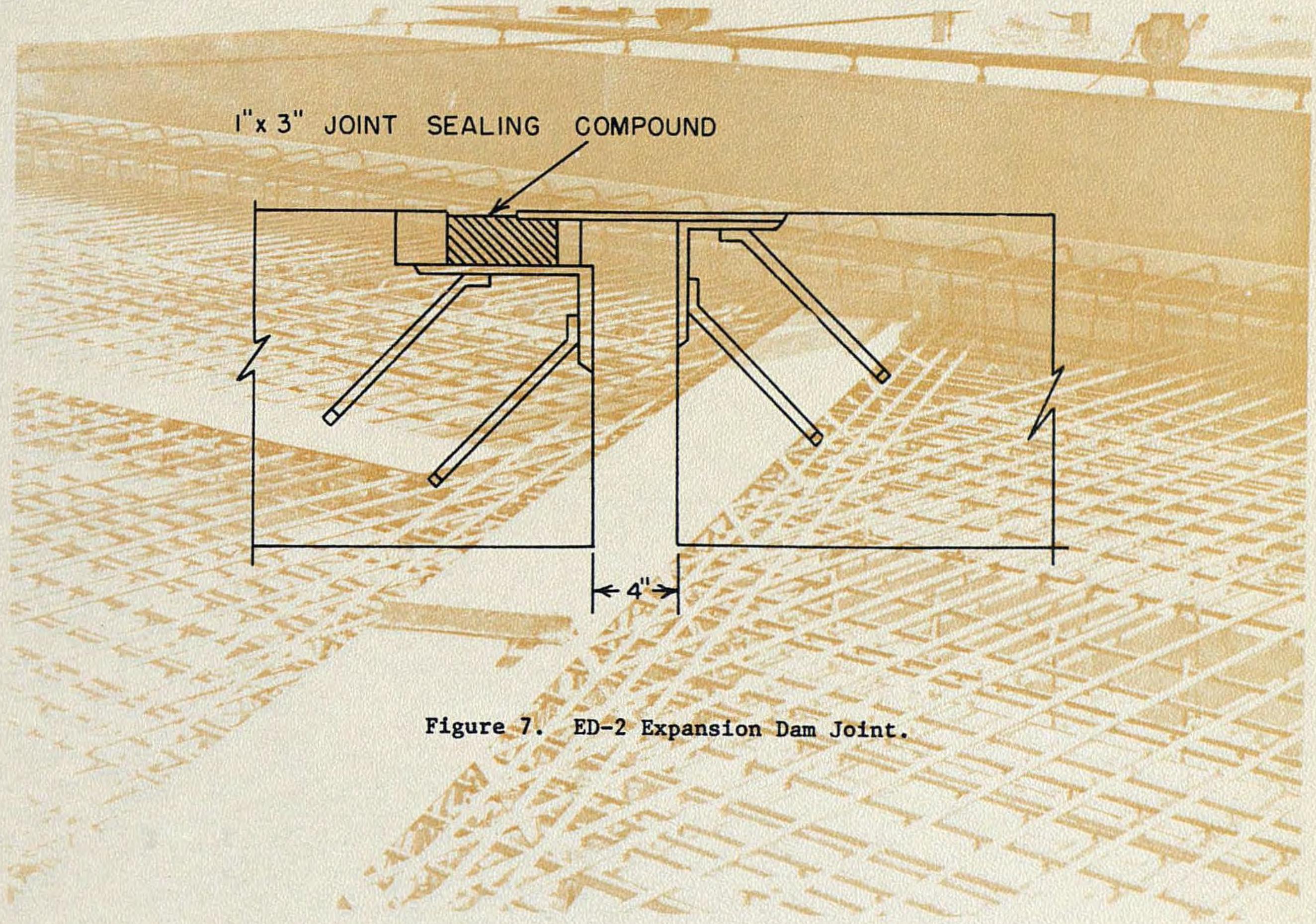


Figure 7. ED-2 Expansion Dam Joint.

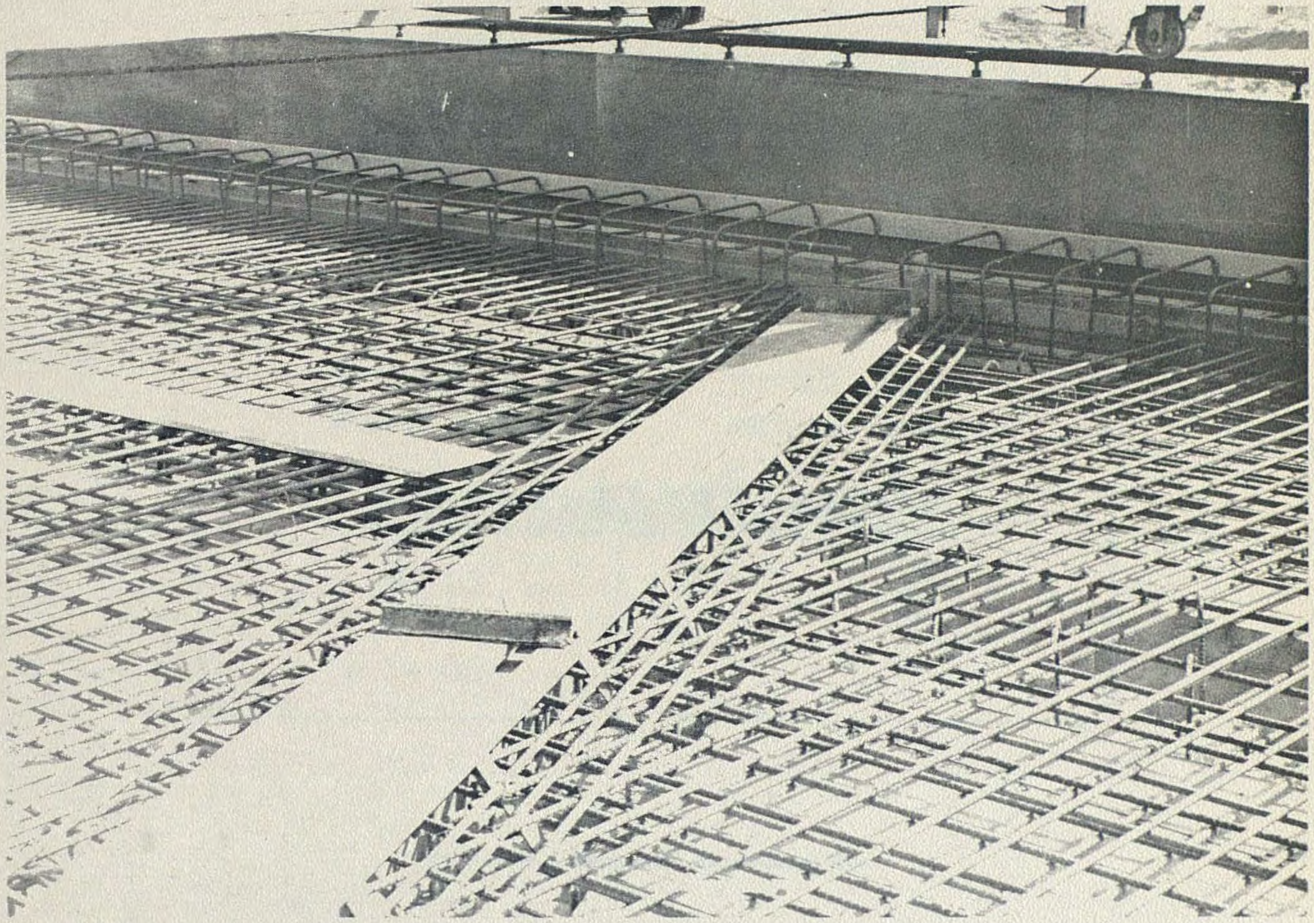


Figure 8. ED-2 Expansion Dam in Place.

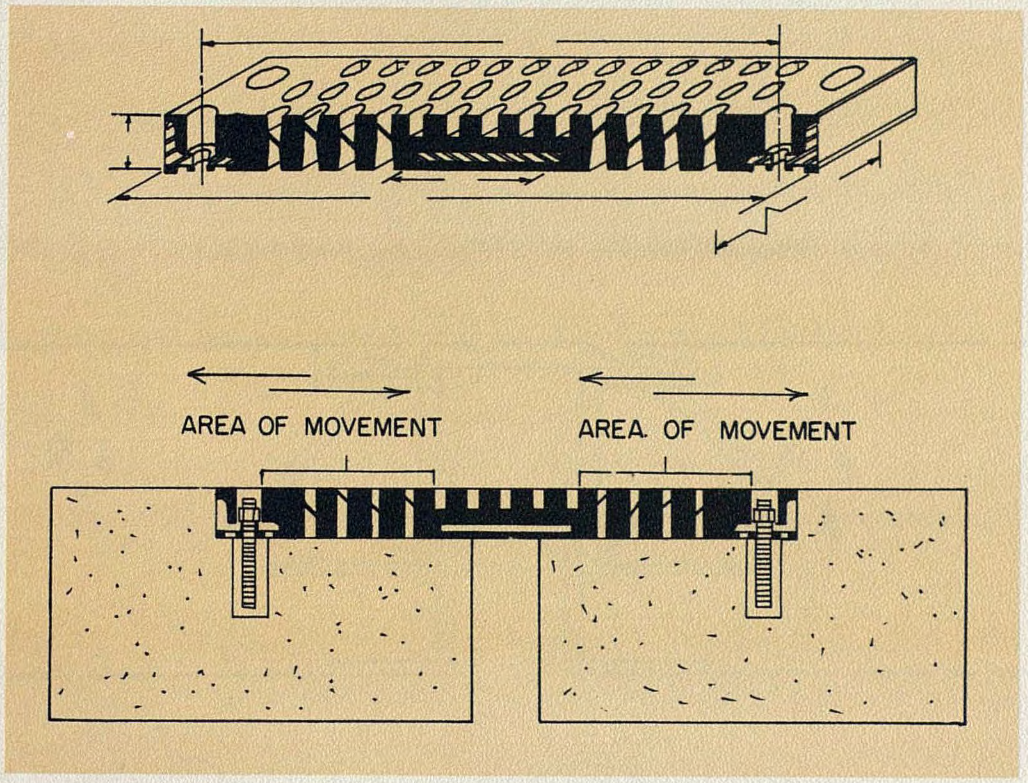


Figure 9. Neoprene Expansion Dam.

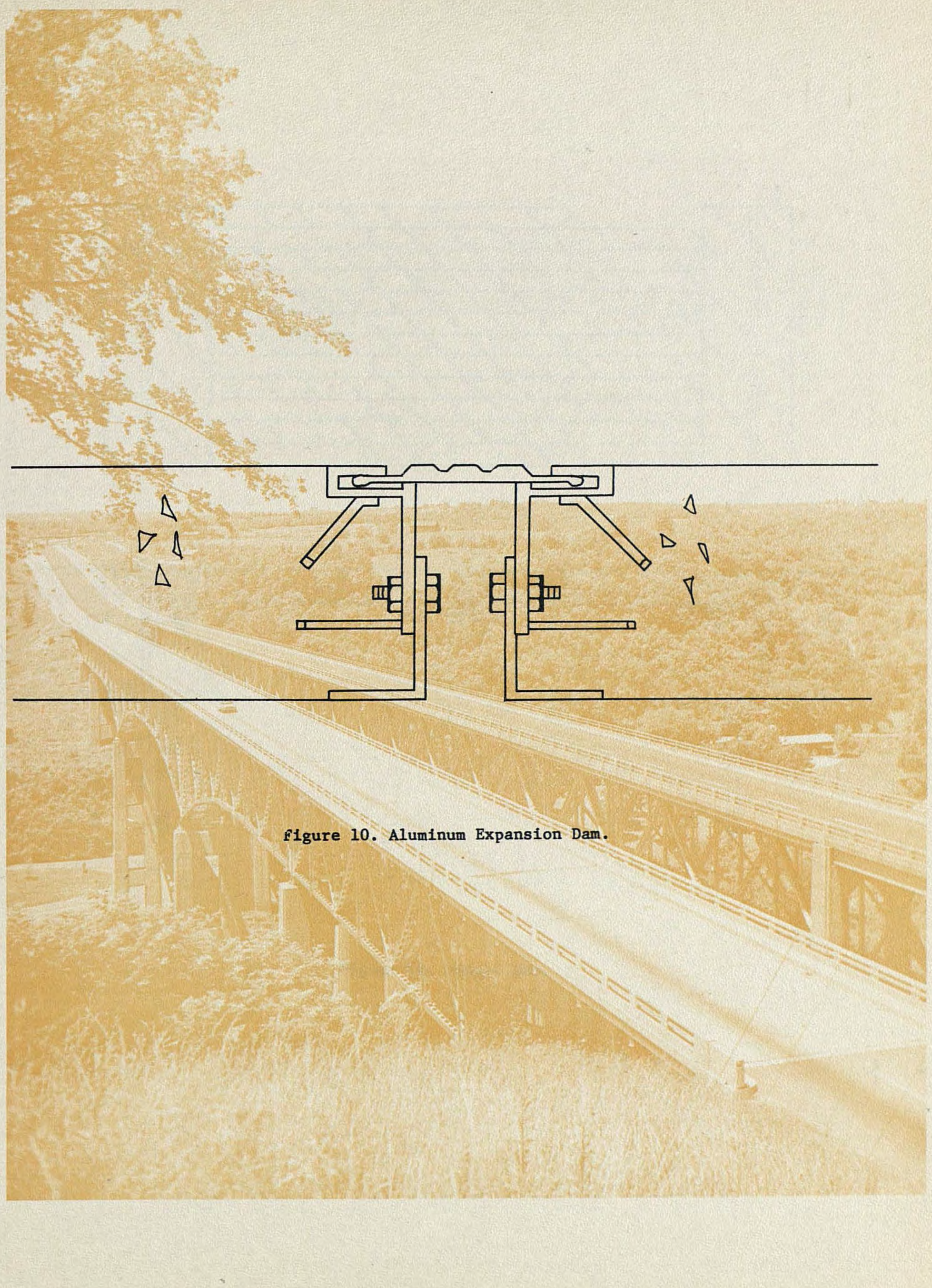


Figure 10. Aluminum Expansion Dam.

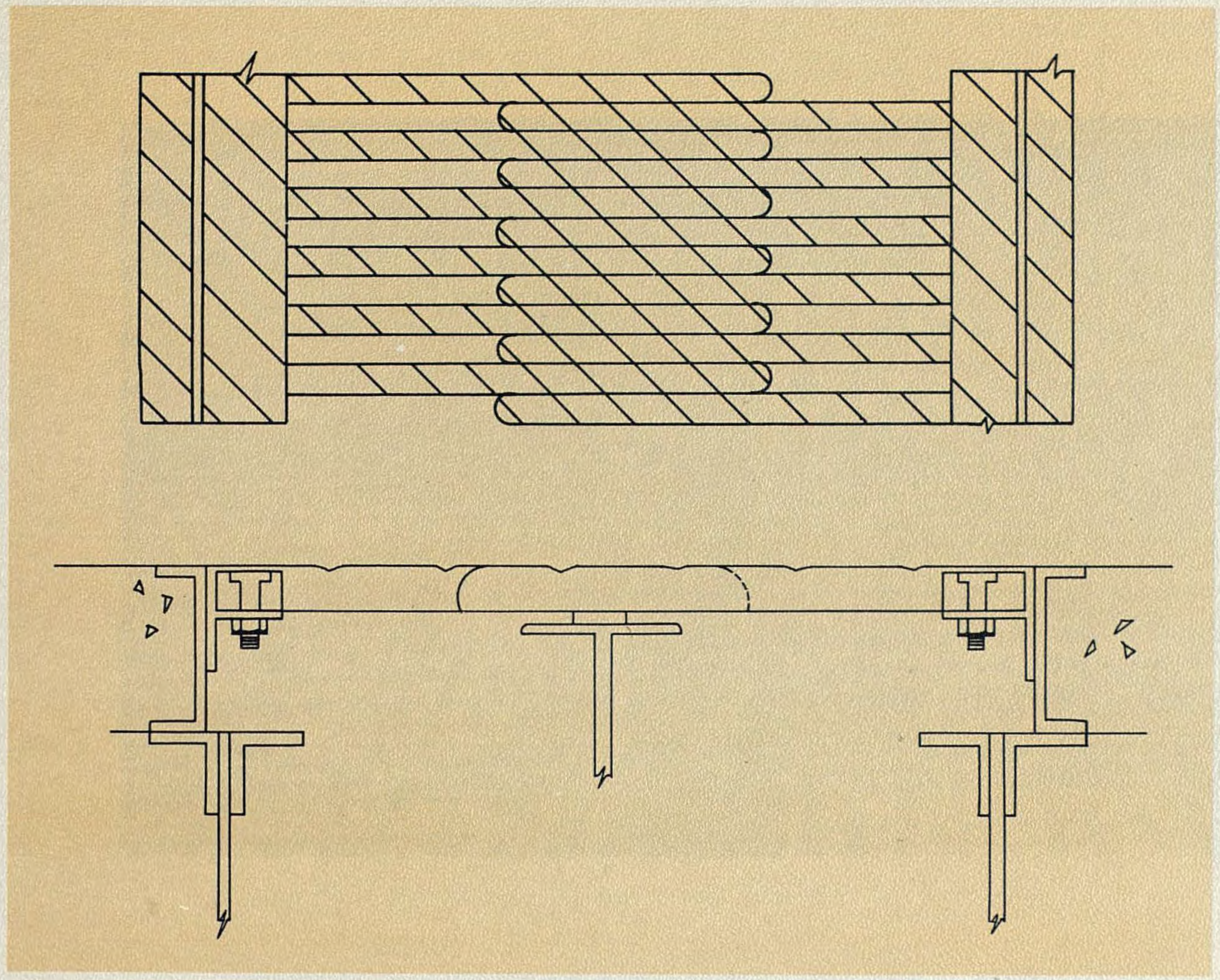


Figure 11. Finger Dam.

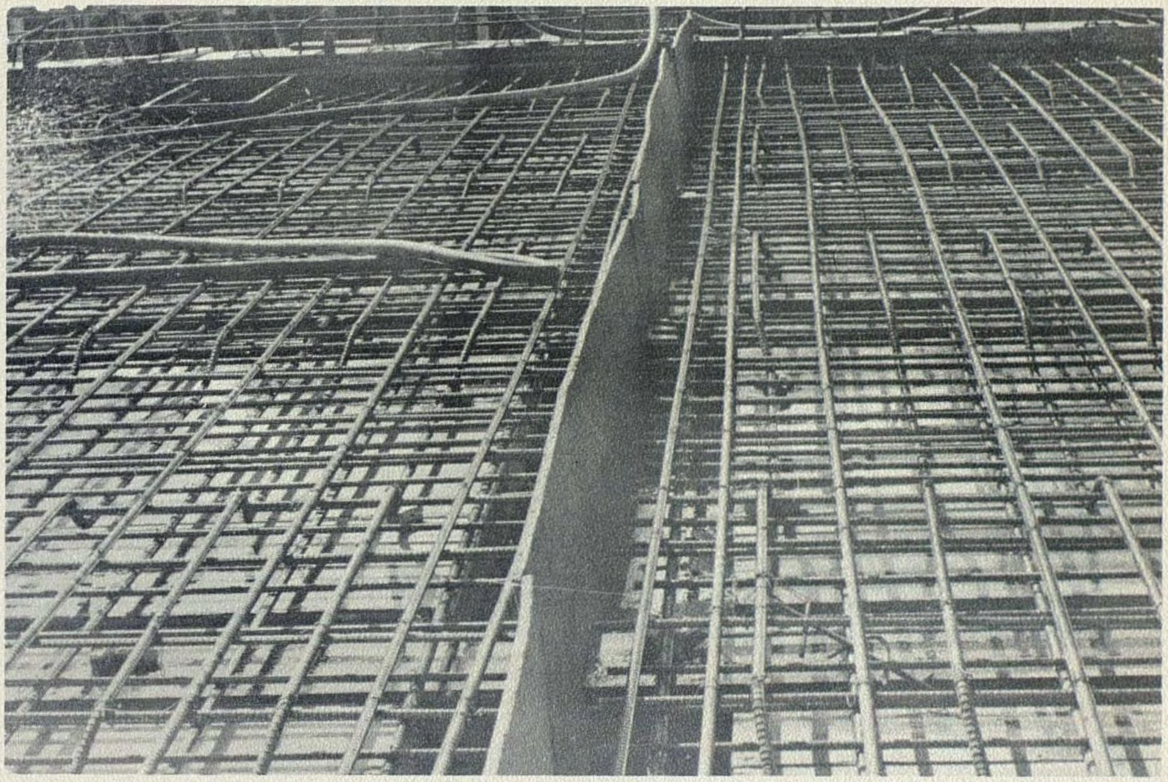


Figure 12. Premolded Joint Filler in Place (Material is tilted and out-of-line).

Figure 13. Concrete Placement around Premolded Joint Filler.

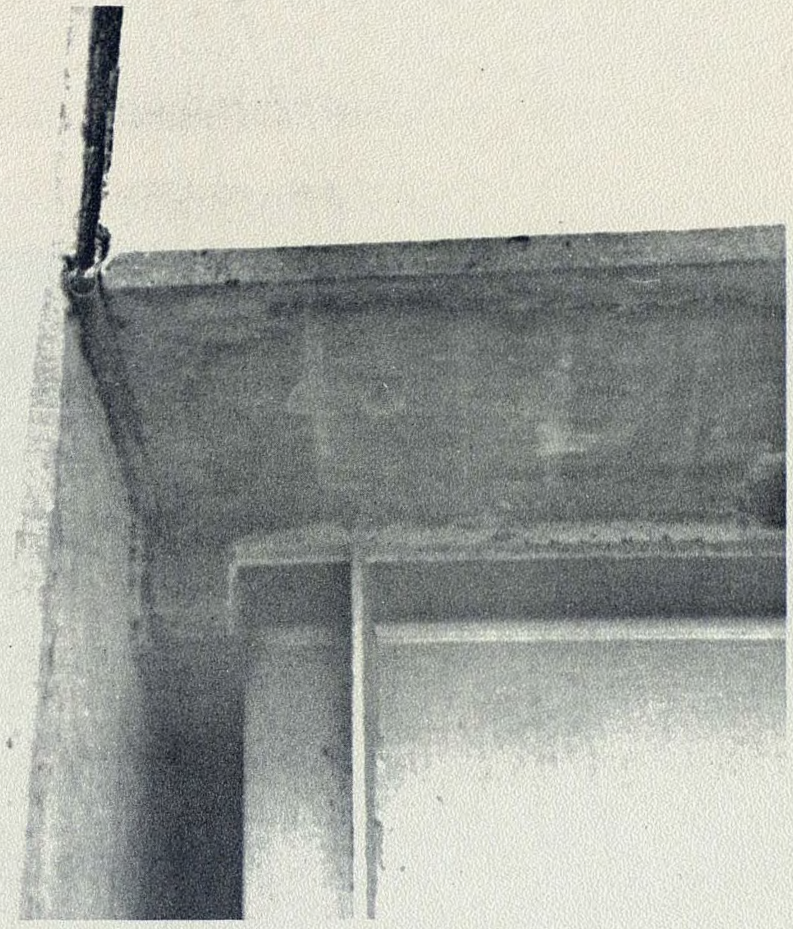


Figure 14. Copper Strip for Support of Premolded Joint Filler in Formed Joint.

Figure 15. Concrete in Place at Joint.

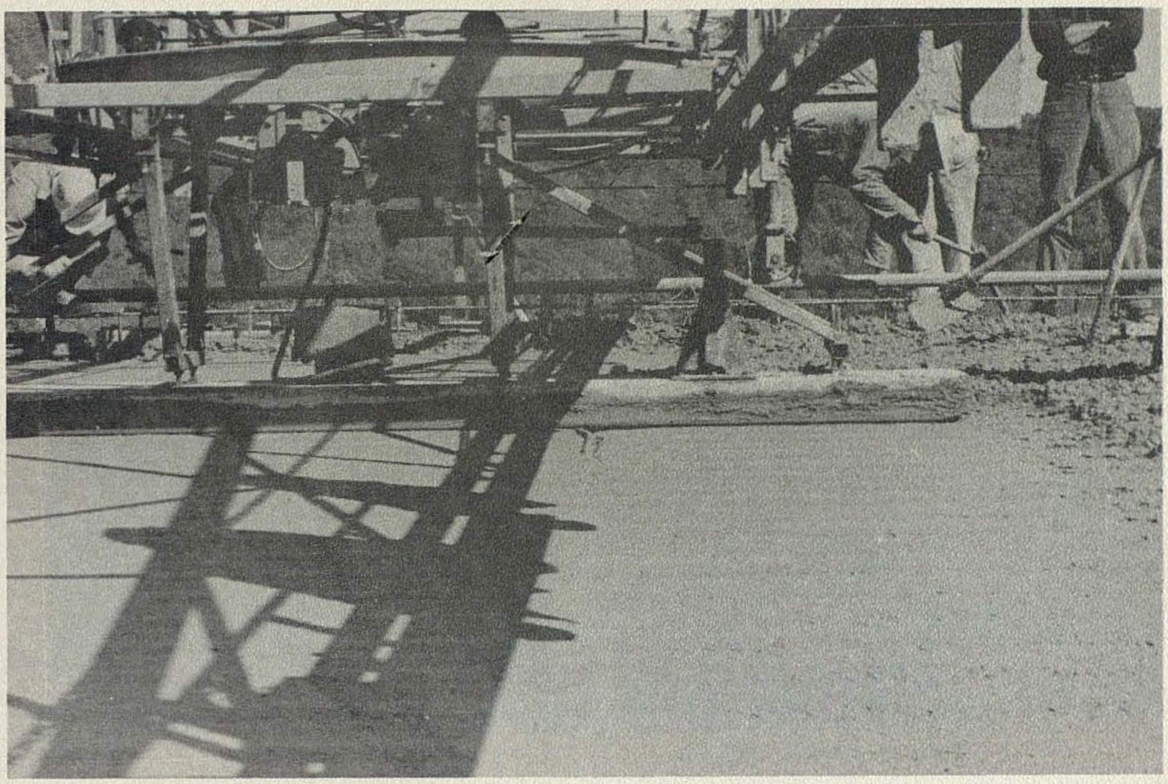


Figure 16. Concrete Screeding Operation at Joint (Joint filler being pulled by screed).

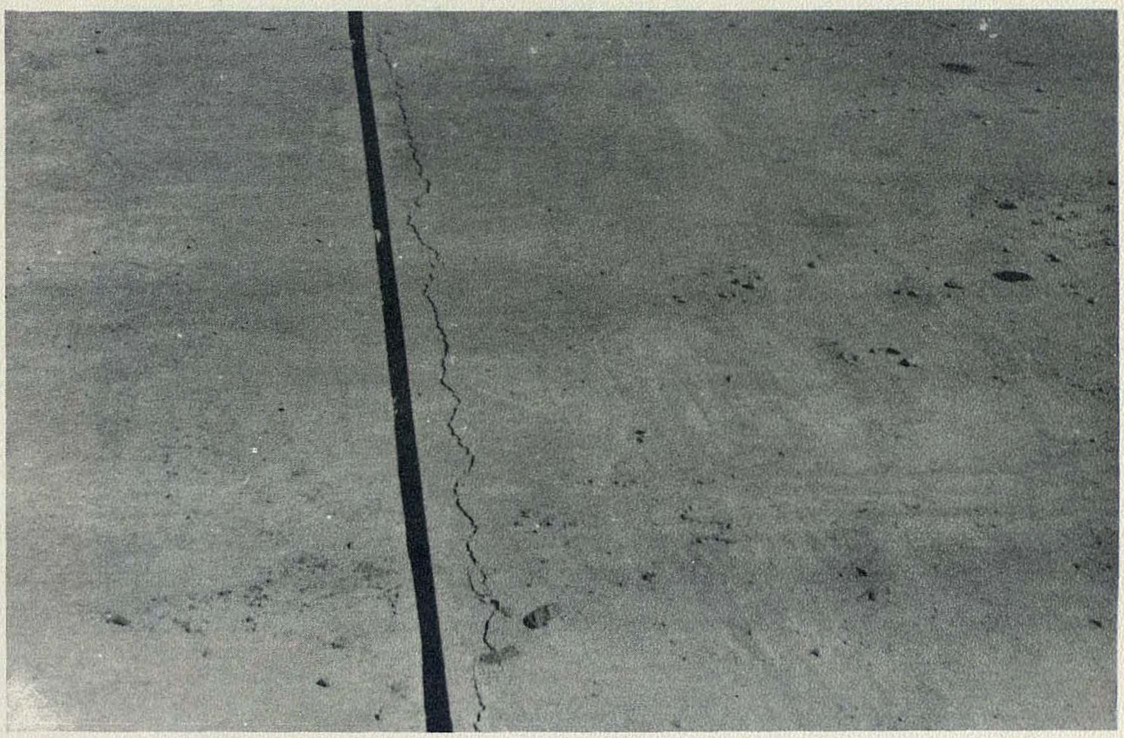


Figure 17. Cracked Concrete at Edge of Joint.

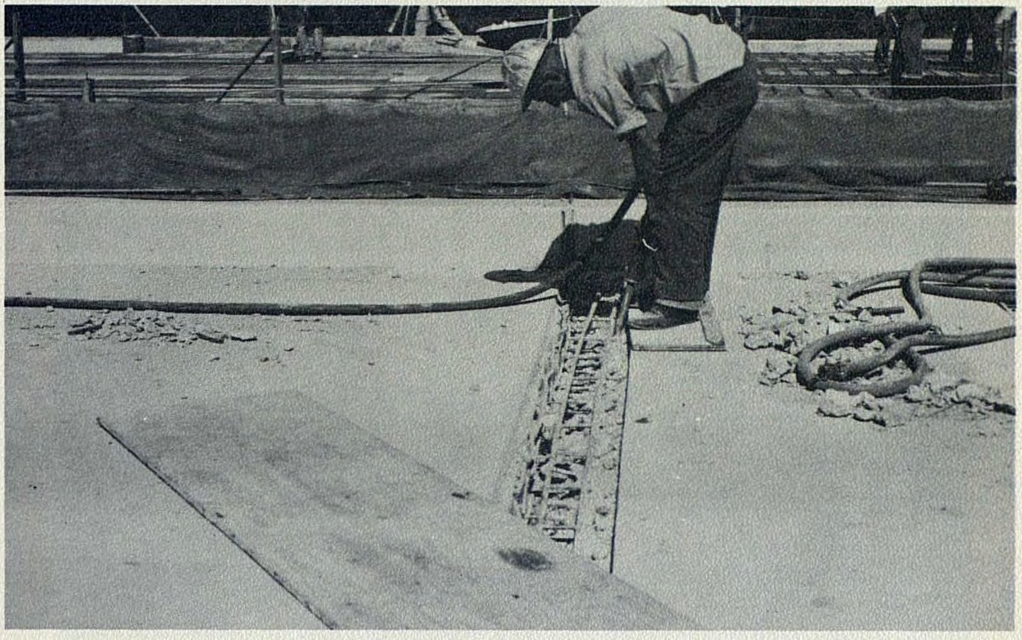


Figure 18. Repair of Joint Shown in Figure 12.

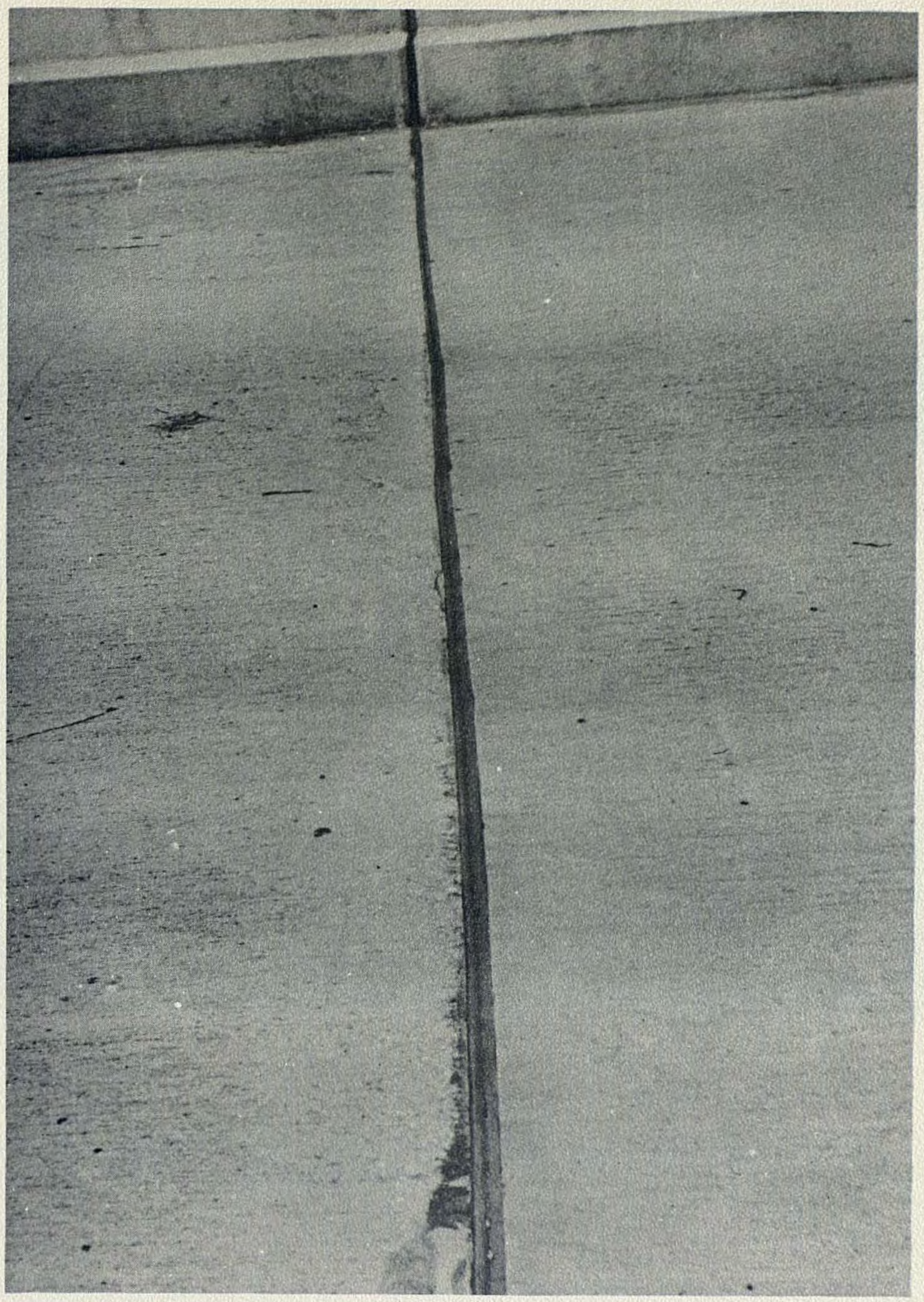


Figure 19. Formed Concrete Joint Sealed with Preformed Neoprene (Abrupt changes in joint width are apparent).

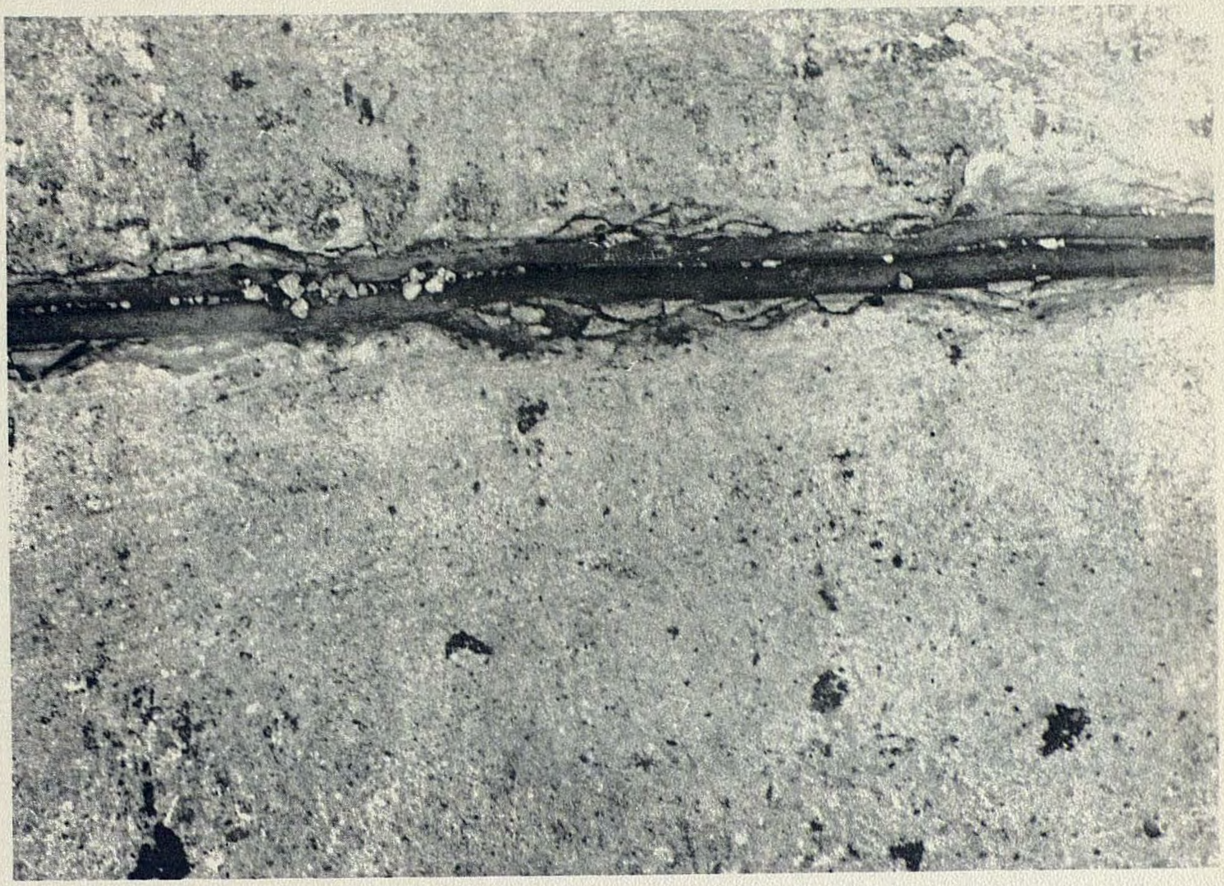


Figure 20. Formed Concrete Joint Sealed with Preformed Neoprene Seal (Joint is spalling badly).

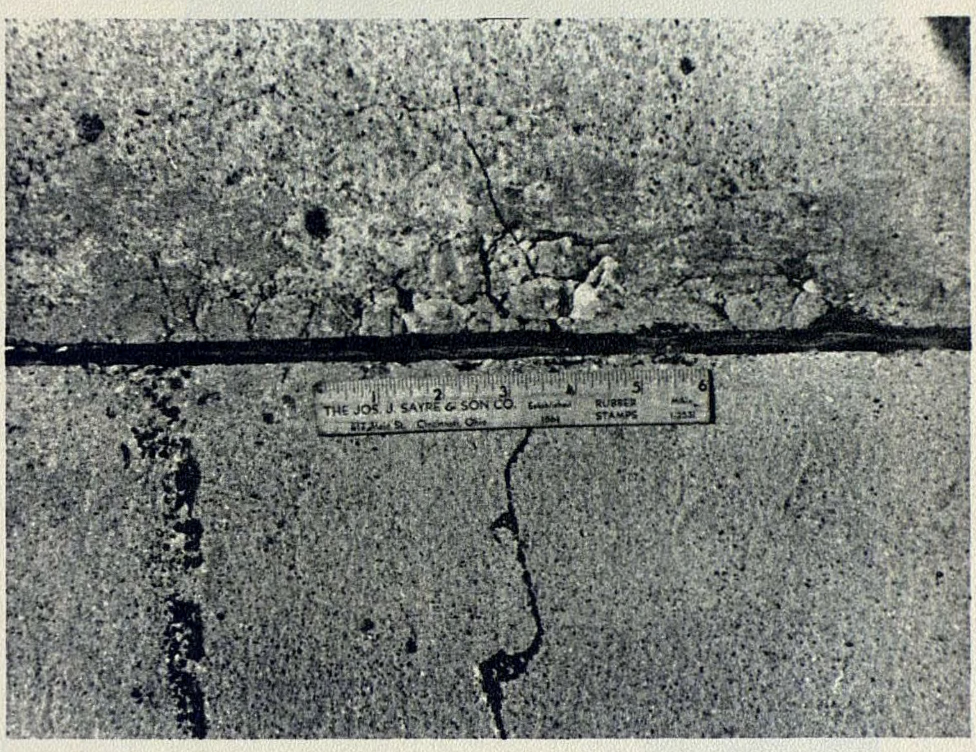


Figure 21. Spalling of Neoprene Sealed, Sawed Joint.

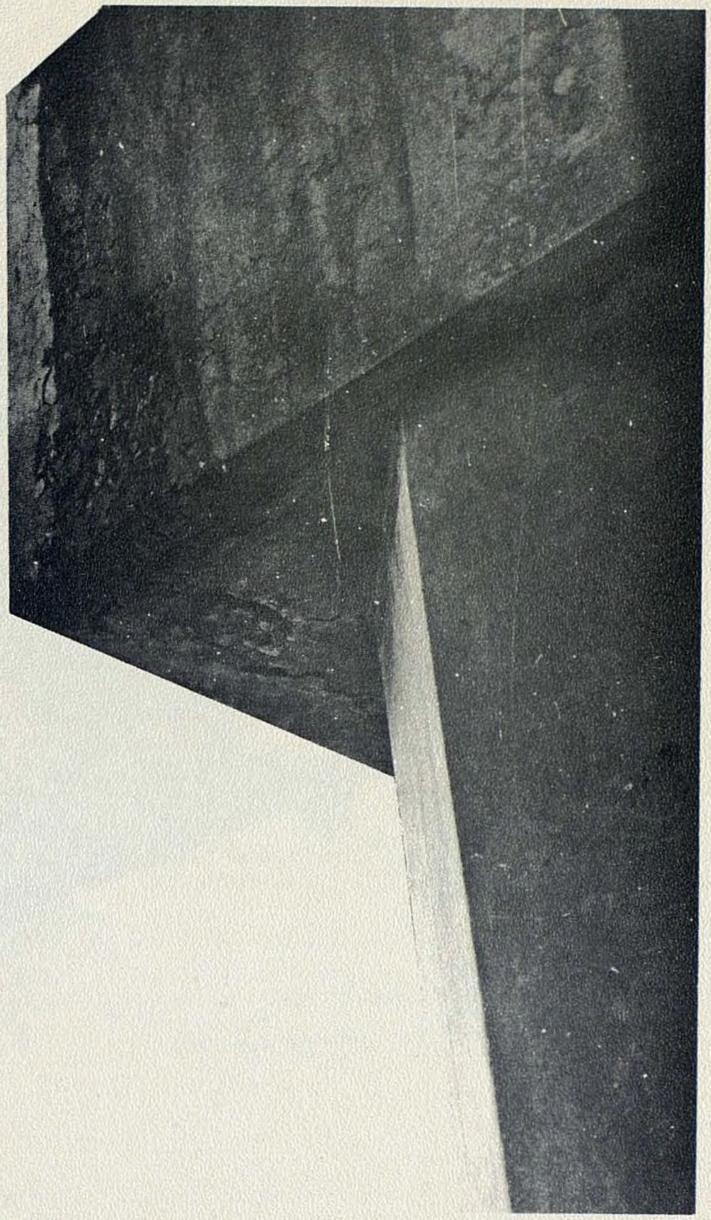


Figure 22. Deterioration of Bridge Pier Cap Caused by Leaking Joint.

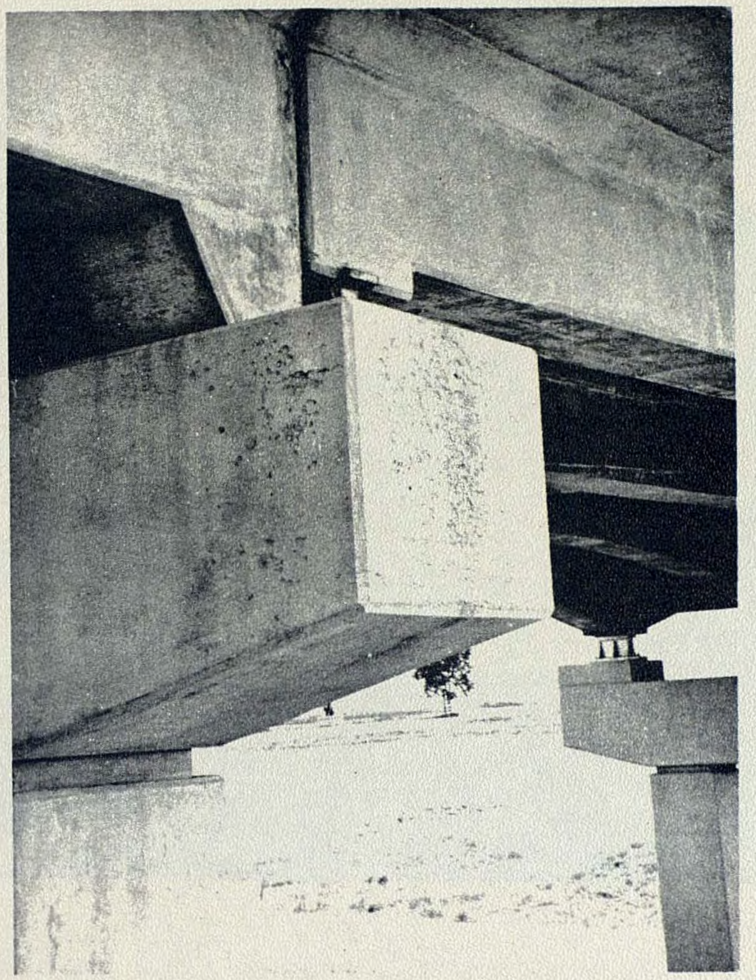


Figure 23. Scaling of Bridge Pier Cap Caused by Leaking Joint.

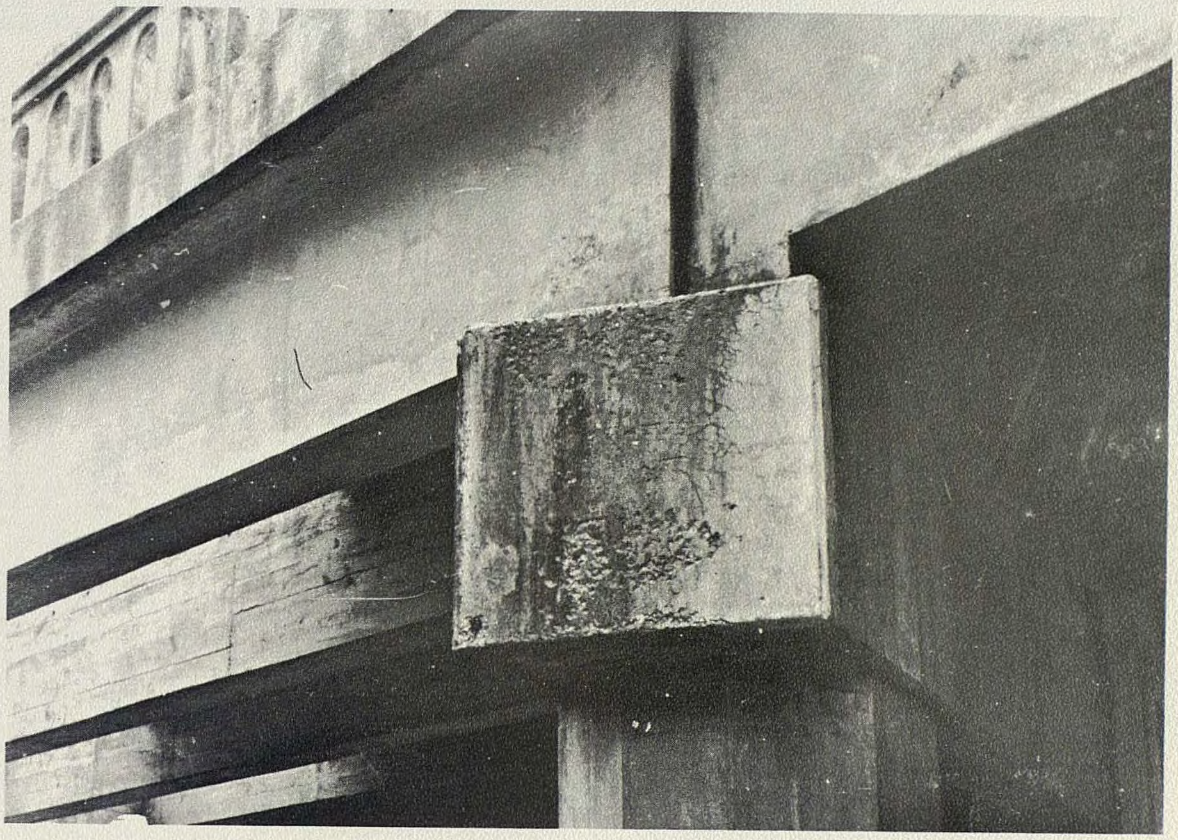


Figure 24. Deterioration of Bridge Pier Cap Caused by Leaking Joint.

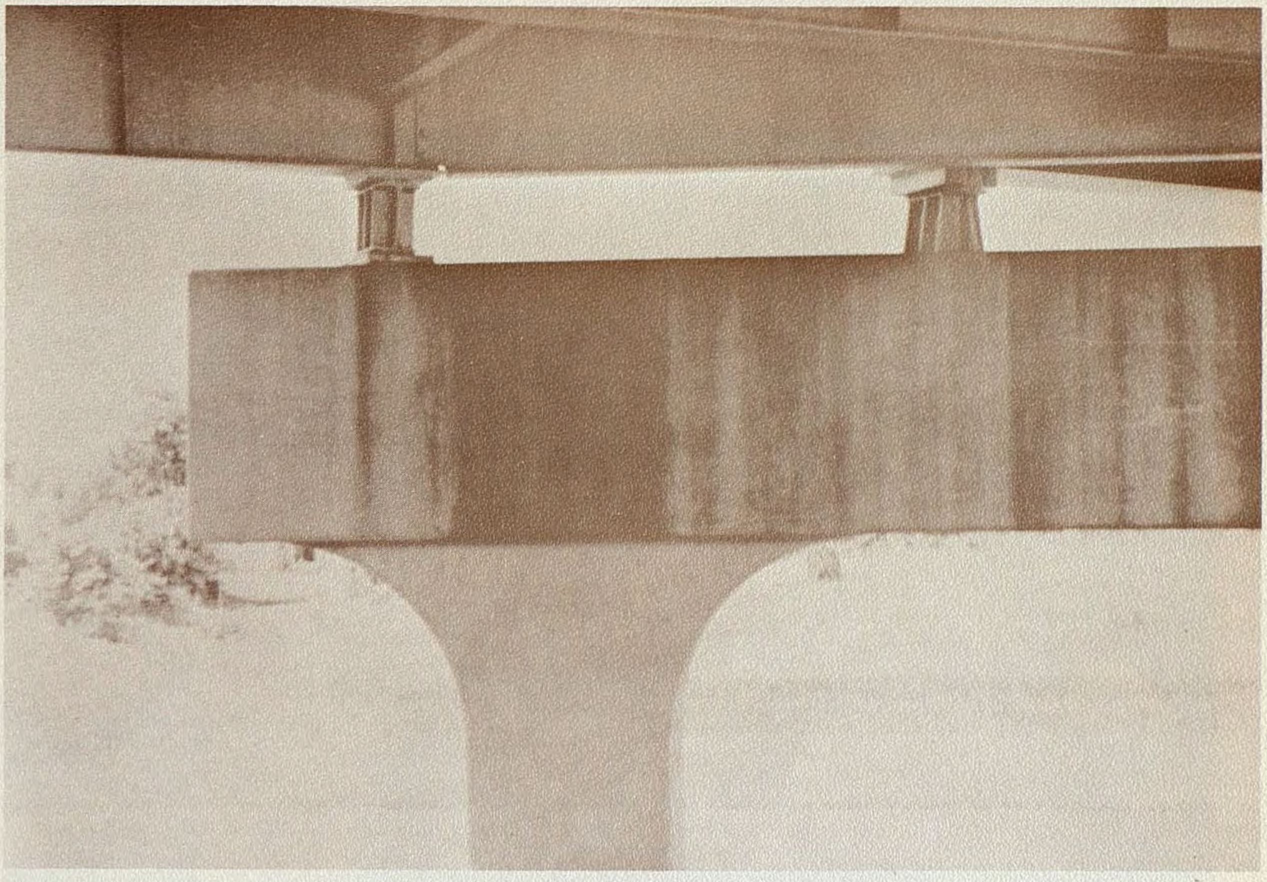


Figure 25. Unsightly Stains Caused by Leaking Joint.

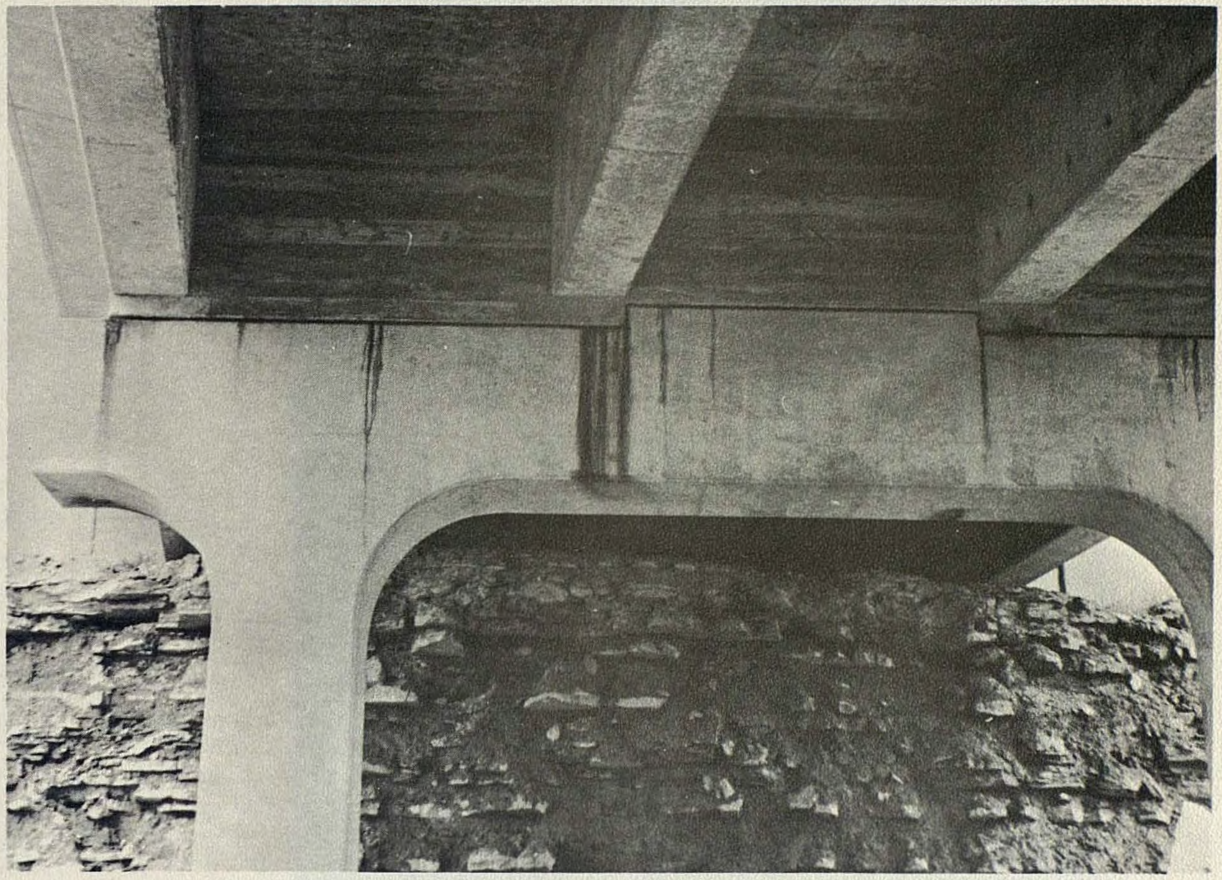


Figure 26. Staining of Concrete Bridge Pier Caused by Joint Shown in Figure 27.

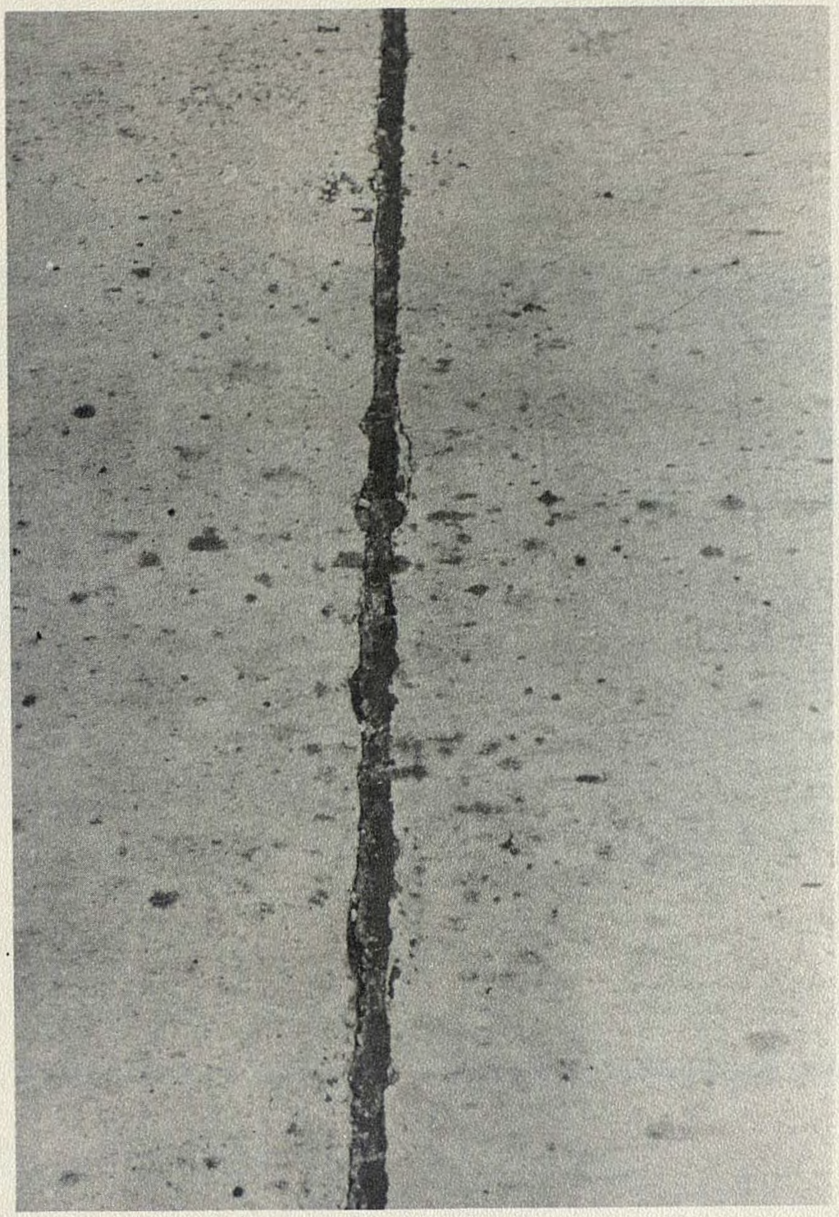


Figure 27. Failed Adhesive Sealant (Leaking joint has caused staining shown in Figure 26).

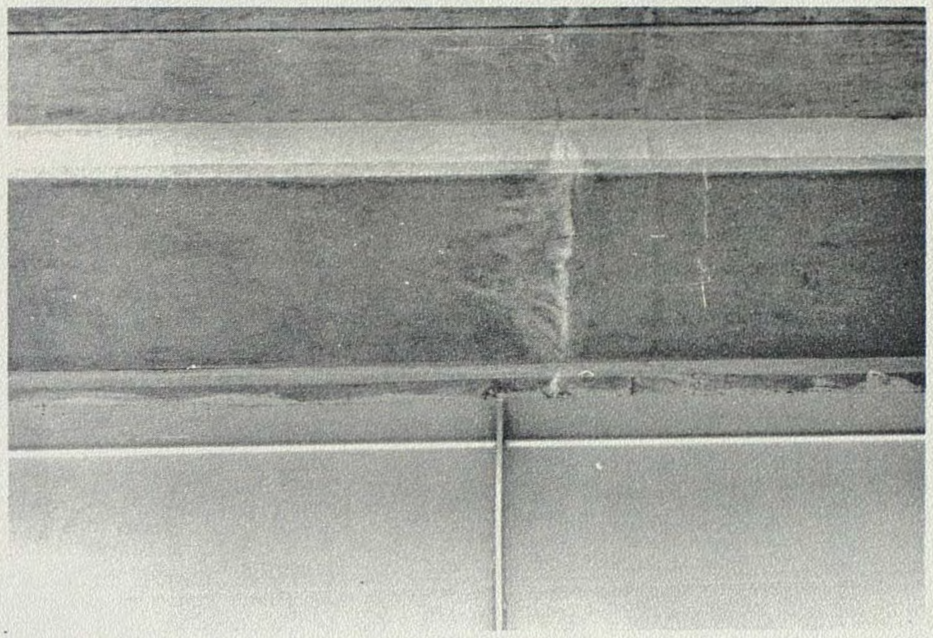


Figure 28. Efflorescence at Crack Under Plinth Due to Leaking Sawed Joint.

Figure 29. Erosion of Earth Fill at Bridge Abutment Caused by Leaking Joint.

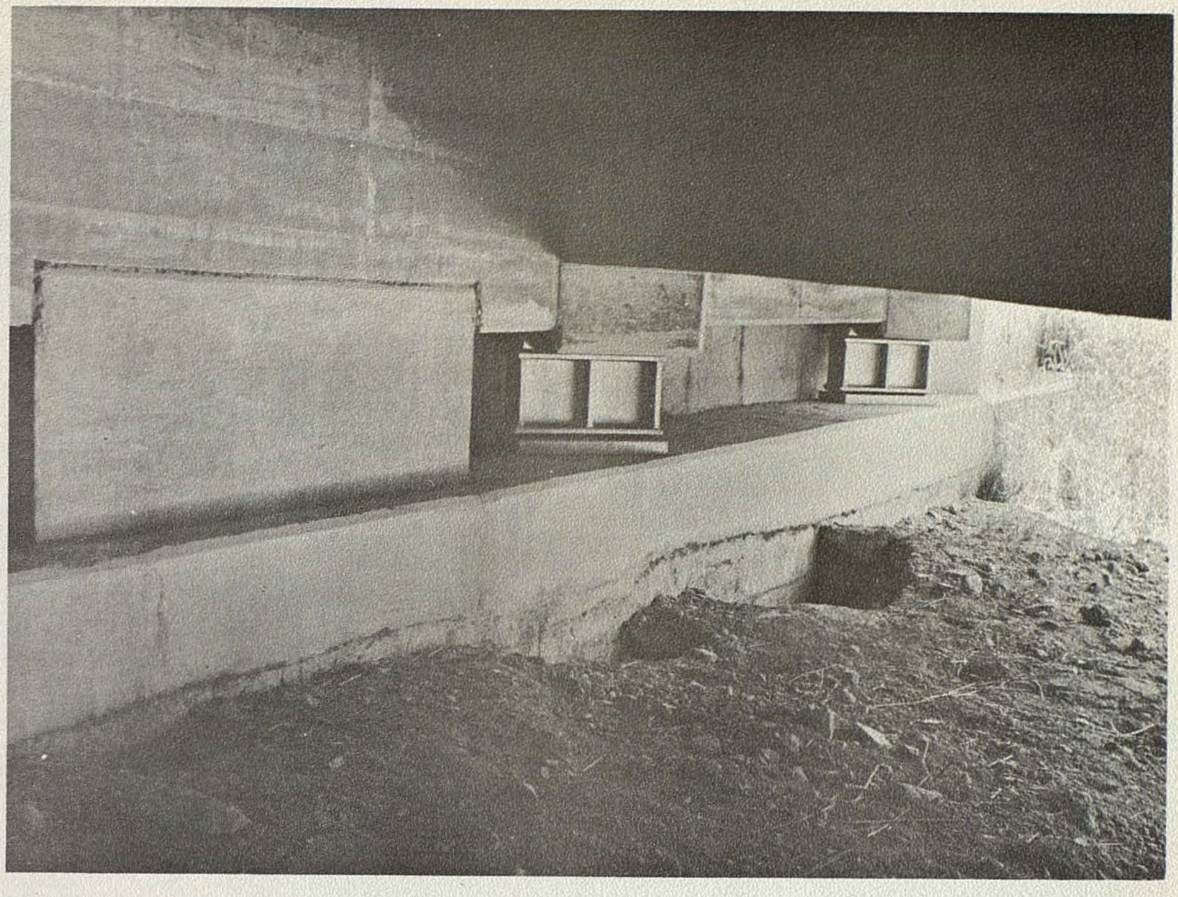


Figure 30. Erosion of Earth Fill Caused by Leaking Joint.

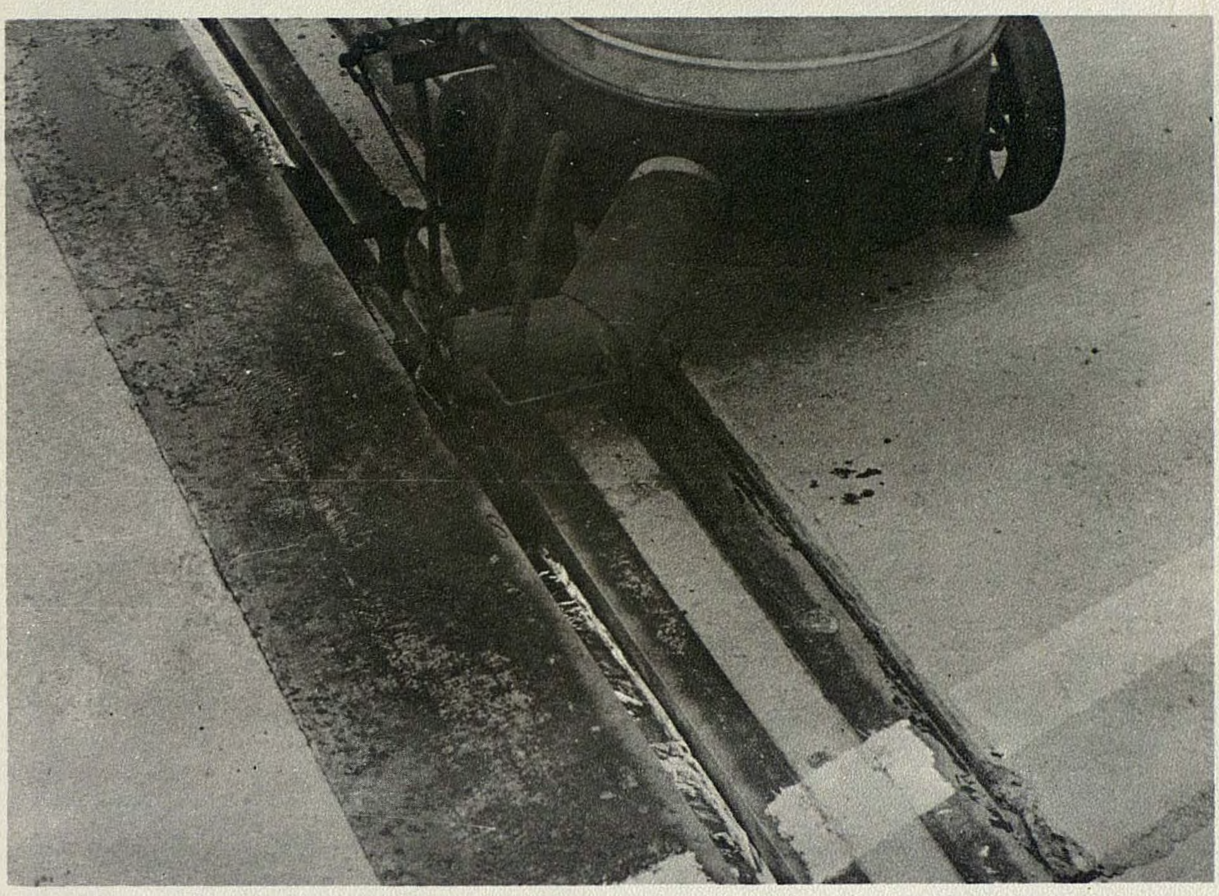


Figure 31. Installation of Hot-Poured Adhesive Sealant in Expansion Dam.

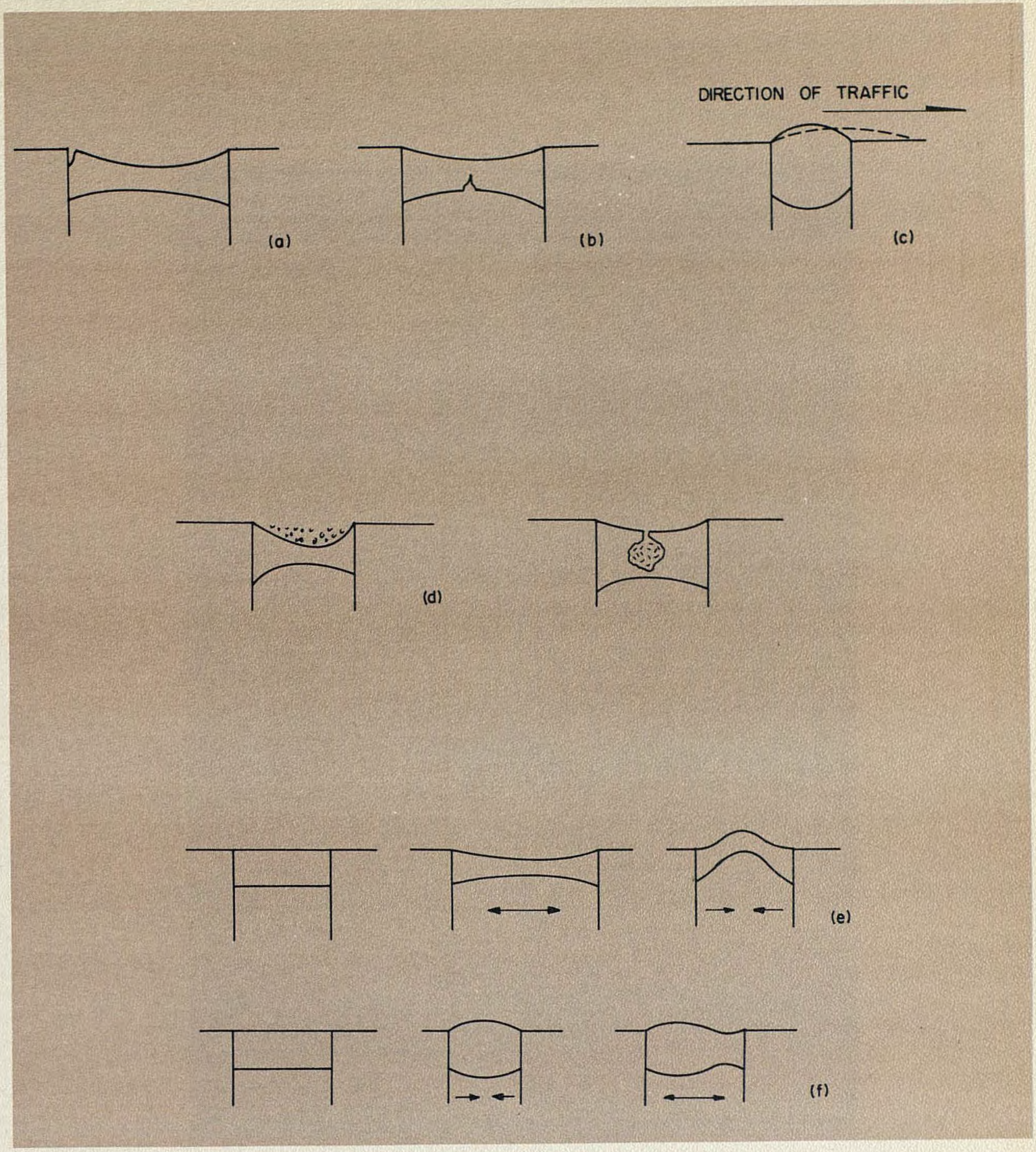


Figure 32. Types of Sealant Failures:
a) adhesion; b) cohesion; c) extrusion; and d) intrusion.
Change in Sealant Shape Due to Flow:
e) viscous tension-compression effect; and
f) viscous compression-tension effect, (Cook, John P., "A Study of Polysulfide Sealants for Joints in Bridges", Record No. 80, Highway Research Board, 1965).

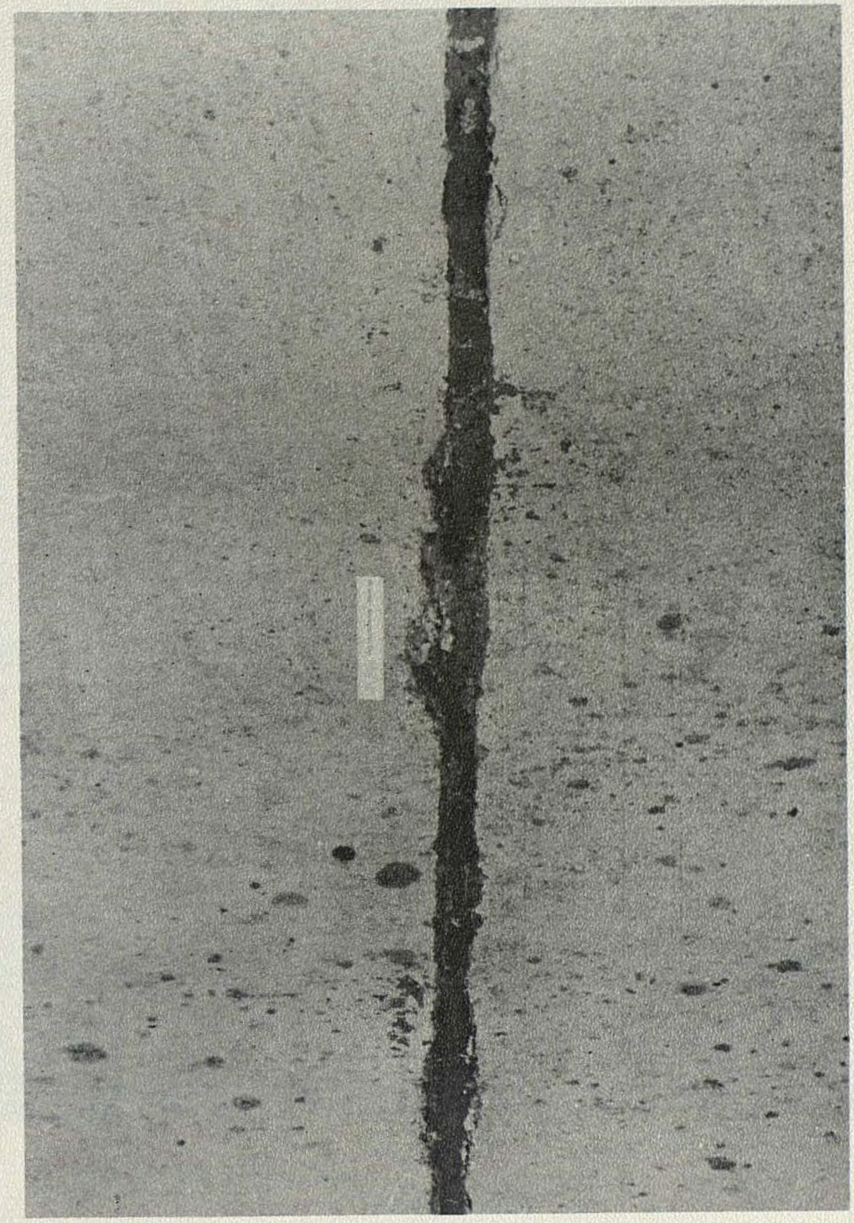


Figure 33. Spalled Formed Concrete Joint Sealed with Adhesive Type Sealant which Has Failed in Adhesion.

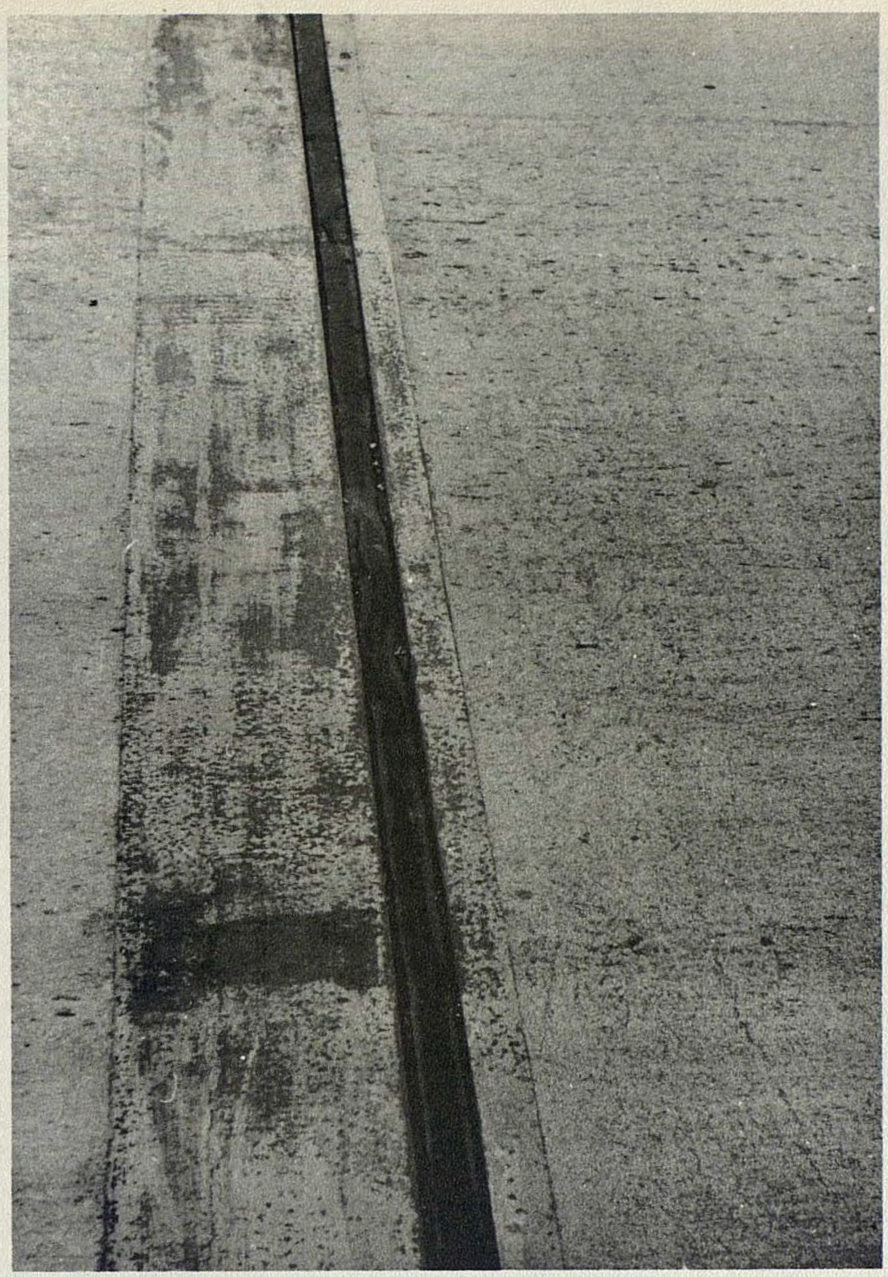


Figure 34. Expansion Dam Sealed with an Adhesive Sealant which Has Failed in Adhesion and Cohesion.

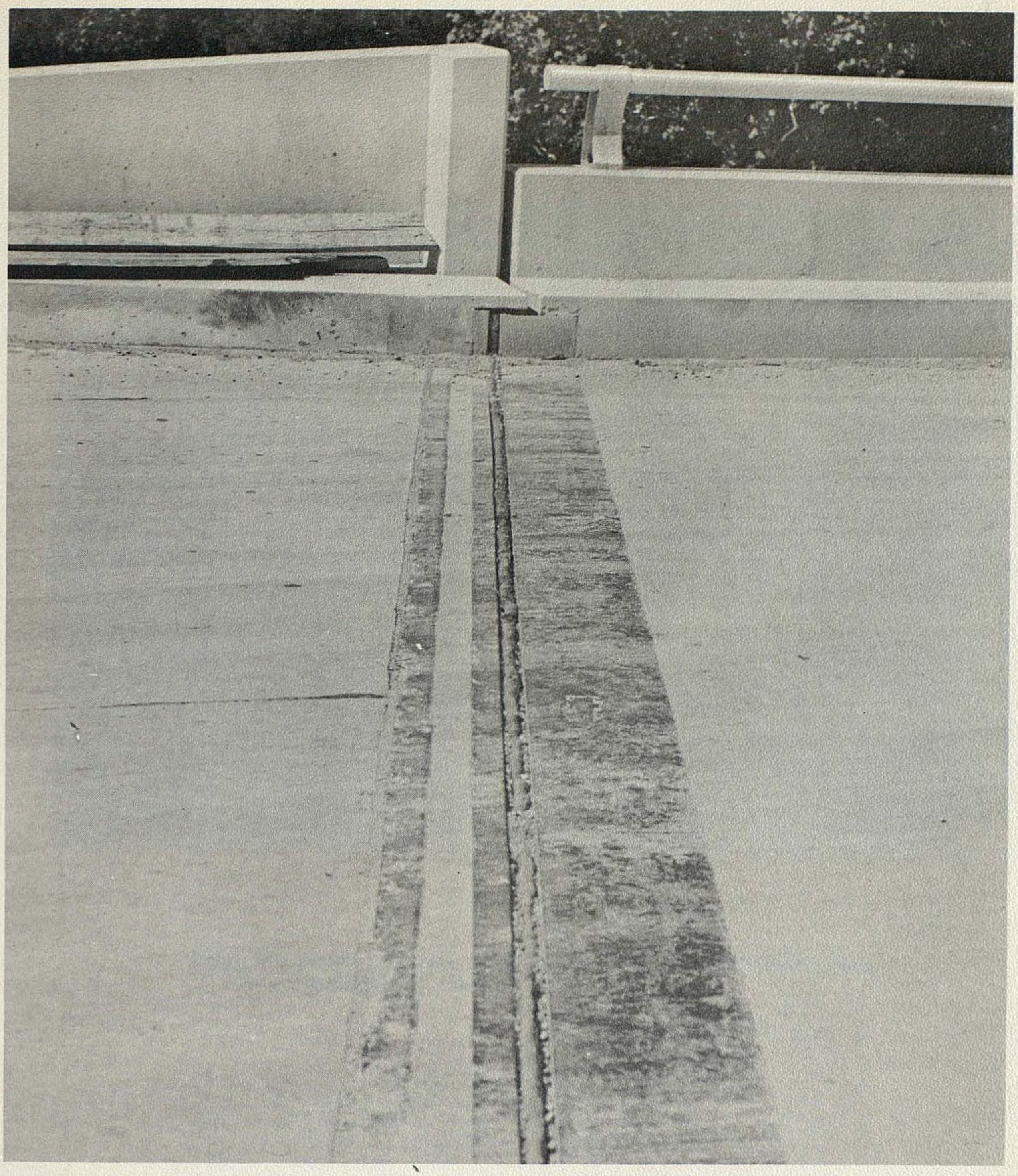


Figure 35. Expansion Dam at Abutment (Adhesive sealant has failed).

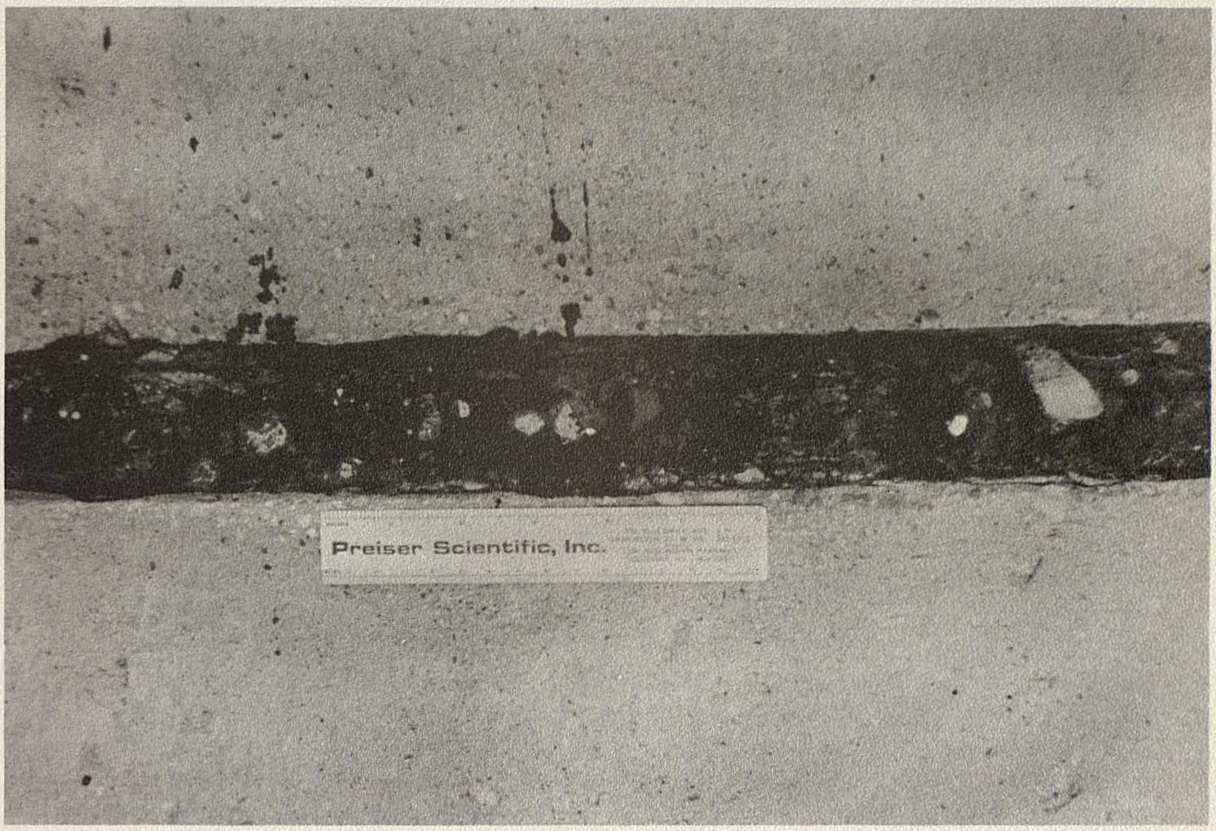


Figure 36. Formed Concrete Joint Sealed with Liquid Sealant (Note intrusion of gravel).

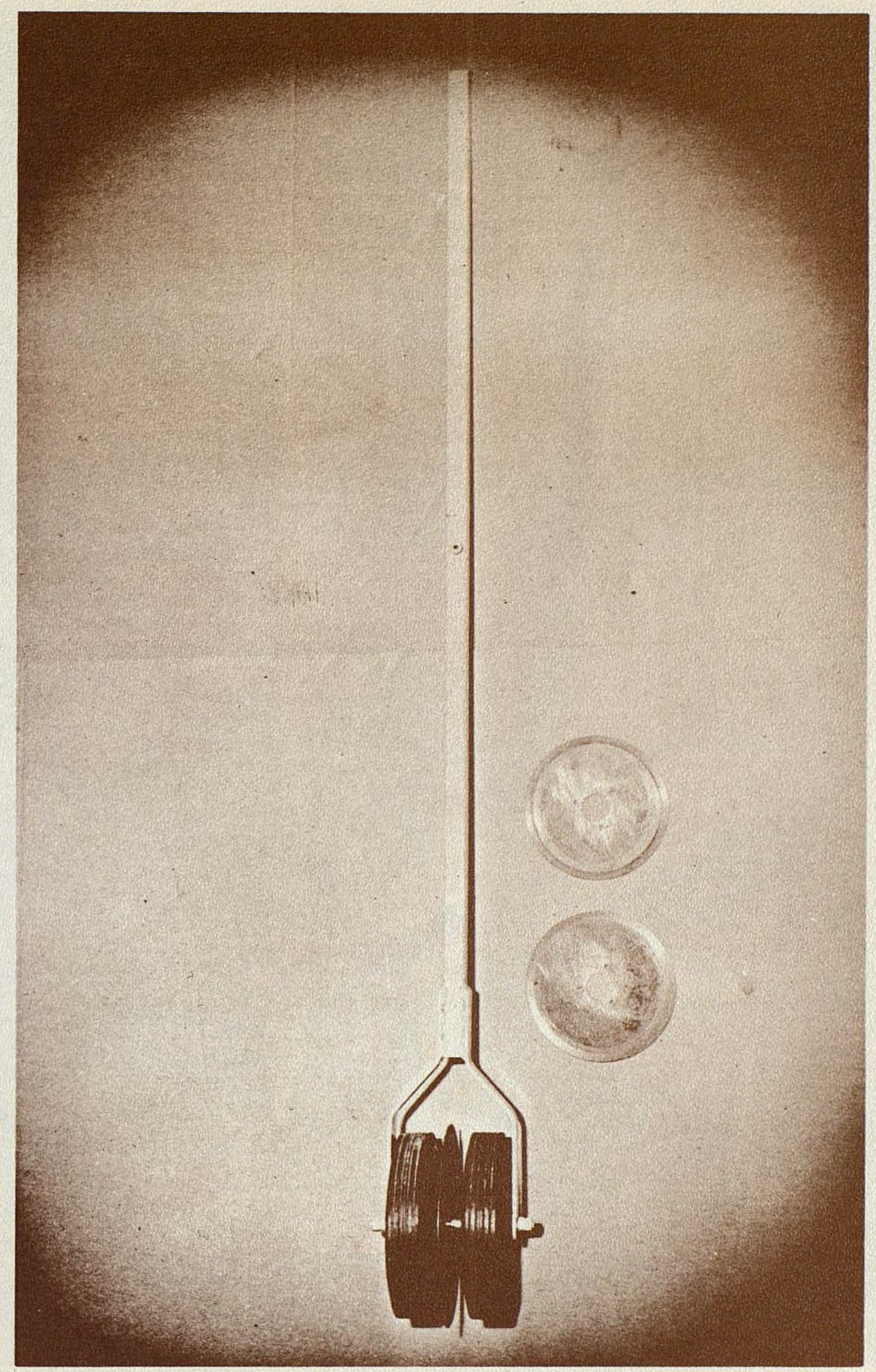


Figure 37. Roller Installer for Preformed Neoprene Seals in Sawed Joints.

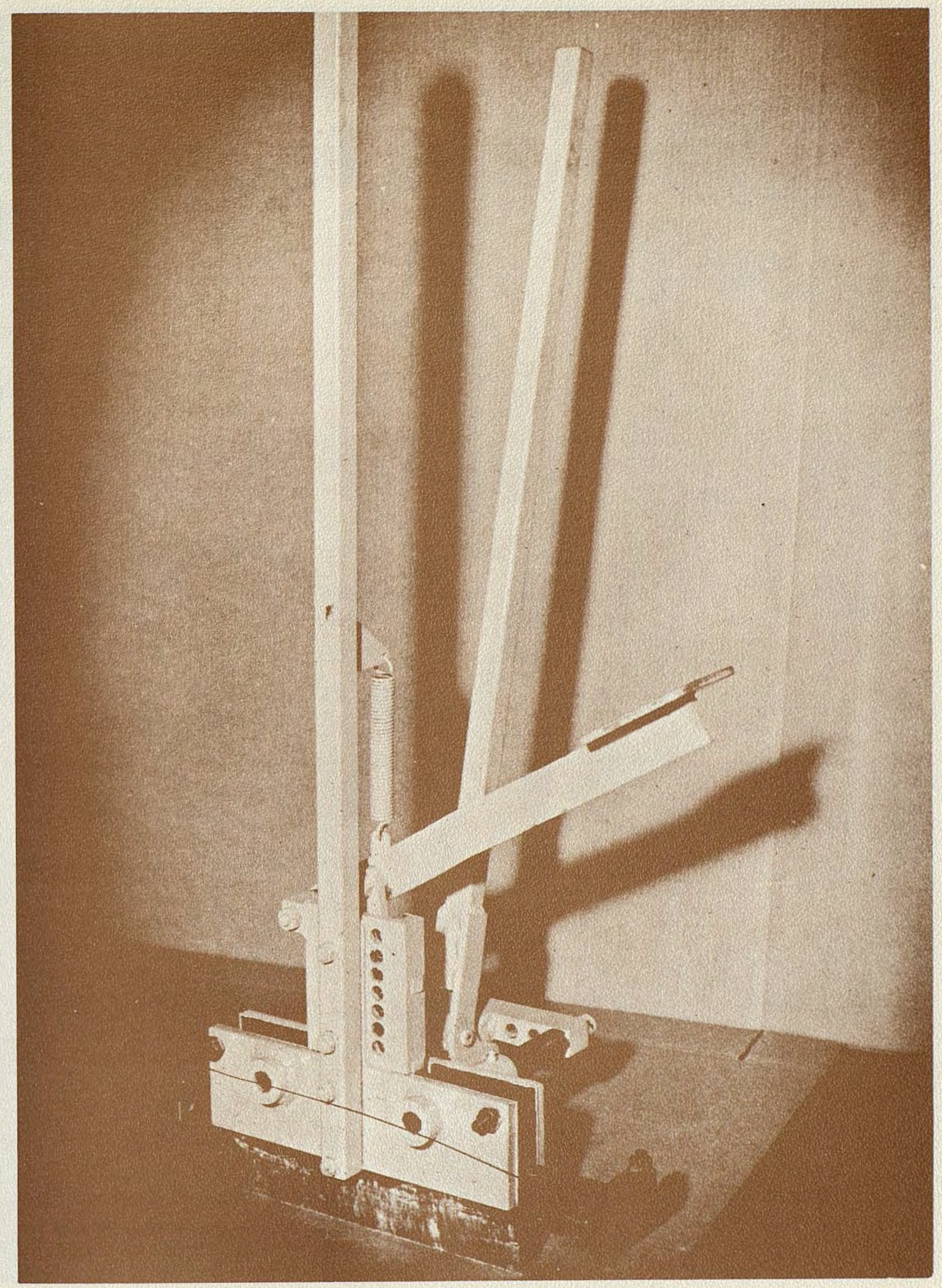


Figure 38. Manual Installation Tool for Preformed Neoprene Seals in Formed and Armored-Edge Joints.

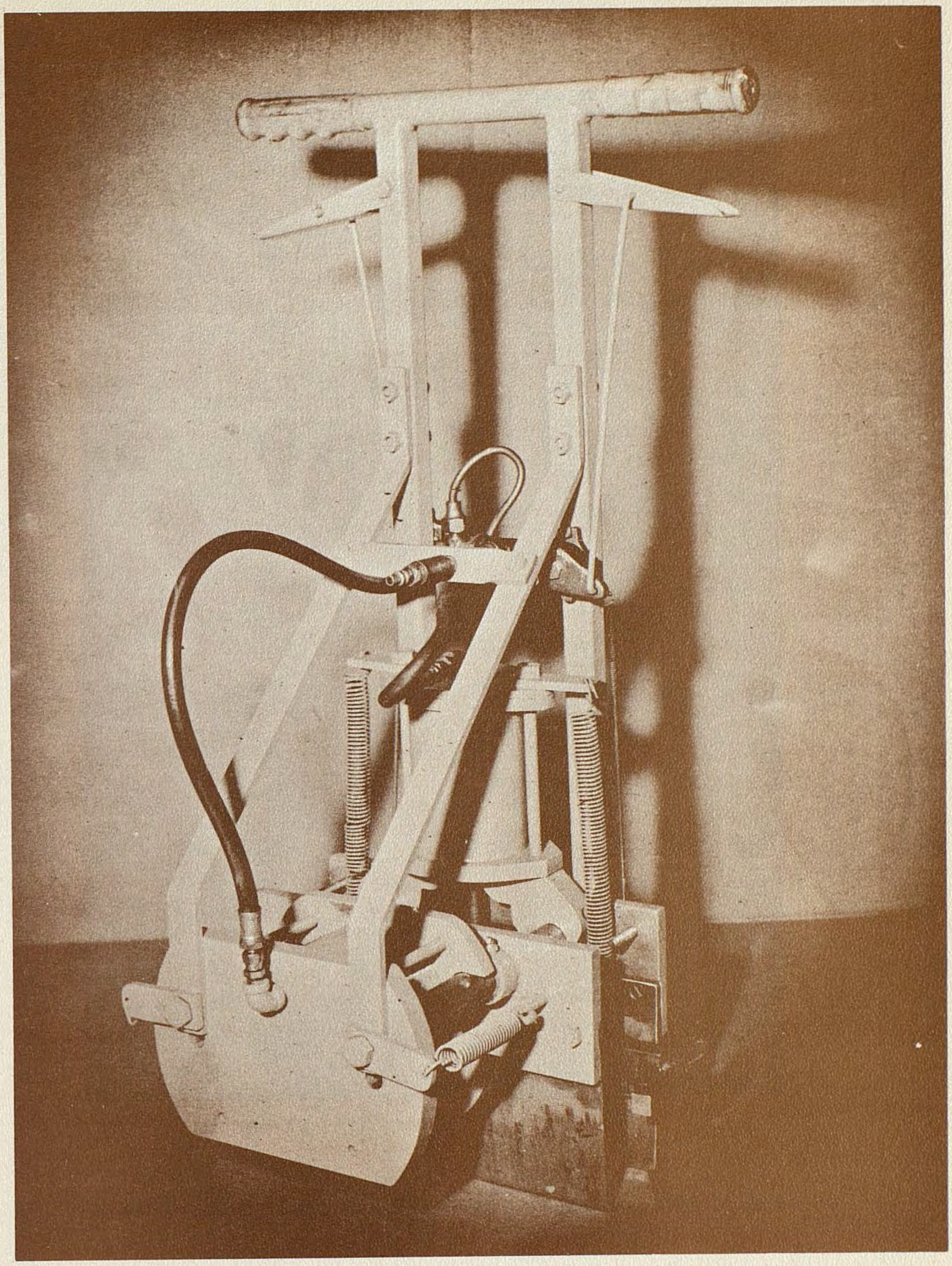


Figure 39. Pneumatic Installation Tool for Preformed Neoprene Seals in Expansion Joints.

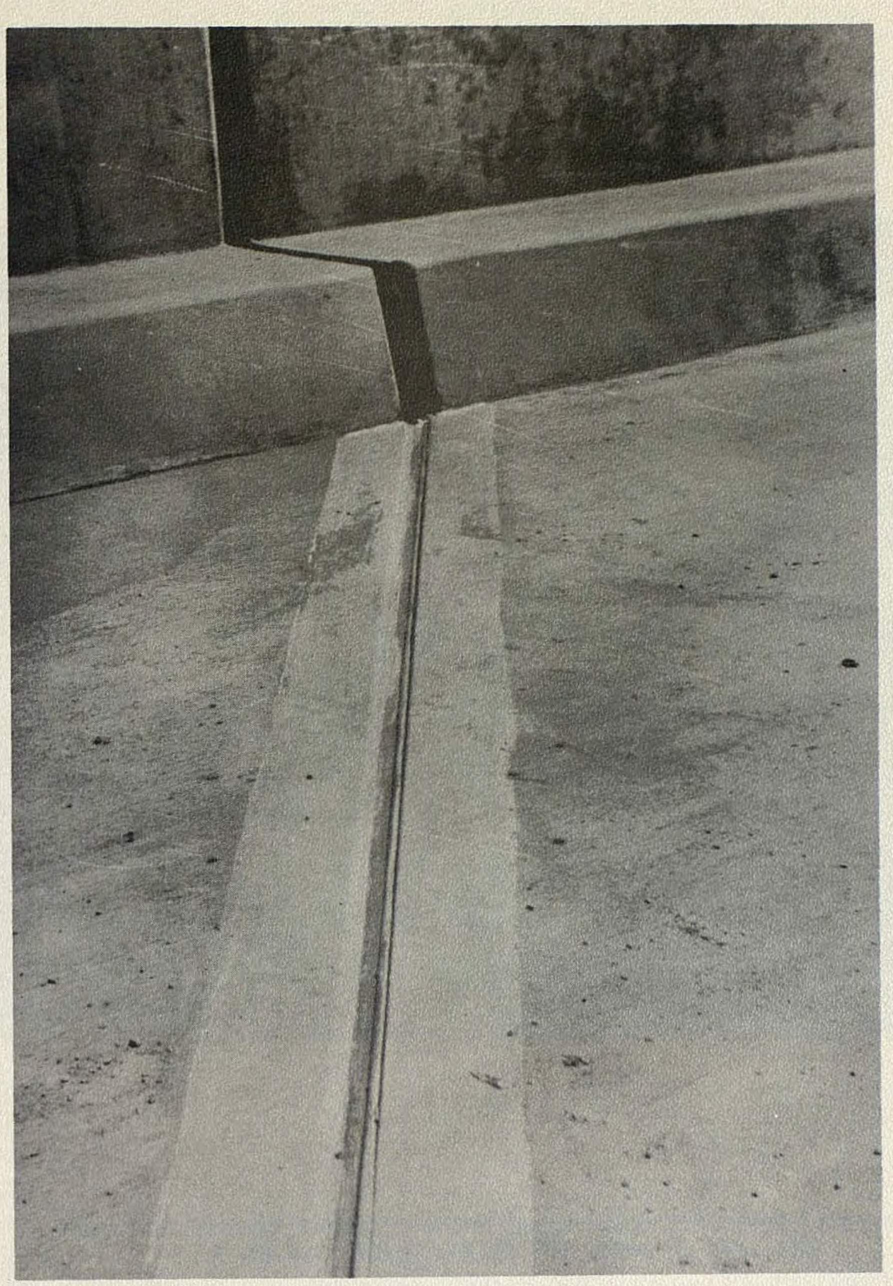


Figure 40. Skewed Joint Showing Buckling of Neoprene Seal at Curb.

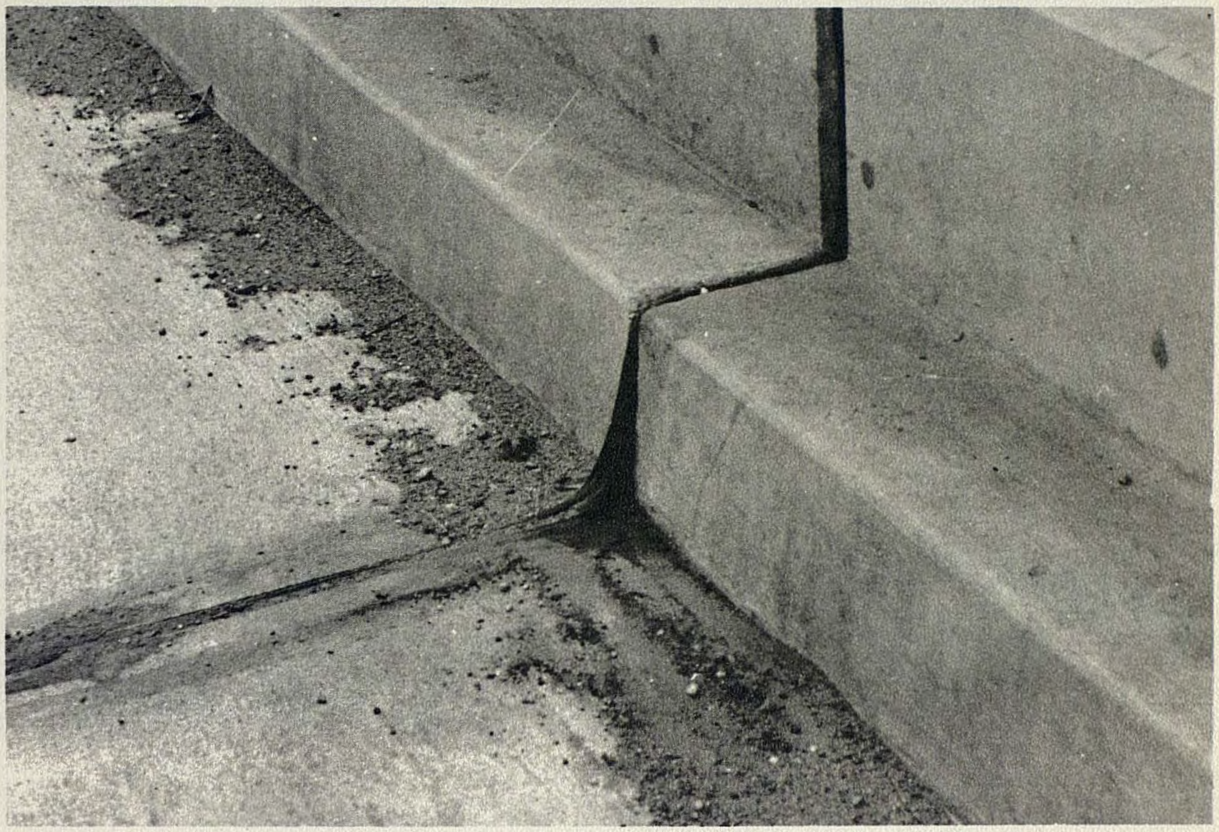


Figure 41. Formed Concrete Joint Sealed with Preformed Neoprene (Seal has pulled out of the joint at the curb).

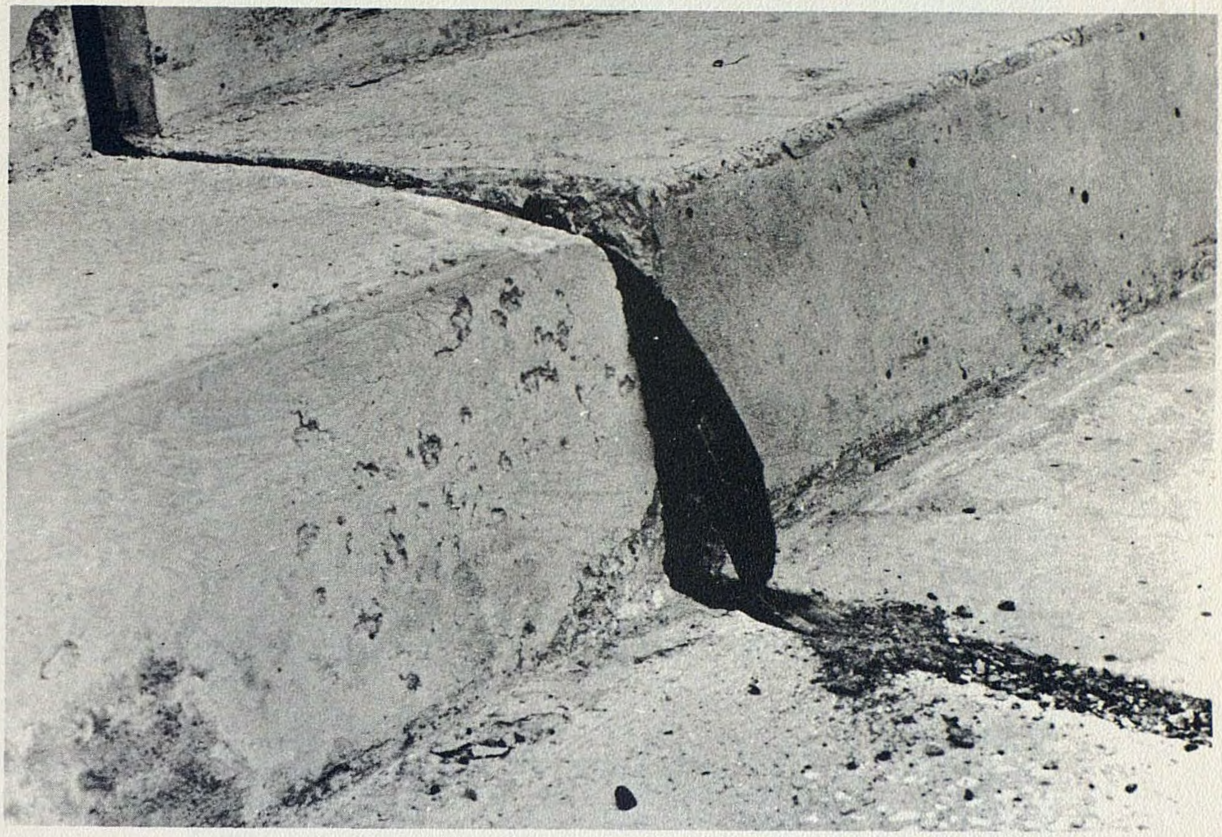


Figure 42. Formed Concrete Joint Sealed with Preformed Neoprene (Seal is torn at the curb leaving the joint completely open).

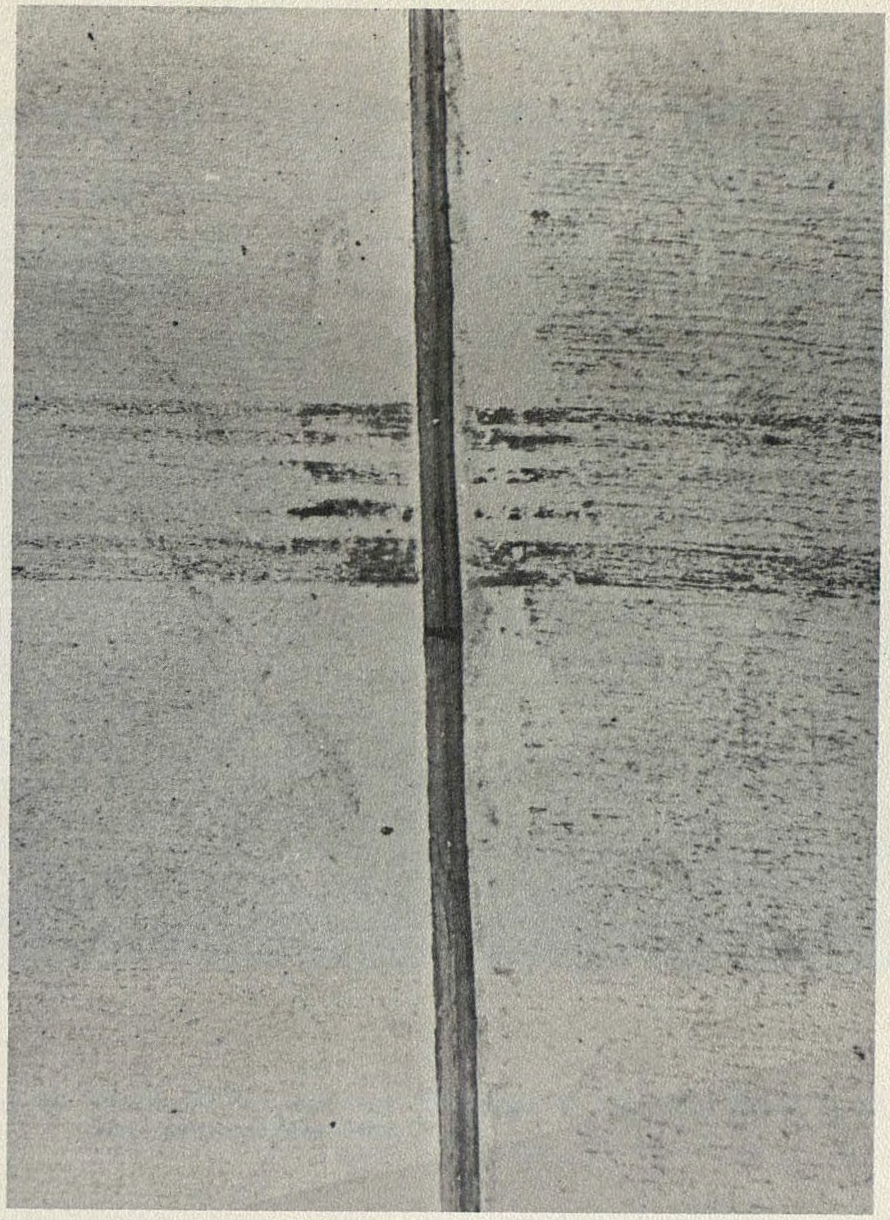


Figure 43. Formed Concrete Joint Sealed with Preformed Neoprene (Seal has separated due to excessive stretching).

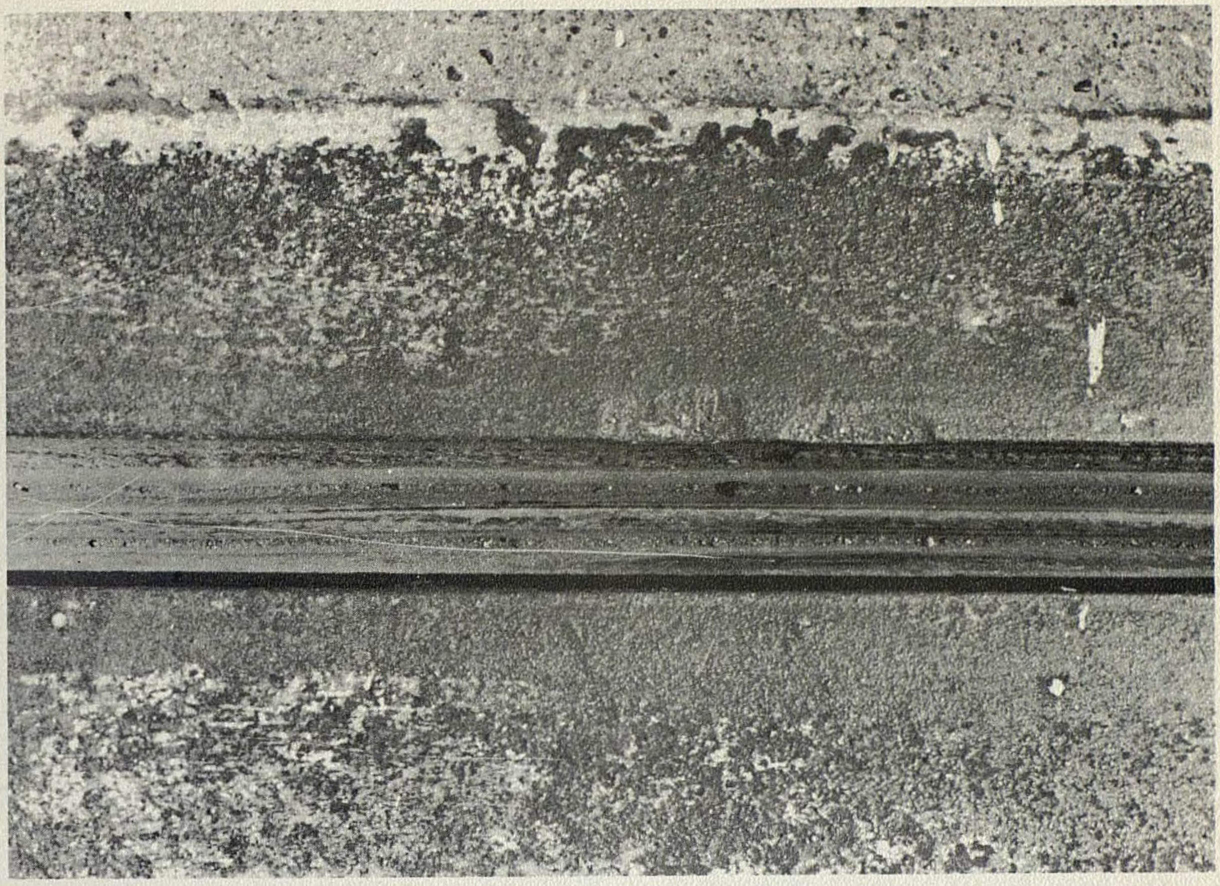


Figure 44. Preformed Neoprene Seal Installed at Excessive Depth in an AE-1 Armored-Edge Joint.

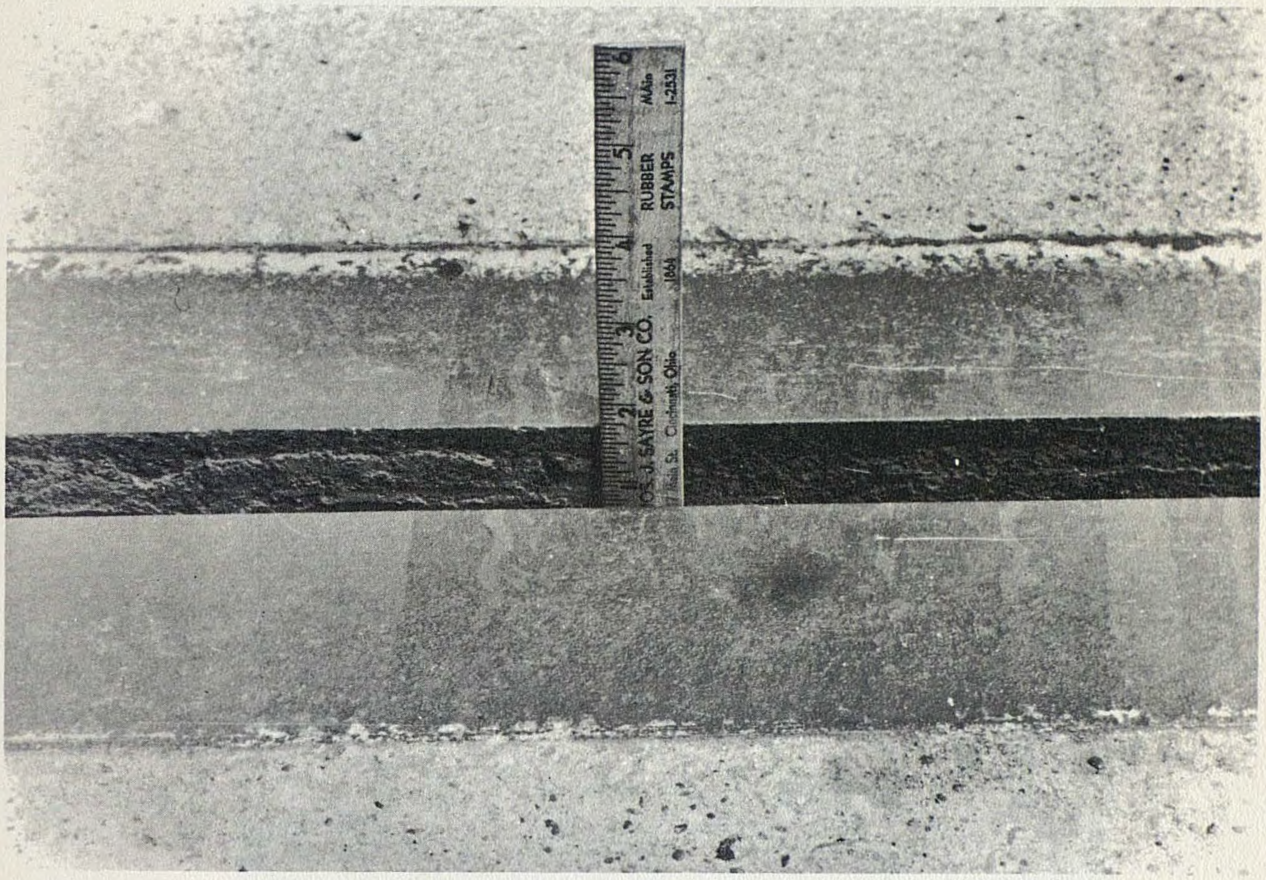


Figure 45. Surface of Seal in Figure 44 after Debris Had Been Swept Away.

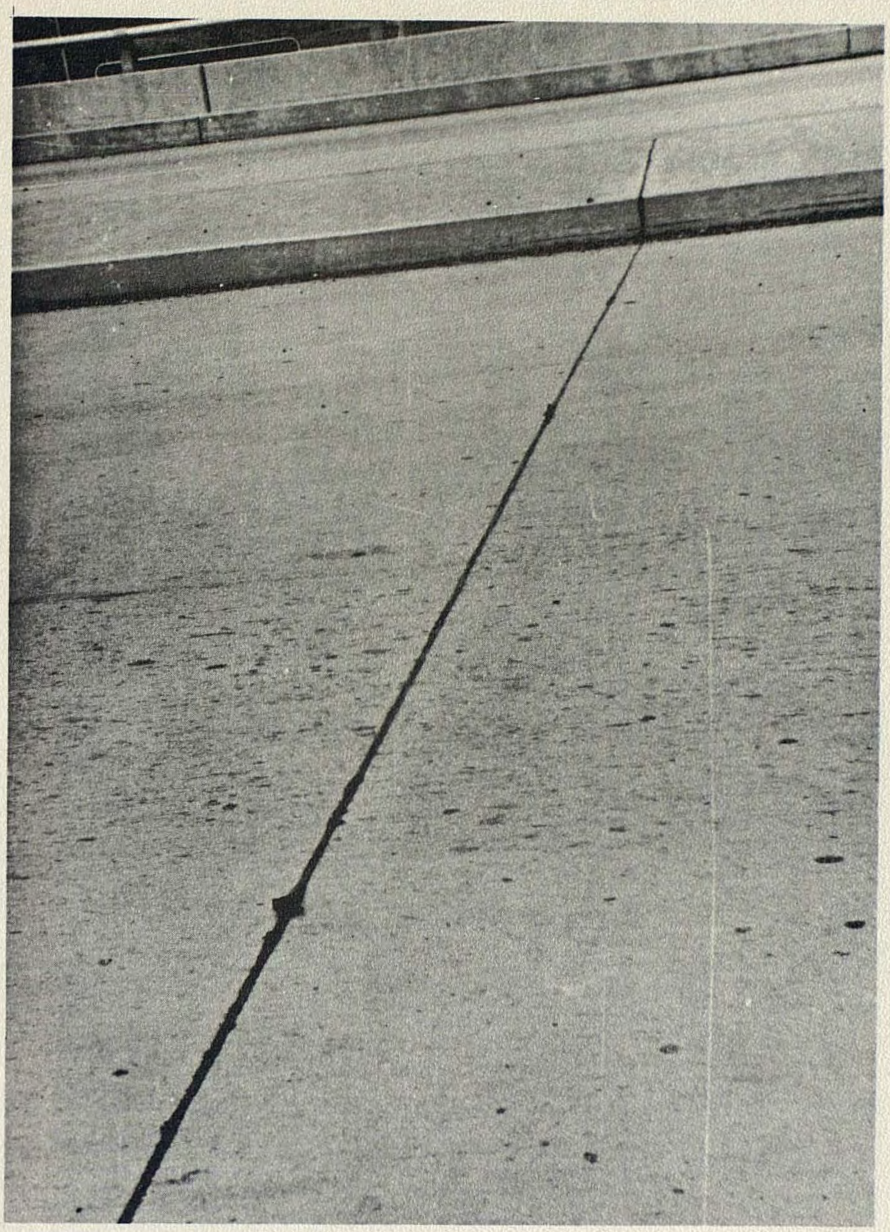


Figure 46. Sawed Joint (Neoprene seal has been torn from the joint).

Figure 47. Sawed Joint Sealed with Preformed Neoprene which Has Pulled Out and Been Torn by Traffic.

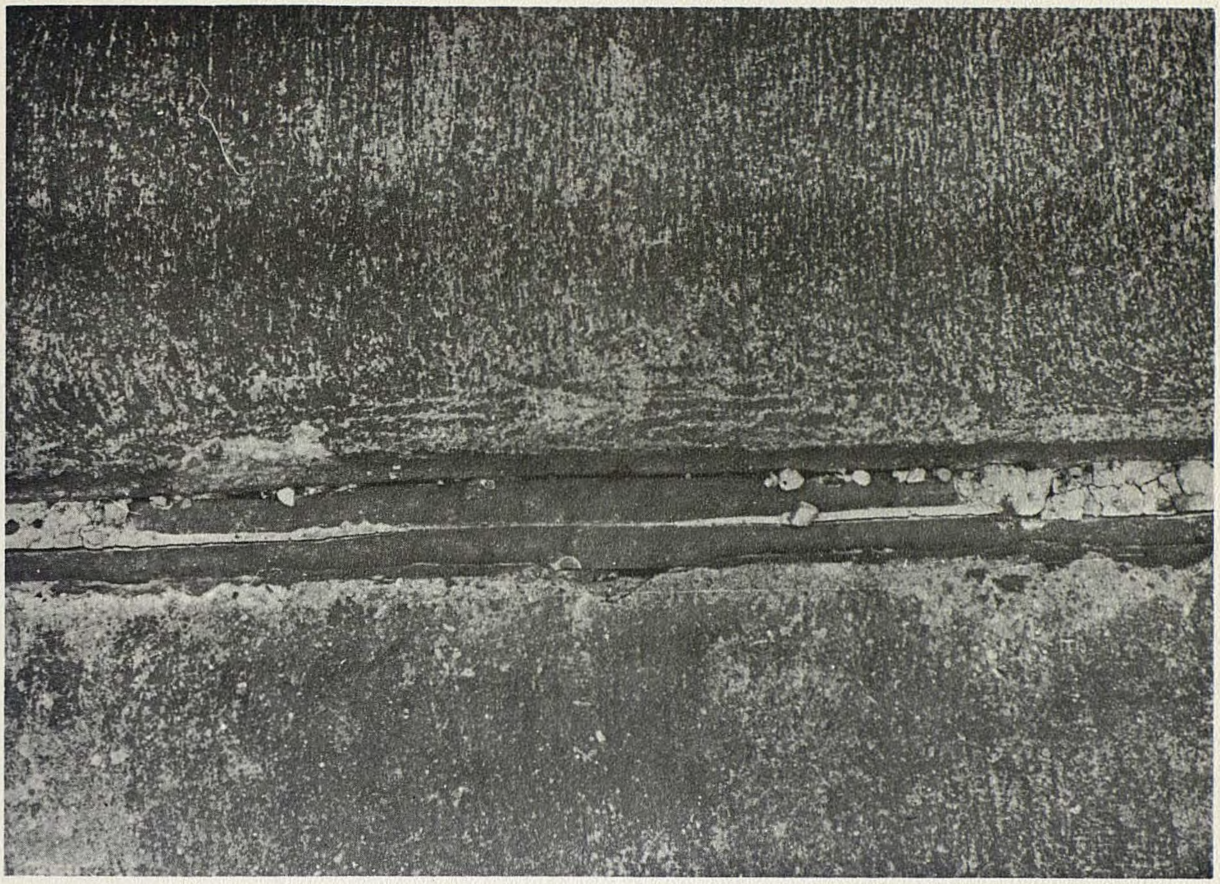


Figure 48. Formed Concrete Joint Containing Preformed Neoprene (Seal too small for joint, seal is not in compression and a gap is noticable between the seal and joint face).

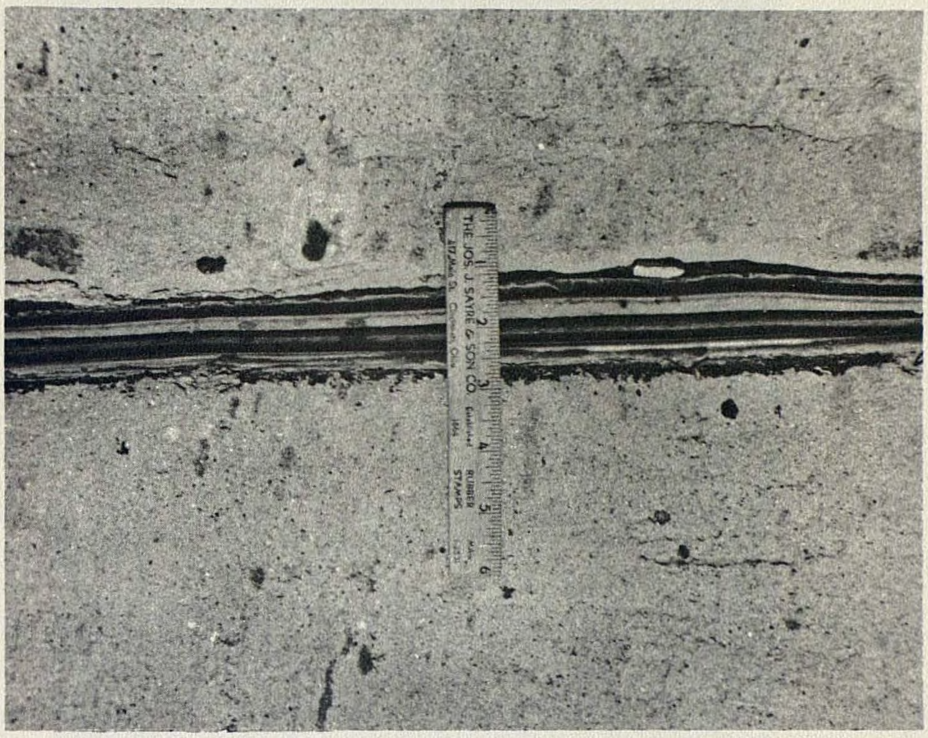


Figure 49. Formed Concrete Joint Sealed with Neoprene (Variation in width has made the seal ineffective).

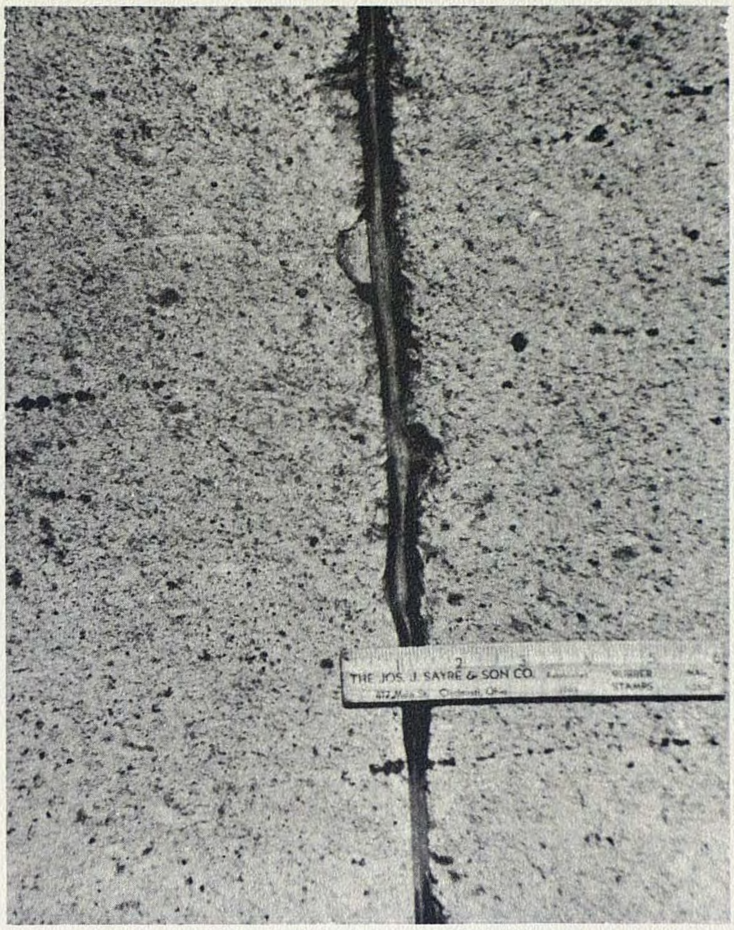


Figure 50. Sawed Joint Sealed with Preformed Neoprene (Note extensive spalling of joint edges).

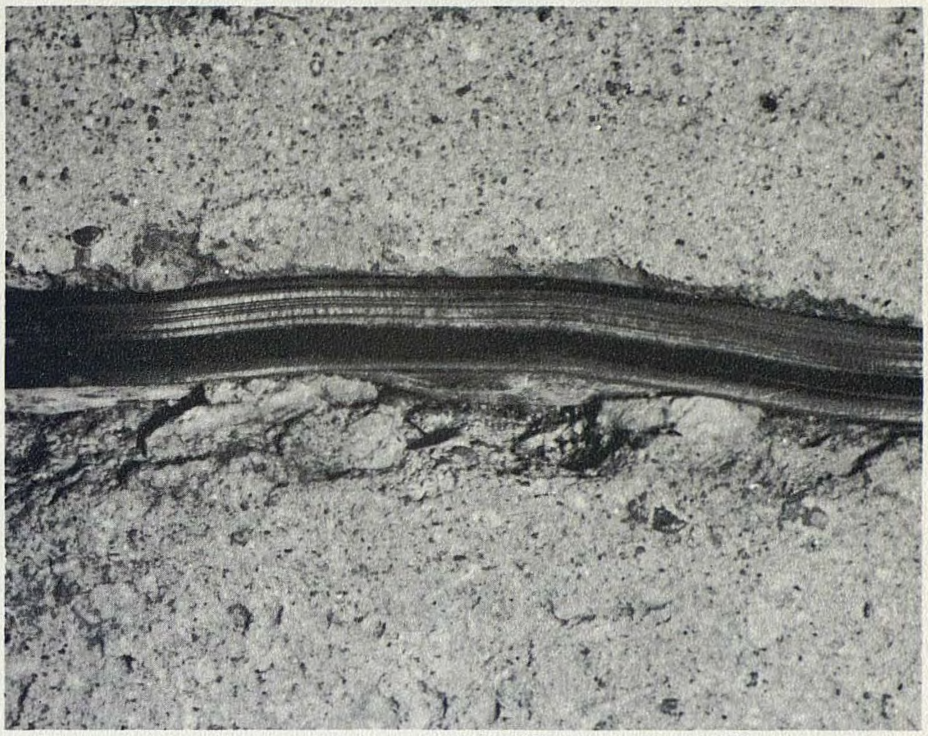


Figure 51. Sawed Joint Sealed with Preformed Neoprene (Spalling is deep enough to expose the bottom of the preformed seal).

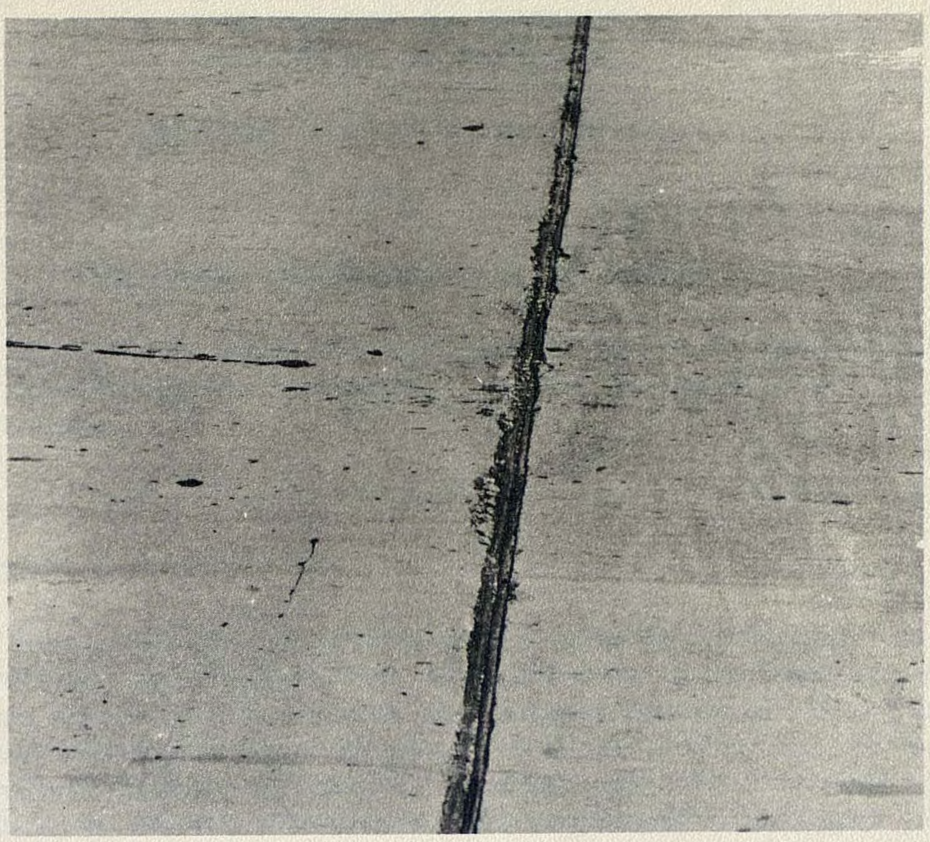


Figure 52. Preformed Neoprene Seal in Formed Concrete Joint (Joint is crooked, badly spalled, and leaking).

COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS

SPECIAL PROVISION NO. 37-A

FOR

PREFORMED COMPRESSION JOINT SEALS

This Special Provision shall be applicable to individual projects only when so indicated on the plans, in the proposal, or in the bidding invitation.

- -

I. DESCRIPTION

This work includes the preparation of the joint faces and edges and the furnishing and installing of preformed elastomeric compression joint seals of the sizes and shapes shown on the plans, or as otherwise permitted by the plans. Machine installation methods shall be required except in curbs, fascia, and other areas that may be inaccessible to machine methods. An approved lubricant shall be utilized in the installation of all seals.

II. MATERIALS

A. Seals. The seals shall be preformed, shall be manufactured from elastic polychloroprene material, shall be compatible with concrete, and shall be resistant to abrasion, oxidation, oils, gasoline, salt, and other materials that may be spilled on or applied to the surface. Factory splicing shall be held to a minimum. The seals shall be accurately marked by the fabricator at 1-foot intervals.

The seals shall be of a design, size, and width so as to be substantially solid and have a minimum of internal void spaces when installed in a highly compressed condition into properly prepared joints which are at or near their minimum opening width. Each seal shall be designed so that the top surface of the seal will not be extended or moved upward from its installed position in the joint by compressive forces.

The seals shall comply with the following test requirements, as determined on actual seals:

PROPERTIES	REQUIREMENTS	TEST PROCEDURES
Tensile Strength, psi., min.	2000	ASTM D-412*
Elongation at Break, % min.	250	ASTM D-412*
Hardness, Type A Durometer	55 ± 5	ASTM D-2240*
Resistance to Heat Aging Change in original properties after 70 Hrs. @ 212° F.		ASTM D-573* (Except testing apparatus may be that used for other high temperature tests as specified herein.)
Hardness, points, max.	+10	
Elongation, %, max.	-40	
Tensile strength, %, max.	-30	
Ozone Resistance, 20% Strain 300 pphm in air, 70 Hrs. @ 104° F. (Wipe with solvent to remove surface contamination)	No Cracks	ASTM D-1149
High Temperature Recovery** 70 Hrs. @ 212° F. under 50% deflection, % min.	85	Refer to II-C-1
Low Temperature Recovery 72 Hrs. @ +14° F. under 50% deflection, % min.	87	Refer to II-C-1
Low Temperature Recovery 22 Hrs. @ -20° F. under 50% deflection, % min.	82	Refer to II-C-1
Weight Change in Oil 22 Hrs. @ 212° F. in ASTM Oil No. 3, % max.	45	Refer to II-C-2

*When it is not possible to obtain the standard size specimen from a sample, a test specimen as near the size of the standard specimen as possible shall be obtained.

**Web adhesion or cracking of specimens shall be cause for rejection.

All test specimens used in the foregoing procedures will be cut from samples of the preformed joint seal. Each lot of the joint seal shall be identified with the manufacturer's name or trade mark and shall be accompanied by the manufacturer's affidavit attesting conformance with this specification. The term "lot" shall mean all seals of the same size and shape contained in any one shipment.

Specimens for hardness testing will be buffed in accordance with ASTM D 15 and a sufficient number of plys of the seal material to obtain the proper thickness for testing will be utilized.

B. Lubricant. Lubricants used to facilitate the installation of the joint seals shall be compatible with the seals and the concrete and shall meet with the approval of the Engineer.

C. Sampling and Testing. Representative specimens of the samples from each lot shall be subjected to the tests listed under Paragraph II-A. Test procedures shall follow the ASTM methods designated excepting the procedures hereinafter specified.

1. High and Low Temperature Recovery Tests.

a. Apparatus. The testing apparatus shall consist of the following items:

(1) Compression Clamp. A compression clamp consists of two or more flat steel plates known as a Method "B" ASTM compression set clamp (ASTM D-395); or a vise having parallel plates on jaws; or any basic device by which uniform compression can be applied to a specimen. The device should be capable of accepting a 5-inch long specimen.

(2) Steel Spacers. If compression clamps are used, steel spacer bars will be required to allow proper spacing of the steel plates.

(3) Air Oven. Any well designed, uniformly heated, standard circulating air oven can be used. The oven shall be provided with proper temperature control to maintain the specified temperature within a permissible variation of ± 2° F.

(4) Low Temperature Box. This apparatus can be any refrigerated box capable of maintaining a temperature variation of ± 2° F. on temperature settings within the range of +20° F. to -20° F.

(5) Dial Gage - Vernier Caliper - Micrometer. A dial gage, vernier caliper, or micrometer graduated in thousandths of an inch shall be used for measurements.

b. Test Specimens. Specimens cut from samples of fabricated seals shall be approximately 5 inches long.

c. Test Procedure.

(1) The outside surfaces of the seal shall be lightly dusted with talc to prevent sticking to the steel compression plates.

(2) Deflect the test specimen between parallel plates to 50% of original top width. Width measurement shall be taken in the center of the 5-inch length. Prior to compression, the specimen shall be placed in a horizontal position in such a manner that the plane between the lip tips is perpendicular to the compression plates. As the specimen is being compressed, care should be taken to insure that the "V" section or the top of the specimen folds so that it projects inward towards the inner web section.

(3) High Temperature. Expose the clamp assembly and compressed sample in an oven for the time and at the temperature specified. Do not pre-heat the clamp assembly. When the oven aging period is completed, remove the clamp assembly and unclamp the test specimen immediately. Cool the test specimen at room temperature (73° F. ± 4°) on a wooden surface for one hour before measuring the heat aged recovery width. The measurement shall be made at the marked location at which the original width was determined.

(4) Low Temperature. To prevent web adhesion due to ice crystal formation, all internal surfaces shall be dusted with talc. Expose the clamp assembly and compressed sample in the low temperature box for the time and at the temperature specified. When each cold aging period is completed, unclamp the test specimen at the test temperature; allow it to recover in a free state at the test temperature for one hour. At this point, measure the recovery width at the test temperature. The measurements shall be made at the marked location at which the original width was determined.

d. Calculations. Calculate the recovery for each test, expressed as a percentage of the original width, as follows:

$$\text{Per Cent Recovery} = \frac{\text{Recovered width}}{\text{Original width}} \times 100$$

2. Weight Change in Petroleum Oil.

a. Apparatus.

(1) Air Oven. Any well designed, uniformly heated, standard circulating air oven can be used. The oven shall be provided with proper temperature control to maintain the specified temperature within a permissible variation of ± 2° F.

(2) Scale. A scale capable of weighing to the nearest tenth of a gram shall be used.

(3) Test Liquid. A petroleum based oil such as ASTM Oil No. 3 (ASTM D-471) shall be used.

(4) Miscellaneous. Pyrex beakers, tongs, filter paper, acetone.

b. Test Specimens. Specimens cut from samples of fabricated seals shall be approximately 3 inches long.

c. Test Procedure.

(1) Weigh each test specimen in air to the nearest tenth of a gram (W_1) and place in a Pyrex beaker containing sufficient test oil, at the specified test temperature, to fully cover the samples throughout the test period. Two specimens shall be tested. They may be placed in the same beaker, but must be separated by large glass balls or beads. The beaker shall be covered loosely with aluminum foil.

(2) The beaker assembly shall be placed in the oven and conditioned for 22 hours at 212° F. ± 2°.

(3) After the immersion period has been completed, remove the test specimens from the hot oil and cool the test specimens to room temperature by transferring them to a cool clean portion of the test liquid for 30 to 60 minutes. Then dip the specimens quickly into acetone to remove surface test oil, blot lightly with filter paper, and immediately determine weight of each specimen (W_2).

d. Calculations. Calculate the change in weight as follows:

$$\text{Change in weight, per cent} = \frac{W_2 - W_1}{W_1} \times 100$$

Where: W_1 = initial weight of specimen in grams
W_2 = weight of specimen in grams after immersion.

D. Approval. The seals accepted for use shall be those approved by the Department on evidence of their compliance with test requirements as hereinbefore specified under paragraph A.

Acceptance shall be made on the basis of one of the following procedures to be designated by the Department.

(1) Approval by the Laboratory from the results of tests made with samples furnished by the Contractor;

(2) Approval by the Department on evidence that the materials have been tested by a recognized laboratory and found to comply with all requirements. Two certified copies of the test report from the laboratory are required by the Department; or

(3) Approval by the Department upon certification by the manufacturer, furnished by the Contractor, stating that the materials are identical in composition with those previously approved.

When the seals are to be tested by the Laboratory, the Contractor shall provide the Engineer with samples at least 3 weeks prior to the anticipated date of installation. The number of samples and the sizes shall be as required by the Laboratory.

If the initial samples fail to meet the specification requirements, the Department may require the Contractor to pay the costs for any retests.

If a seal is approved on the basis of tests performed by a recognized laboratory, such laboratory shall be one approved by the Department to perform such tests.

III. CONSTRUCTION METHODS

All joints, whether sawed or formed, shall be true to alignment and shall have vertical faces. Each joint shall be uniform in width throughout its length.

Construction joints and contraction joints to be sealed by this method shall conform to the details shown on the Standard Drawings or plans.

Joints that are to be sawed shall not be sawed until the concrete has hardened to the extent that tearing and ravelling will not occur, but as soon thereafter as deemed necessary by the Engineer to preclude random cracking.

Expansion joints to be sealed by this method shall be formed and shall be constructed in accordance with the details shown on the Standard Drawings or plans.

If a joint, as constructed, has a width in excess of the specified width, the seal for that joint shall be increased in width as directed by the Engineer.

All joints to be sealed shall be free of cracked or spalled concrete. Cracked areas shall be chipped back to sound concrete and repaired with an approved epoxy resin compound or other materials approved by the Department.

The faces of all joints to be sealed shall be cleaned of laitance, oils, greases, dirt, free water, and other foreign matter immediately prior to the installation of the seal. The method of cleaning shall be as directed by the Engineer as deemed necessary to satisfactorily clean the joints.

The seals shall be installed in the properly prepared joint by a machine designed specially for installing joint seals. Any seal that is damaged during installation shall be removed and replaced with an undamaged seal. Any seal that is improperly positioned in the joint by the machine shall be removed and reinstalled at the proper elevation. Installation of seals by hand methods will be permitted only in areas that are inaccessible to the machine, unless written permission is obtained from the Engineer to install all seals by hand methods.

Prior to placement, the seals shall be precut to the lengths of the joints or as much longer as is needed for proper installation. Each seal shall be measured before and after installing as a check against stretch. Any installed seal that shows more than 5 per cent stretch shall be removed and reinstalled.

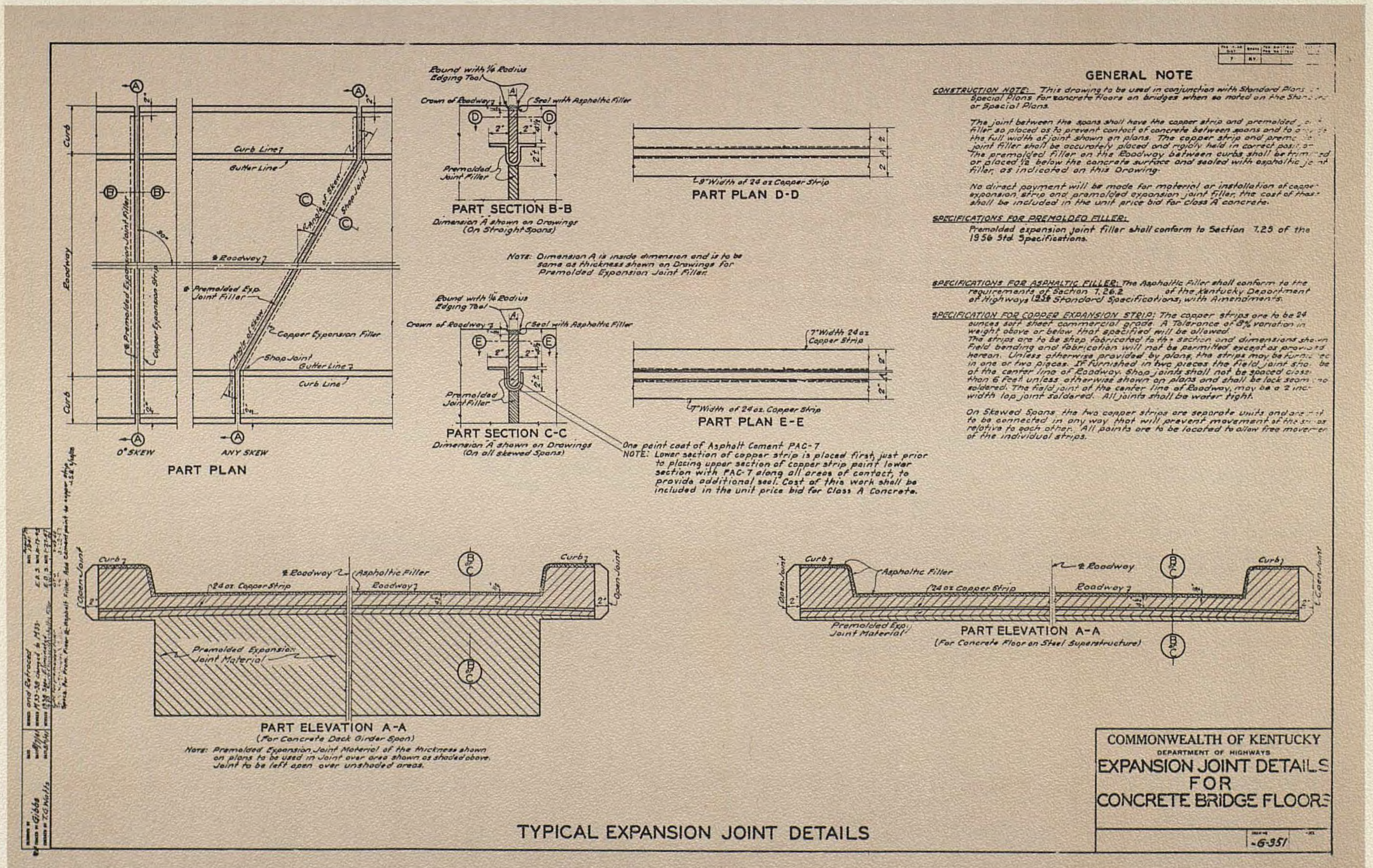
The seals may be installed immediately after the removal of the curing cover. The seals shall be installed securely and shall be free from an objectionable amount of curling or twisting in the joint groove. A lubricant shall be used to facilitate the installation and shall cover both sides of the seal over the full area in contact with the sides of the concrete joint. The lubricant may be applied to the concrete or the seal or both. The seals shall be installed in a highly compressed condition and the top of the seals shall at all times be below the level of the pavement surface to such depth as indicated on the Standard Drawings or plans. The seal shall be in one piece, without field or factory splicing, for the full length of each of the transverse joints. For longitudinal joints, the seal shall be installed in practical lengths without field-splicing.

IV. MEASUREMENT AND PAYMENT

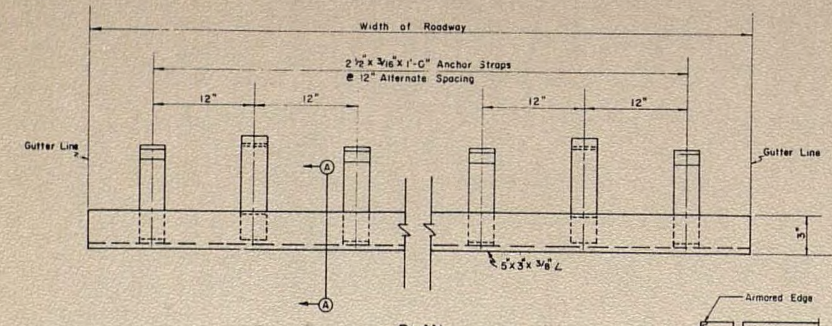
No direct payment will be made for sawing or forming and the preparation of the joint, or for the furnishing and the installation of the seals. The cost of all materials, labor, equipment, and supplies required for this work shall be included in the price bid for the various items incorporated in the work.

APPROVED August 30, 1967

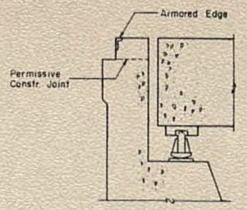
A. O. Neiser
A. O. NEISER
STATE HIGHWAY ENGINEER



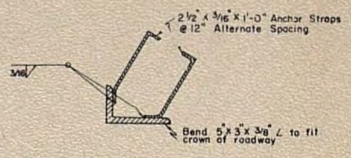
GENERAL NOTE
CONSTRUCTION NOTE: This drawing to be used in conjunction with Standard Plans or Special Plans for concrete floors on bridges when so noted on the Standard or Special Plans.
The joint between the spans shall have the copper strip and premolded joint filler so placed as to prevent contact of concrete between spans and to provide the full width of joint shown on plans. The copper strip and premolded joint filler shall be accurately placed and rigidly held in correct position. The premolded filler on the Roadway between curbs shall be trimmed or placed ½ below the concrete surface and sealed with asphaltic joint filler, as indicated on this Drawing.
No direct payment will be made for material or installation of copper expansion strip and premolded expansion joint filler, the cost of these shall be included in the unit price bid for class "A" concrete.
SPECIFICATIONS FOR PREMOLDED FILLER: Premolded expansion joint filler shall conform to Section 7.25 of the 1956 Std. Specifications.
SPECIFICATIONS FOR ASPHALTIC FILLER: The Asphaltic Filler shall conform to the requirements of Section 7.26.2 of the Kentucky Department of Highways 1956 Standard Specifications, with Amendments.
SPECIFICATION FOR COPPER EXPANSION STRIP: The copper strips are to be 24 ounces soft sheet commercial grade. A Tolerance of 8% variation in weight above or below that specified will be allowed.
The strips are to be shop fabricated to the section and dimensions shown. Field bending and fabrication will not be permitted except as provided hereon. Unless otherwise provided by plans, the strips may be furnished in one or two pieces. If furnished in two pieces the field joint shall be of the center line of Roadway. Shop joints shall not be spaced closer than 6 feet unless otherwise shown on plans and shall be lock seam and soldered. The field joint at the center line of Roadway, may be a 2 inch width lap joint soldered. All joints shall be water tight.
On Skewed Spans the two copper strips are separate units and are not to be connected in any way that will prevent movement of the strips relative to each other. All points are to be located to allow free movement of the individual strips.
Round with ¼ Radius Edging Tool
Crown of Roadway
Seal with Asphaltic Filler
Premolded Joint Filler
PART SECTION B-B
Dimension "A" shown on Drawings (On Straight Spans)
NOTE: Dimension A is inside dimension and is to be same as thickness shown on Drawings for Premolded Expansion Joint Filler.
PART SECTION C-C
Dimension "A" shown on Drawings (On all skewed Spans)
8" Width of 24 oz Copper Strip
PART PLAN D-D
7" Width 24 oz Copper Strip
7" Width of 24 oz. Copper Strip
PART PLAN E-E
One paint coat of Asphalt Cement PAC-7
NOTE: Lower section of copper strip is placed first, just prior to placing upper section of copper strip paint lower section with PAC-7 along all areas of contact, to provide additional seal. Cost of this work shall be included in the unit price bid for Class A Concrete.
Curb
Roadway
Curb Line
Gutter Line
℄ Roadway
℄ Premolded Exp. Joint Filler
Copper Expansion Strip
Copper Expansion Filler
Shop Joint
Angle of Skew
0° SKEW
ANY SKEW
PART PLAN
Open Joint
24 oz Copper Strip
Asphaltic Filler
Premolded Expansion Joint Material
PART ELEVATION A-A
(For Concrete Deck Girder Span)
Note: Premolded Expansion Joint Material of the thickness shown on plans to be used in Joint over area shown as shaded above. Joint to be left open over unshaded areas.
Premolded Exp. Joint Material
PART ELEVATION A-A
(For Concrete Floor on Steel Superstructure)
COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS
EXPANSION JOINT DETAILS FOR CONCRETE BRIDGE FLOORS
G-351
TYPICAL EXPANSION JOINT DETAILS



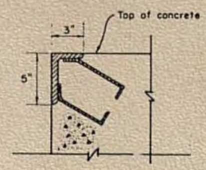
PLAN
(FOR STRAIGHT BRIDGE)



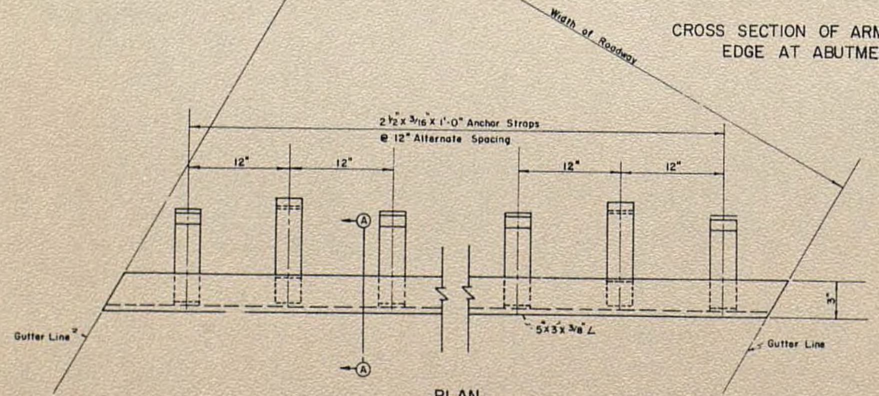
CROSS SECTION OF ARMORED EDGE AT ABUTMENT



SECTION A-A



TYPICAL SECTION



PLAN
(FOR SKEWED BRIDGE)

GENERAL NOTE

SPECIFICATIONS: Kentucky Department of Highways Current Specifications with revisions.

PAINT: All surfaces of the material shown on this sheet, not in contact with concrete, shall be given one shop coat of Type I red lead paint in accordance with the specifications. Exposed surfaces not accessible after erection shall be given one field coat of red lead paint and two coats of aluminum paint before erection. At the direction of the Engineer or when required on the detailed plans, surfaces adjacent to joint sealers shall be required to be free from paint.

WELDING SPECIFICATIONS: All welding materials, welding techiques and welding procedure shall comply with American Welding Society Standard Specifications for Welding Highway and Railway Bridges, Current Edition.

WELDING AND WELDING MATERIAL: The cost of welding, welding material and labor to be included in the lump sum bid for structural steel. No direct payment will be made for welding and welding material.

MILL TEST REPORTS: Notarized statements in triplicate shall be furnished the Department of Highways showing that all structural steel furnished meets the specifications.

SHOP DETAIL PLANS: The contractor shall submit shop detail plans for approval prior to fabrication in accordance with plans and specifications.

ANCHOR STRAPS: When armored edge is used in conjunction with expansion dam, the location of 2½" x 3/16" x 1'-0" anchor straps should be spaced not to interfere with anchor straps located on expansion dam.

MATERIAL SPECIFICATION: Steel material shall conform to ASTM designation A 36.

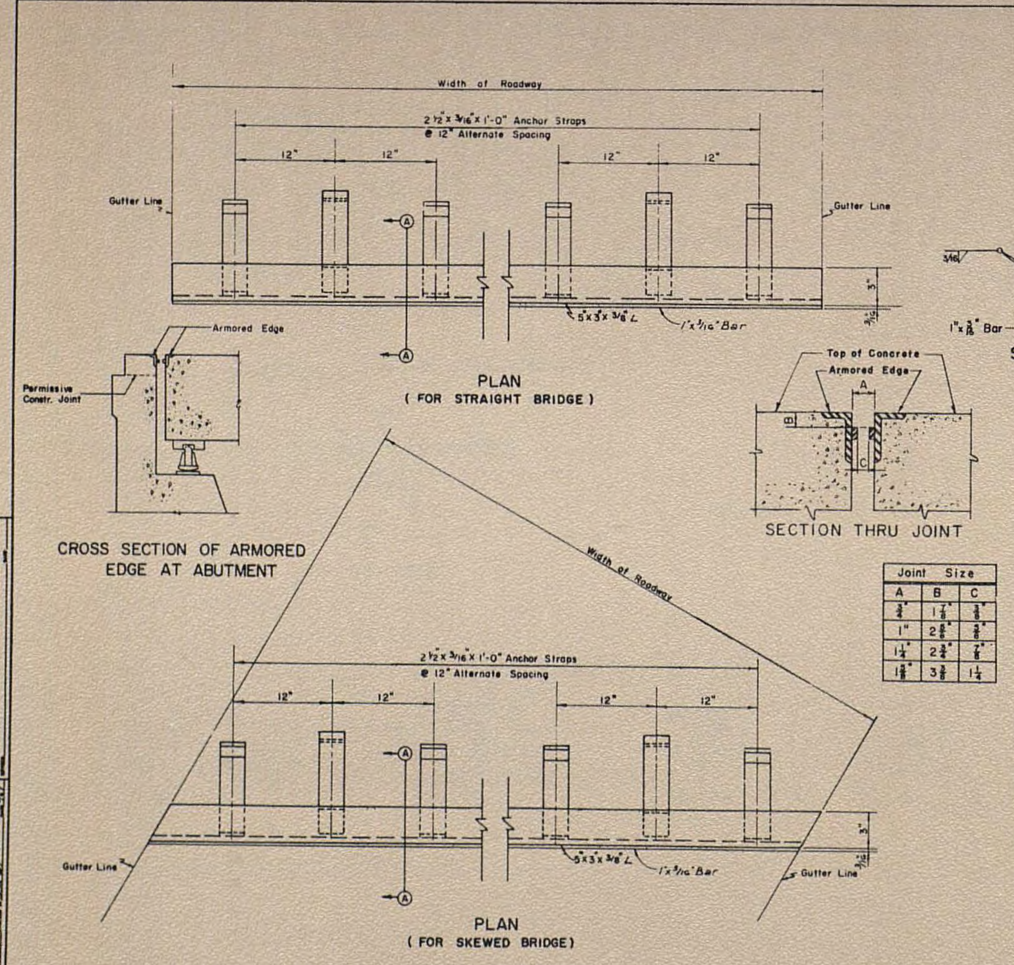
PAYMENT: The cost of furnishing and placing armored edge shall be included in the lump sum bid for Structural Steel.

LOCATION: The location of armored edge shall be shown on the detail plans.

WEIGHT: Weight per foot of assembly = 11.5 lbs.

COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS
FRANKFORT

STANDARD ARMORED EDGE FOR CONCRETE



Joint Size		
A	B	C
3/4"	1 7/8"	3/8"
1"	2 5/8"	5/8"
1 1/4"	2 3/4"	7/8"
1 5/8"	3 3/8"	1 1/4

GENERAL NOTE

SPECIFICATIONS: Kentucky Department of Highways Current Specifications with revisions.

PAINT: All surfaces of the material shown on this sheet, not in contact with concrete, shall be given one shop coat of Type I red lead paint in accordance with the specifications. Exposed surfaces not accessible after erection shall be given one field coat of red lead paint and two coats of aluminum paint before erection. At the direction of the engineer or when required on the detailed plans, surfaces adjacent to joint sealers shall be required to be free from paint.

WELDING SPECIFICATIONS: All welding materials, welding techniques and welding procedure shall comply with American Welding Society Standard Specifications for Welding Highway and Railway Bridges, Current Edition.

WELDING AND WELDING MATERIAL: The cost of welding, welding material and labor to be included in the lump sum bid for structural steel. No direct payment will be made for welding and welding material.

MILL TEST REPORTS: Notarized statements in triplicate shall be furnished the Department of Highways showing that all structural steel furnished meets the specifications.

SHOP DETAIL PLANS: The contractor shall submit shop detail plans for approval prior to fabrication in accordance with specifications.

ANCHOR STRAPS: When armored edge is used in conjunction with expansion dam, the location of 2½" x 3/16" x 1'-0" anchor straps should be spaced not to interfere with anchor straps located on expansion dam.

MATERIAL SPECIFICATION: Steel material shall conform to ASTM designation A36.

PAYMENT: The cost of furnishing and placing armored edge shall be included in the lump sum bid for Structural Steel.

LOCATION: The location of armored edge shall be shown on the detail plans.

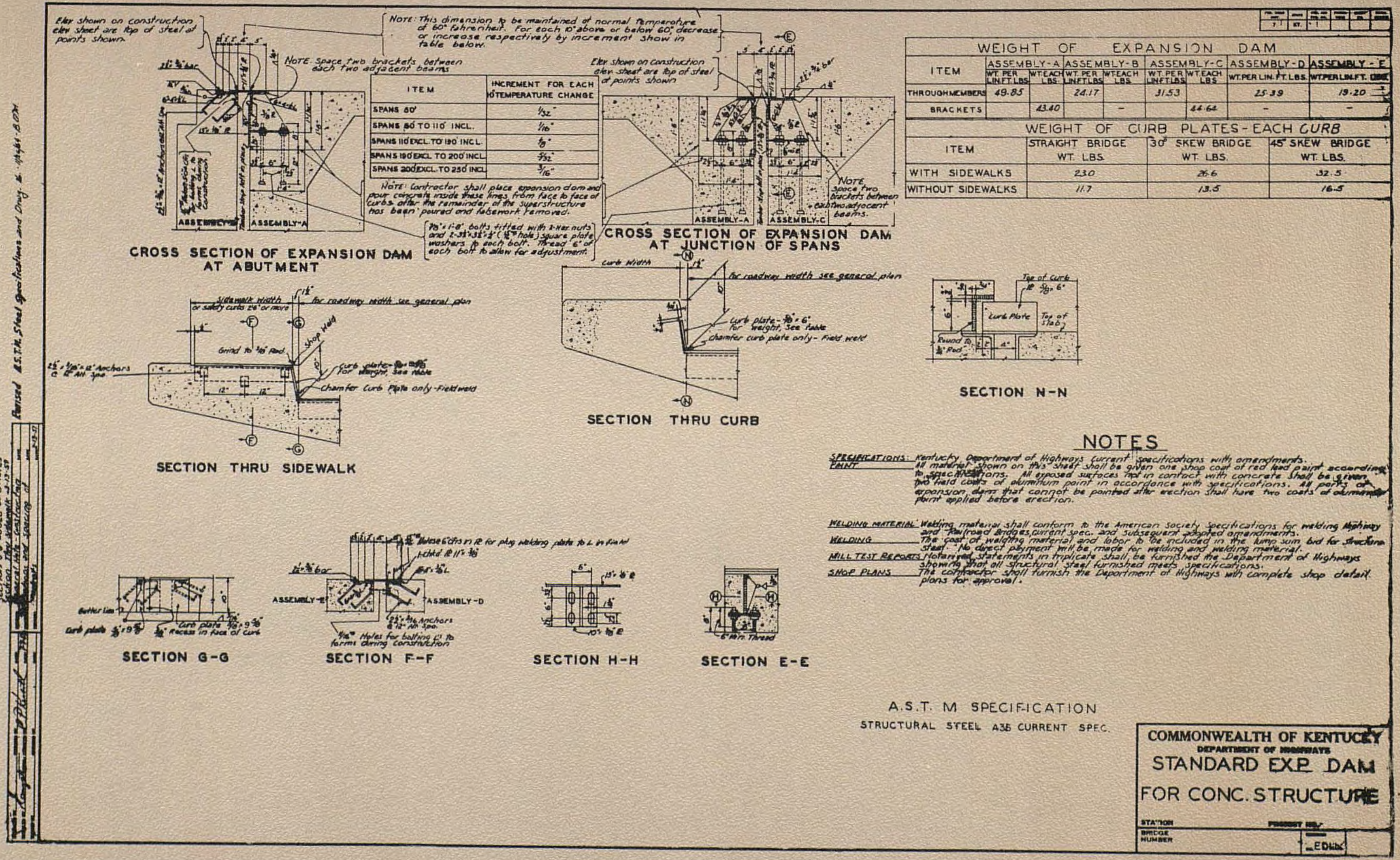
WEIGHT: Weight per foot of assembly = 12.14 lbs.

JOINT SIZE: This drawing to be used only with Joints ¾" or larger.

COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS
FRANKFORT

STANDARD ARMORED EDGE FOR JOINTS IN CONCRETE

BRIDGE NUMBER — AE2-B



ITEM	INCREMENT FOR EACH 10° TEMPERATURE CHANGE
SPANS 60'	1/32"
SPANS 60' TO 110' INCL.	1/16"
SPANS 110' EXCL. TO 190' INCL.	1/8"
SPANS 190' EXCL. TO 200' INCL.	5/32"
SPANS 200' EXCL. TO 250' INCL.	3/16"

WEIGHT OF EXPANSION DAM

ITEM	ASSEMBLY-A		ASSEMBLY-B		ASSEMBLY-C		ASSEMBLY-D	ASSEMBLY-E
	WT. PER LIN.FT. LBS.	WT. EACH LBS.	WT. PER LIN.FT. LBS.	WT. EACH LBS.	WT. PER LIN.FT. LBS.	WT. EACH LBS.	WT. PER LIN. FT. LBS.	WT. PER LIN. FT. LBS.
THROUGH MEMBERS	49.85		24.17		31.53		25.39	19.20
BRACKETS		43.40		-		44.64	-	-

WEIGHT OF CURB PLATES - EACH CURB

ITEM	STRAIGHT BRIDGE WT. LBS.	30° SKEW BRIDGE WT. LBS.	45° SKEW BRIDGE WT. LBS.
WITH SIDEWALKS	23.0	26.6	32.5
WITHOUT SIDEWALKS	11.7	13.5	16.5

NOTES

SPECIFICATIONS: Kentucky Department of Highways current specifications with amendments.

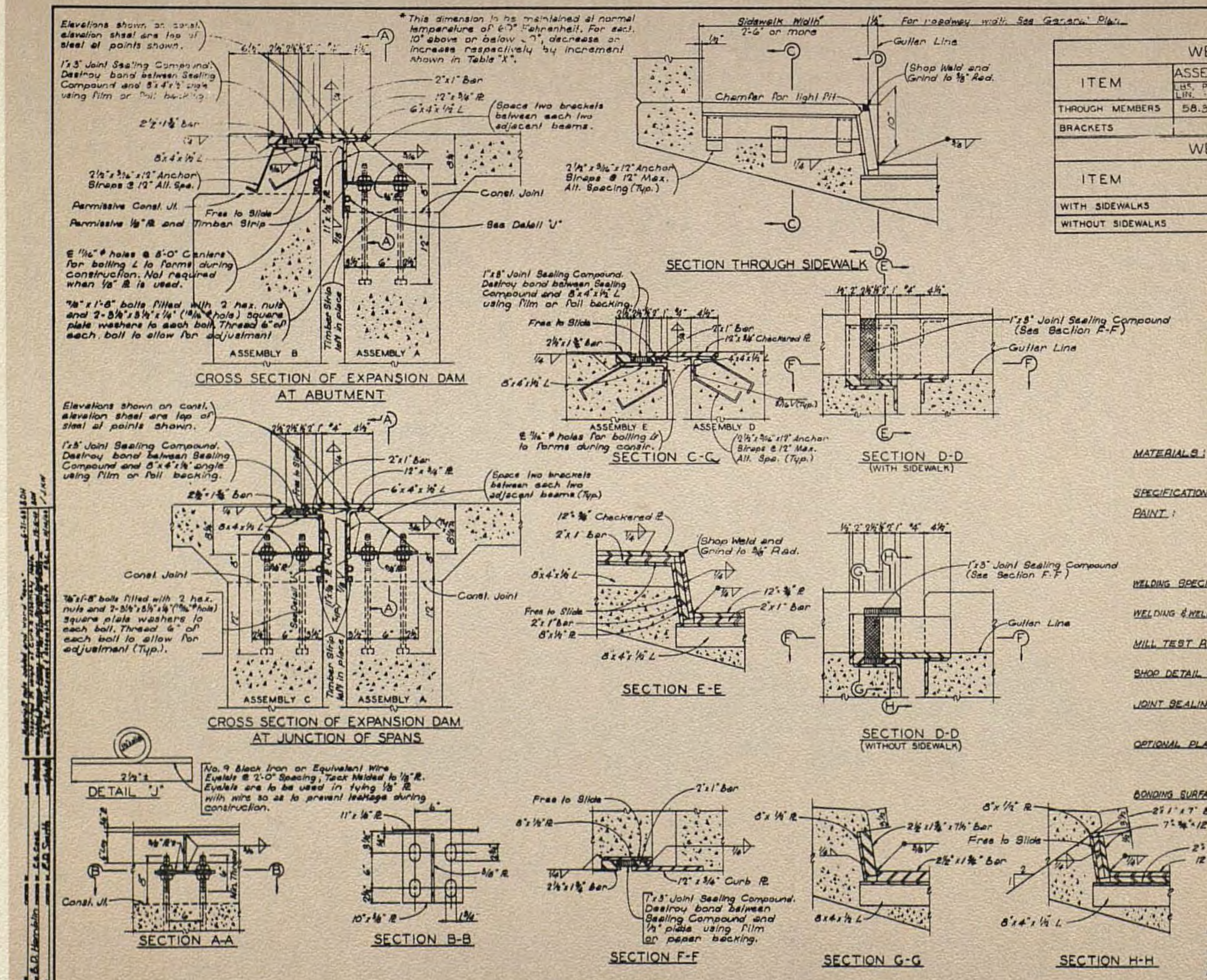
PAINT: All material shown on this sheet shall be given one shop coat of red lead paint according to specifications. All exposed surfaces not in contact with concrete shall be given two field coats of aluminum paint in accordance with specifications. All parts of expansion dam that cannot be painted after erection shall have two coats of aluminum paint applied before erection.

WELDING MATERIAL: Welding material shall conform to the American Society Specifications for welding Highway and Railroad Bridges, current spec. and subsequent adopted amendments.

WELDING: The cost of welding material and labor to be included in the lump sum bid for structural steel. No direct payment will be made for welding and welding material.

MILL TEST REPORTS: Notarized statements in triplicate shall be furnished the Department of Highways showing that all structural steel furnished meets specifications.

SHOP PLANS: The contractor shall furnish the Department of Highways with complete shop detail plans for approval.



7	KY.				

WEIGHT OF EXPANSION DAM								
ITEM	ASSEMBLY A		ASSEMBLY B		ASSEMBLY C		ASSEMBLY D	ASSEMBLY E
	LBS. PER LIN. FT.	WT.-EACH LBS.	LBS. PER LIN. FT.	WT.-EACH LBS.	LBS. PER LIN. FT.	WT.-EACH LBS.	LBS. PER LIN. FT.	LBS. PER LIN. FT.
THROUGH MEMBERS	58.3		36.1		39.2		[illegible]	36.1
BRACKETS		39.0		—		39.4	—	—

WEIGHT OF CURB PLATE ASSEMBLY-EACH			
ITEM	STRAIGHT BRIDGE WT. LBS.	30° SKEW BRIDGE WT. LBS.	45° SKEW BRIDGE WT. LBS.
WITH SIDEWALKS	56.5	65.2	79.8
WITHOUT SIDEWALKS	41.1	47.5	58.1

TABLE "X"	
ITEM	INCREMENT FOR EACH 10° TEMPERATURE CHANGE
SPANS THRU 60'	1/32"
SPANS 61' THRU 100'	1/16"
SPANS 101' THRU 140'	3/32"
SPANS 141' THRU 180'	1/8"
SPANS 181' THRU 220'	5/32"
SPANS 221' THRU 260'	3/16"

GENERAL NOTE

MATERIALS: The following current A.S.T.M. Designations shall govern the materials furnished:
Structural Steel A.S.T.M. A36
Machine Bolts and Nuts A.S.T.M. A307

SPECIFICATIONS: Kentucky Department of Highways Current Specifications with amendments.

PAINT: All material shown on this sheet shall be given one shop coat of type I red lead paint according to specifications, except as noted below. All exposed surfaces not in contact with concrete shall be given two field coats of aluminum paint in accordance with the specifications, except as noted below. Exposed surfaces not accessible after erection shall be given two field coats of aluminum paint before erection, except as noted below.

WELDING SPECIFICATIONS: All welding materials, welding technique and welding procedure shall comply with American Welding Society Standard Specifications for Welded Highway and Railway Bridges, 1963 edition.

WELDING & WELDING MATERIAL: The cost of welding, welding material and labor to be included in the lump sum bid for structural steel. No direct payment will be made for welding and welding material.

MILL TEST REPORTS: Notarized statements in triplicate shall be furnished the Department of Highways showing that all structural steel furnished meets the specifications.

SHOP DETAIL PLANS: The contractor shall submit shop detail plans for approval prior to fabrication in accordance with the specifications.

JOINT SEALING COMPOUND: Cold-applied, elastomeric type joint sealing compound shall conform to the special provisions for this material. Special provisions govern material requirements, sampling and testing, application and payment.

OPTIONAL PLATE: Use of 11"x1/2" ℞ in assembly B is optional. Weight of this plate is not included in assembly weight shown and if used shall be included in the lump sum bid for structural steel. Details of ⊥ plate, if used, shall be incorporated in shop plans submitted for approval.

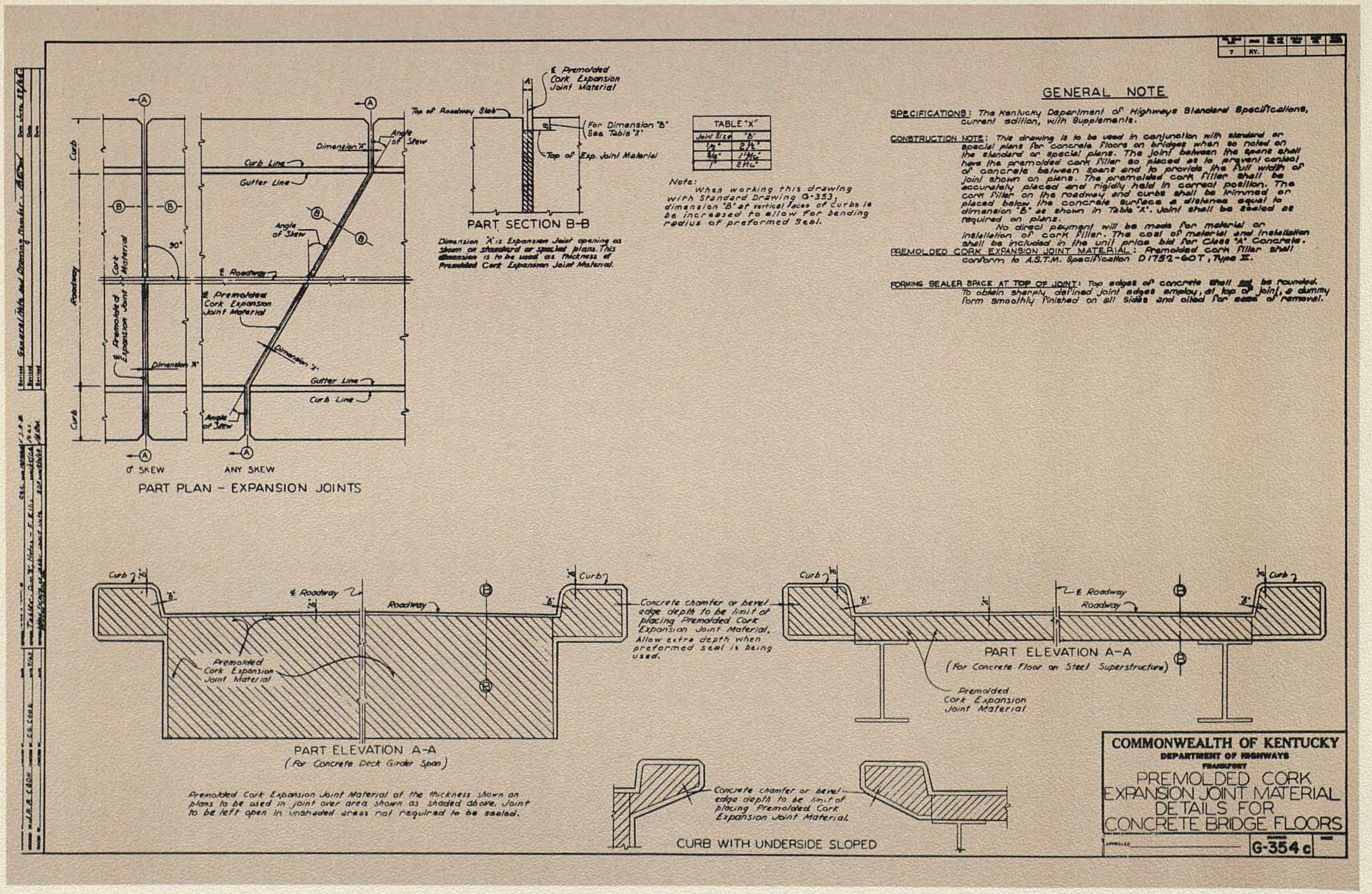
BONDING SURFACE FINISH: Vertical edges of steel bars which require bonding to joint sealing compound shall receive neither shop nor field paint. Before applying joint sealing compound, vertical edges of steel bars shall be cleaned to bare metal.

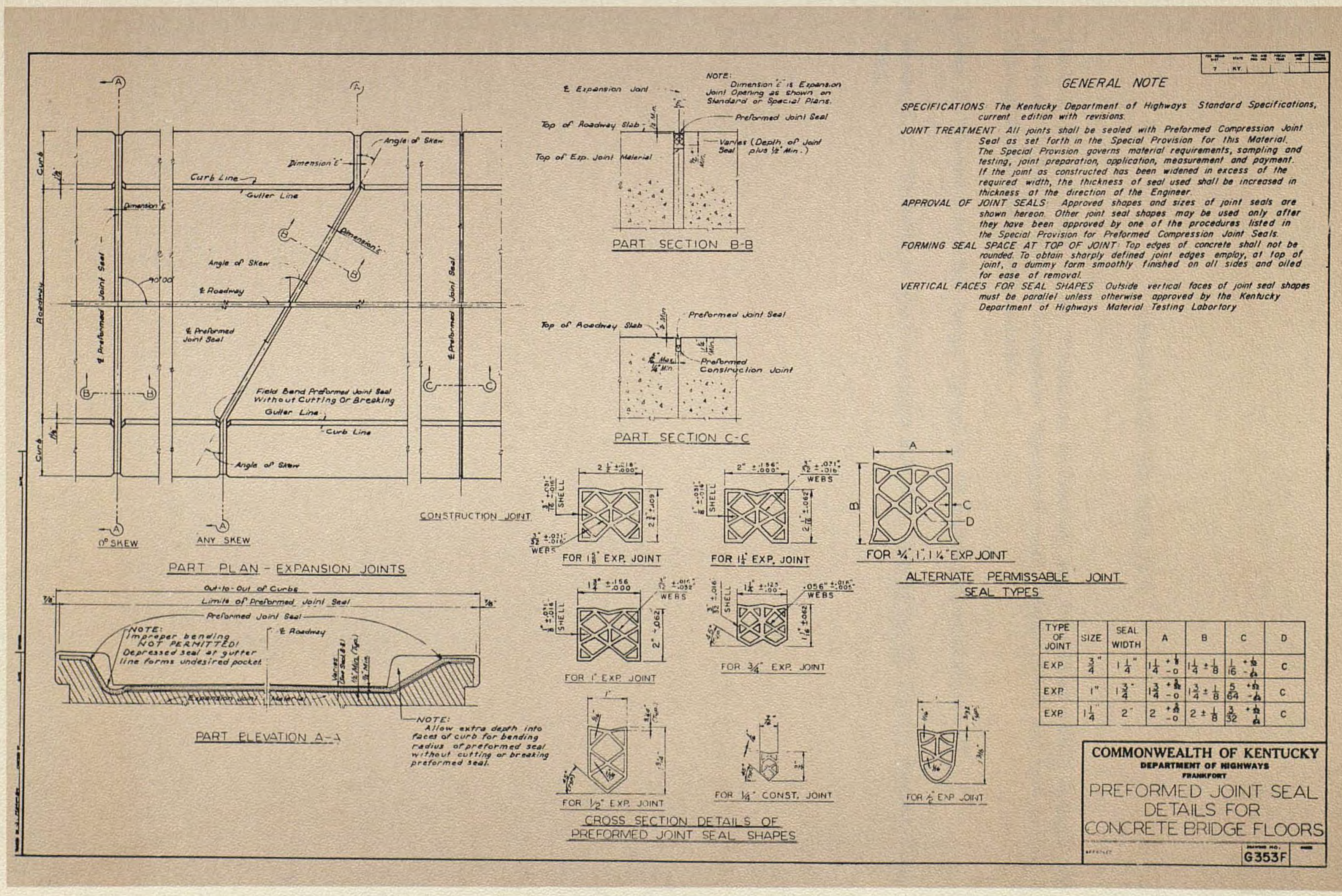
NOTE: Dimensions shown on Sidewalk and Curb Details are for Straight Bridge.

COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS
FRANKFORT

STANDARD EXP. DAM FOR CONCRETE SPANS

ED2 b


PART PLAN - EXPANSION JOINTS
0° SKEW
ANY SKEW
Curb
Roadway
Curb Line
Gutter Line
Dimension "A"
Angle of Skew
℄ Roadway
℄ Premolded Cork Expansion Joint Material
PART SECTION B-B
℄ Premolded Cork Expansion Joint Material
Top of Roadway Slab
For Dimension "B" See Table "X"
Top of Exp. Joint Material
Dimension "A" is Expansion Joint opening as shown on standard or special plans. This dimension is to be used as thickness of Premolded Cork Expansion Joint Material.
TABLE "X"
Joint Size | "B"
1/2" | 2 1/2"
3/4" | 1 13/16"
1" | 2 11/16"
Note:
When working this drawing with Standard Drawing G-353, dimension 'B' at vertical faces of curbs is be increased to allow for bending radius of preformed Seal.
GENERAL NOTE
SPECIFICATIONS: The Kentucky Department of Highways Standard Specifications, current edition, with Supplements.
CONSTRUCTION NOTE: This drawing is to be used in conjunction with standard or special plans for concrete floors on bridges when so noted on the standard or special plans. The joint between the spans shall have the premolded cork filler so placed as to prevent contact of concrete between spans and to provide the full width of joint shown on plans. The premolded cork filler shall be accurately placed and rigidly held in correct position. The cork filler on the roadway and curbs shall be trimmed or placed below the concrete surface a distance equal to dimension "B" as shown in Table "X". Joint shall be sealed as required on plans.
No direct payment will be made for material or installation of cork filler. The cost of material and installation shall be included in the unit price bid for Class "A" Concrete.
PREMOLDED CORK EXPANSION JOINT MATERIAL: Premolded cork filler shall conform to A.S.T.M. Specification D1752-60T, Type II.
FORMING SEALER SPACE AT TOP OF JOINT: Top edges of concrete shall not be rounded. To obtain sharply defined joint edges employ, at top of joint, a dummy form smoothly finished on all sides and oiled for ease of removal.
PART ELEVATION A-A
(For Concrete Deck Girder Span)
Premolded Cork Expansion Joint Material
Concrete chamfer or bevel edge depth to be limit of placing Premolded Cork Expansion Joint Material. Allow extra depth when preformed seal is being used.
Premolded Cork Expansion Joint Material of the thickness shown on plans to be used in joint over area shown as shaded above. Joint to be left open in unshaded areas not required to be sealed.
PART ELEVATION A-A
(For Concrete Floor on Steel Superstructure)
Premolded Cork Expansion Joint Material
CURB WITH UNDERSIDE SLOPED
Concrete chamfer or bevel edge depth to be limit of placing Premolded Cork Expansion Joint Material.
COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS
FRANKFORT
PREMOLDED CORK EXPANSION JOINT MATERIAL DETAILS FOR CONCRETE BRIDGE FLOORS
G-354 c



GENERAL NOTE

SPECIFICATIONS: The Kentucky Department of Highways Standard Specifications, current edition with revisions.

JOINT TREATMENT: All joints shall be sealed with Preformed Compression Joint Seal as set forth in the Special Provision for this Material. The Special Provision governs material requirements, sampling and testing, joint preparation, application, measurement and payment. If the joint as constructed has been widened in excess of the required width, the thickness of seal used shall be increased in thickness at the direction of the Engineer.

APPROVAL OF JOINT SEALS: Approved shapes and sizes of joint seals are shown hereon. Other joint seal shapes may be used only after they have been approved by one of the procedures listed in the Special Provision for Preformed Compression Joint Seals.

FORMING SEAL SPACE AT TOP OF JOINT: Top edges of concrete shall not be rounded. To obtain sharply defined joint edges employ, at top of joint, a dummy form smoothly finished on all sides and oiled for ease of removal.

VERTICAL FACES FOR SEAL SHAPES: Outside vertical faces of joint seal shapes must be parallel unless otherwise approved by the Kentucky Department of Highways Material Testing Labortory

TYPE OF JOINT	SIZE	SEAL WIDTH	A	B	C	D
EXP	$\frac{3}{4}$"	$1\frac{1}{4}$"	$1\frac{1}{4}\ {}^{+\frac{1}{8}}_{-0}$	$1\frac{1}{4} \pm \frac{1}{8}$	$\frac{1}{16}\ {}^{+\frac{1}{32}}_{-\frac{1}{64}}$	C
EXP	1"	$1\frac{3}{4}$"	$1\frac{3}{4}\ {}^{+\frac{3}{32}}_{-0}$	$1\frac{3}{4} \pm \frac{1}{8}$	$\frac{5}{64}\ {}^{+\frac{1}{32}}_{-\frac{1}{64}}$	C
EXP	$1\frac{1}{4}$"	2"	$2\ {}^{+\frac{3}{32}}_{-0}$	$2 \pm \frac{1}{8}$	$\frac{3}{32}\ {}^{+\frac{1}{32}}_{\frac{1}{64}}$	C

ABBREVIATED BIBLIOGRAPHY

1. Cook, J. P., and Lewis, R. M., "Evaluation of Pavement and Joint Crack Sealing Materials and Practices," Report 38, National Cooperative Highway Research Program, 1967. This work contains a thorough bibliography on joints and seals.

2. Tons, E.. "Factors in Joint Seal Design," Record No. 80, Highway Research Board 1965.

3. Watson, S. C., "Performance of a Compression Joint Seal," Record No. 80, Highway Research Board, 1965.