Joint Sealant Considerations for Transverse Contraction Joints in Concrete Highway Pavements

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At the June 1995 American Concrete Pavement Association Board of Director's meeting, several board members questioned the need to use joint sealants in concrete pavement. As a result, the Board of Director's asked for an investigation regarding the necessity of joint sealing and how sealing affects pavement performance and cost.

While the concept of eliminating sealants is unappealing to some, the benefit of sealing joints is commonly questioned. The growing use of permeable subbase material and some DOT's dissatisfaction with the performance of their joint sealants fuels this question.

This report discusses the use of joint sealants and provides background information for considering joint sealing in concrete pavements. It contains the present practices of each state and some new performance information on hot-pour, silicone and preformed compression seals. The report also defines the primary considerations that would accompany elimination of joint sealants. Further investigation and deliberation beyond this report will be necessary to reach a final conclusion.

History & Background:

Sealant use dates back to the early 1900's. Today, 98% of the state agencies building and maintaining concrete roadways, and all agencies building and maintaining concrete airport pavements, require joint sealing for new pavements.

The most widely accepted definition of the purpose of joint sealant is to minimize infiltration of surface water and incompressible material into the joint system. Sealants also reduce the potential for dowel bar corrosion by reducing entrance of de-icing chemicals. Some individuals erroneously claim that joint sealant prevents surface water from entering the joint system. Vacuum tests clearly show that no sealant will provide a perfectly watertight seal.

There is no doubt that water can contribute to subgrade or subbase softening, and lead to pumping of subgrade or subbase fines. This degradation usually results in loss of structural support, pavement settlement and/or faulting. Unfortunately it is not practical to construct and continually maintain a completely watertight pavement. Therefore most engineers use joint seals to minimize passage of surface water through joints and provide a drainable subbase to remove water from the pavement.

Another important function of joint sealants is to prevent incompressible material from entering the joint reservoir. Incompressibles contribute to spalling and in extreme cases may induce "blow-ups." In either case, the incompressibles obstruct pavement expansion in hot weather and cause pressure along the joint faces.

Years ago, the term "joint fillers" described the materials placed in pavement joints. In fact, some specifications still refer to joint sealants as joint fillers. The expectation of filler materials was more to keep out incompressibles than to minimize water infiltration. We believe that sometime in the 1970's there was a switch in expectations on joint fillers. The new expectation that joint fillers would also prevent water infiltration was likely a result of the competitive claims of the increasing variety of available materials. Many engineers began using the word sealant to clearly define this switch in expectations.

Current Use of Sealants:

Today, the most common joint sealant remains the hot-pour liquid sealant. Hot-pour liquid sealants were the first type used for concrete pavement, and have evolved over many years of research and development. Manufacturers have improved their adhesive qualities and now provide low-modulus materials with better elasticity than previous materials. About 25% of roadway agencies use hot-pour sealants in transverse joints of highway pavements. However, most of the hot-pour sealants sold by manufacturers are used in low-volume concrete roads.

Silicone sealants are a field-poured liquid with a base ingredient of silicone polymer. Agencies began using these materials in the 1970's. Installation procedures are similar to those for hot-pour materials. Much care is necessary to clean and prepare the joint reservoir for silicone sealants. About 52% of roadway agencies now use silicone sealant in their highway pavement transverse joints.

Manufacturers introduced compression seals in the early 1960's. They differ from liquid sealants because they are manufactured ready for installation. Unlike liquid sealants, which experience both compression and tension, preformed compression seals are in compression throughout their life. Therefore their success depends solely on the lateral pressure exerted by the seal. Compression seals are often called "neoprene" seals after the seal's primary compound. Today, 21% of roadway agencies use compression seals in their highway pavement transverse joints.

Today the Wisconsin DOT is the only roadway agency that does not use any sealant to seal joints in their concrete pavements. Wisconsin started this practice in about 1990 after several in-state studies concluded that sealants had no positive impact on pavement performance. In the last 25 years, Idaho and California are the only other states to have ever had a policy not to seal joints. These two states only sealed joints in mountainous areas where they use sand for traction control. Idaho used this practice for about ten years. Omitting joint sealants or fillers from the design was a long-standing practice of CALTRANS. Today both agencies require a sealant for transverse contraction joints in all new concrete pavements.

In Europe joint sealing practices also vary widely. The British require a reservoir cut and sealant in all pavement joints. Austria allows some joints to be cut narrow and left unsealed. Spain, allows unsealed joints in the dry regions, but requires a sealant in the wet regions.

Relative Cost of Sealants:

To begin to define the cost/benefit of sealing joints we included a joint sealant section in a recent pavement design features survey. We sent the survey to thirty contractors and have received 12 replies. The survey asked the contractors to provide the cost of four different sealing systems to a reference section. The sealant in the reference section was a standard hot-pour placed in a reservoir made with a single saw cut.

JOINT SEALANT DESIGN	AVERAGE RELATIVE COST
Hot-pour sealant in a 3-inch deep single-width saw cut 20-ft. joint spacing	100%
Silicone sealant in appropriate reservoir 20-ft joint spacing	102.3%
Unsealed single-saw cut 20-ft joint spacing	97.8%
Preformed-compression seal in appropriate reservoir 20-ft joint spacing	104.8%

According to these preliminary figures, the additional cost can be about 7.0% when comparing unsealed joints to those sealed with compression seals. The additional cost for joints sealed with silicone compared to unsealed joints is about 4.5%, and about 2.2% for joints sealed with hot-pour sealants versus unsealed joints.

Drainage Philosophy:

The following table shows the drainage philosophy of the state agencies. Nearly two-third of all state agencies attempt to both seal the pavement and control water through a drainage system.

STATED PHILOSOPHY	NUMBER OF AGENCIES
Attempt to seal pavement as well as possible and are not to concerned about subsurface drainage	9
Take position that water will enter the pavement and attempt to control the water through use of:	
• Drainage Layer	4
• Other Subsurface Drainage	5
• Both	2
Attempt to seal pavement as well as possible and attempt to control the water through use of:	
• Drainage Layer	7
• Other Subsurface Drainage	3
• Both	20

From NCHRP Synthesis 211
(Note: Some states use more than one philosophy depending on the situation.)

Permeable subbases have grown more popular as a means to control water in a pavement system. According to our survey, permeable subbases are the predominate subbase used by 50% of roadway agencies for their highway pavements. Permeable subbases use a uniform grading that leaves many voids for water passage. Under a pavement, water flows quickly through a permeable subbase to an edge drain system. The drainage system carries water away from the subgrade to ditches or storm sewer pipes.

The following table shows the types of permeable subbases currently in use in the United States:

PREDOMINATE PERMEABLE SUBBASE	NUMBER OF STATES
Open-graded Granular	7
Asphalt-treated	13
Cement-treated	4

Impact of Sealants on Pavement Performance:

There have been many studies on the affect that sealants have on performance of concrete pavements. Most conclude that sealing prolongs pavement life. However, there have also been some studies that show a negligible impact of joint sealing. The following sections list the major conclusions of some of the latest or most interesting reports.

<u>*Performance of Concrete Pavements - Draft Final Report, FHWA, June 1995.*</u>
With the goal of improving concrete pavement design and construction practices, this project evaluated the performance of 308 in-service concrete pavement sections in North America. The report provides two models that show that joint sealants do affect pavement performance.

An examination of these models shows that joint spalling depends on pavement age, climatic conditions and joint sealant. The rate of spalling is gradual in the first few years and then increases more rapidly. Both models show that spalling will occur more rapidly in colder climates. A sensitivity plot of the model for plain concrete pavements is attached to this report. The report draws the following conclusions:

- *Transverse joint spalling increases with age.*
- *Significant transverse joint spalling does not begin until about 10 or 15 years after construction if the joints are sealed.*
- *Preformed joint sealant reduces transverse joint spalling more effectively than other types.*
- *Transverse joints without sealant exhibit the largest amount of spalling*
- *For spalling, silicone sealants perform worse than other liquid sealants, presumably because of the silicone pulling on the young concrete before it has gained sufficient strength.*
- *An increase in joint spacing increases the percentage of joints spalled.*
- *The amount of spalling is greater in very cold climates and in very hot climates, but lower in moderate climates.*
- *An appropriate protection of dowels from corrosion (e.g., epoxy coating) reduced joint spalling.*

<u>*Portland Cement Concrete Pavement Performance as Influenced by Sealed and Unsealed Contraction Joints - TRR 1083, 1986.*</u>
This paper summarizes much of the research work done by Wisconsin DOT. The paper discusses conclusions from research done in the 1950's, 1960's and 1970's. Each report concludes that sealing joints has negligible impact on performance compared to sealed joints. The 1960's data even shows that sealed joints performed worse than those left unsealed.

The pavement test section in 1974 was a jointed-reinforced concrete pavement, (20, 40, 60, 80 ft joint spacing), built on a dense-graded subbase course and a free-draining sandy soil. In discussing this project, the paper shows that the sealed joints performed only slightly better than the unsealed joints, but not enough to be cost effective. For sealing to be cost effective the researchers suggest that the pavement would have to ride better, require less maintenance, or have longer life.

Subsequent studies on plain undoweled pavements in Wisconsin produced similar results. With all of these projects providing a technical foundation, the DOT decided that sealed joints were not cost-effective in Wisconsin.

Evaluation of Preformed Neoprene Joint Seals, Iowa DOT, Oct. 1994.
As a result of less than desirable joint seal performance, the Iowa DOT undertook a study of all sealants. The study produced some interesting results for comparing the three basic sealants. The following are applicable to this discussion:

- *Excessive spalling along joints is seen in many paving projects in Iowa.*
- *Hot-pour joint sealants provide a relatively similar performance and life span as silicone sealants (3-5 years).*
- *Preformed neoprene compression seals installed up to five years ago are performing very well, showing no signs of deterioration.*

Primary Issues on the Need for Sealants:

The following paragraphs outline the primary issues on the need for sealants with permeable subbases:

Water — Water will always remain a potential contributor to pavement distress. In the past, almost all concrete pavement designs included relatively impermeable materials surrounding the pavement layers. These "bathtub" pavement sections were particularly prone to moisture-related problems. The need to minimize surface water infiltration in these pavements was an important factor that focused attention on joint sealing. Perhaps this focus led to even higher expectations on sealant materials than should have been reasonably expected. Never-the-less, the need to minimize water infiltration should remain a primary focus for many concrete pavements. Designs that include relatively impermeable layers will continue to exist, particularly for low-volume roads and streets.

Incompressibles — Incompressibles will also remain a potential contributor to pavement distress. Incompressibles that get into open joint reservoirs can cause spalling upon joint closure. While spalling is less likely on slabs less than 20 ft, the recent studies show conclusively that joint filling reduces joint spalling even on short-panel pavements. The influence of incompressibles on narrow joint reservoirs (3 mm) remains unclear. It is reasonable that the narrow reservoir will keep some larger incompressibles out of the joint, but the joint may still pack full of smaller materials. We cannot identify any source that describes whether incompressible particle size influences the occurrence of spalling.

Concrete Expansion — The presence of incompressibles in a joint would be insignificant if concrete did not expand and contract with variations in temperature. We normally look at how a concrete's constituent materials will affect its strength and plastic properties. Equally important are how these materials influence the concrete's thermal behavior. It is well known that the type of coarse aggregate will influence the concrete thermal coefficient. Concrete made from gravel or quartz aggregates will expand or contract to a greater degree than a concrete made with limestone. Presumably, concrete made with limestone will be more tolerant of the presence of incompressibles in the joint system. This factor has not been evaluated in any research on performance of sealants, or sealed versus unsealed joints.

Sealant Performance — Until recently sealant performance was the only issue fueling this debate. It remains an important factor, and from our informal survey, at least 7 state agencies are currently dissatisfied with their sealant performance. These agencies either have changed their sealant material, reservoir design or are contemplating a change. While some agencies are switching to better quality sealants, some are reverting to the joint filler approach. Several agencies also have in-state research projects that will compare sealed joints to unsealed joints.

Sealant Installation — Improvements in technology over the past 20 years has produced effective sealing materials and procedures. Correct sealant application and installation can produce a system that will minimize water damage and increase pavement longevity. Attaining correct sealant application and installation appears to be a significant problem facing the DOT's.

Permeable Subbase Use — Within the last ten years permeable subbase use has grown from about 2 states to 24 states. Today, designers attempt to maximize pavement performance by providing a means to remove water from within a concrete pavement. Using a permeable subbase is currently the best approach to remove water.

Permeable Subbase Longevity — It is logical that a permeable subbase may negate the need to seal joints for surface water control. Certainly, if the subbase efficiently removes water, there is no need to prevent water from entering the pavement. However, not much information on the benefit or longevity of permeable subbases is currently available. Some of the only long-term performance information on unsealed joints on a permeable subbase is from France. After 10 years the French found that the permeable subbase materials clogged with dust and debris. They attributed this partially to the unsealed joints.

Several state agencies have reported stripping problems with their asphalt-treated permeable subbases. A stripping problem has prompted CALTRANS to switch their design policy from asphalt-treated permeable subbases to lean concrete subbases.

Outlet System Maintenance — The outlet systems for a permeable subbase require frequent maintenance for satisfactory performance. Without cleaning, the drain pipes and outlets easily clog with debris and prevent the water from flowing out of the pavement. It is reasonable to question if the DOT's will maintain these systems.

Conclusion

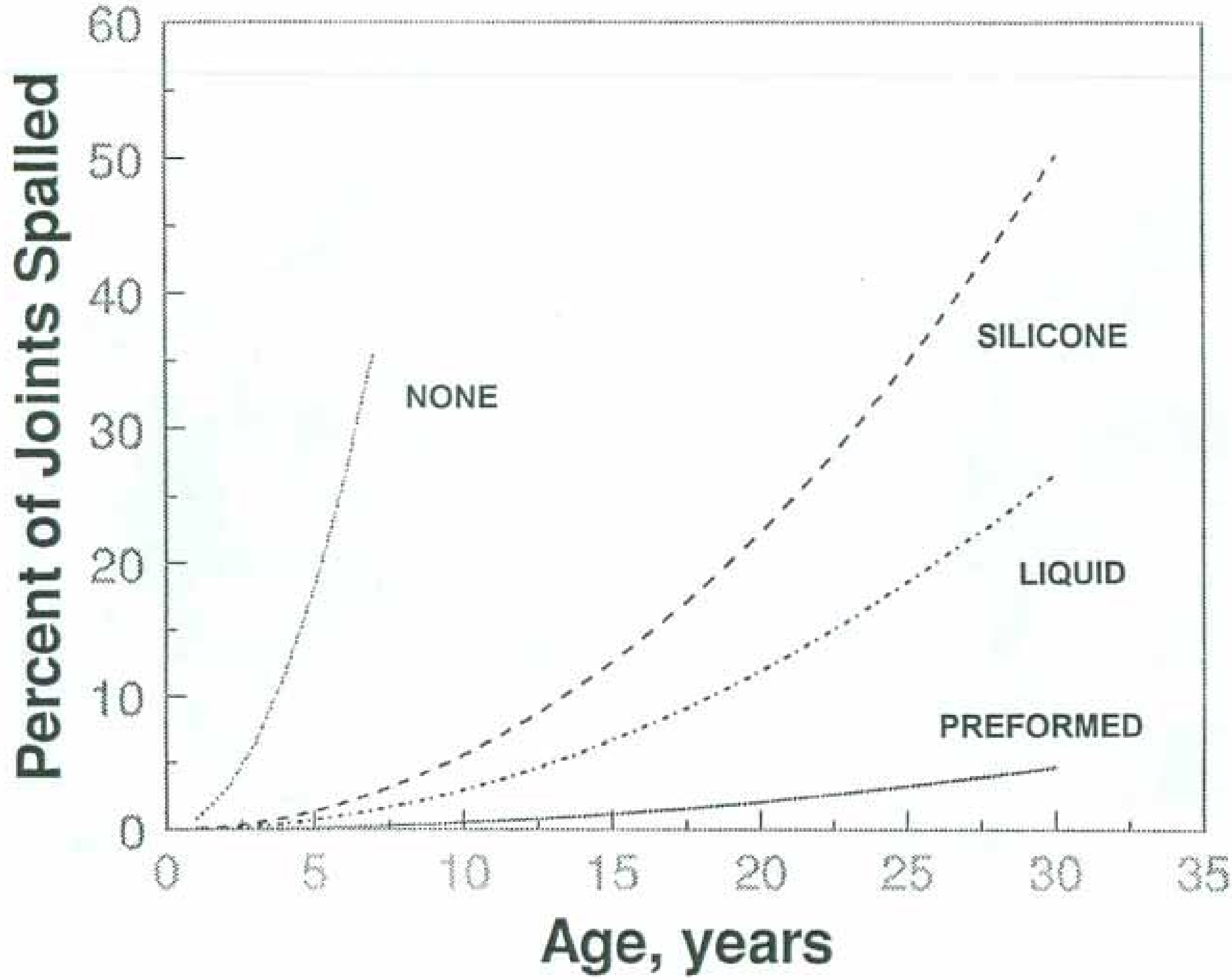
As an industry we should carefully contemplate any no-seal policy, even on permeable subbases. Although economically there appears to be significant savings by eliminating joint sealants, the best available performance data shows that the result will be more spalled joints.

There remain many questions on both sealants and permeable subbases. The drainage philosophy of most agencies suggests that they are not apt to eliminate sealing. To persuade them to do so would require us to provide believable background information. This information is not currently available.

In the last 10 years, the actual trend is away from unsealed joints. Except for Wisconsin, there is no state allowing unsealed joints. It is probably more significant that California reversed their long-standing no-seal policy and recently stopped using asphalt-treated permeable subbases. If we were to use Wisconsin's report as a foundation for a no-seal policy, we would be open to criticism from those citing California's decisions, and the information available in the new FHWA study.

Permeable subbase use has only recently grown. There is no available source of long-term performance information on these subbases. Realistically, the SHRP Long-Term Pavement Performance sections will probably be the best source of information. It will take several more years until LTPP provides any meaningful information.

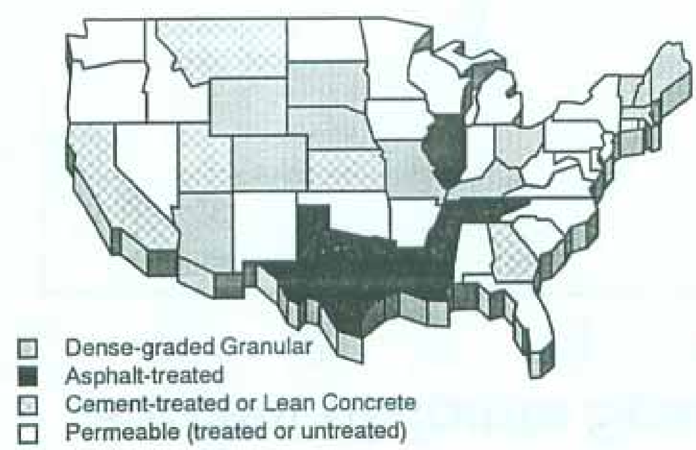
Manufacturers and agencies have made many improvements to sealants over the years. There is no reason to doubt that more improvements will be made in the future. Current information shows that preformed compression seals provide the most consistent long-term performance. Silicone sealants also can provide good performance when applied appropriately and with good technique. As some agencies return to the joint filler mind-set, hot-pour sealants are being used more frequently in highways.



From: Performance of Concrete Pavements - Draft Final Report, FHWA, June 1995.

Predominate Joint Sealants for Concrete Highway Pavements

Predominate Subbases for Concrete Highway Pavements



Joint Design & Sealant Usage on Transverse Contraction Joints in Concrete Pavement Highways

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Current information from survey of state/chapter executives and selected state DOT engineers.

State	Year	Allowable Base Types	Predominate Base Type	Plain Joint Spacing	Reinf. Joint Spacing	Jointing Method	Skew	Largest Dowel Diameter	Min. Reservoir Width	Min. Joint Depth	Allowable Hot-pour	Allowable Cold-Pour	Allowable Silicone	Allowable Preformed	Predom. Joint Sealant
Alabama	1972	DG, AT,CT		20	57.5	saw, insert	no	d / 8	0.3750	0.25 d	D-1190	-	-	-	
	1982	DG, AT,CT		20	-	saw	yes	d / 8	0.3750	0.33 d	D-1190	-	X	D-2628	
	1992	DG, AT,CT		20	-	saw	yes	d / 8	0.3750	0.33 d	D-1190	-	X	D-2628	
	1995		ATPB												Silicone
Arizona	1972	DG, CT		15	-	saw, insert	yes	none	0.2500	0.22 d	D-1190	-	-	D-2628	
	1982	DG, CT, LC		15 av.	-	saw	yes	none	0.1250	0.25 d	D-3406	D-1850	-	-	
	1992	DG, AT		15 av.	-	saw	yes	1.250	0.1250	0.25 d	-	-	X	-	
	1995		DG												Silicone
Arkansas	1972	DG, CT		-	45	saw, insert	no	1.000	0.1875	0.25 d	D-1190	-	-	-	
	1982	DG, AT, CT		15	45	saw	no	1.000	0.3750	0.33 d	-	-	X	D-2628	
	1992	OG, ATPB, CTPB		15	45	saw	no	1.250	0.3750	0.33 d	-	-	X	D-2628	
	1995		CTPB												Silicone
California	1972	DG, AT, CT		15.5 av.	-	saw, insert	yes	none	0.2500	0.21 d	Used only where roads are sanded			-	
	1982	DG, CT, LC, AT		15.5 av.	-	saw, insert	yes	none	0.2500	0.25 d	Used only where roads are sanded			-	
	1992	DG, CT, ATPB		15.5 av.	-	saw	yes	none	0.5000	0.33 d	-	-	X	-	
	1995		LC						0.2500		D-3405 mod.				Hot-Pour
Colorado	1972	DG, AT, CT		15.5 av.	-	saw	yes	none	0.1250	0.25 d	D-1190	-	-	-	
	1982	DG, CT, LC, AT		15.5 av.	-	saw, insert	yes	none	0.2500	0.25 d +0.25"	D-1190	D-1850	-	D-2628	
	1992	DG, AT		15.5 av.	-	saw	no	1.250	0.1250	0.25 d	-	-	X	-	
	1995		DG												Silicone
Conn.	*1972*	*DG*		-	*40*	*form, insert*	*no*	*1.125*	*0.3750*	*0.33 d*	*D-1190*	-	-	-	
	1982	*DG, CT*		-	*40*	*saw*	*no*	*1.5 /*	*0.3750*	*0.33 d*	*D-1190*	*X*	-	*X*	
	1992	*DG, CT*		-	*40*	*form, insert*	*no*	*1.125*	*0.3750*	*0.33 d*	*D-1190*	-	*X*	-	
	1995		*CT*												*Silicone*
Delaware	1972	DG, CT		-	45	saw	no	1.250	0.1875	0.25 d +0.25"	D-1190	-	-	D-2628	
	1982	DG, CT		-	45	saw	no	1.250	0.1875	0.25 d +0.25"	D-1190	-	-	D-2628	
	1992	DG, CT		20	-	saw	no	1.250	0.5000	0.25 d +0.25"	D-1190	-	-	D-2628	
	1995		CT w/ ATPB												Preformed

State	Year	Allowable Base Types	Predominate Base Type	Plain Joint Spacing	Reinf. Joint Spacing	Jointing Method	Skew	Largest Dowel Diameter	Min. Reservoir Width	Min. Joint Depth	Allowable Hot-pour	Allowable Cold-Pour	Allowable Silicone	Allowable Pre-formed	Current Standard Sealant
Florida	1972	AT		20	-	insert	no	1.000	0.3750	0.28 d	D-1190	-	-	-	
	1982	DG, CT, LC		15	-	saw	no	1.000	0.2500	0.25 d	D-1190	-	-	D-2628	
	1992	AT, OG		15.5 av.	-	saw	no	1.250	0.3750	0.25 d	D-1190	-	-	-	
	1995		OG												Silicone
Georgia	1972	CT, AT		19.5 av.	-	saw	yes	D / 8	0.1875	0.25 d	SS-1401	-	-	-	
	1982	DG, CT, LC		20	-	saw	yes	D / 8	0.3750	0.28 d	SS-1401	-	X	-	
	1992	DG, CT, LC, AT		20	-	saw	yes	1.250	0.5000	0.20 d	-	-	X	-	
	1995		LC				no								Silicone
Idaho	1972	CT		15 av.	-	saw, insert	yes	none	0.2500	0.25 d	-	-	-	D-2628	
	1982	DG, AT, CT		15 av.	-	saw, insert	yes	none	0.2500	0.25 d	Used only where roads are sanded			-	
	1992	DG, AT, CT		15 av.	-	saw, insert	yes	none	0.2500	0.25 d	-	-	X	-	
	1995		ATPB												Silicone
Illinois	1972	LT, CT, AT		-	100	saw	no	1.000	0.1250	0.28 d	D-1190	D-1850	-	-	
	1982	LT, CT, LC, AT		-	50	saw	no	1.250	0.6250	0.28 d	D-3405	-	-	-	
	1992	CT, AT, ATPB		15 hinge	45	saw	no	1.500	0.625/0.25	0.28 d	D-3405	-	-	D-2628	
	1995		AT												Preformed
Indiana	1972	DG, AT		-	40	saw	no	1.250	0.1250	0.25 d	D-1190	D-1850	-	-	
	1982	DG, AT		-	40	saw, form	no	1.250	0.2500	0.25 d	D-1190	-	-	D-2628	
	1992	DG, OG		20	-	saw	no	1.250	0.2500	0.25 d	-	-	X	D-2628	
	1995		OG												Silicone
Iowa	1972	DG, AT, CT		20	-	saw	no	1.250	0.1250	0.25 d	D-1190	-	-	-	
	1982	DG		20	-	saw	yes	1.250	0.1250	0.25 d	D-3405	-	X	-	
	1992	OG		20	-	saw	no	1.500	0.3750	0.33 d	D-3405	-	X	-	
	1995		OG						0.2500		D-3405 mod.				Hot-Pour
Kansas	1972	DG		-	61.5	saw, insert	no	1.250	0.3750	0.25 d	X	-	-	-	
	1982	DG, AT, CT		-	30	saw, insert	yes	1.250	0.3750	0.25 d	X	-	-	X	
	1992	DG, CT, ATPB, CTPB		15	-	saw	no	1.250	0.3750	0.25 d	X	-	X	-	
	1995		CT												Preformed
Kentucky	1972	DG		-	50	saw	no	d / 8	0.1250	0.20 d	D-1190	-	-	-	
	1982	DG, CT		-	25	saw	no	d / 8	0.3750	0.20 d	D-1190	-	-	D-2628	
	1992	DG, LT, CT		15 av.	-	saw	no	d / 8	0.2500	0.20 d	D-3405	-	X	D-2628	
	1995		DG						-						Silicone
Louisiana	1972	DG, AT, CT		20	58.5	form, insert	no	1.000	0.4375	-	-	-	-	D-2628	
	1982	DG, AT, CT		20	-	form, insert	no	1.125	0.4375	-	X	X	X	D-2628	
	1992	AT, CT		20	-	saw, form	no	1.250	0.4375	-	-	-	-	D-2628	
	1995		DG w/ AT												Silicone

State	Year	Allowable Base Types	Predominate Base Type	Plain Joint Spacing	Reinf. Joint Spacing	Jointing Method	Skew	Largest Dowel Diameter	Min. Reservoir Width	Min. Joint Depth	Allowable Hot-pour	Allowable Cold-Pour	Allowable Silicone	Allowable Pre-formed	Current Standard Sealant
Maine	*1972*	*DG*		-	-	-	-	-	-	-	-	-	-	-	
	1982	*DG*		*20*	-	*saw*	*no*	*d / 8*	*0.5000*	*0.25 d*	*SS-S-1401*	-	-	-	
	1992	*DG*		*20*	-	*saw*	*no*	*d / 8*	*0.5000*	*0.25 d*	*SS-S-1401*	-	-	-	
	1995		*DG*												***Hot-Pour***
Maryland	1972	DG		-	40	saw, form	no	1.250	0.2500	0.25 d	D-1190	D-1850	-	D-2628	
	1982	DG		-	40	saw	no	1.250	0.2500	0.25 d	D-1190	D-1850	-	D-2628	
	1992	DG, AT, CT, ATPB		*Continuously Reinforced only*				-	-	-	-	-	-	-	
	1995		ATPB												-
Mass.	*1972*	*DG*		-	*40*	*saw, form*	*no*	*1.125*	*0.3750*	*0.25 d*	*D-3406*	-	-	-	
	1982	*DG*		-	*40*	*saw, form*	*no*	*1.125*	*0.3750*	*0.25 d*	*D-3406*	-	-	-	
	1992	*DG*		-	*40*	*saw, form*	*no*	*1.125*	*0.3750*	*0.25 d*	*D-3406*	-	-	-	
	1995		*DG*												***Hot-Pour***
Michigan	1972	DG		-	71.17	saw	no	1.000	0.5000	0.25 d	-	-	-	D-2628	
	1982	DG, OG		-	41	saw	no	1.250	0.5000	0.25 d	D-1190	D-1850	-	D-2628	
	1992	OG, AT, CT, ATPB		-	41	saw	no	1.318	0.5000	0.25 d	-	-	-	D-2628	
	1995		ATPB												**Preformed**
Minn.	1972	DG		20	27	saw, form	plain	1.000	0.3750	0.25 d	D-1190	-	-	D-2628	
	1982	DG		15.5 av.	27	saw, form	plain	1.250	0.3750	0.25 d	D-1190	-	-	D-2628	
	1992	DG, OG		15.5 av.	27	saw	plain	1.750	0.3750	0.25 d	D-1190	-	X	-	
	1995		OG												**Silicone**
Miss.	1972	CT, AT		-	63.75	expansion	no	-	-	-	D-1190	-	-	-	
	1982	CT, AT		-	-	-	-	-	-	-	D-1190	-	-	D-1751	
	1992	CT, AT		16	-	saw	yes	1.250	0.3750	0.33 d	D-1190	-	X	-	
	1995		AT												**Silicone**
Missouri	1972	DG		30	61.5	saw	no	1.000	0.3750	0.25 d	D-1190	-	-	-	
	1982	DG		30	61.5	saw	no	1.250	0.3750	0.25 d	D-1190	-	-	-	
	1992	DG, OG		30	61.5	saw	no	1.500	0.3750	0.25 d	D-1190 mod.	-	-	-	
	1995		DG												**Hot-Pour**
Montana	1972	CT, AT		15.5 av.	-	saw	yes	1.000	0.1250	0.25 d	D-3406	-	-	-	
	1982	CT, AT		15.5 av.	-	saw	yes	1.000	0.1250	0.25 d	D-3406	-	-	-	
	1992	DG, AT, CT		15.5 av.	-	saw	yes	1.500	0.1250	0.50 d	D-3405	-	-	-	
	1995		DG w/ CT												**Hot-Pour**
Nebraska	1972	DG, CT		15	46.5	saw	yes	1.000	0.1250	0.25 d	D-1190	-	-	-	
	1982	DG, CT		15.5 av.	46.5	saw	yes	1.000	0.1250	0.25 d	D-1190	-	-	D-2628	
	1992	DG, CT		16.5	-	saw	yes	1.250	0.1250	0.25 d	D-3405	-	-	-	
	1995		DG												**Silicone**

State	Year	Allowable Base Types	Predominate Base Type	Plain Joint Spacing	Reinf. Joint Spacing	Jointing Method	Skew	Largest Dowel Diameter	Min. Reservoir Width	Min. Joint Depth	Allowable Hot-pour	Allowable Cold-Pour	Allowable Silicone	Allowable Pre-formed	Current Standard Sealant
Nevada	1972	CT		15.5 av.	-	saw	skew	none	0.1250	0.22 d	X	-	-	X	
	1982	CT		15.5 av.	-	saw	skew	none	0.1250	0.25 d	X	-	-	-	
	1992	CTPB, ATPB		15.5 av.	-	saw	skew	1.500	0.1250	0.25 d	-	-	X	-	
	1995		ATPB												Silicone
New Jsy.	1972	OG		-	78.17	expansion	no	special	-	-	X	-	-	-	
	1982	OG		-	78.17	expansion	no	special	-	-	X	-	-	-	
	1992	OG		-	78.17	expansion	no	special	-	-	X	-	-	-	
	1995		OG												Hot-Pour
New Mex.	1972	CT		20	-	saw	skew	d / 8	0.2500	0.22 d	D-1190	D-1850	-	-	
	1982	CT, AT		15.5 av.	-	saw	skew	1.000	0.2500	0.25 d	D-1190	D-1850	X	-	
	1992	ATPB		13.5 av.	-	saw	skew	1.250	0.2500	0.25 d	D-1190	-	X	-	
	1995		ATPB												Silicone
New York	1972	DG		-	60.8	saw, form	no	special	0.6250	0.22 d	-	-	-	D-2628	
	1982	DG		-	60.8	saw, form	no	I-beam	0.3750	0.22 d	X	-	-	D-2628	
	1992	DG, OG		20	-	saw	no	1.125	0.3750	0.33 d	-	-	X	D-2628	
	1995		OG												Preformed
N. Carol.	1972	DG		30	-	saw	no	d / 8	0.3175	0.25 d +0.25"	D-1190	-	-	D-2628	
	1982	DG, CT, LC, AT		21.5 av.	-	saw	no	1.250	0.3175	0.25 d +0.25"	-	-	X	D-2628	
	1992	ATPB		21.5 av.	-	saw	no	1.250	0.3175	0.25 d +0.25"	-	-	X	-	
	1995		ATPB												Silicone
N. Dakota	1972	AT		20	-	saw, form	plain	1.250	0.3750	0.34 d	D-1190 mod.	-	-	D-2628	
	1982	DG, LC		16 av.	-	saw, form	plain	1.250	0.2500	0.25 d	D-1190 mod.	-	-	D-2628	
	1992	DG, ATPB, CTPB		13.5 av.	-	saw, form	plain	1.250	0.3175	0.25 d	D-1190 mod.	-	X	D-2628	
	1995		DG w/ CTPB												Silicone or Preformed
Ohio	1972	CG, AT, CT		17	40	saw	plain	d / 8	0.2500	0.20 d	D-1190	X	-	D-2628	
	1982	CG, AT, CT		17	21	saw	plain	1.250	0.2500	0.20 d	D-1190	X	-	D-2628	
	1992	CG, AT, CT		17	-	saw	no	1.500	0.6250	0.25 d	D-3405	-	X	D-2628	
	1995		CG												Preformed
Okla.	1972	AT		15	-	saw, form	no	1.000	0.3750	0.25 d	D-1190	-	-	-	
	1982	AT		15	-	saw	no	1.250	0.3750	0.25 d	-	X	X	D-2628	
	1992	ATPB, CTPB		15	-	saw	no	1.250	0.3750	0.25 d	-	X	X	D-2628	
	1995		ATPB												Silicone
Oregon	1972	DG, AT, CT		-	61.5	saw, insert	no	1.000	1.1250	0.25 d	D-1190	-	-	D-1751	
	1982	AT, CT, LC		*Continuously Reinforced only*				-	-	-	-	-	-	-	
	1992	DG, ATPB, CT		*Continuously Reinforced only*				-	-	-	-	-	-	-	
	1995		DG w/ ATPB												-

State	Year	Allowable Base Types	Predominate Base Type	Plain Joint Spacing	Reinf. Joint Spacing	Jointing Method	Skew	Largest Dowel Diameter	Min. Reservoir Width	Min. Joint Depth	Allowable Hot-pour	Allowable Cold-Pour	Allowable Silicone	Allowable Pre-formed	Current Standard Sealant
Penn.	1972	DG		-	46.5	saw, insert	no	1.250	0.3750	0.25 d	D-3406	-	-	-	
	1982	DG, AT, CT, LC		20	40	saw, insert	no	1.500	0.5000	0.25 d	D-3405	-	-	D-2628	
	1992	DG, AT, CT, LC, Rub		15	-	saw, insert	no	1.500	0.5000	0.25 d	D-3405	-	X	D-2628	
	1995		DG w/ OG												Preformed
Rhode Is.	*1972*	*DG*		-	*40*	*saw, form*	*no*	*1.000*	*0.2500*	*0.25 d*	*D-1190*	-	-	-	
	1982	*DG*		-	*40*	*saw, form*	*no*	*1.000*	*0.2500*	*0.25 d*	*D-1190*	-	-	-	
	1992	*DG*		-	*40*	*saw, form*	*no*	*1.000*	*0.2500*	*0.25 d*	*D-1190*	-	-	-	
	1995		*DG*												*Hot-Pour*
S. Carol.	1972	DG, AT, CT		21.5 av.	-	saw, insert	yes	1.250	0.2500	0.22 d	D-1190	-	-	-	
	1982	CT, LC		21.5 av.	-	saw	no	1.250	0.3750	0.25 d	D-1190	-	X	-	
	1992	ATPB, CTPB		20	-	saw	no	1.250	0.3750	0.33 d	D-1190	-	X	-	
	1995		ATPB												Silicone
S. Dakota	1972	DG, AT, CT		20	-	saw, insert	plain	none	0.2500	0.25 d	D-1190	-	-	D-2628	
	1982	LT		15	-	saw	yes	none	0.3750	0.25 d	D-1190	-	X	-	
	1992	LT, DG		20	-	saw	yes	1.250	0.3750	0.25 d	D-3405	-	X	-	
	1995		DG												Silicone
Tenn.	1972	DG, AT, CT		25	-	saw, insert	yes	1.250	0.2500	0.22 d	D-1190	X	-	D-2628	
	1982	DG, CT, LC		15.5 av.	-	saw, insert	yes	1.250	0.3750	0.25 d	D-1190	-	-	D-2628	
	1992	DG, AT, CT, LC		15.5 av.	-	saw	yes	1.500	0.3750	0.25 d	D-1190	-	X	D-2628	
	1995		AT												Silicone
Texas	1972	AT, CT		15	60	saw, insert	yes	1.250	0.5000	0.25 d	X	X	-	D-2628	
	1982	AT, CT		15	-	saw, insert	yes	1.250	0.5000	0.25 d	X	-	X	-	
	1992	AT, CT		15	-	saw	yes	1.875	0.5000	0.25 d	X	-	X	D-2628	
	1995		AT												All - by district
Utah	1972	DG, CT		15 av.	-	saw	yes	none	0.1250	0.25 d	D-3406	-	-	-	
	1982	DG, LC		15 av.	-	saw	yes	none	0.1250	0.33 d	D-3406	-	-	-	
	1992	DG, LC		15 av.	-	saw	yes	1.500	0.1250	0.33 d	D-3406	-	-	-	
	1995		LC												Silicone
Vermont	*1972*	*DG*		-	-	*saw, insert*	*no*	-	*0.2500*	*0.20 d*	*D-1190*	*X*	-	-	
	1982	*DG*		-	-	*saw, insert*	*no*	-	*0.2500*	*0.20 d*	*D-1190*	*X*	-	-	
	1992	*DG*		-	-	*saw, insert*	*no*	-	*0.2500*	*0.20 d*	*D-1190*	*X*	-	-	
	1995		*DG*												*Hot-Pour*
Virginia	1972	CT		20	40	saw, insert	no	1.250	0.3750	0.25 d	D-1190	D-1850	-	D-1056	
	1982	DG, CT, LC		20	40	saw, insert	no	1.250	0.6250	0.25 d +0.25"	D-1190	-	-	D-142	
	1992	ATPB, CTPB		15	-	saw, insert	no	1.250	0.2500	0.25 d	-	-	X	-	
	1995		CTPB												Silicone

State	Year	Allowable Base Types	Predominate Base Type	Plain Joint Spacing	Reinf. Joint Spacing	Jointing Method	Skew	Largest Dowel Diameter	Min. Reservoir Width	Min. Joint Depth	Allowable Hot-pour	Allowable Cold-Pour	Allowable Silicone	Allowable Pre-formed	Current Standard Sealant
Wash.	1972	DG, AT		20	-	saw, insert	yes	none	0.1250	0.17 d	D-1190	D-1850	-	-	
	1982	DG, AT		11.5 av.	-	saw	yes	none	0.1250	0.17 d	D-1190	D-1850	-	-	
	1992	DG, ATPB		11.5 av.	-	saw	yes	none	0.1250	0.25 d	D-1190	-	-	M-220	
	1995		ATPB												Hot-Pour
W. Va.	1972	DG, AT, CT		-	61.5	saw, form	no	0.625	0.2500	0.25 d	D-1190	-	-	D-2628	
	1982	DG, AT, CT		-	40	saw	no	0.625	0.2500	0.25 d	D-1190	-	X	D-2628	
	1992	DG, ATPB, CTPB		15	-	saw	no	0.375	0.2500	0.25 d +0.25"	D-3405	-	X	D-1056	
	1995		ATPB												Silicone
Wisc.	1972	DG, AT		-	80	saw	no	1.000	0.2500	0.20 d	D-1190	-	-	-	
	1982	DG		15.5 av.	40	saw	plain	1.250	0.2500	0.25 d	-	-	X	D-2628	
	1992	DG, ATPB, CTPB		15.5 av.	-	saw	plain	1.500	0.2500	0.25 d	No sealant used in any pavement			-	
	1995		CTPB												None
Wyoming	1972	DG, CT		15.5 av.	-	saw, insert	yes	none	0.1250	0.22 d	D-1190	-	-	D-2628	
	1982	DG, CT		13.75 av.	-	saw	yes	none	0.3750	0.25 d	D-1190	-	X	-	
	1992	DG, CT, CS		13.75 av.	-	saw	yes	1.250	0.3750	0.25 d	D-1190	-	X	D-2628	
	1995		DG												Preformed

Key:

DG = Dense graded aggregate or crushed stone
CG = Clean gravel
LT = Lime treated
AT = Asphalt treated
CT = Cement -treated
LC = Lean Concrete or econocrete
OG = Open graded granular
ATPB = Asphalt-treated permeable base
CTPB = Cement-treated permeable base

X = Either no data on specification, or no ASTM or AASHTO specification exists.
D-1190 = ASTM D-1190 or AASHTO M-173 Hot-poured polymeric asphalt-based
SS-S-1401 = Fed. SS-S-1401 Hot-poured polymeric asphalt-based
D-3405 = ASTM D-3405 or AASHTO M-301 Hot-poured polymeric asphalt-based
D-3405 mod. = ASTM D-3405 mod. Hot-poured polymeric low modulus
D-3406 = ASTM D-3406 or FED SS-S-1614 Elastomeric PVC coal tar
D-2628 = ASTM D-2628 or AASHTO M-220 Preformed Polychloroprene elastomeric joint seal

Note: States shown in italics are not currently building concrete highways.