Concrete Pavement Maintenance
Treatment Performance …

SP…

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FOREWORD

During the conduct of the Strategic Highway Research Program on highway operations, flexible and rigid pavement preventive maintenance treatments were placed on pavements in the United States and Canada. The placement and performance monitoring of these Specific Pavement Studies (SPS-3 and SPS-4) has been conducted under the SHRP and Federal Highway Administration (FHWA) Long Term Pavement Performance (LTPP) Program.

Field performance reviews of the preventive maintenance treatments have also been conducted by Expert Task Groups (ETG) organized by the Pavement Division, Office of Engineering, of FHWA. ETG performance surveys conducted after 5 years of service are summarized in this report and are intended to provide early performance information and guidance to public agencies utilizing preventive maintenance techniques.

This report is prepared as part of an FHWA-sponsored study entitled "Pavement Maintenance Effectiveness on SHRP Experimental Pavement Sections," and conducted for the LTPP and Pavement Divisions of FHWA.

Charles J. Nemmers, P.E.
Director
Office of Engineering Research and Development

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16. Abstract The Strategic Highway Research Program developed and coordinated construction of test sections for rigid pavement maintenance throughout the United States and Canada. Test sites included specific test sections for evaluation of the performance of under sealing and joint sealing as maintenance treatments. Each site also included an unsealed control section.

This report discusses the project background and analysis of monitoring data collected over a 5-year period by the Long Term Pavement Performance project at SPS-4 sites throughout the United States and Canada. The analysis considers three important characteristics of the maintenance treatments: treatment performance, timing of application, and cost-effectiveness. In addition to data analysis results, the report conclusions include information from "Pavement Treatment Effectiveness, 1995 SPS-3 and SPS-4 Site Evaluations, National Report," May 1997.

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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
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yards	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	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 (or "metric ton")	Mg (or "t")
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5(F-32)/9 or (F-32)/1.8	Celcius temperature	°C
		ILLUMINATION		
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m^2	cd/m^2
		FORCE and PRESSURE or STRESS		
lbf	poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa

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	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
		VOLUME		
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.71	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
		TEMPERATURE (exact)		
°C	Celcius temperature	1.8C + 32	Fahrenheit temperature	°F
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc
cd/m^2	candela/m^2	0.2919	foot-Lamberts	fl
		FORCE and PRESSURE or STRESS		
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in^2

* SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380.

(Revised September 1993)

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INTRODUCTION

Pavement maintenance operations can be conveniently grouped into two categories, corrective and preventive. Corrective pavement maintenance operations, including patching, are performed to restore distressed areas to an acceptable condition. Preventive maintenance operations are applied to pavement surfaces to prevent the development of damage or to reduce the rate of damage developed.(1) Preventive maintenance operations are intended to preserve rather than improve the structural capacity of the pavement.(2) Preventive maintenance operations for rigid pavements are the subject of this report.

Several preventive maintenance operations are available for treatment of portland cement concrete surfaced pavements. Typical concrete pavement preventive maintenance treatments include joint sealing, crack sealing, undersealing, and hot-mix overlays. The selection of the appropriate preventive maintenance treatment is generally made based on the experience of the maintenance supervisor or engineer with responsibility for a region of the roadways within a public agency. The decision is often made without documentation, which clearly defines the appropriate treatment, when the treatment should be applied during the life of the roadway, and the life expectancy of the treatment.

Since billions of dollars(3) are expended for pavement reconstruction, rehabilitation, and maintenance, and since the optimization of the selection of the treatment type could result in substantial savings, a portion of the Strategic Highway Research Program (SHRP) was devoted to the study of preventive pavement maintenance activities for both asphalt and portland cement concrete surfaced roadways. This preventive maintenance program was performed as part of the project H-101, "Pavement Maintenance Effectiveness," and the Long-Term Pavement Performance (LTPP) study. These studies were responsible for placing preventive pavement maintenance treatments on pavement sections throughout the United States and Canada beginning in 1990.

The performance of these sections (after 5 years of service) has been recently evaluated by Expert Task Groups (ETG) assembled by the Federal Highway Administration (FHWA). The results of these surveys are summarized in this report along with analysis of the LTPP monitoring data for the test sections. This report is intended to provide early performance information and guidance to the public agencies utilizing preventive maintenance techniques.

BACKGROUND

SHRP and LTPP

This report is based on SHRP and LTPP research efforts. Background information on SHRP and LTPP is provided to add context to this study.

SHRP Program History

SHRP was created to support highly focused technical advances in highway research which would improve the way highway systems are operated and maintained. Initiated in 1987, the program provided funding over a 5-year period in four specific areas of research: 1) Long-Term Pavement Performance, 2) Concrete and Structures, 3) Highway Operations, and 4) Asphalt Materials.[4]

LTPP Program History

Unlike the other program areas, the LTPP program was originally envisioned as continuing for 20 years, with the objective of collecting a full cycle of pavement performance data. Since the first 5 years of research, which were funded under SHRP, the LTPP program has continued under the oversight of the FHWA.

The LTPP program was developed to evaluate the long-term performance of pavements consisting of various material and layer compositions. Originally established as a 20-year project, LTPP has necessarily outlived the SHRP program funded under the Intermodal Surface Transportation Efficiency Act (ISTEA). Under the guidance of FHWA, the primary emphasis to date has been on data collection activities. Data analysis efforts have begun more recently.[5]

The Specific Pavement Studies (SPS) relating to maintenance activities (SPS-3 and 4) were developed under the Highway Operations field and continued under the LTPP program. These two experiments were designed to evaluate the effectiveness of standard preventive pavement maintenance activities for asphalt (SPS-3) and portland cement concrete (SPS-4) surfaced pavements. A prior field review was conducted nationally in 1993 and even earlier in the Western region.[6] This report specifically addresses the SPS-4 experimental findings.

Study Objectives

Preventive pavement maintenance treatments selected for study under SHRP Contract H-101 were placed under the LTPP program as the specific pavement study SPS-4 for portland cement concrete surfaced (PCCP) pavements. The purpose of the research experiments was as follows:

- To define the most effective timing for the application of various treatments.
- To evaluate the effectiveness of treatments in prolonging the life of the pavement.
- To share information and experience among highway agencies and industry.[7]

Preventive Pavement Maintenance Treatments

The PCCP preventive maintenance treatments studied included joint/crack sealing and undersealing. These treatments were selected to represent the most commonly used and cost-effective techniques.

Concepts of Preventive Maintenance

As the demands on limited highway agency budgets continue to increase, it becomes more important to make the best use of available funds. Although traditional maintenance practices have focused on corrective maintenance activities, this approach no longer serves the needs of today's pavement agencies in terms of the level of pavement condition expected by the traveling public or in terms of managing highway agency budgets. Preventive maintenance offers a way for agencies to work smarter.

Preventive maintenance is most simply described by the adage once used by the automotive industry for an engine oil filter advertising campaign: "pay me now or pay me later." This adage applies to the automotive industry, as well as to the highway industry. This notion of performing maintenance before serious problems occur, as applied to pavements, not only increases the expected performance period, but it also saves money in the long-term cost of a highway facility. By using preventive maintenance practices, a higher level of service is retained, and a smaller investment in maintenance is made earlier— before extensive change to the highway occurs (paying now). The highway does not have to reach a minimal service level before funds are invested in maintenance activities (paying later).

As agencies have developed and implemented pavement management systems, it has become evident that the monetary requirements for retaining the condition of the vast, but aging, highway network within the United States are huge and growing. As demands on tax funds are sought for other uses, the portion devoted to highways becomes difficult to maintain, even without considering an increase in highway needs. These two factors make the highway agencies' task of providing safe, effective highways at a reasonable cost more difficult than ever.

Figure 1 illustrates the preventive maintenance concept. Assuming a fixed initial investment in a section of pavement, both the long-term condition level and the total investment in preserving the pavement benefit from a preventive maintenance strategy, rather than a corrective approach. In the example, a better pavement condition is maintained by the early application of the preventive maintenance treatment, than by waiting to perform corrective maintenance or rehabilitation. At the same time, the cumulative investment in that section of pavement is lower over the total pavement life. Highway agencies, by using pavement management systems, provide the opportunity to capture actual local performance and cost data needed to quantify the benefits of preventive maintenance.

Agencies are cautious in deciding to adopt a preventive maintenance strategy since this strategy does not result in more available funding or immediately lessen needs for those funds. But, over time it will enable an agency to "do more with less." In the short term, however, limited maintenance funds will be applied to pavements in better condition, while repairs for some pavements in poorer condition are postponed. The public may perceive that scarce funding is not being wisely utilized. Unless a proactive approach is taken by highway agencies to educate the general public of the benefits of converting to a preventive maintenance strategy, significant criticism may be encountered. The automotive industry has achieved some degree

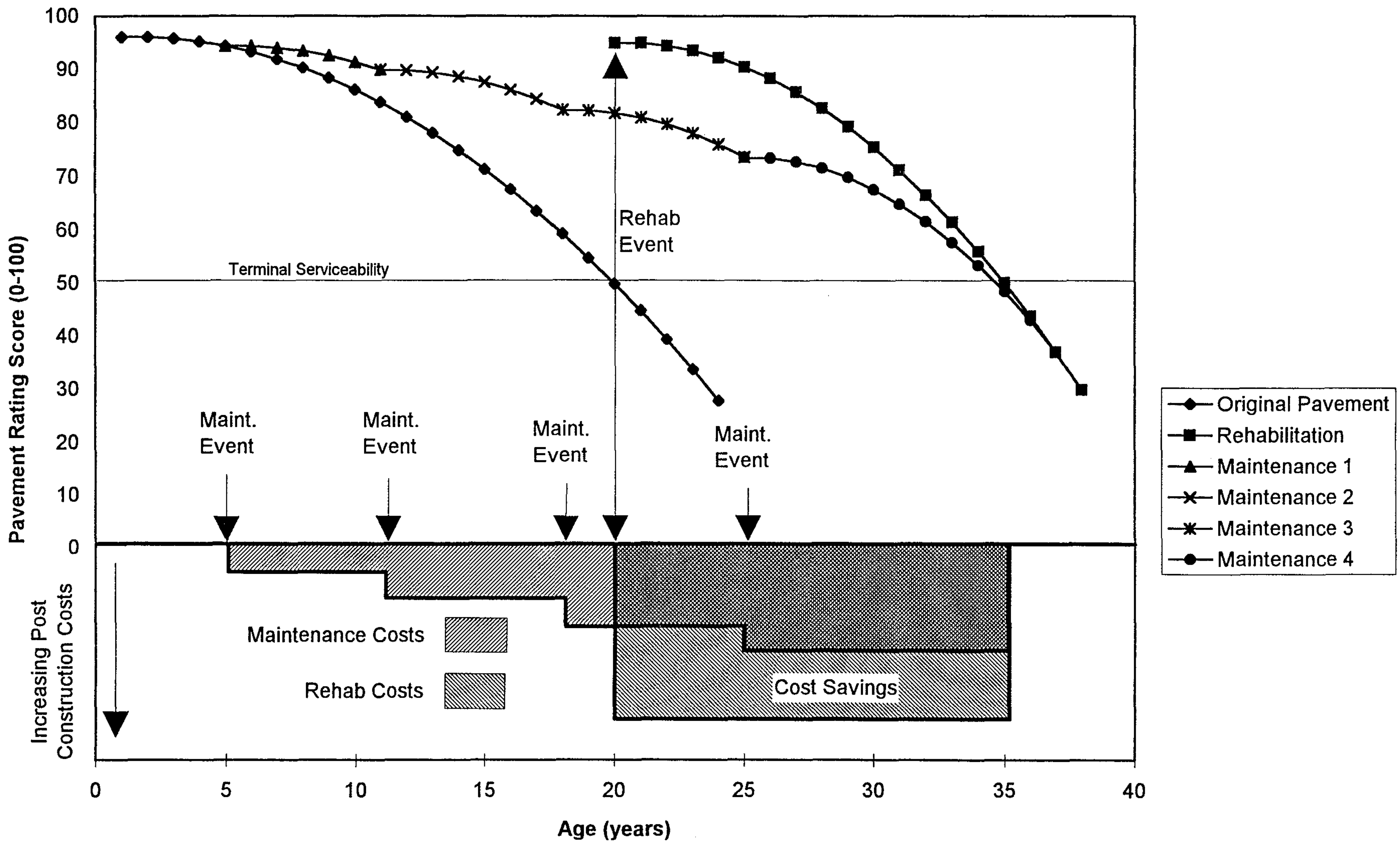

Figure 1. Performance curves and relative costs illustrating the preventive maintenance concept.

of success in selling the "pay me now or pay me later" idea; why not the highway industry? The agencies and the public want highway conditions to improve and to maintain demands on available highway funds. While the agencies and the public may need a transition period to complete the conversion to a preventive maintenance strategy, it is in our collective best interest to do so.

Purpose of Maintenance Treatments

Maintenance treatments are used for several reasons. Two primary reasons for using maintenance treatments are to seal cracks in the pavement and to arrest oxidation aging. Sealing cracks keeps moisture out of the pavement base and subgrade layers, thereby maintaining uniform support and load-carrying capacity. Arresting oxidation aging avoids embrittlement of the asphalt surface and the progressive development of further cracking. Other reasons include the enhancement of pavement friction, lane delineation, and correction of rutting in the case of thin overlay treatments and special applications of slurry seals.

This report will assess the success of the treatments studied in the SPS-4 experiment in accomplishing these objectives.

Field Experiment for Rigid Pavements

Experiment Design

The field experiment was designed in 1987 by the Texas Transportation Institute[1] to evaluate the effectiveness of the various preventive maintenance treatments. The main variables in the experimental design for portland cement concrete pavements were climate (wet/no freeze, wet/freeze, dry/no freeze, dry/freeze), subgrade type (fine and coarse grained), base type (aggregate and stabilized), pavement type (plain and reinforced), and treatment type (joint/crack sealing, undersealing, and no treatment). A total of 24 test sites were desired for the portland cement concrete pavement preventive maintenance study. A total of 31 SPS-4 sites, consisting of 94 test sections, were actually placed in the United States and Canada in 1990 and 1991 (figure 2).

There were significantly fewer sites with underseal sections than there were sites with joint seal sections. Because of this, there was less data available when comparing joint sealed and underseal sections than there was when comparing joint and control section performances.

The standard experiment layout for the SPS-4 experiment included a test section with silicone joint sealant and a control section with unsealed joints. In addition, separate underseal test sections were constructed at eight test sites. Joints were also sealed at these test sections.

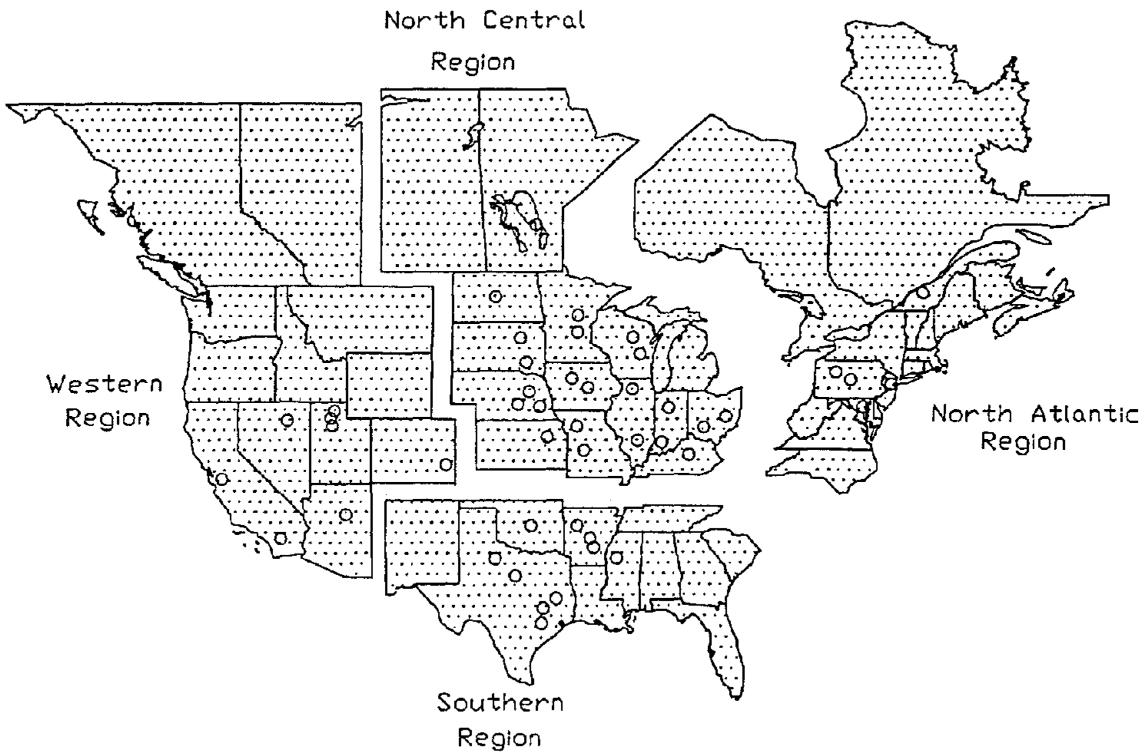

Figure 2. Location of SPS-4 experimental sites.

Placement of Sections

Individual states were responsible for placement of the portland cement concrete pavement preventive maintenance test sections. Most of the test sites were placed in 1990 to 1991. Colorado placed a SPS-4 site in 1995. Specifications used for construction of SPS-4 test sections are contained in appendix A.

State Supplemental Studies

Since the experiment did not vary the type of joint sealant material or sealant design, several states placed supplemental sections to study these variables. These special state studies, located adjacent to the standard sites reviewed in the field, are included in the SPS-4 LTPP evaluation presented in this report.

South Dakota, for example, constructed sections to evaluate longitudinal pavement edge drains, dowel load transfer restoration, and several other individual experiments.

A number of western states constructed a separate joint seal experiment of supplemental sections with various joint seal designs and materials. Construction of these sections is described in a report by Western Technologies, Inc.[8] Preliminary indications of performance are provided in an Arizona Department of Transportation (DOT) report.[9]

Status of Test Sections

As of the 1996 construction season, all 31 SPS-4 test sites remain in service. The majority of these test sites contain only the joint seal treatment and a control section having unsealed joints. Eight sites included both joint seal and undersealing treatment sections. Nine SPS-4 sites were evaluated by ETG in the summer and fall of 1995.

SPS-4 DATA ANALYSIS

The performance of the SPS-4 sites has been evaluated under the LTPP program and by an ETG for each LTPP region. The LTPP program determined the condition of the pavement before the preventive maintenance treatment was applied and at regular intervals after the treatment was applied. The evaluation tools used as part of the LTPP effort include the following:

- Manual distress surveys using the SHRP Distress Identification Manual.
- Distress surveys conducted from film logs taken by the PASCO device.
- Deflection using the Falling Weight Deflectometer (FWD).
- Ride quality or longitudinal profile using the K.J. Law type profilometer.

These measurements are taken biennially. The information from the LTPP data files is currently being analyzed by Nichols Consulting Engineers, Chtd. under contract to FHWA.

EXPERT TASK GROUP FIELD REVIEW

The first phase of the study was to conduct four ETG field evaluations of the test sections. ETGs are composed of highway agency practitioners, industry representatives, and academics, and are organized on a LTPP regional basis to perform SPS-3 and SPS-4 site evaluations. The Western region ETG conducted site reviews in 1991 and 1992. All four LTPP regions conducted evaluations in 1993. A summary report from the 1993 site reviews is available.(6)

The four LTPP regions conducted site reviews again in 1995. The results of these reviews, together with an analysis of the data collected during the tours and the conclusions below, are presented in detail in appendix E of the "Pavement Treatment Effectiveness 1995 SPS-3 and SPS-4 Site Evaluations, National Report."(10)

TOUR CONCLUSIONS

Observations relating to the performance of the SPS-4 projects were relatively limited after 5 years. First, there were a limited number of sites constructed and only a sampling of these were reviewed in the field. Based on the limited number of sites reviewed, the findings are as follows:

- Unsealed joints in the control sections contain significantly more debris than sealed joint sections.
- Unsealed joint sections have significantly more joint spalling than the sealed joint sections.
- Minor amounts of debris lodged in the sealed joint sections have little or no effect on pavement performance to date.
- No conclusions are evident regarding the performance of the underseal sections after 5 years. The sections continue to perform consistently well. Only eight test sections including this factor were originally constructed nationwide, six of which were located in a dry climate.

Based on the performance observations made by ETGs, there are no conclusions about application timing for the SPS-4 maintenance treatments.

ETG REVIEW OF SPS-4 SUPPLEMENTAL SECTIONS

The performance of supplemental SPS-4 sections was reviewed only in the field by ETGs at two sites, Arizona and South Dakota. Four joint sealant materials and five joint reservoir sites were constructed at the Arizona site. Joint reservoirs ranged from 3mm to 9mm in width. Joint sealants included silicon, compression seals, ASTM 3405 and 3406 materials. All sections appear to be performing well to date. Observations from the South Dakota site indicate that diamond grinding, dowel insertion, and edge drains have all reduced pavement pumping at transverse joints.[11]

LTPP DATA BASE ANALYSIS

Compared to the expected performance lives of concrete pavements, the performance life to date of the SPS-4 pavement sections has been brief. Because of the short performance life of the SPS-4 pavement sections, few performance indicators have developed to evaluate the performance of the different treatment sections. A few transverse cracks have occurred within the sections, but otherwise very little distress has occurred within panels at any of the sites.

Because of the small amount of distress data, the researchers focused on performance indicators that did indicate deterioration. The following performance indicators were found around the pavement joints in the sections:

- Joint spalling.
- Joint faulting.
- Longitudinal profile.
- Transverse deflections at the joints and load transfer characteristics.
- Joint seal damage.

Joint sealing and undersealing were used in the SHRP experiment. Joint seals are meant to seal out water and incompressibles and prevent loss of underlying material. Slab undersealing is intended to fill voids under slabs already created by the erosion of material. If the treatments are beneficial, researchers expect that the joint seal sections should exhibit less spalling and faulting and that the underseal sections exhibit less faulting and have lower deflections than the control sections with underseal joints.

The data used in the analysis was obtained from each of the SHRP LTPP regional information management systems (RIMS). Table 1 shows the data base tables requested from each of the LTPP regions for both the SPS-3 and SPS-4 data analysis. Most of these analyses were performed on data contained in the MON_JPCC_FAULT table.

JOINT SPALLING EVALUATION

Researchers evaluated the amount of joint spalling to determine whether the sealed sections performed better than the unsealed control section. Of the 32 sites having spalling data available, 10 sites were located in the dry/freeze and wet/freeze regions. Another seven sections were located in the wet/no freeze region, and the last five in the dry/no freeze region.

The evaluation of these sites clearly indicates that in both wet regions, spalling has occurred less frequently at the sealed joint sections than at the unsealed joints.

Figure 3 shows the mean of average total spalling for all post-construction data with associated underseal sections. It also shows a range of variability around each mean which is based on Fisher's least significant difference (LSD) procedure. These analyses are developed in such

Table 1. RIMS tables needed for data extraction.

SPS-3, SPS-4, and Associated GPS Sections

EXPERIMENT_SECTION
MON_DEFL_COMMENTS
MON_DEFL_LANE_STATS
MON_DEFL_LOC_INFO
MON_DEFL_MASTER
MON_DIS_AC_REV
MON_DIS_CRCP_REV
MON_DIS_JPCC_FAULT
MON_DIS_JPCC_REV
MON_DIS_PADIAS_AC
MON_DIS_PADIAS_CRC
MON_DIS_PADIAS_JC
MON_DIS_PADIAS_MAP
MON_DROP_SEP
MON_DYNATEST_DROP_DATA
MON_FRICTION
MON_PASCO_DEV_CONFIG
MON_PROFILE_MASTER
MON_RUT_DEPTHS
MON_RUT_MASTER
MON_TEMPERATURE_DEPTHS
MON_TEMPERATURE_TEMPS
SPS3_CHIP
SPS3_CHIP_EQUIP
SPS3_CRACK
SPS3_INTERSECTIONS
SPS3_PROJECT_STATIONS
SPS3_ROLLER
SPS3_SLURRY
SPS3_SLURRY_EQUIP
SPS4_BENKELMAN_GENERAL
SPS4_BENKELMAN_MEASURE
SPS4_CONTROL_GENERAL
SPS4_CONTROL_LONG
SPS4_CONTROL_RANDOM
SPS4_CONTROL_SHOULDER
SPS4_CONTROL_TRANS
SPS4_CRACK_SEAL_GENERAL
SPS4_CRACK_SEAL_PVMT
SPS4_CRACK_SEAL_PVMT_MEAS
SPS4_CRACK_SEAL_RAND
SPS4_CRACK_SEAL_RAND_MEAS
SPS4_CRACK_SEAL_SH
SPS4_CRACK_SEAL_SH_MEAS
SPS4_DYNAFLECT_GENERAL
SPS4_DYNAFLECT_MEASURE
SPS4_EPOXY_GENERAL
SPS-4_EPOXY_MEASURE
SPS4_FWD_MEASUREMENTS
SPS4_INTERSECTIONS
SPS4_PROJECT_STATIONS
SPS4_TRANSIENT_GENERAL
SPS4_TRANSIENT_MEASURE
SPS4_UNDERSEAL_GENERAL
SPS4_UNDERSEAL_INIT_GROUT
SPS4_UNDERSEAL_PRES_GROUT
SPS4_UNDERSEAL_REGROUT

Also include the following:
*.A00 files
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SPS_ID	104
SPS_ID	204
SPS_ID	804

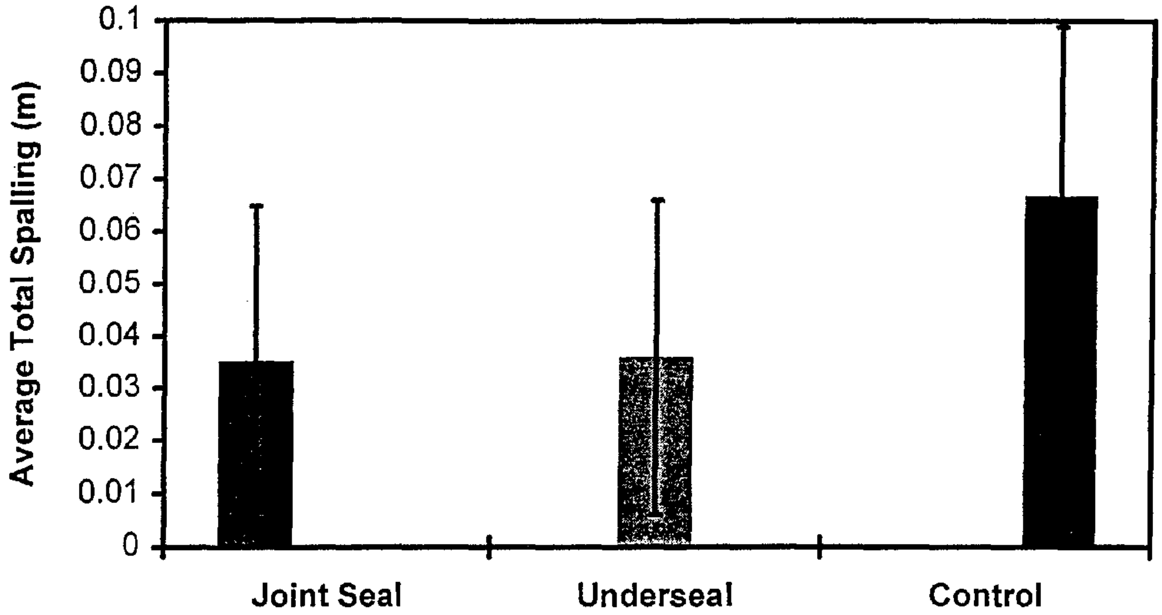


Figure 3. Average total spalling by treatment type for sites with associated underseal sections.

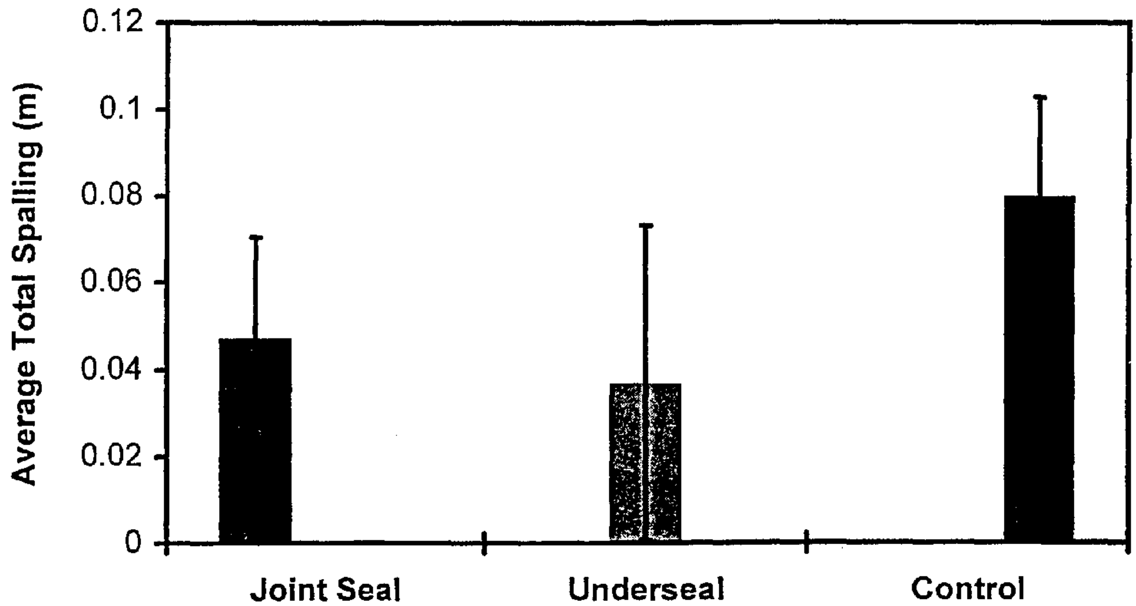


Figure 4. Average total spalling using all available data.

a way that if the means of two sets of data are the same, the LSD intervals will overlap 95 percent of the time. Any pair of intervals that do not overlap vertically, correspond to a pair of means that have a statistically significant difference. In this case, there is not a statistically significant difference between the spalling of the different treatments. However, the control section does show more spalling than the associated joint seal or the underseal sections, which is the expected outcome and corresponds to the observations made by ETG.

Figure 4 shows the mean of average total spalling for all post-construction data, not just those with associated underseal sections. The comparison here is between the joint seal section and the control. Once again there is not a statistically significant difference between the samples, but the mean of the control is higher, and in this case, the interval overlap is less than the overlap for the sections only associated with the undersealing. Again, the supporting observations of ETG add to the significance of the performance difference that is suggested by the data.

FAULTING

An analysis of the faulting data shows that there is very little difference in faulting between the three different treatment types. Two measures of faulting are recorded in the LTPP data base: edge faulting and wheelpath faulting. When all the post-installation data is evaluated, the underseal sections appear to have a significantly higher amount of both faulting measures than the joint seal sections (figures 5 and 6). This would indicate that undersealing contributed to faulting in some way. Possibly unintentional slab jacking had occurred or non-uniform support had been created by the grout injection process. When only faulting data from sites with associated underseal sections are evaluated, however, the performance difference is no longer evident. The sites at which undersealing was performed exhibited greater faulting on all sections than the sites at which only joint sealing was performed.

As seen in figures 7 and 8, neither faulting analysis shows any significant difference between the sections. An attempt was made to see if the presence of doweled or undoweled joints correlated with the presence of faulting in the sections. Once again, at this early stage in the performance life of these pavements, little performance variation can be found.

PROFILE

The results of the profile data analysis closely parallel those of the faulting data. This supports the fact that most pavement roughness associated with relatively new concrete pavements relates to the transverse joints and joint faulting. Figure 9 shows the average profile data in terms of the International Roughness Index (IRI) for all sections. Once again, the sealed and control sections are similar, having an average IRI of about 1.97 m/km. The underseal sections appear to be significantly rougher than either the joint seal or control sections. This is partially because of the much smaller data set for the underseal sections. Also, as seen in figure 9, the roughness for the underseal section is uniformly higher than for the data set as a whole. Figure 10 shows a comparison of sections with associated underseal data. The average roughness for the underseal sections is higher than for the joint seal or control sections, but

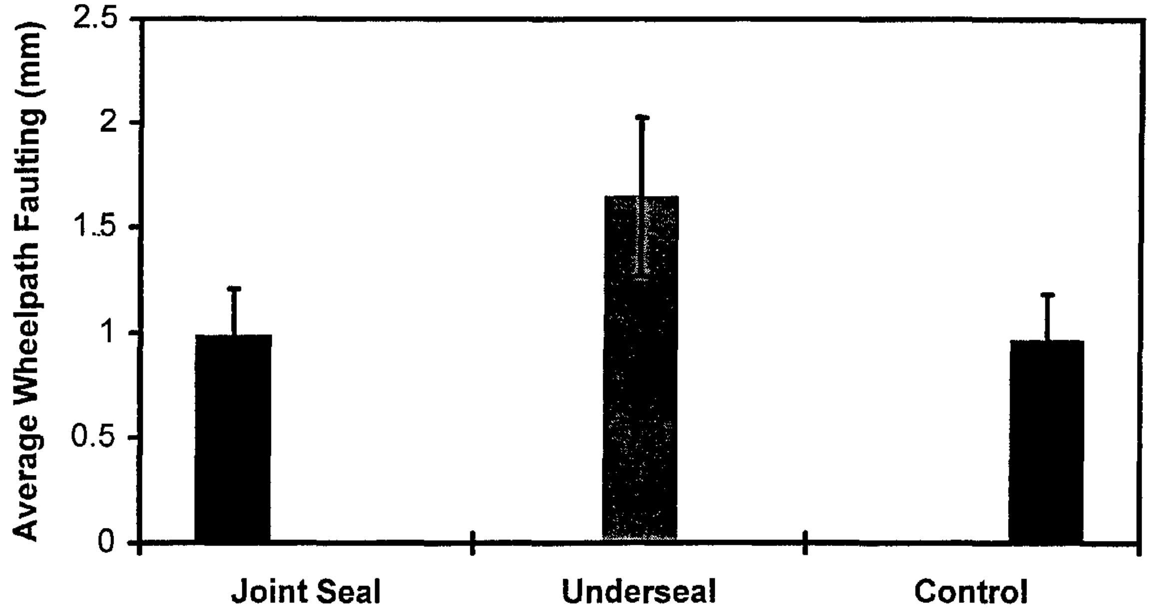


Figure 5. Average wheelpath faulting for all available data.

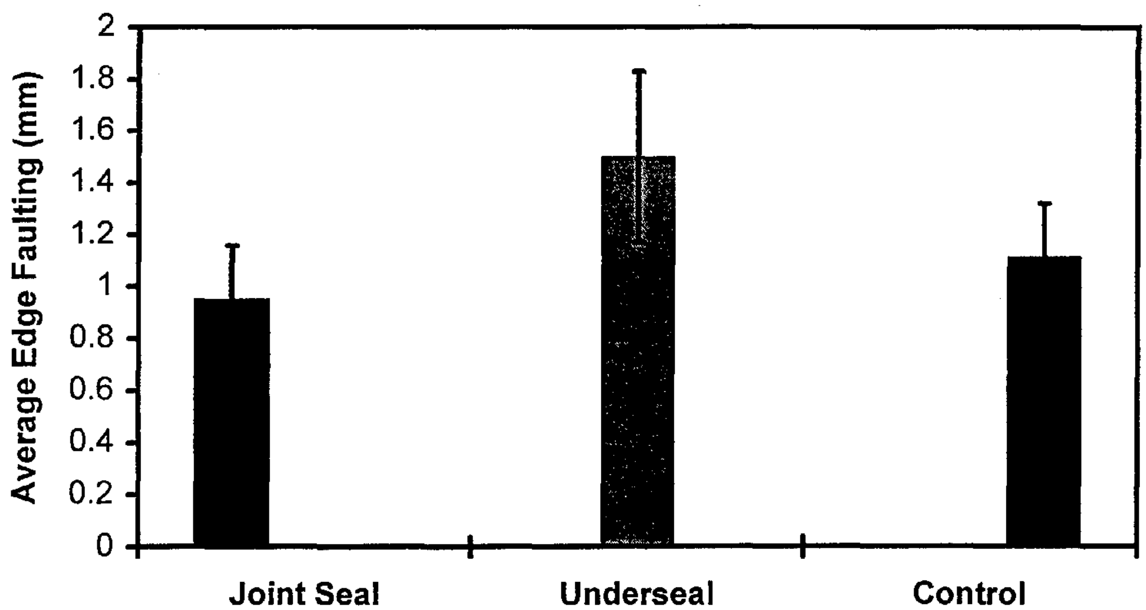


Figure 6. Average edge faulting for all available data.

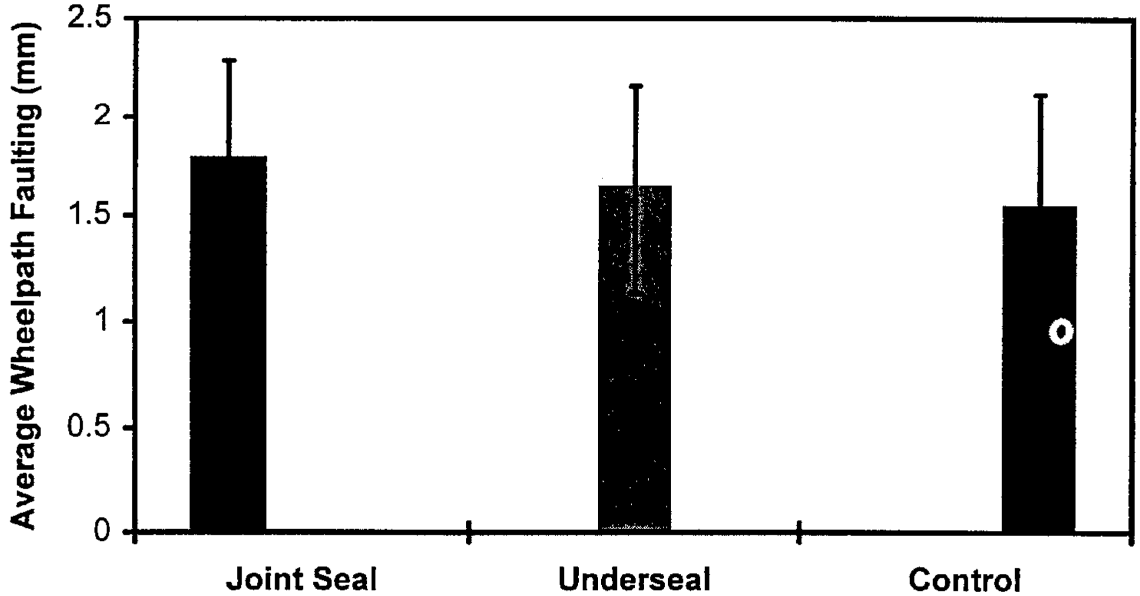


Figure 7. Average wheelpath faulting for associated underseal data.

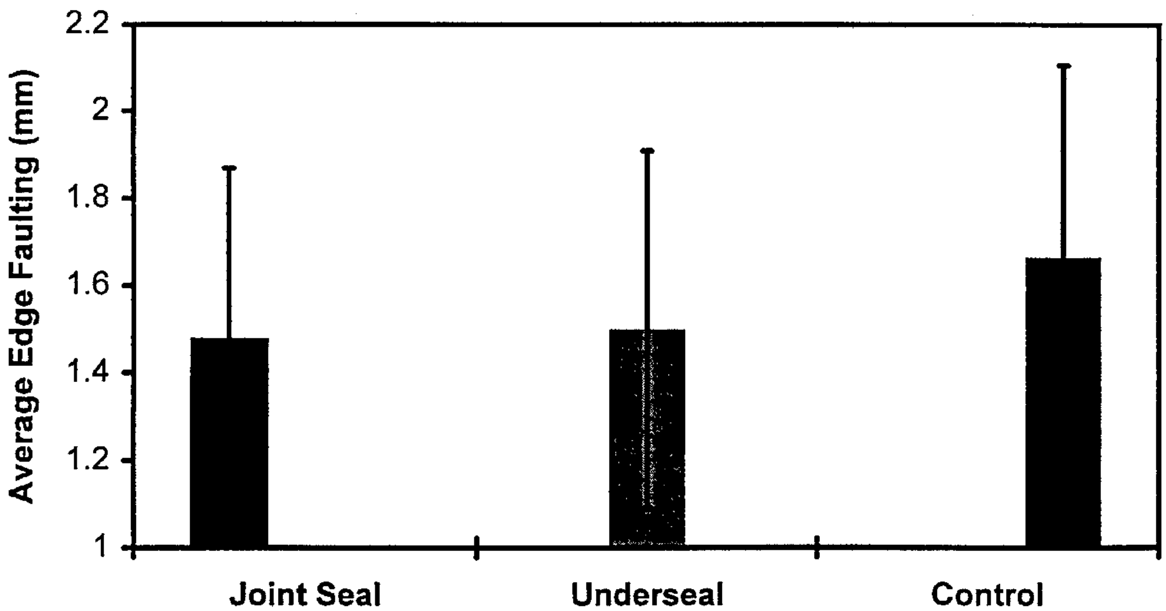


Figure 8. Average edge faulting for associated underseal data.

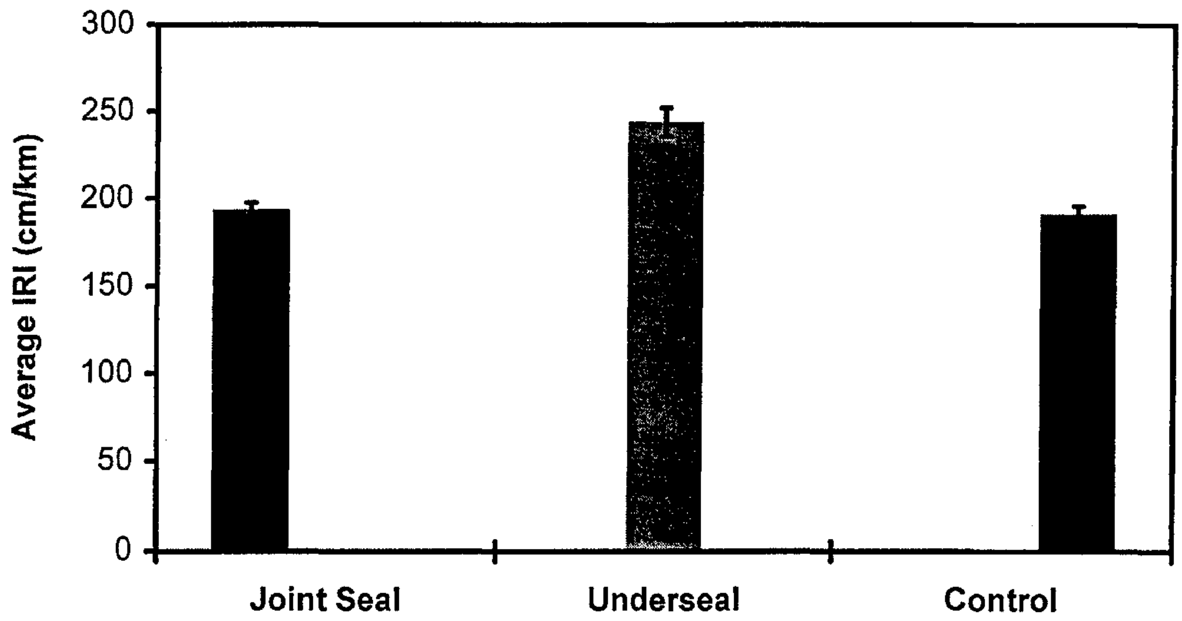


Figure 9. Average profile by treatment type using all available data.

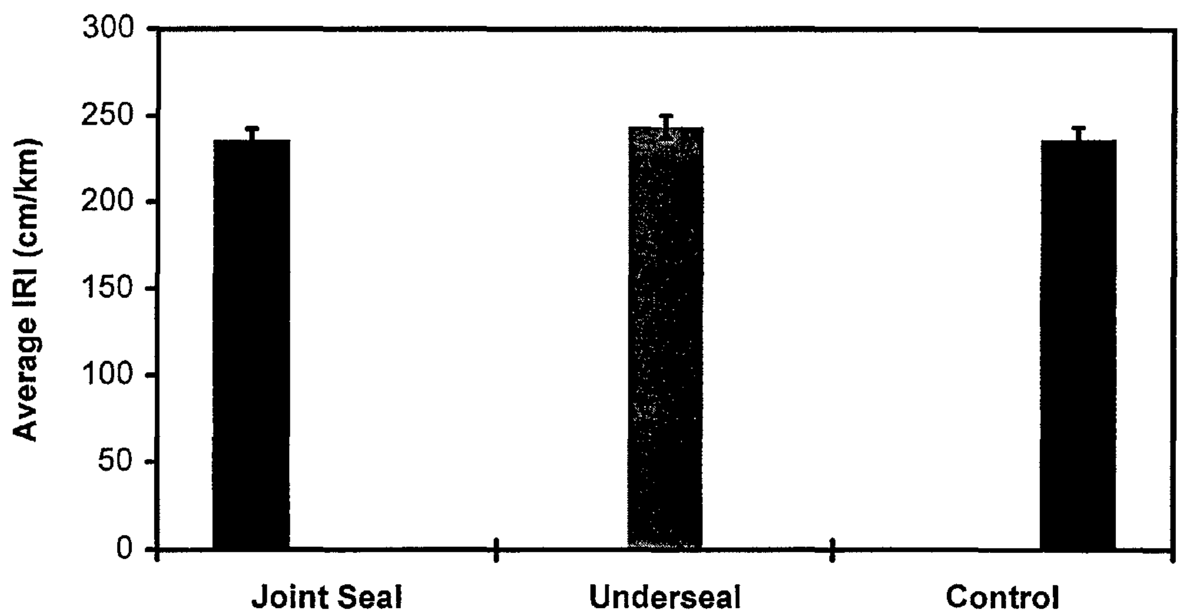


Figure 10. Average profile by treatment type for associated underseal data.

this difference does not prove to be significant when evaluated using Fisher's LSD at a 95 percent confidence level.

EFFECTS OF DOWELS AND REINFORCEMENT

Researchers attempted to determine if any difference in performance could be detected between doweled and undoweled sites, and reinforced and non-reinforced sites. No statistically significant differences were found, therefore, the hypothesis for this analysis was rejected.

ENVIRONMENTAL EFFECTS

In order to determine whether environmental factors had any effect on performance, the different sites were grouped into the four SHRP LTPP environmental zones shown in figure 11. The treatments were then evaluated in terms of spalling, wheelpath faulting, and edge faulting. The treatments were first grouped together by environmental zone and then researchers evaluated each SHRP treatment.

Figure 12 shows total spalling for all treatments by environmental zone. This figure indicates that the wet/freeze region is the harshest climate.

STATE SUPPLEMENT EXPERIMENTS AND SEALANT TYPE PERFORMANCE

Several states who participated in the SPS-4 experiment built additional experimental sections to evaluate additional treatment methods. Predominant among supplemental sections was a comparison of joint sealant types. Data from 11 states with 23 different sealant products was identified in the data base. These products are listed in table 2. An evaluation of each product performance is not within the scope of this study; however, it was possible to group the products into three sealant categories:

- Hot pours.
- Compression seals.
- Silicone sealants.

The primary SPS-4 experiment specified the use of a silicone sealant for the transverse joint seals. The compression and hot pour sealants were added as supplements by many of the states involved in the experiment. Several state supplemental joint evaluations were conducted including a secondary factor considering sealant reservoir dimensions. An analysis of these evaluations is available from Arizona DOT.[9] Because it is still early in the performance life, the general performance of the SPS-4 sites remain high. However, there is enough data available to provide an indication of how these different types of treatments are performing.

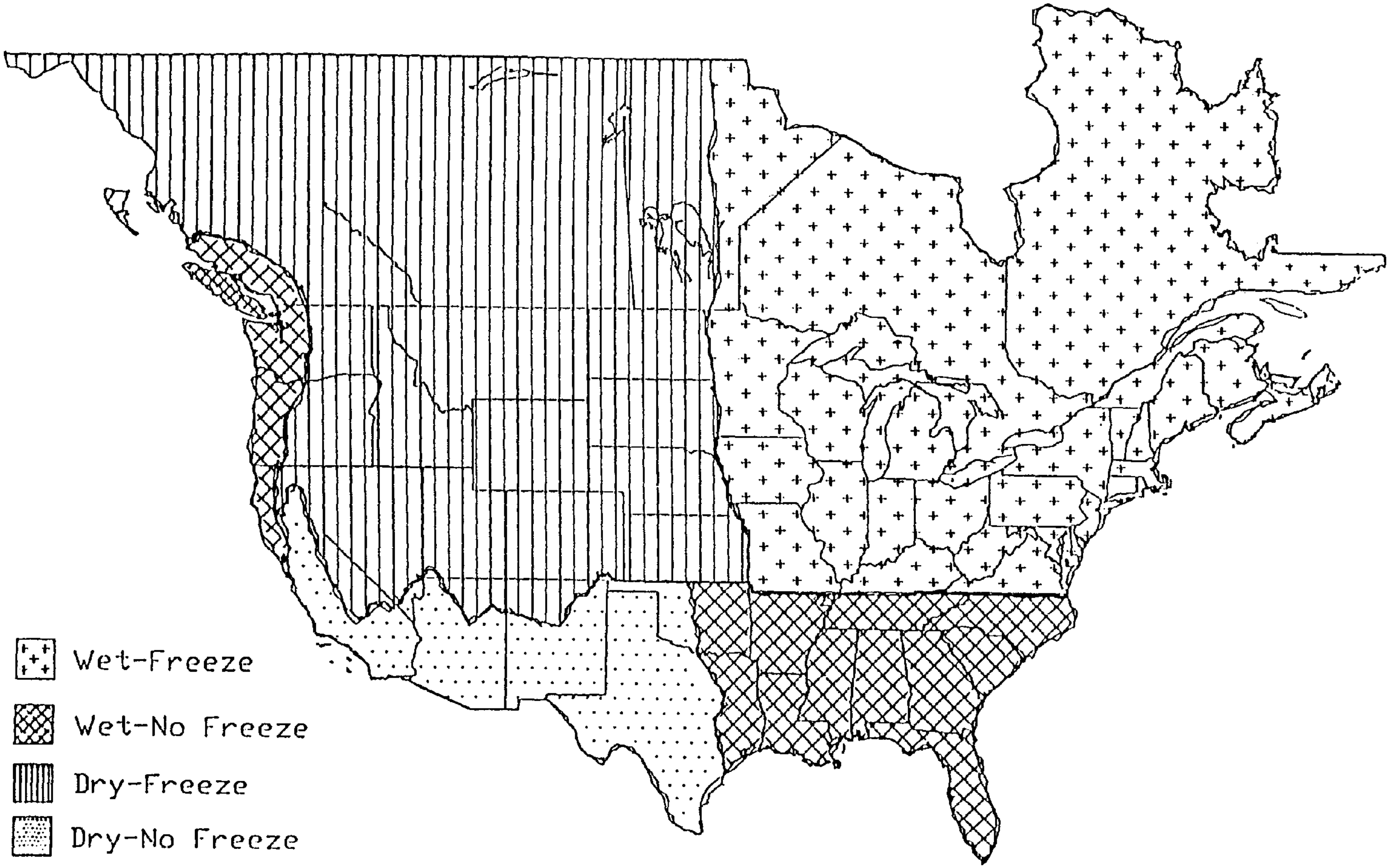


Figure 11. Climatic zone.

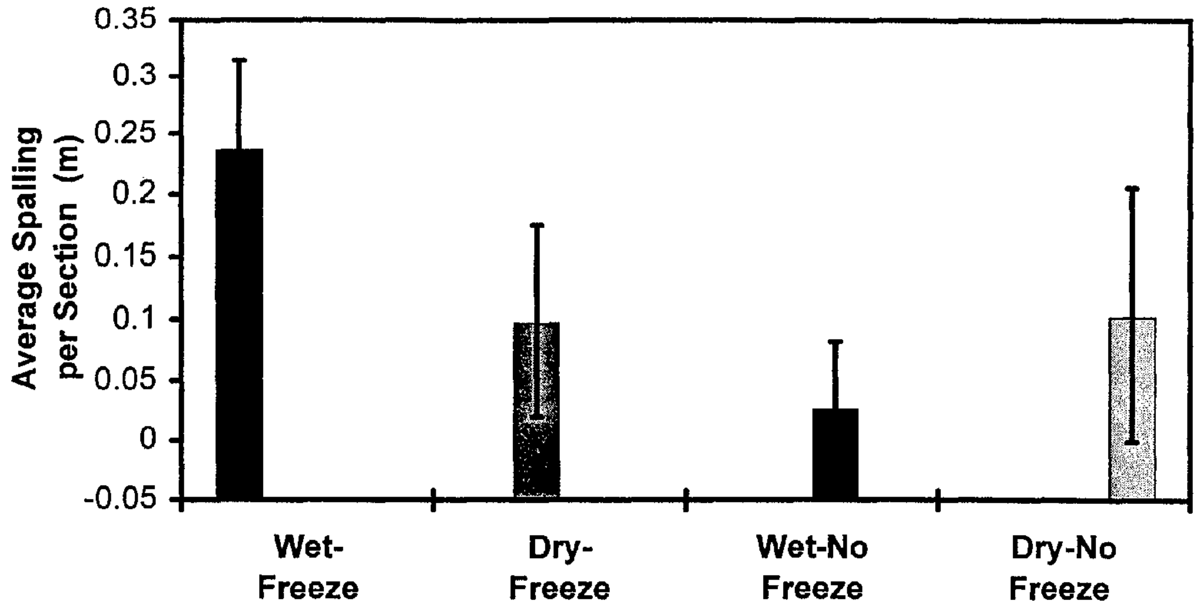


Figure 12. Spalling by environmental zone, all treatments combined.

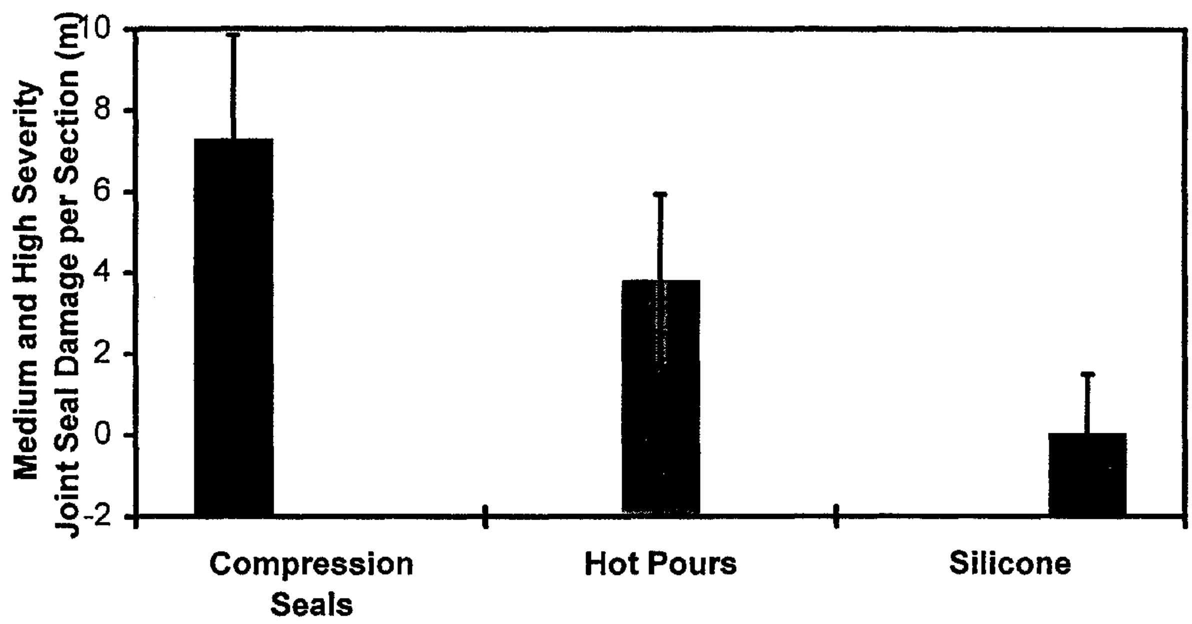


Figure 13. Medium and high severity joint seal damage by sealant type.

Table 2. Treatment types used in the SPS-4 supplemental sections.

HOT POURS

<u>ASTM D 3406</u>
Koch 9012
9050 SL Polysulfide
Koch Jet Fuel Resistant
9000 PFJ

<u>ASTM D 3405</u>
Koch 9005 AST
Koch K 1195
Crafco 57
Koch (3405) 9005

SILICONE

Dow 888
Dow 888 SL
Dow 890 SL
Dow 880
Mobag Reg. Silicone (Basilone)
Crafco Reg. Silicone
Crafco SL Silicone

COMPRESSION SEALS

DS Brown V-812
DS Brown V-687
Intermountain 9.525 mm
KoldSeal Neo Loop 6.35 mm
Delastic V-687
Esco PV687 (9.525 mm)
Osbrow E 437 H
Megaseal 1323

The data set used for this analysis was taken from the JPCC distress monitoring table of the LTPP data base (MON_DIS_JPCC_REV). There is a portion of this table for storing distress data related to joint seals in terms of high, medium, or low severity damage based on definitions in the LTPP Distress Identification Manual. If a pavement has unsealed joints, no data should be recorded. If sealed joints are present at all, however, the joints are rated as having low severity damage. When significant amounts of debris or cracking are present, the joint is rated as having medium or high severity joint seal damage. The number of joints at each condition level is then recorded at each site. Because all sealed joints are rated as having low severity damage, the different sealant types (hot pours, silicones, and compression seals) were compared based on the average number of joints rated as having medium- or high-severity damage. In other words, the average number of joints having medium- and high-severity cracking were summed over each sealant type group.

The results of this analysis are shown in figure 13. As can be seen in figure 13, the silicone sealants have fewer joints exhibiting medium- and high-severity damage than the hot pours and significantly less than the compression seals.

The success of all joint sealant materials is dependent on installation techniques. One of the most critical aspects of the installation is to assure that the joints are thoroughly cleaned prior to the installation. Any residual moisture or dust from joint sawing will result in sealant bond loss. This problem applies equally to all three types of sealant discussed.

Using theoretical joint movement calculations to size compression seals in jointed rigid pavements has not been successful in the past. Often during paving, the development of slab joint cracking does coincide with sawn joint locations on a one-to-one basis. Depending on the daily range of temperature extremes between daytime highs and night-time lows, cracking occurs in a consistent pattern. PennDOT, for example, found that when paving in the fall, every third joint initially cracked. Since the PennDOT joint spacing is 6.1 m, those joints which do initially crack exhibit slab movement as if the slabs were 18.3 m long. Obviously, this extent of joint movement will exceed the capacity of a seal sized for one-third that movement. The required compressive state of the joint seal is not maintained, and the sealant becomes dislodged from the joint. This phenomenon of joint cracking has been confirmed in locations outside Pennsylvania as well. PennDOT addressed this problem by specifying over-sized seals, designed to accommodate the movement of a 18.3-m slab.

Other problems with compression seals have also been identified. One problem identified by PennDOT quality assurance testing was an occasional failure in the production quality control process.

Another problem was that the acceptance test requirement for compression seals, ASTM 3542-83, required only one cycle of recovery for acceptance. It seems probable that compression set is taking place in compression seals after many repeated cycles of joint expansion and contraction.

The successful use of compression seals in many miles of jointed concrete pavement indicates that these intermittent material and design problems can be controlled.

Once again, these results are by no means conclusive because so few joints exhibit any damage at this early stage. There is enough data available, however, for these findings to be interpreted as an indicator of future performance.

DEFLECTION DATA

Researchers collected deflection data at the SPS-4 sites at least every other year, resulting in a good amount of data available for evaluation. However, this data was collected randomly at different times of the year (depending on the climate of the particular region) with no correction for seasonal or temperature variability. Consequently, a number of the data collection points reflect a "locked joint" condition and could not be used in the analysis.

Deflection analysis is particularly useful in assessing the structural performance of slab undersealing. A review of deflection data over time indicates a change in the slab support level. Also, researchers compared deflection magnitude with data for the joint seal and unsealed control sections. Presumably, there should be a noticeable difference between the support erosion at the unsealed joints, and sealed and underseal joints when evaluated over time.

Of the eight sites which included slab underseal sections, only six had more than one set of deflection data available for analysis. All but one of these six are located in dry climates. The sixth, in Oklahoma, is in a wet/no freeze climate, but is near the dividing line between wet and dry/no freeze zones.

Consequently, the best analyses that can be made from this site data are for dry climate and individual sites. Comparison of the deflection data for underseal, joint seal, and control section data are provided in tables 3 through 5. Data for sites in California, Nevada, and South Dakota are provided since they are the only sites with at least three rounds of deflection data available. Other sites in California, Nevada, and Oklahoma show small increases (50.8 μm or less) in deflection (table 4).

Researchers collected six rounds of data at the South Dakota site. This is by far the most site data available. This analysis,[12] provided in figures 14a through 16b, shows that deflection, indicated by the y-axis intercept in the plots, remains far below the criteria for undersealing initially used during construction (0.5 mm) (appendix A).

The comparison of joint sealed, underseal, and unsealed joint deflections at the South Dakota site indicate that the greatest deflections exist at the sealed joints. Deflection for the underseal joints are nearly zero. Those for the control sections are quite low as well (figures 17 through 22).

Table 3. Sensor 1 deflections for approach and leave slabs for California Section 06B-400

	Joint Seal		Underseal		Control	
	A	L	A	L	A	L
June 1990	13.8	9	16	11.6	14	11.7
December 1991	13.9	13.8	13.4	10.7	8.2	8.7
January 1994	12.3	10.3	12.3	10.5	--	--

Table 4. Sensor 1 deflections for approach and leave slabs for Nevada Section 32A-400

	Joint Seal		Underseal		Control	
	A	L	A	L	A	L
August 1991	3.2	5	7.5	7.9	3.8	3.8
November 1993	7.4	7.7	8.1	7.5	6.2	8.2
1994	--	--	9.5	10.1	--	--

Table 5. Sensor 1 deflections for approach and leave slabs for South Dakota Section 46A-400

	Joint Seal		Underseal		Control	
	A	L	A	L	A	L
July 1991	12	12	27	20	11	11
October 1991	20	18	21	18	17	13
October 1992	38	34	15	13	26	25
July 1993	28	23	13	12	26	19
August 1994	36	25	32	23	23	18
July 1995	34	24	--	--	27	24

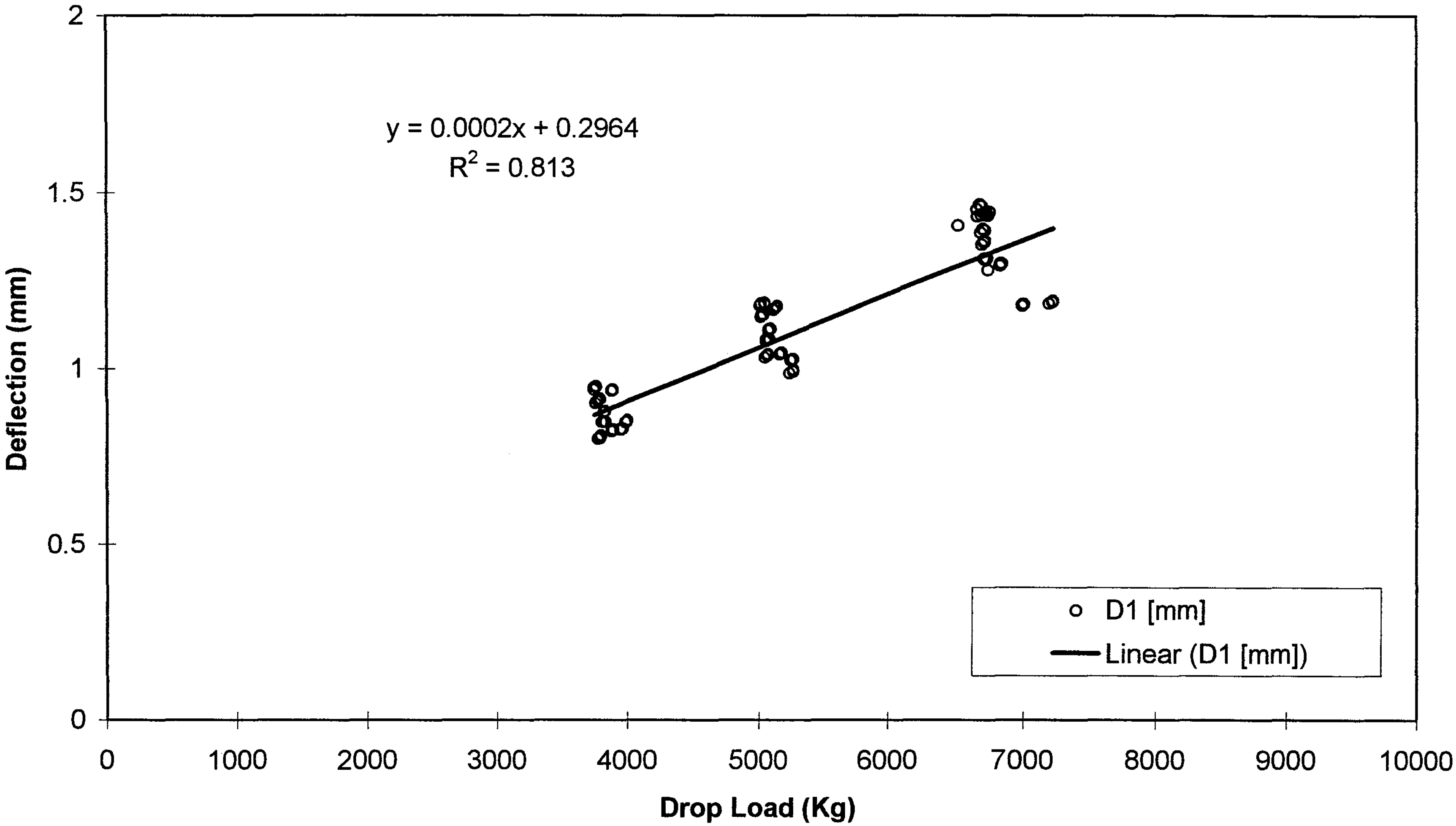


Figure 14a. Sensor 1 deflection vs. drop load, approach slab (J4), 46A410 (DF), 8/2/94.

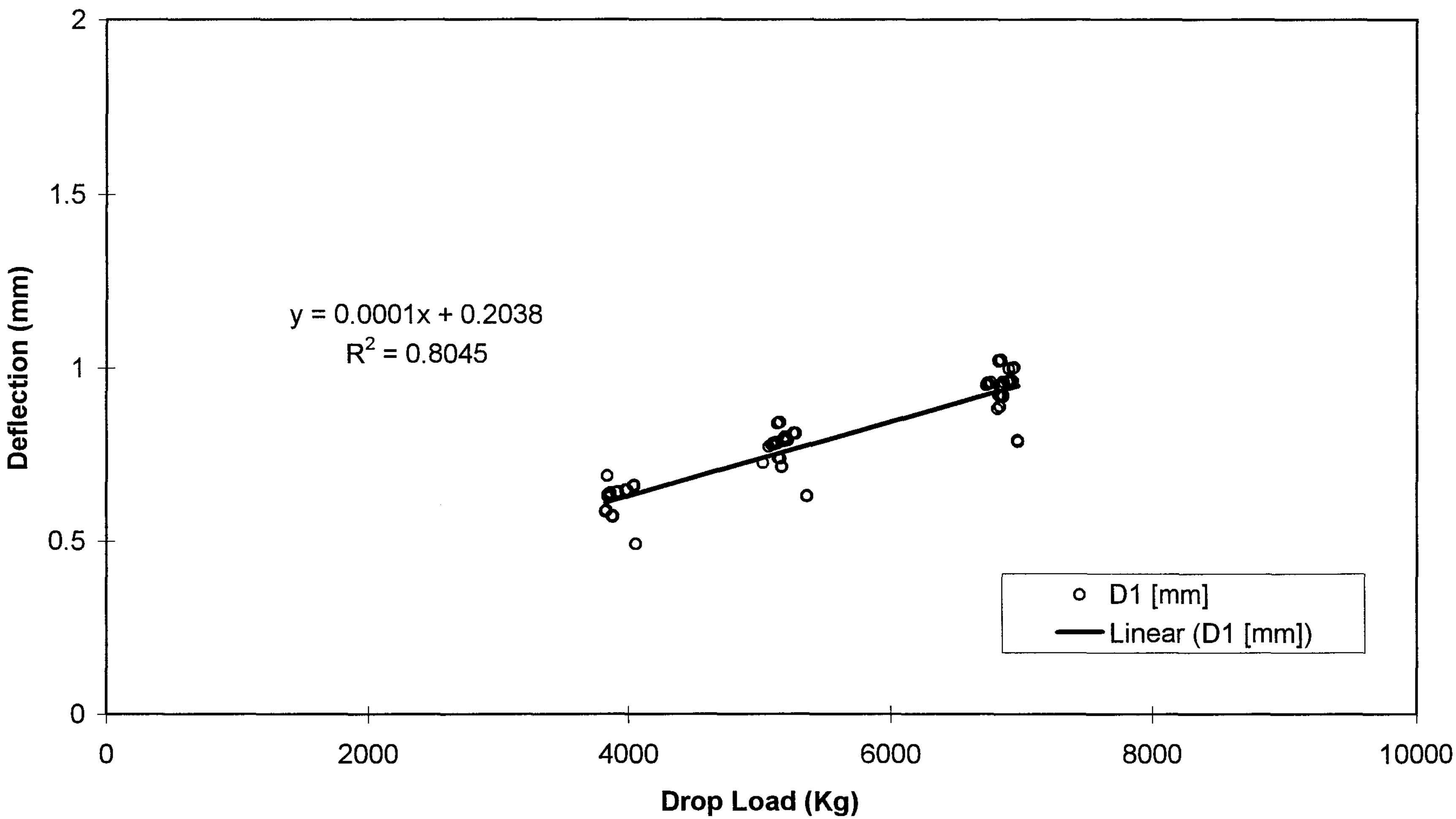


Figure 14b. Sensor 1 deflection vs. drop load, leave slab (J5), 46A410 (DF) 8/2/94.

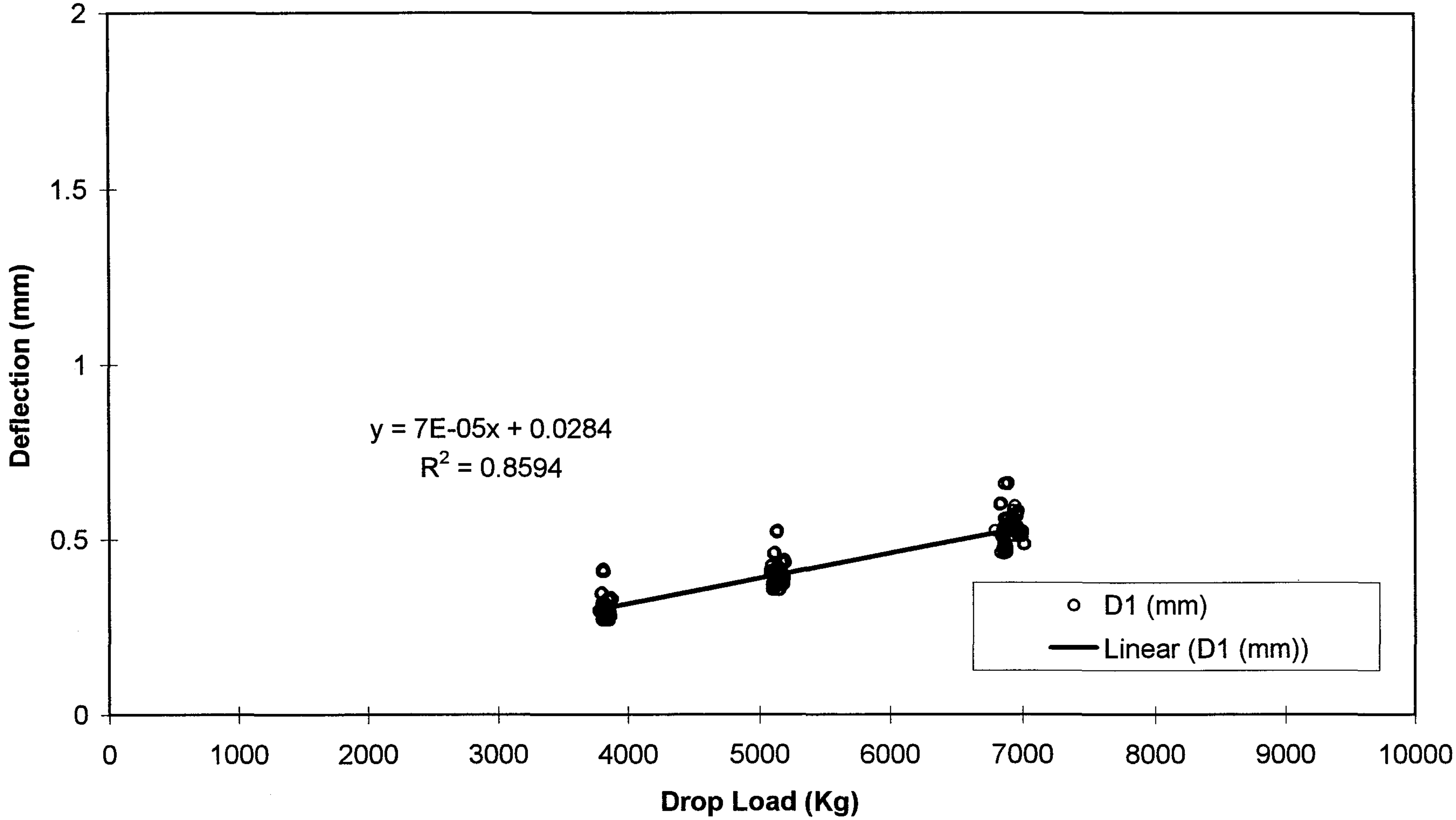


Figure 15a. Sensor 1 deflection vs. drop load, approach slab (J4), 46A420 (DF), 8/2/94.

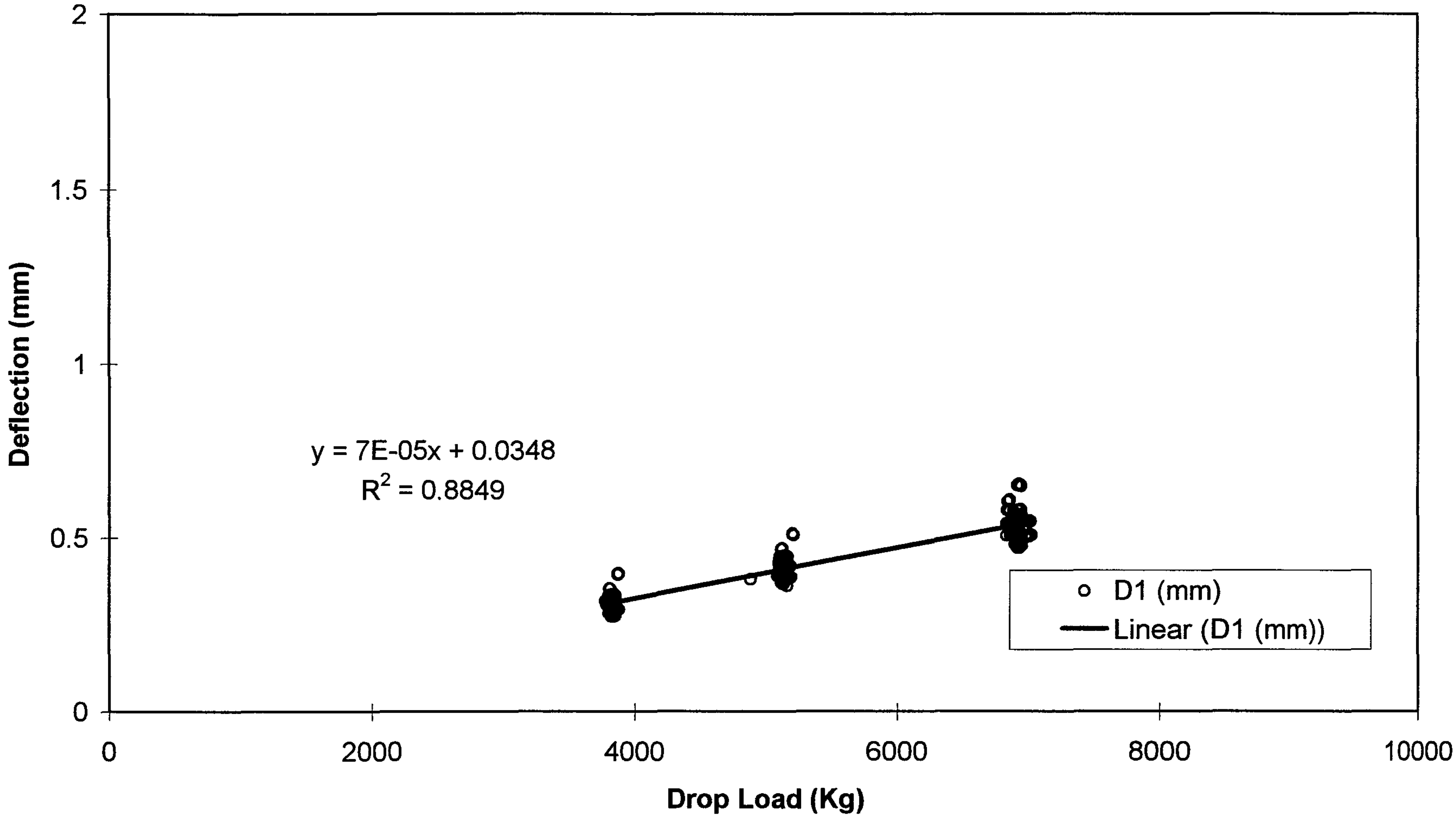


Figure 15b. Sensor 1 deflection vs. drop load, leave slab (J5), 46A420 (DF) 8/2/94.

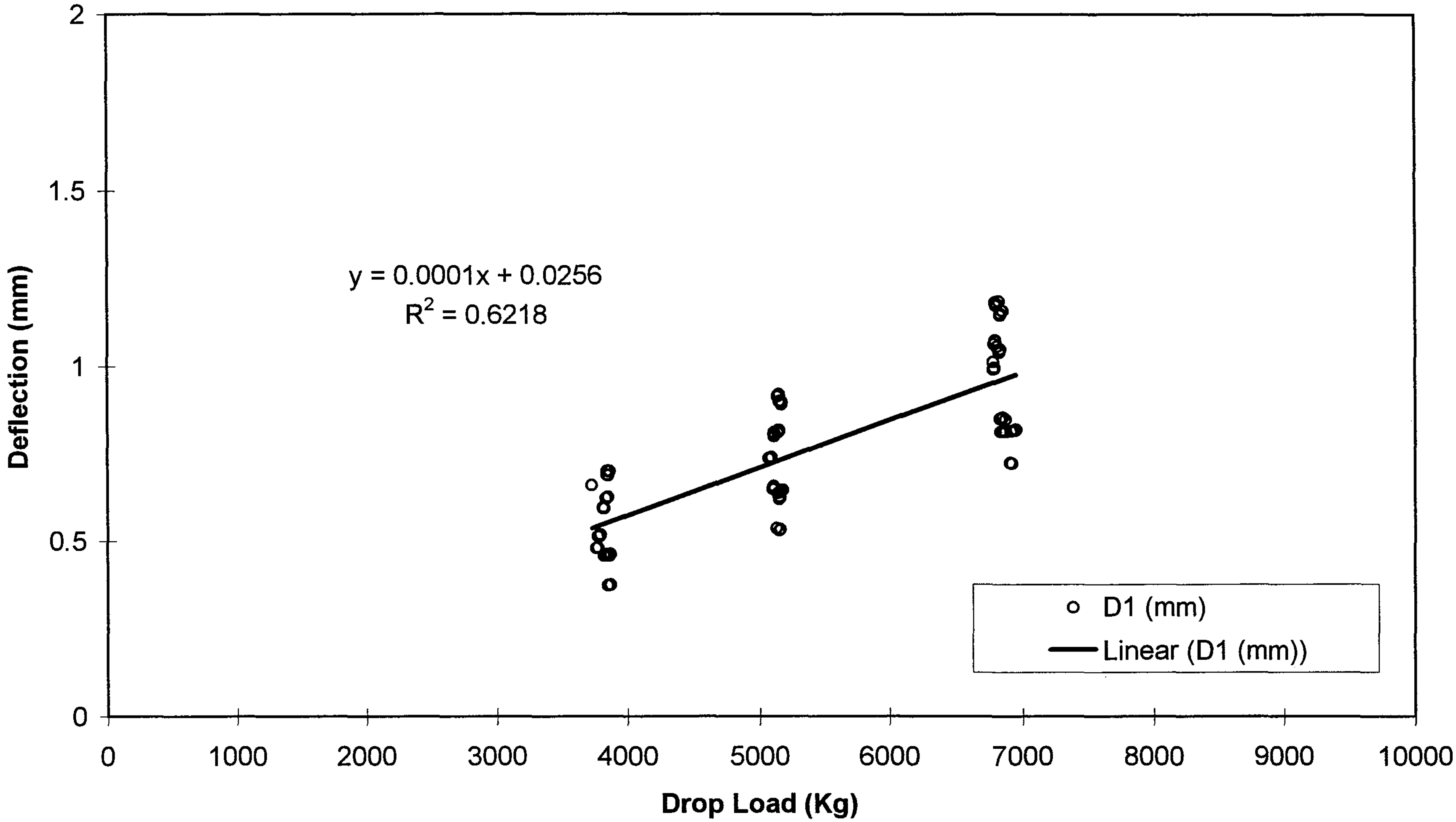


Figure 16a. Sensor 1 deflection vs. drop load, approach slab (J4), 46A430 (DF), 8/2/94.

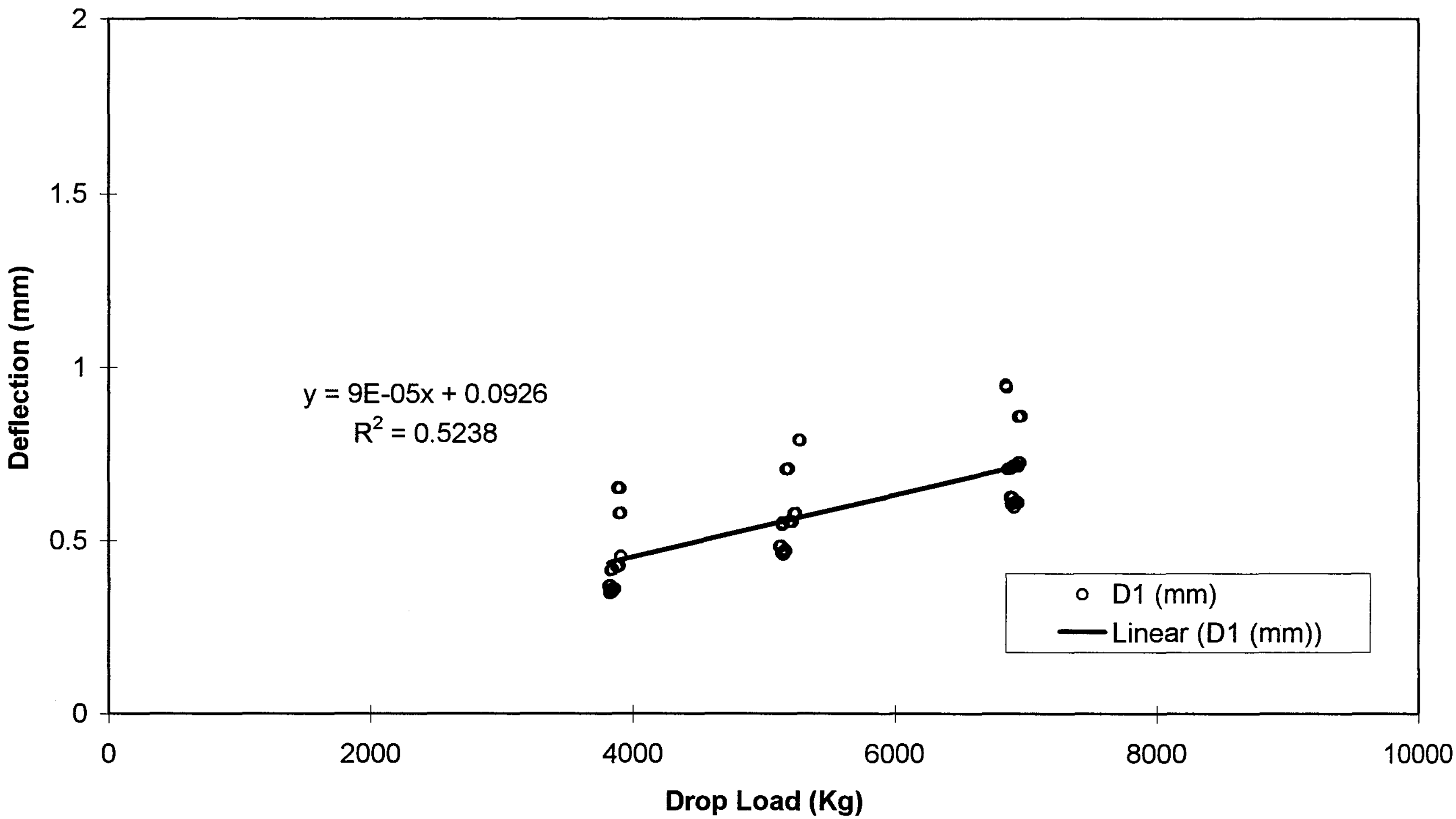


Figure 16b. Sensor 1 deflection vs. drop load, leave slab (J5), 46A430 (DF) 8/2/94.

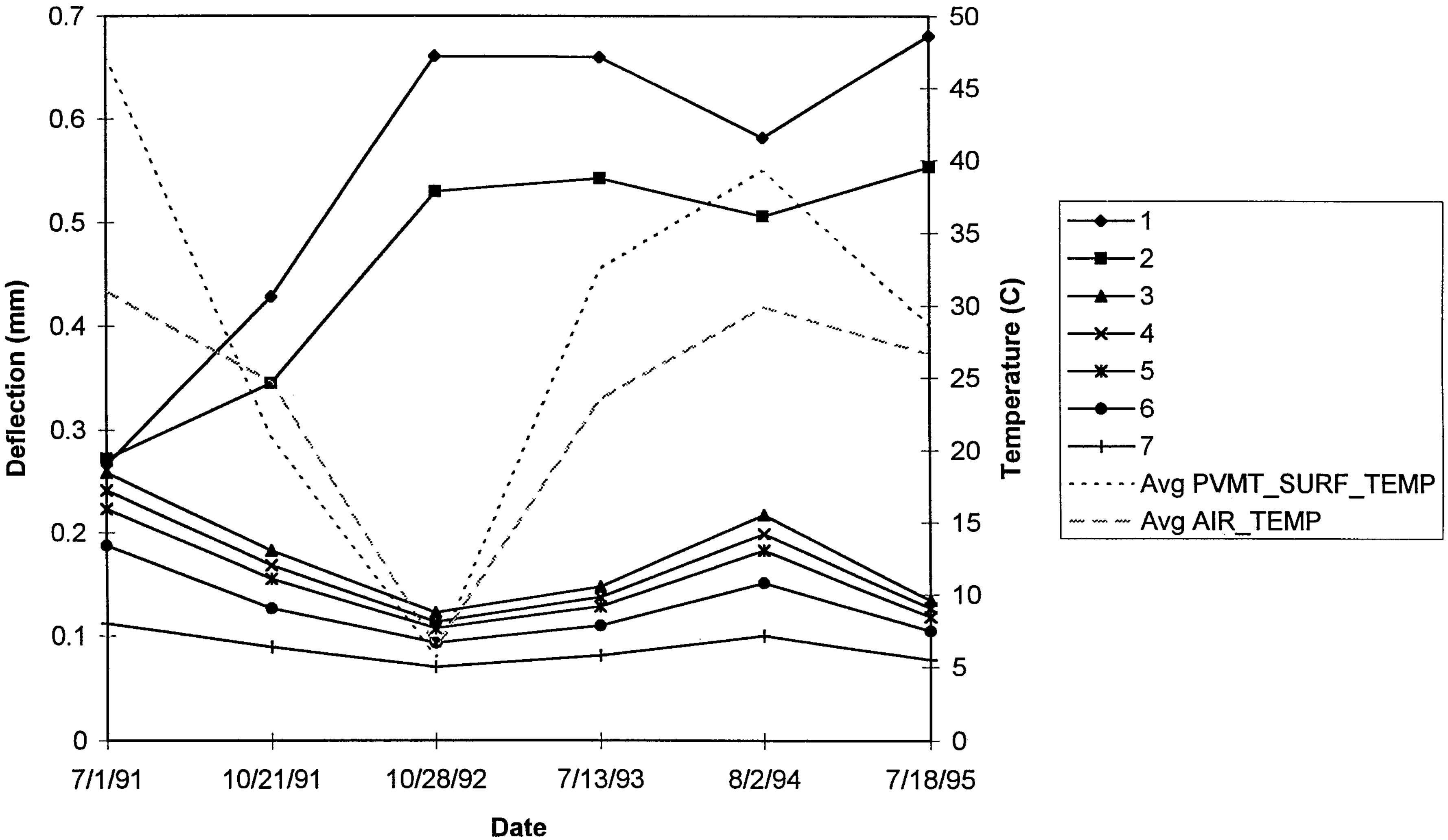


Figure 17. Normalized deflections for South Dakota section 46A430, approach slab (J4), all sensors.

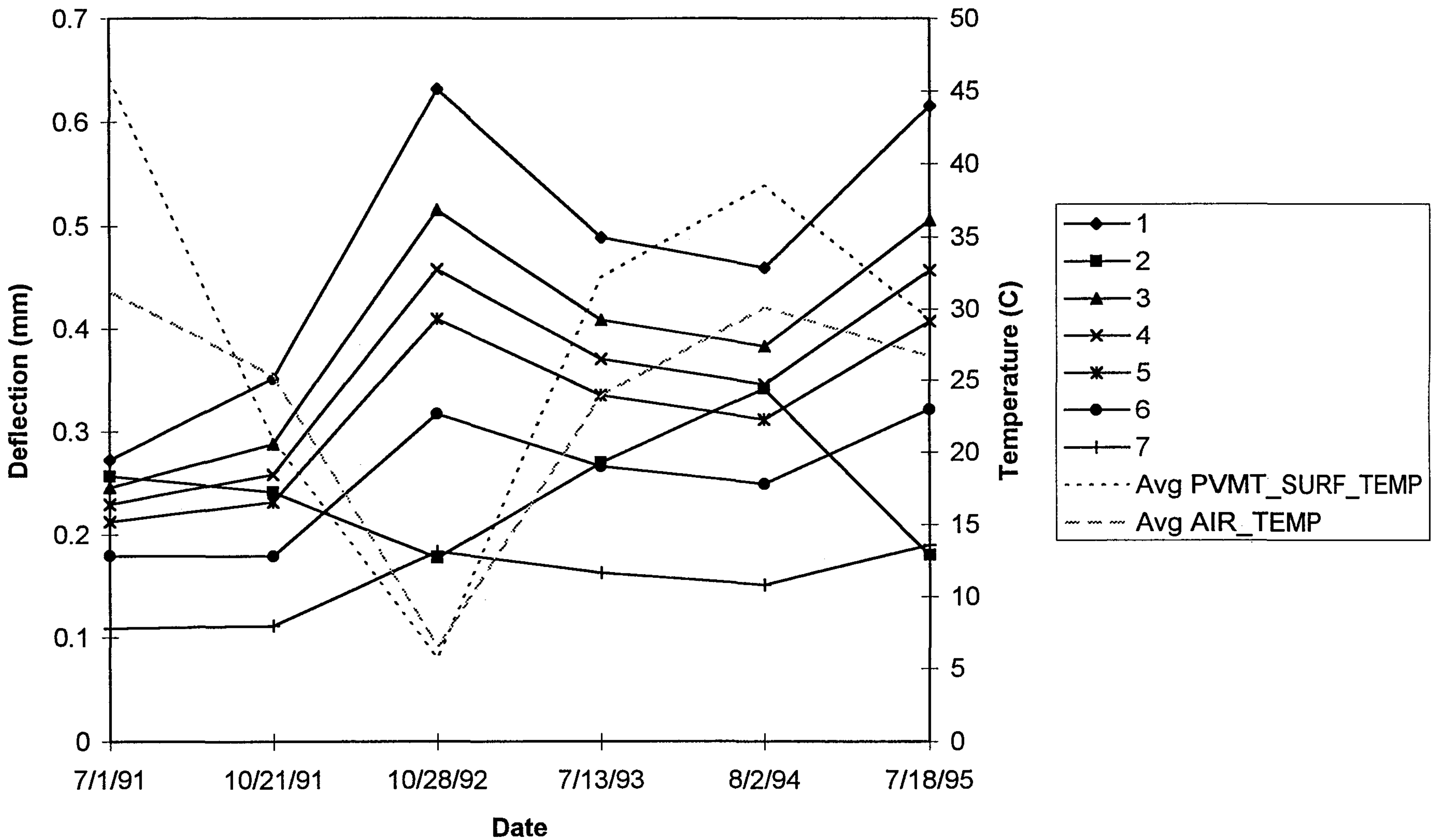


Figure 18. Normalized deflections for South Dakota section 46A430, leave slab (J5), all sensors.

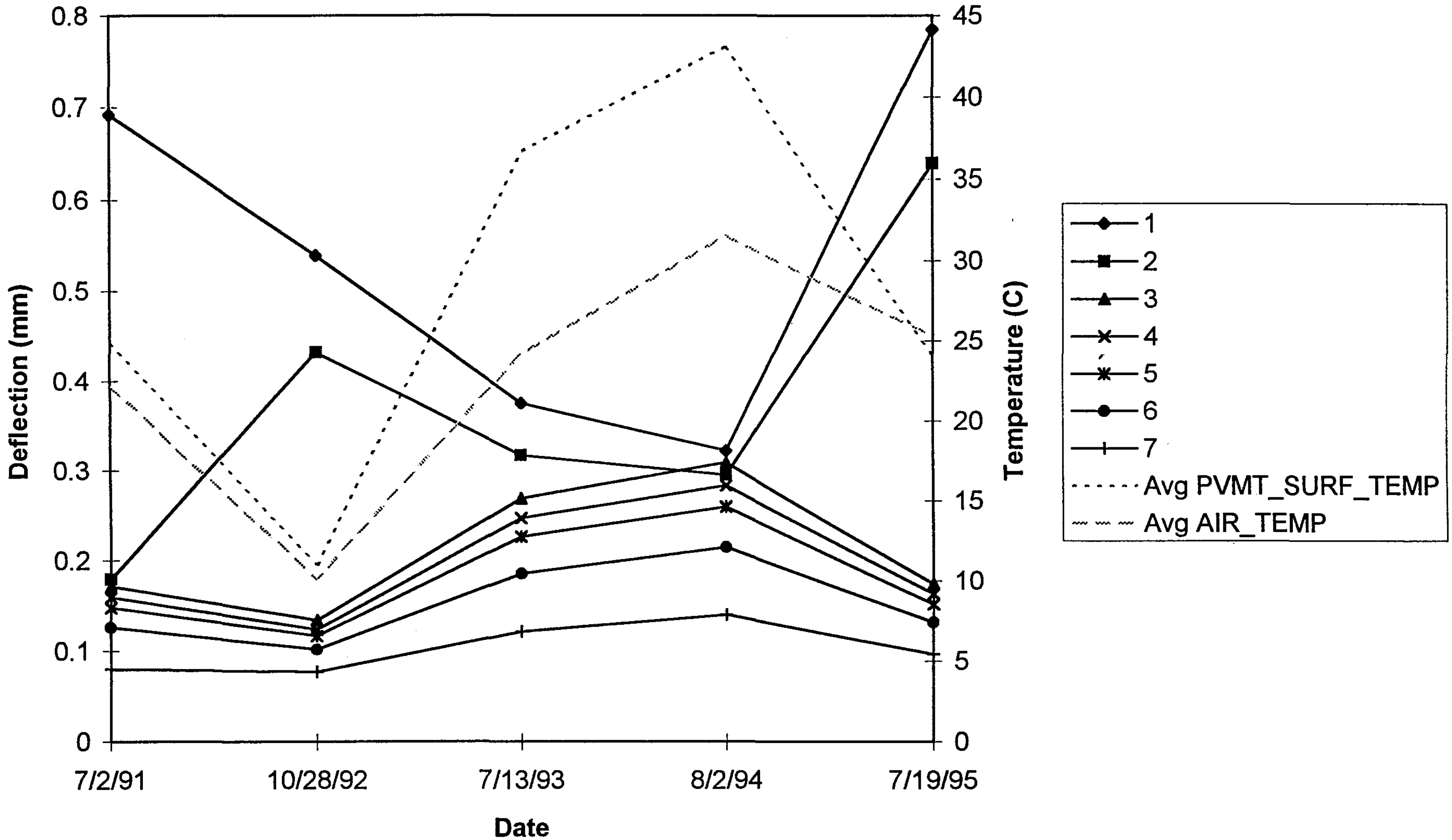


Figure 19. Normalized deflections for South Dakota section 46A420, approach slab (J4), all sensors.

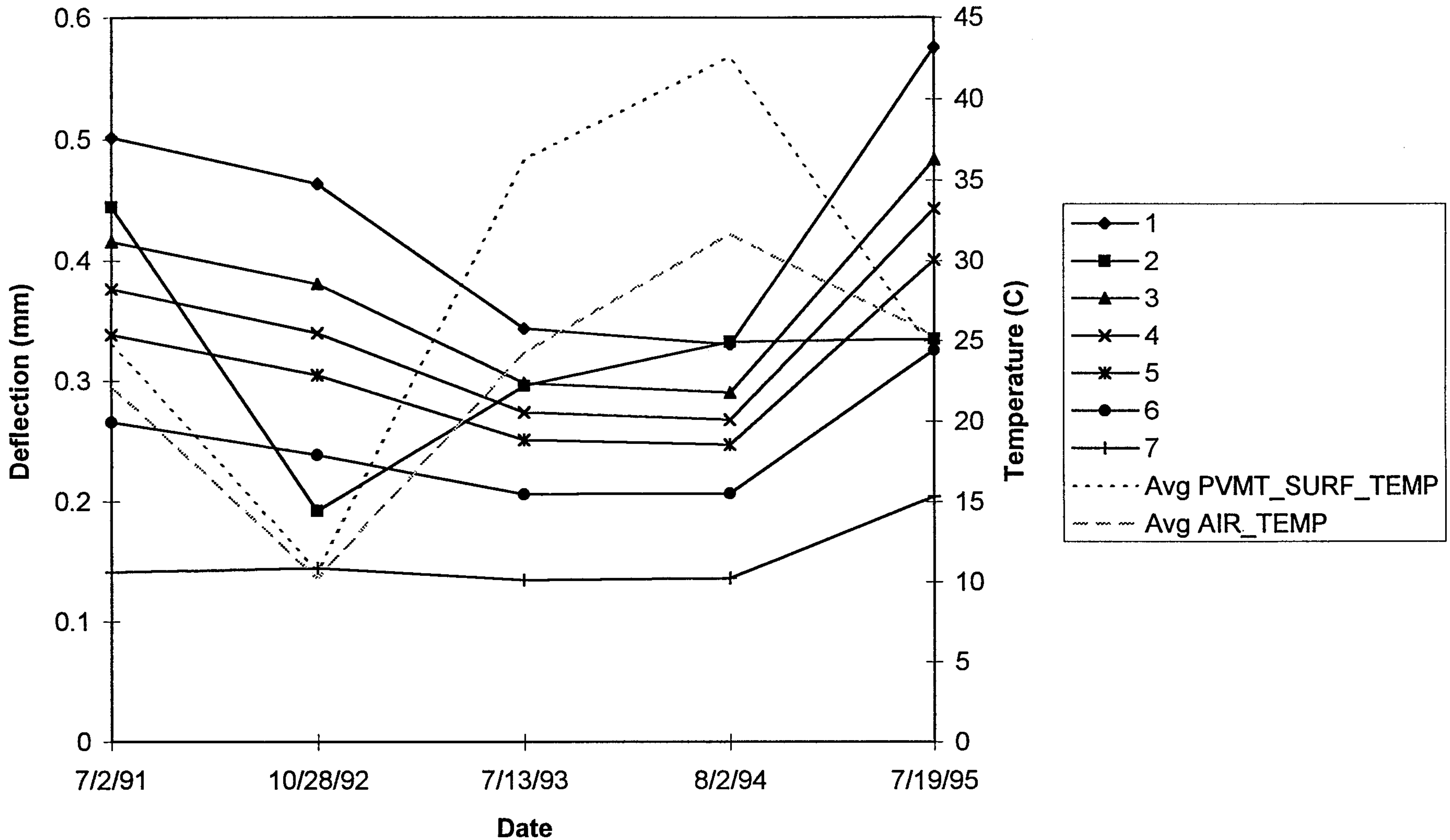


Figure 20. Normalized deflections for South Dakota section 46A420, leave slab (J5), all sensors.

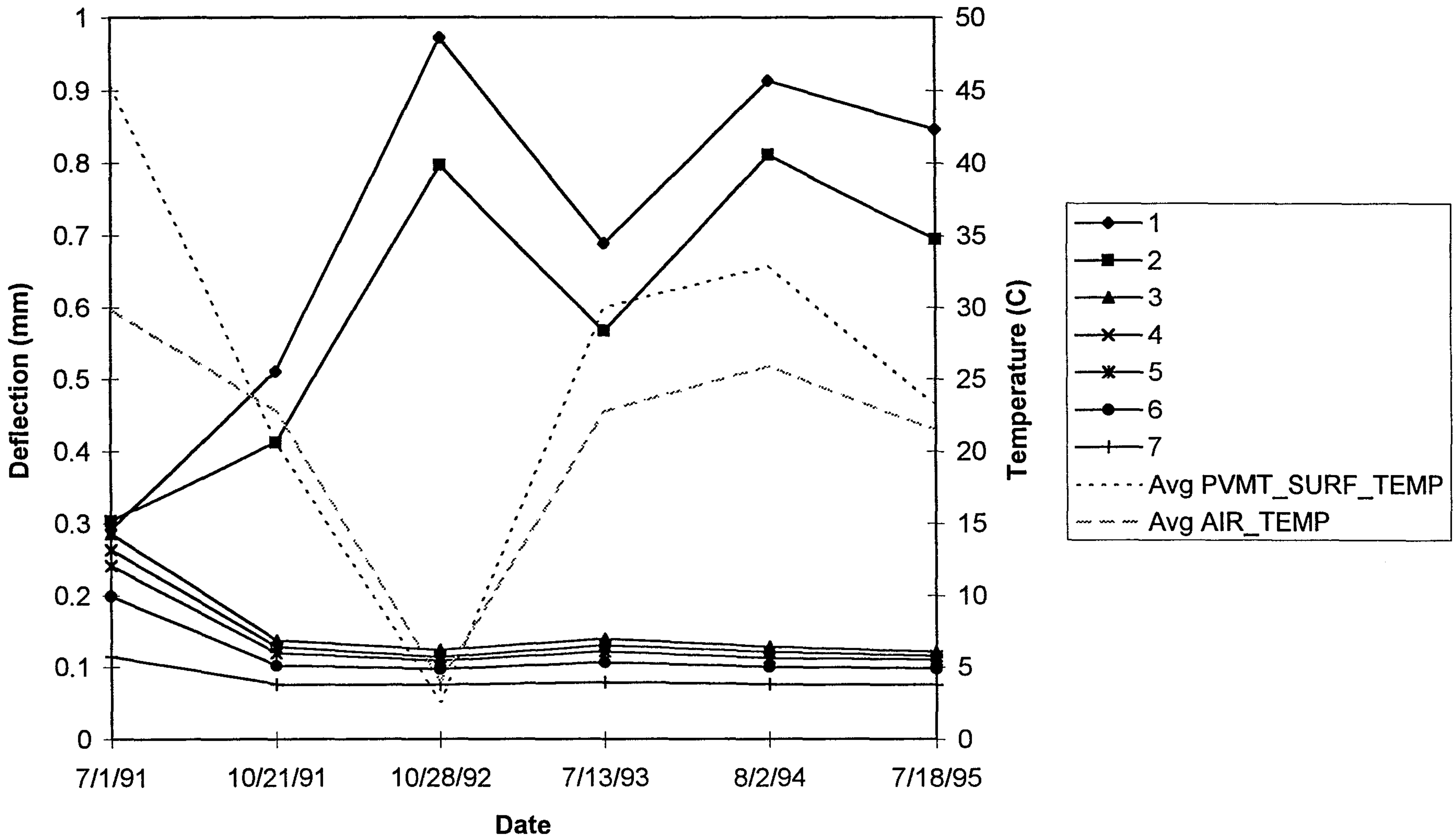


Figure 21. Normalized deflections for South Dakota section 46A410, approach slab (J4), all sensors.

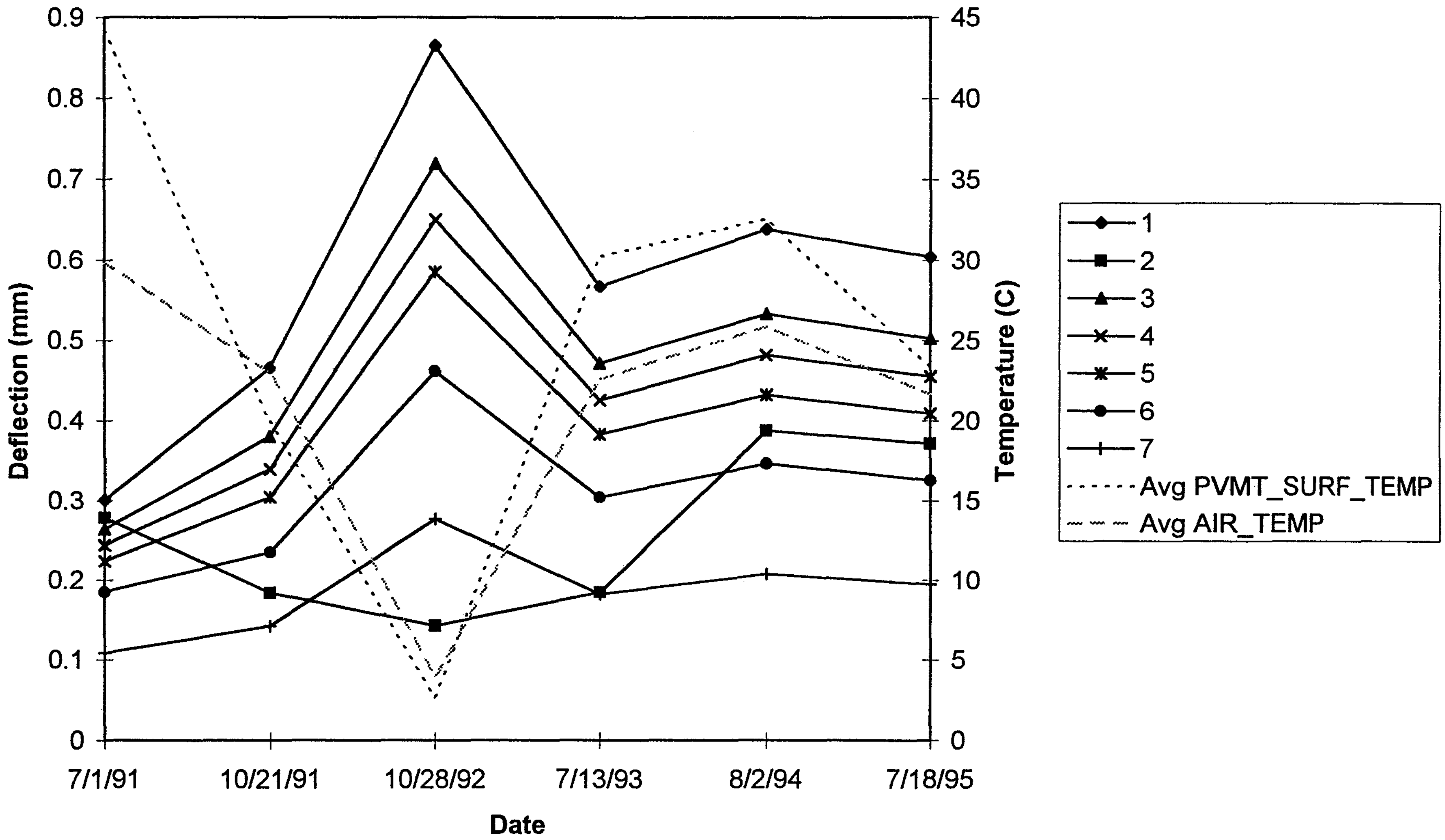


Figure 22. Normalized deflections for South Dakota section 46A410, leave slab (J5), all sensors.

Three test sections increased slightly over time: California-6B, Nevada-32A, and South Dakota-46A. Also, a problem with locked joints during testing rendered some of the data unusable. This is particularly evident at the Nevada site where approach and leave slab deflections remain virtually equal throughout (table 4).

By comparing the approach and leave slab deflections, researchers could measure the effectiveness of the load transfer. For example, if deflection data indicates less than excellent load transfer (less than 90 percent) at one point in time, and high load transfer (nearly 100 percent) at a later point in time, the reason for changes in load transfer is that the joints locked because of slab temperature expansion. When this happens, slab support cannot be measured. Researchers can extrapolate slab temperature by considering the season in which data was collected. For example, the underseal section deflections for approach and leave slab are nearly equal in July 1993. Previous measures in October 1991 and 1992 indicate less load transfer efficiency.

After 5 years of monitoring, it is not possible with the available SPS-4 site data to determine the effective duration of slab undersealing. It is reasonable to expect that this duration is affected by climate.

Normalized deflection plots over time are presented in figures 23 and 24 for the South Dakota site.

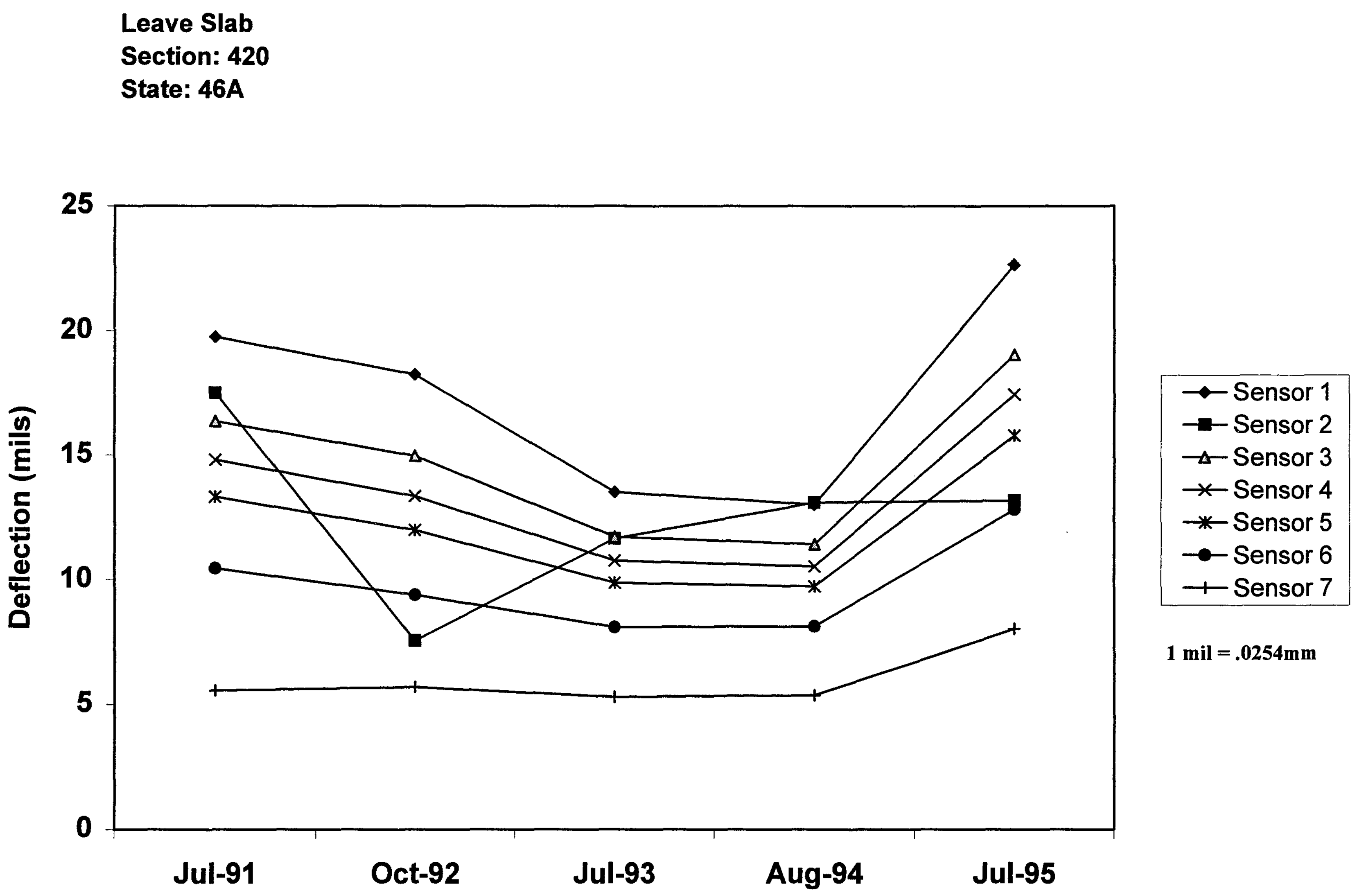


Figure 23. Deflections for SHRP underseal projects, normalized to 9000 lbs (4082kg) (South Dakota).

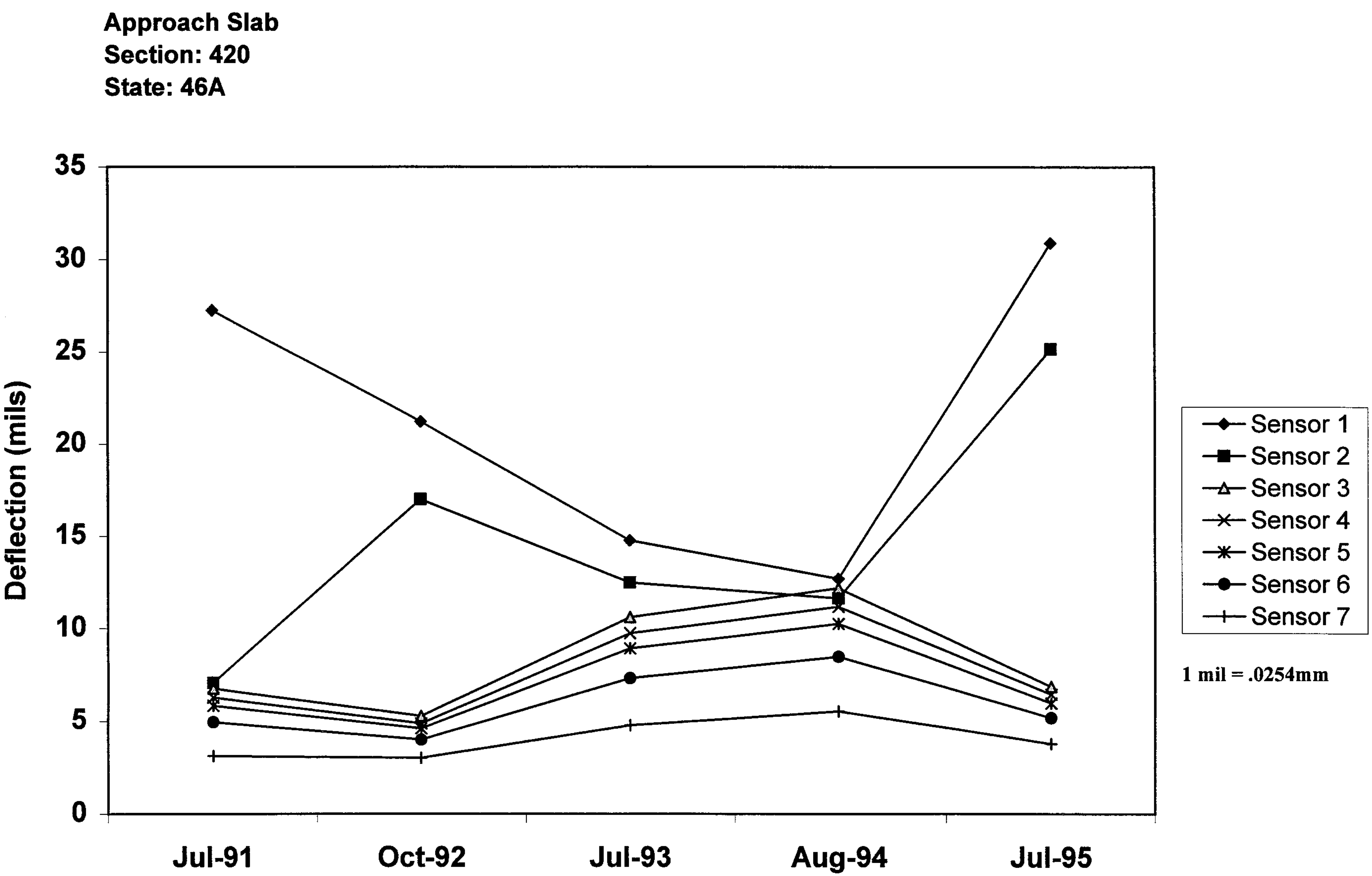


Figure 24. Deflections for SHRP underseal projects, normalized to 9000 lbs (4082kg) (South Dakota).

LIFE-CYCLE COST ANALYSIS

At this early stage of performance evaluation, not enough information is available to address the issue of life-cycle costs for the rigid pavement treatments. While failure data is being gathered on the joint sealant material supplemental sections, this has been analyzed elsewhere.[13]

SUMMARY AND CONCLUSIONS

SUMMARY

The SHRP SPS-4 experiment provided an opportunity to evaluate the performance of preventive maintenance treatments. The objectives were to evaluate the effectiveness of the treatments in preserving pavement condition level, to determine the optimum timing to apply the treatments in terms of pavement distress, and to provide an opportunity for highway agencies to share information about maintenance treatments.

The study of these test sections has met these objectives. Although the treatment test sections have not reached the end of their performance lives, strong evidence has been collected to support the positive contribution of the maintenance treatments to preserving pavement condition. Continuation of the experiment evaluation will allow for the SPS-4 evaluation to be closed out as the test sections reach the end of their performance lives.

CONCLUSIONS

More time is required to obtain meaningful results from the SPS-4 sections. To date, sealed joints have incurred less distress than unsealed joints, and supplemental sections of diamond grinding, load transfer, and pavement edge drains appear to help maintain good pavement performance.

Underseal sections generally are performing better than unsealed joint sections, as determined from profile and limited deflection data. The unsealed sections generally are rougher and have greater deflections than sealed sections. These observations are based on a limited number of sections, particularly the underseal sections, with very limited geographical distribution. Most of the underseal sections are in dry climates. In some cases, it is apparent that roughness was increased in the underseal sections, presumably as a result of improper construction monitoring. Much of the deflection data reveals locked joints, leaving very limited useful data for comparison purposes.

These conclusions can be summarized as follows:

- Joint seal sections are performing better than unsealed sections.
- Underseal sections are generally performing better than unsealed sections.
- The results of performance comparisons between joint seal sections and underseal sections are site specific.
- Silicone joint sealants appear to be providing the least joint seal failure to date.

These indications of performance are intended as preliminary guidance to highway agencies regarding the maintenance and preservation of jointed rigid pavements. The findings are not thoroughly conclusive at this early stage in rigid pavement performance.

Reprinted from the "SPS-4 Construction & Data Collection Guidelines"

APPENDIX A

SHRP MAINTENANCE EFFECTIVENESS STUDY OF RIGID PAVEMENTS (SPS-4)

This document provides guidance on implementation of the SHRP Maintenance Effectiveness Study of Rigid Pavements (SPS-4). Guidance is provided for state and provincial participating agencies and for SHRP Regional Engineers (RE) and Regional Coordinating Office Contractors (RCOC).

The rigid pavement maintenance effectiveness study (SPS-4) has been modified to allow agencies to participate in installation of sections with joint sealing and undersealing or with only joint sealing. Each agency may contract for installation of the test sections or install the test sections with their own forces. Some participating agencies have elected to cooperate in the installation by entering into a joint agreement for construction of the treatments. Joints and cracks in the concrete pavement will be sealed with silicone and the longitudinal concrete pavement-asphalt shoulder joint will be sealed with ASTM D 3405 material. A cement-fly ash grout will be used for undersealing as described on page 7 of these SPS-4 guidelines.

Future inspection of joint and crack sealing and resealing will be done by the participating agency. However, the RCOC should plan for some level of quality control on this activity.

Regional Task Group - Each agency is a member of the Regional Task Group (RTG) established to guide the SHRP regional personnel during the planning, construction, and monitoring of the test sections. Each agency should have designated a representative to serve on the RTG and should plan to participate in all RTG meetings. For SPS-4 activities the RTG will provide a focus to communicate the individual agency activities with respect to SPS-4. These groups should assist in coordinating supplemental experimental sections that are planned by participating agencies within a region as well as provide a forum for developing cooperative testing and treatment application programs.

Payment for Treatments - Each participating state or province will be responsible for construction of the SPS-4 treatments according to participating agency regulations. States may use federal funds to pay for the SPS-4 treatments. The local FHWA representative should be contacted concerning the method for accomplishing this.

Data Entry - The RCOC is responsible for all data entry into the SHRP data base. This includes data collected by RCOC personnel, during lab testing, and by participating agency personnel.

Coordinate the Work to be Performed - SHRP Regional Engineers (RE) and RCOCs will assist in coordinating the construction schedule. Coordination should insure that any required surface preparation is applied at least 15 days prior to application of the maintenance treatments. The SHRP RCOC staff will function as a technical resource in support of participating agency SPS-4 activities.

Where possible the SHRP RCOC will provide staff to collect construction data on joint/crack sealing and undersealing installations. When SHRP RCOC staff is not available participating agency staff will collect the data.

Laying Out Treatment Sites - The RCOC will layout the SPS-4 treatment sites with participating agency assistance. An example of an SPS-4 site is shown in Figure 1. SHRP-LTPP procedures and data sheets for maintenance location can be utilized to lay out the specific SPS-4 treatment sections. Figure 2 is an example of use of such a location summary sheet. The data collection sheets include a "Reference Project Station Table, Construction Data Sheet 1", which must be completed for each SPS-4 test location which ties all treatment sections and control sections to the adjacent GPS section. Each joint, crack, verification hole, deflection test location, distress, epoxy core test location, grout injection hole, etc. can be located by station number or station number and offset from the pavement edge.

Location of the unsealed section may influence other treatment sections. Figure 3 provides guidance on treatment location within an SPS-4 site for various terrain conditions to minimize this influence. Sag verticle curves should be avoided if at all possible.

Assurance Coring and Site Verification - Assurance coring is part of the site verification process and should precede treatment application. The participating agency will perform the coring in coordination with the SHRP RCOC. Verification of the pavement sections for SPS-4 sites is slightly different than for SPS-3 sites. Testing at the GPS site will provide general confirmation of the pavement section for SPS-4. However, construction records should be reviewed to insure that there is no change in surface thickness. The participating agency will provide manpower and the coring and drilling equipment to take at least one six inch diameter core from the paved shoulder adjacent to each test section. Drilling should extend into the subgrade. Each layer material and thickness and subgrade type should be identified. Information concerning the field sampling, core, and classification of base and subgrade material will be recorded in accordance with the LTPP Field Material Sampling and Field Testing Guide. The SHRP section ID number will be the SPS-4 section ID number. The following sheets will be required:

1. Project Site Reports, Form S07, and

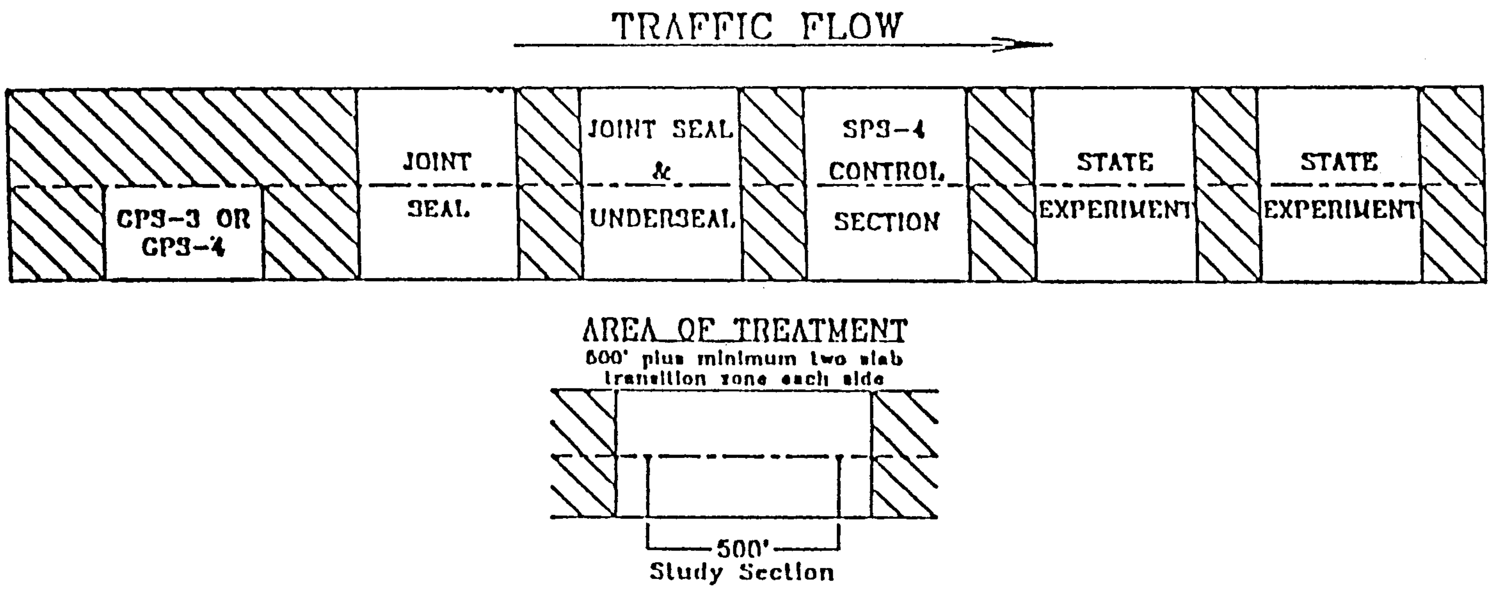
2. Field Material Sampling and Field Testing, Log of Bore Hole, Form S05

The SHRP section testing number system for SPS 3 and 4 was previously provided to all RCOC's and Regional Engineers. No laboratory testing of cores or materials obtained during verification sampling is planned.

FIGURE 1

PROPOSED CONSTRUCTION LAYOUT OF H-101 MAINTENANCE TREATMENTS

SPS-4: JCP Maintenance Effectiveness



Maintenance Data

LTPP Program

MAINTENANCE LOCATION SUMMARY

State Assigned ID [_ _ _ _

State Code [_ _

SHRP Section ID [_ _ _

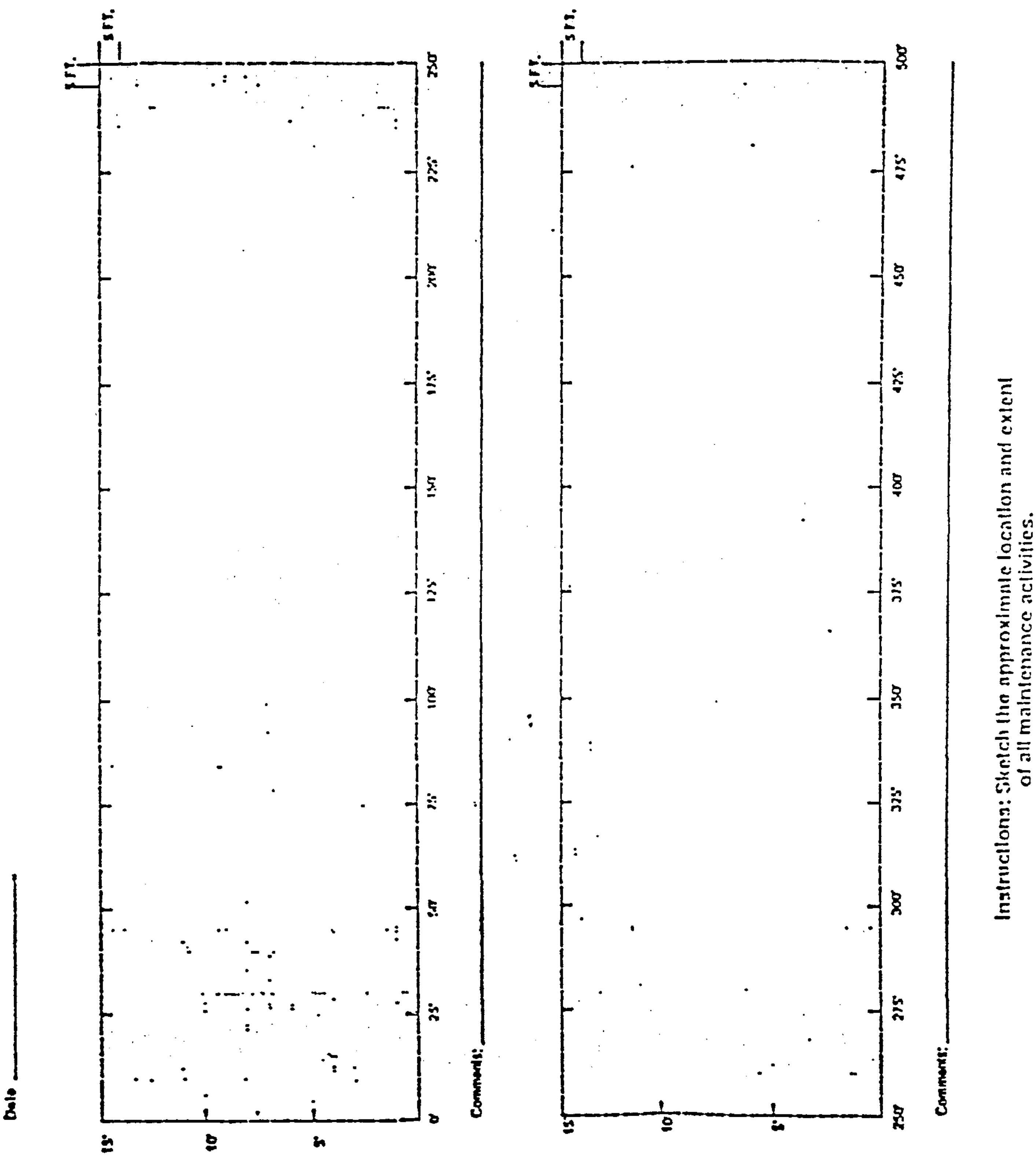
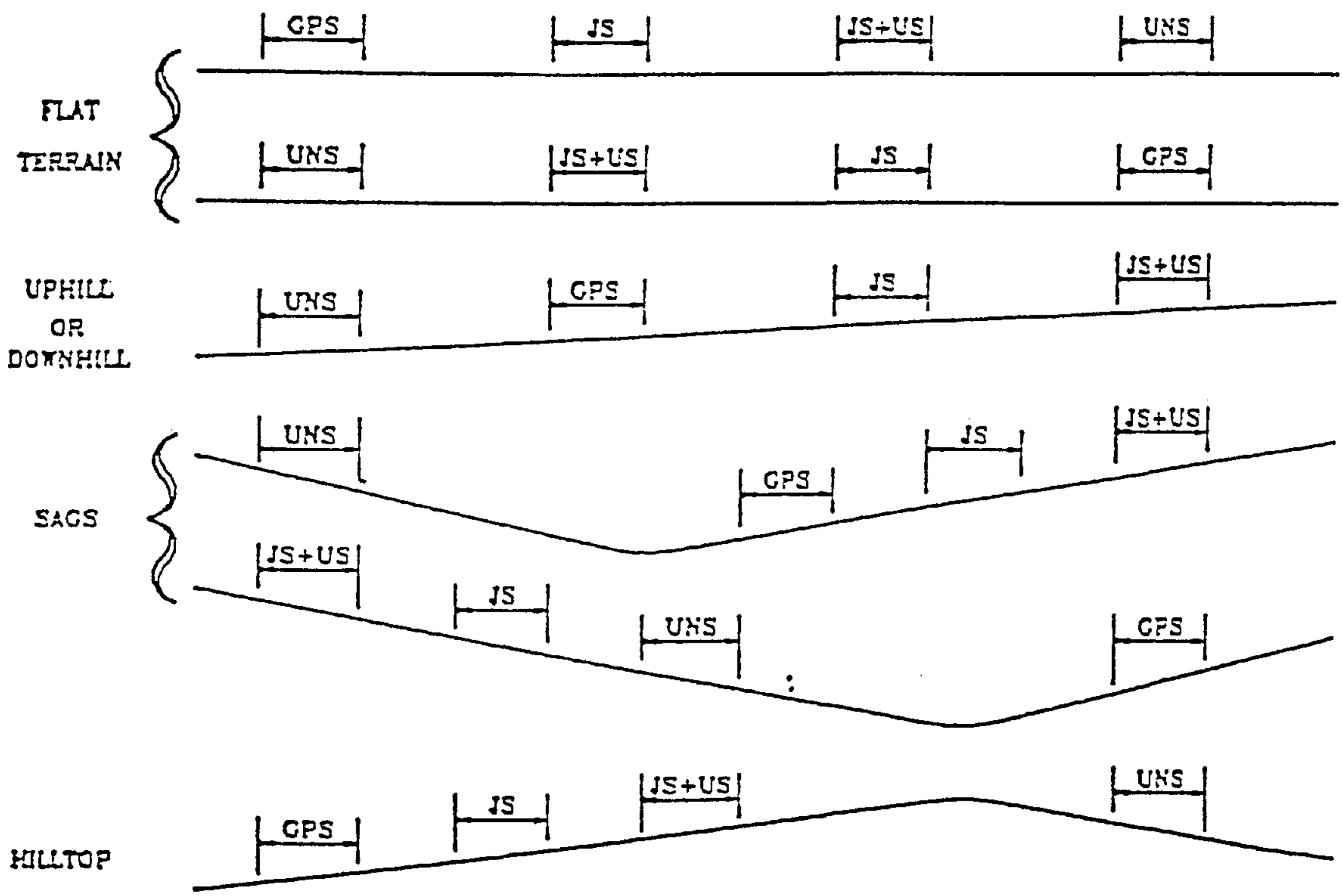


Figure 2. Example Location Summary Sheet.

FIGURE 3

POTENTIAL OPTIONS FOR SPS-4 SECTION LAYOUT



JS = JOINT SEAL, US = UNDERSEAL, UNS = UNSEALED control

GPS = GPS-3 or GPS-4 Section.

Initial Condition Testing - SHRP will conduct a distress survey within 90 days prior to application of the treatments. This and subsequent distress surveys should include measurement of faulting and edge drop off. FWD deflection and roughness testing should also be conducted on the GPS and all SPS-4 sections prior to treatment applications and biennially thereafter. Standard loss of support testing for underseal sections will be conducted using the Benkelman Beam (Field Protocol H32F) to determine which joints and cracks to underseal. The undersealing criteria are provided in the SPS-4 Attachment B. Field Protocols describing the testing are given in SPS-4 Attachment A.

Surface Preparation - Surface preparation should be performed at least 15 days in advance of treatment application. The participating agency is responsible for performing the necessary surface preparation for all test sections. This includes completing the appropriate parts of the quality assurance and construction monitoring checklists. Surface preparation will be coordinated with the RCOC who will assist in identifying the areas to be repaired. SPS-4 Attachment C contains guidelines for surface preparation and suggested materials. The surface preparation data collection sheets are provided in SPS-4 Attachment D.

Materials Sampling - The RCOC may assist with material sampling if adequate prior coordination is completed. Either the participating agency or RCOC will sample, package, and submit the joint and crack sealant material samples to Western Technologies, Phoenix, AZ for testing. Joint and crack sealant sampling is required for each lot purchased. Sampling requirements for ASTM D 3405 liquid sealant and silicone sealant are given in SHRP protocols H33F and H34F respectively, which are included in SPS-4 Attachment A.

All joint and crack sealant samples will be marked, packaged, and shipped in accordance with the SHRP-LTPP Field Material Sampling and Field Testing Guide. They will be accompanied by Form S06, Material Samples Inventory for Shipment to Laboratory. Sample location will be S001 when they are taken at the source at which the materials are produced. Joint and crack sealant sample numbers will be designated HC01 for H-101 joint and crack sealing material. The joint and crack sealant materials will be designated CKSL for the ASTM D 3405 and CKSS for the silicone. Sample material will be identified with the section identification number when section identification numbers are required.

For the undersealing sections, a single cement source will be used. Cement may be type I, II or III as per AASHTO M-85. Similarly, the fly ash as specified by ASTM C 618 will be purchased from a single source. Certification of the cement and fly ash will be submitted to the RCOC.

Laboratory Testing - The SHRP Materials Testing Laboratory, Western Technology, Inc. Phoenix, AZ will conduct joint and crack sealant testing. Upon receipt of samples, tests will be completed as quickly as possible. Copies of the results will be forwarded to the participating agency, RCOC and T.J. Freeman, TTI, Texas A&M University, College Station, TX 77843-3135. Test results will be entered into the SHRP data base by the RCOC.

Laboratory testing requirements for liquid sealant and silicone sealant are given in SHRP Lab Protocols H16L and H17L respectively as described in SPS-4 Attachment A. Results should be recorded on Form H15 and Form H19 provided in SPS-4 Attachment E.

Traffic Control During Construction - Each agency is responsible for providing, directly with its own forces or through contract, traffic control during surface preparation, testing and installation of joint seal and underseal test sections.

Preparation of Control Section - The control section for joint sealing will be a section with ineffective joint sealer. If the section is new construction then the joint sealer should not be installed. The control section of an existing pavement should have the existing joint seal rendered ineffective or removed. As a result, three joint seal conditions will exist:

1. Ineffective joint seal (SPS-4 control)

2. Routine Maintenance (GPS section)

3. Complete Seal (SPS-4 joint seal section) and if desired complete seal and underseal (SPS-4 joint seal/underseal section.)

It is hoped that specific performance relations can be developed as to the benefit of good joint sealing as opposed to routine maintenance and ineffective joint sealing.

Joint Seal and Underseal Materials - Longitudinal joints between the concrete pavement and asphalt shoulders are to be sealed with ASTM D 3405 liquid sealant. A silicone sealant is to be used to seal joints and cracks in the concrete pavement. Portland cement grout is to be used for undersealing consisting of 1 part (by volume) cement, 3 parts (by volume) fly ash, and sufficient water to achieve an efflux of 9 to 15 seconds per ASTM C 939-87. Data sheets for documenting the mix design and material sources are in Attachment F.

Installation of Joint Seal and Underseal - A set of guide specifications is provided in Attachment G for undersealing, joint sealing of cracks and joints, and patching. These guide specifications are provided to help the participating agency adjust their own specifications and practices to achieve some measure of uniformity among the installations. Examples of grout injection hole patterns are included with the specifications in Attachment G. However, site conditions will likely control the final hole pattern.

Undersealing will be applied to both approach and leave sides of joints/cracks that exceed 0.020 inch deflection when measured by the Benkelman Beam. The undersealing will be applied to both sides of the joint even though only one side of the joint/crack exceeds the 0.020 inch deflection criteria. The undersealing will be applied to the joint or crack in the adjacent lane when the joint or crack is undersealed in the SPS-4 test section.

The participating agency will be responsible for installation of the joint seal and underseal test sections including completing the quality assurance and construction monitoring checklist. The appropriate data collection sheets are provided in Attachment F. General items to be monitored includes initial deflection tests, stability tests, equipment calibration, material volumes, locations, temperatures and other similar tasks.

Specific data required for joint and crack sealing activities include air temperature, relative humidity, temperature of the sealant, width of joint and cracks, depth of sealant below pavement surface, depth of backer rod, application pressure, and thickness of sealant. Relative humidity can be based on local weather information. Temperature of the ASTM D 3405 sealant can be based on the calibrated temperature gage on the sealant heating equipment.

Undersealing data required includes deflection measurements, air temperature, relative humidity, fluidity of the grout (Field Protocol H35F), volume of the grout pumped per hole, hole pattern distances, depth of holes, amount of materials, and pumping pressure. Relative humidity can be based on local weather information.

Each agency is requested to coordinate the installation of the joint seal and underseal test sections with their SHRP RCOC. There may be SHRP representatives at some sites during construction.

State Experimental Sections - Several participating agencies are interested in installing their own test sections adjacent to the SHRP designated test sections. The participating agency will be responsible for constructing these test sections and for completing the appropriate quality assurance and construction monitoring checklists. Appropriate background data must be collected for these additional sections. Data collections sheets to be utilized may be taken from those found in SPS-4 Attachment F or the SHRP "Data Collection Guide for Long-Term Pavement Performance Studies" The later data collection sheets are found in Chapter 6, Maintenance Data or Chapter 7, Rehabilitation Data. These data sheets are available from the RCOC.

After Construction Condition Monitoring - A distress survey should be made six months after application, one year after application, and on an annual basis thereafter. Initial and subsequent condition surveys should include measurements of faulting and edge drop off. It is requested that the deflection testing be conducted on the SPS-4 test sections biennially. At this time, deflection testing of the underseal section should include Benkelman Beam testing (Field Protocol H32F) in addition to FWD testing (Field Protocol H30F) using the SPS-4 testing plan for these devices.

Resealing Crack and Joints - Each agency will be required to check the condition of the crack and joint sealant in the SPS-4 sections following the initial installation and to reseal them when needed. It is requested that the reinspection and resealing be conducted semi-annually before the wet or freeze periods at the particular site. The goal is to keep the cracks and joints sealed so the effect on pavement performance can be determined over a reasonable time period. The RCOC should coordinate a quality control process with the agencies for this important activity.

Control of Future Maintenance and Coordinate Major Maintenance or Rehabilitation - The participating agency must control and document the maintenance and rehabilitation applied to the SPS-4 sites. This includes the sections to which a treatment has been applied as well as the control sections.

Safety related, localized maintenance may be performed according to the governing highway authority standards at any time; however, information concerning the application of that maintenance should be recorded on applicable data sheets from the SHRP "Data Collection Guide for Long-Term Pavement Performance Studies". These data sheets are contained in Chapter 6, Maintenance Data and can be provided by the SHRP RCOC. Safety related items include patching of deteriorated areas or other surface defects that would be a hazard to the travelling public.

At some point the test sections will reach a condition level which is unacceptable to the responsible highway authority and the condition cannot be maintained at an acceptable level with the spot maintenance allowed. Prior to the application of any intense maintenance or rehabilitation, the agency should contact the SHRP Regional Coordination Office to arrange for a mutually agreeable date after which the agency can apply their desired rehabilitation treatment. This will allow the SHRP RCOC to collect a final set of data prior to removing any specific section from the study. Some lead time will be required to arrange for the required testing and data collection. Each test section should be allowed to deteriorate to a reasonably low level of condition to adequately define the impact of applying preventive maintenance. However, that condition level should not create a safety hazard. General guidance on the minimum condition for SPS-4 sections is:

1. A PSI of 2.5

2. Criteria normally used by the responsible highway authority.

Each individual test section in a SPS-4 site should be allowed individually to reach the reduced level of condition and be removed from the test one at a time. It is believed that the control sections will reach the terminal condition first. After the last test section reaches the terminal condition and it is inspected by the SHRP RCOC, the location will no longer be considered an SPS-4 test site.

Provide and Maintain Signs and Markings - The participating agency must provide, install and maintain permanent signs and paint markings to indicate that the site is an SPS-4 test site. A copy of the signing requirements are included an Attachment H.

Provide Quality Assurance - Participating agencies are responsible for surface preparation, quality assurance during installation of the test sections and acceptance of the final product.

Miscellaneous - Various points have been raised by reviewers and users of this document. The points have been stated in the form of questions. A list of these questions and answers are given in SPS-4 Attachment I.

Expanded Testing Program for Undersealing Projects

A few agencies have expressed an interest in an expanded test program to determine suitability of site for undersealing. The expanded testing program for loss of support conditions will only be conducted in cooperating participating agencies or groups of participating agencies which request such a program through their respective SHRP Regional Engineers. It is fully described in SPS-4 Attachment J which will be distributed under separate cover to those desiring to participate in that study.

SPS-4 ATTACHMENT A
LABORATORY AND FIELD PROTOCOLS

LIST OF LAB PROTOCOLS FOR SPS-4

TEST NUMBER	SHRP PROTOCOL NUMBER	SUBJECT	PAGE NO.
AE02	H03L	Penetration of Bituminous Materials	A2
CS01	H16L	Joint Sealants, Hot-poured, for Cement and Asphalt Pavement	A3
CS02	H17L	Joint Sealants, Silicone	A4

LIST OF FIELD PROTOCOLS FOR SPS-4

TEST NUMBER	SHRP PROTOCOL NUMBER	SUBJECT	PAGE NO.
HF10	H30F	Falling Weight Deflectometer Deflection Testing	A5
HF12	H32F	Benkelman Beam Deflection Testing	A6
HF13	H33F	Sampling ASTM D 3405 Crack and Joint Sealant Material	A7
HF14	H34F	Sampling Silicone	A8
HF15	H35F	Flow of Grout Mixtures	A9

SHRP Protocol: H03L
For SHRP Test Designation: AE02
Penetration of Bituminous Materials

The SHRP protocol covers the determination of the penetration of asphalt cements at 25° C (77° F). It is intended to be used on asphalt cements extracted from cores recovered from pavements as a part of the SPS-3 studies. The test shall be performed in accordance with AASHTO T 49-89I, Standard Method of Test for Penetration of Bituminous Materials, except as designated below. The test shall be conducted at 25° C (77° F). The 50 gram weight will be placed on the needle providing a 100 gram weight total. Use this test in place of ASTM D5 when necessary. When performing the test in accordance with ASTM D3407-78, use a penetration cone in place of the needle, meeting the requirements established in paragraph in paragraph 5 of ASTM D3407-78.

The results will be recorded on SHRP Test Sheet H15 for SPS-4 in SPS-4 Attachment E.

SHRP Protocol: H16L
For SHRP Test Designator: CS01
Joint Sealants, Hot-Poured, for Cement and Asphalt Pavements

This SHRP protocol covers the test for bituminous hot-poured types of joint sealants for portland cement concrete and asphaltic concrete pavements. These tests are intended for materials which are hot-poured, joint or crack sealants. The tests will be performed in accordance with ASTM D 3407-78, Standard Method of Testing Joint Sealants, Hot-Poured, for Concrete and Asphalt Pavements. Alternate Procedure 7.4.1 may not be used, and Preparation of Specimens under 9.1.1 must be completed in accordance with AASHTO T 245-89I. Penetration tests required in paragraph 5 shall be completed in accordance with SHRP Protocol H03L.

The results will be recorded on SHRP Test Sheet H15 in SPS-4 Attachment E.

SHRP Protocol: H17L
For SHRP Test Designator: CS02
Joint Sealants, Silicone

This SHRP protocol covers the tests for silicone joint sealants for portland cement concrete pavements. The tests will be performed in accordance with Georgia DOT Standards Specifications, GA Dot 833.06, Silicone Sealants and Bond Breakers (Modification). A copy of the specification and test methods are given in SPS-4 Attachment G of the Manual for the SHRP Maintenance Effectiveness Study of Rigid Pavements (SPS-4). The results will be recorded on SHRP Test Sheet H19 in SPS-4 Attachment E.

SHRP Protocol: H30F
For SHRP Test Designation: HF10
Falling Weight Deflectometer Deflection Testing

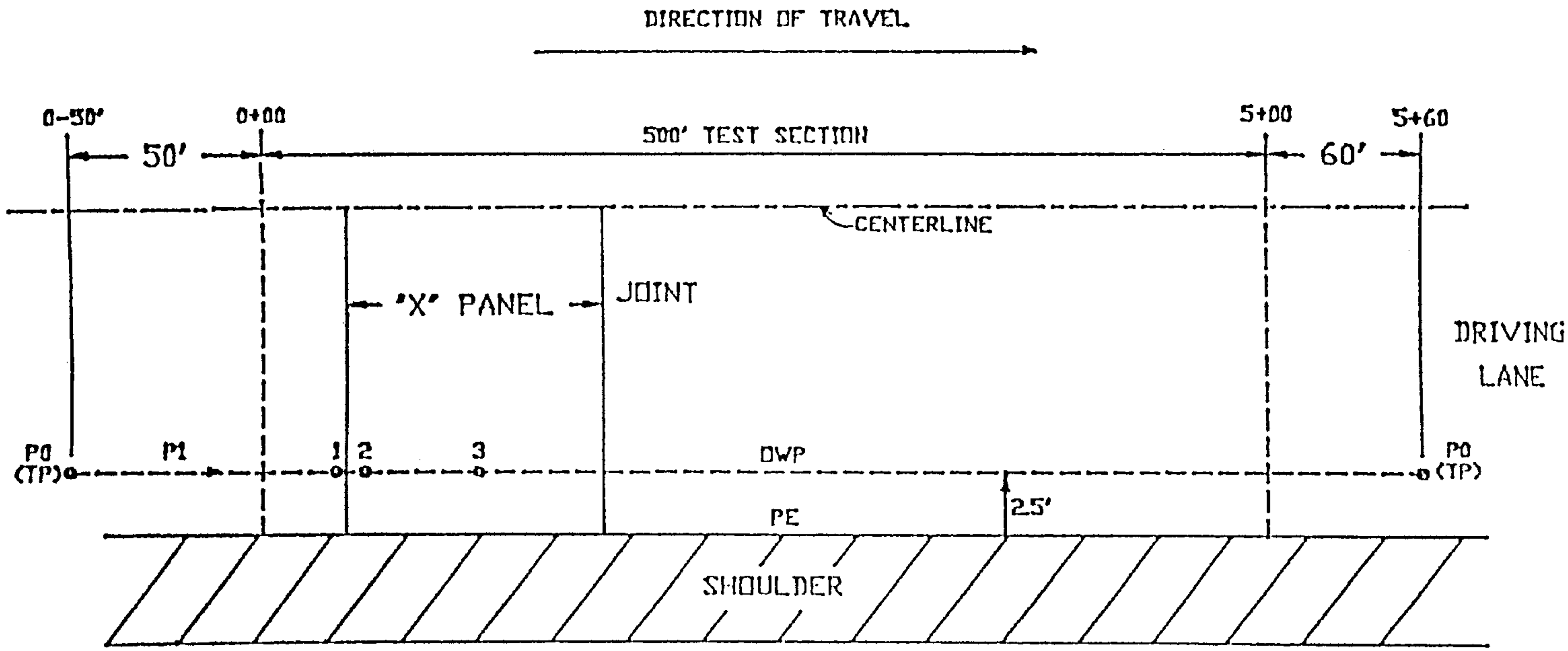
This SHRP protocol covers the use of a falling weight deflectometer (FWD) to obtain information on joint/crack load transfer, structural capacity and loss of support for SPS-4 sites. Operation guidelines and data transfer directions are found in the latest version of the "SHRP LTPP Manual for FWD Testing." The deflection testing for SPS-4 sites will consist of a single pass in the outer wheel path (OWP). Tests will be conducted on each side of the joint/crack and at the midslab as shown in the attached figure using the load transfer test sensor configuration. The standard test procedure for joint/crack sealing test sections, control sections, and state test sections will be to test the first joint and the center of the first slab. Every third joint and slab will be tested thereafter. Any cracks within the slabs tested will also be tested. For the underseal test sections, all slabs/panels in the section will be tested. For routine testing, the standard Rigid drop sequence will be used. When the FWD is being used in conjunction with other deflection equipment to test for void locations, the following drop sequence will be used:

Sequence No.	No. of Drops	Drop Height	Remarks
1	2	h_3	Note 1
2	3	h_1	Note 2
3	3	h_2	Note 2
4	3	h_3	Note 2

Note 1 Drops used for seating only, no data taken.
Note 2 Store deflection peaks only.

Data for the location and other information will be recorded on the Data Sheet in SPS-4 Attachment F. The deflection data will be recorded on diskettes in accordance with the "SHRP LTPP Manual for FWD Testing."

Temperature measurements will be conducted in accordance with the latest version of the "SHRP LTPP Manual for FWD Testing." However, temperature measurements need only be made at the GPS locations and at two additional locations within the treatment layout.



NOTE: FWD TESTS TO BE CONDUCTED AT BOTH (TP) LOCATIONS ON P0 (FIRST SET OF TESTS)
PANEL LENGTH "X" WILL BE VARIABLE DEPENDING UPON SPECIFIC JOINT SPACING, TRANSVERSE CRACK PATTERN AND PAVEMENT TYPE.

FWD TEST PLAN (SPS-4 TEST SECTIONS)

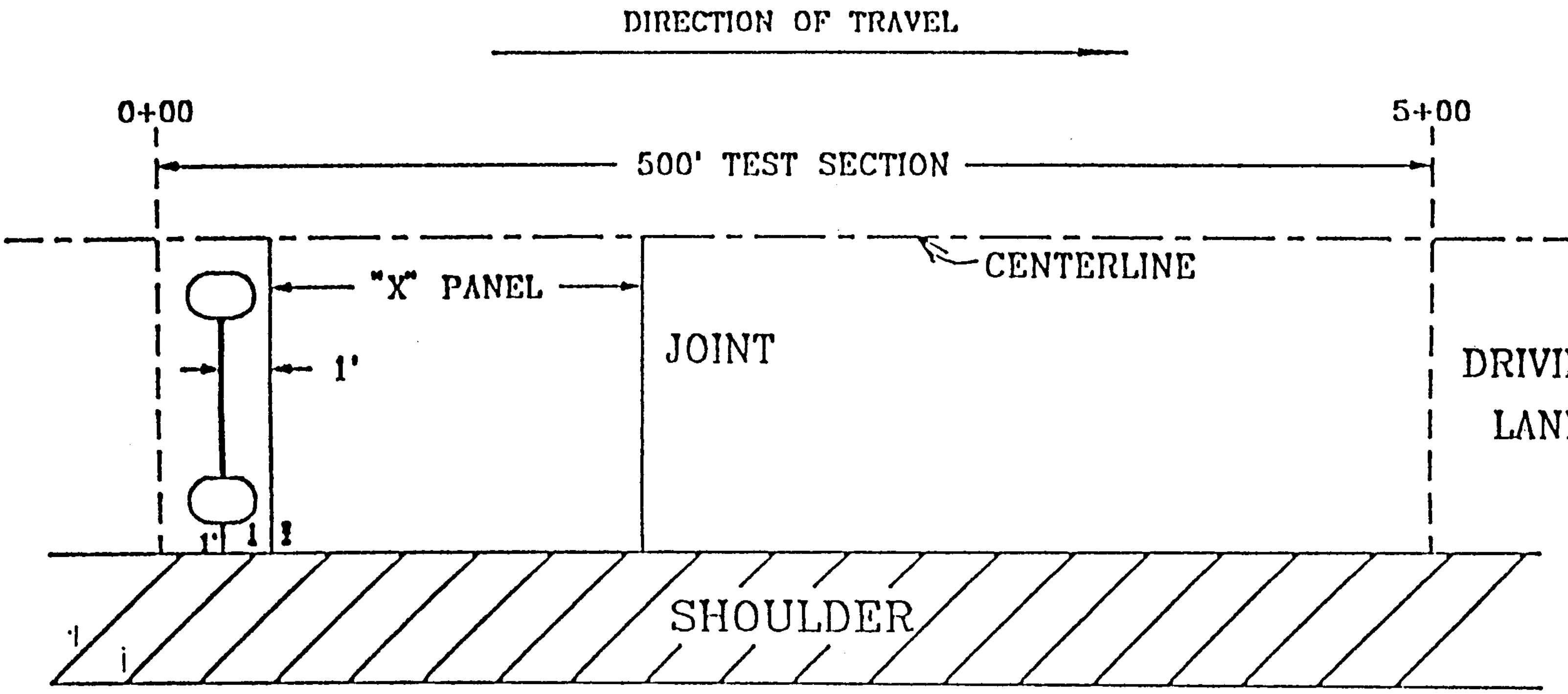
SHRP Protocol: H32F
For SHRP Test Designation: HF12
Benkelman Beam Deflection Testing

This SHRP protocol covers the use of a Benkelman Beam to determine locations to be undersealed as a part of SPS-4. Benkelman Beams shall comply with AASHTO T256, Standard Recommended Practice for Pavement Deflection Measurements, Part 3.2

Each joint or crack defining a slab or panel shall be tested. All testing shall be limited to the hours of midnight to 10 a.m. The testing should be stopped earlier if there is evidence of slab lockup due to thermal expansion of the slabs. Testing may be continued after the hour specified if the slabs are not interlocked or under compression. However, a stronger foundation or other improved pavement feature could also result in decreased deflection. Joint interlock will have to be evaluated on a site by site basis.

Time of testing may be reduced by using two Benkelman Beams. In such a case, position each Benkelman Beam so that the probes are across from each other at a joint or crack on the corners of adjoining slabs. Zero the gages with no load on the slab on either side of the joint or crack. Move the test vehicle parallel to the edge of the pavement so that the outside wheel of the test axle is within one foot of the edge. Stop the vehicle when the center of the test axle is about one foot from the joint or crack on the approach slab. Read both gages and record the data. Move the test vehicle across the joint or crack to a similar position on the leave slab with the center of the test axle one foot beyond the joint or crack. Read both gages and record the data on the Data Sheets in SPS-4 Attachment F. Test adjoining slabs or panels for each joint or crack. All joints with deflections in excess of 0.020 inch will be subsealed in accordance with the plans and specifications. If only one Benkelman Beam is used the axle load will have to be repositioned to obtain loaded and unloaded data for each side of the joint or crack.

During deflection testing the Benkelman Beam will be positioned on the shoulders for two lane roads or on an adjoining lane when there are more than two lanes.



NOTE: BENKELMAN BEAM TESTS TO BE CONDUCTED AT EVERY JOINT/CRACK IN SECTION WITH TEST AXLE LOCATED AS SHOWN AND ON OTHER SIDE OF JOINT/CRACK. POINTS 1 & 2 ARE LOCATIONS OF BENKELMAN BEAM PROBES. PANEL LENGTH "X" WILL BE VARIABLE DEPENDING UPON JOINT SPACING, TRANSVERSE CRACK PATTERN AND PAVEMENT TYPE.

BENKELMAN BEAM TEST PLAN (SPS-4 TEST SECTIONS)

SHRP Protocol: H33F
For SHRP Test Designation: HF13
Sampling of ASTM D 3405 Crack and Joint Sealant Material

This SHRP protocol covers the sampling of ASTM D 3405 crack and joint sealant materials at the point of manufacture, supply terminal, or at point of delivery. It is intended that the sampling be performed on crack and joint sealants used in the H-101/SPS-4 studies. The sampling shall be performed in accordance with ASTM D 3405, paragraph 6. The sample size will conform to the requirements of paragraph 6, (ten pounds). A sample from each individual source of sealant used shall be taken.

SHRP Protocol: H34F
For SHRP Test Designation: HF14
Sampling Silicone Sealant

This SHRP protocol covers the sampling of GA DOT 833.06 joint sealant materials at the point of manufacture, supply terminal, or at point of delivery. It is intended that the sampling be performed on joint sealants used in the H-101/SPS-4 studies. Two quart tubes or six 10 ounce tubes of sealant are required. A sample from each individual source of sealant shall be taken. The GA DOT specification and testing requirements are given in SPS-4 Attachment G.

SHRP Protocol: H35F
For SHRP Test Designation HF15
Flow of Grout Mixtures

This SHRP protocol covers the determination of flow of grout mixtures by the flow-cone method. It is intended that the testing be performed on the material used as grout for undersealing as a part of SPS-4. The test shall be performed in accordance with ASTM C 939, Standard Test Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method).

SPS-4 ATTACHMENT B
TESTING SPS-4 UNDERSEAL SECTIONS FOR LOSS OF SUPPORT

General

This document describes the procedures for deflection and void detection testing. The standard testing includes the use of Benkelman beams and falling weight deflectometer (FWD). Referenced SPS-4 Field Protocols are in SPS-4 Attachment A.

Deflection Testing

Deflection testing is required before and after undersealing installation. The Benkelman Beam will be used to determine the slabs to be undersealed. All slabs with deflections in excess of 0.020 inch will be subsealed. Stability testing will be done the day after the undersealing installation. Slabs which deflect in excess of 0.020 inch will be regrouted. Stability testing shall again be performed if regrouting occurs. Any slab that continues to show movement in excess of that specified after two properly performed groutings will be accepted. However, the accepted deflections need to be recorded.

Benkelman Beam

The following procedure is an excerpt from the SHRP SPS-4 specifications and is also contained in SHRP SPS-4 Field Protocol H32F. Each joint or crack defining a slab or panel within designated areas of the project shall be tested by the contractor in cooperation with the engineer using the Benkelman Beam. The contractor shall provide and operate the test truck and Benkelman beams. The engineer shall determine the areas to be undersealed. All testing shall be limited to the hours of midnight to 10 a.m. The testing should be stopped earlier if there is evidence of slab lockup due to thermal expansion of the slabs. Testing may be continued after the hour specified if the slabs are not interlocked or under compression. Joint deflections decrease significantly with joint interlock. However, a stronger foundation or other improved pavement feature could also result in decreased deflection. Joint interlock will have to be evaluated on a site by site basis.

The contractor shall provide and operate two Benkelman beams which comply with AASHTO Designation: T 256-77, Pavement Deflection Measurements. In that test method, procedures for use of the Benkelman beam are given in Section 5.2, Benkelman Beam.

During deflection testing the Benkelman Beam will be positioned on the shoulders for two lane roads or on an adjoining lane when there are more than two lanes. Position each Benkelman beam so that the probes are across from each other at a joint or crack on the corners of adjoining slabs. Zero the gages with no load on the slab on either side of the joint or crack. Move the test vehicle parallel to the edge of the pavement so that the outside wheel of the test axle is within one foot of the edge. Stop the vehicle when the center of the test axle is about one foot from the joint or crack on the approach slab. Read both gages and record the data. Move the test vehicle across the joint or crack to a similar position on the leave slab with the center of the test axle one foot beyond the joint or crack. Read both gages and record the data. Test adjoining slabs or panels for each joint or crack. The contractor will be responsible for reading and recording gage readings. Results shall be recorded in the appropriate SPS-4 data sheets. All slabs with deflections in excess of 0.020 inch will be subsealed in accordance with the plans and specifications.

It is the option of the participating agency to provide their own Benkelman beam and use their own forces. If only one Benkelman Beam is used the axle load will have to be repositioned to obtain loaded and unloaded data for each side of the joint or crack.

FWD

A testing plan has been developed that will be effective in obtaining information on joint/crack load transfer as well as structural capacity. Only one pass in the wheel path will be made, testing each side of the joint/crack and the midslab as shown in Figure 1. It has been shown that this test sequence can be accomplished on the SPS sections and GPS section in one morning with an early morning start. This procedure is also contained in SHRP SPS-4 Field Protocol H30F.

Expanded Analysis of Loss of Support

A few agencies have expressed an interest in participating in an expanded test program and analysis of deflection testing to determine loss of support. This testing would include using the Dynaflect, transient dynamic response system (TDR), and the epoxy core test for void detection. Those interested should contact their Regional Engineer to determine the requirements and procedures for that testing.

SPS-4 ATTACHMENT C

SURFACE PREPARATION REQUIREMENTS

SURFACE PREPARATION

Partial depth patching in the SPS-4 test sections may be required to insure sound concrete at joints and cracks to be sealed. In addition, patching restores the joint shape required for sealing. This work consists of partial depth patching of spalls and other surface distresses in portland cement concrete pavements. The areas to be patched will be determined by the contracting agency. Existing patching material and broken, damaged, or disintegrated concrete in the area to be repaired shall be removed and replaced with a high early strength portland cement concrete mixture. Sawing equipment shall be capable of sawing concrete to the specified depth in one pass. Concrete removal equipment shall be capable of removing the concrete in the repair area to the depth required without damaging the sound concrete below. The finished patch surface should be in close conformity with the existing pavement cross-section.

The extent of the repair area will be no less then 4 inches outside the distressed area. Spalled areas adjacent to joints less than 0.5 feet in length and 0.2 feet in width at the widest point shall be filled with the joint sealant material specified.

Concrete within the patch area shall be broken out to a minimum depth of 1 1/2 inches or until sound concrete is exposed. Shoulders adjacent to the patch shall be cut longitudinally to the depth of the patch and removed to a width not more than 12 inches. The cut shall extend 1 foot beyond both transverse limits of the patch.

The patch mixture shall be placed and consolidated to eliminate essentially all voids at the interface of the patch and existing concrete. An insert or other bond-breaking medium shall be used to maintain working joints or cracks if a partial depth repair area abuts a working joint or crack which penetrates the full depth of the slab. This is to prevent contact between the patch and any adjacent slab which could cause patch failure. The newly formed or sawn joint segement should have the same width as the existing joint or crack. A preformed compression insert or a form in combination with caulking can be used to insure that the patch material does not come into contact and bond to adjoining slabs. Data collection sheets for recording surface preparation location and techniques are given in SPS-4 Attachment D.

SPS-4 ATTACHMENT D

DATA COLLECTION SHEETS FOR RECORDING SURFACE PREPARATION

The following sheets from the SHRP "Data Collection Guide for Long-Term Pavement Performance Studies" from the Maintenance Data, Chapter 6, must be completed:

Sheet #	Title	Page
2	Maintenance Location Summary	D2
7	Partial Depth Patching Data for Pavements with Portland Cement Concrete Surfaces	D3
8	Partial Depth Patching Data for Pavements with Portland Cement Concrete Surfaces (Continued)	D4
9	Partial Depth Patching Data for Pavements with Portland Cement Concrete Surfaces (Continued)	D5

They are attached for your convenience.

Revised August 30, 1999

Sheet 2

Maintenance Data

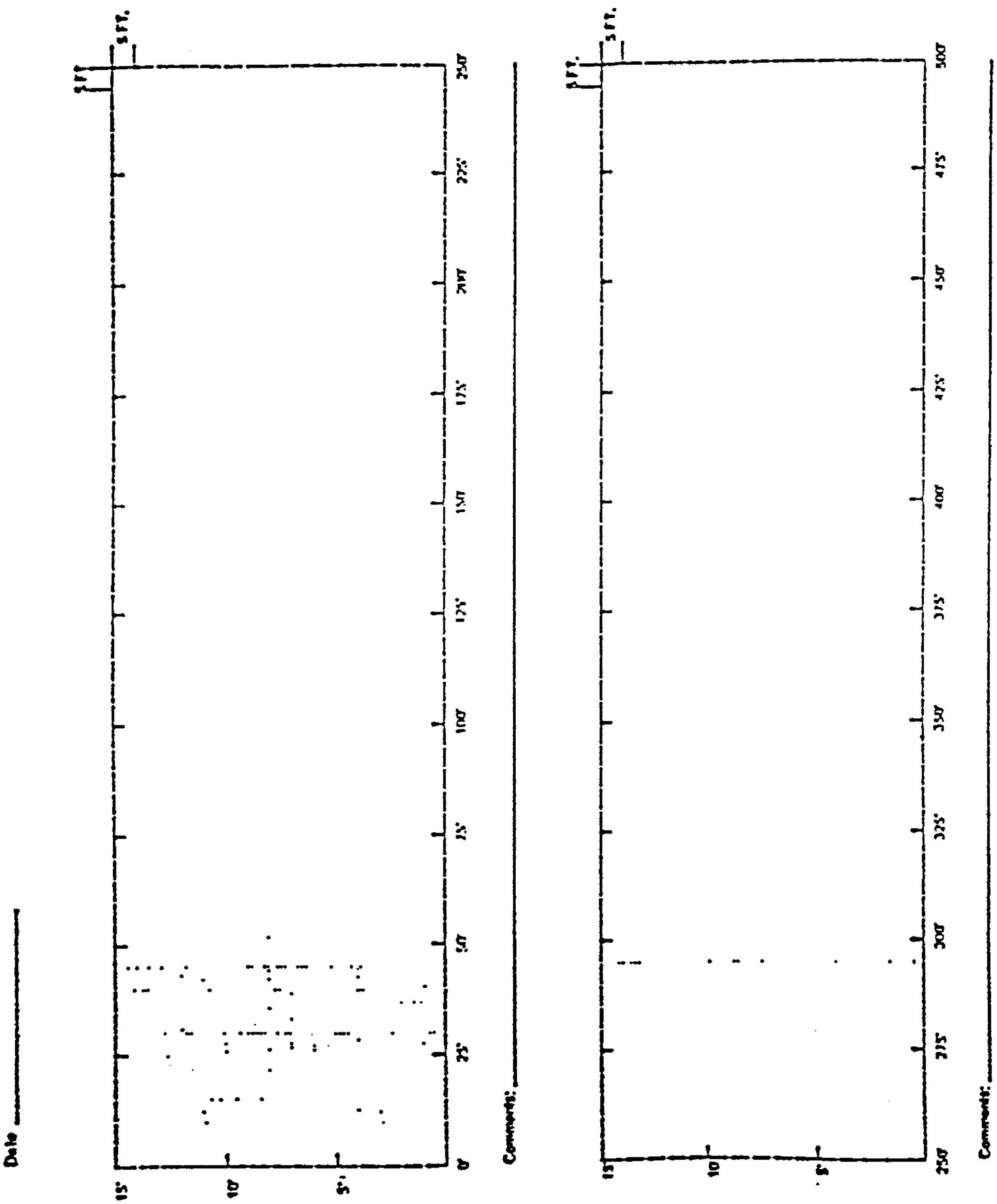
LTPP Program

MAINTENANCE LOCATION SUMMARY

State Assigned ID [_ _ _ _]

State Code [_ _]

SHRP Section ID [_ _ _ _]



Instructions: Sketch the approximate location and extent of all maintenance activities.

Revised August 30, 1989

*STATE ASSIGNED ID [_ _ _ _]

SHEET 7 *STATE CODE [_ _]

MAINTENANCE DATA *SHRP SECTION ID [_ _ _ _]

LTPP PROGRAM

PARTIAL DEPTH PATCHING DATA FOR PAVEMENTS WITH PORTLAND CEMENT CONCRETE SURFACES

1. *DATE WORK BEGAN (MONTH/DAY/YEAR) [_ _/_ _/_ _]
   *DATE WORK WAS COMPLETED (MONTH/DAY/YEAR) [_ _/_ _/_ _]

2. *PRIMARY REASON FOR PATCHES (SEE TABLE A.22 FOR TYPE CODES) [_ _]
   OTHER (SPECIFY)________________

3. SECONDARY REASON FOR PATCHES (SEE TABLE A.22 FOR TYPE CODES) [_ _]
   OTHER (SPECIFY)________________

4. *PATCHES
   TOTAL SQUARE FEET [_ _ _ _ _]
   NUMBER [_ _ _]
   AVERAGE DEPTH, INCHES [_ _._]

5. METHOD USED FOR PATCH BOUNDARY DETERMINATION _
   VISUAL 1
   BALL PEEN HAMMER, STEEL ROD, CHAIN
   OR EQUIVALENT.........................2
   DELAM-TECH............................3
   OTHER________________4
   DATA SOURCE - ACTUAL = 1 PLANS/SPECS = 2 JUDGEMENT = 3 _

6. METHOD USED TO CUT BOUNDARIES _
   DIAMOND BLADE SAW.......1 AIR HAMMER...............4
   CARBIDE BLADE SAW.......2 COLD MILLING............5
   NONE.....................3
   OTHER (SPECIFY)________________6
   DATA SOURCE - ACTUAL = 1 PLANS/SPECS = 2 JUDGEMENT = 3 _

7. METHOD USED TO BREAK UP AND/OR REMOVE
   DETERIORATED CONCRETE _
   JACKHAMMER...............1 COLD MILLING............2
   OTHER (SPECIFY)________________3
   DATA SOURCE = ACTUAL = 1 PLANS/SPECS = 2 JUDGEMENT = 3 _

8. METHOD FOR FINAL CLEANING OF PATCH AREA _
   NONE.....................1 WATERBLASTING...........3
   SANDBLASTING............2
   OTHER (SPECIFY)________________4
   DATA SOURCE - ACTUAL = 1 PLANS/SPECS = 2 JUDGEMENT = 3 _

*STATE ASSIGNED ID [__ __ __ __

SHEET 8 — *STATE CODE [__ __

MAINTENANCE DATA — *SHRP SECTION ID [__ __ __ __

LTPP PROGRAM

PARTIAL DEPTH PATCHING DATA FOR PAVEMENTS WITH PORTLAND CEMENT CONCRETE SURFACES (CONTINUED)

1. *PATCH MATERIAL USED [__]
   PORTLAND CEMENT CONCRETE.1 EPOXY MORTOR............3
   POLYMER CONCRETE.........2 ASPHALT CONCRETE........4
   OTHER (SPECIFY)________________________________5
   DATA SOURCE - ACTUAL = 1 PLANS/SPECS = 2 JUDGEMENT = 3 [__]

2. *BONDING AGENT [__]
   NONE......................1 EPOXY RESIN.............3
   CEMENT GROUT..............2 CUTBACK ASPHALT.........4
   OTHER________________________________5
   DATA SOURCE - ACTUAL = 1 PLANS/SPECS = 2 JUDGEMENT = 3 [__]

3. *MIXTURE DESIGN FOR PATCH MATERIAL, LB./CUBIC YD.
   COARSE AGGREGATE [__ __ __ __.]
   FINE AGGREGATE [__ __ __ __.]
   CEMENT [__ __ __ __.]
   WATER (GALLONS/CUBIC YD.) (LEAVE BLANK FOR A.C.) [__ __ __ __.]

   DATA SOURCE - ACTUAL = 1 PLANS/SPECS = 2 JUDGEMENT = 3 [__]

4. *TYPE CEMENT USED (SEE CEMENT TYPE CODES, TABLES A.11 AND A.16) [__ __]
   DATA SOURCE - ACTUAL = 1 PLANS/SPECS = 2 JUDGEMENT = 3 [__]

5. *AIR CONTENT, PERCENT BY VOLUME .(LEAVE BLANK FOR A.C.)
   MEAN [__ __.__]
   RANGE [__ __.__ TO __ __.__]
   DATA SOURCE - ACTUAL = 1 PLANS/SPECS = 2 JUDGEMENT = 3 [__]

6. *ADMIXTURES (LEAVE BLANK FOR A.C.) [__ __]
   (SEE CEMENT ADDITIVE CODES, TABLE A.12) [__ __]
   DATA SOURCE - ACTUAL = 1 PLANS/SPECS = 2 JUDGEMENT = 3 [__]

7. *SLUMP, INCHES (LEAVE BLANK FOR A.C.)
   MEAN [__ __.]
   RANGE [__ __. TO __ __.]
   DATA SOURCE - ACTUAL = 1 PLANS/SPECS = 2 JUDGEMENT = 3 [__]

8. *COMPRESSIVE STRENGTH OF PATCH MATERIAL, PSI [__ __ __ __.]
   CURING TIME, DAYS (LEAVE BLANK FOR A.C.) [__ __.]
   IF UNAVAILABLE, AND OTHER STRENGTH TEST CONDUCTED,
   ENTER ALTERNATE TEST [________________________]
   TYPE OF LOADING [________________________]
   AGE, DAYS [__ __]; STRENGTH, PSI [__ __ __ __]
   DATA SOURCE - ACTUAL = 1 PLANS/SPECS = 2 JUDGEMENT = 3 [__]

9. MAXIMUM SIZE OF COARSE AGGREGATE, INCHES __.__
   DATA SOURCE - ACTUAL = 1 PLANS/SPECS = 2 JUDGEMENT = 3 __

Revised August 30, 1989

*STATE ASSIGNED ID [_ _ _ _]

SHEET 9 *STATE CODE [_ _]

MAINTENANCE DATA *SHRP SECTION ID [_ _ _ _]

LTPP PROGRAM

PARTIAL DEPTH PATCHING DATA FOR PAVEMENTS
WITH PORTLAND CEMENT CONCRETE SURFACES
(CONTINUED)

1. *CURING METHOD (LEAVE BLANK FOR A.C.) METHOD 1 [_ _]
METHOD 2 [_ _]

NONE........................1 BURLAP-POLYETHYLENE BLANKETS.6
MEMBRANE CURING COMPOUND....2 INSULATING LAYERS............7
BURLAP CURING BLANKETS......3 COTTON MAT CURING............8
WATERPROOF PAPER BLANKETS...4 HAY..........................9
WHITE POLYETHYLENE SHEETING.5
OTHER (SPECIFY)________________________10
DATA SOURCE - ACTUAL = 1 PLANS/SPECS = 2 JUDGEMENT = 3 [_]

2. *APPROXIMATE TIME BETWEEN PATCHING AND
OPENING TO TRAFFIC, HOURS [_ _._]
DATA SOURCE - ACTUAL = 1 PLANS/SPECS = 2 JUDGEMENT = 3 [_]

3. *AMBIENT CONDITIONS AT TIME OF PATCHING LOW [_ _ _._]
AIR TEMPERATURE (°F) HIGH [_ _ _._]

SURFACE MOISTURE - DRY = 1, WET = 2 [_]
DATA SOURCE - ACTUAL = 1 PLANS/SPECS = 2 JUDGEMENT = 3 [_]

4. METHOD OF CONSOLIDATING MATERIALS (LEAVE BLANK FOR A.C.) _
VIBRATORS...............1 RODDING/TAMPING.........4
VIBRATING SCREEDS.......2 ROLLING.................5
TROWELING...............3
OTHER (SPECIFY)________________________6
DATA SOURCE - ACTUAL = 1 PLANS/SPECS = 2 JUDGEMENT = 3 _

5. FINISHING METHOD (LEAVE BLANK FOR A.C.) _
SCREEDING...............1 MACHINE-TROWELING.......3
HAND-TROWELING..........2
OTHER (SPECIFY)________________________4
DATA SOURCE - ACTUAL = 1 PLANS/SPECS = 2 JUDGEMENT = 3 _

6. JOINT FORMING METHOD (LEAVE BLANK FOR A.C.)
SHOULDER _
TRANSVERSE _
LONGITUDINAL _

NONE.......................1 FIBERBOARD INSERT.......4
POLYETHYLENE STRIP INSERT.2 SAWING..................5
STYROFOAM INSERT..........3 FORMS...................6
OTHER (SPECIFY)________________________7
DATA SOURCE - ACTUAL = 1 PLANS/SPECS = 2 JUDGEMENT = 3 _

Revised 3/91

SPS-4 ATTACHMENT E

LABORATORY DATA SHEETS

The following laboratory data sheets must be completed for testing of ASTM D3405 and silicone joint sealant materials.

Form #	Title
H15	Properties of Joint Sealants, Testing of Joint Sealants, Hot Poured
H19	Properties of Joint Sealants, Testing of Silicone Joint Sealants

They are attached for your convenience.

SHRP-LTPP
LABORATORY MATERIAL
HANDLING AND TESTING

LABORATORY SOURCE: (a) LTPP REGIONAL LABORATORY (b) STATE AGENCY LABORATORY
(c) OTHER ______________
LTPP REGIONAL LABORATORY FOR ASPHALTIC MATERIAL, AGGREGATE AND SOILS ___________

LABORATORY MATERIAL TEST DATA

TEST SHEET H1

SAMPLES FROM: (a) SHRP REGION ____________ (b) STATE __________ (c) STATE CODE _
(d) LTPP EXPT ____________ (e) SHRP SECTION ID _ _ _ _ _ _ (f) FIELD SET NUMBER _
SAMPLED BY ______________________ DATE SAMPLED _ _-_ _-_ _ _ _

PROPERTIES OF JOINT SEALANTS
TESTS JOINT SEALANTS, HOT-POURED

SHRP TEST DESIGNATION: CS01

SHRP PROTOCOL H16

1. LAYER NUMBER _ _ _

2. SHRP LABORATORY TEST NUMBER _

3. LOCATION NUMBER _ _ _

4. SHRP SAMPLE NUMBER _ _ _ _

5. TEST RESULTS

		Initial	After Prolonged Heating
a.	Average Penetration Temperature	_ _ _ (0.1 MM) _ _ °C	_ _ _ (0.1 MM) _ _ °C
b.	Flow (Change in Length)	_ _ . _ mm	_ _ . _ mm
c.	Bond (all three samples)	_ pass _ fail	_ pass _ fail
d.	Resilience (Average recovery)	_ _ %	_ _ %
e.	Asphalt Compatibility Compatibility results	_ pass _ fail approved rejected	_ pass _ fail

6. TEST DATE _ _-_ _-_ _ _ _ _ _-_ _-_ _ _ _

GENERAL REMARKS: ______________________________

SUBMITTED BY, DATE

CHECKED AND APPROVED, DATE

LABORATORY CHIEF
Affiliation __________

SHRP REPRESENTATIVE
Affiliation __________.

Form H15, January 1991

SHRP-LTPP
LABORATORY MATERIAL HANDLING AND TESTING

LABORATORY SOURCE: (a) LTPP REGIONAL LABORATORY (b) STATE AGENCY LABORATORY
(c) OTHER ____________________
LTPP REGIONAL LABORATORY FOR ASPHALTIC MATERIAL, AGGREGATE AND SOILS ____________

LABORATORY MATERIAL TEST DATA

TEST SHEET H1

SAMPLES FROM: (a) SHRP REGION ______________ (b) STATE __________ (c) STATE CODE __
(d) LTPP EXPT ____________ (e) SHRP SECTION ID _ _ _ _ _ _ (f) FIELD SET NUMBER _
SAMPLED BY ______________________________ DATE SAMPLED _ _-_ _-_ _ _ _

PROPERTIES OF JOINT SEALANTS
TESTS JOINT SEALANTS, SILICONE

SHRP TEST DESIGNATION: CS02

SHRP PROTOCOL H17

1. LAYER NUMBER ___ ___ ___
2. SHRP LABORATORY TEST NUMBER ___
3. LOCATION NUMBER ___ ___ ___
4. SHRP SAMPLE NUMBER ___ ___ ___ ___
5. TEST RESULTS
   A. TENSILE STRESS AT 150% STRAIN __________PSI
   B. DUROMETER HARDNESS (SHORE A) __________
   C. BONDING STRENGTH ON CONCRETE MORTAR (AVERAGE OF 5 TESTED) __________PSI
   D. TACK FREE TIME __________MIN
   E. EXTRUSION RATE __________G/MIN
   F. NON-VOLATILE __________%
   G. SPECIFIC GRAVITY __________
   H. MOVEMENT CAPABILITY AND ADHESION SATISFACTORY __________
      UNSATISFACTORY __________
   I. OZONE AND U.V. RESISTANCE SATISFACTORY __________
      UNSATISFACTORY __________
6. TEST DATE ___/___/___

SUBMITTED BY, DATE ______________________ CHECKED AND APPROVED, DATE ______________________

LABORATORY CHIEF ______________________ SHRP REPRESENTATIVE ______________________

AFFILIATION ______________________ AFFILIATION ______________________

Form H19, January 1991

Revised 3/91

SPS-4 ATTACHMENT F

FIELD INSTALLATION AND TESTING DATA SHEETS

DESCRIPTION	SHEET
Joint and Crack Sealing	1 to 10
Undersealing	11 to 16
Benkelman Beam	17
Falling Weight Deflectometer	18
Control Section	24 & 25

GENERAL INSTRUCTIONS

1. All measurements are to be made only in the 500 feet of the test section in the test section lane.

2. Leave questions blank when they do not apply. Enter a dash if there should have been a response but the inspector missed the data element during the data collection process.

3. Sheets 1 through 10 apply to longitudinal and transverse joints in portland cement concrete pavements; diagonal, longitudinal and transverse cracks in portland cement concrete pavement, the joint between the main pavement and shoulder (Section 410).

4. Sheets 11 through 16 apply to undersealing portland cement concrete pavement (Section 420).

5. Sheets 24 and 25 apply to the portland cement concrete control section (Section 430).

6. An LTPP-SPS Construction Data, Reference Project Station Table must be completed for each project site which identifies all test sections at that location.

7. Many of the data sheets are arranged in columnar form. This allows multiple responses to questions that must be answered for several joint types, dates or regrouting activities.

8. Use multiple sheets where needed. These types of sheets are identified on the sheet.

9. It is suggested that each joint in each test section be numbered and identified with spray paint on the shoulder. These joints can then be correlated with SHRP stationing. This will help keep track of measurements in the field during construction and construction related testing.

10. Collect any construction notes and diagrams into a set of field notes. Note on the data sheets for the test sections if field notes are available.

Revised 3/91

Sheet 1 *STATE ASSIGNED ID [_ _ _ _]

SPS-4 DATA *STATE CODE [_ _]

LTPP PROGRAM *SHRP PROJECT ID [_ _ _ _]

JOINT AND CRACK SEALING

(THESE DATA SHEETS APPLY TO CONCRETE PAVEMENT/ASPHALT SHOULDER LONGITUDINAL JOINTS AND CONCRETE PAVEMENT TRANSVERSE JOINTS, LONGITUDINAL JOINTS AND CRACKS. LEAVE BLANK WHEN DATA ELEMENT DOES NOT APPLY)

1. *DATES (MONTH/DAY/YEAR)

DATE WORK BEGAN	[_ _/_ _/_ _]
DATE WORK COMPLETED	[_ _/_ _/_ _]

TIME (24 HOUR CLOCK-HR/MIN)

	DAY 1	DAY 2	DAY 3
TIME WORK BEGAN	[_ _/_ _]	[_ _/_ _]	[_ _/_ _]
TIME WORK COMPLETED	[_ _/_ _]	[_ _/_ _]	[_ _/_ _]

2. *LENGTH OF TEST SECTION TO BE MONITORED (Feet) [_ _ _ _]

LANE WIDTH OF TEST SECTION (Feet) [_ _._]

3. *WEATHER CONDITIONS

AIR TEMPERATURE (°F)	DAY 1	DAY 2	DAY 3
AT BEGINNING OF SEALING	[_ _ _]	[_ _ _]	[_ _ _]
AT END OF SEALING	[_ _ _]	[_ _ _]	[_ _ _]

HUMIDITY (%)	DAY 1	DAY 2	DAY 3
AT BEGINNING OF SEALING	[_ _ _]	[_ _ _]	[_ _ _]
AT END OF SEALING	[_ _ _]	[_ _ _]	[_ _ _]

4. *TYPE OF JOINTS AND CRACKS SEALED (ALL SEALED=1, MOST SEALED=2, FEW SEALED =3, NONE SEALED=4, NONE PRESENT TO SEAL=5)

CONCRETE PAVEMENT/ASPHALT SHOULDER JOINT	[_]
TRANSVERSE PAVEMENT JOINTS	[_]
LONGITUDINAL PAVEMENT JOINTS	[_]
TRANSVERSE RANDOM CRACKS	[_]
LONGITUDINAL RANDOM CRACKS	[_]
DIAGONAL RANDOM CRACKS	[_]

Sheet 2 | *STATE ASSIGNED ID [_ _ _ _]
SPS-4 DATA | *STATE CODE [_ _]
LTPP PROGRAM | *SHRP PROJECT ID [_ _ _ _]

JOINT AND CRACK SEALING (CONTINUED)

5. *JOINT SEALANT MATERIAL (ASTM D3405=1, SILICONE=2, OTHER=3)
DESCRIBE IF OTHER ______________________

	SHOULDER JOINT	PAVEMENT JOINT	RANDOM CRACK
MATERIAL TYPE	[_]	[_]	[_]
BRAND	[________] [________]	[________] [________]	[________] [________]
SOURCE (NAME AND ADDRESS)	[________] [________] [________] [________]	[________] [________] [________] [________]	[________] [________] [________] [________]
DATE OF PRODUCTION (MONTH/YEAR)	[_ _/_ _]	[_ _/_ _]	[_ _/_ _]
LOT NUMBER	[________]	[________]	[________]
UNIT OF SUPPLY FOR SEALANT	[_]	[_]	[_]

OUNCES 1
QUARTS 2
GALLONS 3
POUNDS 4
FEET 5

	SHOULDER JOINT	PAVEMENT JOINT	RANDOM CRACK
SMALLEST QUANTITY OF MATERIAL SUPPLIED	[_ _ _ _ _]	[_ _ _ _ _]	[_ _ _ _ _]

Sheet 3 *STATE ASSIGNED ID [__ __ __ __]

SPS-4 DATA *STATE CODE [__ __]

LTPP PROGRAM *SHRP PROJECT ID [__ __ __ __]

JOINT AND CRACK SEALING (CONTINUED)

6. *MANUFACTURER'S SEALANT HANDLING RECOMMENDATIONS

LIQUID SEALANT

	SHOULDER JOINT	PAVEMENT JOINT	RANDOM CRACK
INDIRECT OIL HEATING (YES=1, NO=2)	[__]	[__]	[__]
OIL TEMPERATURE (°F)			
MINIMUM	[__ __ __]	[__ __ __]	[__ __ __]
MAXIMUM	[__ __ __]	[__ __ __]	[__ __ __]
SEALANT TEMPERATURE (°F)			
MINIMUM	[__ __ __]	[__ __ __]	[__ __ __]
MAXIMUM	[__ __ __]	[__ __ __]	[__ __ __]
TIME OF HEATING (HR)			
MINIMUM	[__ __.__]	[__ __.__]	[__ __.__]
MAXIMUM	[__ __.__]	[__ __.__]	[__ __.__]
AGITATION (YES=1, NO=2)	[__]	[__]	[__]

SILICONE SEALANT

	SHOULDER JOINT	PAVEMENT JOINT	RANDOM CRACK
SHELF LIFE (MONTHS)	[__ __]	[__ __]	[__ __]
SUGGESTED MAXIMUM STORAGE TEMPERATURE (°F)	[__ __]	[__ __]	[__ __]
SUGGESTED MINIMUM STORAGE HUMIDITY (%)	[__ __]	[__ __]	[__ __]
APPLICATION METHOD (HAND=1, PRESSURE=2)	[__]	[__]	[__]
APPLICATION PRESSURE (PSI) (0 IF HAND APPLICATION)	[__ __ __]	[__ __ __]	[__ __ __]
OTHER CONDITIONS	[____________ ____________ ____________]	[____________ ____________ ____________]	[____________ ____________ ____________]

Sheet 4 — *STATE ASSIGNED ID [_ _ _ _]

SPS-4 DATA — *STATE CODE [_ _]

LTPP PROGRAM — *SHRP PROJECT ID [_ _ _ _]

JOINT AND CRACK SEALING (CONTINUED)

7. *BACKER MATERIAL UNDER SEALANT

	SHOULDER JOINT	PAVEMENT JOINT	RANDOM CRACK
BACKER TYPE	[_]	[_]	[_]

NONE ....1 TAPE 2
ROD ....3 OTHER 4

DIAMETER (WIDTH) (1/16TH INCH)	[_ _]	[_ _]	[_ _]
BRAND	[____________] [____________]	[____________] [____________]	[____________] [____________]
SOURCE (NAME AND ADDRESS)	[____________] [____________] [____________] [____________]	[____________] [____________] [____________] [____________]	[____________] [____________] [____________] [____________]

8. *OLD SEALANT REMOVAL FROM JOINTS

	SHOULDER JOINT	PAVEMENT JOINT	RANDOM CRACK
METHOD OF REMOVING OLD SEALANT	[_]	[_]	[_]

NO SEALANT ....1 NOT REMOVED 2
JOINT PLOW - V-SHAPED ....3 JOINT PLOW - RECTANGULAR 4
HIGH PRESSURE WATER BLASTING ...5 DIAMOND BLADE SAW 6
CARBIDE BLADE SAW ....7 PULL-OUT OF OLD COMPRESSION SEALANT ..8
OTHER 9

DESCRIBE IF OTHER	[____________] [____________]	[____________] [____________]	[____________] [____________]
AMOUNT OF SPALLING CAUSED BY JOINT SEALANT REMOVAL	[_]	[_]	[_]

NONE ....1 VERY LITTLE 2
SOME ....3 CONSIDERABLE 4

WATER USED WITH SAWING? (YES=1, NO=2)	[_]	[_]	[_]

Sheet 5 *STATE ASSIGNED ID [__ __ __ __]

SPS-4 DATA *STATE CODE [__ __]

LTPP PROGRAM *SHRP PROJECT ID [__ __ __ __]

JOINT AND CRACK SEALING (CONTINUED)

9. *REFACING OF JOINTS

	SHOULDER JOINT	PAVEMENT JOINT	RANDOM CRACK
JOINT SAWED?	[__]	[__]	[__]
DIAMETER OF SAW BLADE (0 IF SAW NOT USED) (INCHES)	[__ __.__ __]	[__ __.__ __]	[__ __.__ __]
WATER USED WITH SAWING? (YES=1, NO=2)	[__]	[__]	[__]
SAWING ACCOMPLISHED IN ONE PASS? (YES=1, NO=2)	[__]	[__]	[__]

JOINT SAWED?

NO ....1 YES - ONE-BLADE ..2
YES - TWO-BLADE ..3 OTHER (SPECIFY) ..4

10. *AMOUNT OF SPALLING OR SECONDARY CRACKING IN CONCRETE CAUSED BY SAWING

SHOULDER JOINT	PAVEMENT JOINT	RANDOM CRACK
[__]	[__]	[__]

NONE ....1 VERY LITTLE 2
SOME ....3 CONSIDERABLE 4

11. *PATCHING

REQUIRED SHOULDER PATCHING COMPLETED? (YES=1, NO=2) [__]

REQUIRED CONCRETE PATCHING COMPLETED? (YES=1, NO=2) [__]

12. *JOINT/CRACK PREPARATION - WALL(S) SAWED VERTICALLY?

SHOULDER JOINT	PAVEMENT JOINT	RANDOM CRACK
[__]	[__]	[__]

NEVER ....1 SOMETIMES 2
USUALLY ....3 ALWAYS 4

Sheet 6 — *STATE ASSIGNED ID [__ __ __ __]

SPS-4 DATA — *STATE CODE [__ __]

LTPP PROGRAM — *SHRP PROJECT ID [__ __ __ __]

JOINT AND CRACK SEALING (CONTINUED)

13. *INFORMATION ON JOINT/CRACK SEALANT RESERVOIR PREPARATION

	SHOULDER JOINT	PAVEMENT JOINT	RANDOM CRACK
WATER BLASTING USED TO CLEAN RESERVOIR? (YES=1, NO=2)	[__]	[__]	[__]
WATER PRESSURE (PSI) (0 IF NOT WATER BLASTED)	[__ __ __]	[__ __ __]	[__ __ __]
WATER VOLUME (GPM) (0 IF NOT WATER BLASTED)	[__ __ __]	[__ __ __]	[__ __ __]
WATER FLUSHING USED TO CLEAN RESERVOIR? (YES=1, NO=2)	[__]	[__]	[__]
AIR USED TO CLEAN AND DRY RESERVOIR? (YES=1, NO=2)	[__]	[__]	[__]
AIR PRESSURE (PSI) (0 IF AIR NOT USED)	[__ __ __]	[__ __ __]	[__ __ __]
HOT COMPRESSED AIR LANCE USED TO CLEAN, DRY AND HEAT RESERVOIR? (YES=1, NO=2)	[__]	[__]	[__]
AIR PRESSURE OF AIR LANCE (PSI) (0 IF NOT USED)	[__ __ __]	[__ __ __]	[__ __ __]
SANDBLASTING USED TO CLEAN THE RESERVOIR? (YES=1, NO=2)	[__]	[__]	[__]
OTHER SEALANT RESERVOIR PREPARATION (DESCRIBE)	[________ ________ ________]	[________ ________ ________]	[________ ________ ________]

14. *ASPHALT SHOULDER MATERIAL BURNED BY THE HOT COMPRESSED AIR LANCE? [__]

NEVER ....1 SOMETIMES 2
USUALLY ....3 ALWAYS 4

Sheet 7 — *STATE ASSIGNED ID [_ _ _ _]

SPS-4 DATA — *STATE CODE [_ _]

LTPP PROGRAM — *SHRP PROJECT ID [_ _ _ _]

JOINT AND CRACK SEALING (CONTINUED)

15. *DIMENSIONS OF RESERVOIR AFTER PREPARATION AND BEFORE SEALING

AVERAGE WIDTH OF RESERVOIR (MEASURE TEN RANDOM LOCATIONS) (1/16TH INCH)

	SHOULDER JOINTS	PAVEMENT JOINTS TRANSVERSE	PAVEMENT JOINTS LONGITUDINAL	RANDOM CRACKS
1.	[_ _]	[_ _]	[_ _]	[_ _]
2.	[_ _]	[_ _]	[_ _]	[_ _]
3.	[_ _]	[_ _]	[_ _]	[_ _]
4.	[_ _]	[_ _]	[_ _]	[_ _]
5.	[_ _]	[_ _]	[_ _]	[_ _]
6.	[_ _]	[_ _]	[_ _]	[_ _]
7.	[_ _]	[_ _]	[_ _]	[_ _]
8.	[_ _]	[_ _]	[_ _]	[_ _]
9.	[_ _]	[_ _]	[_ _]	[_ _]
10.	[_ _]	[_ _]	[_ _]	[_ _]
MINIMUM	[_ _]	[_ _]	[_ _]	[_ _]
MAXIMUM	[_ _]	[_ _]	[_ _]	[_ _]
AVERAGE	[_ _]	[_ _]	[_ _]	[_ _]

AVERAGE DEPTH OF RESERVOIR (MEASURE TEN RANDOM LOCATIONS) (1/16TH INCH)

	SHOULDER JOINTS	PAVEMENT JOINTS TRANSVERSE	PAVEMENT JOINTS LONGITUDINAL	RANDOM CRACKS
1.	[_ _]	[_ _]	[_ _]	[_ _]
2.	[_ _]	[_ _]	[_ _]	[_ _]
3.	[_ _]	[_ _]	[_ _]	[_ _]
4.	[_ _]	[_ _]	[_ _]	[_ _]
5.	[_ _]	[_ _]	[_ _]	[_ _]
6.	[_ _]	[_ _]	[_ _]	[_ _]
7.	[_ _]	[_ _]	[_ _]	[_ _]
8.	[_ _]	[_ _]	[_ _]	[_ _]
9.	[_ _]	[_ _]	[_ _]	[_ _]
10.	[_ _]	[_ _]	[_ _]	[_ _]
MINIMUM	[_ _]	[_ _]	[_ _]	[_ _]
MAXIMUM	[_ _]	[_ _]	[_ _]	[_ _]
AVERAGE	[_ _]	[_ _]	[_ _]	[_ _]
TOTAL LENGTH OF JOINTS/CRACKS PREPARED (FEET)	[_ _ _ _]	[_ _ _ _]	[_ _ _ _]	[_ _ _ _]

Sheet 8	*STATE ASSIGNED ID [__ __ __ __]
SPS-4 DATA	*STATE CODE [__ __]
LTPP PROGRAM	*SHRP PROJECT ID [__ __ __ __]

JOINT AND CRACK SEALING (CONTINUED)

	SHOULDER JOINTS	PAVEMENT JOINTS TRANSVERSE	PAVEMENT JOINTS LONGITUDINAL	RANDOM CRACKS

16. *SEALANT RESERVOIR CONDITIONS AT TIME SEALANT APPLIED

SEALANT RESERVOIR CONDITION BEFORE SEALANT APPLIED [__] [__] [__] [__]

CLEAN ....1 MOSTLY CLEAN 2
SOMEWHAT DIRTY ...3 DIRTY 4

SEALANT RESERVOIR MOISTURE CONDITION BEFORE SEALANT APPLIED [__] [__] [__] [__]

DRY ....1 MOSTLY DRY 2
SOMEWHAT DAMP ....3 WET 4

17. *TIME BETWEEN CLEANING AND INSTALLATION? (DAYS/HRS) [__ __/__ __] [__ __/__ __] [__ __/__ __] [__ __/__ __]

18. *BACKER MATERIAL MEASUREMENTS AFTER JOINT PREPARATION AND BEFORE SEALING

AVERAGE DEPTH OF BACKER MATERIAL OR TAPE FROM PAVEMENT SURFACE (MEASURE TEN RANDOM LOCATIONS) (16TH INCH)

	SHOULDER JOINTS	TRANSVERSE	LONGITUDINAL	RANDOM CRACKS
1.	[__ __]	[__ __]	[__ __]	[__ __]
2.	[__ __]	[__ __]	[__ __]	[__ __]
3.	[__ __]	[__ __]	[__ __]	[__ __]
4.	[__ __]	[__ __]	[__ __]	[__ __]
5.	[__ __]	[__ __]	[__ __]	[__ __]
6.	[__ __]	[__ __]	[__ __]	[__ __]
7.	[__ __]	[__ __]	[__ __]	[__ __]
8.	[__ __]	[__ __]	[__ __]	[__ __]
9.	[__ __]	[__ __]	[__ __]	[__ __]
10.	[__ __]	[__ __]	[__ __]	[__ __]
MINIMUM	[__ __]	[__ __]	[__ __]	[__ __]
MAXIMUM	[__ __]	[__ __]	[__ __]	[__ __]
AVERAGE	[__ __]	[__ __]	[__ __]	[__ __]

Sheet 9	*STATE ASSIGNED ID [__ __ __ __]
SPS-4 DATA	*STATE CODE [__ __]
LTPP PROGRAM	*SHRP PROJECT ID [__ __ __ __]

JOINT AND CRACK SEALING (CONTINUED)

	SHOULDER JOINT	PAVEMENT JOINT	RANDOM CRACK
19. *SILICONE SEALANT APPLICATION SILICONE SEALANT TOOLED? (YES=1, NO=2)	[__]	[__]	[__]
TIME BETWEEN END OF SILICONE JOINT AND CRACK SEALING AND END OF TRAFFIC CONTROL (24 HR CLOCK) (HR/MIN)	[__ __/__ __]	[__ __/__ __]	[__ __/__ __]
20. *LIQUID SEALANT APPLICATION HOSE CONNECTING THE WAND TO THE SEALANT CHAMBER HEATED DURING SEALING OPERATIONS? (YES=1, NO=2)	[__]	[__]	[__]
SEALANT TEMPERATURE AT THE BEGINNING OF APPLICATION (°F)	[__ __ __]	[__ __ __]	[__ __ __]
SEALANT TEMPERATURE AT END OF APPLICATION (°F)	[__ __ __]	[__ __ __]	[__ __ __]
HOSE BACKFLUSHED BEFORE SEALING BEGINS? (YES=1, NO=2)	[__]	[__]	[__]
TIME BETWEEN END OF SEALING AND END OF TRAFFIC CONTROL (24 HR CLOCK) (HR/MIN)	[__ __/__ __]	[__ __/__ __]	[__ __/__ __]

21. *DISTANCE FROM SURFACE OF PAVEMENT TO TOP OF SEALANT
DEPTH TO TOP OF SEALANT (MEASURE TEN RANDOM LOCATIONS) (1/16TH INCH) (NEGATIVE IF SEALANT IS ABOVE PAVEMENT SURFACE)

	SHOULDER JOINT	PAVEMENT JOINT	RANDOM CRACK
1.	[__ __ __]	[__ __ __]	[__ __ __]
2.	[__ __ __]	[__ __ __]	[__ __ __]
3.	[__ __ __]	[__ __ __]	[__ __ __]
4.	[__ __ __]	[__ __ __]	[__ __ __]
5.	[__ __ __]	[__ __ __]	[__ __ __]
6.	[__ __ __]	[__ __ __]	[__ __ __]
7.	[__ __ __]	[__ __ __]	[__ __ __]
8.	[__ __ __]	[__ __ __]	[__ __ __]
9.	[__ __ __]	[__ __ __]	[__ __ __]
10.	[__ __ __]	[__ __ __]	[__ __ __]
MINIMUM	[__ __ __]	[__ __ __]	[__ __ __]
MAXIMUM	[__ __ __]	[__ __ __]	[__ __ __]
AVERAGE	[__ __ __]	[__ __ __]	[__ __ __]

Revised 3/91

Sheet 10 *STATE ASSIGNED ID [_ _ _ _]

SPS-4 DATA *STATE CODE [_ _]

LTPP PROGRAM *SHRP PROJECT ID [_ _ _ _]

JOINT AND CRACK SEALING (CONTINUED)

INSPECTIONS TO BE COMPLETED DAY AFTER APPLICATION OF SEALANT

	SHOULDER JOINTS	PAVEMENT JOINTS TRANSVERSE	PAVEMENT JOINTS LONGITUDINAL	RANDOM CRACKS
22. *SEALANT BONDED TO BOTH SURFACES OF JOINT OR CRACK AS CHECKED WITH A FLAT TOOL?	[_]	[_]	[_]	[_]
23. *FILM DEVELOPED ON SILICONE SEALANT? (YES=1, NO=2, N/A=3)	[_]	[_]	[_]	[_]
24. *BUBBLES PRESENT IN SURFACE OF LIQUID JOINT SEALER?	[_]	[_]	[_]	[_]
25. *LIQUID JOINT SEALANT TACKY? (YES=1, NO=2, N/A=3)	[_]	[_]	[_]	[_]

22: LITTLE BONDING ...1 MOSTLY BONDED ...2 ALL BONDED ...3

24: SIGNIFICANT BUBBLES ...1 FEW BUBBLES ...2 NO BUBBLES ...3 N/A ...4

31. FIELD NOTES AVAILABLE? (YES=1, NO=2) [_]
FIELD NOTE LOCATION [_______________]

SUBMITTED BY, DATE CHECKED AND APPROVED, DATE

_______________ _______________
DATA RECORDER SHRP REPRESENTATIVE

AFFILIATION _______________ AFFILIATION _______________

Sheet 11
SPS-4 DATA
LTPP PROGRAM

*STATE ASSIGNED ID [__ __ __ __]
*STATE CODE [__ __]
*SHRP PROJECT ID [__ __ __ __]

UNDERSEALING

1. *DATES OF UNDERSEALING (MONTH/DAY/YEAR) WORK BEGAN [__ __/__ __/__ __]
WORK COMPLETED [__ __/__ __/__ __]

TIME OF DAY (24 HOUR CLOCK)

	INITIAL GROUTING	REGROUTING
BEGAN (HR/MIN)	[__ __/__ __]	[__ __/__ __]
COMPLETED (HR/MIN)	[__ __/__ __]	[__ __/__ __]

(LEAVE BLANK IF NO REGROUTING)

2. *LENGTH OF UNDERSEALING TEST SECTION (FEET) [__ __ __ __]

*LANE WIDTH OF UNDERSEALING TEST SECTION (FEET) [__ __.__]

3. *PAVEMENT SURFACE MOISTURE CONDITION AT TIME OF UNDERSEALING

INITIAL GROUTING	REGROUTING
[__]	[__]
[__]	[__]

DRY 1
MOSTLY DRY 2
SOMEWHAT DAMP 3
WET 4

4. *WEATHER CONDITIONS

	INITIAL GROUTING	REGROUTING
TEMPERATURE (°F)		
BEGINNING OF UNDERSEALING	[__ __ __]	[__ __ __]
END OF UNDERSEALING	[__ __ __]	[__ __ __]
HUMIDITY (%)		
BEGINNING OF UNDERSEALING	[__ __ __]	[__ __ __]
END OF UNDERSEALING	[__ __ __]	[__ __ __]

(LEAVE BLANK IF NO REGROUTING)

5. *CEMENT USED PER AASHTO M85 (TYPE I=41, TYPE II=42, TYPE III=43) [__ __]

SOURCE [________________________]
ADDRESS [________________________]
[________________________]
[________________________]

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UNDERSEALING (CONTINUED)

6. *FLY ASH USED PER ASTM C618 (NATURAL POZZOLAN=09, CLASS F=10, CLASS C=11) [__ __]

SOURCE [______________________]
ADDRESS [______________________]
[______________________]
[______________________]

7. *SOURCE OF WATER

SOURCE [______________________]
ADDRESS [______________________]
[______________________]
[______________________]

8. *METHOD OF SELECTING SLABS/PANELS TO BE UNDERSEALED [__]
BLANKET UNDERSEALING 1
DEFLECTION CRITERIA 2
VISUAL SIGNS 3
OTHER (SPECIFY) 4
DESCRIBE IF OTHER ______________________________

9. *UNDERSEAL HOLE INSTALLATION METHOD [__]
CORING ......1 IMPACT DRILL ....2 OTHER 3

	INITIAL GROUTING	REGROUTING
10. *TIME OF DAY HOLES DRILLED (24 HOUR CLOCK - HR/MIN)		
BEGAN	[__ __/__ __]	[__ __/__ __]
COMPLETED	[__ __/__ __]	[__ __/__ __]
11. *WATER USED TO FLUSH OUT HOLES? (YES=1, NO=2)	[__]	[__]
12. *HOLES RETAIN DRILLING OR FLUSHING WATER?	[__]	[__]

NEVER ....1 SOMETIMES 2
USUALLY ....3 ALWAYS 4

Sheet 13
SPS-4 DATA
LTPP PROGRAM

*STATE ASSIGNED ID [__ __ __ __]
*STATE CODE [__ __]
*SHRP PROJECT ID [__ __ __ __]

UNDERSEALING (CONTINUED)

	INITIAL GROUTING	REGROUTING
13. *GROUT MIXING CHAMBER CLEANLINESS	[__]	[__]

CLEAN ....1 MOSTLY CLEAN 2
SOMEWHAT DIRTY ...3 DIRTY 4

	INITIAL GROUTING	REGROUTING
14. *NUMBER OF BAGS OF CEMENT USED PER BATCH	[__ __ __]	[__ __ __]
15. *NUMBER OF BAGS OF FLY ASH USED PER BATCH	[__ __ __]	[__ __ __]
16. *NUMBER OF GALLONS OF WATER USED PER BATCH	[__ __ __]	[__ __ __]
17. *GROUT MIXING		
MIXING SPEED? (RPM)	[__ __ __ __]	[__ __ __ __]
TIME GROUT MIXED? (MINUTES)	[__ __ __]	[__ __ __]
GROUT WELL BLENDED?	[__]	[__]

NEVER ....1 SOMETIMES 2
USUALLY ....3 ALWAYS 4

	INITIAL GROUTING	REGROUTING
18. *MAXIMUM ALLOWABLE PUMPING PRESSURE (GAUGE AT PLANT) (PSI)	[__ __ __]	[__ __ __]
19. *MAXIMUM SURGE PRESSURE (PSI)	[__ __ __]	[__ __ __]

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UNDERSEALING (CONTINUED)

20. *VOLUME OF GROUT FOR EACH HOLE DETERMINED? [_]
NEVER ....1 SOMETIMES 2
USUALLY ....3 ALWAYS 4

21. *TOTAL VOLUME OF INSTALLED GROUT DETERMINED? (YES=1, NO=2) [_]

22. *HOLES PLUGGED? (YES=1, NO=2) [_]

23. *ESTIMATED EXCESS GROUT SUBTRACTED FROM TOTAL GROUT QUANTITY? [_]
NEVER ....1 SOMETIMES 2
USUALLY ....3 ALWAYS 4

24. *UPLIFT MONITORED FOR EACH SLAB/PANEL? [_]
NEVER ....1 SOMETIMES 2
USUALLY ....3 ALWAYS 4

25. *CONSTRUCTION TRAFFIC RESTRICTED? [_]
NEVER ....1 SOMETIMES 2
USUALLY ....3 ALWAYS 4

26. *METHOD TO DETERMINE USER TRAFFIC RESTRICTION [_]
TIME OF SET ......1 MINIMUM CURE TIME ...2
OTHER 3
SPECIFY IF OTHER ______________________________

Sheet 15

SPS-4 DATA

LTPP PROGRAM

*STATE ASSIGNED ID [_ _ _ _]

*STATE CODE [_ _]

*SHRP PROJECT ID [_ _ _ _]

UNDERSEALING (CONTINUED)

USE MULTIPLE SHEETS IF NECESSARY

27. *PRESSURE GROUTING

JOINT NUMBER	HOLE NUMBER	HOLE LOCATION STATION*	OFFSET (FEET)	HOLE DEPTH (INCHES)	GROUT PUMPED PER HOLE (CU. FEET)	CUTOFF CRITERIA**	INITIAL OR REGROUT***
_ _	_ _ _	_ _+_ _._	_ _._	_ _	_ _._	_	_
_ _	_ _ _	_ _+_ _._	_ _._	_ _	_ _._	_	_
_ _	_ _ _	_ _+_ _._	_ _._	_ _	_ _._	_	_
_ _	_ _ _	_ _+_ _._	_ _._	_ _	_ _._	_	_
_ _	_ _ _	_ _+_ _._	_ _._	_ _	_ _._	_	_
_ _	_ _ _	_ _+_ _._	_ _._	_ _	_ _._	_	_
_ _	_ _ _	_ _+_ _._	_ _._	_ _	_ _._	_	_
_ _	_ _ _	_ _+_ _._	_ _._	_ _	_ _._	_	_
_ _	_ _ _	_ _+_ _._	_ _._	_ _	_ _._	_	_
_ _	_ _ _	_ _+_ _._	_ _._	_ _	_ _._	_	_

* USE SHRP STATION NUMBERS; ** REFUSAL=1, RAISED SLAB=2, GROUT EXTRUSION=3, OTHER=4
*** INITIAL GROUT APPLICATION=1, REGROUTING=2

Sheet 16 *STATE ASSIGNED ID [_ _ _ _]

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UNDERSEALING (CONTINUED)

MEASUREMENTS MADE DAY AFTER APPLICATION

	AFTER INITIAL GROUTING	AFTER REGROUTING
28. *SLAB/PANEL STABILITY CHECKED? (YES=1, NO=2)	[_]	[_]
29. *UNSTABLE SLABS REGROUTED? (YES=1, NO=2)	[_]	[_]

30. *SAME CONTROLS USED FOR REGROUTING AS WERE USED FOR INITIAL GROUTING? [_]
    NEVER ....1 SOMETIMES 2
    USUALLY ....3 ALWAYS 4

31. FIELD NOTES AVAILABLE (YES=1, NO=2) [_]
FIELD NOTE LOCATION [________________________________]

SUBMITTED BY, DATE

____
DATA RECORDER

AFFILIATION ______________

CHECKED AND APPROVED, DATE

____
SHRP REPRESENTATIVE

AFFILIATION ______________

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Sheet 17A
SPS-4 DATA
LTPP PROGRAM

*STATE ASSIGNED ID [_ _ _ _]
*STATE CODE [_ _]
*SHRP PROJECT ID [_ _ _ _]

BENKELMAN BEAM DEFLECTION MEASUREMENTS
(18 KIP SINGLE AXLE LOAD)

1. *DATES (MONTH /DAY/YEAR) AND TIME (24 HOUR CLOCK-HR/MIN) OF TESTING

DATE WORK BEGAN [_ _/_ _/_ _]
DATE WORK COMPLETED [_ _/_ _/_ _]

TIME BEGAN [_ _/_ _]
TIME COMPLETED [_ _/_ _]

2. *WEATHER CONDITIONS: AIR TEMPERATURE (°F) AND HUMIDITY (%)

AIR TEMPERATURE (°F)
BEGINNING OF TESTING [_ _ _]
END OF TESTING [_ _ _]

HUMIDITY (%)
BEGINNING OF TESTING [_ _ _]
END OF TESTING [_ _ _]

3. *PAVEMENT SURFACE MOISTURE CONDITION AT TIME OF TESTING [_]
DRY ....1 MOSTLY DRY 2
SOMEWHAT DAMP ....3 WET 4

4. *PURPOSE OF TESTING [_]
DETERMINE NEED FOR UNDERSEALING 1
SLAB STABILITY AFTER INITIAL GROUTING ...2
SLAB STABILITY AFTER REGROUT 3
POST CONSTRUCTION MONITORING 4

5. *SOURCE OF TESTING DEVICE [_]
SHRP ....1 HOST STATE OR PROVINCE ..2
OTHER STATE ....3 OTHER 4

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Sheet 17B

SPS-4 DATA

LTPP PROGRAM

*STATE ASSIGNED ID [_ _ _ _]

*STATE CODE [_ _]

*SHRP PROJECT ID [_ _ _ _]

BENKELMAN BEAM DEFLECTION MEASUREMENTS (CONTINUED)

(18 KIP SINGLE AXLE LOAD)
USE MULTIPLE SHEETS IF NEEDED

5.*LOCATION (STATION) OF JOINT OR CRACK	6.*JOINT NUMBER	7.*TESTING AT: (JOINT=1, CRACK=2)	8.*LOCATION OF AXLE (APPROACH=1, LEAVE=2)	DEFLECTION (MILS) 9.*APPROACH	DEFLECTION (MILS) 10.*LEAVE
_ _+_ _._	_ _ _	_	_	_ _._ _	_ _._ _
_ _+_ _._	_ _ _	_	_	_ _._ _	_ _._ _
_ _+_ _._	_ _ _	_	_	_ _._ _	_ _._ _
_ _+_ _._	_ _ _	_	_	_ _._ _	_ _._ _
_ _+_ _._	_ _ _	_	_	_ _._ _	_ _._ _
_ _+_ _._	_ _ _	_	_	_ _._ _	_ _._ _
_ _+_ _._	_ _ _	_	_	_ _._ _	_ _._ _
_ _+_ _._	_ _ _	_	_	_ _._ _	_ _._ _
_ _+_ _._	_ _ _	_	_	_ _._ _	_ _._ _
_ _+_ _._	_ _ _	_	_	_ _._ _	_ _._ _
_ _+_ _._	_ _ _	_	_	_ _._ _	_ _._ _
_ _+_ _._	_ _ _	_	_	_ _._ _	_ _._ _

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Sheet 17C

SPS-4 DATA

LTPP PROGRAM

*STATE ASSIGNED ID [_ _ _ _]

*STATE CODE [_ _]

*SHRP PROJECT ID [_ _ _ _]

BENKELMAN BEAM DEFLECTION MEASUREMENTS (CONTINUED)
(18 KIP SINGLE AXLE LOAD)

5.*LOCATION (STATION) OF JOINT OR CRACK	6.*JOINT NUMBER	7.*TESTING AT: (JOINT=1, CRACK=2)	8.*LOCATION OF AXLE (APPROACH=1, LEAVE=2)	DEFLECTION (MILS) 9.*APPROACH	10.*LEAVE
_ _+_ _._	_ _ _	_	_	_ _._ _	_ _._ _
_ _+_ _._	_ _ _	_	_	_ _._ _	_ _._ _
_ _+_ _._	_ _ _	_	_	_ _._ _	_ _._ _
_ _+_ _._	_ _ _	_	_	_ _._ _	_ _._ _
_ _+_ _._	_ _ _	_	_	_ _._ _	_ _._ _
_ _+_ _._	_ _ _	_	_	_ _._ _	_ _._ _
_ _+_ _._	_ _ _	_	_	_ _._ _	_ _._ _
_ _+_ _._	_ _ _	_	_	_ _._ _	_ _._ _
_ _+_ _._	_ _ _	_	_	_ _._ _	_ _._ _

:UBMITTED BY, DATE

IATA RECORDER

.FFILIATION ______________________

CHECKED AND APPROVED, DATE

SHRP REPRESENTATIVE

AFFILIATION ______________________

Sheet 18
SPS-4 DATA
LTPP PROGRAM

*STATE ASSIGNED ID [__ __ __ __
*STATE CODE [__ __
*SHRP PROJECT ID [__ __ __ __

FALLING WEIGHT DEFLECTOMETER MEASUREMENTS

1. *DATES (MONTH /DAY/YEAR) AND TIME (24 HOUR CLOCK-HR/MIN) OF TESTING

DATE WORK BEGAN [__ __/__ __/__ __]
DATE WORK COMPLETED [__ __/__ __/__ __]

TIME BEGAN [__ __/__ __]
TIME COMPLETED [__ __/__ __]

2. *WEATHER CONDITIONS: AIR TEMPERATURE (°F) AND HUMIDITY (%)

AIR TEMPERATURE (°F)
BEGINNING OF TESTING [__ __ __]
END OF TESTING [__ __ __]

HUMIDITY (%)
BEGINNING OF TESTING [__ __ __]
END OF TESTING [__ __ __]

3. *PAVEMENT SURFACE MOISTURE CONDITION AT TIME OF TESTING [__]
   DRY 1   MOSTLY DRY 2
   SOMEWHAT DAMP 3   WET 4

4. *PURPOSE OF TESTING [__]
   DETERMINE NEED FOR UNDERSEALING 1
   SLAB STABILITY AFTER INITIAL GROUTING ...2
   SLAB STABILITY AFTER REGROUT 3
   POST CONSTRUCTION MONITORING 4

5. *FILE IDENTIFICATION WITH FWD TEST RESULTS [__ __ __ __ __ __ __]

6. *SOURCE OF TESTING DEVICE [__]
   SHRP 1   HOST STATE OR PROVINCE ..2
   OTHER STATE 3   OTHER 4

SUBMITTED BY, DATE

____
DATA RECORDER

AFFILIATION ______________

CHECKED AND APPROVED, DATE

____
SHRP REPRESENTATIVE

AFFILIATION ______________

Sheet 24 | *STATE ASSIGNED ID [_ _ _ _]
SPS-4 DATA | *STATE CODE [_ _]
LTPP PROGRAM | *SHRP PROJECT ID [_ _ _ _]

CONTROL SECTION

(THESE DATA SHEETS APPLY TO CONCRETE PAVEMENT CONTROL SECTIONS)

1. *DATE (MONTH/DAY/YEAR) [_ _/_ _/_ _]

TIME (24 HOUR CLOCK-HR/MIN) [_ _/_ _]

2. *LENGTH OF CONTROL SECTION TO BE MONITORED (Feet) [_ _ _ _]

LANE WIDTH OF CONTROL SECTION (Feet) [_ _._]

3. *WEATHER CONDITIONS

AIR TEMPERATURE (°F) [_ _ _]

HUMIDITY (%) [_ _ _]

4. *PROCESS USED TO OPEN JOINTS (SEALANT REMOVED=1, SEALANT CUT=2, SEALANT NOT EFFECTIVE AND LEFT IN PLACE=3, SEALANT SOMEWHAT EFFECTIVE AND LEFT IN PLACE=4, OTHER=5) [_]

DEFINE OTHER [______________________________]

5. *TYPE OF JOINTS AND CRACKS PRESENT (ALL SEALED=1, MOST SEALED=2, FEW SEALED =3, NONE SEALED=4, NONE PRESENT TO SEAL=5)

CONCRETE PAVEMENT/ASPHALT SHOULDER JOINT [_]
TRANSVERSE PAVEMENT JOINTS [_]
LONGITUDINAL PAVEMENT JOINTS [_]
TRANSVERSE RANDOM CRACKS [_]
LONGITUDINAL RANDOM CRACKS [_]
DIAGONAL RANDOM CRACKS [_]

6. *PATCHING COMPLETED ON CONTROL SECTION (NO PATCHING=1, MINOR PATCHING=2, MODERATE PATCHING=3, MAJOR PATCHING=4) [_]

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SPS-4 DATA *STATE CODE [_ _]

LTPP PROGRAM *SHRP PROJECT ID [_ _ _ _]

CONTROL SECTION (CONTINUED)

7. *DIMENSIONS OF JOINTS AND CRACKS

AVERAGE WIDTH OF JOINTS/CRACKS (MEASURE TEN RANDOM LOCATIONS) (1/16TH INCH)

	SHOULDER JOINTS	PAVEMENT JOINTS TRANSVERSE	PAVEMENT JOINTS LONGITUDINAL	RANDOM CRACKS
1.	[_ _]	[_ _]	[_ _]	[_ _]
2.	[_ _]	[_ _]	[_ _]	[_ _]
3.	[_ _]	[_ _]	[_ _]	[_ _]
4.	[_ _]	[_ _]	[_ _]	[_ _]
5.	[_ _]	[_ _]	[_ _]	[_ _]
6.	[_ _]	[_ _]	[_ _]	[_ _]
7.	[_ _]	[_ _]	[_ _]	[_ _]
8.	[_ _]	[_ _]	[_ _]	[_ _]
9.	[_ _]	[_ _]	[_ _]	[_ _]
10.	[_ _]	[_ _]	[_ _]	[_ _]
MINIMUM	[_ _]	[_ _]	[_ _]	[_ _]
MAXIMUM	[_ _]	[_ _]	[_ _]	[_ _]
AVERAGE	[_ _]	[_ _]	[_ _]	[_ _]

Revised 3/91

SPS-4 ATTACHMENT G

GUIDE PROCEDURES

GUIDE PROCEDURES
1 UNDERSEALING SPECIFICATION

1.0 GENERAL

This specification for undersealing of concrete pavements was developed for the Strategic Highway Research Program (SHRP) for use in the Maintenance Effectiveness Study of Concrete Pavements (SPS-4). A number of state and federal agencies and individuals contributed to its development. The term "contracting agency" is being used to designate the state highway department for whom the work is being done. Engineer refers to the contracting agency representative.

1.01 DESCRIPTION OF WORK

The work performed under these specifications shall consist of filling the existing voids in the pavement system without raising the slabs and includes such items as traffic control, providing 18,000 pound axle load truck, coordinating with testing of the pavement for location of voids to be filled, drilling and coring test holes, drilling injection holes, placing material, monitoring to control profile of pavement, retesting for slab stability after grouting, clean-up, traffic control and other related work.

1.02 SPECIAL BIDDING REQUIREMENTS

Normally, construction specifications include in this section statements that set forth the administrative guidelines to be followed in the conduct of the contract. These guidelines address responsibilities of the agency and contractor, limits of liability for parties, bonding requirements, legal and employment requirements, time constraints, etc.

1.03 TRAFFIC CONTROL

The contractor is responsible for supplying all temporary signing, cones and other traffic control devices. During construction of the test sections the existing road will be kept open to all traffic. The portion of the project being used by public traffic, whether it be through or local traffic, shall be maintained in a safe and satisfactory condition by the contractor.

1.04 MATERIALS

1.04.1 MIX DESIGN

The grout material used for subsealing shall consist of the following:

1 part (by volume) Portland Cement Type I, II or III and

3 parts (by volume) Fly Ash and

Sufficient water to achieve required fluidity as per Section 1.04.5.

1.04.2 PORTLAND CEMENT

Portland Cement shall meet the requirements for Portland Cement Type I, II or III as per AASHTO M-85.

1.04.3 FLY ASH

Fly ash shall meet the requirements of ASTM C-618.

1.04.4 WATER

Water shall meet the requirements as outlined in ASTM C94, Section 4.1.3. Water used in normal ready mix concrete operations is acceptable.

1.04.5 FLUIDITY

As a laboratory check, fluidity of the grout slurry shall be measured by ASTM C 939-87, Flow of Grout for Preplaced Aggregate Concrete (Flow Cone Method). Time of efflux for cement-fly ash grouts shall range from 9 to 15 seconds. Two measurements shall be made for each 500 feet of test section which is undersealed. Data will be recorded by the engineer.

1.04.6 MATERIAL PROPOSAL

The contractor shall submit in advance a proposal for materials and additives meeting the requirements of Section 1.04.1 above. Submittals shall include address and telephone number of point of contact for sources, mill certifications for cement, and physical and chemical analysis for the fly ash. The grout slurry may be tested, if required, by an approved laboratory as a check showing one day, three day, and seven day strengths, flow cone times, shrinkage and expansion observed and time of initial set. The seven day strength shall not be less than 600 psi as measured using AASHTO Test Method T-106. Test specimens shall use the materials (including water) which are to be used in the project. The time of initial set test shall comply with AASHTO T-154.

1.05 EQUIPMENT

The contractor shall furnish all equipment necessary or incidental to the adequate performance of this contract as follows.

1.05.1 GROUT PLANT

The grout plant shall consist of a positive displacement cement injection pump and a high-speed colloidal-mixing machine which shall operate at a minimum speed of 800 RPM and maximum speed to 2000 RPM. As a result a high shearing action will be developed and the subsequent pressure release will produce a homogeneous grout mixture. The injection pump shall have pressure capability of 250-300 psi when pumping a grout slurry mixed to a 12 second flow cone time. The injection pump shall be capable of continuous pumping at rates as low as 1 1/2 gallons per minute or the system should be modified by adding a recirculating hose and by-pass valve at the discharge end of the system.

Materials shall be dry and accurately measured by weight or volume if delivered in bulk or shall be packaged in sacks containing a uniform volume. Water used in the grout mixture shall be batched through a meter or scale capable of measuring the day's total consumption.

Because of the research nature of this work the grout plant shall have the capability to measure the volume of grout which is pumped into each hole. It is the responsibility of the engineer to record such readings.

1.05.2 WATER TANKER

If water tanks and pumps are not an integral part of the plant, water shall be supplied from a water truck with adequate capacity and pressure for delivery to the grout plant.

1.05.3 DRILLING

Core drilling will be the only acceptable method of making injection holes. The hole shall be approximately 2 inches in diameter. Washing of the core hole to allow ease of grout flow will be allowed but the excess water will be allowed to drain out of the void prior to undersealing.

1.05.4 TRANSPORT

Necessary material transport and handling equipment shall be available and meet all specified safety requirements.

1.05.5 MISCELLANEOUS

All necessary hoses, valving and valve manifolds, positive cutoff and bypass provisions to control pressure and volume, pressure gauges with gauge protectors, expanding packers or hoses to provide a positive seal during grout injection, hole washing tools, and core barrels shall be available.

1.05.6 VERTICAL MOVEMENT TESTING

The contractor shall supply equipment to measure slab lift. This equipment shall be capable of detecting the lift of the pavement edge relative to the adjoining shoulder or of any two outside slab corners adjacent to a joint or crack. The equipment shall have the capability of making such measurements to 0.001 inch. These devices must make lift measurements against stable reference points and be of a design satisfactory to the contracting agency.

The contractor shall furnish a vehicle having a single rear axle that can be loaded to 18,000 pounds evenly distributed between the inside and outside wheel path, a vehicle driver and sufficient manpower to assist in the operation of the static load measuring gauges. This equipment will be one of several devices used for preliminary and stability testing. The static load deflection testing is outlined in Section 1.06.

1.05.7 OTHER

Any and all miscellaneous tools, equipment and supplies required to complete the work.

1.06 TESTING

1.06.1 PRELIMINARY TESTING

Each joint, crack and slab on the project or within designated areas of the project shall be tested by the contractor in cooperation with the engineer using static methods. The contractor shall provide and operate the test truck and Benkelman beams. The engineer shall determine the areas to be undersealed. This work shall be performed as follows:

All testing shall be limited to the hours of midnight to 10 a.m. The testing should be stopped earlier if there is evidence of slab lockup due to thermal expansion of the slabs. Testing may be continued after the hour specified if the slabs are not interlocked or under compression. Joint deflections decrease significantly with joint interlock. However, a stronger foundation or other improved pavement feature could also result in decreased deflection. Joint interlock will have to be evaluated on a site by site basis.

The contractor shall provide and operate two Benkelman beams which comply with AASHTO Designation: T 256-77, Pavement Deflection Measurements. Procedures for use of the Benkelman beam are given in T256-77, Section 5.2, Benkelman Beam.

Position each Benkelman beam so that the probes are across from each other at a joint or crack on the corners of adjoining slabs. Zero the gages with no load on the slab on either side of the joint or crack. Move the test vehicle parallel to the edge of the pavement so that the outside wheel of the test axle is within one foot of the edge. Stop the vehicle when the center of the test axle is about one foot from the joint or crack on the approach slab. Read both gages and record the data. Move the test vehicle across the joint or crack to a similar position on the leave slab with the center of the test axle one foot beyond the joint or crack. Read both gages and record the data. Test adjoining slabs or panels for each joint or crack. The contractor will be responsible for reading and recording gage readings.

All slabs with deflections in excess of 0.020 inch will be undersealed in accordance with the plans and specifications. The contractor may also have to provide support for additional testing including coordination, drilling and coring.

1.06.2 STABILITY TESTING

Stability testing will not be done until the next day and then shall be done between the hours of midnight to 10 a.m. as outlined in 1.06.1. The test section will be opened to traffic after undersealing as outlined in 1.07.4 and closed by the contractor the next day for this stability testing. All joints shall be retested in accordance with 1.06.1. Slabs which deflect in excess of 0.020 inch shall be regrouted and retested as directed.

Any slab that continues to show movement in excess of that specified after two properly performed groutings will be accepted. However, the accepted deflections need to be recorded.

1.07 SUBSEALING

1.07.1 DRILLING HOLES

Grout injection holes shall be cored in a pattern determined by the contracting agency in consultation with the contractor. They shall not be larger than 2 inches in diameter, cored vertically and round, and to a depth sufficient to penetrate any stabilized base and into the subgrade material. Subgrade penetration shall not exceed three inches. (Note: Examples of two hole patterns are shown at the end of this section of the specification.)

1.07.2 WASHING HOLES

Subject to the contracting agency's approval, holes may be washed or blown to create a small cavity, to better intercept the void structure. The excess water will be allowed to drain out of the void prior to undersealing.

1.07.3 SUBSEALING

During the subsealing operation, a positive means of monitoring lift shall be used as described in Section 1.05.6. The upward movement of the pavement shall not be greater than 0.125 inch. An expanding rubber packer or other approved device connected to the discharge from the plant shall be lowered into the hole. The discharge end of the packer or hose shall not extend below the lower surface of the concrete pavement. Each hole shall be pumped until maximum pressure is built up or material is observed flowing from hole to hole. Maximum allowable pressure shall not exceed 40 to 60 pounds per square inch or other values specified by the contracting agency to minimize slab raising, except that a short surge to 150 psi will be allowed when starting to pump the hole in order for the grout to penetrate into the void structure. The pressure shall be monitored by an accurate pressure gauge in the grout line that is protected from the grout slurry. Water displaced from the void structure by the grout shall be allowed to flow out freely. Holes shall not be plugged with a temporary stopper until after all holes at the joint location have been pumped. Excessive loss of the grout through cracks, joints, or from backpressure in the hose or in the shoulder area shall not be tolerated. Pay quantities will be reduced by the contracting agency according to Section 1.11.5. Excess grout should be picked up and not squeezed into joints and cracks.

1.07.4 OPEN TO TRAFFIC

The contractor may be required to test for initial grout set using AASHTO T-154. The pavement can be opened to traffic at the time an acceptable initial set test has been achieved but in no case will that time be less than 2 hours. If the contractor elects not to run the initial set test, the treated pavement shall remain closed to all traffic (including all construction traffic) for a minimum of 4 hours.

1.07.5 CORRECTING PANEL DISPLACEMENT

Pavement that has been raised in excess of the specified tolerance shall be ground to the correct grade at no cost to the contracting agency. However, because of the research nature of this undersealing study care should be exercised to limit the deficiencies of excess displacement, radial cracks and transverse cracks.

1.07.6 RADIAL CRACKS

Cracks emanating radially from the grout injection holes will be presumed to have been caused by improper injection techniques. For each 5 lineal feet of such crack measured, the contractor's pay quantity will be reduced by 1 cubic foot of grout. Alternatively, the contracting agency may require replacement of the damaged panel or a portion thereof at no cost to the contracting agency.

1.07.7 TRANSVERSE CRACKS

In the event that cracks develop between adjacent grout injection holes, the contractor shall be required to repair these cracks by a method satisfactory to the contracting agency at no cost to the contracting agency. Alternatively, at the discretion of the contracting agency, replacement of the entire panel or a portion thereof may be required at no cost to the contracting agency.

1.07.8 HOLE PATCHING

Upon completion of the subsealing, all core holes shall be sealed flush with the surface of the pavement with a fast setting sand/cement material or other patch material approved by the contracting agency.

1.07.9 WEATHER CONDITIONS

Grout subsealing shall not be performed when pavement surface temperatures are below 40°F., or if the subgrade and/or base course material is frozen. At times when the pavement temperature routinely falls below 40°F., grout subsealing shall be suspended for the season; not to be resumed until temperatures may be expected to rise again above 40°F.

1.07.10 ACCEPTANCE

Before final acceptance, all waste material shall be cleaned up and the surrounding areas shall be left in a neat and orderly condition as determined by the contracting agency.

1.08 TIME AND TIME LIMITATIONS

1.08.1 COMMENCEMENT OF WORK

The contractor shall commence work under this contract within the specified number of calendar days of the date stipulated in the "Notice to Proceed."

1.08.2 OPERATIONAL LIMITS

The construction activities will be in compliance with 1.06.1, Preliminary Testing; 1.06.2, Stability Testing and 1.07.9, Weather Conditions. The contractor shall be ultimately responsible for the construction schedule and will coordinate it with the state highway agency. It is the responsibility of the contractor to initiate this coordination effort.

1.09 METHODS OF MEASUREMENT

The quantities to be paid for will be measured as follows.

1.09.1 MOBILIZATION

Mobilization will be measured as a lump sum.

1.09.2 TRAFFIC CONTROL

Traffic control will be measured on a lump sum basis.

1.09.3 TESTING

Preliminary testing as described in Section 1.06.1 will be measured on a lump sum basis.

1.09.4 STABILITY TESTING

Stability testing will be incidental to Section 1.09.3, "Testing."

1.09.5 HOLES

Holes cored through the existing concrete slabs, at the location and to the depth shown on the plans or directed by the engineer, will be measured on a per hole basis.

1.09.6 SUBSEAL MATERIAL

Subseal material will be measured per cubic foot of grout incorporated under the pavement or pavement structure and includes all material necessary to produce the grout.

1.09.7 RESEARCH STUDY MEASUREMENTS

The measurements for the research study will be recorded by the engineer. However, it is the responsibility of the contractor to provide the calibrated equipment and measurement reading. The measurements shall include but not be limited to the following: deflection testing results, hole pattern cored, grout take per hole, and stability testing results.

1.10 BASIS OF PAYMENT

The accepted quantities measured will be paid for at the contract unit price for:

1.10.1 MOBILIZATION

Mobilization will be paid for as a lump sum.

1.10.2 TRAFFIC CONTROL

Traffic control will be paid for as a lump sum.

1.10.3 TESTING

Testing will be paid for as shown at the contract price bid per lump sum for each lane of roadway tested.

1.10.4 STABILITY TESTING

Stability testing will be incidental to Section 1.09.3, "Testing," and shall not include a separate pay item. Such payment will be full compensation for furnishing the load test truck, driver and necessary personnel to assist in testing.

1.10.5 HOLE DRILLING

Holes will be paid for at the contract unit price per hole. Such payment will be full compensation for coring, plugging, and sealing the hole after the undersealing is completed.

1.10.6 UNDERSEAL MATERIAL

The contract unit price per cubic foot of grout will be full compensation for the furnishing of all materials, including water and additives, labor, equipment and tools, and all other costs necessary and incidental to accomplish the undersealing of the pavement at the designated locations in accordance with these specifications and the details shown on the plans.

1.11 CORRECTIONS AND PAY ADJUSTMENTS

1.11.1 DISPLACEMENT

If the pavement is displaced as per Paragraph 1.07.5, correction shall be made as described in that paragraph.

1.11.2 RADIAL CRACKING

Penalty for radial cracking will be as per Paragraph 1.07.6.

1.11.3 TRANSVERSE CRACKING

Penalty for transverse cracking will be as per Paragraph 1.07.7.

1.11.4 WASTED UNDERSEAL MATERIAL

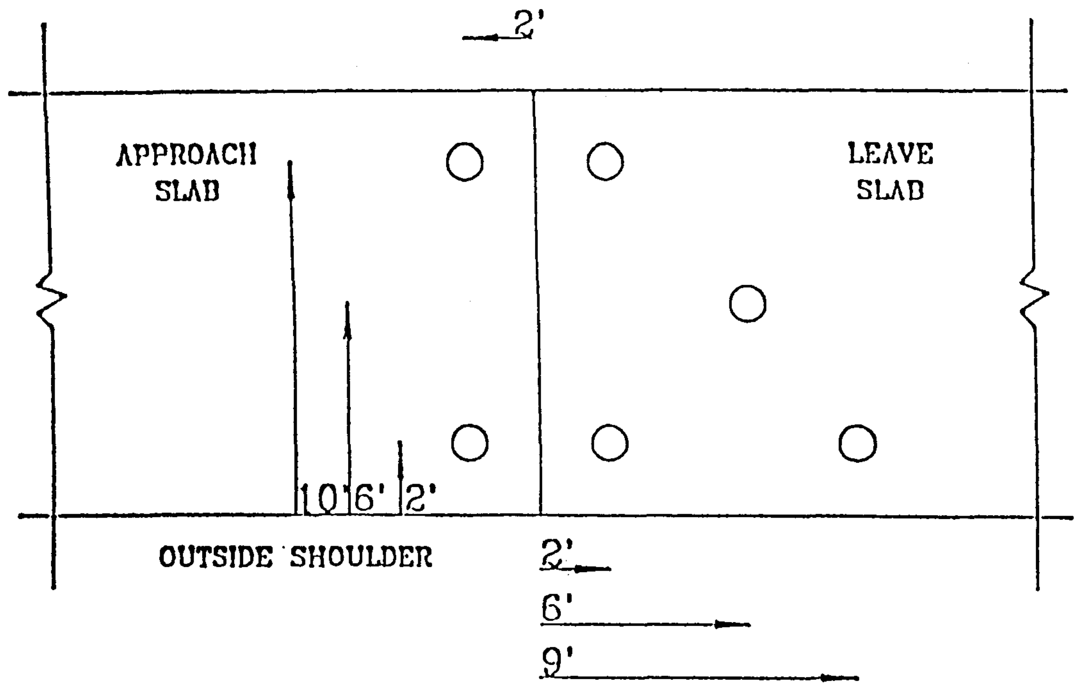
Mixed material shall not be held in the mixer or injection sump pump for more than one hour after mixing. Any material held for longer times shall be wasted and will not be paid for. Additional water shall not be added after initial mixing of the grout.

1.11.5 UNCONTROLLED FLOW

Material wasted by uncontrolled flow as described in Section 1.07.3 will not be paid for and will be deducted from the pay quantities by the contracting agency.

FIGURE 1

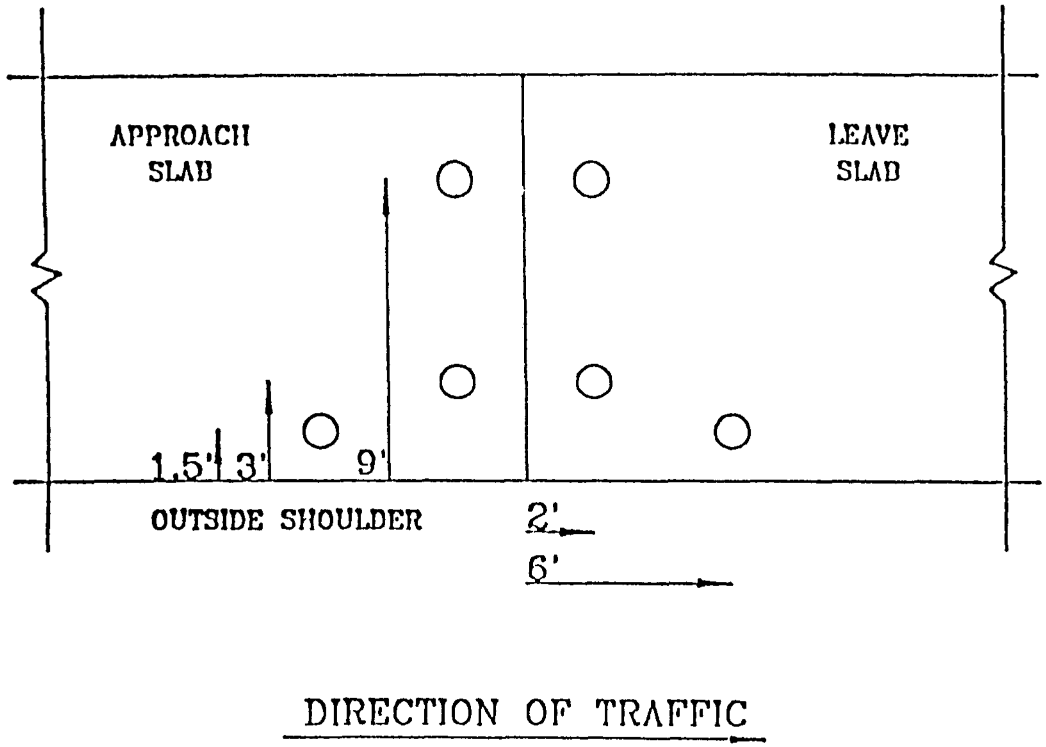
JNDERSEALING GROUT INJECTION HOLE PATTERN



DIRECTION OF TRAFFIC

FIGURE 2

UNDERSEALING GROUT INJECTION HOLE PATTERN



Revised 3/91

GUIDE PROCEDURES
2 JOINT AND CRACK RESEALING

2.0 GENERAL

This specification covers the resealing of joints and cracks in existing portland cement concrete pavements.

2.01 DESCRIPTION OF WORK

The joint or crack shall be prepared by removing the old sealant or joint insert and refacing and cleaning the joint. Repairs meeting the requirements of Section 3 shall be completed prior to this operation. Installation of separating or blocking medium (if required) and installation of new sealant shall be in accordance with this specification in order to produce the proper shape factor in the joint sealant.

2.02 TRAFFIC CONTROL

The contractor is responsible for supplying all temporary signing, cones and other traffic control devices. During construction of the test sections the existing road will be kept open to all traffic. The portion of the project being used by public traffic, whether it be through or local traffic, shall be maintained in a safe and satisfactory condition by the contractor.

2.03 RESEALING OF JOINTS - LIQUID SEALANTS (ASTM D 3405)

2.03.1 MATERIALS

This material and procedure shall be used for sealing joints between the concrete pavement and asphalt shoulders.

All sealant materials and separating and blocking medium shall be certified or tested and approved by the engineer before being incorporated into the work. The contractor shall furnish a complete written statement of the origin, composition and manufacture of any or all materials that are to be used in the work. Where installation procedures or any part thereof are required to be in accordance with recommendations of the manufacturer of sealing compounds, the contractor shall submit catalog data and copies of recommendations prior to installation of the materials.

The following specification covers the only type of liquid sealant material approved.

ASTM D 3405 Sealing Compound, Hot Applied

2.03.2 EQUIPMENT

Sealing equipment must be in accordance with the manufacturer's recommendations for the specific material listed. The equipment for hot applied sealing compounds shall be a melting kettle of a double boiler, indirect heating type, using oil as a heat-transfer medium. The kettle shall have an effective mechanically operated agitator and shall be equipped with a positive thermostatic temperature control which shall be checked for calibration before commencing. Manufacturer's recommendations for application temperature shall be followed. Overheating shall not be permitted. The hoses and applicator wand shall be insulated and shall be recirculating.

2.03.3 CONSTRUCTION

Removal of existing joint sealant or insert, refacing of joints and cleaning, shape factor dimensions, blocking medium and sealant installation shall be in accordance with these specifications.

2.03.3.1 JOINT INSERT REMOVAL

Inserts shall be removed from all joints and the joints shall be sawed to provide a clean vertical face. The width and depth of the saw cuts shall be sufficient to insure removal of all the insert and to provide a finished joint of the correct joint shape dimensions. The width of the joint shall be kept to a minimum and in no case shall it exceed 1 1/2". If the joint width is in excess of 1 1/2", the joint should be repaired.

2.03.3.2 EXISTING SEALANT REMOVAL

Any in-place sealant shall be cut loose from each joint face independently using a vertical cutting edge tool. Alternatively, a power driven concrete saw with diamond or abrasive blades may be used. After cutting the existing sealant free from both joint faces, the sealant shall be removed to the depth required to accommodate any separating and/or depth blocking medium used, and to provide the specified depth for the new sealant material to be installed. Equipment and procedures used in the cutting and removal operations causing spalling will not be allowed.

2.03.3.3 REPAIR OF DEFECTIVE CONCRETE

Concrete which is spalled, deteriorated or delaminated shall be repaired as outlined in Section 3.

2.03.3.4 REPAIR OF ASPHALT SHOULDER

Asphalt which is spalled, deteriorated or delaminated shall be removed and replaced with hot mix asphalt prior to insert or sealant removal. A tack coat should be applied prior to patching. The interface of the concrete and patched asphalt shoulder will be saw cut to a depth of 3/4" to give a minimum vertical face.

2.03.3.5 REFACING OF JOINTS

Joints shall be refaced using a power driven concrete saw with diamond or abrasive blades to remove all old sealant from the joint faces, to expose new clean concrete and, if required, to cut the joint to the width and depth necessary to provide for an effective shape factor for the joint sealant. Every effort will be made in the joint refacing operation to minimize the enlargement of the joint opening. In no case shall the refaced joint opening be larger than 1 1/2".

2.03.3.6 CLEANING PRIOR TO RESEALING

Following the refacing operation, the concrete joint face shall be thoroughly cleaned using a high-pressure water jet. Subsequently, an oil-free air jet should be used to remove all cuttings or debris remaining on the faces or in the joint opening. The newly exposed concrete joint face shall then be cleaned by sandblasting. Sandblasting should be performed using a compressor that can supply air at the rate of not less than 150 cu ft/min at a pressure of not less than 90 psi at the nozzle. The nozzle should be narrow enough that it can be partially inserted into the joint and the air stream directed against the joint wall. The air stream is directed against one side of the joint until a clean surface is obtained; then the operation is repeated on the opposite wall. For final cleaning immediately prior to installation of the blocking medium, the joints shall be blown clean with oil-free compressed air and left completely free of sand and water. Any special joint cleaning requirements shall follow the recommendations of the manufacturer of the jointseal being used.

In addition to the above, the asphalt shoulder will be pre-heated with a heater lance prior to the application of the joint sealant.

2.03.3.7 SEPARATING AND BLOCKING MEDIUM

The lower portion of the joint groove shall be plugged or sealed off at a uniform depth with a backer rod to prevent entrance of the sealant below the specified depth. Backer rod size will depend on the joint width. The backer rod shall be compatible with the sealant (see sealant manufacturer's recommendations) and shall be clean, free of scale or foreign matter, oil or moisture and shall be nonabsorbing. Proper size for different joint widths are listed below:

Joint Width	Blocking Media Dia.
5/16 in. (.8 cm.)	3/8 in. (.96 cm.)
3/8 in. (.96 cm.)	1/2 in. (1.28 cm.)
1/2 in. (1.28 cm.)	5/8 in. (1.6 cm.)
5/8 in. (1.6 cm.)	3/4 in. (1.92 cm.)
3/4 in. (1.92 cm.)	1 in. (2.54 cm.)
1 in. (2.54 cm.)	1 1/4 in. (3.18 cm.)
1 1/4 in. (3.18 cm.)	1 1/2 in. (3.8 cm.)
1 1/2 in. (3.8 cm.)	2 in. (5.08 cm.)

The backer rod shall not be stretched during insertion in the joint. When the existing sealant has been removed to the required depth and the bottom of the joint opening to be resealed is formed by previously installed sealant material (such as in an expansion joint), a nonreactive adhesive-backed tape shall be inserted in lieu of the backer rod. The tape shall be 1/8 inch wider than the nominal width of the joints.

2.03.3.8 LIMITS OF JOINT PREPARATION

Work required for the joint sealant removal; widening and/or deepening of the joint openings, if required; refacing of joint faces, and sandblasting of the joint faces should proceed at reasonable production rates determined by the contractor. The final stages of joint preparation which includes compressed air cleaning of joints, and placement of separating and/or blocking medium if required, shall be limited to only that lineal footage of joint that can be resealed during a day's production.

2.03.3.9 INSTALLATION OF SEALANTS

Sealant compound shall not be placed unless the joint is dry, clean and free of dust. The face of the joint shall be surface dry and the atmospheric and pavement temperature shall both be at least 50° F at the time of application of the sealant. Installation of the sealant shall be such that the cured in-place sealant shall be well bonded to the concrete and free of voids or entrapped air. Sealant shall be installed in a neat and workmanlike manner, so that upon completion of the work, the surface of the sealant material is 3/16 ± 1/16 in. below the adjacent pavement surface. The contractor shall "spot up" or refill all low joints before final acceptance. Any excess material on the surface of the pavement shall be removed and the surface left in a clean condition.

2.03.4 OPEN TO TRAFFIC

Vehicular or heavy equipment traffic shall not be permitted on the pavement in the area of the joints during the curing period. Unless otherwise specified, the period of cure shall be in accordance with the manufacturer's recommendations.

2.04 RESEALING JOINTS - SILICONE SEALANT

2.04.1 MATERIALS

This specification shall be used for the sealing of all concrete joints.

All sealant materials and separating and blocking medium shall be inspected, tested and approved by the contracting agency before being incorporated into the work. The contractor will arrange with the supplier for the purchasing agency to obtain samples for acceptance testing. Two quart tubes or six 10 oz tubes are required for acceptance testing. Any work in which untested and unaccepted materials are used without approval or written permission of the contracting agency shall be performed at the contractor's risk. The contractor shall furnish a complete written statement of the original composition and manufacture of any or all materials that are to be used in the work. Where the installation procedures or any part thereof are required to be in accordance with recommendations of the manufacturer of sealing compounds, the contractor shall submit catalog data and copies of recommendations before installation of the material is commenced.

The sealant material shall comply with the following Federal or Agency Specifications:

TT-S-001543A	One-component silicone sealant (Class A)
Georgia DOT 833.06	Type A Silicone (Type A is preferred, although types B and C are allowed.)

(Note: A copy of Georgia DOT 833.06 is given at the end of this section of the specification.)

2.04.2 EQUIPMENT

The sealant material shall be installed with an approved mechanical device suitable for the purpose intended. The nozzle used to apply the sealant shall be shaped to fit inside the joint to introduce the sealant between the joint faces. An air powered extrusion pump with a 35:1 min. ratio is recommended. However, hand held caulking guns will be allowed.

2.04.3 CONSTRUCTION

Removal of existing joint sealant or insert, refacing of joints and cleaning, joint shape, blocking medium and sealant installation shall be in accordance with these specifications.

2.04.3.1 INSERT REMOVAL

Inserts shall be removed from all joints and the joints shall be sawed to provide a clean vertical face. The width and depth of the saw cuts shall be such as to insure removal of all the insert and to provide a finished joint of the dimensions necessary for the sealant material selected for the resealing operation.

2.04.3.2 REMOVAL OF EXISTING SEALANT

Any in-place sealant shall be cut loose from each joint face independently using a vertical cutting edge tool. Alternatively, a power driven concrete saw with diamond or abrasive blades can be utilized. After cutting free the existing sealant from both joint faces, the sealant shall be removed from both joint faces to the depth required to accommodate any separating and/or depth blocking medium used, and to maintain the specified depth for the new sealant material to be installed. Equipment and procedures used in the cutting and removal operations causing spalling will not be allowed.

2.04.3.3 REPAIR OF DEFECTIVE CONCRETE

Concrete which is spalled, deteriorated or delaminated shall be repaired as outlined in Section 3.

2.04.3.4 REFACING OF JOINTS

Joints shall be refaced using a power driven concrete saw with diamond and/or abrasive blades to remove all old sealant from the joint faces, to expose new clean concrete and, if required, to widen the joint to the width and depth necessary to provide for an effective shape factor. Every effort will be made in the joint refacing operation to minimize the enlargement of the joint opening. In no case shall the refaced joint opening be larger than 1 1/2".

2.04.3.5 SHAPE FACTOR

Actual width and depth of joints will depend on the original construction and existing field conditions. The joint reservoir shape shall be such that the sealant material is a minimum of 1/4 inch thick, but not greater than 1/2 inch thick for joints up to 1 inch wide. Joint depth should be sufficient for a gap of 1/8 to 1/4 inch between backer material and bottom of joint. This allows for potential expansion of old sealant that might remain below the reservoir. Thickness of sealant in joints over 1 inch wide shall be limited to 1/2 inch. A width to depth ratio of 1:1 to 2:1 shall be maintained for joints less than 1 inch wide.

2.04.3.6 CLEANING PRIOR TO SEALING

Following the refacing operation, the joint faces and opening shall be thoroughly cleaned using a high-pressure water jet followed by an air jet (oil-free) to dry and remove all cuttings or debris remaining on the faces or in the joint opening. The newly exposed joint faces shall then be cleaned by sandblasting. Sandblasting should be performed using a compressor that can supply air at the rate of not less than 150 cu ft/min at a pressure of not less than 90 psi at the nozzle. The nozzle should be narrow enough that it can be partially inserted into the joints and the air stream directed against both walls of the joints. The air stream is directed against one side of the joint until a clean surface is obtained; then the operation is repeated on the opposite wall. For final cleaning immediately prior to installation of the blocking medium, the joints shall be blown with oil-free compressed air and left completely free of sand and water. Cleaning of the joint shall follow the recommendations of the manufacturer of the joint seal being used.

2.04.3.7 SEPARATING AND BLOCKING MEDIUM

The lower portion of the joint groove or opening shall be plugged or sealed off at a uniform depth with a blocking medium to prevent entrance of the sealant below the depth specified. Blocking medium material shall be compatible with the sealant, clean and free of scale, foreign matter, oil or moisture and shall be nonabsorbing.

The size of blocking medium required shall depend on the width of the joints after proper preparation, as shown below:

Joint Width	Blocking Media Dia. (or width for tape)
5/16 in. (.8 cm.)	3/8 in. (.96 cm.)
3/8 in. (.96 cm.)	1/2 in. (1.28 cm.)
1/2 in. (1.28 cm.)	5/8 in. (1.6 cm.)
5/8 in. (1.6 cm.)	3/4 in. (1.92 cm.)
3/4 in. (1.92 cm.)	1 in. (2.54 cm.)
1 in. (2.54 cm.)	1 1/4 in. (3.18 cm.)
1 1/4 in. (3.18 cm.)	1 1/2 in. (3.8 cm.)
1 1/2 in. (3.8 cm.)	2 in. (5.08 cm.)

2.04.3.8 LIMITS OF JOINT PREPARATION

The work required for the removal of existing joint sealant, widening and/or deepening of the joint openings if required, refacing of joint faces and sandblasting of the joint faces may proceed at any production rate determined by the contractor. The final stages of joint preparation which includes compressed air cleaning of joints and placement of separating and/or blocking medium, if required, shall be limited to that lineal footage of joint that can be resealed during a day's production.

2.04.3.9 PRIMING

Some silicone highway sealants require priming of the joint before installation. The priming procedure should always follow the manufacturer's instructions for proper application rate and proper time of cure before the sealant is applied. In most cases the primer cure time will change as the temperature and relative humidity changes.

2.04.3.10 SEALANT INSTALLATION

Installation of the sealant shall be such that the in- place sealant will adhere to the concrete and be free of voids. The joints shall be sealed in a neat and workmanlike manner. It is recommended that upon completion of the work, the surface of the sealant material shall be 3/16 + 1/16 inch below the pavement surface. Any excess material on the surface of the pavement shall be removed and the pavement surface shall be left in a clean condition.

If the silicone sealant material is not self-leveling, the sealant material shall be tooled in a manner which causes it to wet the joint surfaces.

Climatic conditions should be considered when this type of material is to be specified. Silicone sealant cures by reacting with atmospheric moisture, but the rate of cure is also temperature dependent. At a temperature of 75°F. (24°C.) and 50 percent relative humidity, the sealant will cure to a tack-free surface in one hour and reach its ultimate properties in seven to twenty-one days. At a temperature of 40°F. (4°C.), the tack-free time will be about two to three hours. If sealing is done at low temperature or if faulting and deflections are severe, longer cure time should be allowed. Re-opening the roadway is generally permitted within an hour, but where large deflections occur or in areas of low humidity, a 3 or 4 hour cure time is recommended before opening the road to traffic.

2.05 CRACK RESEALING - SILICONE SEALANT

2.05.1 MATERIALS

All materials shall be in accordance with Section 2.04.1 , Resealing Joints - Silicone Sealant, of this specification.

2.05.2 EQUIPMENT

Sealing equipment shall conform to Section 2.04.2 of this specification. A concrete saw with a pivotal, small-diameter blade which will follow the crack shall be used to provide a joint reservoir.

2.05.3 CONSTRUCTION

Low severity or hairline cracks with no spalling may be left unsealed. Removal of any existing joint sealant, construction of a proper joint shape factor, cleaning, installation of a blocking medium (if necessary) and sealant installation shall be in accordance with Section 2.04.3 with the following exceptions.

2.05.3.1 CRACK REFACING

Refacing cracks shall be accomplished using a special power-driven concrete saw with a small-diameter diamond and/or abrasive blades to remove all old sealant from the crack faces and expose new clean concrete. If required, the crack shall be widened to the width and depth necessary to produce an effective shape factor. In no case shall the widened crack be less than 3/8 inch in width.

Where crack widths vary and crack faces are raveled and somewhat irregular, a minimum crack reservoir depth of approximately 3/4 inch shall be maintained.

2.05.3.2 CRACK CLEANING

This operation shall be the same as that outlined for joints in Section 2.04.3.6 of this specification.

2.05.3.3 DEFECTIVE CONCRETE REPAIR

Concrete which is spalled, deteriorated or delaminated shall be repaired as outlined in Section 3.

2.05.3.4 BLOCKING MEDIUM

The blocking material shall comply with section 2.04.3.7 of this specification.

2.05.3.5 SEALANT INSTALLATION

Sealant installation shall be done in accordance with Section 2.04.3.10 of this specification.

2.06 METHODS OF MEASUREMENT

The quantities to be paid for will be measured as follows.

2.06.1 MOBILIZATION

Mobilization will be measured as a lump sum.

2.06.2 TRAFFIC CONTROL

Traffic control will be measured on a lump sum basis.

2.06.3 RESEALING OF JOINTS

Resealing of joints and cracks shall be measured by the length to the nearest foot.

2.06.4 RESEARCH STUDY MEASUREMENTS

Measurements for the study will be recorded by the engineer. However, the contractor will provide the calibrated equipment and measurement readings. The readings shall include but not be limited to joint geometry, materials, volumes, and temperatures.

2.07 BASIS OF PAYMENT

The accepted quantities measured will be paid for at the contract unit price for:

2.07.1 MOBILIZATION

Mobilization will be paid for as a lump sum.

2.07.2 TRAFFIC CONTROL

Traffic control will be paid for as a lump sum.

2.07.3 RESEALING/SEALING JOINTS

Liquid Sealant will be paid for by the lineal feet.

2.07.4 RESEALING/SEALING JOINTS

Silicone Sealant will be paid for by the lineal feet.

2.07.5 RESEALING/SEALING CRACKS

Silicone Sealant will be paid for by the lineal feet.

DEPARTMENT OF TRANSPORTATION
STATE OF GEORGIA

SUPPLEMENTAL SPECIFICATION

Modification of Standard Specifications

SECTION 833 - JOINT FILLERS AND SEALERS

833.06 SILICONE SEALANTS AND BOND BREAKERS:

Silicone sealant shall be furnished in a one part silicone formulation. The sealant shall be compatible with the surface to which it is applied. Acid cure sealants are not acceptable for use on Portland cement concrete. Bond breakers shall be chemically inert and resistant to oils, gasoline, solvents, and primer if one is required. Preparation and installation of silicone and bond breakers shall be in accordance with Section 442 or 461 whichever is applicable.

A. SILICONE: Silicones shall be identified in the following manner:

Type A - A low modulus non-sag silicone for use in sealing horizonal and vertical joints in Portland cement concrete pavements and bridges. Tooling is required.

Type B - A very low modulus self-leveling silicone used to seal horizontal joints in Portland cement concrete pavements and bridges. Tooling is not normally required.

Type C - An ultra low modulus self-leveling silicone used to seal horizontal joints in Portland cement concrete pavements and bridges. It can also be used to seal the joints between Portland cement concrete pavement and asphaltic concrete shoulders. Tooling is not normally required.

I. Physical Requirements

TYPE SILICONE	A	B	C
Tensile Stress at 150% Strain (Max. PSI) (Note 1)	45	40	15
Durometer Hardness, Shore (0° and 77±3°F) (Note 1)	"A" 10-25	"00" 40-80	"00" 20-80
Bond to Concrete Mortar (Min. PSI) (Note 1) (Note 3)	50	40	35
Tack Free Time (Skin-over) (Max. Minutes) (Note 2)	90	90	90
Extrusion Rate (Min. Grams/Minute)	75	90	100
Non-volatile (Min. %)	90	90	90
Specific Gravity	1.1 - 1.5	1.1 - 1.5	1.1 - 1 5
Shelf Life (from date of shipment)	6 months	6 months	6 months
Movement Capability & Adhesion (Note 1)			
Ozone and U.V. Resistance (Note 1)			

Note 1: The cure time for these specimens shall be 21 days for Type A and 28 days for Types B and C. Specimens shall be cured at 77°±3°F and 50±5% relative humidity.

Note 2: At conditions of 77°±3° and 50±5% relative humidity.

Note 3: Type C silicone must also meet its bond strength requirement to asphalt concrete.

2. Test Methods:

Tensile Stress	ASTM D-412 (Die "C")
Durometer Hardness	ASTM D-2240
Bond to Concrete Mortar	GDT-106
Tack Free Time (Skin-over)	GDT-106 (Note)
Extrusion Rate	GDT-106
Non-volatile	GDT-106
Specific Gravity	ASTM D-792 (Method A)
Movement Capability & Adhesion	GDT-106
Ozone and U.V. Resistance	ASTM C-793-75

Note: In cases of dispute, ASTM D-2377 shall be used as a referee test. The exposure period under Section 7, Procedure, shall be the Tack Free Time requirement of this specification.

B. BOND BREAKERS: Silicone sealants must be installed over a bond breaker to prevent the sealant from bonding to the bottom of the joint. Bond breakers shall be chemically inert and resistant to oils, gasoline, solvents, and primer if one is required. The bond breaker must not stain or adhere to the sealant. Bond breakers shall be either a backer rod or tape identified and used in accordance with the following:

1. Backer Rods:

Type L - A closed-cell expanded polyethylene foam backer rod. This backer rod may be used with Type A silicone only and is suitable for roadway and bridge joints.

Type M - A closed-cell polyolefin foam backer rod which has a closed-cell skin over an open-cell core. This backer rod may be used with all three types of silicone and is suitable for use in roadway and bridge joints.

Test Requirements: Both types of backer rod shall meet the following requirements.

Density (ASTM D-1622)	2.0 lbs/Ft^3 Minimum
Tensile Strength (ASTM D-1623)	25 PSI Minimum
Water Absorption (ASTM C-509	0.5% by Volume Maximum

2. Bond Breaking Tapes:

Type N - Bond breaking tape shall be made from extruded polyethylene and shall have a pressure sensitive adhesive on one side. Bond breaking tapes may be used with all three types of silicone but is suitable for bridge joints only.

Test Requirements: Bond breaking tapes shall meet the following requirements:

Thickness	.005" Minimum

C. CERTIFICATION: The manufacturer of the joint sealant shall furnish certified test results on each lot of sealant furnished to a project. All of the test requirements of this specification shall be certified to except the Bond to Concrete Mortar and Shore Durometer Hardness at 0°F.

GDT 106
METHOD OF TEST FOR
SILICONE SEALANTS

A. SCOPE:

This method covers the tests procedures to be used in determining Bond To Concrete Mortar, Extrusion Rate, Tack Free Time, Movement Capability and Adhesion and Non-Volatile Content of Silicone Sealants.

B. APPARATUS:

1. All necessary equipment required by GDT-58 to make and cut briquets.

2. Testing machine, as specified in ASTM D-638, equipped with a drive to allow speed of testing of 0.30 inch per minute.

3. Suitable, self-aligning grips for testing briquets in accordance with AASHTO T-132.

4. Air powered caulking gun capable of operating at 90 PSI air pressure.

5. Cabinet or room capable of maintaining a temperature of 77±3°F at 50±5% relative humidity.

6. Spatula, steel, having a 4 to 5 inch long narrow blade.

7. Freezer, chest type, capable of maintaining a temperature of 0°F.

8. Extension Machine - An extension machine consisting of one or more screws rotated by an electric motor through suitable gear reductions. Self-aligning plates or grips, one of each pair fixed and the other carried by the rotating screw or screws, shall be provided for holding the test specimens in position during the test.

9. Concrete Test Blocks - Concrete test blocks approximately 1"x1"x3" shall be saw cut from any convenient size specimen of concrete. The concrete shall be Class A or better. The blocks shall be thoroughly cleaned and oven dried at 230±9°F.

10. Scale or balance accurate to 1 gram and a balance accurate to 0.001 gram.

11. Unwaxed paper cups, 480 ml (oz.) 76mm (3 inch) diameter base.

12. Stopwatch or timer.

13. Forced draft oven.

C. BOND TO CONCRETE MORTAR PROCEDURE:

1. Prepare cement mortar briquets in accordance with GDT-58 Section E 1-3.

2. After cooling matching briquets shall be "buttered" with sealant and squeezed together forcing excess sealant out until the briquet halves are tightly fit together with only a thin film of sealant between them.

3. The specimen halves will then be tightly held together with rubber bands until cured in accordance with Standard Specification Section 833.06.

4. Five specimens shall be made and tested.

5. The specimens shall be tensile tested at a loading rate of 0.3 inch per minute using briquet testing grips mounted in the testing machine.

6. Report the average bond strength obtained on the five specimens discarding any erratic results.

D. EXTRUSION RATE PROCEDURE:

1. Using the air operated caulking gun place an appropriate size caulking tube of silicone in it. Carefully square cut the nozzle to give an inside diameter opening of 1/8". Break the seal or cut the tip of the cartridge.

2. Set the air pressure at the caulking gun to 90 PSI

3. Use a disposable container of sufficient size and determine its weight.

4. Gun at 90 PSI the entire contents of the cartridge into the container while using a stopwatch to time the extrusion.

5. Weigh the container and sealant to the nearest gram.

6. Calculate the weight of sealant extruded by subtracting the weight of the container from the total weight.

7. Calculate the extrusion rate per minute as follows:

$$\frac{W}{T}(60)$$

where:

W = weight of silicone extruded, in grams
T = elapsed time, in seconds
60 = 1 minute

E. TACK FREE TIME PROCEDURE: (SKIN OVER)

1. Fill the outside bottom indention of a 16 ounce unwaxed paper cup with silicone and strike it off smooth with a spatula. Record the time or start a timer.

2. If the actual tack free time is needed occasionally touch the silicone with the finger. The time it takes for the material to skin over so that when touched no material will adhere will be considered the Tack Free Time.

3. If you want to determine whether the material is tack free at the maximum tack free time make only one check at that required time.

4. Report the actual Tack Free Time or less than (Required Tack Free time) or greater than (Required Tack Free Time).

F. MOVEMENT CAPABILITY AND ADHESION PROCEDURE:

1. Using 1"x1"x3" concrete blocks a total of ten specimens shall be prepared for testing.

2. Simulated roadway joints shall be made by bonding two sawed block faces together in such a manner that in the middle two inches of the formed joint the silicone will be 3/8" deep by 1/2" wide.

3. Prepared specimens using Type "A" silicone shall be cured 21 days. Type "B" and "C" silicone shall be cured 28 days prior to testing.

4. After curing, five of the specimens shall be soaked in water for seven days prior to testing.

5. All specimens shall be tested at 0°F.

6. The specimens shall be mounted in the extension machine grips and extended at a rate of 1/8" per hour. One cycle is defined as extension to 1 inch width and return to the initial 1/2" width.

7. The specimens shall go through 10 cycles at 0°F with no adhesive or cohesive failures.

8. Results shall be reported as satisfactory or unsatisfactory.

G. NON-VOLATILE CONTENT PROCEDURE:

1. Weigh as rapidly as possible approximately 10 grams of uncured sealant, to the nearest 0.001 gram, in an aluminum foil cup approximately 2 inches in diameter and 1/2 inch deep.

2. Place the cup in a forced draft oven at a temperature of 105±5°C for 24 hours.

3. At the end of 24 hours remove the sample and immediately weigh to the nearest 0.001 gram. Place the sample back in the oven for an additional hour and then remove and reweigh again. There should be no change in weight.

4. If the material has not reached a constant weight place back in the oven until a constant weight is reached.

5. When a constant weight is reached place the sample in a desiccator until the sample has cooled to room temperature. Weigh the sample again to the nearest 0.001 gram. This is the final weight of the sample.

6. Percent non-volatile shall be calculated in the following manner:

$$\frac{A}{B} x 100$$

where:

A = Final weight of sample
B = Original weight of sample

GUIDE PROCEDURES
3 PATCHING

3.0 GENERAL

This specification is for partial depth patching of concrete pavements to insure adequate concrete at joints and cracks to be sealed.

3.01 DESCRIPTION OF WORK

This work shall consist of partial depth patching of spalls, or other surface distress in portland cement concrete pavements. The patch area shall be prepared by removing existing patching material and broken, damaged or disintegrated concrete from the area to be repaired. Approved materials in accordance with this specification shall be used for patches. The finished patch should be in close conformity with the existing pavement cross-section.

3.02 TRAFFIC CONTROL

The contractor is responsible for supplying all temporary signing, cones, and other traffic control devices. During construction of the test sections the existing road will be kept open to all traffic. The portion of the project being used by public traffic, whether it be through or local traffic, shall be maintained in a safe and satisfactory condition by the contractor.

3.03 MATERIALS

Materials for repairing and patching portland cement concrete pavements shall conform to the following requirements.

3.03.1 SPECIFICATION

The materials used shall meet the requirements of the following AASHTO specifications:

Portland Cement	M-85
Aggregates	M-80 & M-6
Curing Compound	M-148
Concrete Admixtures	M-194
Calcium Chloride	M-144

Epoxy Resin Adhesives	M-235
Rapid Setting Patching Materials	Approved List
Fine Aggregate for Epoxy Concrete	Gradation specified by epoxy manufacturer
Coarse Aggregates - Size 89 AASHTO	M-43, Draft Specification

3.03.2 PATCHING MIXTURES

3.03.2.1 HIGH-EARLY STRENGTH PORTLAND CEMENT CONCRETE MIXTURES

Accelerated strength shall be obtained by using Type I or Type III portland cement and a calcium chloride or other accelerator to obtain a compressive strength in excess of 3,000 psi in under 24 hours. The plastic concrete shall have an air content of 6 1/2 $\pm$ 1 1/2%. The recommended slump is 1 to 3 inches at time of placing unless a non-retarding high range water reducing system is used.

3.03.2.2 NORMAL PORTLAND CEMENT CONCRETE MIXTURE

The specifications of the contracting agency will apply.

3.03.2.3 RAPID SETTING PATCHING MATERIALS

Rapid setting patching materials shall have a minimum compressive strength of 3,000 psi in 24 hours.

3.03.2.4 EPOXY RESIN PATCHING MORTARS

Epoxy resin patching mortars shall be prepared in accordance with the manufacturer's recommendations regarding suitable aggregates and gradation of aggregate. See approved products list for suitable materials.

3.04 EQUIPMENT

3.04.1 SAWING EQUIPMENT

Sawing equipment shall be capable of sawing concrete to the specified depth in one pass.

3.04.2 CONCRETE REMOVAL EQUIPMENT

Concrete removal equipment shall be capable of removing the concrete in the repair area to the depth required without damaging sound concrete below the bottom of the patch.

3.04.3 FORMS

Forms for patches adjacent to the shoulder must be straight and free of defects. Wood or metal forms may be permitted.

3.04.4 PROPORTIONING AND MIXING EQUIPMENT

Proportioning and mixing equipment shall meet the requirements of the contracting agency. Mobile mixing equipment shall be permitted subject to the specifications in ASTM C 685.

3.05 DETERMINATION OF PATCH AREAS

Areas to be patched will be determined by the contracting agency using a rod, hammer or other device to determine defective or delaminated areas. The extent of the repair area will be marked by the contracting agency to no less than 4 inches outside the area of delamination. Spalled areas, adjacent to joints, less than 0.5 feet in length and 0.2 feet in width at the widest point shall not be repaired under this specification but shall be filled with the joint sealant material specified.

3.06 PREPARATION OF PARTIAL DEPTH PATCH AREA

Partial Depth patches shall be constructed at locations shown on the plans or as directed by the contracting agency. A saw cut shall be made around the perimeter of the patch area to provide a vertical face at the edge and sufficient depth to provide integrity to the patch. The saw cut shall have a minimum depth of 1 1/2 inches. Nearly vertical edges resulting from the use of milling or grinding machines shall be considered acceptable.

Concrete within the patch area shall be broken out to a minimum depth of 1 1/2 inches with pneumatic tools and until sound and clean concrete is exposed. The maximum size pneumatic hammer shall be 30 pounds. It is the intent of this specification that proper size tools be used which will not fracture the concrete below that needed to reach sound and clean concrete.

Any shoulders adjacent to the patch shall be cut longitudinally to the depth of the patch and to a width not more than 12 inches. The cut shall extend 1 foot beyond both transverse limits of the patch to facilitate placement of form work. Shoulders shall be patched with material similar to the existing shoulder.

The exposed faces of the concrete shall be sandblasted free of loose particles, oil, dust, traces of asphaltic concrete and other contaminates before patching. All sandblasting residue must be removed immediately prior to placement of the bonding agent.

3.07 PLACING PATCH MATERIAL

The patch mixture shall be placed and consolidated to eliminate essentially all voids at the interface of the patch and existing concrete. If a partial depth repair area abuts a working joint or crack which penetrates the full depth of the slab, an insert or other bond-breaking medium shall be used to maintain working joints or cracks. It is the intent of this requirement to prevent contact between the patch and any adjacent slab which could cause a compression or other type failure in the patch. Therefore, the new joint should be formed or sawed to the same width as the existing joint or crack. A caulking compound can be used at the bottom and ends of insert to insure that the patch material does not come into contact and bond to adjoining slabs.

3.07.1 HIGH EARLY STRENGTH PORTLAND CEMENT CONCRETE PATCH MIXTURES

High early strength portland cement concrete (in excess of 3,000 psi in under 24 hours) patch mixtures can be used where early opening (4 to 6 hours) to traffic is required. An epoxy bonding agent is required when placing accelerated pcc patches for early opening to traffic. The epoxy prime coat shall be applied in a thin coating and scrubbed into the surface with a stiff bristled brush and placement of the concrete shall be delayed until the epoxy becomes tacky.

Accelerated portland cement concrete patches should not be placed when the air or pavement temperature is below 40° F. At air temperatures below 55° F, a longer cure period may be required. All patches shall be finished to match the cross-section of the existing pavement. The patch shall be textured with a stiff bristled brush or to conform to the texture of the existing pavement. Curing procedures shall conform to those used for normal concrete paving. Accelerated curing can be improved with a layer of polyethylene over the normal curing compound and then covered with building insulation board.

3.07.2 NORMAL SET PORTLAND CEMENT CONCRETE PATCH MATERIALS

Normal set portland cement concrete patch materials may be used where the patch is protected from traffic for 24 hours or more. A sand-cement grout may be used for bonding the patch. The bonding grout shall be composed of 1 part portland cement to 1 part sand, by volume, with sufficient water to produce a mortar with thick, cream consistency. Water-cement contact time shall not exceed 90 minutes.

The grout shall be scrubbed evenly over the surface of the area to be patched. Excess grout shall not be permitted to collect in pockets. The concrete patch material shall be placed before the bonding grout dries. Dried or hardened grout shall be removed by sandblasting and replaced at no cost to the contracting agency. The patch mixture shall be placed and consolidated to eliminate essentially all voids at the interface between the patch and adjacent concrete.

All patches shall be finished to match the cross-section of the existing pavement.

The patch shall be textured with a stiff bristled brush or to conform to that on the existing pavement. Curing procedures shall conform to those used for normal concrete paving.

3.07.3 RAPID SET PATCH MATERIALS

Rapid set patch materials shall be installed in accordance with the manufacturer's written instructions. Preparation of the repair area surface shall be as outlined under Section 3.07.1 except where written instructions specify otherwise. The method of bonding, placing and curing shall be as recommended. The time period recommended by the manufacturer before opening to traffic shall be observed.

3.07.4 EPOXY RESIN PATCHING MORTARS OR EPOXY CONCRETE

Epoxy mortar and epoxy concrete mix designs may be submitted to the laboratory as a check. Those designs determined to be compatible with concrete pavement will be approved.

The epoxy resin and the catalyst shall be preconditioned before blending to produce a blended liquid that is between 75° F. and 90° F. The epoxy components shall be mixed in strict compliance with the manufacturer's mixing recommendations before aggregates are added to the mixture. The mixture shall be blended in a suitable mixer to produce a homogeneous mass. Only that quantity of materials that is usable in one hour shall be mixed at one mixing and material that has begun to generate appreciable heat shall be discarded.The entire surface of the repair areas shall be primed with neat blended epoxy immediateLy before the mixture is placed. Priming shall include overlapping the surface of the area adjacent to the patch. The mixture shall be placed and tamped with sufficient effort to eliminate voids and to thoroughly compact the product. The surface shall be screeded to produce the required finish. The repaired area shall be allowed to remain undisturbed for at least 3 hours before it is subjected to traffic.

3.07.5 OPEN TO TRAFFIC

High early strength concrete shall meet the minimum strength requirements established by the state contracting agency prior to opening to traffic. Epoxy concrete shall meet the minimum requirements established by the manufacturer. At ambient temperatures below 55° F, longer waiting periods may be required by the contracting agency. Traffic shall not normally be permitted on normal-set concrete patches for at least 72 hours. Traffic shall not normally be permitted on rapid-set concrete patches for at least 4 hours.

3.08 METHODS OF MEASUREMENT

The quantities to be paid for will be measured as follows:

3.08.1 MOBILIZATION

Mobilization will be measured as a lump sum.

3.08.2 TRAFFIC CONTROL

Traffic control will be measured as a lump sum.

3.08.3 PATCHES

3.08.3.1 CLASS A PATCH

A Class A patch shall consist of a patch with no surface dimension less than 0.2 feet and a depth no greater than 2 inches. It shall be measured in square feet. A Class A patch less than 2 square feet in area shall be measured as 2 square feet.

3.08.3.2 CLASS B PATCH

A Class B patch shall be used for a joint or crack spall having a width of 0.2 feet or less and a depth no greater than 2 inches. It shall be measured in lineal feet. A Class B patch less than 2 feet in length shall be measured as 2 feet long.

3.08.4 EXTRA DEPTH

Patches meeting the surface measurement dimensions requirements of Class A or Class B patches shall require measurement of the average depth. The average depth in excess of 2 inches shall be measured as extra depth to the nearest inch. The unit of measurement shall be square feet - inches for Class A and lineal feet - inches for Class B patches.

3.08.5 RESEARCH STUDY MEASUREMENTS

Measurements for the study will be recorded by the RCOC. Readings to be provided by the contractor shall include but not be limited to patch geometry, times, and temperatures.

3.09 BASIS OF PAYMENT

For the performance of acceptable work, measured as provided above, the contractor will be paid the contract unit price in accordance with the following provisions:

3.09.1 MOBILIZATION

Mobilization will be paid for as a lump sum.

3.09.2 TRAFFIC CONTROL

Traffic control will be paid for as a lump sum.

3.09.3 PATCHES

3.09.3.1 CLASS A PATCHES

Partial depth patches will be paid for at the contract price per square foot. This price will be full compensation for the removal and disposal of the old pavement, furnishing, placing, finishing, joint, curing of the concrete and repair of the shoulder.

3.09.3.2 CLASS B PATCHES

Class B patches will be paid for at the contract price per lineal foot. This price shall be full compensation for the removal and disposal of the old pavement, furnishing, placing, finishing, jointing, and curing the concrete and repairing the shoulder, if required.

3.09.4 EXTRA DEPTH

Extra depth will be paid for at the contract price in square feet - inches for Class A patches and lineal feet - inches for Class B patches. This price shall be full compensation for the removal and disposal of the old pavement, furnishing, placing, and jointing the concrete, and repairing the shoulder.

3.09.5 CLEANUP

Cleanup operation, to the satisfaction of the contracting agency, will be contingent to the project with no extra payment provided.

SPS-4 ATTACHMENT H

MARKING AND SIGNING OF SPS-3 & 4 SECTIONS

Marking and signing of SPS-3 and 4 test sections generally follow the GPS marking and signing requirements. Figure 1 Provides a typical layout of the signing requirements for both the GPS and H-101 test sections. The major difference between the GPS and SPS-3 & 4 requirements is that sign B of the GPS signing requirements will not be utilized as a location aid on SPS-3 & 4. The spikes and delineator signs will be used as shown. If the delineator posts and iron spikes are lost and the white stripes faded to level where a positive identification is impossible, the section limits will be recreated from the GPS section. White crosses will be painted on the shoulder (if possible) at one hundred foot intervals to aid in location for distress surveys and other data collection.

In most cases, GPS sections are near the beginning of the construction section. In cases where a SPS 3 or 4 section will be the first test section in the series, Sign C should be placed 500 ft in front of the first section.

Figure 2 provides the format for the section sign (Sign C) that will be placed 100 feet in advance of each of the actual test sections. A minimum of five SHRP logos must be provided for each site in each state.

The numbering scheme shown for each sign retains the LTPP 6 digit coding scheme. The first two numbers are the state code. The third number is the "multiple site designator." In SPS-3 and SPS-4, the first section within a state will be designated with the letter "A" in the "Multiple Site Designator" field. Additional sites in a state will continue with the rest of the alphabet. The fourth number is the experiment number. It is 3 for the SPS-3 sections and 4 for the SPS-4 sections.

The fifth number designates the type of treatment. The sixth number is used to identify state experiments which are variants of the SPS-3 and 4 experiments. The sixth number is always a zero for the standard SPS-3 and 4 treatments. Table 1 illustrates the numbering system. "xx" represents the State Code.

Regardless of position on the road all test sections with the same treatment will have the same "Test Section Designation". A state may not have an additional experiment on each site. In this case the other state experiments will govern the "Multiple Site Designator". An example is shown in Table 1 where a "*" is shown for the Second Site in a State - 2nd State Experiment.

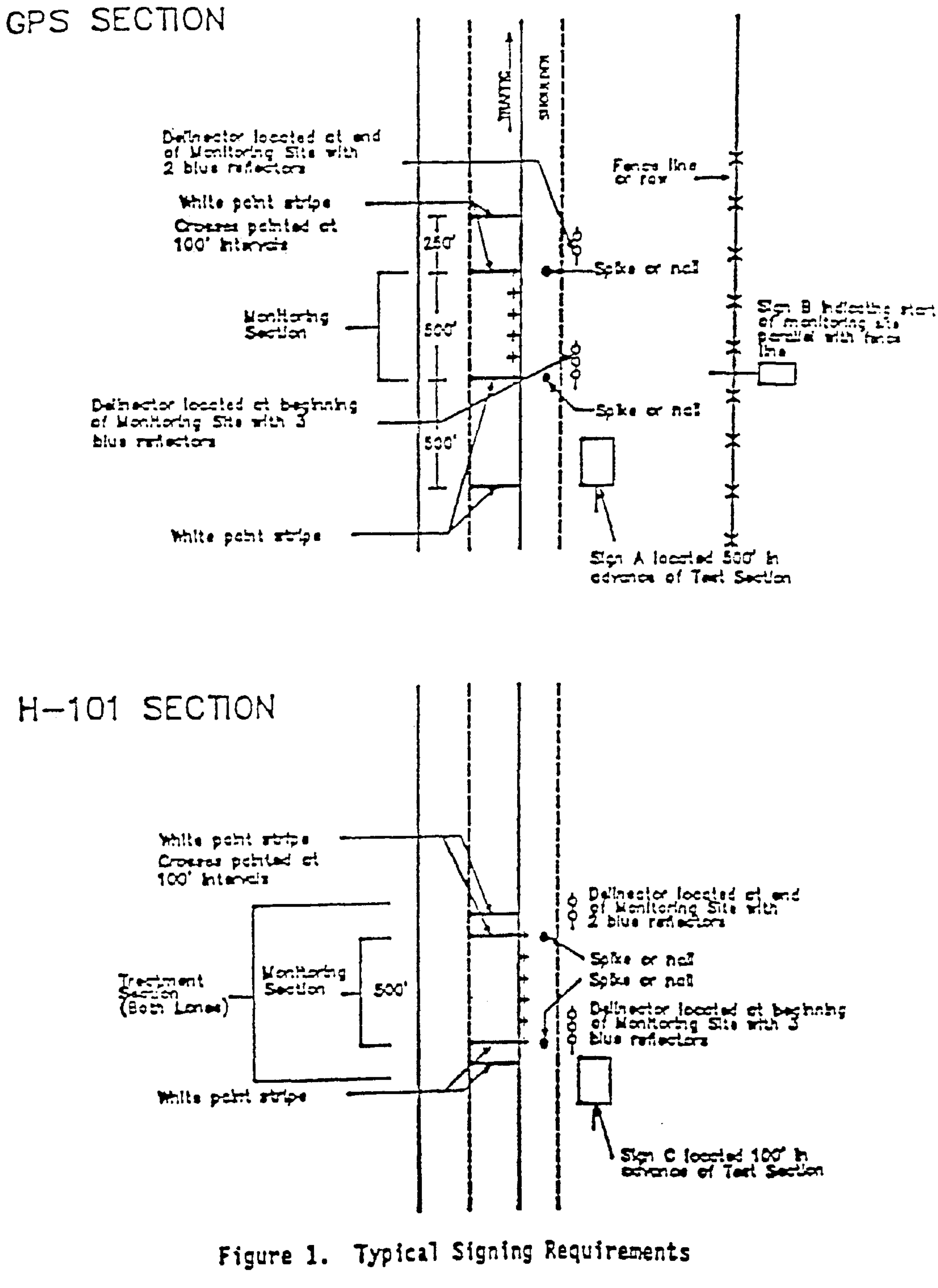


Figure 1. Typical Signing Requirements

H-101 SIGNING REQUIREMENTS

Notes:

- Blue Background
- White letters
- White Border, 1" wide
  1/2" offset from edge
- Letters 3" high
- Numbers 3" high
- SHRP logo 6"x9"

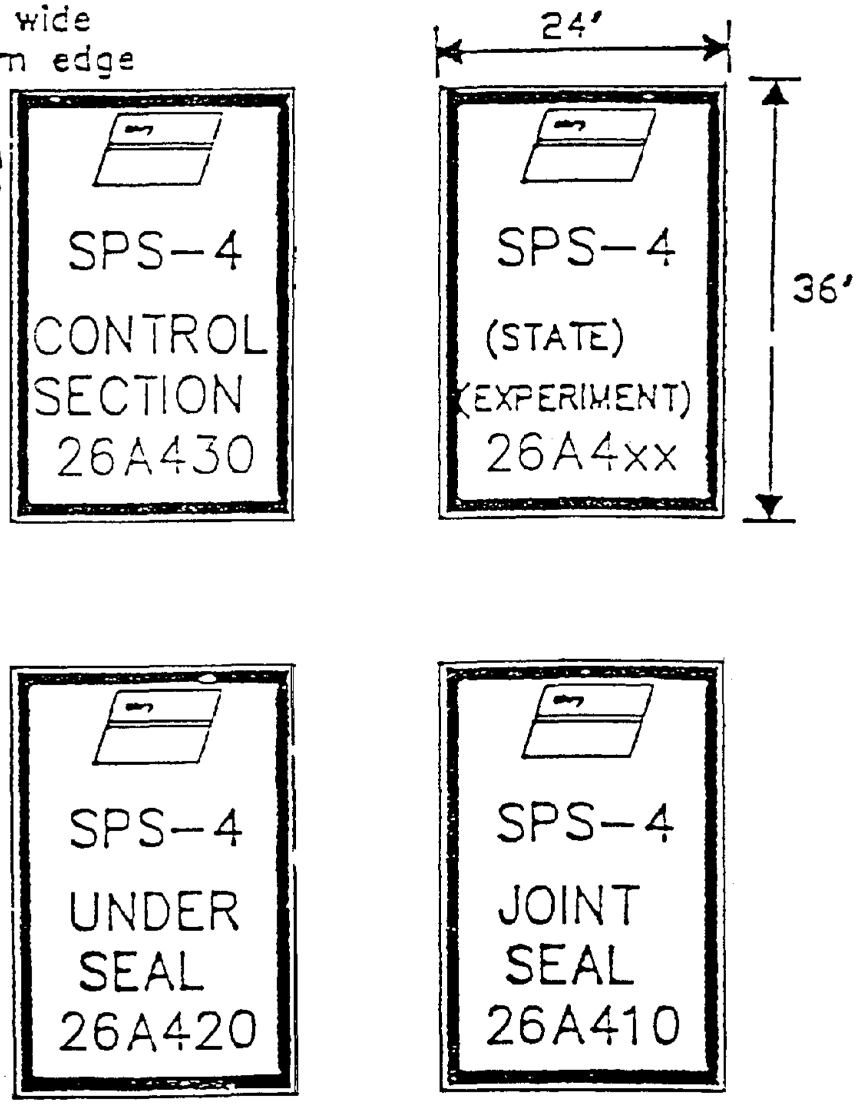


Figure 2. Sign Details

Table 1. SPS-3 and SPS-4 Test Section Numbering

	First Site in a State	Second Site in a State	Third Site in a State
Thin Overlay	xxA310	xxB310	xxC310
Slurry Seal	xxA320	xxB320	xxC320
Crack Seal	xxA330	xxB330	xxC330
SPS-3 Control Section	xxA340	xxB340	xxC340
Chip Seal	xxA350	xxB350	xxC350
State Experiment on Slurry	xxA321	xxB321	xxC321
State Experiment on crack Seal	xxA331	xxB331	xxC331
2nd State Experiment on Crack Seal	xxA332	*	xxC332
State Experiment With No Corresponding SPS Treatment	xxA360	xxB360	xxC360
Joint Seal	xxA410	xxB410	xxC410
Joint Seal and Underseal	xxA420	xxB420	xxC420
State Experiment on Joint Seal	xxA411	xxB411	xxC411
2nd State Experiment on Joint Seal	xxA412	xxB412	xxC412
State Experiment on Joint Seal and Underseal	xxA421	xxB421	xxC421
2nd State Experiment on Joint Seal and Underseal	xxA422	xxB422	xxC422

SPS-4 ATTACHMENT I
QUESTIONS AND ANSWERS

Some questions have arisen concerning SPS-4 test sections. These questions and proposed answers are given in the following sheets to help address specific situations. Additional questions and answers will be added as they arise.

1. Sealing meandering cracks and mid-panel cracks with 3/4" deep x 3/8" wide routing and then recessing the sealing 3/8" ± 1/8" seems like a high level of effort. Please respond to this.

   Significant water enters into the pavement structure from the surface. The only way to answer how beneficial sealing can be is to make sure the section is sealed.

2. How high should the pressure of the high-pressure water jet be to clean the concrete joint face? Won't the face already be clean after the joints have been refaced?

   The refaced joint will not be clean enough to insure joint seal adhesion. The high pressure water jet is only used to clean out the joint/crack not for cleaning/removing joint seal residue.

3. How is a crack to be repaired if the contractor makes the crack? If the slab is damaged in any other way, will a full-depth repair be required, and if it is required, won't this damage the experiment?

   One or two full depth repairs are not considered detrimental. If more cracks exist the project should be considered for a rehabilitation experiment. The same is true for contractor induced cracks.

4. If the pavement must be dry before the sealant is applied, and water is used for sawing, flushing and cleaning, how long will it take to dry? How is this determined?

   The joint should be dry to visual inspection.

5. There seems to be some confusion about the distance between sections. The requirements say two slabs, but some people say it is greater than this

   Two slabs minimum.

6. Paragraph 2.03.3.7 of the guide specification mentions a non-reactive adhesive-backed tape being used instead of a backer rod. Why can't the backer rod be used in all cases?

   Can use backer rod if desired.

7. Paragraph 2.03.3.9 requires the sealant materials to be 3/16 ± 1/16 in. below the adjacent pavement surface. This 1/16 in. limit seems to be a problem.

   Yes, but we would like to try. This seems to be what is being recommended.

8. Paragraph 2.03.3.4 is about the repair of the asphalt shoulder and specifies repairing it with hot mix asphalt. Is this hot mix laid or hot mix cold laid? What exactly does hot mix mean?

   Hot mix, hot laid. A hot mix, cold laid material would not be stable to sawing operation.

9. Do meandering cracks that are unspalled and tight need to be repaired?

   If tight probably not.

10. Paragraphs 2.03.3.1 and 2.03.3.2 are for joint insert removal and existing sealant removal. Is this all in one operation? Are these the same thing?

    May or may not be. Sawing will finish the job.

11. Paragraph 2.03.3.1 recommends that the width of the joint shall in no case exceed 1 1/2 in. What if the width is already greater than 1 1/2 in.? Does this need to be repaired.

    Yes.

SPS-4 ATTACHMENT J
EXPANDED LOSS OF SUPPORT STUDY

General

This document describes the procedures for deflection and void detection testing in the expanded test program. The standard testing includes the use of Benkelman beams and falling weight deflectometer (FWD). The expanded testing program includes the Dynaflect (Field Protocol H29F), Transient Dynamic Response System (Field Protocol H31F) and epoxy core test (Field Protocol H36F).

This expanded testing program is designed to evaluate loss of support conditions for undersealing test sections. The expanded testing program would involve utilization of several devices to compare their capability of predicting loss of support conditions. In addition to the Benkelman Beam the expanded testing program would involve deflection testing with a Dynaflect and Falling Weight deflectometer. In an attempt to verify the presence of voids a procedure termed the epoxy-core test will also be applied. The epoxy-core test involves dry drilling a one and one-half inch hole near a joint or crack. After debris is vacuumed from the hole a low viscosity epoxy with red food coloring added is used to fill up the hole. If the level of the epoxy falls additional epoxy is added. After the epoxy hardens a core is taken near the original drilled hole. A hardened seam of epoxy reveals the presence of a void. Participating agencies would be required to provide equipment for the deflection testing and the epoxy-core test. In the event a participating agency does not have all of the equipment for deflection testing the appropriate RCOC should be contacted to coordinate making the equipment available. This contact should be made at least 60 days prior to the anticipated testing date. Except for the epoxy-core test cores the expanded testing could be completed in one morning prior to 10:00 a.m. To evaluate the need for undersealing, Benkelman beam tests for all underseal sections as well as in combination with other tests in the expanded testing program may be conducted prior to the underseal installation (i.e. within 15 days.) This testing could determine the need to mobilize equipment for undersealing. For those sites involving the expanded testing program it is suggested that the expanded testing program be conducted the day before the underseal installation. The RCOC will need to participate in the expanded testing program with particular emphasis on coordinating equipment availability. Staff for the expanded test data collection for underseal sections will be provided by the SHRP RCOC.

Testing Procedures

The testing procedures for the Benkelman Beam and FWD are described in SPS-4 Attachement B. The other equipment testing procedures are described in the following.

Dynaflect

Testing using the Dynaflect will be done in the same manner as the FWD testing described above. This procedure is also contained in SHRP SPS-4 Field Protocol H29F. Results shall be recorded in SPS-4 Data Sheets 22A through 22D.

TDR

SHRP Headquarters has indicated a willingness to make this equipment available at some sites. Its use is described in SHRP SPS-4 Field Protocol H31F. Results shall be recorded on SPS-4 Data Sheets which are attached.

Epoxy Core Test

The epoxy core test should be done after deflection testing and before undersealing. It is desirable to have this technique applied in the same time frame or under the same weather conditions (temperature/sun) as those when the deflection testing was conducted. This should be done in the early morning when the effects of slab curl have not had a chance to mask the presence of voids.

The epoxy access holes shall be drilled in both the approach slab and the leave slab, approximately 18" by 18" away from the intersection of the joint/crack and edge of pavement. To achieve a distribution of results the epoxy core test should be applied at six to eight joints/cracks with small or no deflections and six to eight joints/cracks with large deflections. These large and small deflection groups will be based on the 0.020 inch deflection criteria from the Benkelman Beam results. The RCOC will determine these locations. With an access hole on each side of the joints/cracks, 24 to 32 access holes will be required.

A rotohammer (not a core drill) using a 1-1/2" to 2" dry bit shall be used to drill through the pavement and into the subgrade to a depth of about 1". Scrape down the sides of the access hole using a long screw driver to make sure that any chips at the bottom of the hole are loose.

Vacuum the debris from the rotohammer operation out of the hole leaving a small reservoir at the bottom. A shop vacuum can be used for this purpose. If water is present, the reservoir will provide a place for it to pond. Vacuum out any accumulated water.

To facilitate mixing and pouring of the epoxy, a coffee can (approximately one and one-half pound size), funnel, and disposable pint measuring device are useful. A baby bottle has been used in some instances.

A two-part epoxy is mixed with enough food coloring (i.e., red) to provide good color contrast and poured into the hole. The viscosity of the epoxy should be approximately 400 cps, which is the same as pancake syrup. An epoxy formulation can be selected that will set in from ten minutes to two hours. Thirty minutes has proven adequate in most cases. Access time to the pavement and how quickly the epoxy can be utilized will determine the appropriate set time. The epoxy supplier can help in selecting the correct epoxy formulation.

Typically, one pint of the epoxy will initially fill the access hole to the pavement surface. The epoxy should flow down, saturate the subbase/subgrade, and fill any voids which might be present. After another pint, the flow will probably stop. It is uncertain as to the amount of epoxy that will fill a hole and void. However, if an average of about 2 pints will fill a hole, and up to 32 holes are filled, then 8 gallons of epoxy will be needed for the test section. More epoxy may be needed if large voids are present.

One indication of a large void is the rapid intake of epoxy. If up to a quart is rapidly taken into the hole, steps should be taken to prevent the waste of epoxy material, which can be expensive. This can be accomplished by adding an equal part of clean masonry sand to additional epoxy introduced into the hole. The sand will thicken the epoxy so that it will not keep flowing into the void. This thickening process should be continued until the access hole is filled. No attempt is being made to fill the entire void, only a localized area around the access hole. This is only a void detection test, not a rehabilitation technique.

Undersealing should take place after the epoxy sets. Subsequently after the grout is thoroughly set, a core of 4 to 6 inches in diameter shall be taken through the pavement, cross-sectioning the access hole, and through the subbase/pavement interface. If the grout flows under the epoxy, then the core should show this and prove that the slab is being lifted. The subbase will generally be bonded to the bottom of the pavement with the voids (now a pink epoxy) trapped between the two. The thickness of this epoxy should be measured and recorded to the nearest 1/16 inch.

All information must be recorded on Data Sheets which are attached. This test is also described in SHRP SPS-4 Field Protocol H36F.

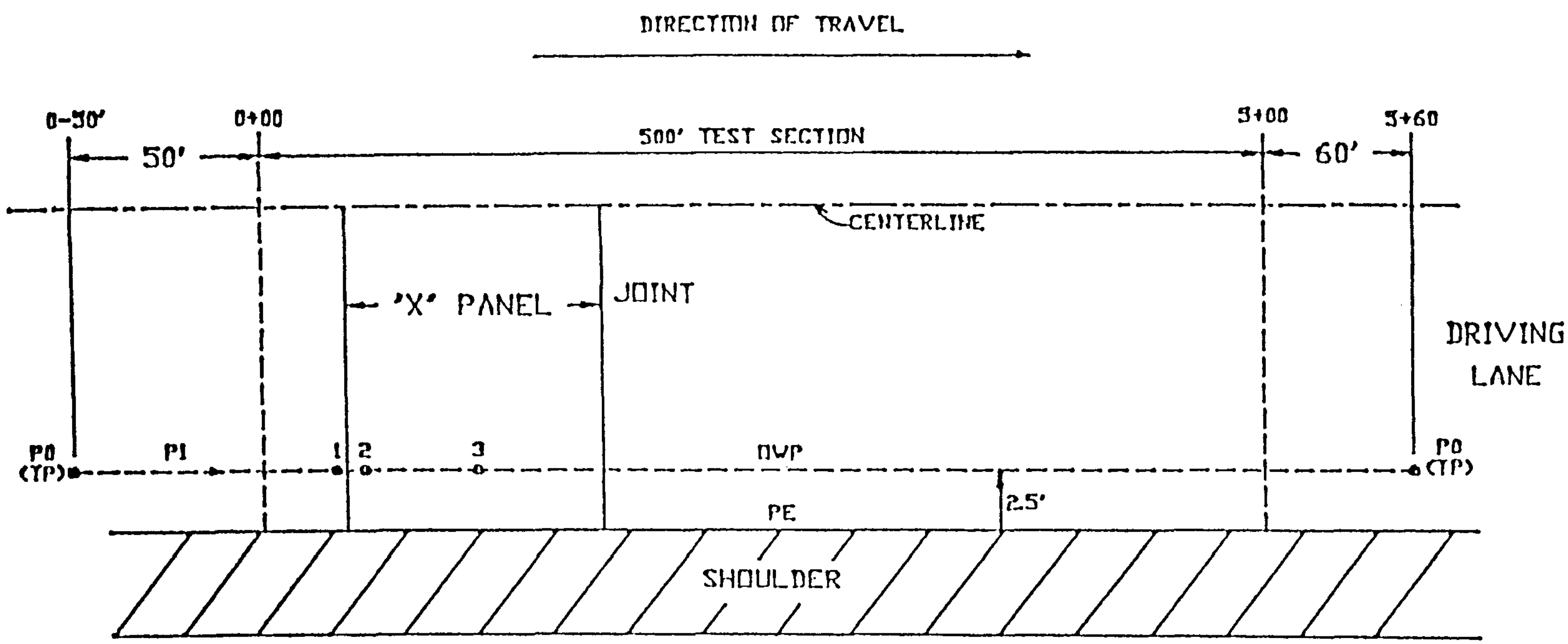
LIST OF FIELD PROTOCOLS FOR SPS-4
EXPANDED LOSS OF SUPPORT STUDY

Revised 3/91

SHRP Protocol: H29F
For SHRP Test Designation: HF09
Dynaflect Deflection Testing

This SHRP protocol covers the use of a Dynaflect deflection device to obtain information on joint/crack load transfer and loss of support for SPS-4 sites. One pass in the wheel path will be made, testing each side of the joint/crack and the midslab as shown in the attached figure. All slabs in the section shall be tested.

Data for location, surface moisture condition, load, air and pavement temperatures, and measurements from deflection sensors shall be recorded on Data Sheets which are attached.



NOTE: DYNAFLECT TESTS TO BE CONDUCTED AT BOTH (TP) LOCATIONS ON P0 (FIRST SET OF TESTS). PANEL LENGTH 'X' WILL BE VARIABLE DEPENDING UPON SPECIFIC JOINT SPACING, TRANSVERSE CRACK PATTERN AND PAVEMENT TYPE.

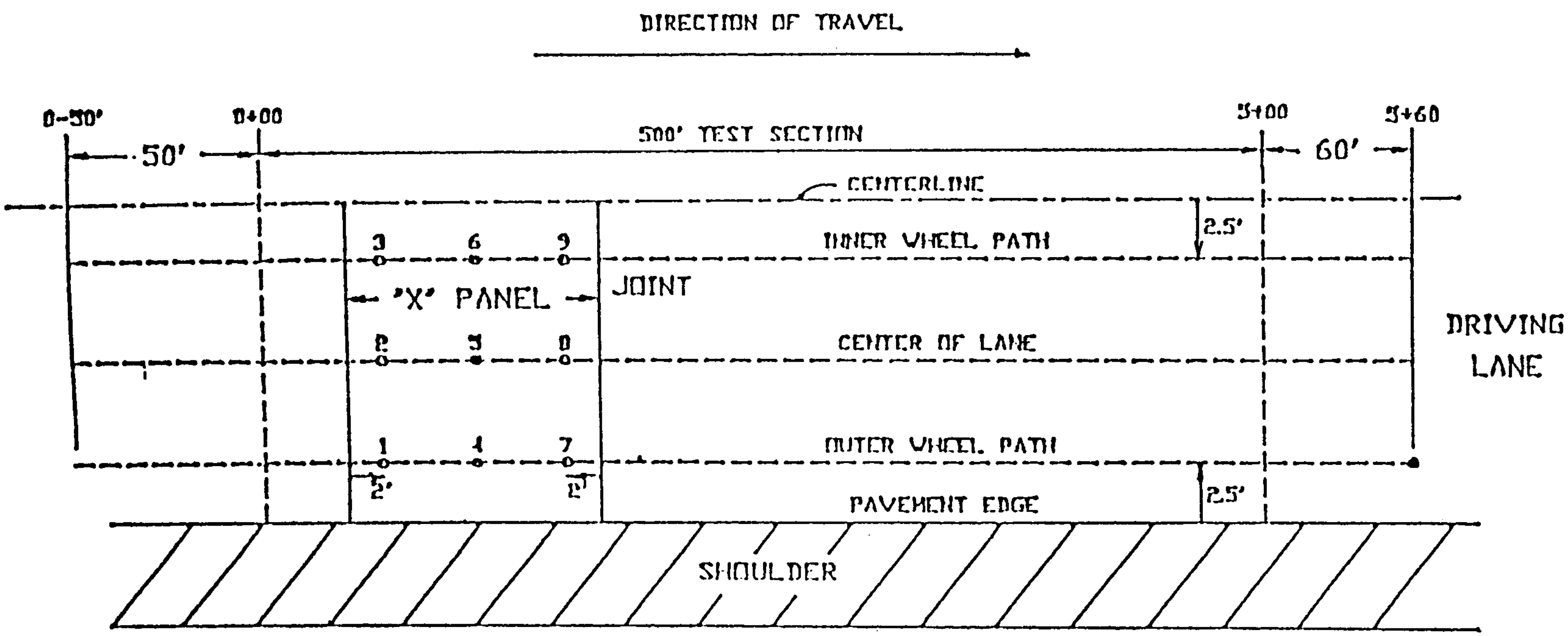
DYNAFLECT TEST PLAN (SPS-4 TEST SECTIONS)

Revised 3/91

SHRP Protocol: H31F
For SHRP Test Designation: HF11
Transient Dynamic Response System Testing

This SHRP protocol overs the use of the transient dynamic response system (TDR) to obtain information on joint/crack load transfer as well as loss of support for SPS-4 sites. Each slab or panel in the test section shall be tested at three longitudinal positions; two feet from each joint or crack and at the slab midpoint. At each longitudinal position, simultaneous tests will be conducted in the outer wheel path, lane centerline and inner wheel path. Test positions are indicated on the attached figure.

Data for location, surface moisture condition, air and pavement temperatures, and description of slab/support condition shall be recorded on Data Sheets which are attached.



NOTE: TDR TESTS TO BE CONDUCTED ON THE OUTER WHEEL PATH, THE CENTER OF THE LANE, AND THE INNER WHEEL PATH AT 2 FEET FROM THE PAVEMENT EDGE, THE SLAB MIDPOINT, AND 2 FEET FROM THE CENTERLINE, RESPECTIVELY. SEE POINTS 1 THROUGH 9.

TDR TEST PLAN (SPS-4 TEST SECTIONS)

SHRP Protocol: H36F
For SHRP Test Designation: HF16
Epoxy-Core Test for Void Detection

The epoxy-core test should be done after deflection testing and before undersealing. This technique should be applied in the same time frame or under the same weather conditions (temperature/sun) as when the deflection testing was conducted. This should be done in the early morning when the effects of slab curl have not had a chance to mask the presence of voids.

The epoxy access holes shall be drilled in both the approach slab and the leave slab, approximately 18" by 18" away from the intersection of the joint/crack and edge of pavement. The epoxy core test should be applied at six to eight joints/cracks with small or no deflections and six or eight joints/cracks with large deflections. These small and large deflection groups will be based on the 0.020 inch deflection criteria from the Benkelman beam results. With an access hole on each side of the joints/cracks, 24 to 32 access holes will be required.

A rotohammer (not a core drill) using a 1-1/2" to 2" dry bit shall be used to drill through the pavement and into the subgrade to a depth of about 1". Scrape down the sides of the access hole using a long screw driver to make sure that any chips at the bottom of the hole are loose.

Vacuum the debris from the rotohammer operation out of the hole leaving a small reservoir at the bottom. A shop vacuum can be used for this purpose. Vacuum out any accumulated water.

To facilitate mixing and pouring of the epoxy, a coffee can (approximately one and one half pound size), funnel, and disposable one pint measuring device are useful. A two-part epoxy is mixed with enough food coloring (i.e., red) to provide good color contrast and poured into the hole. The viscosity of the epoxy should be approximately 400 cps. An epoxy formulation can be selected that will set in from ten minutes to two hours. Thirty minutes has proven adequate in most cases. Access time to the pavement and how quickly the epoxy can be utilized will determine the appropriate set time. The supplier can help in selecting the correct epoxy formulation.

One indication of a large void is the rapid intake of epoxy. If up to a quart is rapidly taken into the hole, steps should be taken to prevent the waste of epoxy material. This can be accomplished by adding an equal part of clean masonry sand to additional epoxy introduced into the hole. The sand will thicken the epoxy so that it will not keep flowing into the void. This thickening process should be continued until the access hole is filled.

Undersealing should take place after the epoxy sets. Subsequently, after the grout thoroughly sets, a core of 4 to 6 inches in diameter shall be taken through the pavement, cross-sectioning the access hole, and through the subbase/pavement interface. If the grout flows under the epoxy, then the core should show this and prove that the slab is being lifted. The subbase will generally be bonded to the bottom of the pavement with the voids (now a pink epoxy) trapped between the two. The thickness of this epoxy should be measured to the nearest 1/16 inch.

Data to be recorded includes weather conditions, viscosity of epoxy, location of holes, amount of epoxy per hole, and thickness of epoxy. This information shall be recorded in Data Sheets which are attached.

FIELD INSTALLATION AND TESTING DATA SHEETS FOR EXPANDED LOSS OF SUPPORT STUDY

Sheet 19 | *STATE ASSIGNED ID [_ _ _ _]
SPS-4 DATA | *STATE CODE [_ _]
LTPP PROGRAM | *SHRP PROJECT ID [_ _ _ _]

EPOXY-CORE TEST

1. *DATES (MONTH /DAY/YEAR) AND TIME (24 HOUR CLOCK-HR/MIN) OF TESTING

DATE WORK BEGAN [_ _/_ _/_ _]
DATE WORK COMPLETED [_ _/_ _/_ _]

TIME BEGAN [_ _/_ _]
TIME COMPLETED [_ _/_ _]

2. *WEATHER CONDITIONS: AIR TEMPERATURE (°F) AND HUMIDITY (%)

AIR TEMPERATURE (°F)
BEGINNING OF TESTING [_ _ _]
END OF TESTING [_ _ _]

HUMIDITY (%)
BEGINNING OF TESTING [_ _ _]
END OF TESTING [_ _ _]

3. *LENGTH OF TEST SECTION (FEET) [_ _ _ _]

LANE WIDTH OF TEST SECTION (FEET) [_ _ _]

4. *HOLES 18 INCHES FROM THE JOINT/CRACK AND EDGE OF PAVEMENT INTERSECTION? [_]
   NEVER ....1 SOMETIMES 2
   USUALLY ....3 ALWAYS 4

5. *METHOD OF HOLE INSTALLATION [_]
   ROTOHAMMER ......1 CORING 2
   OTHER 3

6. *SIZE OF DRILL BIT (INCHES) [_ _ _]

7. *SIDES SCRAPED DOWN? (YES=1, NO=2) [_]

Sheet 20 — *STATE ASSIGNED ID [_ _ _ _]

SPS-4 DATA — *STATE CODE [_ _]

LTPP PROGRAM — *SHRP PROJECT ID [_ _ _ _]

EPOXY-CORE TEST (CONTINUED)

8. *DEBRIS AT BOTTOM OF HOLES REMOVED? [_]
   NEVER 1   SOMETIMES 2
   USUALLY 3   ALWAYS 4

9. *VACUUM NOZZLE REACHES BOTTOM OF HOLE? (YES=1, NO=2) [_]

10. *WATER IN HOLES? [_]
   NEVER 1   SOMETIMES 2
   USUALLY 3   ALWAYS 4

11. *WATER VACUUMED OUT OF HOLES? [_]
   NEVER 1   SOMETIMES 2
   USUALLY 3   ALWAYS 4

12. *EPOXY MATERIAL

   BRAND [_________________]
   TYPE [_________________]
   SOURCE (NAME AND ADDRESS) [_________________]
   [_________________]
   [_________________]

13. *FORMULATED TIME OF SET (MINUTES) [_ _ _]

14. *EPOXY VISCOSITY (CENTISTOKES PER SECOND) [_ _ _]

15. *DIAMETER OF CORES (INCHES) [_ _ _]

16. *TIME BETWEEN DRILLING AND VACUUMING (DAYS/HR/MIN) [_ _/_ _/_ _]

17. *TIME BETWEEN VACUUMING AND FILLING (DAYS/HR/MIN) [_ _/_ _/_ _]

18. *TIME BETWEEN FILLING AND UNDERSEALING (DAYS/HR/MIN) [_ _/_ _/_ _]

19. *TIME BETWEEN UNDERSEALING AND CORING (DAYS/HR/MIN) [_ _/_ _/_ _]

Sheet 21A

SPS-4 DATA

LTPP PROGRAM

*STATE ASSIGNED ID [_ _ _ _]

*STATE CODE [_ _]

*SHRP PROJECT ID [_ _ _ _]

EPOXY-CORE TEST (CONTINUED)
USE MULTIPLE SHEETS IF NECESSARY

20.*HOLE LOCATION STATION	OFFSET(FT)	21.*JOINT NUMBER	22.*LOCATION AT (JOINT=1, CRACK=2)	23.*SIDE OF JOINT/ CRACK (APPROACH=1, LEAVE=2)	24.*TOTAL AMOUNT OF EPOXY PER HOLE (PINTS)	25.*THICKNESS OF HARDENED EPOXY AFTER CORING (1/16th INCH)	26.*WAS SAND ADDED? (YES=1, NO=2)	27.*GROUT UNDER EPOXY (YES=1, NO=2)
_ _+_ _._	_ _._	_ _ _	_	_	_ _._ _	_ _ _	_	_
_ _+_ _._	_ _._	_ _ _	_	_	_ _._ _	_ _ _	_	_
_ _+_ _._	_ _._	_ _ _	_	_	_ _._ _	_ _ _	_	_
_ _+_ _._	_ _._	_ _ _	_	_	_ _._ _	_ _ _	_	_
_ _+_ _._	_ _._	_ _ _	_	_	_ _._ _	_ _ _	_	_
_ _+_ _._	_ _._	_ _ _	_	_	_ _._ _	_ _ _	_	_
_ _+_ _._	_ _._	_ _ _	_	_	_ _._ _	_ _ _	_	_
_ _+_ _._	_ _._	_ _ _	_	_	_ _._ _	_ _ _	_	_
_ _+_ _._	_ _._	_ _ _	_	_	_ _._ _	_ _ _	_	_
_ _+_ _._	_ _._	_ _ _	_	_	_ _._ _	_ _ _	_	_
_ _+_ _._	_ _._	_ _ _	_	_	_ _._ _	_ _ _	_	_
_ _+_ _._	_ _._	_ _ _	_	_	_ _._ _	_ _ _	_	_

Revised 2/91

Sheet 21B

SPS-4 DATA

LTPP PROGRAM

*STATE ASSIGNED ID [__ __ __ __]

*STATE CODE [__ __]

*SHRP PROJECT ID [__ __ __ __]

EPOXY-CORE TEST (CONTINUED)

20.*HOLE LOCATION STATION	OFFSET(FT)	21.*JOINT NUMBER	22.*LOCATION AT (JOINT=1, CRACK=2)	23.*SIDE OF JOINT/ CRACK (APPROACH=1, LEAVE=2)	24.*TOTAL AMOUNT OF EPOXY PER HOLE (PINTS)	25.*THICKNESS OF HARDENED EPOXY AFTER CORING (1/16th INCH)	26.*WAS SAND ADDED? (YES=1, NO=2)	27.*GROUT UNDER EPOXY (YES=1, NO=2)
__+__ __.__	__ __.__	__ __ __	__	__	__ __.__ __	__ __ __	__	__
__+__ __.__	__ __.__	__ __ __	__	__	__ __.__ __	__ __ __	__	__
__+__ __.__	__ __.__	__ __ __	__	__	__ __.__ __	__ __ __	__	__
__+__ __.__	__ __.__	__ __ __	__	__	__ __.__ __	__ __ __	__	__
__+__ __.__	__ __.__	__ __ __	__	__	__ __.__ __	__ __ __	__	__
__+__ __.__	__ __.__	__ __ __	__	__	__ __.__ __	__ __ __	__	__
__+__ __.__	__ __.__	__ __ __	__	__	__ __.__ __	__ __ __	__	__
__+__ __.__	__ __.__	__ __ __	__	__	__ __.__ __	__ __ __	__	__

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Revised January 24, 199[illegible]

Sheet 22A
SPS-4 DATA
LTPP PROGRAM

*STATE ASSIGNED ID [_ _ _ _]
*STATE CODE [_ _]
*SHRP PROJECT ID [_ _ _ _]

DYNAFLECT DEFLECTION MEASUREMENTS

1. *DATES (MONTH /DAY/YEAR) AND TIME (24 HOUR CLOCK-HR/MIN) OF TESTING

DATE WORK BEGAN [_ _/_ _/_ _]
DATE WORK COMPLETED [_ _/_ _/_ _]

TIME BEGAN [_ _/_ _]
TIME COMPLETED [_ _/_ _]

2. *WEATHER CONDITIONS: AIR TEMPERATURE (°F) AND HUMIDITY (%)

AIR TEMPERATURE (°F)
BEGINNING OF TESTING [_ _ _]
END OF TESTING [_ _ _]

HUMIDITY (%)
BEGINNING OF TESTING [_ _ _]
END OF TESTING [_ _ _]

3. *PAVEMENT SURFACE MOISTURE CONDITION AT TIME OF TESTING [_]
   DRY ....1 MOSTLY DRY 2
   SOMEWHAT DAMP ....3 WET 4

4. *PURPOSE OF TESTING [_]
   DETERMINE NEED FOR UNDERSEALING 1
   SLAB STABILITY AFTER INITIAL GROUTING ...2
   SLAB STABILITY AFTER REGROUT 3
   POST CONSTRUCTION MONITORING 4

5. *SOURCE OF TESTING DEVICE [_]
   SHRP ....1 HOST STATE OR PROVINCE ..2
   OTHER STATE ....3 OTHER 4

Sheet 22B

SPS-4 DATA

LTPP PROGRAM

*STATE ASSIGNED ID [_ _ _ _]

*STATE CODE [_ _]

*SHRP PROJECT ID [_ _ _ _]

DYNAFLECT DEFLECTION MEASUREMENTS (CONTINUED)
USE MULTIPLE SHEETS IF NEEDED

5.*POINT LOCATION (STATION)	6.*JOINT NUMBER	7.*LOCATION (JOINT=1, CRACK=2, NEITHER=3)	8.*SIDE OF JOINT/CRACK (APPROACH=1, LEAVE=2, NEITHER=3)	9. *MEASUREMENTS FROM DEFLECTION SENSORS (MILS) 1	2	3	4	5
_ _+_ _ _._	_ _ _	_	_	_ _._ _	_ _._ _	_ _._ _	_ _._ _	_ _._ _
_ _+_ _ _._	_ _ _	_	_	_ _._ _	_ _._ _	_ _._ _	_ _._ _	_ _._ _
_ _+_ _ _._	_ _ _	_	_	_ _._ _	_ _._ _	_ _._ _	_ _._ _	_ _._ _
_ _+_ _ _._	_ _ _	_	_	_ _._ _	_ _._ _	_ _._ _	_ _._ _	_ _._ _
_ _+_ _ _._	_ _ _	_	_	_ _._ _	_ _._ _	_ _._ _	_ _._ _	_ _._ _
_ _+_ _ _._	_ _ _	_	_	_ _._ _	_ _._ _	_ _._ _	_ _._ _	_ _._ _
_ _+_ _ _._	_ _ _	_	_	_ _._ _	_ _._ _	_ _._ _	_ _._ _	_ _._ _
_ _+_ _ _._	_ _ _	_	_	_ _._ _	_ _._ _	_ _._ _	_ _._ _	_ _._ _
_ _+_ _ _._	_ _ _	_	_	_ _._ _	_ _._ _	_ _._ _	_ _._ _	_ _._ _
_ _+_ _ _._	_ _ _	_	_	_ _._ _	_ _._ _	_ _._ _	_ _._ _	_ _._ _
_ _+_ _ _._	_ _ _	_	_	_ _._ _	_ _._ _	_ _._ _	_ _._ _	_ _._ _
_ _+_ _ _._	_ _ _	_	_	_ _._ _	_ _._ _	_ _._ _	_ _._ _	_ _._ _

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Sheet 22C

SPS-4 DATA

LTPP PROGRAM

*STATE ASSIGNED ID [_ _ _ _]

*STATE CODE [_ _]

*SHRP PROJECT ID [_ _ _ _]

DYNAFLECT DEFLECTION MEASUREMENTS (CONTINUED)

5.*POINT LOCATION (STATION)	6.*JOINT NUMBER	7.*LOCATION (JOINT=1, CRACK=2, NEITHER=3)	8.*SIDE OF JOINT/CRACK (APPROACH=1, LEAVE=2, NEITHER=3)	9. *MEASUREMENTS FROM DEFLECTION SENSORS (MILS) 1	2	3	4	5
_ _+_ _._	_ _ _	_	_	_ _._ _	_ _._ _	_ _._ _	_ _._ _	_ _._ _
_ _+_ _._	_ _ _	_	_	_ _._ _	_ _._ _	_ _._ _	_ _._ _	_ _._ _
_ _+_ _._	_ _ _	_	_	_ _._ _	_ _._ _	_ _._ _	_ _._ _	_ _._ _
_ _+_ _._	_ _ _	_	_	_ _._ _	_ _._ _	_ _._ _	_ _._ _	_ _._ _
_ _+_ _._	_ _ _	_	_	_ _._ _	_ _._ _	_ _._ _	_ _._ _	_ _._ _
_ _+_ _._	_ _ _	_	_	_ _._ _	_ _._ _	_ _._ _	_ _._ _	_ _._ _
_ _+_ _._	_ _ _	_	_	_ _._ _	_ _._ _	_ _._ _	_ _._ _	_ _._ _
_ _+_ _._	_ _ _	_	_	_ _._ _	_ _._ _	_ _._ _	_ _._ _	_ _._ _

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Sheet 23A
SPS-4 DATA
LTPP PROGRAM

*STATE ASSIGNED ID [__ __ __ __]
*STATE CODE [__ __]
*SHRP PROJECT ID [__ __ __ __]

TRANSIENT DYNAMIC RESPONSE SYSTEM MEASUREMENTS

1. *DATES (MONTH /DAY/YEAR) AND TIME (24 HOUR CLOCK-HR/MIN) OF TESTING

DATE WORK BEGAN [__ __/__ __/__ __]
DATE WORK COMPLETED [__ __/__ __/__ __]

TIME BEGAN [__ __/__ __]
TIME COMPLETED [__ __/__ __]

2. *WEATHER CONDITIONS: AIR TEMPERATURE (°F) AND HUMIDITY (%)

AIR TEMPERATURE (°F)
BEGINNING OF TESTING [__ __ __]
END OF TESTING [__ __ __]

HUMIDITY (%)
BEGINNING OF TESTING [__ __ __]
END OF TESTING [__ __ __]

3. *PAVEMENT SURFACE MOISTURE CONDITION AT TIME OF TESTING [__]
   DRY ....1 MOSTLY DRY 2
   SOMEWHAT DAMP ....3 WET 4

4. *PURPOSE OF TESTING [__]
   DETERMINE NEED FOR UNDERSEALING 1
   SLAB STABILITY AFTER INITIAL GROUTING ...2
   SLAB STABILITY AFTER REGROUT 3
   POST CONSTRUCTION MONITORING 4

Revised 2/91

Sheet 23B

SPS-4 DATA

LTPP PROGRAM

*STATE ASSIGNED ID [_ _ _ _]

*STATE CODE [_ _]

*SHRP PROJECT ID [_ _ _ _]

TRANSIENT DYNAMIC RESPONSE SYSTEM MEASUREMENTS

USE MULTIPLE SHEETS IF NEEDED

4. *POINT LOCATION (STATION)	5. *POINT OFFSET(FT)	6. *LOCATION AT (JOINT=1, CRACK=2, MIDPOINT=3)	7. *SIDE OF JOINT/ CRACK (APPROACH=1, LEAVE=2, NEITHER=3)	TEMPERATURE (°F) 8. *AIR	9. *PAVEMENT	10. *DESCRIPTION OF LOCATION (GOOD CONCRETE/GOOD SUPPORT=1, POOR/DISTRESSED CONCRETE=2, POOR SUPPORT=3, SMALL VOID=4, MEDIUM VOID=5, LARGE VOID=6, VOID/POOR SUPPORT=7)
_ _+_ _._	_ _._ _	_	_	_ _ _	_ _ _	____
_ _+_ _._	_ _._ _	_	_	_ _ _	_ _ _	____
_ _+_ _._	_ _._ _	_	_	_ _ _	_ _ _	____
_ _+_ _._	_ _._ _	_	_	_ _ _	_ _ _	____
_ _+_ _._	_ _._ _	_	_	_ _ _	_ _ _	____
_ _+_ _._	_ _._ _	_	_	_ _ _	_ _ _	____
_ _+_ _._	_ _._ _	_	_	_ _ _	_ _ _	____
_ _+_ _._	_ _._ _	_	_	_ _ _	_ _ _	____
_ _+_ _._	_ _._ _	_	_	_ _ _	_ _ _	____

Revised 2/9

Sheet 23C

SPS-4 DATA

LTPP PROGRAM

*STATE ASSIGNED ID [_ _ _ _

*STATE CODE [_ _

*SHRP PROJECT ID [_ _ _ _

TRANSIENT DYNAMIC RESPONSE SYSTEM MEASUREMENTS

4. *POINT LOCATION (STATION)	5. *POINT OFFSET(FT)	6. *LOCATION AT (JOINT=1, CRACK=2, MIDPOINT=3)	7. *SIDE OF JOINT/ CRACK (APPROACH=1, LEAVE=2, NEITHER=3)	TEMPERATURE ("F") 8. *AIR	9. *PAVEMENT	10. *DESCRIPTION OF LOCATIOI (GOOD CONCRETE/GOOD SUPPORT=1, POOR/DISTRESSED CONCRETE=2, POOR SUPPORT=3, SMALL VOID=4, MEDIUM VOID=5, LARGE VOID=6, VOID/POOR SUPPORT=7)
_ _+_ _._	_ _._ _	_	_	_ _ _	_ _ _	___
_ _+_ _._	_ _._ _	_	_	_ _ _	_ _ _	___
_ _+_ _._	_ _._ _	_	_	_ _ _	_ _ _	___
_ _+_ _._	_ _._ _	_	_	_ _ _	_ _ _	___
_ _+_ _._	_ _._ _	_	_	_ _ _	_ _ _	___
_ _+_ _._	_ _._ _	_	_	_ _ _	_ _ _	___

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