ARIZONA DEPARTMENT OF TRANSPORTATION

**REPORT NUMBER: FHWA-AZ97-450**

# BRIDGE APPROACH / ANCHOR SLAB JOINT EVALUATION

**Final Report**

**Prepared by:**
Shan Sundaram
Michael Dadik
Sundaram Engineering, Inc.
833 West Portobello Avenue
Mesa, AZ 85210

**July 1997**

**Prepared for:**
Arizona Department of Transportation
206 South 17th Avenue
Phoenix, Arizona 85007
in cooperation with
U.S. Department of Transportation
Federal Highway Administration

Technical Report Documentation Page

| 1. Report No. | 2. Government Accession No. | 3. Recipient's Catalog No. |
|---|---|---|
| FHWA-AZ 97 - 450 | | |

| 4. Title and Subtitle | 5. Report Date |
|---|---|
| BRIDGE APPROACH/ANCHOR SLAB JOINT EVALUATION | JULY 1997 |
| | 6. Performing organization code |
| 7. Author<br>Shan Sundaram, Michael Dadik | 8. Performing Organization Report No. |
| 9. Performing Organization Name and Address<br>SUNDARAM ENGINEERING, INC.<br>833 WEST PORTOBELLO AVENUE<br>MESA, ARIZONA 85210 | 10. Work Unit No.<br><br>11. Contract or Grant No.<br>SPR-PL-1(49) 450<br>T96-09-A0015 |
| 12. Sponsoring Agency Name and Address<br>ARIZONA DEPARTMENT OF TRANSPORTATION<br>206 S. 17TH AVENUE<br>PHOENIX, ARIZONA 85007<br>Project Manager: Tim Wolfe | 13. Type of Report and Period Covered<br>FINAL, 11-20-96 THRU 7-20-97<br><br>14. Sponsoring Agency Code |

15. Supplementary Notes

Prepared in cooperation with the U.S. Department of Transportation, Federal Highway Administration

16. Abstract

Portland cement concrete pavements between bridges expand in warm weather and contract when cooled and due to shrinkage of concrete. Pavement movements have to be accommodated close to the bridge for the safety of the bridge structure. Reinforced anchor slabs with the monolithic lugs underneath, are provided to resist the pavement movement by the passive soil pressure after mobilization. Nevertheless, additional positive relief is provided by the joint between the approach slab and the anchor slab, which butts against the PCCP. The function of this joint is crucial to the safety of the bridge. A material or device that will not let water and debris inside the joint and at the same time allows sufficient expansion and contraction under traffic and weather conditions, is required to seal the joint. ADOT Construction and Maintenance staff have been observing the ineffectiveness of the joint in several locations on Arizona Freeways, due to debris and water penetrating the joint. This prompted ADOT to undertake the evaluation of the existing joint and to improve or modify the joint to make it more functional and efficient. Sundaram Engineering, Inc. the Consultant to ADOT on this Project, has gathered pertinent data on the subject from the available literature and also solicited information from Departments of Transportation from other States regarding the joint. The firm also undertook the inspection of about 30 bridge approaches and evaluated the performance of existing joints. Hot poured coal tar sealant (ASTM D3406) is the predominant material used in sealing the joint. Though the designated width is 75 mm, the actual widths varied from 38 mm to 100 mm. The inspection and evaluation revealed two major types of joint failure, adhesive failure (debonding from the edges of slabs) and loss of flexibility of the material. The inspection also revealed not following proper and adequate installation procedures in the construction of the joint, is a major contributing factor to the joint failure. Based on the study of the available joint systems and materials, five new solutions for the joint were devised and proposed. The new joints have improved quality in the material of the sealant (low modulus hot poured sealant, silicone sealant and membrane foam sealant) and compression and strip seals. Adaptation of these to the existing joints is also discussed. Joint preparation requirements and termination treatments at side barriers are also addressed.

| 17. Key Words | 18. Distribution Statement | 23. Registrant's Seal |
|---|---|---|
| Joint types, Approach/Anchor slab, Sealants, Joint installation, PCCP expansion | Document is available to the U.S. Public through the National Technical Information Service, Springfield, Virginia 22161 | Registered Professional Engineer (Structural)<br>CERTIFICATE NO. 14764<br>N. SHANMUGHA SUNDARAM<br>Date Signed 8-8-97<br>ARIZONA, U.S.A. |

| 19. Security Classification | 20. Security Classification | 21. No. of pages | 22. Price |
|---|---|---|---|
| Unclassified | Unclassified | | |

# SI* (MODERN METRIC) CONVERSION FACTORS

## APPROXIMATE CONVERSIONS TO SI UNITS

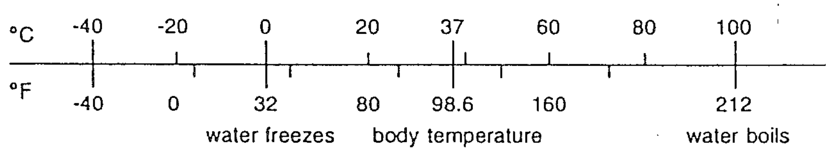
| Symbol | When You Know | Multiply By | To Find | Symbol |
|---|---|---|---|---|
| | | **LENGTH** | | |
| in | inches | 25.4 | millimeters | mm |
| ft | feet | 0.305 | meters | m |
| yd | yards | 0.914 | meters | m |
| ml | miles | 1.61 | kilometers | km |
| | | **AREA** | | |
| $in^2$ | square inches | 645.2 | millimeters squared | $mm^2$ |
| $ft^2$ | square feet | 0.093 | meters squared | $m^2$ |
| $yd^2$ | square yards | 0.836 | meters squared | $m^2$ |
| ac | acres | 0.405 | hectares | ha |
| $mi^2$ | square miles | 2.59 | kilometers squared | $km^2$ |
| | | **VOLUME** | | |
| ft oz | fluid ounces | 29.57 | milliliters | mL |
| gal | gallons | 3.785 | liters | L |
| $ft^3$ | cubic feet | 0.028 | meters cubed | $m^3$ |
| $yd^3$ | cubic yards | 0.765 | meters cubed | $m^3$ |

NOTE: Volumes greater than 1000 L shall be shown in $m^3$.

| Symbol | When You Know | Multiply By | To Find | Symbol |
|---|---|---|---|---|
| | | **MASS** | | |
| oz | ounces | 28.35 | grams | g |
| lb | pounds | 0.454 | kilograms | kg |
| T | short tons (2000 lb) | 0.907 | megagrams | Mg |

### TEMPERATURE (exact)

| Symbol | When You Know | Do The Following | To Find | Symbol |
|---|---|---|---|---|
| °F | Fahrenheit temperature | °F - 32 ÷ 1.8 | Celcius temperature | °C |




## APPROXIMATE CONVERSIONS FROM SI UNITS

| Symbol | When You Know | Multiply By | To Find | Symbol |
|---|---|---|---|---|
| | | **LENGTH** | | |
| mm | millimeters | 0.039 | inches | in |
| m | meters | 3.28 | feet | ft |
| m | meters | 1.09 | yards | yd |
| km | kilometers | 0.621 | miles | mi |
| | | **AREA** | | |
| $mm^2$ | millimeters squared | 0.0016 | square inches | $in^2$ |
| $m^2$ | meters squared | 10.764 | square feet | $ft^2$ |
| $m^2$ | meters squared | 1.19 | square yards | $yd^2$ |
| ha | hectares | 2.47 | acres | ac |
| $km^2$ | kilometers squared | 0.386 | square miles | $mi^2$ |
| | | **VOLUME** | | |
| mL | milliliters | 0.034 | fluid ounces | fl oz |
| L | liters | 0.264 | gallons | gal |
| $m^3$ | meters cubed | 35.315 | cubic feet | $ft^3$ |
| $m^3$ | meters cubed | 1.31 | cubic yards | $yd^3$ |
| | | **MASS** | | |
| g | grams | 0.035 | ounces | oz |
| kg | kilograms | 2.205 | pounds | lb |
| Mg | megagrams | 1.102 | short tons (2000 lb) | T |

### TEMPERATURE (exact)

| Symbol | When You Know | Do The Following | To Find | Symbol |
|---|---|---|---|---|
| °C | Celcius temperature | °C x 1.8 + 32 | Fahrenheit temperature | °F |

| | |
|---|---|
| METER: | a little longer than a yard (about 1.1 yards) |
| LITER: | a little larger than a quart (about 1.06 quarts) |
| GRAM: | a little more than the weight of a paper clip |
| MILLIMETER: | diameter of a paper clip wire |
| KILOMETER: | somewhat further than 1/2 mile (about 0.6 mile) |

*SI is the symbol for the International System of Measurement

## TABLE OF CONTENTS

## LIST OF FIGURES



## LIST OF TABLES

# CHAPTER I

# INTRODUCTION

Portland Cement Concrete Pavements on highways expand and contract due to temperature differentials. Contraction occurs due to shrinkage also, but most of the shrinkage takes place within the initial few weeks after concrete is poured. When these movements are restricted, compressive and tensile stresses are developed leading to cracks in the pavement. In continuously reinforced concrete pavements, the reinforcement allows the pavement to withstand these stresses; however continuous reinforced pavement highway is an expensive proposition. Arizona highways employ plain Portland cement concrete pavements with control joints. These joints provide controlled cracking along designated lines rather than random cracking. They do not allow for pavement movement or what is commonly referred to as pavement growth. Pavement growth occurs after incompressible material enters a joint when the pavement is cool. As the pavement warms and the concrete expands, joint closure is restricted by the incompressible material. When PCCP adjoins bridge structures, pavement movements have to be accommodated on both sides of the bridge for the safety of the bridge structure.

In order to provide for this movement, ADOT has been using two features on the concrete paved highways, since early 1980. One is the reinforced concrete anchor slab to handle pressure resulting from pavement expansion. This is a 300 mm thick concrete slab, 5 to 15 meters long (depending on the length of PCCP before and after the bridge) with one or two vertical lugs 600 mm wide and 1100 mm to 1700 mm deep. These vertical lugs provide passive resistance to the PCCP movement after mobilization of the passive soil pressure. Stresses caused by this pressure are withstood by the reinforcement in the anchor slab. The anchor slab also protects the integrity of the PCCP. Unrestrained pavement growth is accommodated by the second feature . This is the joint between the approach slab and the anchor slab. Since a joint is provided, steps have to be taken to seal the joint and to make certain that the seal is capable of expansion and contraction and can accept pavement growth, allowing the joint to function under traffic and weather conditions. This would ensure the safety of the approach slab and the bridge structure that is ahead or behind the joint.

The metric equivalent of the joint as used now is shown in Figure 1. In recent years, ADOT construction and maintenance staff have been observing the deficiencies in the function of the joint. The hot poured sealant at the top layer is peeling off the edges of the slabs; water and debris find their way through the gaps between the sealant and the slabs and also through the side joints between the slab and the barriers. The material of the sealant is becoming dry and brittle and the approach slab experiences settlement adjacent to the joint. Spalling has occurred along the joint at random due to the impact of the traffic. These concerns have prompted ADOT to have a consultant investigate and evaluate the joint and make recommendations to improve and /or modify the joint to make it more functional, efficient and durable. Sundaram Engineering, Inc. is pleased to have been hired by ADOT and to have the opportunity to undertake this task and report on the findings with solutions for ADOT's verification.

The evaluation consisted of four steps.

- Conduct literature survey to gather information on joint function, requirements and materials.

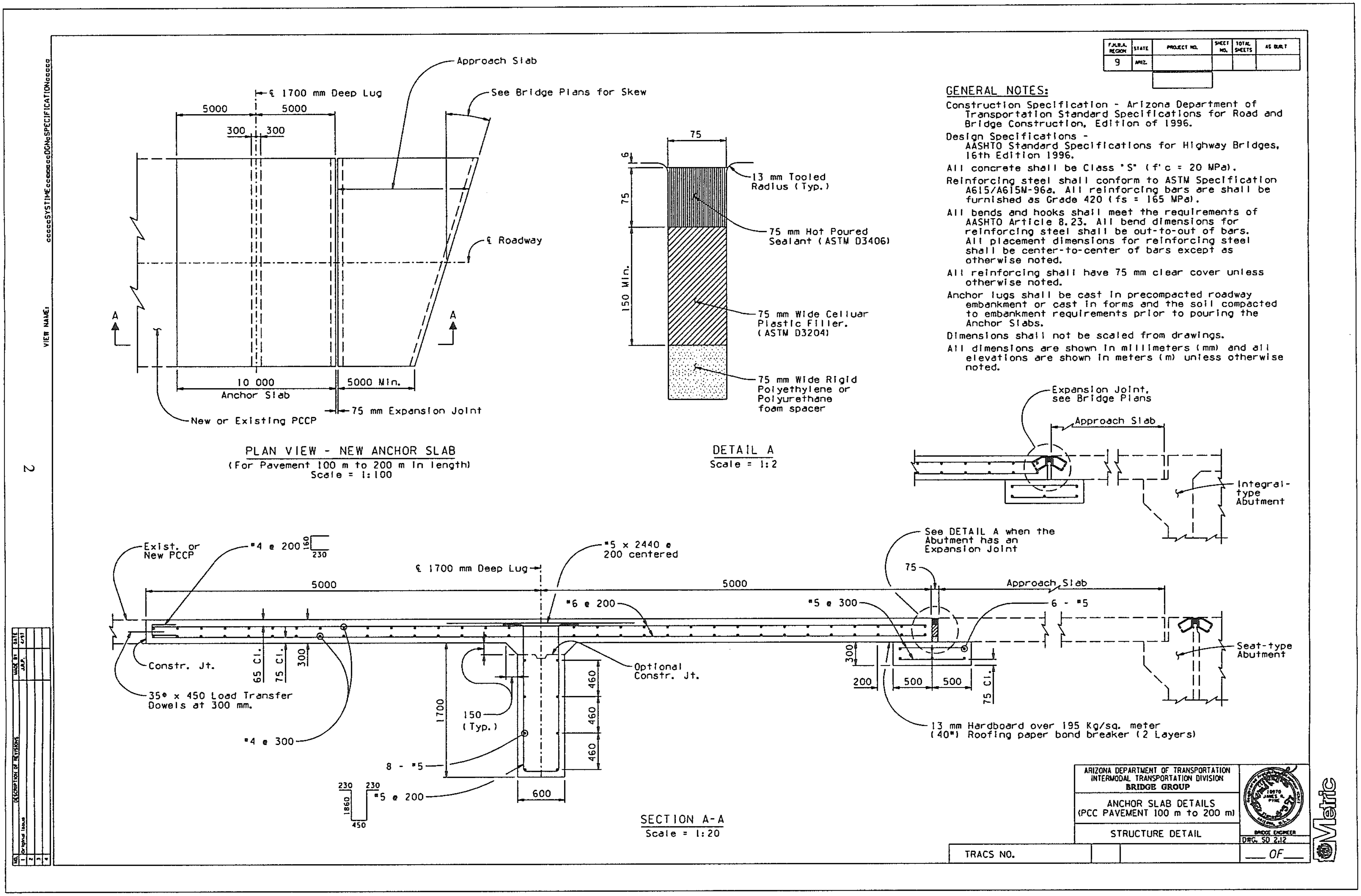



**Figure 1. Current ADOT Joint**

This includes contacting DOTs of other States (1)*. Responses from them provided an insight into the different joint types in use.

- Conduct inventory of bridges at ADOT Records since early 1980s, select the ones with approach/anchor slab joint. Prepare an evaluation form, inspect the joints and collect the data.

- Based on the above information, devise solutions of joint systems for ADOT's verification. Indicate ways to adapt them to existing joints. Furnish terminal treatment of joints at side barriers.

- Present the evaluation findings and solutions in the form of a Research Report with conclusions.

The chapter on Joint Function, Requirements and Materials summarizes the information obtained from different sources including the DOTs of other States, pertinent to this investigation. The materials which have been subject to test and in use are listed in the Appendix 2 (pages A4 - A5). The types of joints used by some of the other States as their Standards that are representative of and pertinent to this study are furnished in the Appendix 3 (pages A6-A12)..

The chapter on Inspection and Evaluation of Joints present the evaluation procedure and summarizes the findings on the joints inspected in a tabular form. The table lists the location of the bridges, the joint type and the type of failures observed. Possible causes are also indicated.

The chapter on Solutions stems from the above two chapters. It discusses the qualities that a joint should have for its proper function. Solutions for improved joint systems are furnished. Modification of the existing joints are discussed. Terminal treatment of the joints is presented. The importance of proper installation procedures is stressed.

The final chapter presents the Conclusions arrived at as a result of this study. The Arizona Transportation Research Center guidelines are followed in the preparation of this Research Report.

---

* Numbers in parentheses refer to the references furnished at the end of the report

## CHAPTER II

## JOINT FUNCTION, REQUIREMENTS AND MATERIALS

The information gathered from the literature and from DOTs of other States provided an insight into the joint function, requirements of the joint and materials in use. A summary of the joint system used by DOTs of other States as their Standards is furnished at the end of this Chapter. The joint between the approach slab and the anchor slab functions the same way as the cyclic control joints in the pavement, except the approach/anchor slab joint is more of a pavement growth joint. The cycles of expansion and contraction and the consequences of intrusive incompressibles are shown in Figure 2. After a joint opens during the contraction cycle, debris falls into the joint. During the expansion cycle, the expansion is restricted. From Figure 2, the stress $f_c = E_c \epsilon = 4800\ (20)^{1/2} \times .0003 = 6.4$ MPa., where $f_c' = 20$ MPa, .0003 = average shrinkage strain = $( \Delta_e - \Delta_{re} )/L_s$, $L_s$ = the length between joints. This means, in a 20 meter pavement between the joints, 6 mm (20 x 1000 x .0003) is filled with debris. The pavement undergoes or imparts a stress of 6.4 MPa at the assumed 50°°C. If there is no anchor slab, this force is imparted on the structure.

The requirements of a joint are enunciated by Wahls, in his paper on Design and Construction of Bridge approaches (2). " The joints must transfer traffic loads and be able to accommodate thermal expansion and contraction of the pavement. The joints must be sealed to prevent entry of water and debris. When the pavement movements are <u>fully</u> restrained, very large compressive stresses and buckling may develop." As another author Burke Jr. puts it (4), "there is great growth potential of unrestrained rigid pavement and great pressure potential of restrained rigid pavement". Providing for growth or providing for relief of pressure is same. There are different means of achieving each. That is the reason, the joint is also called pressure relief joint, in which case wide strip of bitumen or less stiff material is used to fill a wide joint. The flexible material relieves the pressure imposed by the movement of the pavement. These types of joints are used in the States of Kansas, New York, Pennsylvania, West Virginia and Connecticut ( See Appendix).

The Design Elements that one should look for in a joint are further elaborated by Moussa Issa et al of Florida DOT in their paper "On Site Evaluation of Bridge Deck Expansion Joints" (3). They are as follows.

- shall accommodate full expansion and contraction range of movements anticipated.
- shall have adequate anchorage and structural capacity.
- shall provide good riding surface.
- shall not induce undue stress in structure due to expansion and contraction.
- shall be silent and vibration free under traffic.
- shall facilitate maintenance repair, removal and replacement.
- shall be leak proof with continuous sealing element.
- shall be corrosion resistant.
- shall not be a catalyst or vehicle for electrolytic action.
- The joint seal shall be durable.
- Material and installation shall be cost effective.
- shall provide ease of installation.
- Time of installation shall be reasonable, since this has bearing on the length and degree of traffic interruption.

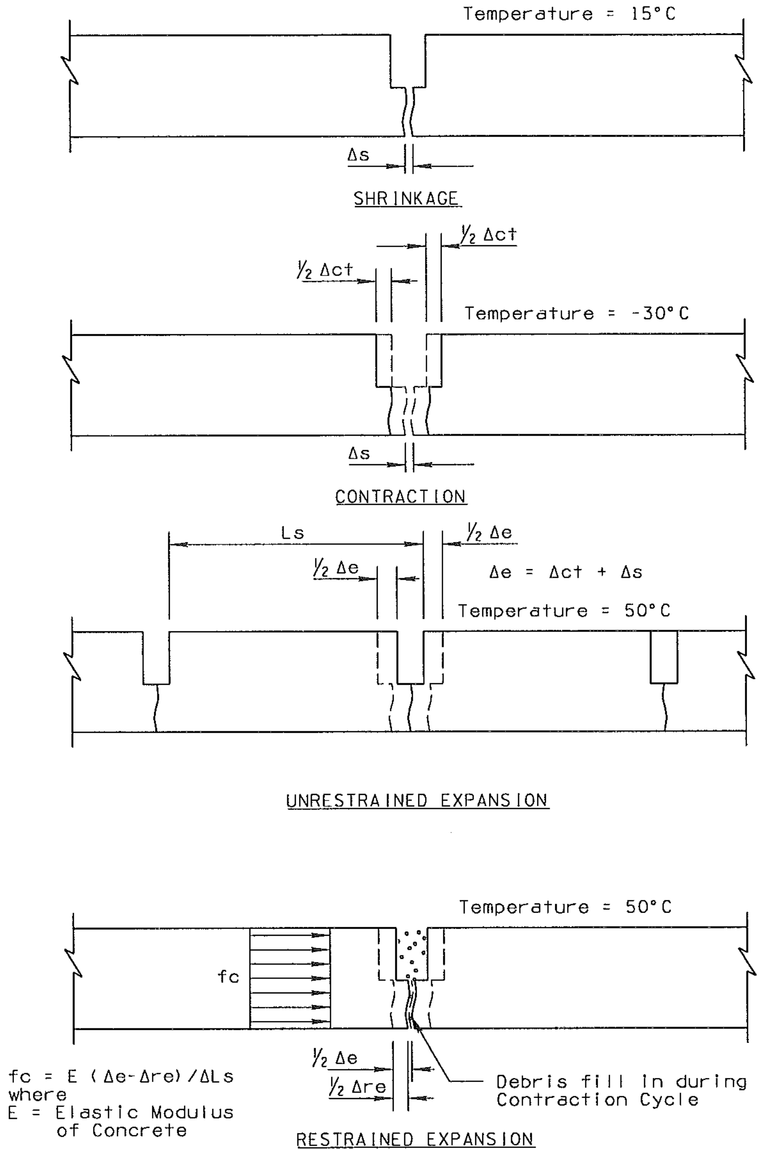



**Figure 2. Cyclic Movement at Joint**

- Any failure shall not pose danger to traffic.

The design of the joint shall also take into consideration that the wear and deterioration at edges of adjacent slabs reduce the effectiveness of expansion joints. These high stress zones shall be treated with elastomeric and polymeric nosing materials. For the solutions proposed in this report (Chapter IV), epoxy conrete is recommended for the nosing material. Elastomeric concrete may be more resilient, but has less than 50% of the bond and compressive strengths of epoxy concrete. Alternately, better tooling of the edges of the slabs may be adapted dispensing with the nosing material. Another important factor to be considered in choosing the material for the joint is that the joint movement shall be less than the strain limit of the sealant. The desirable range for the shape factor (depth/width) of the sealant is recommended to be 1 to 1.5 (5). This will be hard to satisfy with silicone joints. The approach/anchor slab joint shall be at least 50 mm, unless bridges are closer than 100 meters.

To aid in this investigation, information was sought from DOTs of other States. A summary of the responses which are pertinent to this study, from the States who answered our request is furnished below.

Arkansas: The State provides 3 expansion joints, one between the approach slab and the PCCP and the other two in the PCCP itself, spaced at about 5 meters apart. The joint is 40 mm wide with 20 mm thick sealant over 50 mm backer rod. The joint is supported over 915 x 305 mm sleeper slab.

Colorado: The State DOT recommends increase in shape factor ( depth / width ) of the present hot poured sealant from 1 to 3 to allow the stretch of the sealant and to resist debonding. The State uses an armored strip seal expansion joint 75 mm to 203 mm between the approach slab and the PCCP. The joint butts against a reinforced inverted Tee sleeper slab. The PCCP is presumed to rest on the sleeper slab.

Connecticut: The State provides 3 to 5 meter wide pressure relief joint with 200 mm thick bituminous concrete and subbase, between the approach slab and PCCP.

Florida: There is no anchor slab. There are four PCCP transverse expansion joints in a stretch of 5.5 meters of PCCP, including the one between the approach slab and the PCCP. The 57 to 75 mm wide joint has a recessed compression seal resting on jambs of narrower opening.

Georgia: The State uses preformed joint filler between the approach slab and backwall of the abutment. The top 1" of the joint is sealed with silicone sealant.

Illinois: The State uses a stretch of CRCP between approach slab and PCCP. The CRCP is similar to the anchor slab. The joint between the approach slab and CRCP is 100 mm preformed joint seal over reinforced sleeper slab on subgrade.

Iowa: The State allocates 18.3 meters minimum Pavement between the approach slab and the PCCP to provide 4 different doweled joints. The joints beginning with the end of approach slab are at 6.1 m centers. The top of the joint is filled with 6 mm wide hot poured sealant. The third joint from end is a 100 mm expansion joint with preformed urethane foam expansion joint filler.

Kansas: There is no anchor slab. A pressure relief joint is provided between the reinforced approach slab and the PCCP. This is 100 mm preformed urethane foam joint material with lubricant adhesive. In addition, there is an expansion joint within the approach slab. This joint system is shown in the Appendix page A7 under Joints of other DOTs.

Kentucky : The State uses a 38 mm wide joint between PCCP and the approach slab. The joint is recessed 6 mm and contains self - leveling silicone sealant over backing rod. The joint edges are armored with 16 mm x 203 mm steel plates anchored to slabs. The bottom of he joint has 38 mm wide styrofoam.

Maryland: The State does not use approach slabs or anchor slabs. It uses 15 meters of bituminous pavement behind the abutment backwall, before commencing the PCCP.

Minnesota: The joint is between the approach slab and the PCCP. It is 102 mm wide and supported by 1.2 meter x 305 mm sleeper slab. The joint is formed with preformed filler topped by a hot poured sealant.

New York: The State uses 1.5 meter wide strip of pressure relief joint with asphalt concrete between the approach slab and PCCP. There is a 2.3 meter sleeper slab centered on the joint width. This joint is shown in the Appendix page A8 under Joints of other DOTs.

Oklahoma: The State does not use similar joints. However, the DOT recommends Dow Corning 902 rapid cure silicone sealant in place of hot poured sealant. It also recommends the application of the sealant in summer, to avoid use of excess sealant which will be squeezed out during joint closure and will get damaged by the vehicles.

Oregon: The State concentrates on the joint between the approach slab and the abutment backwall. It prefers Dow 902 poured joint sealant to hot poured sealant. This requires sand blasting the joint faces and applying primer to concrete. The State also discourages the rigid polyurethane foam spacer on account of its incompressibility. The State seems to be using lot of CRCP.

Pennsylvania: The State provides a 300 mm wide pressure relief joint with bituminous binder between the approach slab and a transition reinforced concrete pavement (minimum 4 meters long ). A construction joint is introduced between the transition pavement and the regular PCCP. This joint is shown in the appendix page 9 under joints of other DOTs.

Texas: The State provides a 40 mm wide joint with preformed joint sealant (extruded elastomeric material with multi-channeled shape) or with sealing compound (self-leveling or non sag low modulus or rapid curing low modulus silicone) between 6 meter reinforced approach slab and the PCCP. The joint is supported by 700 mm x 250 mm sleeper slab. Between the pavement and the sleeper slab, two layers of 1.46 $kg/m^3$ roofing felt with graphite lightly sprinkled between the layers is provided. The joint is shown in the Appendix page A10 under joint systems of other DOTs.

Washington State: The State provides a 40 mm wide and 6 mm recessed compression seal between the approach slab and abutment seat wall. Apparently, the PCCP butts against the approach slab.

Wisconsin: The State provides a 2 " expansion joint between the abutment backwall and approach slab and a 1" doweled expansion joint between the approach slab and the PCCP.

West Virginia: The State uses transition pavement in lieu of the anchor slab, butting 6.1 meter approach slab. The joint is not between the approach slab and the transition pavement, but between the transition pavement and the PCCP. This a pressure relief joint with hot poured bituminous concrete. The joint is shown in the Appendix page A11 under Joint Systems of Other DOTs.

Wyoming: There is no anchor slab. Both pavement growth and expansion are taken care of by the 75 mm joint between the approach slab and the PCCP. There is a 130 mm wide and 50 mm deep nosing material either side of the joint to safeguard against spalling. This joint is shown in the Appendix page A12 under Joint Systems of Other DOTs.

## CHAPTER III

## INSPECTION AND EVALUATION OF JOINTS

For identifying the bridges to be inspected, an inventory of bridges with approach/anchor slab joints was made with the assistance of the ADOT Bridge Management Team. ADOT maintains a data base of more than 1000 bridges. The Approach/Anchor slab joint was used on bridges constructed after 1986 on concrete paved highways. This limited the number of bridges constructed with the joint in question to 183. The inventory list is furnished in the Appendix at the end of the report. Among these 183 bridges, thirty one bridges in the Phoenix Metropolitan area were inspected with the assistance of the ADOT District One Construction and maintenance staff. These bridges are identified in the inventory. Necessary traffic closures were arranged by the staff during the inspection.

For the inspection purposes a field evaluation form was developed (Figure 3) based on Rahman and Scofield's research report (6). Data regarding the following qualities of the joint were collected.

- <u>General Pavement Condition:</u> The condition of the approach and anchor slab, cracks and settlements.

- <u>Sealant Type</u> : Type of material used to seal the joint. In all but four bridge joints, the sealant is hot poured coal tar per ADOT's standard. Silicone sealant has been used in the approaches of one bridge and three bridges have compression seals installed

- <u>Flexibility of the sealant or seal:</u> The ability of the material to retain its original shape after a finger pressed into the seal is removed. This quality is rated as excellent, good, medium or poor. Localized cracking of the hardened surface of the joint seal material determined whether the seal rated good or medium. Seals rated poor were hard and were reinspected when possible, at higher temperatures because of the significant variation, due to temperature, on the force required to deform the material.

- <u>Missing sealant</u>: The gap in the joint is measured and recorded to the nearest tenth of the meter.

- <u>Adhesive Failure:</u> This failure indicates the debonding of the sealant or seal from the edges of the slab. Two types of failure were recorded; one is the full depth debonding where no adherence exists between the material and the slabs; the other is the partial depth failure indicating the debonding does not penetrate the full depth of the seal. The extent and depth of debonding was observed by sliding a one inch stiff blade spatula between the slab edges and the seal. The length of debonding was recorded to the nearest tenth of a meter. The average depth of debonding was recorded, but not furnished in the summary.

- <u>Cohesive Failure:</u> This is the cracking and checking of the sealant within the material. This is due to oxidation of the material due to UV rays and results in small cubes of the sealant breaking off and exposing new material. In this case also, two types of failures were observed, full depth and partial depth. Lengths of these failures were recorded to the nearest tenth of a meter. Cohesive failure is

## APPROACH/ANCHOR SLAB JOINT EVALUATION FORM

STRUCTURE NUMBER ____________
STRUCTURE NAME ____________ ROUTE ________ MILEPOST ________
APPROACH/DEPART ____________ DIRECTION ________
OBSERVER ____________
WEATHER ____________ DATE ________
TRAFFIC CONTROL ____________ TEMP ________ TIME ________

GENERAL PAVEMENT CONDITION ____________

SEALANT TYPE ____________
FLEXIBILITY (GOOD, MEDIUM, BAD) ____________
MISSING SEALANT ____________
ADHESIVE FAILURE ____________
PARTIAL DEPTH ____________
FULL DEPTH ____________
COHESIVE FAILURE ____________
PARTIAL DEPTH ____________
FULL DEPTH ____________
INTRUSION OF INCOMPRESSIBLES ____________
JOINT WIDTH ____________
SEALANT RECESS ____________
SPALLING ____________

COMMENTS, SKETCH

**Figure 3. Field Evaluation Form**

evident by visual inspection. The average depth of failure in partial depth oxidation was measured, but not furnished in the summary.

- Intrusion of Incompressibles: The typical incompressibles were sand and gravel in areas of adhesive failure. However, due to the large width of the joint, there were not large enough incompressibles to prevent joint movement.

- Joint Width: The width of the joint was measured in several locations along the roadway width. An average value was recorded to the nearest 5 mm. Joint widths of some bridges were measured both in winter and summer months. There was no significant difference.

- Sealant Recess: Sealant recess varied within each joint and from joint to joint. This is, due in part, to the effects of the roadway cross slope on the seal during installation. The recess was measured in several locations of each joint to the nearest 5 mm and recorded accordingly.

- Spalling: This condition along the edges of the approach and anchor slabs were recorded as minor, when some spalling has occurred but had not compromised the integrity of the joint. In case of spalling that allowed infiltration of water, the length of spalling was measured and recorded to the nearest tenth of a meter.

The bridges inspected and the data gathered are summarized in Table 1.

**Observations from inspection**

The general condition of the seal does not seem to depend on the age of the seal. Seals installed in 1987 are in conditions similar to seals installed in 1996. Exposure to traffic and sun seem to affect the aging process. Older seals in very good condition are exposed to less traffic and in general adhesive failure occurs more frequently along wheel tracks of travel lanes. It was also noted that the seals buried under sand (typically near the pavement edge and along lane stripes) were more flexible than seals exposed to sunlight. For example, on Structure Number 2128 built in 1989, the north end seal shaded by another bridge during summer months, was in very good condition. The south seal, which is never shaded, rated fair.

Exposure to water also affects the aging process of the sealant. Cohesive failures frequently occur in areas where water accumulates during storms, typically around catch basins.

Spalling due to traffic also presents a problem for an effective joint seal. Spalling results in a crack between the slab edge and the joint seal, compromising the seal. While spalling was not as severe a problem as adhesive failure, it contributes to problems with this seal system. Spalling occurs more frequently in areas where the slab edge is irregular and rough.

Another factor increasing the likelihood of infiltration, is the placement of the Approach/Anchor slab joints adjacent to retaining walls. Movement of these walls away from the roadway result in openings along the edge of the slab next to the walls. In addition, at the end of the retaining walls (where barriers or guard rails begin), the joint between the curb and gutter moves, resulting in larger than anticipated openings. Currently, these areas are not sealed with the

**Table 1. Inspection and Evaluation Summary**

| Structure Number and Bridge End | | Year of Const. | General Condition | Flexibility | Missing Sealant (meter) | Adhesive Failure Partial (meter) | Adhesive Failure Full (meter) | Cohesive Failure Partial (meter) | Cohesive Failure Full (meter) | Spalling | Joint Width* (mm) | Joint Recess (mm) | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1988 | Approach | 1987 | Excellent | Very Good | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | none | 55 | 15 | Low traffic volume |
| 1988 | Depart | 1987 | Excellent | Very Good | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | none | 55 | 15 | Low traffic volume |
| 2040 | Approach | 1989 | Fair | Medium | 0.0 | 12.2 | 12.2 | 1.9 | 1.0 | none | 70 | 10 | Medium traffic volume |
| 2040 | Depart | 1989 | Fair | Medium | 0.0 | 3.1 | 3.1 | 3.1 | 0.0 | none | 85 | 10 | Medium traffic volume |
| 2122 | Approach | 1989 | Fair | Good | 0.0 | 1.0 | 3.7 | 0.0 | 0.0 | 0.6 m | 105 | 10 | Concrete edge is rough |
| 2122 | Depart | 1989 | Fair | Good | 0.0 | 0.4 | 1.3 | 0.0 | 0.0 | none | 80 | 10 | Concrete edge is rough |
| 2128 | Approach | 1989 | Fair | Medium | 0.0 | 1.9 | 0.0 | 0.0 | 0.0 | none | 80 | 10 | Fair condition |
| 2128 | Depart | 1989 | Very Good | Very Good | 0.0 | 0.0 | 6.5 | 0.0 | 0.0 | none | 80 | 15 | Joint in partial shade |
| 1927 | North | 1990 | Fair | Poor | 0.0 | 3.4 | 1.3 | 1.6 | 0.0 | minor | 80 | 10 | Temp. at inspection 70 F |
| 1927 | South | 1990 | Fair | Poor | 0.0 | 2.2 | 1.3 | 2.2 | 0.0 | minor | 80 | 10 | Fair condition |
| 2048 | North | 1990 | Fair | Poor | 0.0 | 0.7 | 0.0 | 0.0 | 0.0 | 0.9 m | 70 | 15 | Temp. at inspection 60 F |
| 2048 | South | 1990 | Fair | Poor | 0.0 | 0.0 | 0.0 | 0.7 | 1.3 | none | 70 | 15 | Fair condition |
| 2053 | North | 1990 | Poor | Poor | 0.0 | 21.4 | 0.0 | 0.0 | 0.0 | none | 85 | 0 | Compression Seal |
| 2053 | South | 1990 | Poor | Poor | 0.0 | 21.4 | 0.0 | 0.0 | 0.0 | none | 70 | 0 | Compression Seal |
| 2063 | Approach | 1990 | Good | Medium | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | none | 65 | 15 | Temp. at inspection 70 F |
| 2063 | Depart | 1990 | Good | Medium | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | none | 80 | 20 | Good condition |
| 2064 | Approach | 1990 | Very Good | Medium | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | none | 70 | 20 | Good condition |
| 2064 | Depart | 1990 | Very Good | Medium | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | none | 70 | 20 | Good condition |
| 2074 | East | 1990 | Poor | Poor | 0.0 | 16.8 | 1.9 | 10.7 | 0.0 | minor | 80 | 10 | Angle guard on anchor slab |
| 2074 | West | 1990 | Poor | Poor | 5.5 | 1.0 | 8.3 | 18.0 | 0.0 | minor | 80 | 10 | Angle guard on anchor slab |
| 2155 | Approach | 1990 | Excellent | Good | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | minor | 90 | 10 | Excellent Condition |
| 2155 | Depart | 1990 | Excellent | Good | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | minor | 90 | 10 | Excellent Condition |
| 2240 | Approach | 1990 | Good | Good | 0.0 | 0.0 | 0.7 | 0.0 | 0.0 | none | 85 | 10 | Spalling at wheel tracks |
| 2240 | Depart | 1990 | Good | Good | 0.0 | 0.0 | 0.7 | 0.0 | 0.0 | none | 85 | 10 | Spalling at wheel tracks |
| 2050 NB | Approach | 1990 | Poor | Poor | 0.0 | 3.1 | 0.0 | 3.1 | 0.0 | none | 90 | 0 | No Full Depth Failure |
| 2050 NB | Depart | 1990 | Poor | Poor | 0.0 | 6.1 | 0.0 | 3.1 | 0.0 | none | 80 | 0 | No Full Depth Failure |
| 2050 SB | Approach | 1990 | Poor | Poor | 0.0 | 3.1 | 0.0 | 3.1 | 0.0 | none | 85 | 0 | No Full Depth Failure |
| 2050 SB | Depart | 1990 | Poor | Poor | 0.0 | 12.2 | 0.0 | 12.2 | 0.0 | none | 85 | 0 | No Full Depth Failure |
| 2199 | Approach | 1991 | Very good | Poor | 0.0 | 0.4 | 0.0 | 0.0 | 0.0 | none | 65 | 10 | Temp. at inspection 65 F |
| 2200 | Depart | 1991 | Very good | Poor | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | none | 80 | 10 | Temp. at inspection 65 F |
| 2218 | Approach | 1991 | Fair | Good | 0.0 | 0.0 | 0.0 | 2.2 | 0.7 | none | 80 | 20 | Fair condition |
| 2218 | Depart | 1991 | Fair | Good | 0.0 | 0.0 | 0.0 | 2.2 | 2.5 | none | 80 | 20 | Fair condition |
| 2220 | Approach | 1991 | Good | Good | 0.0 | 0.4 | 1.9 | 0.0 | 0.0 | minor | 100 | 30 | Failure at lap in joint material |
| 2220 | Depart | 1991 | Good | Good | 0.0 | 0.0 | 0.7 | 0.0 | 0.0 | minor | 100 | 30 | Good condition |

* No significant change in joint widths measured in summer and winter months

**Table 1 (cont'd.) Inspection and Evaluation Summary**

| Structure Number and Bridge End | | Year of Const. | General Condition | Flexibility | Missing Sealant (meter) | Adhesive Failure Partial (meter) | Adhesive Failure Full (meter) | Cohesive Failure Partial (meter) | Cohesive Failure Full (meter) | Spalling | Joint Width* (mm) | Joint Recess (mm) | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2134 | Approach | 1992 | Excellent | Good | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | none | 85 | 10 | Low traffic volume |
| 2134 | Depart | 1992 | Excellent | Good | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | none | 85 | 10 | Low traffic volume |
| 2135 | Approach | 1992 | Excellent | Good | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | none | 90 | 10 | Low traffic volume |
| 2135 | Depart | 1992 | Excellent | Good | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | none | 85 | 10 | Low traffic volume |
| 2209 | Approach | 1992 | Fair | Good | 0.0 | 0.0 | 4.3 | 0.0 | 0.0 | none | 40 | 10 | Silicone Sealant |
| 2211 | Approach | 1992 | Fair | Good | 0.0 | 0.0 | 4.6 | 0.0 | 2.2 | minor | 90 | 15 | Seal is wearing at travel lane |
| 2211 | Depart | 1992 | Fair | Good | 0.0 | 0.0 | 3.1 | 0.0 | 0.0 | minor | 90 | 15 | Seal is wearing at travel lane |
| 2069 EB | Approach | 1992 | Excellent | Good | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | none | 85 | 10 | Low traffic volume |
| 2069 EB | Depart | 1992 | Excellent | Good | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | none | 85 | 10 | Low traffic volume |
| 2069 WB | Approach | 1992 | Excellent | Good | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | none | 85 | 10 | Low traffic volume |
| 2069 WB | Depart | 1992 | Excellent | Good | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | none | 80 | 10 | Low traffic volume |
| 2070 EB | Approach | 1992 | Excellent | Good | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | none | 85 | 10 | Low traffic volume |
| 2070 EB | Depart | 1992 | Excellent | Good | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | none | 85 | 10 | Low traffic volume |
| 2070 WB | Approach | 1992 | Excellent | Good | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | none | 85 | 10 | Low traffic volume |
| 2070 WB | Depart | 1992 | Excellent | Good | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | none | 85 | 10 | Low traffic volume |
| 2133 | North | 1993 | Poor | Medium | 0.0 | 0.0 | 22.9 | 0.0 | 2.2 | 0.9 m | 90 | 0 | Joint edge very uneven |
| 2133 | South | 1993 | Poor | Medium | 0.0 | 0.0 | 6.1 | 0.0 | 0.0 | 0.6 m | 90 | 0 | Joint edge very uneven |
| 2228 | Approach | 1996 | Excellent | Excellent | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | none | 105 | 15 | Concrete edge is smooth |
| 2268 | Approach | 1996 | Excellent | Excellent | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | none | 100 | 10 | Compression Seal |
| Bell/17 | Approach | 0 | Poor | Medium | 0.0 | 18.3 | 13.8 | 4.6 | 4.6 | none | 115 | 10 | High traffic volume |
| Bell/17 | Depart | 0 | Poor | Medium | 0.7 | 0.0 | 18.3 | 4.6 | 7.7 | none | 115 | 10 | High traffic volume |
| Cactus/17 | Approach | 0 | Poor | Medium | 3.1 | 18.3 | 18.3 | 1.6 | 1.6 | none | 105 | 15 | Concrete patch in good cond |
| Cactus/17 | Depart | 0 | Poor | Medium | 3.1 | 18.3 | 18.3 | 1.6 | 1.6 | none | 105 | 10 | High traffic volume |
| Greenway/17 | Approach | 0 | Good | Medium | 0.0 | 1.6 | 4.6 | 0.0 | 0.7 | none | 105 | 15 | High traffic volume |
| Greenway/17 | Depart | 0 | Fair | Medium | 1.0 | 1.6 | 12.2 | 0.0 | 3.1 | none | 115 | 15 | High traffic volume |
| Peoria/17 | Approach | 0 | Poor | Medum | 1.0 | 2.2 | 4.6 | 0.0 | 0.0 | none | 100 | 10 | Sealant is cracking into blocks |
| Peoria/17 | Depart | 0 | Poor | Medum | 1.6 | 0.0 | 4.6 | 0.7 | 0.7 | none | 105 | 10 | Sealant is cracking into blocks |

* No significant change in joint widths measured in summer and winter months

sealant specified for the transverse joint. Bridge plans call for hot poured sealant. These openings are a significant source of storm water infiltration below the slabs.

Irregular and rough slab edges point to installation problems. The fact that with the same sealant, some joints are in good condition while others experience adhesive failure also indicates inadequate joint preparation. Certain general installation procedures must be followed for all joint systems. The manufacturer's specific recommended procedures for each material shall be followed. Installation procedures are dealt with in Chapter IV on Solutions.

In cross slopes, it appears, for hot poured sealant, temperature of each pour has to be monitored with extreme care; the self leveling sealant flows along the slope resulting in less thickness at high point and more thickness at low point. This necessitates laps in the sealant. Due to temperature differential, there is loss of homogeneity between the layers and adherence is lessened. To circumvent this problem, installers have tried joint filler dams at intervals along the joint. However these fillers leave openings for infiltration. Both these solutions have produced ineffective seals.

In general, the materials in use by ADOT to seal the gap between the approach and anchor slabs may produce effective and long lasting seals. However, there is a large percentage of joints that do not perform well indicating the need to upgrade the material and /or to follow proper installation procedures. In most cases, the seals have some openings that allow infiltration of debris and water. Most frequently, the function of the joint is compromised by failure of the seal to adhere to concrete pavement, resulting in a thin opening between the slab edge and the sealant material.

# CHAPTER IV

## SOLUTIONS

Prior to addressing solutions for joints for ADOT's verification, certain general requirements for all joints are presented for efficient function of the joint. These include the installation procedures as well as the general roadway design requirements.

- Concrete shall cure for a minimum period of seven days prior to sealant or seal installation.
- Joint reservoirs shall be formed and constructed so they are uniform and consistent in width.
- The sealant or seal bonding faces of the joint (new and existing joints to be repaired) shall be refaced by diamond sawing, immediately flushed with high pressure water and then sand blasted (on same day of sealing) prior to seal installation. The field inspectors should verify joint cleanliness before installation.
- Sand blasting shall be performed in two passes, one for each joint face, with the nozzle directed at each face in the same direction for both passes.
- Just prior to joint installation, the joint shall be blown out in one direction only.
- The nozzle used to install sealant should be such that the sealant is filled from <u>bottom to top.</u>
- The temperature of hot poured sealant shall be monitored at all stages of installation.
- Material manufacturer's installation specifications shall be followed. If required by the manufacturer, the installer shall be certified by the manufacturer of the Material.
- Allow three days to elapse after joint installation, prior to any traffic. Protect the joints from long-term construction traffic etc.
- Continue pavement under barriers. Do not provide joints between pavement and barriers. Joint terminations are shown on Joint solution details.
- At retaining wing walls, seal the joints with the same or other suitable seal as the transverse joint. Again proper installation procedures shall be followed.
- Seal the joint at curb and gutter, do not allow storm water to infiltrate between them.

Based on the information gathered from the literature, the responses obtained from other DOTs and the field inspection and evaluation, solutions for five different joints are devised. One is with hot poured sealant, one is with self leveling or toolable silicone sealant, one is with preformed membrane sealant, one is with elastomeric compression seal and the last one is with armored strip seal. All have the cellular plastic fill material below as in the ADOT joint. The polyurethane foam spacer shown in the ADOT joint is removed since it is incompressible. All have epoxy concrete header (nosing) for protection against spalling and for anchoring the armor of the strip seal. All except the silicone joint are adaptable to the existing joints. Joint width for silicone is restricted to maximum 50 mm. These solutions are shown in Figures 4 thru 8. Figure 9 shows the joint termination treatment at barriers. Figure 10 gives the Joint seal remediation steps for existing joints.

Measurements of joint widths were made in winter and summer months. No significant differences were found. Apparently the anchor slab accommodates most of the pavement expansion. Under these circumstances, a maximum joint width of 50 mm is recommended for new installations.

**Base Specifications** for the various new materials used in the above solutions are given below to aid the ADOT in procuring materials for installing the joints for verification and adaptation.

1. Epoxy Concrete for Header (Figures 4 thru 8): The coarse and fine aggregates for the concrete shall be per current ADOT standard specifications for Road and Bridge Construction. The mix design shall be as recommended by the manufacturer. The surface shall be primed with epoxy prior to applying the epoxy concrete. The epoxy shall conform to current ASTM C-881 and AASHTO M-235 specifications and shall be USDA approved. The viscosity shall be about 1400 cps; Pot life for 60 gram mass shall be 25 minutes. The bond strength (ASTM C-882) between hardened concretes shall be 7.58 MPa at 2 days dry cure and 11 MPa at 14 days moist cure.

2. Low Modulus Hot Poured Sealant (Figure 4): The sealant shall be a low modulus high quality single component, hot applied jet fuel resistant material intended for sealing joints in portland cement concrete pavements. It shall meet ASTM D3569 and Federal SS-S-1614A specifications.

3. Rapid Cure Silicone Joint Sealant (Figure 5): This shall be self-leveling, cold applied, rapid cure two part, ultra low modulus 100% silicone rubber sealant, intended for sealing expansion joints that experience both thermal and vertical movements due to traffic loading.

4. Backer Rod (Figure 5): The material shall be capable of holding the fluid sealant in place. It shall not bond to the sealant. It shall meet the requirements of the sealant manufacturer. It shall be a compressible type material, such as closed-cell, resilient foam or sponge rubber stock of vinyl, butyl or neoprene or expanded polyethylene or polyurethane. The diameter of the rod shall be at least 30% larger than the reservoir width.

5. Toolable or Non Self-Leveling Silicone Joint Sealant (Figure 5): This sealant shall be one part silicone material that readily extrudes over a wide temperature range. On curing it shall produce a durable, flexible, low modulus joint seal. Shall meet Federal specifications TT-S-001543A Class A.

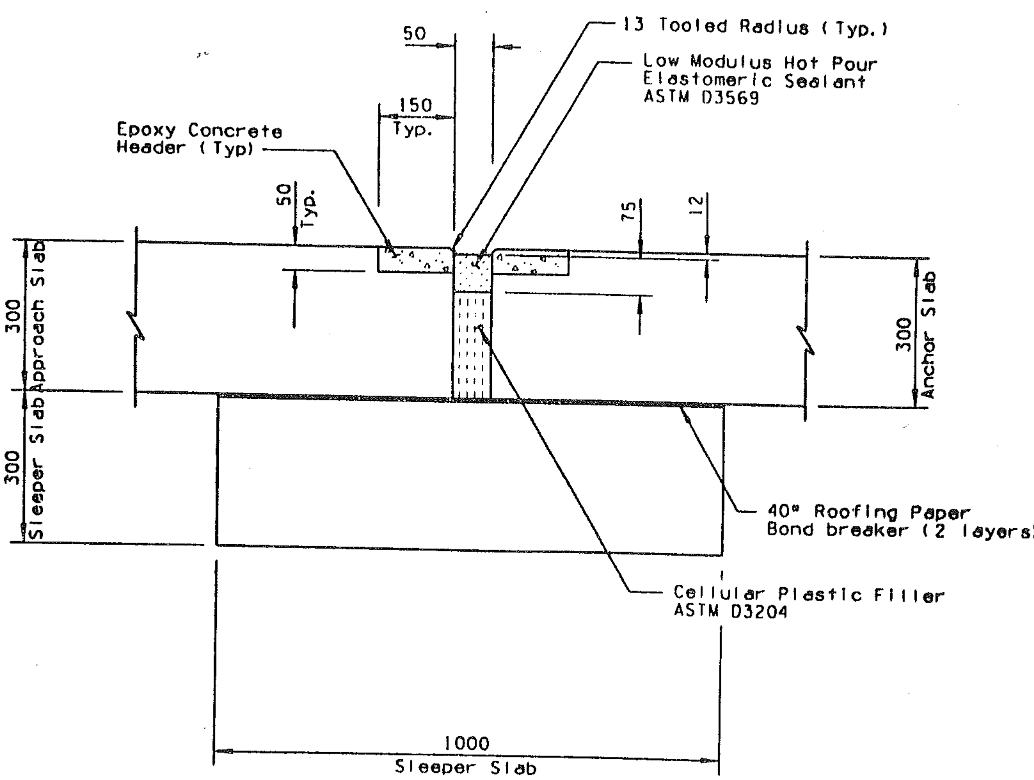



**Figure 4. Low Modulus Hot Poured Sealant Joint**

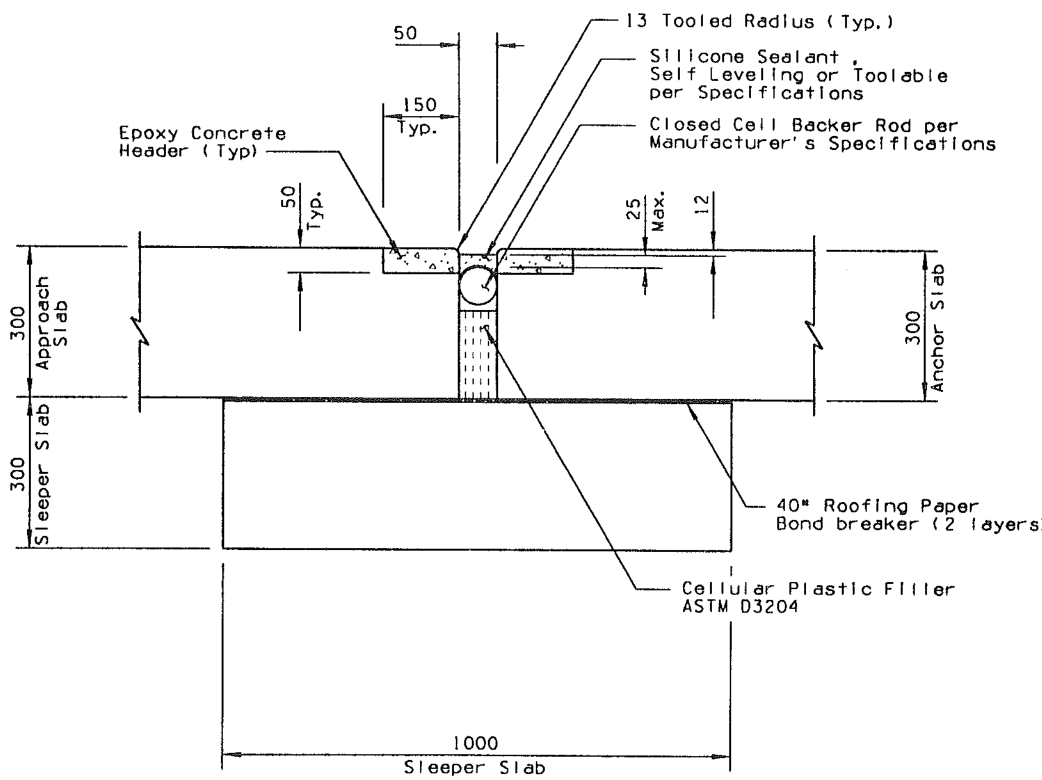



**Figure 5. Silicone Sealant Joint**

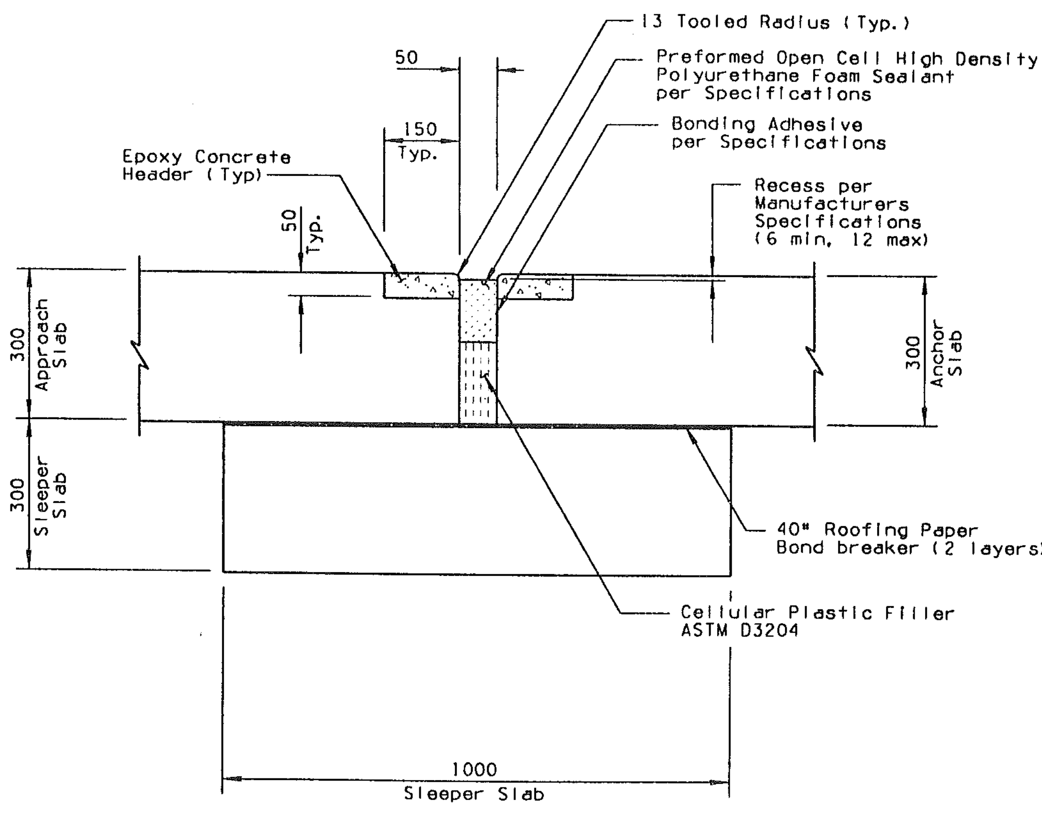



**Figure 6. Precompressed Foam Joint**

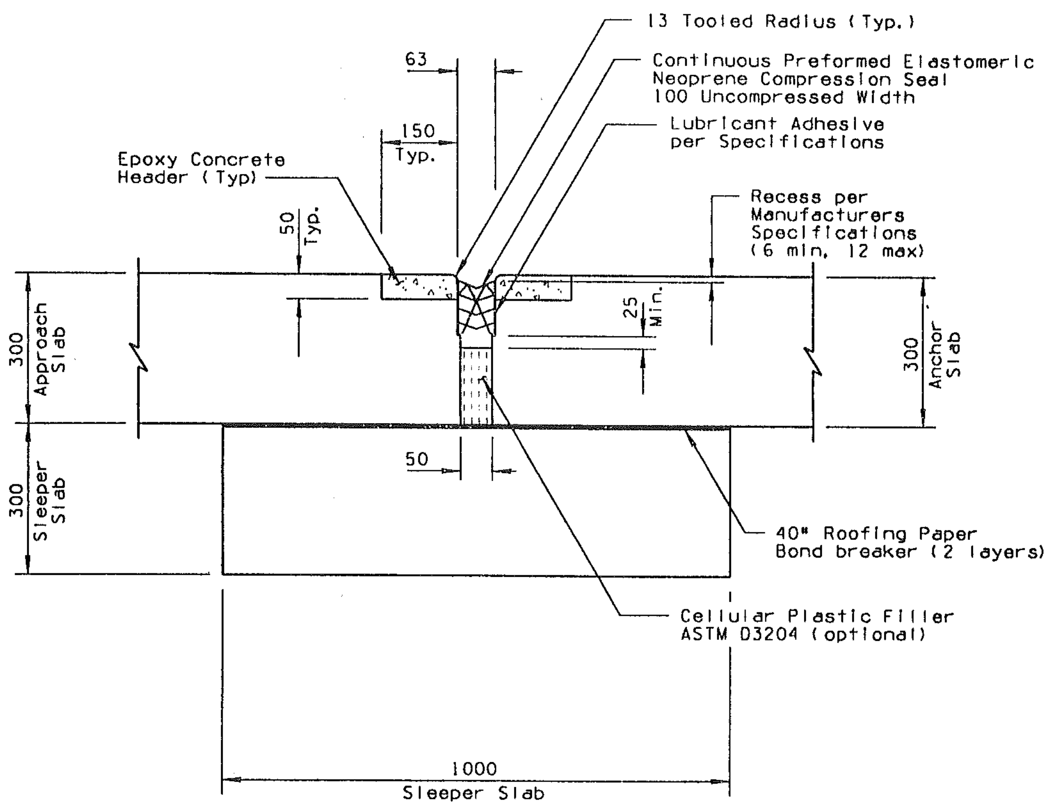



**Figure 7. Compression Seal Joint**

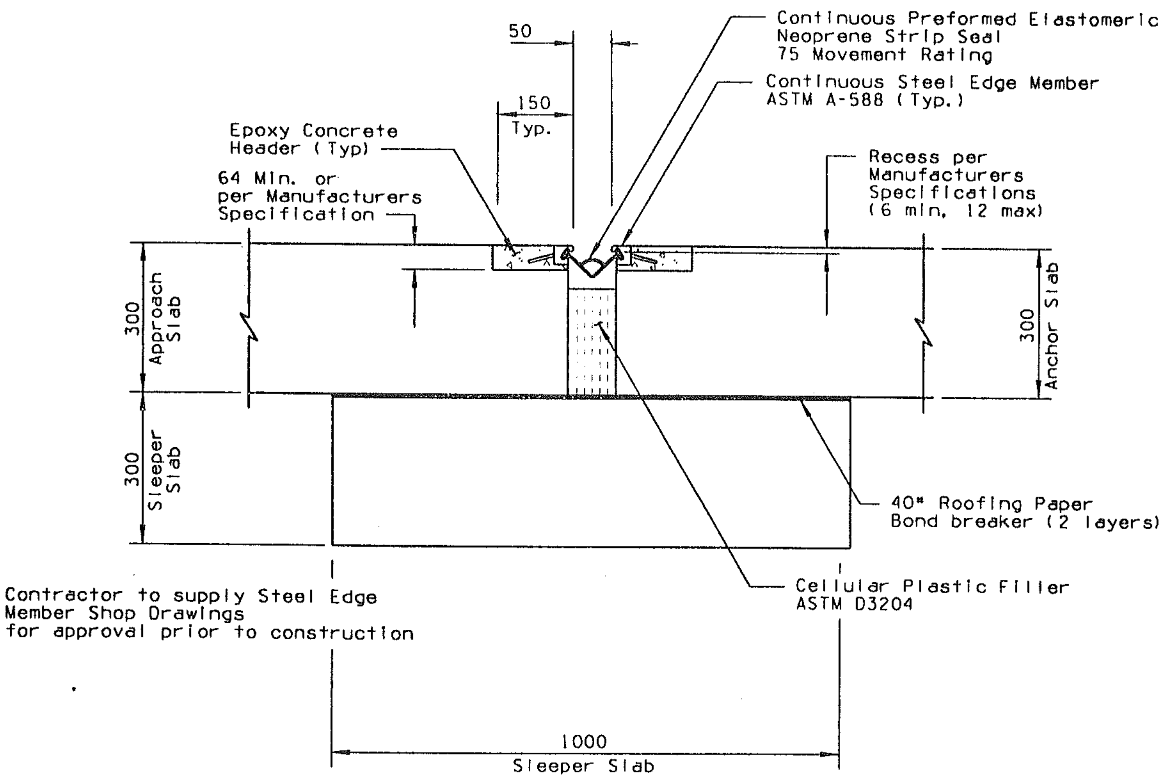



**Figure 8. Armored Strip Seal Joint**

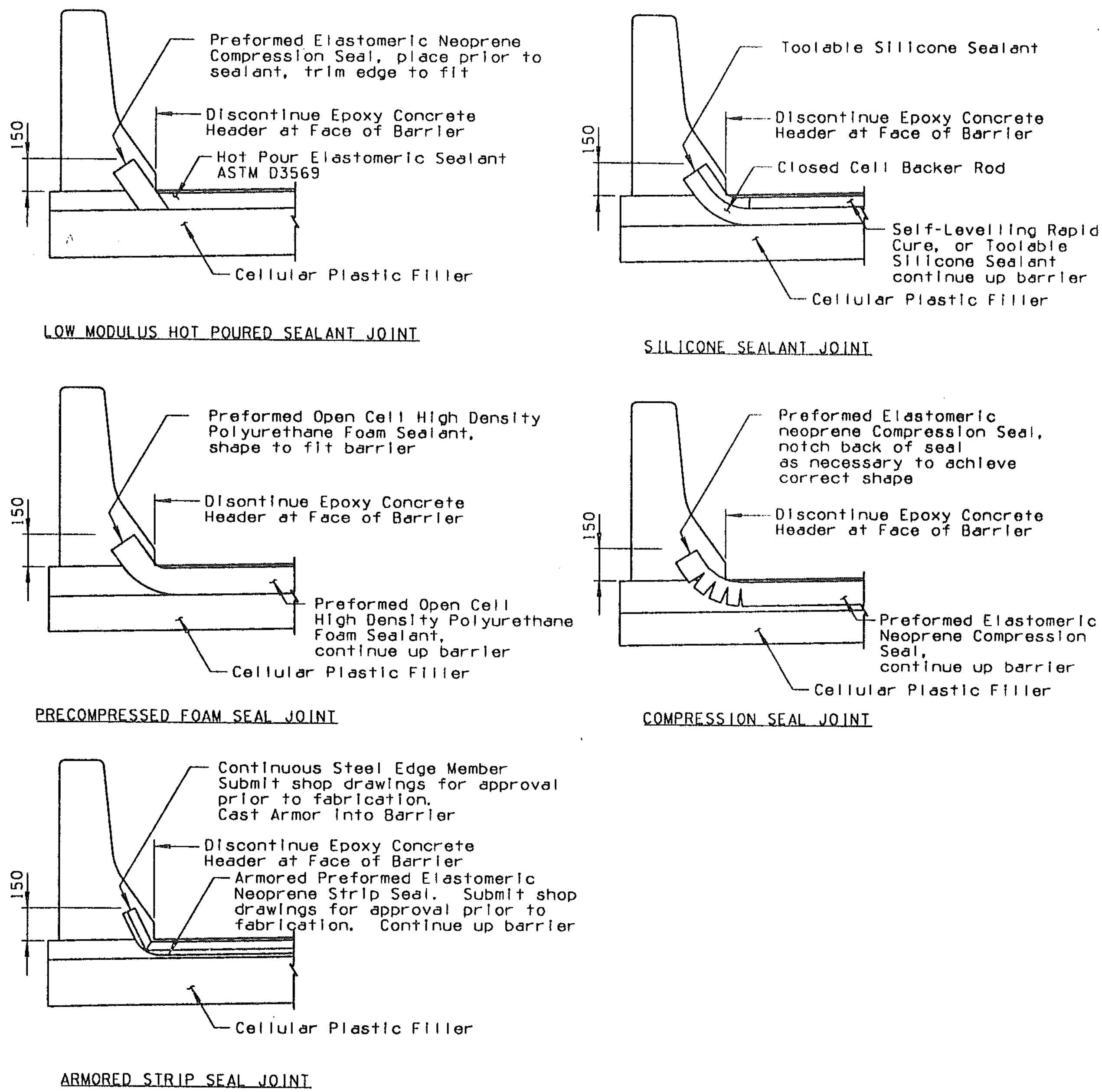
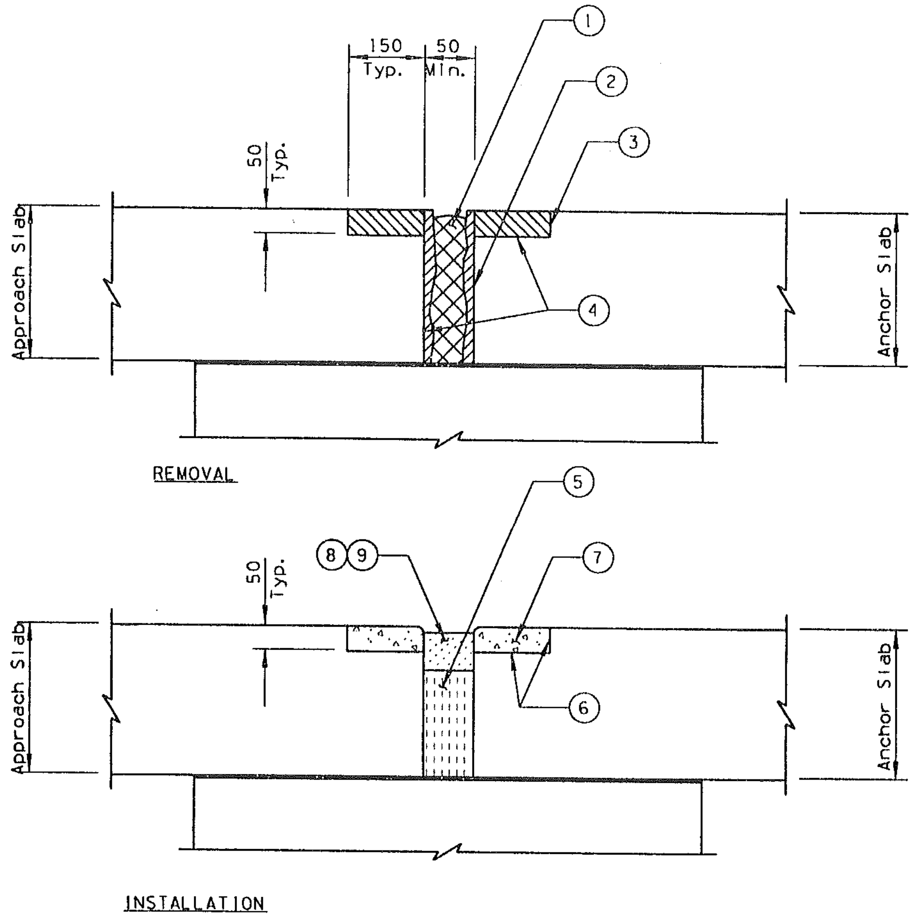



**Figure 9. Terminal Treatment of Joints**




JOINT SEAL REMEDIATION FOR EXISTING JOINTS

1: Completely remove the existing joint seal material.
2: Saw cut the existing joint using a diamond blade saw. Saw the full depth of the slab to provide a clean, smooth, and true edge.
3: Saw cut and remove existing concrete to form the Epoxy Concrete Header Block Out
4: Sand blast the bond surfaces the same day as joint seal installation.
5: Install filler and Backer Materials.
6: Prime bonding surfaces.
7: Install Epoxy Concrete Header
8: Air Blast the joint to remove all debris, just prior to seal installation
9: Install the joint seal immediately after the header has set.
10: The joint systems shown in Figures 4 through 7 are adapatable for remediation. The Silicone Seal shown in Figure 5 cannot be used for joints with a finished opening greater than 50mm. The Strip Seal shown in Figure 8 is not recommended for seal remediation.

**Figure 10. Joint Seal Remediation for Existing Joints**

6. Continuous Preformed Elastomeric Neoprene Compression Seal (Figure 7): This shall be an extruded elastomeric material having a multi-channeled shape. The uncompressed width shall be greater than the reservoir width.

7. Bonding Adhesive for Compression Seal (Figure 7): The lubricant adhesive shall be a double component, epoxy based type, which is mixed at the job site. Its minimum tensile strength shall be 28.54 MPa and axial compressive strength 60.4 MPa. The initial cure time shall be 24 hours and complete curing time 7 days at 20°C.

8. Strip Seal (Figure 8): The expansion joint device shall be designed for HS-20 truck loading and impact in accordance with current AASHTO specifications and shall accommodate the movements indicated on the drawings. The strip seal made of polychloroprene gland shall be supplied and installed in one continuous length. The shape of the gland shall promote self-removal of foreign material during normal joint operation. Its minimum tensile strength shall be 13.79 MPa and elongation at break 250%. The TYPE A Durometer Hardness shall be 55± 5 points. The lubricant adhesive to bond the gland to the steel shall be one part moisture curing polyurethane and hydrocarbon solvent mixture meeting the requirements of ASTM D-4070-81.

9. Membrane Foam Sealant (Figure 6): The foam sealant shall consist of an open cell high density polyurethane foam impregnated with either a polymer modified bitumen or a neoprene rubber suspended in chlorinated hydrocarbons. The precompressed dimension shall not exceed 75% of the joint width. The sealant shall be UV and ozone resistant. Its tensile strength shall be minimum 144.8 KPa and ultimate elongation 150% minimum.

10. Bonding Adhesive (Figure 6): The adhesive shall be any waterproof epoxy adhesive that is compatible with concrete and recommended by the manufacturer of the foam sealant.

11. Splicing Adhesive (Figure 6): This may be any polyurethane adhesive recommended by the manufacturer of the foam sealant.

# CHAPTER V

# CONCLUSIONS

This chapter reiterates the need for the anchor slab and the pavement growth joint at the end of the bridge approach for portland cement plain concrete pavements. The importance of proper installation and implementation of the joint, the choice of the joint system and the external factors that impact the function of the joint cannot be overemphasized. To repeat the words of Martin Burke, Jr. (4), there is great growth potential for unrestrained rigid pavement and great pressure potential of restrained pavement. The pressure potential is accommodated by the anchor slab and the growth potential is taken care of by the approach/anchor slab joint. Provision for expansion and contraction and at the same time exclusion of water and debris are a must for the joint. <u>In choosing the material for the seal or sealant, the joint movement (not the joint width) shall always be less than the strain limit of the seal.</u> The strain limit shall be obtained from the manufacturer.

Spalling due to the vehicular traffic has been a problem reported in the literature; it has been verified in the inspections carried out in this investigation. Hence nosing or header material stronger than regular concrete shall be incorporated in all joints. Adhesive or debonding failure is attributable to some extent to the material property, but to no less extent to the preparation of slab edges. Cohesive failure is largely due to sun's ultra violet rays drying the petroleum base; but maintaining proper temperatures while pouring the sealant, especially in more than one layer at laps in cross slopes, is extremely important in the case of hot poured sealants. Materials with better resistance to UV rays (ASTM D 3569) shall replace the current sealants.

Based on these considerations, the five solutions outlined in Chapter IV are devised and presented for ADOT's verification and implementation. Joints at the longitudinal face of barriers shall be avoided by continuing the pavement under the barriers. At wing walls, the joints between the walls and the pavement shall be sealed the same way as the transverse joint and also maintained since the wall tends to drift away due to active pressure of soil. At curb and gutter, the joint between them shall be sealed to avoid storm water seeping under the approach and anchor slabs.

In Chapter II, summaries of responses from DOTs of other States were furnished. The conclusions drawn from them are presented here. About 20 States responded with information on the joint system used at bridge approaches. No State uses exclusively an anchor slab. Some States have reinforced transition pavements or a stretch of CRCP, which may be considered the equivalent of an anchor slab. Most States have the joint between the approach slab and the PCCP. Some States have more than one joint within the approach slab or within the allocated stretch of PCCP. No State is using exclusively hot poured sealant. Joints fall into two categories. One is the narrow joint with preformed filler, compression seal or armored strip seal or with silicone sealing compound or combination of preformed seal and hot poured sealant. The other is the wide strip joint wherein bituminous concrete or binder is used; this is referred to as pressure relief joint. Some States provide the joint only between the abutment backwall and the approach slab. The State of Maryland uses a stretch of bituminous concrete pavement from bridge abutment to the PCCP. Each State uses what is best in their evaluation or what works best for them. The majority of the States use silicone sealant and sleeper slab. Sleeper slabs are always used under pressure relief joints.

**Acknowledgements**

The Arizona Transportation Research Center guide lines were followed in the preparation of this report. Sundaram Engineering, Inc. wish to thank the support of the ADOT's Technical Advisory Committee constituted for the purpose of overseeing this investigation. The ADOT's construction and maintenance staff assisted the firm in the selection of bridges for inspection and arranged the inspections as well as traffic closures. The ADOT Bridge Management Team provided necessary help in preparing an inventory of the bridges with the joint under evaluation. The ATRC provided assistance in the literature survey. We are thankful for the DOTs of States who have taken time and interest to call us and respond to our request for their research work and standards. Crafco Inc. contributed their expertise in the sealants and the installation requirements. Stanley Consultants Inc., Phoenix is the subconsultant on the Project and Michael E. Dadik was assigned to work with Shan Sundaram of Sundaram Engineering, Inc. on this study.

## REFERENCES


1. AASHTO Reference Book, 1994-1995

2. Harvey E. Wahls, North Carolina State University, North Carolina, " Design and Construction of Bridge Approaches, National Cooperative Highway Research Program, Synthesis of Highway Practice, Transportation Research Board, National Research Council, Washington D.C.

3. Mousse Issa etal, "On Site Evaluation of Bridge Deck Expansion Joints", Florida Department of Transportation, September 1996.

4. Martin Burke,Jr., "Bridge Approach Pavements, Integral Bridges and Cycle Control Joints", Transportation Research Record 1113.

5. W.R.Meir Jr., Edward J.Elnicky, Western Technologies Inc. " Construction Report for Arizona SHRP SPS-4 Experiment", ADOT Report No. AZ 92-377-1

6. Mushtaqur Rahman, Larry Scofield, "Performance Evaluation of Concrete Pavement Joint Sealants", Arizona Transportation Research Center, December 1990

## APPENDICES

| 1 BRIDGE INVENTORY | | | | | |
|---|---|---|---|---|---|
| BRIDGE NUMBER | ROUTE | MILE POST | BRIDGE NAME | YEAR BUILT | INSPECTION PERFORMED |
| 01956 | 10 | 142.65 | 27TH AVENUE OP EB | 1986 | |
| 01957 | 10 | 142.65 | 27TH AVENUE OP WB | 1986 | |
| 01938 | 10 | 142.83 | NB&SB17-WB10 RAMP BR | 1986 | |
| 01939 | 10 | 143.02 | EB10-SB17 RAMP OP | 1988 | |
| 01942 | 10 | 143.08 | SB17-WB10 RAMP UP | 1987 | |
| 01940 | 10 | 143.11 | EB10-NB17 RAMP LVL 4 | 1988 | |
| 01941 | 10 | 143.14 | NB17-WB10 RAMP LVL 2 | 1988 | |
| 01945 | 10 | 143.16 | SB17-EB10 RAMP LVL 2 | 1990 | |
| 01946 | 10 | 143.21 | WB10-SB17 RAMP LVL 4 | 1990 | |
| 01944 | 10 | 143.24 | NB17-EB10-RAMP OP | 1990 | |
| 01955 | 10 | 143.74 | WB10 TO 19TH AV RAMP | 1988 | |
| 01954 | 10 | 143.77 | 19TH AV TO EB10 RAMP | 1988 | |
| 01960 | 10 | 144.72 | HOV RAMP I-10 TO 5TH | 1988 | |
| 01961 | 10 | 144.84 | HOV RAMP 5TH TO 3RD | 1988 | |
| 01966 | 10 | 145.45 | HOV RAMP 3RD TO I-10 | 1988 | |
| 01998 | 10 | 147.15 | HOV RAMP LVL 4 | 1987 | |
| 02126 | 10 | 147.21 | EB10-NB51 RAMP LVL3 | 1990 | |
| 01973 | 10 | 147.22 | EB10-EB202 RAMP LVL4 | 1987 | |
| 01974 | 10 | 147.24 | WB202-WB10 RAMP LVL4 | 1987 | |
| 02127 | 10 | 147.25 | SB51-EB202 RAMP LVL5 | 1990 | |
| 02122 | 10 | 147.25 | WB202-EB10 N LVL2 | 1989 | X |
| 02128 | 10 | 147.25 | WB202-EB10 S LVL2 | 1989 | X |
| 01976 | 10 | 147.25 | SB51-EB10 RAMP LVL2 | 1987 | |
| 02124 | 10 | 147.26 | SB51-WB10/EB202 RAMP | 1990 | |
| 02125 | 10 | 147.26 | SB51-WB10 RAMP | 1990 | |
| 02123 | 10 | 147.26 | EB10/WB202-NB51 RAMP | 1989 | |
| 02116 | 10 | 147.27 | WB10/SB51-EB202 RAMP | 1989 | |
| 02115 | 10 | 147.77 | WB202-EB10/NB51 RAMP | 1989 | |
| 01978 | 10 | 147.92 | VAN BUREN ST OP EB | 1986 | |
| 01983 | 10 | 147.92 | VAN BUREN ST OP WB | 1986 | |
| 01979 | 10 | 148.13 | WASH JEFF TI OP EB | 1986 | |
| 01980 | 10 | 148.13 | WASH JEFF TI OP WB | 1986 | |
| 01988 | 10 | 148.40 | SPRR ACCESS RD OP SB | 1987 | X |
| 01989 | 10 | 148.40 | SPRR ACCESS RD OP NB | 1987 | |
| 01981 | 10 | 148.41 | SPRR OP EB | 1986 | |
| 01982 | 10 | 148.41 | SPRR OP WB | 1986 | |
| 01985 | 10 | 148.61 | GRANT ST OP EB | 1988 | |
| 01986 | 10 | 148.61 | GRANT ST OP WB | 1988 | |
| 01990 | 10 | 148.89 | BUCKEYE RD OP EB | 1988 | |
| 01991 | 10 | 148.90 | BUCKEYE ROAD OP WB | 1988 | |
| 02031 | 10 | 149.11 | SKY HAR 22ND OP WB | 1988 | |
| 02032 | 10 | 149.11 | SKY HAR 22ND OP EB | 1988 | |
| 01987 | 10 | 149.20 | SKY HARBOR 24 TH OP | 1986 | |
| 01992 | 10 | 149.30 | MOHAVE ST OP EB | 1988 | |
| 01993 | 10 | 149.30 | MOHAVE ST OP WB | 1988 | |
| 01996 | 10 | 149.47 | SB17-EB10 RAMP LVL 2 | 1988 | |
| 01995 | 10 | 149.51 | WB10 OVER SB17-WB10 | 1988 | |
| 01994 | 10 | 149.53 | EB10 OVER SB17-WB10 | 1988 | |
| 01997 | 10 | 149.57 | WB10-NB17 RAMP LVL 3 | 1987 | |
| 02003 | 10 | 150.72 | SALT RIVER BRIDGE | 1986 | |
| 02004 | 10 | 151.49 | UNIVERSITY DR TI UP | 1986 | |
| 02194 | 10 | 260.55 | 10TH AVE OP | 1991 | |
| 02164 | 10 | 261.41 | FRTGE RD SPRR OP WB | 1991 | |
| 02196 | 10 | 261.41 | LOOP RD/SPRR OP EBFR | 1991 | |
| 02197 | 10 | 261.41 | VETERANS SPRR OP | 1991 | |
| 02018 | 10 | 265.02 | ALVERNON WY TI OP EB | 1986 | |
| 02045 | 10 | 304.91 | OCOTILLO RD TI OP WB | 1987 | |
| 02247 | 17 | 202.93 | INDIAN SCHL RD TI UP | 1992 | |
| 01440 | 17 | 208.25 | ACDC BRIDGE | 1988 | |
| | 17 | 209.00 | PEORIA OP NB | | X |
| | 17 | 209.00 | PEORIA OP SB | | |

| BRIDGE INVENTORY | | | | | |
|---|---|---|---|---|---|
| BRIDGE NUMBER | ROUTE | MILE POST | BRIDGE NAME | YEAR BUILT | INSPECTION PERFORMED |
| | 17 | 210.00 | CACTUS ROAD OP NB | | X |
| | 17 | 210.00 | CACTUS ROAD OP SB | | |
| | 17 | 211.00 | THUNDERBIRD ROAD OP NB | | |
| | 17 | 211.00 | THUNDERBIRD ROAD OP SB | | |
| | 17 | 212.00 | GREENWAY ROAD OP NB | | |
| | 17 | 212.00 | GREENWAY ROAD OP SB | | |
| | 17 | 213.00 | BELL ROAD OP NB | | X |
| | 17 | 213.00 | BELL ROAD OP SB | | |
| 02055 | 17 | 213.98 | UNION HILLS DR TI OP | 1989 | |
| 02076 | 40 | 198.28 | BUTLER AVE TI OP EB | 1988 | |
| 02077 | 40 | 198.28 | BUTLER AVE TI OP WB | 1988 | |
| 02414 | 51 | 0.52 | MCDOWELL RD OP | 1987 | |
| 02429 | 51 | 1.33 | 20TH STREET NB OP | 1990 | |
| 02416 | 51 | 1.57 | THOMAS RD TI OP | 1989 | |
| 02417 | 51 | 1.66 | 20TH ST SB OP | 1990 | |
| 02418 | 51 | 1.90 | GRAND CANAL BRIDGE | 1987 | |
| 02419 | 51 | 2.05 | OSBORN ROAD OP | 1986 | |
| 02420 | 51 | 2.57 | INDIAN SCHL RD TI OP | 1988 | |
| 02427 | 51 | 5.44 | ARIZONA CANAL BRIDGE | 1989 | |
| 02193 | 51 | 7.01 | NORTHERN AVE TI OP | 1993 | |
| 02223 | 51 | 9.48 | SHEA BLVD TI UP | 1996 | |
| 02350 | 60 | 172.37 | PRIEST DRIVE OP EB | 1995 | |
| 02112 | 60 | 177.09 | MESA DRAIN RAMP B | 1990 | |
| 02111 | 60 | 177.09 | RAMP E-N BRIDGE | 1993 | |
| 02113 | 60 | 177.45 | DOBSON RD RAMP A BR | 1994 | |
| 01927 | 60 | 189.39 | SOSSAMAN ROAD TI UP | 1990 | X |
| 02048 | 60 | 191.40 | ELLSWORTH RD TI UP | 1990 | X |
| 02063 | 60 | 192.38 | CRISMON RD TI OP | 1990 | X |
| 02064 | 60 | 193.38 | SIGNAL BUTTE RD TIOP | 1990 | X |
| 02065 | 60 | 195.39 | IRONWOOD DR TI OP | 1990 | |
| 02199 | 60 | 199.12 | SIPHON DRAW BR EB | 1991 | X |
| 02200 | 60 | 199.12 | SIPHON DRAW BR WB | 1991 | X |
| 02034 | 101 L | 8.06 | NORTHERN AVE TI OP | 1987 | |
| 02035 | 101 L | 9.27 | OLIVE AVE TI OP | 1987 | |
| 02036 | 101 L | 10.28 | PEORIA AVE TI OP | 1987 | |
| 02039 | 101 L | 12.65 | THUNDERBIRD RD TI OP | 1989 | |
| 02040 | 101 L | 13.49 | SKUNK CREEK BRIDGE | 1989 | X |
| 02050 | 101 L | 14.73 | BELL ROAD TI OP | 1990 | X |
| 02060 | 101 L | 15.12 | 83RD AVENUE UP | 1990 | |
| 02002 | 101 L | 15.80 | UNION HILLS DR TI UP | 1990 | |
| 02051 | 101 L | 17.24 | 75TH AVE TI UP | 1990 | |
| 02052 | 101 L | 18.24 | 67TH AVE TI UP | 1990 | |
| 02053 | 101 L | 19.18 | 59TH AVENUE TI UP | 1990 | X |
| 02069 | 101 L | 20.19 | 51ST AVENUE TI OP | 1992 | X |
| 02070 | 101 L | 22.19 | 35TH AVENUE TI OP | 1992 | X |
| 02134 | 101 L | 22.69 | 31ST AVENUE OP EB | 1992 | X |
| 02135 | 101 L | 22.69 | 31ST AVENUE OP WB | 1992 | X |
| 02133 | 101 L | 23.20 | 27TH AVE TI UP | 1993 | X |
| 02132 | 101 L | 23.70 | 23RD AVENUE UP | 1991 | |
| 02249 | 101 L | 43.06 | VIA DE VENTURA TI OP | 1991 | |
| 02250 | 101 L | 44.46 | INDIAN BEND RD TI OP | 1991 | |
| 02251 | 101 L | 45.14 | ARIZONA CANAL BRIDGE | 1996 | |
| 02252 | 101 L | 45.51 | MCDONALD DR TI OP | 1991 | |
| 02255 | 101 L | 48.03 | THOMAS ROAD TI UP | 1992 | |
| 02256 | 101 L | 49.54 | MCDOWELL ROAD TI OP | 1993 | |
| 02257 | 101 L | 50.03 | MCKELLIPS RD TI OP | 1992 | |
| 02358 | 101 L | 51.00 | RAMP N-W | 1995 | |
| 02379 | 101 L | 51.24 | RAMP W-S OVER L202 | 1995 | |
| 02359 | 101 L | 51.47 | RAMP E/W-S | 1995 | |
| 02357 | 101 L | 51.55 | RIO SALADO PKWY OP | 1995 | |
| 02071 | 101 L | 52.07 | UNIVERSITY DR TI UP | 1990 | |

| BRIDGE INVENTORY | | | | | |
|---|---|---|---|---|---|
| BRIDGE NUMBER | ROUTE | MILE POST | BRIDGE NAME | YEAR BUILT | INSPECTION PERFORMED |
| 02041 | 101 L | 52.27 | VICTORY DRIVE UP | 1988 | |
| 02042 | 101 L | 52.60 | APACHE BLVD UP | 1988 | |
| 02073 | 101 L | 53.07 | BROADWAY RD TI UP | 1990 | |
| 02074 | 101 L | 54.07 | SOUTHERN AVE TI UP | 1990 | X |
| 02108 | 101 L | 54.57 | EFR OVER RAMP E-N | 1994 | |
| 02103 | 101 L | 54.57 | SB 101 TO EB 60 | 1994 | |
| 02182 | 143 | 1.37 | SALT RIVER BRIDGE | 1990 | |
| 02183 | 143 | 1.73 | SKY HARBOR TI OP | 1990 | |
| 02241 | 143 | 2.07 | GRAND CANAL SPRR OP | 1990 | |
| 02240 | 143 | 2.40 | WASHINGTON ST TI OP | 1990 | X |
| 02155 | 143 | 2.65 | VAN BUREN ST OP NB | 1990 | X |
| 02154 | 143 | 2.65 | VAN BUREN RAMP SB OP | 1990 | |
| 02156 | 143 | 2.65 | VAN BUREN ST OP SB | 1990 | |
| 02157 | 143 | 2.65 | VAN BUREN RAMP NW OP | 1990 | |
| 02158 | 143 | 3.00 | RAMP NW UP | 1990 | |
| 02160 | 143 | 3.25 | EAST PAPAGO TI UP EB | 1990 | |
| 02161 | 143 | 3.25 | EAST PAPAGP TI UP WB | 1990 | |
| 02159 | 143 | 3.25 | RAMP E-N @ E PAPAGO | 1991 | |
| 02228 | 153 | 1.91 | SALT RIVER BRIDGE NB | 1996 | X |
| 02229 | 153 | 1.91 | SALT RIVER BRIDGE SB | 1996 | |
| 02231 | 153 | 2.37 | WB SKY HARBOR OP NB | 1996 | |
| 02232 | 153 | 2.38 | WB SKY HARBOR OP SB | 1996 | |
| 02237 | 153 | 2.38 | EB SKY HARBOR OP | 1991 | |
| 02230 | 153 | 2.42 | RAMP E-S OP | 1996 | |
| 02236 | 153 | 2.44 | RAMP A OP | 1996 | |
| 02233 | 153 | 2.45 | EB SKY HARBOR OP NB | 1996 | |
| 02234 | 153 | 2.46 | EB SKY HARBOR OP SB | 1996 | |
| 02239 | 153 | 2.50 | RAMP B OVERPASS | 1991 | |
| 02021 | 202 L | 0.70 | 24TH ST TI OP | 1987 | |
| 02022 | 202 L | 1.75 | 32ND ST TI OP | 1988 | |
| 02023 | 202 L | 2.01 | GRAND CANAL BRIDGE | 1988 | |
| 02024 | 202 L | 2.45 | 40TH STREET TI OP | 1989 | |
| 02142 | 202 L | 2.80 | RAMP N/S-2 @ WB FRNT | 1989 | |
| 02144 | 202 L | 2.80 | RAMP E-N/S @ EB FRNT | 1989 | |
| 02140 | 202 L | 2.90 | 44TH STREET TI OP | 1989 | |
| 02141 | 202 L | 2.90 | RAMP N/S-W | 1989 | |
| 02143 | 202 L | 2.90 | RAMP E/N-S | 1990 | |
| 02198 | 202 L | 3.45 | 48TH STREET OP EB | 1990 | |
| 02327 | 202 L | 3.45 | 48TH STREET OP WB | 1990 | |
| 02208 | 202 L | 3.89 | RAMP B OP EB | 1992 | |
| 02209 | 202 L | 3.89 | RAMP B OP WB | 1992 | X |
| 02210 | 202 L | 4.04 | 52ND STREET OP EB | 1992 | |
| 02211 | 202 L | 4.04 | 52ND STREET OP WB | 1992 | X |
| 02217 | 202 L | 4.83 | SPRR/GRAND CNL BR EB | 1991 | |
| 02218 | 202 L | 4.83 | SPRR/GRAND CNL BR WB | 1991 | X |
| 02219 | 202 L | 5.02 | SKY HARBOR BLVD EBOP | 1991 | |
| 02220 | 202 L | 5.02 | SKY HARBOR BLVD WBOP | 1991 | X |
| 02221 | 202 L | 5.48 | SKY HARBOR BLVD EBOP | 1991 | |
| 02258 | 202 L | 6.34 | MILL AVE VIADUCT | 1993 | |
| 02227 | 202 L | 6.45 | CENTER PARKWAY TI UP | 1993 | |
| 02259 | 202 L | 7.13 | W PEDESTIRAN OP EBWB | 1993 | |
| 02260 | 202 L | 7.41 | E PEDESTRIAN OP EBWB | 1993 | |
| 02261 | 202 L | 7.55 | COLLEGE AVENUE OP | 1993 | |
| 02262 | 202 L | 7.55 | COLLEGE AVE RAMP AOP | 1993 | |
| 02263 | 202 L | 7.71 | SCOTTSDALE RD TI OP | 1994 | |
| 02265 | 202 L | 8.06 | INDIAN BEND WASH BR | 1994 | |
| 02269 | 202 L | 8.17 | SALT RIVER BRIDGE WB | 1994 | |
| 02268 | 202 L | 8.17 | SALT RIVER BRIDGE EB | 1994 | |
| | | | | | |
| | | | | | |
| | | | | | |

## 2 Joint Systems And Materials in Market

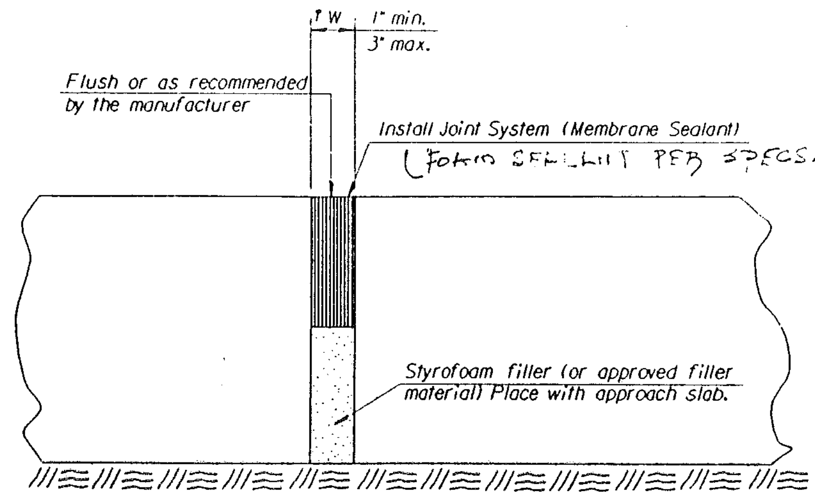
| | | |
|---|---|---|
| • | Chemcrete | Complete Joint |
| • | Delcrete Elastomeric Concrete / Steelflex Strip Seal System (D.S.Brown) | Complete Joint |
| • | Dow Corning 902 RCS Joint Sealant | |
| • | XJS Expansion Joint System(Dow Corning/Silicone Specialties) | |
| • | Ceva 250 Joint System (Epoxy Industries Inc.) | Complete Joint |
| • | Ceva 300 Joint System (Epoxy Industries Inc.) | Complete Joint |
| • | Evazote 380 ESP Sealant (Epoxy Industries Inc.) | |
| • | Jeene Structural Sealing Joint System (PC35) Hydrozo/Jeene Inc. | Complete Joint |
| • | Jeene Structural Sealing Joint System (PC 92M) Hydrozo/Jeene Inc. | Complete Joint |
| • | Sylcrete ten minute Joint Sealant (Sylvex Corporation) | |
| • | Resurf IV | Polymer Header |
| • | Expandex Buried Joint System ( Watson, Bowman and Acme Corporation) | Complete Joint |
| • | Wabocrete ACM Expansion Joint (Watson, Bowman and Acme Corporation) | Complete Joint |
| • | BJS Joint System (Linear Dynamics Corporation) | Complete Joint |
| • | Flexcon 2000 Joint Sealing System (R.J.Watson Inc.) | Complete Joint |
| • | Tech Star Elastomeric Strip Seal (Tech Star Inc.) | |
| • | Sikaflex-15LM, Cold poured Low modulus one component Polyurethane based elastomeric self leveling sealant | |
| • | Sikaflex 1CSL sealant | |

leveling sealant

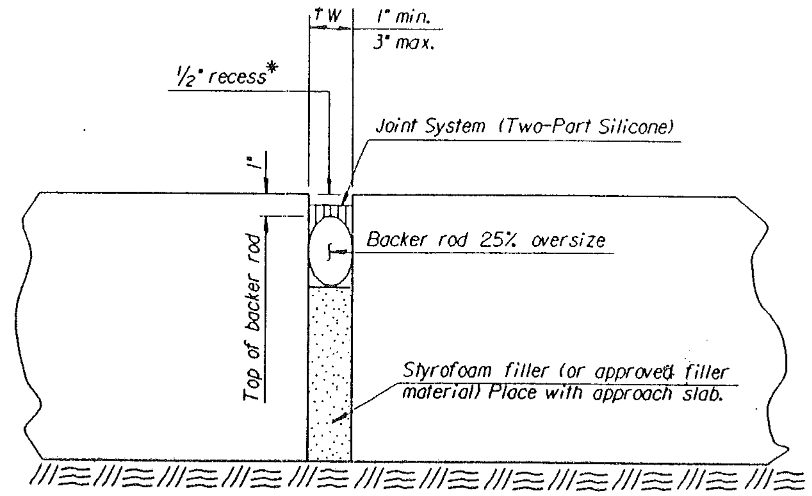
- Sikaflex 1CSL sealant
- Dow 888 Silicone Sealant
- Dow 890 Self Leveling Silicone Sealant
- Crafco Roadsaver SL Silicone Sealant

# 3 JOINTS OF OTHER DOTs

| FHWA REGION NO. | STATE | PROJECT NO. | YEAR | SHEET NO. | TOTAL SHEETS |
|---|---|---|---|---|---|
| 7 | KANSAS | | 19.. | | |

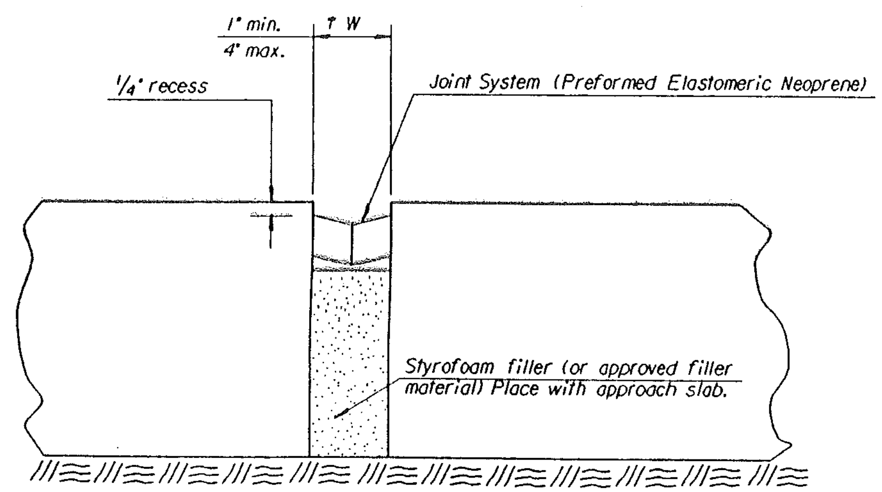



TYPE A

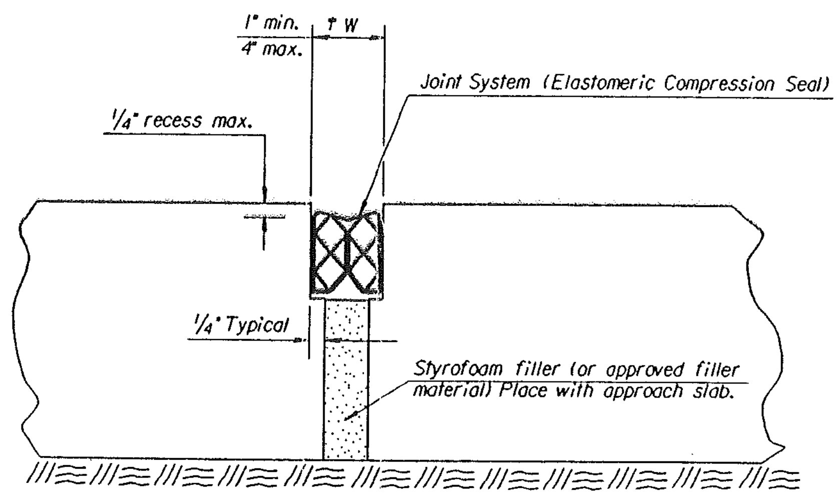



TYPE B

*Note: Joint shall be recessed 1/2" in areas subject to traffic. Joint shall be flush in shoulder areas. Maintain 1/2" depth of silicone joint sealant. Vary depth of backer rod.




TYPE C




TYPE D

↑ W = INSTALLATION GAP

## GENERAL NOTES

See Concrete Bridge Approach Pavement standard drawings for location and type of expansion joints.

The joint opening shall be formed just prior to placement of the pavement approach. The material used to form the joint opening shall be removed after the pavement approach has been in place for a minimum of six days.

Cleaning and construction of the joint shall not begin until the concrete in the approach slab has cured a minimum of 7 days.

The joint shall be thoroughly cleaned by sandblasting and by high pressure air blast to remove all laitance and contaminants from the joint. When any part of the joint is shaped by saw cutting in lieu of forming, a water blast shall preceed sandblasting and air cleaning.

Sandblasting shall be accomplished in two passes to clean each face of the joint (one pass for each face). The nozzle shall be held at an angle to the joint face and within 1 to 2 inches of the face.

Any contaminants such as oil, curing compound, etc. shall be removed by sandblasting to the satisfaction of the Engineer. Solvents, wire brushing, or grinding shall not be permitted.

The joint shall be air blasted just prior to installation of the backer rod. The air compressor used for joint cleaning shall be equipped with trap devices capable of providing moisture-free and oil-free air. Recommended pressure is 90 psi. Immediately prior to installation of the backer rod, the joint shall be spot checked by rubbing a finger on the face of the joint to determine that residual dust or dirt has been removed. It is required that the Engineer inspect the joint immediately prior to installation of the joint material.

Traffic shall not be allowed on the joint for a minimum of 3 hours unless otherwise directed by the Engineer.

All work and materials necessary for the preparation, construction, and installation of the joint will be subsidiary to the concrete approach pavement.

TYPE A

The joint shall be sealed with "Joint System (Membrane Sealant)" in accordance with the K.D.O.T. Specifications.

The seal shall be installed at locations shown on the plans and placed as one continuous unit. The seal shall be installed with the manufacturer's recommended bonder to the concrete pavement.

TYPE B

The joint shall be sealed with "Joint System (Two-Part Silicone)" in accordance with the K.D.O.T. Specifications.

The sealant shall be installed immediately after the backer rod is placed. The faces of the joint shall be completely free of any dampness or free water. Placement of the rod and sealant shall not begin when there is any expectation of rain or moisture occurring before the joint can be completed.

The sealant shall be installed to the depth shown in the details but shall not be greater than 1/2" deep at any location. The sealant shall be a silicone material Type II (Self Leveling).

Sealant shall not be installed when air temperature is less than 40° F or when air temperature is expected to be less than 40° F within 3 hours after installation is complete.

TYPE C

A joint will be provided as shown in the details. The seal will be recessed 1/4" below slab grade. The seal will be a "Joint System (Preformed Elastomeric Neoprene)". The seal shall be installed as per product specifications to provide a watertight joint throughout the roadway. See K.D.O.T. Specifications.

If the finished joint will be spliced, an epoxy adhesive shall be used to provide a watertight seal at the splice.

TYPE D

A joint will be provided as shown in the details. The seal will be recessed 1/4" below slab grade. The seal will be a "Joint System (Elastomeric Compression Seal)". The seal shall be installed as per product specifications to provide a watertight joint throughout the roadway. See K.D.O.T. Specifications.

If the finished joint will be spliced, an epoxy adhesive shall be used to provide a watertight seal at the splice.

| NO. | DATE | REVISIONS | BY | APP'D |
|---|---|---|---|---|
| 3 | | | | |
| 2 | | | | |
| 1 | 12-28-93 | Add definition of "W" | R.J.S. | J.O.B. |

KANSAS DEPARTMENT OF TRANSPORTATION

# EXPANSION JOINT DETAILS (BRIDGE APPROACH SLABS)

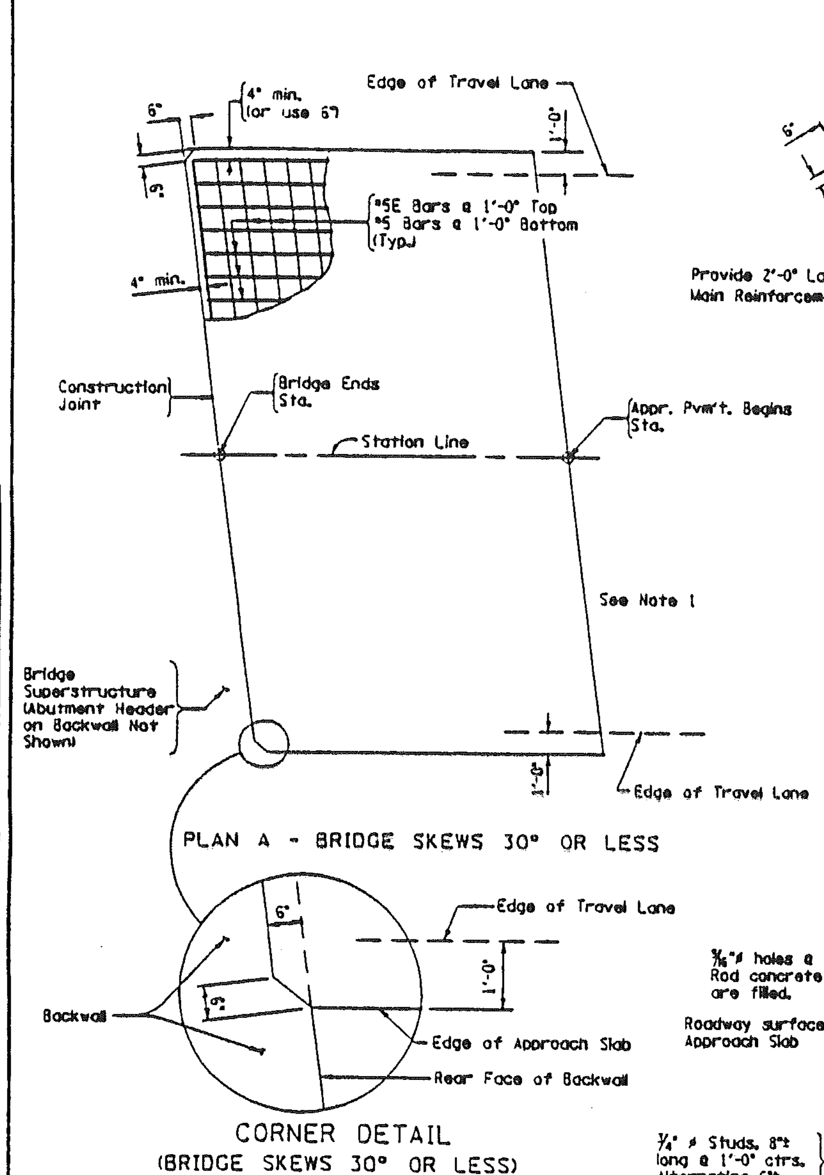
RD712

| | | | |
|---|---|---|---|
| FHWA APPROVAL 2-10-94 | | APP'D James O. Brewer | |
| DESIGNED | DETAILED | QUANTITIES | TRACED |
| DESIGN CK. | DETAIL CK. | QUAN.CK. | TRACE CK. |

Drawn By: rood | Plotted: 24-AUG-1995 15:55
File: /usr7/rood/us/rd712.dgn

# BRIDGE DESIGN DATA SHEET

BDD 95-90



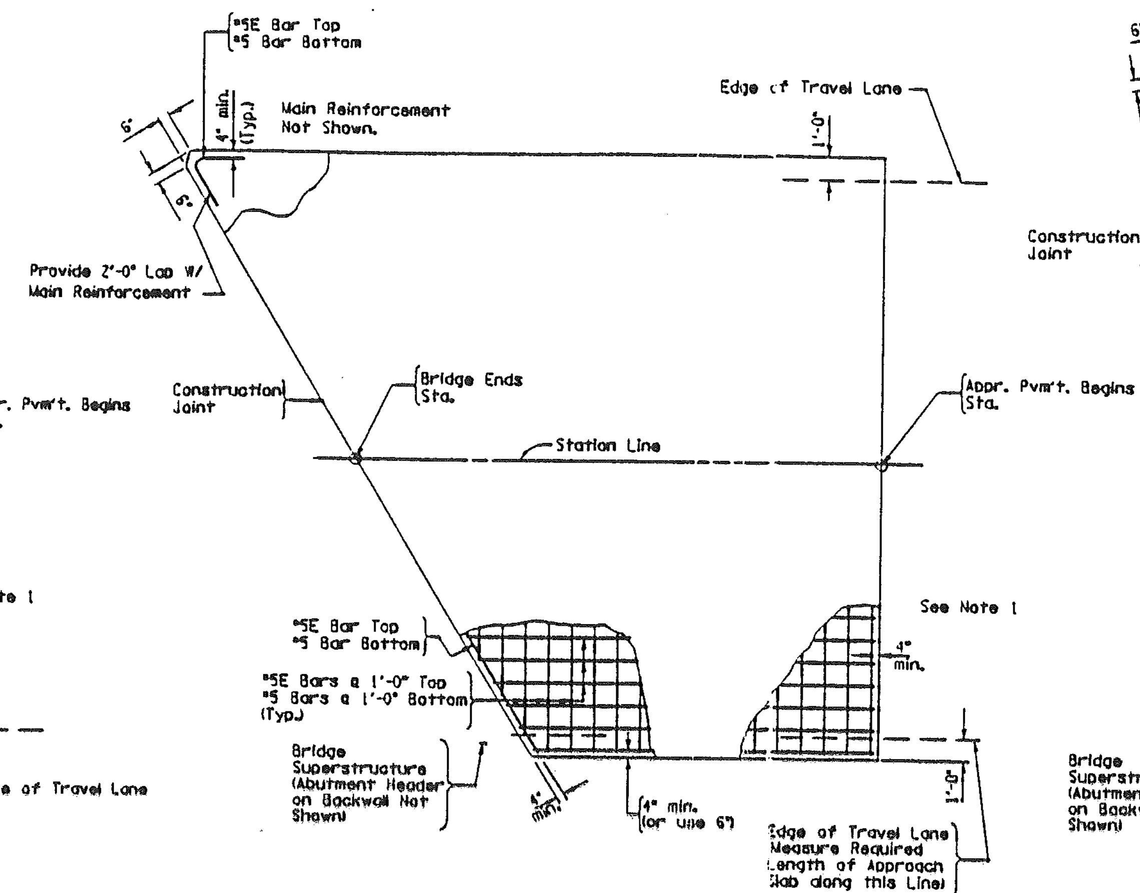

PLAN A - BRIDGE SKEWS 30° OR LESS



CORNER DETAIL

(BRIDGE SKEWS 30° OR LESS)

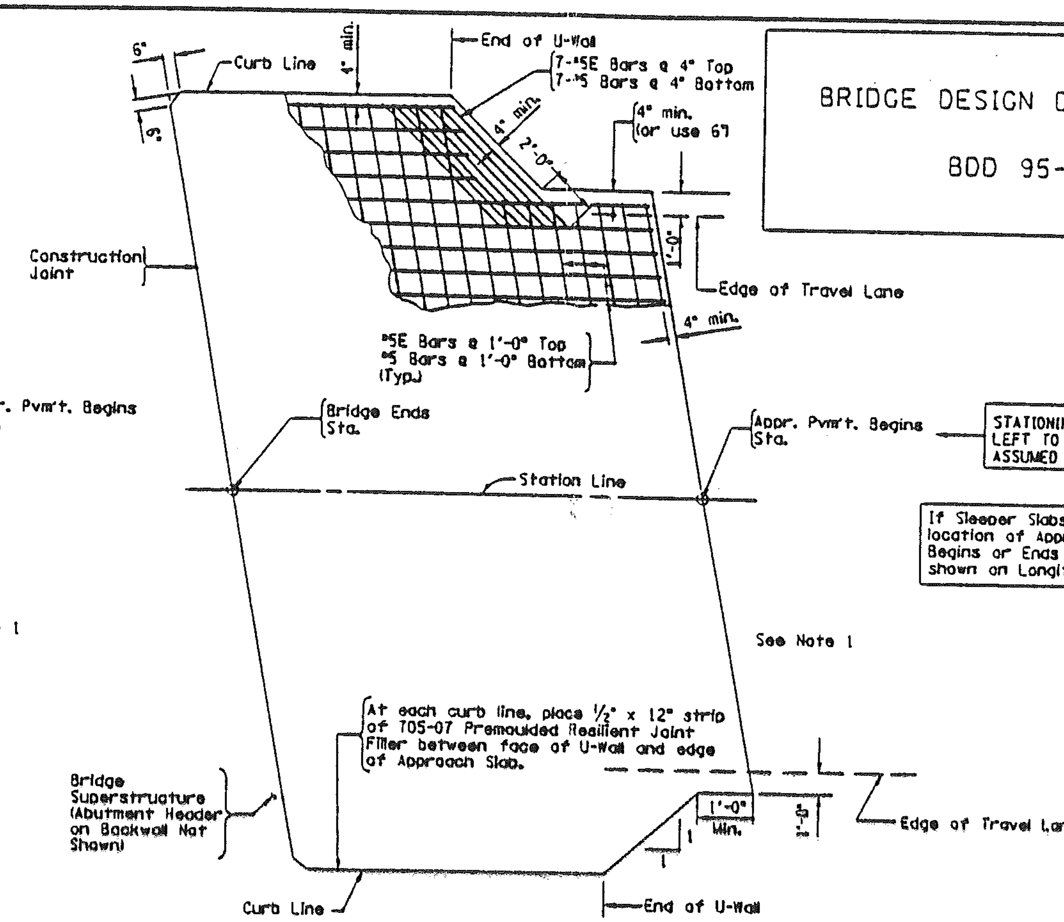
Scale : 3/4" = 1'-0"




PLAN B - BRIDGE SKEWS GREATER THAN 30°

PLAN

Scale: 1/4" = 1'-0"

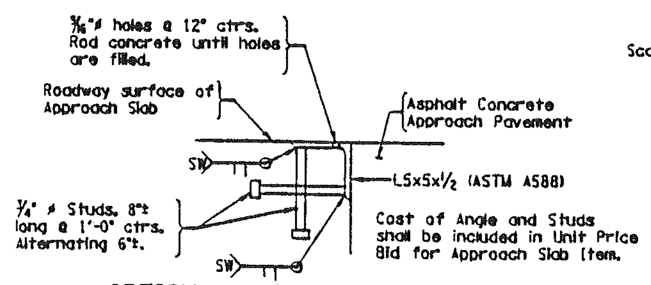



PLAN C - U-WALL ABUTMENT - SHOULDER WIDTH 5' OR LESS

(See Note 5)

STATIONING LEFT TO RIGHT ASSUMED

If Sleeper Slabs are required, location of Approach Pavement Begins or Ends shall be as shown on Longitudinal Section.




OPTIONAL ARMORING ANGLE

(USE ONLY IF REQUESTED BY REGIONAL OFFICE)

Scale: 1 1/2" = 1'-0"

**Note A:**

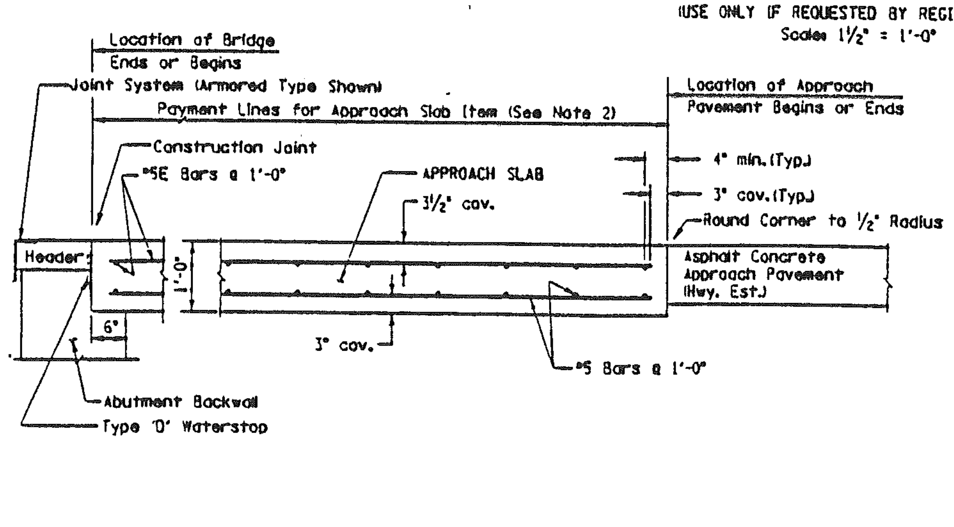
Excavation for sleeper slabs shall be carefully made after compacted abutment embankment material is in place. The sleeper slabs are founded on undisturbed compacted material (or re-compacted material). No loose backfill will be allowed. The Contractor shall take all necessary precautions to protect the sleeper slab from temporary loadings or any condition which could cause movement or uneven settlement.

**Note B:**

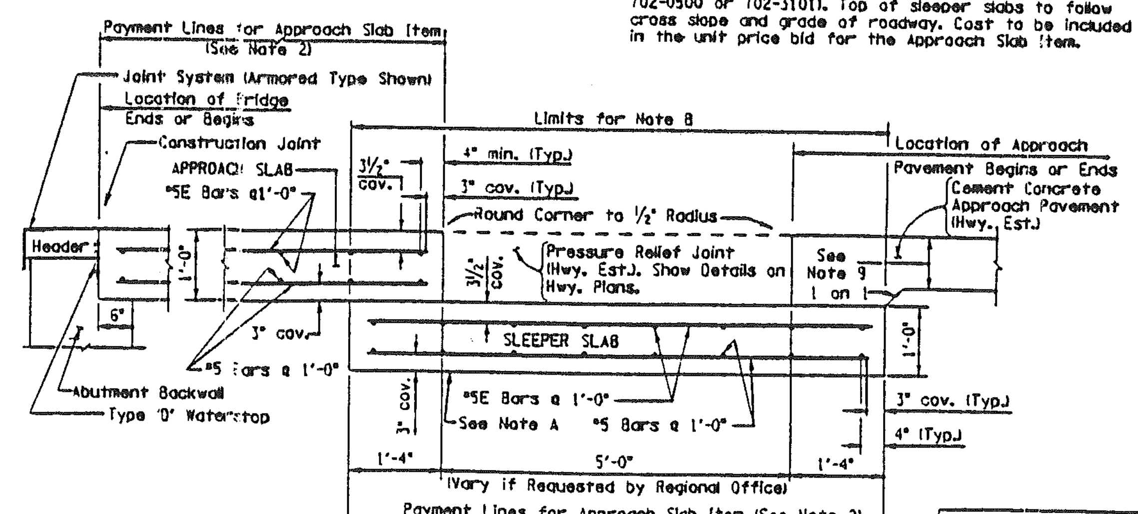
Steel trowel finish top of sleeper slabs, and coat with a 30 mil nominal thickness of asphalt (702-0300, 702-0500 or 702-3101). Top of sleeper slabs to follow cross slope and grade of roadway. Cost to be included in the unit price bid for the Approach Slab Item.

**NOTES TO DESIGNER:**

1. Sleeper Slabs and Pressure Relief Joints, if required, are not shown in Plan views.
2. Approach Slabs and Sleeper Slabs shown on this sheet shall be paid for under the Concrete For Structures, Class E (Structural Approach Slab with Integral Wearing Surface) Item. The plan area of each Approach Slab and each Sleeper Slab shall be tabulated on the Contract Plans.
3. For additional information on types, uses, lengths, widths and skews of Approach Slabs, see Section 1 of the Standard Details For Highway Bridges.
4. Approach Slabs and Sleeper Slabs, including their Bar Reinforcement, shall be included in the Bridge Estimate.
5. U-Wall Abutment-Shoulder Width 5' or Less (Measured from Edge of Travel Lane to Curb Line). Detail shown is for Bridge Skews 30° or Less. If Bridge Skew is greater than 30°, extend Approach Slab to curb lines as shown in Plan C, and orient main reinforcement as shown in Plan B.
6. U-Wall Abutment-Shoulder Width Greater than 5': Use Plan A or Plan B.
7. On Superelevated Bridge, with crown line at edge of travel lane, do not extend approach slab 1'-0" beyond crown line.
8. Exposed top surface of approach slabs shall be grooved under the Transverse Sawcut Grooving of Structural Slab Surface Item.
9. Eliminate Haunch if Approach Pavement Thickness equals or exceeds 1'-0". If Approach Pavement Thickness exceeds 1'-0", haunch Approach Slab down to Sleeper Slab.




WITH ASPHALT CONCRETE APPROACH PAVEMENT




WITH CEMENT CONCRETE APPROACH PAVEMENT

LONGITUDINAL SECTION

Scale: 3/4" = 1'-0"

NOTE: Dimensions shown for Sleeper Slab are perpendicular to its long axis.

APPROVED

DATE: 1/12/95

ORIGINAL SIGNED BY A.M. SHIROLE

DEPUTY CHIEF ENGINEER (STRUCTURES)

STATE OF NEW YORK
DEPARTMENT OF TRANSPORTATION
STRUCTURES DESIGN AND CONSTRUCTION DIVISION

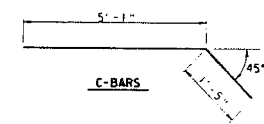
REINFORCED CONCRETE APPROACH SLABS FOR USE AT CONVENTIONAL ABUTMENTS

| PROJ. ENG. | DATE MADE |
|---|---|
| SQUAD | DRAWING NO. OF |

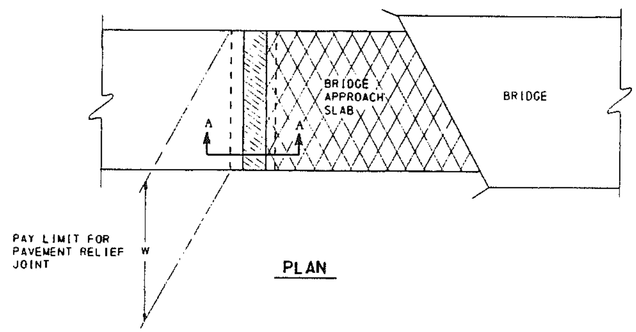
DESIGNED BY / DESIGN CHECKED BY / DETAILED BY / DETAIL CHECKED BY

SCHEDULE OF REINFORCEMENT STEEL

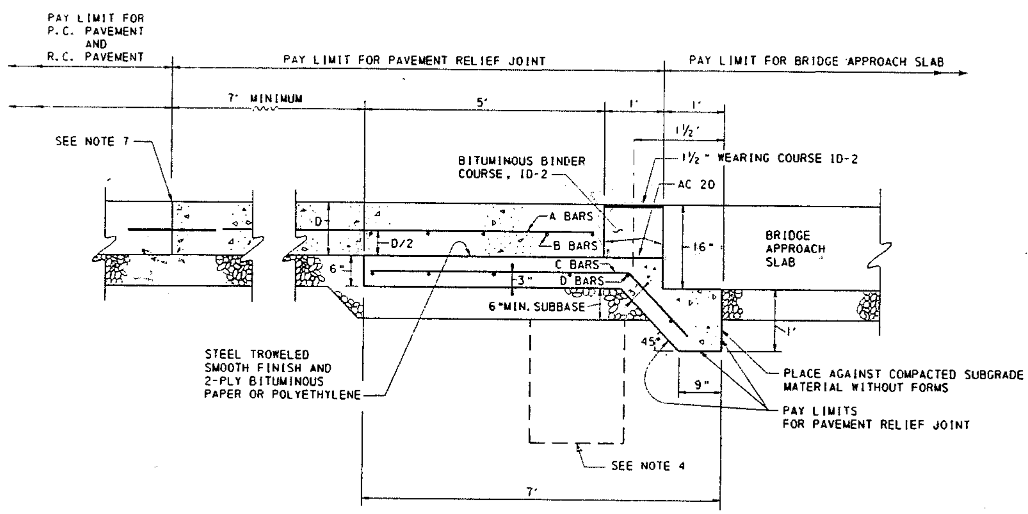
| MARK | SIZE | SPACING C - C | LENGTH | NUMBER REQUIRED |
|---|---|---|---|---|
| A | #4 | 12" | 10'-6" | W |
| B | #4 | 12" | W minus 4" | 5 |
| C | #4 | 6" | 6'-6" | W x 2 |
| D | #4 | 12" | W minus 4" | 7 |




C-BARS




PLAN




SECTION A-A

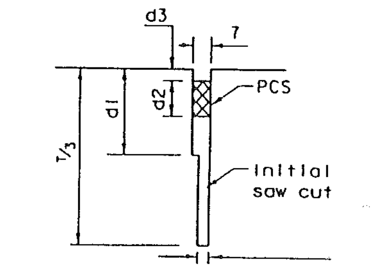
## NOTES

1. PAVEMENT RELIEF JOINTS ARE APPLICABLE FOR ALL CEMENT CONCRETE PAVEMENTS.
2. CONCRETE IN SUBSLAB SHALL BE CLASS AA (AT CONTRACTORS OPTION, SUBSLAB CONCRETE MAY BE H.E.S.).
3. PORTIONS OF REINFORCING BARS WHICH ARE LOCATED OUTSIDE THE INDICATED PAY LINES SHALL BE INCLUDED IN BID PRICE FOR PAVEMENT RELIEF JOINT.
4. WHEN THE PAVEMENT GRADE CAUSES DRAINAGE TOWARDS THE BRIDGE, A SUBGRADE DRAIN (SEE RC-30) SHALL BE PLACED UNDER THE 6" PORTION OF THE SUBSLAB AND WILL BE MEASURED AND PAID FOR AS SPECIFIED IN SECTION 612, PUBLICATION 408.
5. WHERE BRIDGES ARE LOCATED LESS THAN 1,000 FT. APART, AS MEASURED FROM THE FACE OF THE NEAREST ABUTMENTS, NO RELIEF JOINT WILL BE USED BETWEEN THE BRIDGES.
6. WHERE BRIDGES ARE LOCATED BETWEEN 1,000 FT. AND 1,500 FT. APART, AND THE PAVEMENT STRUCTURE IS CEMENT CONCRETE, ONE RELIEF JOINT SHALL BE PLACED MIDWAY BETWEEN THE BRIDGES. IN THESE CASES, THE SUBSLAB SHALL BE A UNIFORM 6 IN. THICK AND 7 FT. WIDE.
7. FOR JOINT DETAILS ON NEW CONSTRUCTION, SEE RC-20. FOR JOINT DETAILS ON RECONSTRUCTION, SEE RC-26. IF THE DISTANCE TO THE NEAREST JOINT IS LESS THAN 10'; REMOVE THE EXISTING PAVEMENT TO THE JOINT.

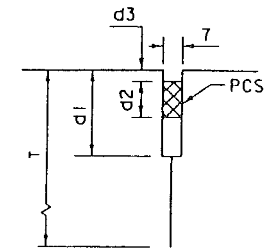
COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF TRANSPORTATION
BUREAU OF DESIGN

# PAVEMENT RELIEF JOINT

| RECOMMENDED MAR. 25, 1994 | RECOMMENDED MAR. 25, 1994 | SHT. 1 OF 1 |
|---|---|---|
| DIRECTOR, BUREAU OF DESIGN | CHIEF ENGINEER | RC-24 |

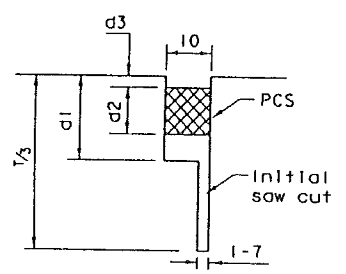



SAWED
LONGITUDINAL JOINT

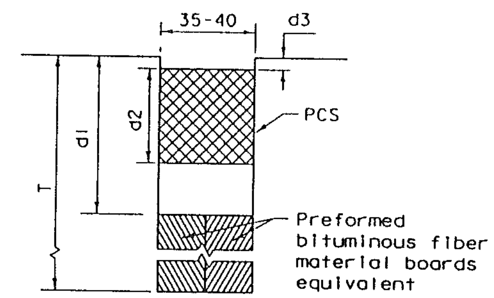



LONGITUDINAL
CONSTRUCTION JOINT

## LONGITUDINAL JOINT SEALS




SAWED
CONTRACTION JOINT



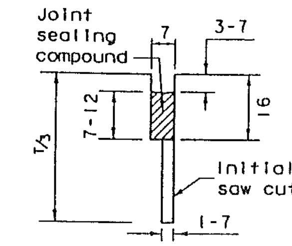

FORMED
FORMED EXPANSION JOINT

## TRANSVERSE JOINT SEALS

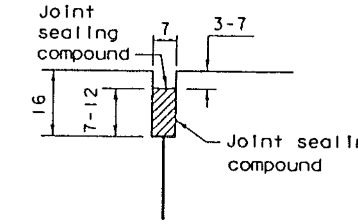
# METHOD A: PREFORMED COMPRESSION SEALS (PCS)
## (CLASS 6 PREFORMED JOINT SEALANT)

### GENERAL NOTES FOR METHOD "A"

1. Unless otherwise shown in the plans, either method "A" or method "B" may be used.
2. The location of joints shall be as shown elsewhere in the plans.
3. Dimension d1, d2, and d3 shall be in accordance with the preformed compression seal manufacturers recommendation.
4. The joint reservoir for sealant shall be sawed unless otherwise shown on the plans for the longitudinal and transverse construction and the two sawed joints.
5. The joints shall be cleaned in accordance with the specification item for "Cleaning and / or Sealing Joints and Cracks (Portland Cement Concrete)". Prior to begining operations, the Contractor shall submit a statement from the sealant manufacturer showing the recommended equipment and installation procedures to be used.
6. The saw cut for the longitudinal joint may be one fourth the slab thickness when crushed limestone is used as the coarse aggregate.

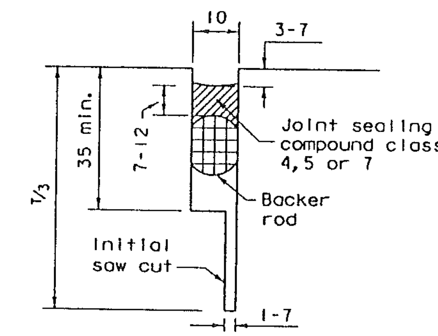



SAWED
LONGITUDINAL JOINT

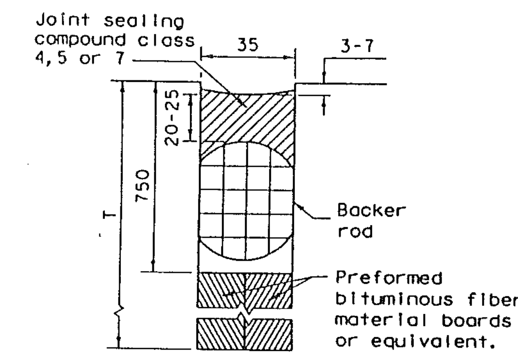



LONGITUDINAL OR TRANSVERSE
CONSTRUCTION JOINT

## LONGITUDINAL JOINT SEAL




TRANSVERSE SAWED
CONTRACTION JOINT




TRANSVERSE FORMED
EXPANSION JOINT

# METHOD B: JOINT SEALING COMPOUND

### GENERAL NOTES FOR METHOD "B"

1. Unless otherwise shown in the plans, either method "A" or method "B" may be used.
2. The location of joints shall be as shown elsewhere in the plans.
3. The Engineer shall select a target placement thickness for the sealant details which show ranges in thickness. The target thickness will normally be the mid point of the range.
4. The joint reservoir for sealant shall be sawed unless otherwise shown on the plans for the longitudinal and transverse construction and the two sawed joints.
5. The joints shall be cleaned in accordance with the item 438 and prior to begining operations, the Contractor shall submit a statement from the sealant manufacturer showing the recommended equipment and installation procedures to be used.
6. The saw cut for the lonitudinal joint may be one fourth the slab thickness when crushed limestone is used as the coarse aggregate.

R = Radius
D = Diameter

All unit-less dimensions are millimeters

Texas Department of Transportation
Design Division (Pavement)

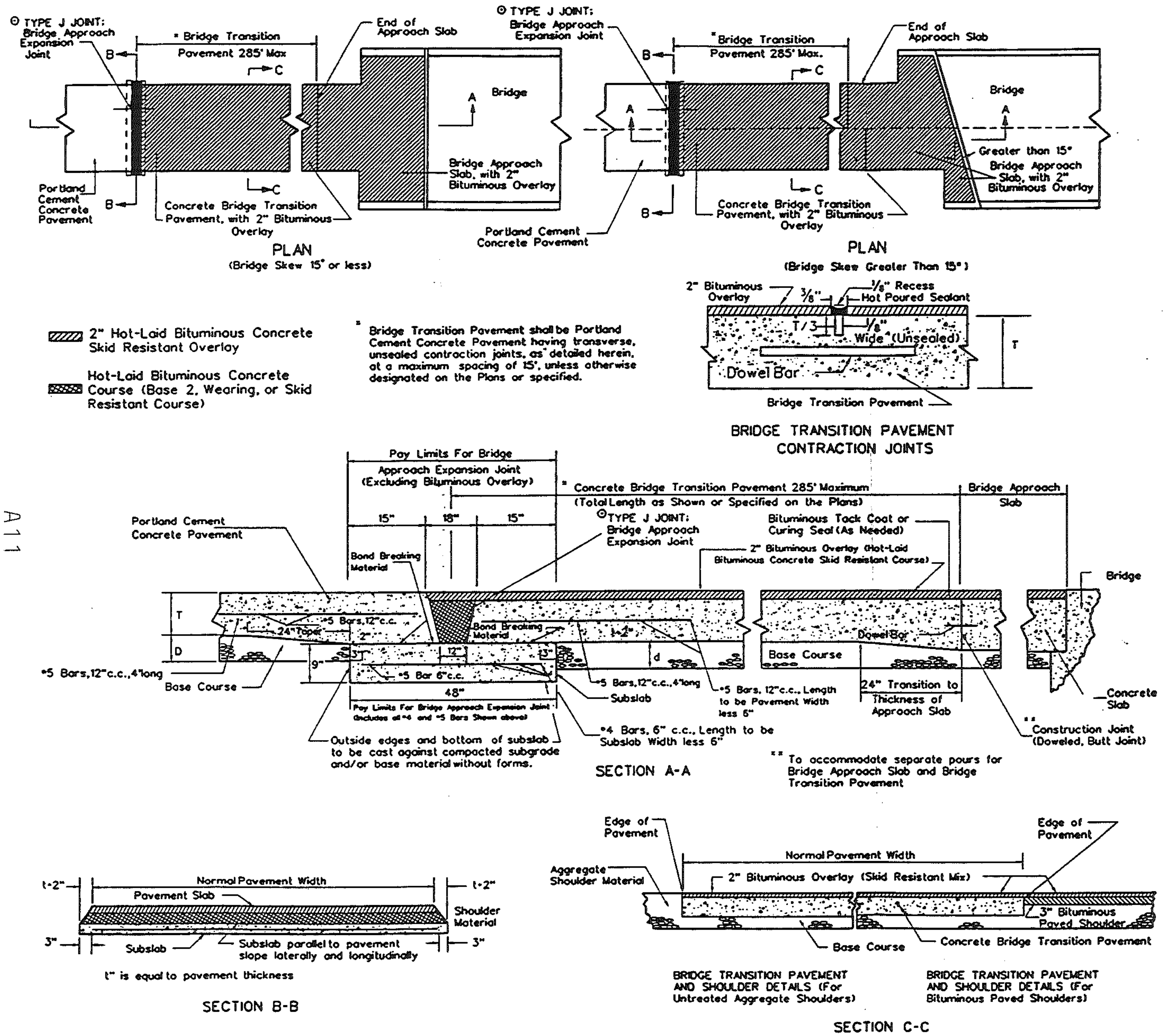
CONCRETE PAVING DETAILS
JOINT SEALS

JS-95(M)

| FILE: JS95V.DGN | DN: LJB | CK: LJB | DW: BCD | CK: |
|---|---|---|---|---|
| ORIG DATE: JULY 1994 | DIST 6 | FED REG | FEDERAL AID PROJECT | SHEET |
| REVISIONS | | COUNTY | CONTROL SECT JOB | HIGHWAY |



LEVELS DISPLAYED




## NOTES

Material and Construction for hot-laid bituminous concrete course (bridge approach expansion joint filler) shall be in accordance with 401 or 402 of the Specifications, as applicable. Materials and construction for the 2" hot-laid bituminous concrete skid resistant overlay shall be in accordance with 402 of the Specifications.

Concrete in subslab shall be Class B or pavement concrete, meeting the requirements of 601 or 501, respectively, of the Specifications.

Bond-breaking material between concrete subslab and pavement may be bituminous material meeting the requirements of 705 or 706 of the Specifications, polyethylene sheeting, asphalt roofing paper, or other acceptable material, which will not be detrimental to the concrete.

Reinforcing steel shall be new billet steel of the size and length shown and shall conform to the requirements of 709.1 of the Specifications.

The cost of the completed four-foot wide joint; including the bituminous expansion joint filler, the 1'-3" wide strip of concrete pavement, the 1'-3" wide strip of concrete bridge transition pavement, the concrete subslab and additional excavation therefor, all reinforcing steel, and the bond breaking material between pavement and subslab; shall be included in the unit price bid for the bridge approach expansion joint.

Concrete bridge transition pavement shall meet the requirements for concrete pavement in 501 of the Specifications, except final finish (fine texturing) requirements are waived, pavement contraction and longitudinal joints need not be sealed, and bituminous (tack coat) curing seal conforming to 408 of the Specifications, shall be used between the transition pavement and the bituminous overlay in lieu of any other concrete pavement curing material except as permitted hereinafter. If deemed necessary by the Engineer, an additional tack coat may be required just prior to placement of the bituminous overlay. Other pavement curing materials and methods: e.g., wet curing methods, resin-base curing compound having self-removal properties (disappears following curing), etc.; which would be compatible with the pavement and overlay and which would not interfere with the bond between the two surfaces, may be used in place of the bituminous curing seal; however, a bituminous tack coat would then be necessary just prior to placement of the bituminous overlay. Transition pavement, along with the bituminous curing seal and/or tack coat as needed, shall be paid for as portland cement concrete pavement, except for the 1'-3" wide strip included in the cost of the bridge approach expansion joint.

The 2" overlay shall be measured and paid for as Item 402-2, Hot-Laid Bituminous Concrete Skid Resistant Pavement", per square yard Or item 402-1, " Hot-Laid Bituminous Concrete Skid Resistant Pavement", per ton.

The 2" overlay shall be sawed at the same location of the contraction joints in the concrete pavement. The joint shall then be filled with hot-poured elastic type joint sealer meeting the requirements of AASHTO M173. The cost of sawing and sealing the overlay joint will not be paid for separately, but shall be included in the cost of the overlay.

Requirements for bridge approach slabs shall be as detailed and specified elsewhere in the Contract and will be paid for as "Portland Cement Concrete Approach Slab".

Details and requirements for bridge approach expansion joints used in conjunction with concrete medians, concrete shoulders and concrete curbs and gutters are located on Standard Sheet PVT5 (Sheet 2 of 2).

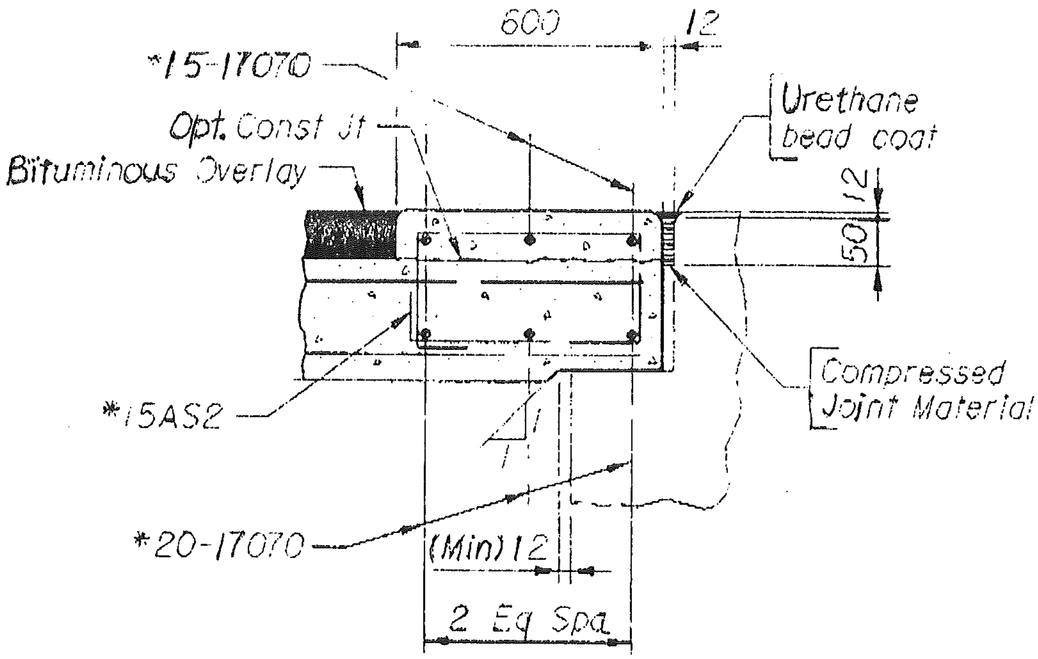
To provide adequate drainage and prevent entrapment of water in the base course at the concrete subslab, adequate cross drainage installation: e.g., filter fabric underdrains; shall be provided on the upgrade end of the subslab as shown elsewhere on the Plans or directed by the Engineer.

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
STANDARD DETAIL

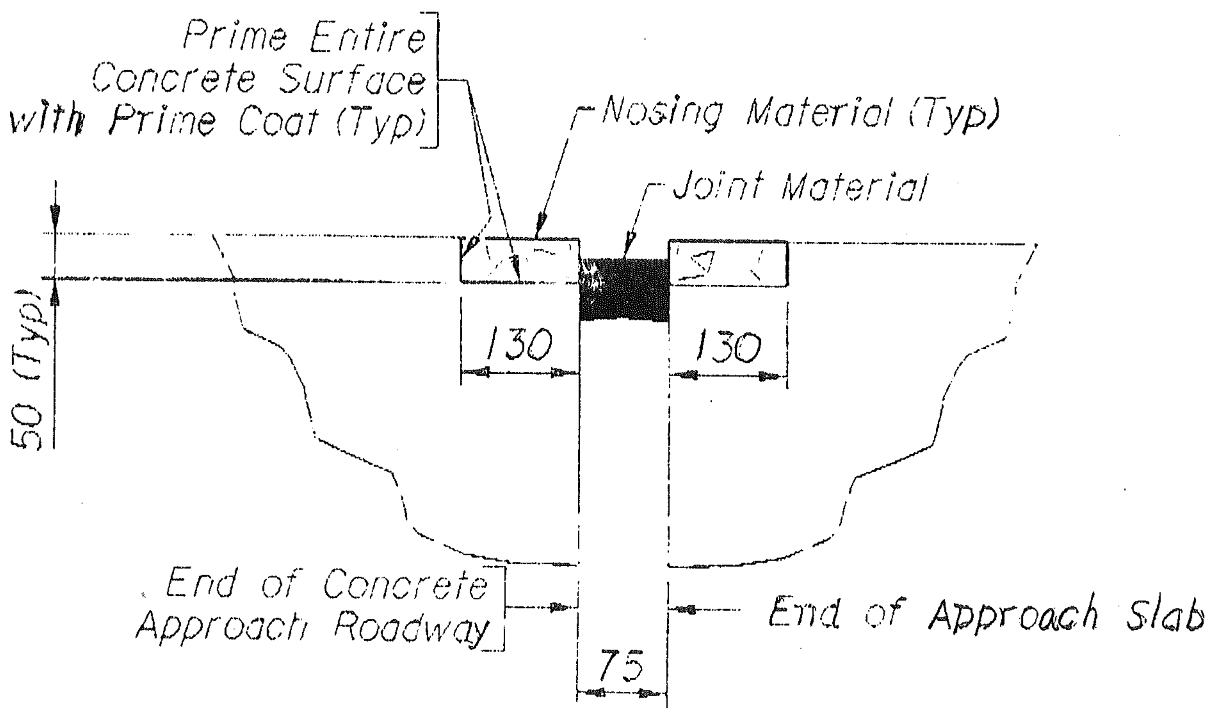
PREPARED 1-1-93
REVISION DATE

**BRIDGE APPROACH EXPANSION JOINT; BRIDGE TRANSITION PAVEMENT WITH SKID RESISTANT OVERLAY, TYPE J JOINT**
**(sheet 1 of 2)**

STANDARD SHEET PVT5




SECTION THRU JOINT BETWEEN ABUTMENT AND APPROACH SLAB
(Dimensions measured normal to Abutment)




SECTION THRU JOINT BETWEEN APPROACH SLAB AND ROADWAY
(Expansion Joint with Nosing)

WYOMING DOT

**(See the reverse side for instructions and definitions.)**

Project Title: BRIDGE APPROACH/ANCHOR SLAB JOINT EVALUATION

Work Plan Administrator: ______________________ Date: July 21, 1997

**Preparations:**

1. Have you requested a literature search from ATRC on the problem(s)?
   - ☐ Yes, proceed to the next question.
   - ☐ No. **STOP**. Contact ATRC Library at 831-0624 to conduct a literature search.

2. Have you conducted or requested ATRC to conduct a search for products/techniques that can achieve the same objectives?
   - ☐ Yes, proceed to the next question.
   - ☐ No. **STOP**. Contact ATRC/PRIDE program (831-5790) to conduct a product search.

**Evaluation Work Plan:**

1. Problem Statement: (Attach additional sheets when needed.)

SEE ATTACHED SHEETS (Pages A17-A18)

2. Project Objectives: (Attach additional sheets when needed.)

The work plan or the project objective is to test the solutions devised under the bridge approach/anchor slab joint study. These are presented in section 4 of this work plan. Experimental installation and verification or testing of these solutions will provide knowledge in the installation techniques, behavior of the materials, give a comparison of the different joint systems and to select the best system or systems for adoption by ADOT.

3. Implementation: (Attach additional sheets when needed.)

ADOT will implement the verification program of the suggested solutions, through the Construction Group, Materials testing Group and the Maintenance Group. Construction will provide the PCCP ( a four lane width is recommended), approach slab, anchor slab, sleeper slab, nosing, the joint space, concrete barriers, preparation of slab edges and joint seal installation including the terminal treatment at barriers. Materials testing will take care of all the field measurements, field testing and laboratory testing for a period of five years, commencing with the installation. Maintenance division will monitor the material and the function of the joint throughout the test period.

4. Product/Technique Selection: (Attach additional sheets when needed.)

SEE ATTACHED SHEET (page A18)

**Seal and Sign**

**(See the reverse side for instructions and definitions.)**

5. Site Selection: (Attach additional sheets when needed.)
Field testing and monitoring of the joints are required at the test site. The site shall have the following minimum characteristics.

- shall be suitable or shall be prepared for Portland Cement Concrete Pavement.
- shall be unshaded and shall have normal exposure to sunlight.
- shall be subject to a minimum temperature range of 10°°C to 45° C
- shall be subject to a high traffic volume, 1600 vehicles /hour/ lane

6. Engineering Design: (Attach additional sheets when needed.)

The material selection criteria under section 4 above shall apply here also. ADOT's design parameters and specifications for construction shall be followed. Sealant's and seal's Manufacturer's recommendations regarding shape factors and other requirements have to be considered and discussed with them prior to joint installation.

7. Test Section Layout and Experimental Design: (Attach additional sheets when needed.)

SEE ATTACHED SHEETS (pages A18-A20)

8. Field Installation and Removal: (Attach additional sheets when needed.)

SEE ATTACHED SHEET (pages A21- A22)

Seal and Sign

**(See the reverse side for instructions and definitions.)**

9. Laboratory Testing Required: (Attach additional sheets when needed.)

The materials used in the five solutions proposed for the verification program and the minimum tests required are listed below. The manufacturer shall be asked to furnish their own test certifications for review for conformance to specifications.

| Material | Test |
|---|---|
| Epoxy Concrete | Bond Strength per ASTM C 882 |
| Epoxy | Viscosity Test |
| Compression Seal Bonding Adhesive | Tensile and Compressive Strengths |
| Strip Seal | Tensile Strength<br>Elongation<br>Type A Durometer Hardness |
| Membrane Foam Sealant | UV Resistance<br>Ozone Resistance<br>Tensile Strength<br>Elongation |

10. Evaluation Criteria: (Attach additional sheets when needed.)

For the explicit evaluation, the evaluation items listed under section 7 of this work plan, may be repeated every 6 months. The initial laboratory tests shall meet the specification requirements. If the joint essentially remains leak proof and accommodates pavement growth without showing signs of adhesive and cohesive failures, then it can be rated as "Pass". Otherwise it shall be deemed as "Failure". This shall be repeated every 6 months till the test is terminated at five year limit. For laboratory tests, at least two samples of each material used in the joint system shall be tested per requirements of section 9 above. Any other tests that come up at the time of installation shall also be looked into. The actual test values shall be kept as records for comparison with the same type of joints in other locations. Field test records shall be kept for comparison with those at different time intervals.

11. Cost Benefit Analysis: (Attach additional sheets when needed.

SEE ATTACHED SHEETS (pages A22 - A23)

Seal and Sign

**(See the reverse side for instructions and definitions.)**

12. Reports: (Attach additional sheets when needed.)

All reports shall be submitted to the Materials Products Evaluation Committee (MPEC).

Construction Report shall be prepared and submitted at time of Joint Installation. This shall include joint preparations, problems encountered during joint installation and laboratory test results.

Interim reports at 6 month intervals shall include the Joint Evaluation Form and a Pass-Fail Rating for each joint.

Final Report shall be submitted at the end of five years. This shall include the performance of each joint system, Ratings and the recommendation by the work plan Administrator as to the choice or choices of the joint systems that ADOT can adopt on the Highways.

13. Responsibilities: (Attach additional sheets when needed.)

These are outlined in the Instructions for the Work Plan. They are stated as follows.

a. Field evaluations will primarily be the responsibility of the District Personnel in conjunction with the ATRC and/or the Materials Group.

b. The District will oversee the preparation of the test sites by the Contractors, as well as the joint installations by the Contractors in the presence of the manufacturers of the products.

c. The District will arrange for the initial laboratory testing of the materials , will monitor and regularly inspect test sites and report on the performance of the product, as determined by the work plan.

d. The final performance report will be the responsibility of the Work Plan Administrator.

14. Duration: (Attach additional sheets when needed.)

The total duration for the verification program is recommended to be five years. Monitoring and evaluations shall be at maximum intervals of 6 months. The joint system shall be considered acceptable if there is no failure rating during the five year period.

15. Approved by:____________________________________Date:____________

16. Appendices: (Attach additional sheets when needed.

Seal and Sign

**1. Problem Statement**

a. Problems and needs:

The Bridge Approach/Anchor Slab Joint serves to accommodate the portland cement concrete pavement growth at the bridge approaches. Without the space for the pavement to grow, the bridge will be subjected to significant lateral stresses compromising the safety of the bridge. ADOT has been observing the past few years, debris and water penetrating the joint in several locations, essentially making the joint ineffective. The sealant material has become brittle and dry and even settlement of the approach slabs have taken place. ADOT needs a joint system that will not allow water and debris inside the joint and at the same time provides for sufficient expansion and contraction under traffic and weather conditions. Necessary attention to proper installation procedures are not being given.

b. Justification

ADOT has been confronted with defective joints in several locations in the State during the past few years. Unattended, the problem will remain without a solution. Defective joints will increase in number and costlier repairs and fix-ups will eventually follow. Verification of the proposed solutions is essential to choose one or more joint systems for adaptation by ADOT and thus for the upkeep of the bridges and the highway system throughout the State.

c. Literature search findings

The surveyed literature emphasizes the need and importance of bridge approach and pavement joints. Without them, undue stresses are built up against bridge structures. The joint must prevent entry of debris and water, provide for thermal and shrinkage movements and transfer traffic loads smoothly. Joint systems are two kinds; one is narrow with sealants and seals, the other is wide with flexible material to relieve pressure from the pavement resistance or growth. Qualities of an efficient and effective joint were obtained from the literature study. Spalling concerns are addressed. The literature search included the joint systems in use in other States. New joint solutions proposed are based on in part on the literature study.

d. Product/Technique search findings

The literature survey, the information obtained from DOTs of other States and the product manufacturers, brought to limelight several products in use and available for the joints. The products used in the solutions for the testing program under this work plan are furnished below. The specifications for the same are given on pages 16 and 24 of the research report.

- Epoxy Concrete for Header
- Low Modulus Hot Poured Sealant
- Rapid Cure Silicone Joint Sealant
- Backer Rod
- Toolable or Non Self-Leveling Silicone Joint Sealant
- Continuous Preformed Elastomeric Neoprene Compression Seal
- Bonding Adhesive for Compression Seal
- Strip Seal
- Membrane Foam Sealant
- Bonding Adhesive
- Splicing Adhesive

**4. Product /Technique Selection**

a. The controlling joint system is the current ADOT joint with coal tar sealant. Solutions are devised around this system.
b. The criteria for selection of the material and installation are furnished on page 4 of Chapter II, Joint Function Requirements and Materials. They are repeated here for the benefit of the work plan Administrator.

The joint

- shall accommodate full expansion and contraction range of movements anticipated.
- shall have adequate anchorage and structural capacity.
- shall provide good riding surface.
- shall not induce undue stress in structure due to expansion and contraction.
- shall be silent and vibration free under traffic.
- shall facilitate maintenance repair, removal and replacement.
- shall be leak proof with continuous sealing element.
- shall be corrosion resistant.
- shall not be a catalyst or vehicle for electrolytic action.
- seal shall be durable.
- material and installation shall be cost effective.
- shall provide ease of installation.
- installation time shall be reasonable, since this has bearing on the length and degree of traffic interruption.
- failure shall not pose danger to traffic.

c. The following joint systems are devised for the verification program. The diagrams are furnished on pages 17-22 of the research report. The product guide specifications are given on pages 16 and 24 of the report.

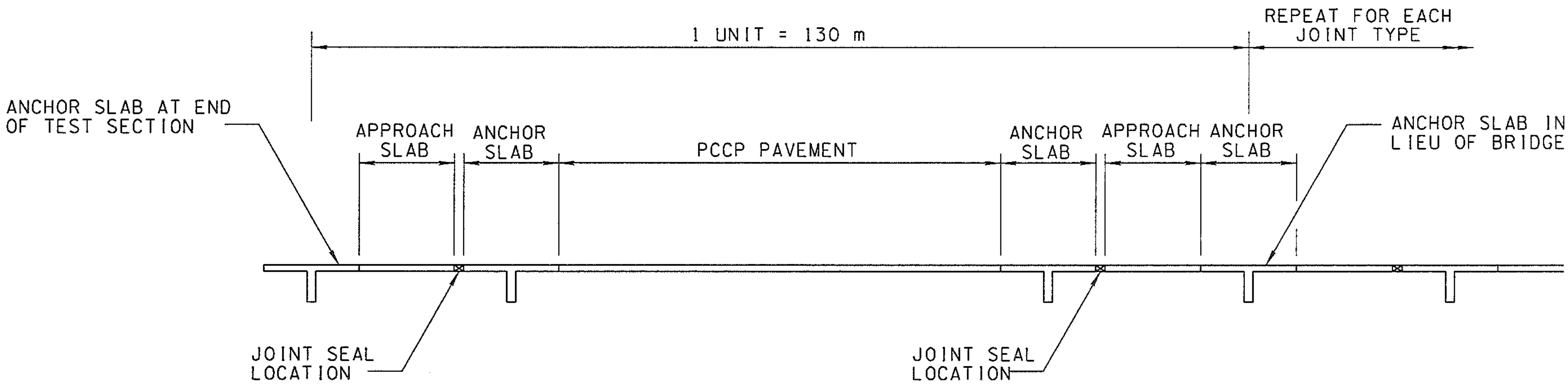
- Low Modulus Hot Pour Sealant Joint
- Silicone Sealant Joint
- Precompressed Foam Joint
- Compression Seal Joint
- Armored Strip Seal Joint

**7. Test Section Layout and Experimental Design**

Test sections of PCCP and approach slabs shall be at regular intervals in order to compare the different solutions. Install a minimum of two joints of the same kind separated at random order. A test joint layout pattern is shown on page A19. Terminal joint treatments (Figure 9, page 22 of the research report) shall be followed since the function of the entire joint may depend on how well the transverse ends are protected. The PCCP shall have control and expansion joints as in a regular roadway. Seal and Sealant manufacturer's representative shall be present during the preparation of the slab edges and during the installation of the joint.

Joints shall be installed in a test section at the same temperature. The installation procedures shall be followed carefully at each location (page 15 of the report). Samples of all materials used in each system shall be taken and appropriate laboratory tests shall be performed. Traffic shall not be allowed till the joints are completely installed in a test section and all the materials are well set and cured.

The Joints shall be monitored at maximum 6 month intervals. The field evaluation form attached herewith (page A20) and the inspection requirements stated below shall be followed.




TEST JOINTS LAYOUT PATTERN

## APPROACH/ANCHOR SLAB JOINT EVALUATION FORM

STRUCTURE NUMBER ____________
STRUCTURE NAME ____________ ROUTE ________ MILEPOST ________
APPROACH/DEPART ____________ DIRECTION ________
OBSERVER ____________ DATE ________
WEATHER ____________ TEMP ________ TIME ________
TRAFFIC CONTROL ________

GENERAL PAVEMENT CONDITION ____________

SEALANT TYPE ____________
FLEXIBILITY (GOOD, MEDIUM, BAD) ____________
MISSING SEALANT ____________
ADHESIVE FAILURE
PARTIAL DEPTH ____________
FULL DEPTH ____________
COHESIVE FAILURE
PARTIAL DEPTH ____________
FULL DEPTH ____________
INTRUSION OF INCOMPRESSIBLES ____________
JOINT WIDTH ____________
SEALANT RECESS ____________
SPALLING ____________

COMMENTS, SKETCH

- General Pavement Condition: The condition of the approach slab and PCCP, cracks and settlements.

- Sealant Type : Type of material used to seal the joint.

- Flexibility of the sealant or seal: The ability of the material to retain its original shape after a finger pressed into the seal is removed. This quality is rated as excellent, good, medium or poor. Localized cracking of the hardened surface of the joint seal material determines whether the seal rates good or medium. Hard seals that rate poor may be reinspected when possible, at higher temperatures because of the significant variation, due to temperature, on the force required to deform the material.

- Missing sealant: The gap in the joint is measured and recorded nearest to the tenth of the meter.

- Adhesive Failure: This failure indicates the debonding of the sealant or seal from the edges of the slab. Two types of failure shall be recorded; one is the full depth debonding where no adherence exists between the material and the slabs; the other is the partial depth failure indicating the debonding does not penetrate the full depth of the seal. The extent and depth of debonding may be observed by sliding a one inch stiff blade spatula between the slab edges and the seal. The length of debonding shall be recorded to the nearest tenth of a meter. The average depth of debonding may be recorded to the nearest cm.

- Cohesive Failure: This is the cracking and checking of the sealant within the material. This is due to oxidation of the material due to UV rays and results in small cubes of the sealant breaking off and exposing new material. In this case also, two types of failures may be observed, full depth and partial depth. Lengths of these failures may be recorded to the nearest tenth of a meter. Cohesive failure is evident by visual inspection. The average depth of failure in partial depth oxidation may be measured to the nearest cm.

- Intrusion of Incompressibles: The typical incompressibles are sand and gravel in areas of adhesive failure. Periodically, the joint shall be maintained reasonably clean.

- Joint Width: The width of the joint may be measured in several locations along the roadway width and an average value may be recorded to the nearest 5 mm. Joint widths may be measured both in winter and summer months and recorded.

- Sealant Recess: Sealant recess may be measured within each joint and from joint to joint and recorded to the nearest 5 mm.

- Spalling: This condition along the edges of the approach slabs and PCCP may be recorded as minor or severe; minor when some spalling has occurred but had not compromised the integrity of the joint. The condition is severe in case of spalling that allows infiltration of water and or debris. The length of spalling may be measured and recorded to the nearest tenth of a meter.

## 8. Field Installation and Removal

The need for removal arises only if the joint becomes dysfunctional and involve heavy repair costs. The installation guide lines are furnished on page 15 of the research report. They are repeated here for the benefit of the work plan administrator.

- Concrete shall cure for a minimum period of seven days prior to sealant or seal installation.
- Joint reservoirs shall be formed and constructed so they are uniform and consistent in width.
- The sealant or seal bonding faces of the joint (new and existing joints to be repaired) shall be refaced by diamond sawing, immediately flushed with high pressure water and then sand blasted (on same day of sealing) prior to seal installation. The field inspectors should verify joint cleanliness before installation.
- Sand blasting shall be performed in two passes, one for each joint face, with the nozzle directed at each face in the same direction for both passes.
- Just prior to joint installation, the joint shall be blown out in one direction only.
- The nozzle used to install sealant should be such that the sealant is filled from bottom to top.
- The temperature of hot poured sealant shall be monitored at all stages of installation.
- Material manufacturer's installation specifications shall be followed. If required by the manufacturer, the installer shall be certified by the manufacturer of the material.
- Allow three days to elapse after joint installation, prior to traffic.
- Continue pavement under barriers. Do not provide joints between pavement and barriers. Joint terminations are shown on Joint solution details (Figure 9, page 22 of the report).

Depending on the joint system, the manufacturer of the product may have additional recommendations or requirements to consider.

## 11. Cost Benefit Analysis

a. Cost of Testing may be based on the following breakdown of items

| Project Item | Quantity | | Cost per | Cost |
|---|---|---|---|---|
| Site selection, Planning and Coordination | Lump Sum | | | Lump Sum |
| PCCP 20 m wide and 65 m long | 10 sections = | 13,000 $m^2$ | $m^2$ | |
| Approach Slab 20 m wide 5 m long | 10 sections = | 1,000 $m^2$ | $m^2$ | |

| Project Item | Quantity | Cost per | Cost |
|---|---|---|---|
| Subgrade preparation | 13,000 $m^2$ | $m^2$ | |
| Concrete Barrier | 1,300 m | m | |
| Joint System I | 2 x 20 m | m | |
| Joint System II | 2 x 20 m | m | |
| Joint System III | 2 x 20 m | m | |
| Joint System IV | 2 x 20 m | m | |
| Joint System V | 2 x 20 m | m | |
| Laboratory Testing | | | Lump Sum |
| Field Inspection and Evaluation for 5 years at 6 month intervals | 10 times | evaluation | |

b. Cost Benefit Analysis

The failure of existing joint system could lead to the failure of other features of the bridge approaches. Overall the cost of repairs and remediation including the cost of freeway closures could run very high. The cost of new joint system including the proportionate cost of testing, is anticipated to be comparatively low. More existing joint failures and more repairs would mean more cost savings with new tested joint system. This is the cost benefit to ADOT in undertaking this verification program.