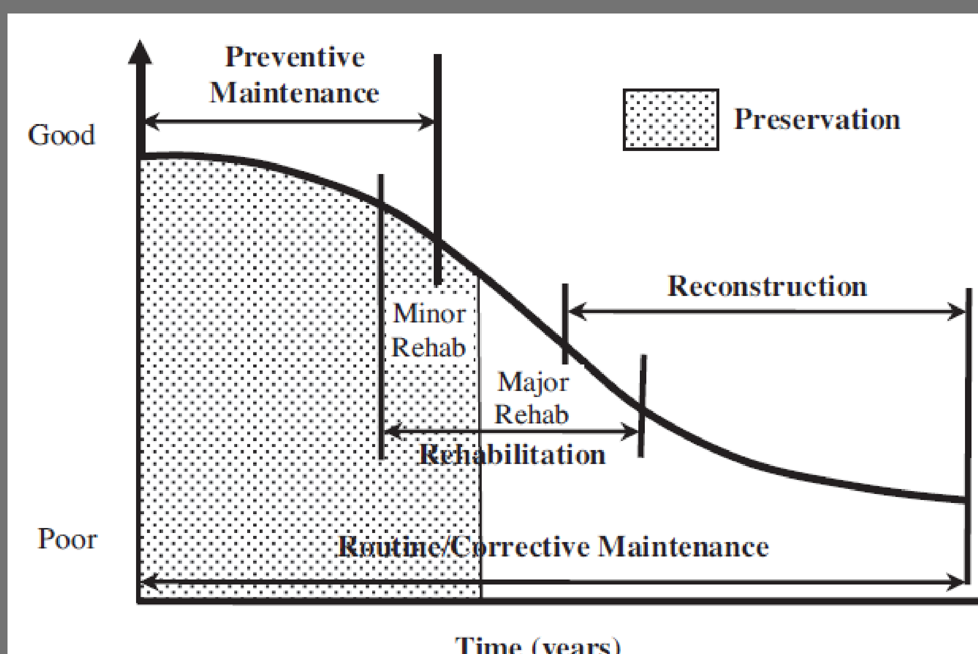
2012

Development of an SPS-2 Pavement Preservation Experiment

Preliminary Draft—Not for Distribution

This report provides a concept to develop a pooled fund effort targeted at developing and implementing a pavement preservation experiment for extending the service life of the LTPP SPS-2 projects. The report contains general information regarding the original experimental design and presents potential pavement preservation opportunities. The appendix contains more detailed information regarding the original experimental design and the supplemental sections constructed by the 14 states that participated in the SPS-2 Experiment.



IGGA
Larry Scofield
7/25/2012

Background

The Long Term Pavement Performance Program (LTPP), which began in 1987, was initially designed as a comprehensive 20 year study of in-service pavements. This effort resulted in the development of a series of rigorous long-term field experiments monitoring more than 2,400 asphalt and concrete pavement test sections across the U.S. and Canada.

The LTPP program consisted of two approaches: General Pavement Studies (GPS) and Specific Pavement Studies (SPS). The GPS efforts used existing roadway sections of various ages, designs, and climates selected through a controlled experimental design to determine the effects of specific features on performance. Since this experiment used existing roadway sections, it was established to provide research results in the short term.

The SPS experiment consisted of nine experiments designated as SPS-1 through SPS-9 that address the effects of structural factors, maintenance treatments, rehabilitation alternatives, environmental effects, and asphalt concrete mixture type on pavement performance. The SPS approach required construction of standard test sections which enabled testing of the original materials and monitoring and documenting the construction procedures. This approach also enabled a cradle to grave analysis of the projects providing a more rigorous experiment. Most of the SPS experiments were designed as long-term experiments. The SPS experiments are indicated below by category type:

- Evaluation of Structural Factors for New Construction
  - SPS-1- Strategic Study of Structural Factors for Flexible Pavements
  - SPS-2 Strategic Study of Structural Factors for Rigid Pavements
- Evaluation of Pavement Preservation Treatments
  - SPS-3 Preventive Maintenance Effectiveness of Flexible Pavements
  - SPS-4 Preventive Maintenance Effectiveness of Rigid Pavements
- Evaluation of Rehabilitation Strategies
  - SPS-5 Rehabilitation of AC Pavements
  - SPS-6 Rehabilitation of Concrete Pavements
- Evaluation of Unbonded Concrete Overlays
  - SPS-7 Bonded Concrete Overlays of Concrete Pavements
- Evaluation of Environmental Factors
  - SPS-8 Study of Environmental Effects in the Absence of Heavy Loads
- Evaluation of Super Pave Mixture
  - SPS-9 Validation of SHRP Asphalt Specifications and Mix Design and innovations in Asphalt Pavements

The standard SPS-2 experiment consists of 12 LTPP test sections constructed in each of 14 states as indicated in Figure 1. The numbers within each state represent the year the SPS-2 test sections were constructed in the respective state. As indicated, the projects now range in age between 12 to 20 years.

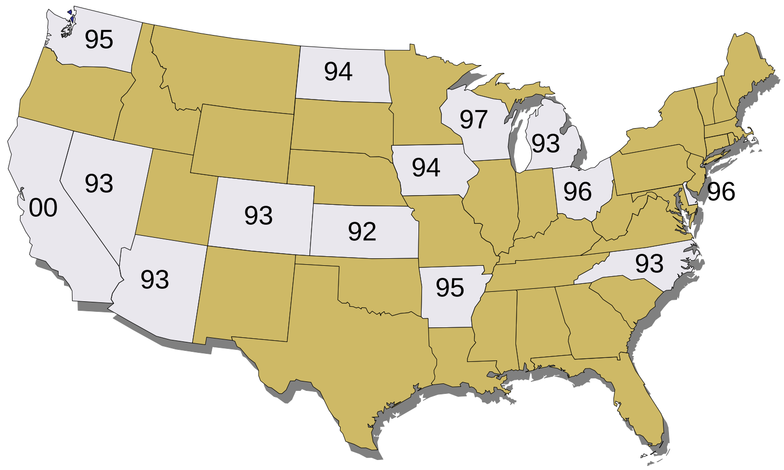


Figure 1 Location of LTPP SPS-2 Sites and Years Constructed

As such, these projects should be considered candidates for pavement preservation to extend their service life. To accomplish this, it is desirable to develop a second tier experiment which creates yet another designed experiment based on the original SPS-2 work. This experiment could identify when to initiate preservation treatments, what treatments to use, implement the strategies, and monitor and evaluate their performance for an additional 10 to 20 years after application.

The current SPS-2 experiment represents the most comprehensive concrete research since the AASHO road test. The experiment includes permanent weigh-in-motion instrumentation which allows reliable traffic and loading data collection. Comprehensive material testing has occurred since the original construction which is complete and extensive. Rigorous performance monitoring has also occurred since original construction. The specifications required to construct the SPS-2 projects were consistent across the states ensuring quality construction and minimizing variability.

The SPS-2 experiment was designed to evaluate the relative influence and long term effectiveness of five design features and three site factors. The five design factors are indicated below:

- **Concrete Thickness** (8" and 11")
- **Base Type** (Lean Concrete, Dense Graded aggregate, Permeable Bituminous Treated,)
- **Concrete Flexural Strength** (550 psi and 900 psi at 14 days)
- **Lane Width** (12 ft and 14 ft)
- **Drainage** (with and without edge drains)

The three site factors considered in the experimental design are indicated below:

- Climate—Temperature and Freeze/No Freeze
- Climate—Precipitation
- Subgrade—Fine Grained and Coarse Grained Soils

Traffic was not part of the experimental design, but was treated as a covariant with the only requirement that candidate projects achieve a minimum traffic level of 200,000 ESALs/ year.

The original SPS-2 experiment consisted of a factorial experiment consisting of 24 test sections; however, only 12 test sections were constructed at any one location for the core experiment. Additional sections were allowed as supplemental sections if the agency desired to construct them. The supplemental sections have been tested and evaluated in the same manner using the same equipment as the LTPP SPS-2 sections since original construction. The LTPP core experiment numbering scheme is indicated in Table 1.

Since fixed structural designs were used for all traffic levels and site conditions, the design life of each SPS-2 test section may be different within a given project and among the fourteen projects. So it should be anticipated that preservation treatments will occur at different times for different sections.

TABLE 1 LTPP SPS-2 Test Section Numbering Scheme(6)

			Drainage		
			No		Yes
			Base type		
Slab Thickness (in.)	Flexural Strength (psi)	Lane Width (ft)	Aggregate	Lean Concrete Base	Permeable Asphalt-Treated Base
8	550	12	0201	0205	0209
		14	0213	0217	0221
	900	12	0214	0218	0222
		14	0202	0206	0210
11	550	12	0215	0219	0223
		14	0203	0207	0211
	900	12	0204	0208	0212
		14	0216	0220	0224

Opportunities for SPS-2 and SPS-2 Pavement Preservation Research

Life Extension of Concrete Pavement Preservation Treatments

The most recent national study of concrete pavement preservation was conducted by the SHRP-2 program in 2011 (1). Table 1 is an excerpt from that report and indicates the expected pavement life extension for each of the listed concrete preservation strategies. As indicated, insufficient information exists to quantify actual life extension. It is evident there is a compelling need to determine actual pavement life extension results for each of the treatments indicated in Table 2 so that cost-effective solutions can be selected.

TABLE 2 Treatment Life and Pavement Life Extension for PCCP Preservation Treatments (1)

	Expected Performance	
Treatment	Treatment Life (yr)	Pavement Life Extension (yr)
Concrete joint resealing	2–8	5–6
Concrete crack sealing	4–7	NA
Diamond grinding	8–15	NA
Diamond grooving	10–15	NA
Partial-depth concrete patching	5–15	NA
Full-depth concrete patching	5–15	NA
Dowel bar retrofitting	10–15	NA
Ultra-thin bonded wearing course	6–10	NA

Development of PMS Triggers for Concrete Preservation

The rigid subcommittee of the FHWA ETG on Pavement Preservation recently completed a survey of states' practices regarding the use of pavement management in determining when and how to conduct preservation of concrete pavements (2). This survey indicated that approximately 60% of the states use PMS triggers for this process. However, it was noted that few if any states use the same procedures, suggesting that additional research is necessary to define the best techniques for defining the intervention thresholds, appropriate measurements, and determining strategy effectiveness.

Recently, the FHWA has completed a study of the Arizona SPS-2 project (still in review). This study, conducted by Mr. Steve Karamihas and Mr. Kevin Senn, has developed a technique for removing the curling and warping affects from the profile to determine long-term roughness changes independent of these affects. It appears this approach has the potential to be a very useful tool for determining the appropriate intervention threshold in lieu of the traditional approach where distress is managed. Since only one site has been evaluated with this technique, additional research is necessary to further explore the benefits of this approach. Since roughness is implicit in the new design guide, this technique could very well impact the design side as well.

Improved Ride Quality

If it is determined that the ride quality of any of the sections have exceeded a reasonable level, it is possible to determine the amount of improvement resulting from diamond grinding through tools like the FHWA ProVAL software. Coupled with the analysis capability of the MEPDG it is now possible to determine the predicted pavement life extension resulting through different levels of smoothness improvement. This then provides a vehicle for optimizing the diamond grinding process by balancing cost to attain the smoothness and the resulting benefit or life extension. Such an approach has not been possible previously and may provide the incentives to conduct earlier interventions.

Recent experience with the Next Generation Concrete Surface (NGCS) has indicated that concrete pavements can be ground to an IRI in the low 20s. Research may indicate that by improving the ride quality of the SPS-2 sections to smoothness levels not obtained in the original construction that an additional pavement life extension may be possible. This is in addition to the added consumer satisfaction.

Since traffic is not a design variable (see Appendix 2) and the structural sections vary within the experiment (see Appendix 1), the test sections will require intervention at different times. It is most likely that the 8 inch thick concrete sections and any undowelled concrete supplemental sections will require diamond grinding to alleviate ride issues. The timing of this should be monitored and evaluated to define actual life extension.

PCCP Design Life Verification

Traditionally, pavements are designed for a specified performance period and level which is determined based upon the expected traffic/load levels, environmental setting, and material properties and thicknesses. This way each pavement design is unique to its particular setting. The SPS-2 experiment was based on fixed structural thickness and material properties essentially independent of the traffic/load levels at the specific site location as long as a specified minimum traffic level was achieved.

The MEPDG analysis tool should be used in conjunction with the actual project material properties, thicknesses, and traffic and environmental information to predict the "design performance period" for each of the 12 standard sections and any supplemental sections at each location. This would allow a comparison of the "designed performance curve" and the actual performance curve. This should provide better insight into the proper timing of the preservation treatment as well as the efficacy of the MEPDG prediction capability.

Comparison of Remaining Capacity to Remaining Service Life

The design life verification procedure previously described can be used to develop a remaining expected capacity for each of the test sections based on actual conditions and properties. The remaining capacity could be used by a PMS system to program future activities and is a function of the accuracy of the analysis tool.

The remaining life can also be evaluated using the LTPP performance monitoring data collected at each of the sites. The remaining life prediction is generally performed using performance data to "predict" continued performance of the pavement. In a perfect world the remaining capacity and remaining service life should result in similar answers. However, both approaches are dependent upon the efficacy of the analysis procedures themselves. The SPS-2 experiment allows the opportunity to investigate these concepts and hopefully improve them. Cradle to grave management of concrete pavements assumes both approaches would need to be reasonably accurate.

Sealant Research

One of the unanswered questions regarding concrete pavement preservation is the effectiveness of joint sealing and resealing. Since these projects are 12 to 20 years of age, the effectiveness of the sealant and the need for resealing should be considered. The current LTPP procedures do not adequately address this issue. Techniques such as ground penetrating radar coupled with wetting of the surface could be used to evaluate the sealant effectiveness and to evaluate locations of water movement within the sections. These techniques could be used to determine when to reseal. For the four SPS-2 projects with seasonal monitoring capability (if it still works), more intensive research could be conducted to see how the intrusion of moisture from ineffective sealing could be impacting performance. This would allow the effectiveness of sealing to be assessed. Traditionally, if a sealant exists it is considered a "sealed" joint even if the seal is breached. By having some measure of "sealing" quality, it may then be possible to determine if it is cost effective.

The impact of the interaction of sealing and base drainage could also be evaluated for these sections. This research has not been undertaken by the SPS-2 experiment. The Seal-No Seal Group has been working with Dan Zollinger of TTI who has developed a model to predict the impact of water infiltration into joints on base erosion and pavement performance. Although only a model at this time, if successful field calibration can be attained through the SPS-2 experiment, it would be a tool that could eventually be incorporated in the MEPDG.

Texture Durability

Since the SPS-2 experiment consisted of two flexural strengths (e.g. 550 and 900 psi), it is possible to evaluate the impact on wear rates of the existing textures and any preservation treatments such as diamond grinding or diamond grooving. This currently is not an aspect of the SPS-2 experiment but could be included in the preservation experiment. Texture measurements in the wheelpaths, between the wheelpaths and on the shoulders could be compared. This would provide insight into the historical texture wear rates as well as providing a benchmark to begin the evaluation of the preservation experiment. Since the flexural strengths were determined by a 14 day test, it is not known if a significant difference exists in the flexural strength at the current time. The LTPP program has purchased new profiling units which will also be capable of measuring texture. Therefore, as part of the normal LTPP monitoring for these projects, it will be possible to evaluate texture data starting in about 2013.

Changes in Material Properties Over Time

One of the attributes of concrete is that it continues to gain strength over time. This should be characterized prior to the placement of the preservation treatment to enhance the information available for the original SPS-2 experiment as well as to benchmark conditions for the new preservation experiment. Non-destructive and destructive testing of other materials incorporated into the SPS-2 should be considered as well. During the period of 2003-2004, as part of the LTPP Materials Action Plan, additional samples were retrieved from the SPS-2 sites and these materials should now be tested and/or the data reviewed to see if additional testing is required and whether or not it appears that changes in properties over time are occurring. Since the previous action plan is almost a decade old, consideration should be given to updating this information with newer samples.

The largest study ever undertaken of the long-term properties of concrete was reported in 1992 and evaluated mixes that were constructed between 1940 and 1956(6). The 1992 study indicated that strength gains of 30% to 40% over the 28 day strength were achieved in projects older than 20 years. However, the age of these mixes and the relevance to today is questionable. In 1995 the Arizona Transportation Research Center did a limited review of the early SPS-2 project mix results and evaluated the difference between the 550 and 900 psi flexural strengths(7). In 2001 an analysis of the early results of the material properties were evaluated for specimens up to 500 days in age(9). No long term evaluation has occurred to date.

Development of the Best Preservation Techniques and Materials

The SPS-2 projects provide a unique opportunity for a partnership between industry and agencies to gauge the performance of concrete pavements and their preservation techniques/materials that have been used across the country, and to verify which techniques are performing best. Based on this type of assessment, it may then be possible to foster development of improved products. This would allow a better opportunity for defining the best practices available today.

US Scanning Tour of the SPS-2 Performance

Since construction of the original experiment, there has been little or no opportunity for agencies to evaluate the performance of the various sites outside of their own states. A valuable technology transfer function would be the ability to conduct a scanning tour of the largest on-going concrete experiment in the nation. This could be an excellent agency-industry partnership and would represent a significant opportunity to bring home the early findings of the SPS-2 experiment first hand. That is, to tell the story as to what is happening, and to evaluate how the pavement performed at each location and why. A best practices document could be developed from the tour as described above. Maintenance procedures and issues could also be addressed. This approach was used in the SPS-4 projects in the western region. Consideration of a living virtual tour could be considered whereby the regional contractors as they visit the sites annually could prepare a video of the section conditions. A standard format or process could be developed whereby all the reviews would be conducted in the same format and posted on a national website.

Evaluation of Non Destructive Test Devices

Non-Destructive test equipment has been refined since the construction of the SPS-2 experiment. For example, it is now readily possible to identify the location and tolerances of the dowel bars and tie bars in the sections. This will allow more comprehensive evaluation of pavement performance instead of just assuming they are located per plans. Similarly, ground penetrating radar and other technologies have advanced so as to be more accurate and reliable. A unique opportunity exists to characterize the pavement design features from a continuous standpoint as opposed to discrete test locations. This should provide advantages in analysis.

Extending Environmental Monitoring Test Results

One aspect of the SPS-2 experiment was installation of seasonal monitoring equipment at selected sites. This equipment could be re-established or improved in an attempt to characterize the long term impact of environmental factors on the pavement performance. This would provide indications if different moisture conditions exist within these sections; especially since joint sealant conditions are probably suspect at many locations at this time.

Improving the Current SPS-2 Experiment

Through the development of an SPS-2 preservation experiment, additional information could be collected that will have equal value or benefit to the original SPS-2 experiment and any future analysis of that data. This provides a leveraging of research resources for the benefit of the existing SPS-2 experiment, the SPS-2 preservation experiment, and any future calibration of the MEPDG guide which incorporates the SPS-2 data. This would then provide an opportunity to evaluate the design, performance, and preservation of concrete pavements in a much more comprehensive manner.

Dowel Bar Retrofit (DBR)

For the undowelled supplemental sections and possibly the 8" dowelled sections, it may be necessary to install dowel bar retrofits to ensure future ride quality and maintain effective load transfer. Both the appropriate intervention intervals and the impact on pavement life extension should be determined for each of these applications. Recently reported analysis procedures such as those described in reference 8 may provide new tools for determining the proper time for dowel bar retrofit (BBR) in conjunction with other deflection-based tools.

Implementing SHRP2 R26 "Preservation Approaches to High Traffic-Volume Roadways"

R26 was one the SHPR2 renewal research efforts and has been recently completed. Implementation of the results is expected to begin soon. The SPS-2 experiment is the ideal candidate for this implementation effort since performance data is already being conducted and accurate and complete historical data exists for each location. This would allow leveraging of existing research efforts to improve the implementation results.

Measurement of Solar Reflectance

With the growing interest in urban heat island effects and the need to sustain our environment, counter measures for offsetting the impact of pavements on the environment are needed. One approach to limiting this impact is by controlling the albedo of the pavement surface. Concrete generally has a favorable albedo measurement but this type of information is generally not obtained in the pavement community. By testing the albedo of the test sections, the changes over time could be investigated to a limited extent.

Rolling Resistance Measurement

Recently the Minnesota Department of Transportation conducted rolling resistance measurements on its MnROADs sections. Those results indicated the concrete pavement had the lowest rolling resistance. Since little US research has been conducted in this area, and it appears to have an impact on fuel economy, it is desirable to determine this as part of the preservation experiment. This test measurement may provide some very revealing improvements as a result of preservation treatments like diamond grinding.

The SPS-2 Preservation Research Impact on the Original SPS-2 Program

The LTPP SPS-2 experiment is currently set up to allow maintenance of the test sections while allowing continuation within the existing SPS-2 experiment. When rehabilitation is conducted, the project moves from the SPS-2 category to the GPS-7(X) category. Although with this change the test section would no longer be evaluated under the SPS-2 experiment, testing and evaluation would continue in the GPS-7 (X) category by LTPP.

The concrete pavement preservation strategies which fall into the respective LTPP maintenance and rehabilitation categories are indicated below:

Maintenance Activities which would allow continuation within the SPS-2 experiment:

- Diamond Grinding
- Diamond Grooving
- Joint and Crack Sealing and Resealing

- Partial Depth Spall Repair
- Full-Depth Slab Replacement (Dependent Upon Quantity)

Rehabilitation activities which would change the experiment category from SPS-2 to GPS-7(X):

- Full-Depth Repairs (extensive)
- Ultra-thin Bonded Overlays
- Dowel Bar Retrofit

References

1. Peshkin, D., et al, "Guidelines for the Preservation of High Traffic Volume Roadways," SHRP 2 Report S2-R26-RR2, Transportation Research Board, 2011
2. Scofield, L., et al, "Survey of State DOT PMS Trigger Values for Concrete Pavement Preservation," FHWA ETG on Pavement Preservation-Rigid Subcommittee, December 2011.
3. Hall, K.T., Crovetti, J.A., "8th Annual Pennsylvania Concrete Conference," Presentation-Does Drainage Matter, January 2007
4. Jiang, J., Darter, M., "Structural Factors of Jointed Plain Concrete: SPS-2 Initial Evaluation and Analysis," FHWA-HRT-01-167, April 2005
5. Hall, K.T., Crovetti, J.A., "Effects of Subsurface Drainage on Pavement Performance,", NCHRP 583, TRB,2007
6. Wood, S.L., "Evaluation of the Long-Term Properties of Concrete," Portland Cement Association, PCA R&D Serial No. 1895, 1992
7. Scofield, L., "Critical Evaluation of the SPS-2 Flexural Design Requirements", Unpublished Report, Arizona Department of Transportation, April 1995.
8. Karamihas, S.; Senn, K.; Curl and Warp Analysis of the SPS-2 Site in Arizona, FHWA, Draft Report
9. Mallela, J; Titus-Glover, L; Ayers, M. E; Wilson, T. P., "Characterization of Mechanical Properties and Variability of PCC Materials for Rigid Pavement Design," ISCP 7th Int. Conf. on Concrete Pavements, 2001

Related Reports and Papers on LTPP SPS-2 Pavement Performance

Title	Authors	Year	Publisher
Characterization of Mechanical Properties and Variability of PCC Materials for Rigid Pavement Design	Mallela, J; Titus-Glover, L; Ayers, M. E; Wilson, T. P.	2001	ISCP-Seventh International Conference on Concrete Pavements
LTPP Data Analysis: Factors Affecting Pavement Smoothness	Perera, R.W; Kohn, S. D.	2001	NCHRP—Web Document 40
Determination of Pavement Layer Stiffness on the Ohio SHRP Test Road Using Non-Destructive Testing Techniques	Sargand, Shad	2002	Ohio DOT
An Evaluation of LTPP SPS-2 Sections in Michigan	Vongchusiri, K; Buch, N; Desaraju, P; Salama, H.	2003	Universidade do Minho, Portugal
Factors Affecting Rigid Pavement Performance: Evaluation of the LTPP SPS-2 Experiment	Jiang, Y; Darter, M.I.	2004	Center for Portland Cement Concrete Paving Technology; FHWA
Structural Factors of Jointed Plain Concrete Pavements: SPS-2 Initial Evaluation and Analysis	Jiang, Y. Jane; Darter, Michael I.	2005	ERES Consultants for FHWA

Statistical Challenges Presented by the SPS-2 Experiment and Data	Buch, N.; Haider, K; Pulipaka, S.W.; Lyles, R.W.; Gilliland, D.	2005	Proc. 8th Int. Conf. on Concrete Pavements, 2005
LTPP Data Analysis: Influence of Design and Construction Features on the Response and Performance of New Flexible and Rigid Pavements	Chatti, K; Buch, N; Haider, S. W; Pulipaka, A. S; Lyles, R. W; Gilliland, D; Desaraju, P.	2005	NCHRP- Web Document 74
Performance of SPS-2 Project in Kansas	Khanum, T.; Hossain, M.; Gisis, A.J.	2005	Proceedings of the 2005 Mid-Continent Transportation Research Symposium
Effects of Subsurface Drainage on Pavement Performance: Analysis of the SPS-1 and SPS-2 Field Sections	Hall, Kathleen T.; Crovetti, James A	2007	NCHRP
Performance of Drained and Undrained Rigid Pavements in LTPP SPS-2 Experiments	Hall, Kathleen T.; Crovetti, James A	2007	TRB Annual Meeting
15- Year Performance of SPS-2 Project in Kansas	Khanum, Taslima; Hossain, Mustaque; Gisi, Andrew, J; Daba S. Gedafa	2008	9th International Conference on Concrete Pavements
Curl and Warp Analysis of the LTPP SPS-2 Site in Arizona,	Karamihas, S.M.; Senn, K.	2012	FHWA

XXXXXXX SPS-2 Experiment

XXXXX Test Section Layout[6]

Appendix 1 SPS-2 Site Locations & Experimental Design

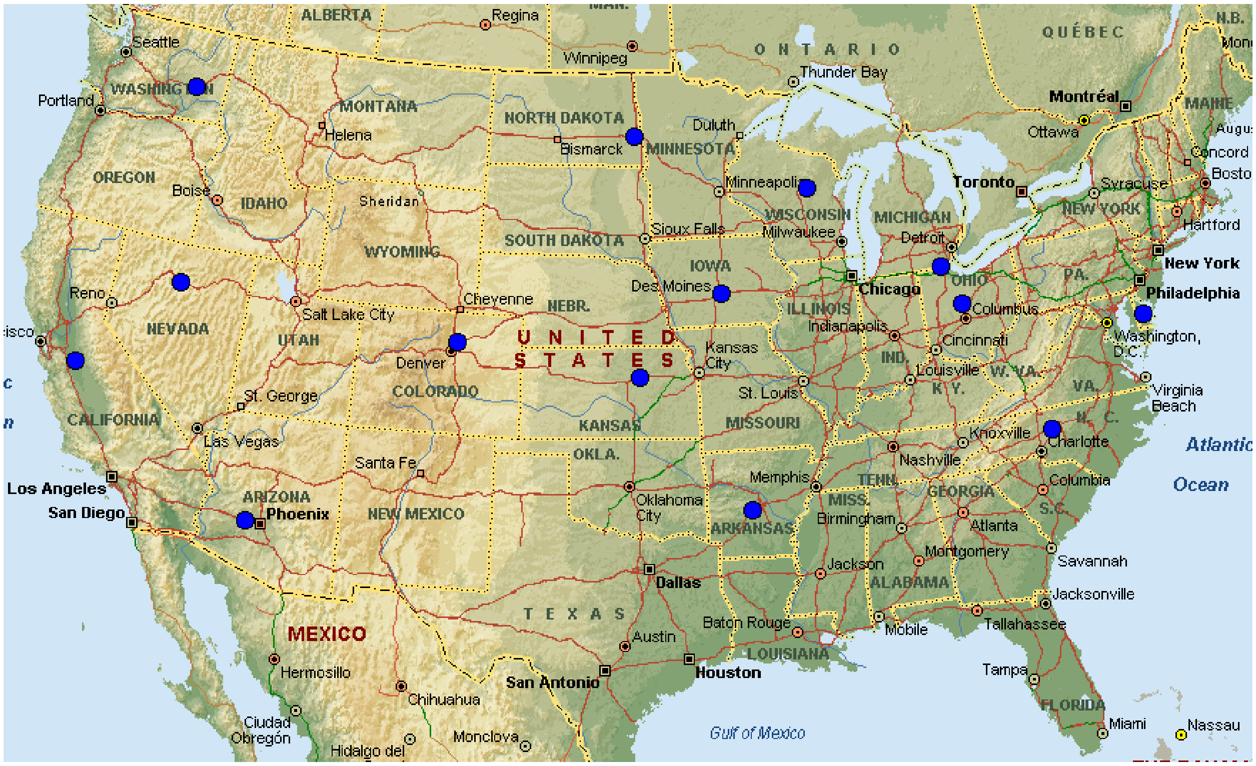


Figure 1-1 Locations of SPS-2 Experiments (3)

						Drainage		
						No		Yes
						Base type		
						AGG	LCB	PATB
Slab thickness, inches	8	Flexural strength, psi	550	Lane width, ft	12	0201	0205	0209
					14	0213	0217	0221
			900		12	0214	0218	0222
					14	0202	0206	0210
	11		550		12	0215	0219	0223
					14	0203	0207	0211
			900		12	0204	0208	0212
					14	0216	0220	0224

Figure 1-2 SPS-2 Experimental Design (3)

Appendix 1 SPS-2 Site Locations & Experimental Design

Table 4. List of constructed SPS-2 core and supplemental sections.

State	State Code	Core Sections ID	Core Sections Record Status	Supplemental Sections	Seasonal Sections
AZ	04	0213-0224	E	0260-0268 (9)	0215
AR	05	0213-0224	E	-	-
CO	08	0213-0224	E	0259	-
DE	10	0201-0212	E	0259-0260 (2)	-
IA	19	0213-0224	E	0259	-
KS	20	0201-0212	E	0259	-
MI	26	0213-0224	E	0259	-
NV	32	0201-0211 (0212 was removed)	E	0259	0204
NC	37	0201-0212	E	0259-0260 (2)	0201, 0205, 0208, 0212
ND	38	0213-0224	E	0259-0264 (6)	-
OH	39	0201-0212	E	0259-0265 (7)	0204
WA	53	0201-0212	E	0259	-
WI	55	0213-0224	A	0259-0266 (8)	-
Total number of sections		**155**		**40**	**7**

Figure 1-3 SPS-2 Information on Original and Supplemental Sections (4)

Table 6. List of the constructed SPS-2 State supplemental sections and designs.

State	SHRP ID	Pavement Design Description
AZ	0260	216 mm dense-graded AC on 102 mm DGAB.
	0261	216 mm dense-graded AC on 102 mm DGAB.
	0262	203 mm undoweled JPC (3.8 MPa Resilient Modulus (MR)) on DGAB and 4.27 m lane.
	0263	203 mm undoweled JPC (3.8 MPa MR) on PATB and DGAB and 4.27 m lane.
	0264	279 mm undoweled JPC (3.8 MPa MR) on PATB and DGAB and 3.66 m lane.
	0265	279 mm undoweled JPC (3.8 MPa MR) on DGAB and 3.66 m lane.
	0266	318 mm doweled JPC (3.8 MPa MR) on bituminous treated base (BTB) and

Appendix 1 SPS-2 Site Locations & Experimental Design

		4.27 m lane.
	0267	279 mm doweled JPC (3.8 MPa MR) on BTB and 4.27 m lane.
	0268	203 mm doweled JPC (3.8 MPa MR) on BTB and 4.27 m lane.
CO	0259	279 mm JPC (4.5 MPa) on subgrade and 3.66 m lanes.
DE	0259	254 mm JPC (20.7 MPa f'c) on 203 mm DGAB; 3.66 m lane; steel dowels.
	0260	254 mm JPC (20.7 MPa f'c) on 203 mm DGAB; 3.66 m lane; plastic dowels.
IA	0259	279 mm JPC; 4.27 m wide lane.
KS	0259	305 mm doweled JPC (4.1-MPa mix) on 152 mm stabilized subbase on 152 mm modified fly ash subgrade and 3.66 m lane.
MI	0259	267 mm JRC on 102 mm open-graded base course (OGBC) on 76 mm aggregate base.
NV	0259	267 mm JPC on 38 mm leveling course, 27.6 MPa +- 20% 14-day compressive strength.
NC	0259	254 mm JPC on 102 mm PATB on 25.4 mm AC on 203-mm lime-stabilized subgrade.
	0260	279 mm JPC on 25.4 mm AC on 127 mm BTB on 203-mm cement-treated subgrade.
ND	0259	254 mm doweled JPC (ND mix) on 203 mm salve with skewed joints and 3.66 m lanes.
	0260	279 mm doweled JPC (ND mix) on DGAB with skewed joints and 4.27 m lanes.
	0261	279 mm undoweled JPC (3.8 MPa MR) on DGAB with skewed joints and 3.66 m lanes.
	0262	279 mm undoweled JPC on LCB with skewed joints (various lengths) and 4.27 m lanes.
	0263	279 mm undoweled JPC on PATB with random skewed joints and 3.66 m lanes.
	0264	279 mm undoweled JPC on PATB with skewed joints and 4.27 m lanes.
OH	0259	279 mm JPC (3.8 MPa MR) on 152 mm DGAB.
	0260	279 mm JPC (3.8 MPa MR) on 102 mm PATB on 102 mm DGAB.
	0261	279 mm JPC (3.8 MPa MR) on 102 mm CTPB on 102 mm DGAB.
	0262	279 mm JPC on 102 mm CTPB on 102 mm DGAB.
	0263	279 mm JPC on 152 mm DGAB.
	0264	279 mm JPC on 152 mm DGAB.
	0265	279 mm JPC (3.8 MPa MR) on 102 mm PATB on 102 mm DGAB.
WA	0259	Undoweled 254 mm JPC (4.5 MPa MR) on 76 mm ATB on 51 mm crushed surfacing base course; 4.27 m lane.
WI	0259	279 mm JPC (3.8 MPa MR) on 152 mm DGAB.

	0260	279 mm JPC (3.8 MPa MR) on 152 mm DGAB, with alternate dowel bar placement.
	0261	203 mm JPC (3.8 MPa MR) on 102 mm OGBC on 102 mm DGAB.
	0262	203 mm JPC (6.3 MPa MR) on 152 mm DGAB, with tied concrete shoulder.
	0263	203-279 mm JPC (3.8 MPa MR) on 152 mm DGAB, variable pavement thickness.
	0264	279 mm JPC (3.8 MPa MR) on 152 mm DGAB, with composite dowels.
	0265	279 mm JPC (3.8 MPa MR) on 152 mm DGAB, with stainless steel dowels.
	0266	Unknown

Note: The Arkansas SPS-2 project site does not contain any supplemental sections.

Figure 1-4 Listing of SPS-2 Supplemental Sections by State (4)

Additional California SPS-2 Information

Since California was constructed after the other projects some of the earlier reports do not include information as evident in the Tables. As such, some additional information is provided the Table 1-1

TABLE 1-1 California SPS-2 Information

State Code	Test Section IDs	Supplemental Sections	Seasonal Monitoring Sections
06	0201-0212	None	None

Appendix 2 SPS-2 Traffic Levels

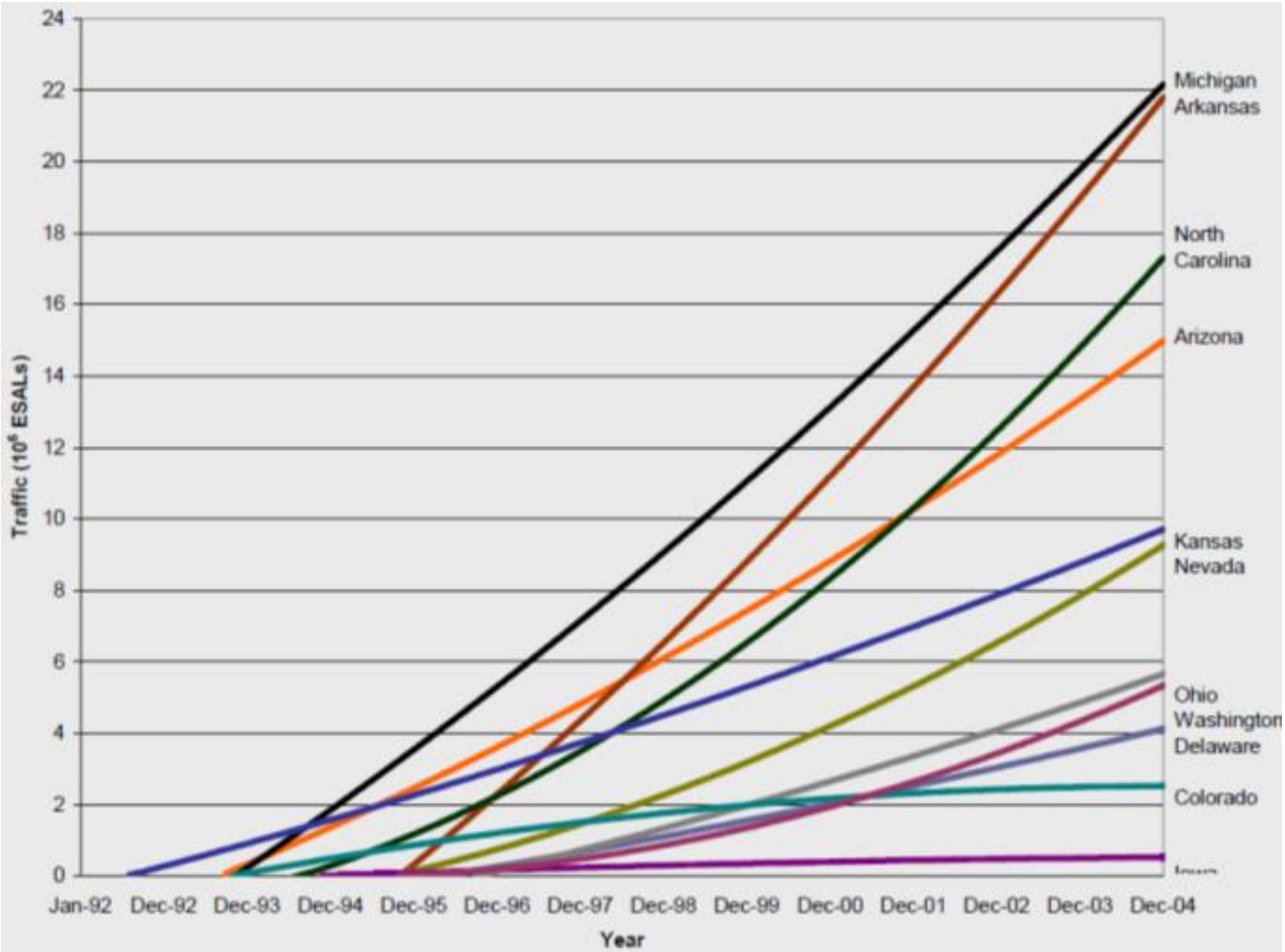


Figure 2-1 SPS-2 Traffic Levels (Accumulative ESALs) (3)

Appendix 3 SPS-2 Environmental Information

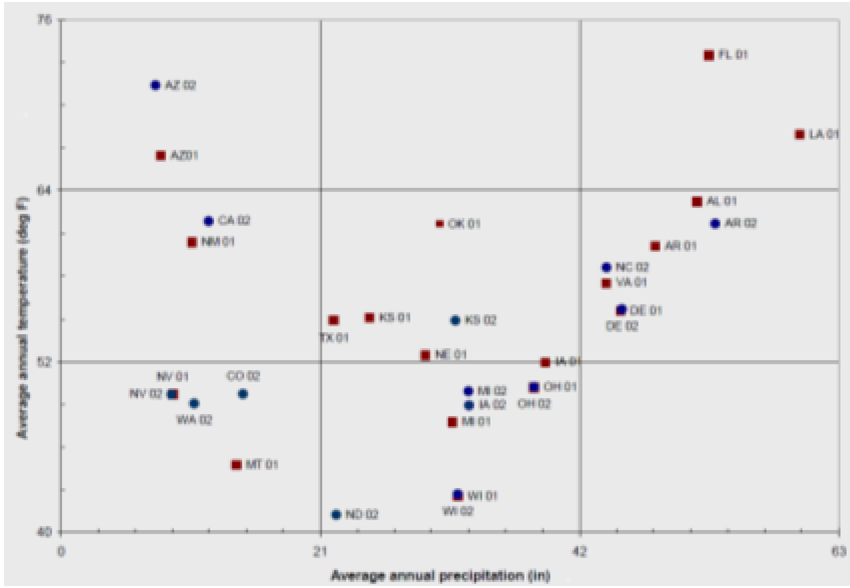


Figure 3-1 SPS-1 & SPS-2 Average Annual Temperature and Rainfall (3)

Appendix 4 SPS-2 Soil Classifications

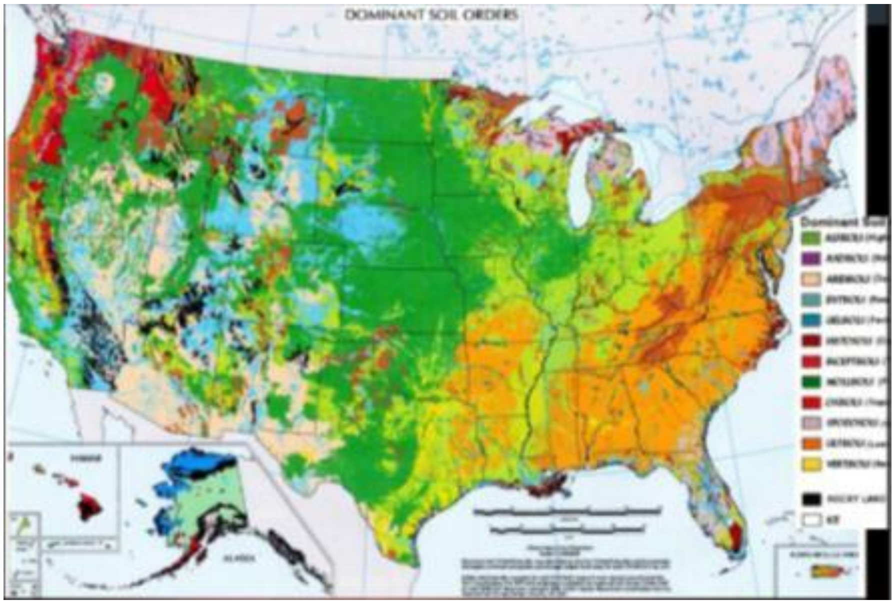


Figure 4-1 Dominant Soil Orders (3)

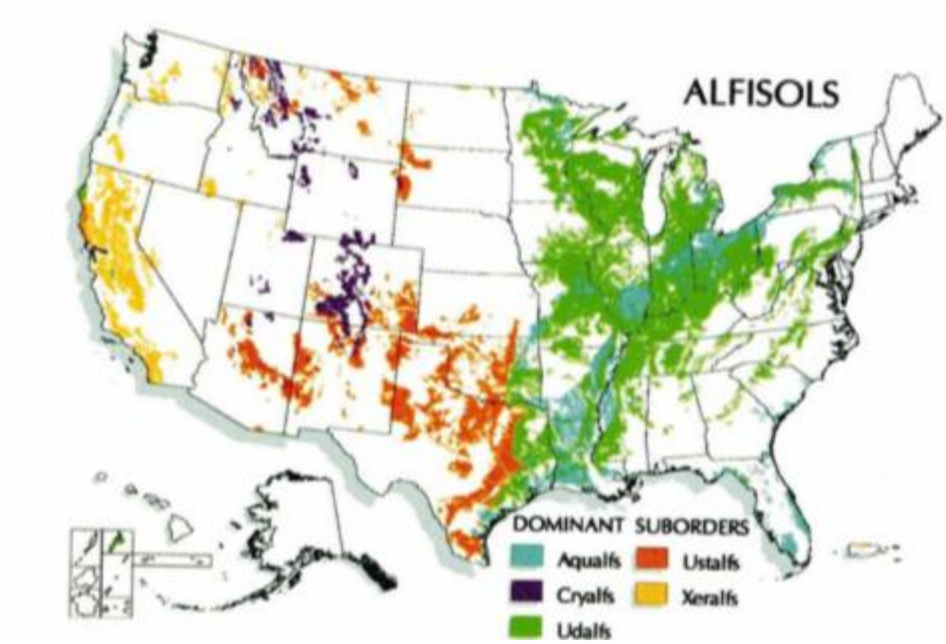


Figure 4-2 Dominant Soil Suborders (3)

Appendix 4 SPS-2 Soil Classifications

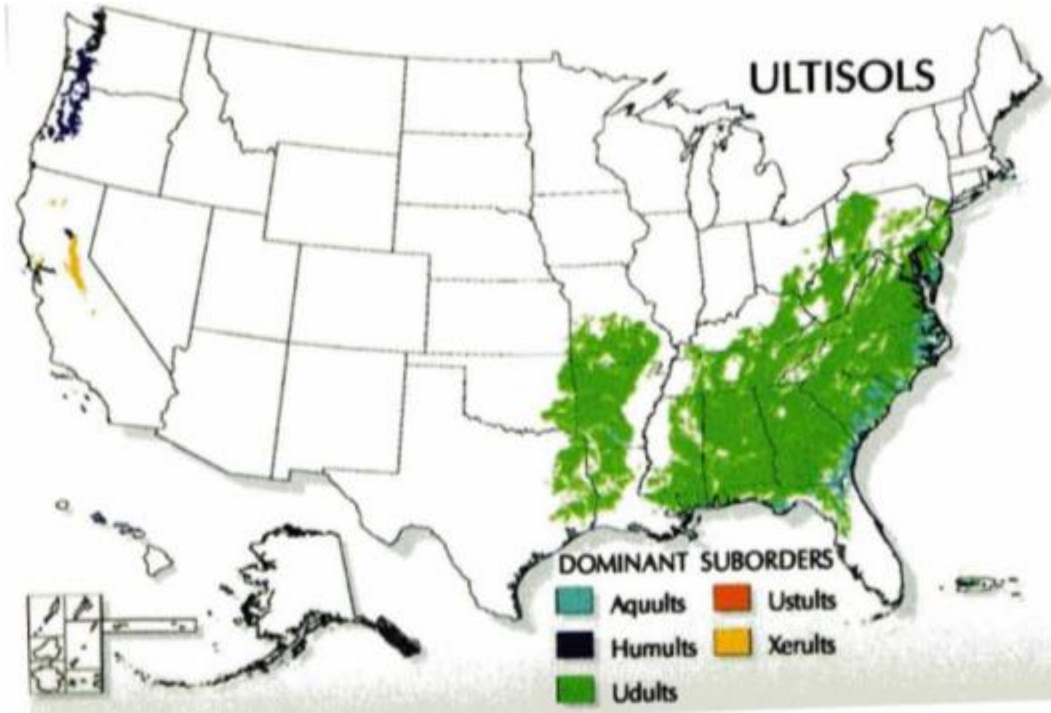


Figure 4-3 Dominant Soil Suborders (3)

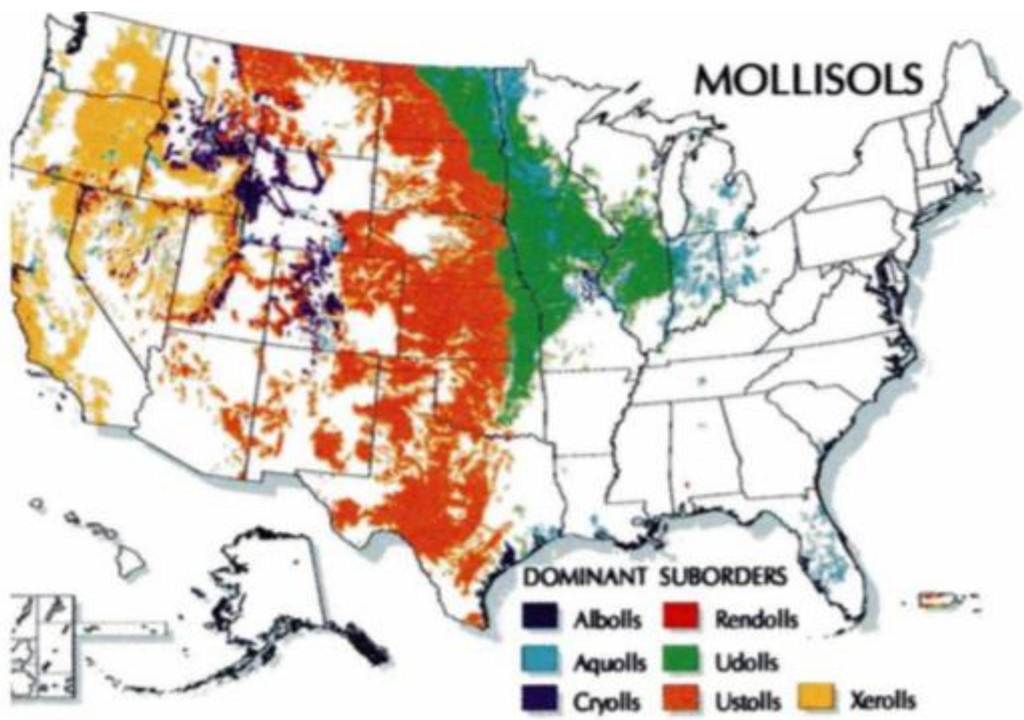


Figure 4-4 Dominant Soil Suborders (3)

Appendix 4 SPS-2 Soil Classifications

Figure 4-5 Dominant Soil Suborders (3)

Appendix 7 Friction Test Results

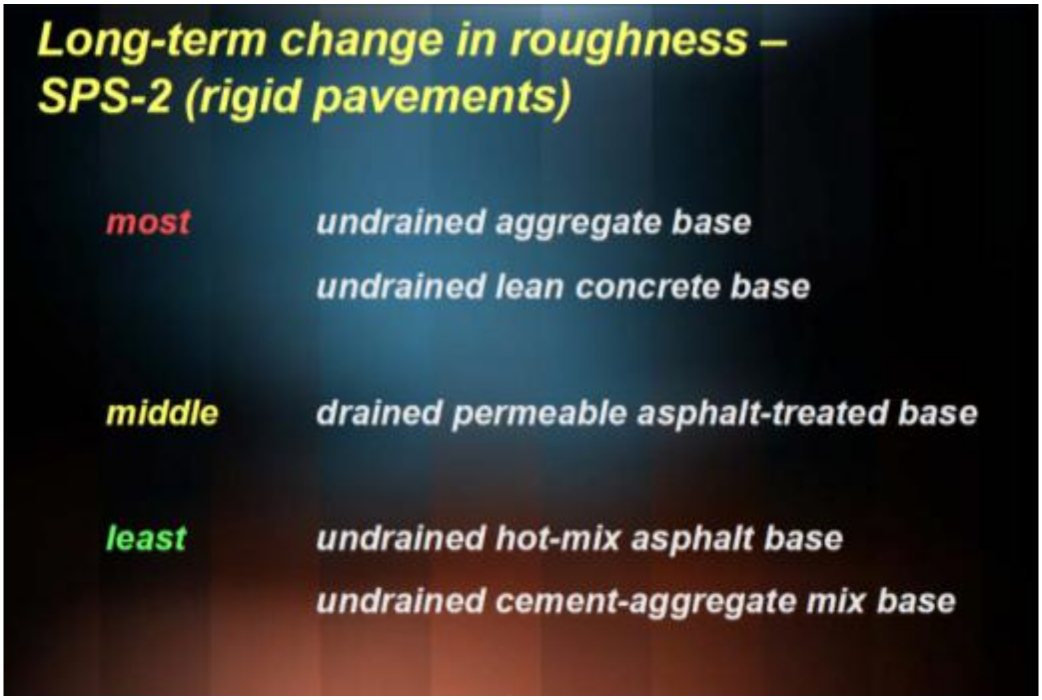


Figure 5-1 Long-term Change In SPS-2 Roughness as a Function of Base Type (3)

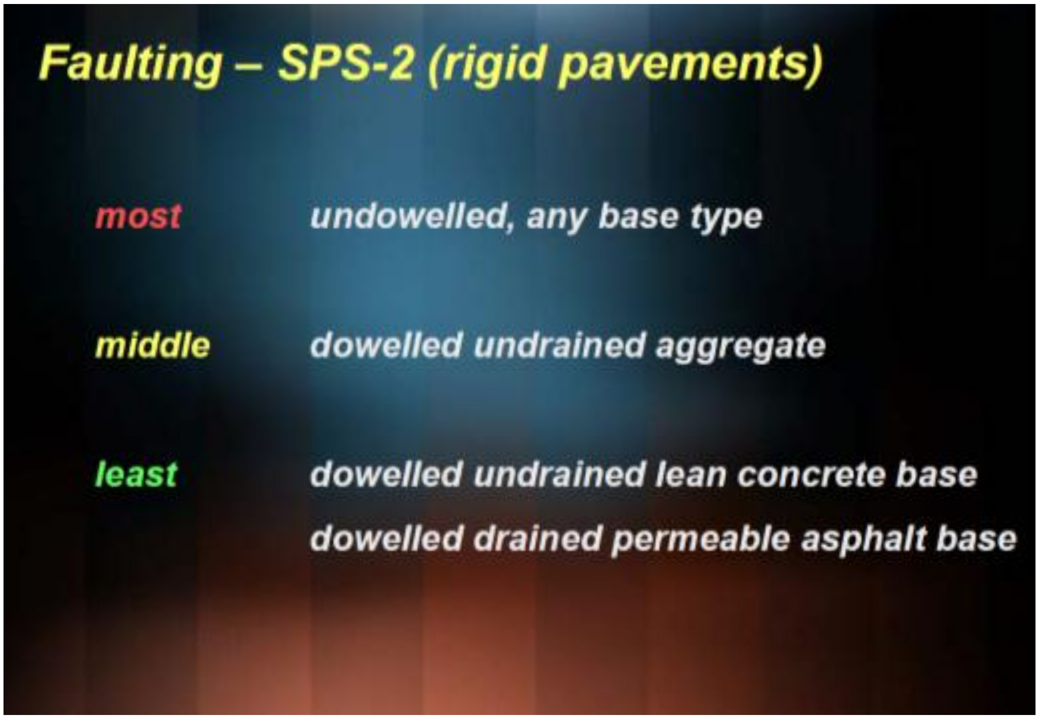


Figure 5-2 SPS-2 Fault Levels as a Function Base Type (3) (Note that Undowelled Pavements were the Supplemental Sections

Appendix 4 SPS-2 Soil Classifications

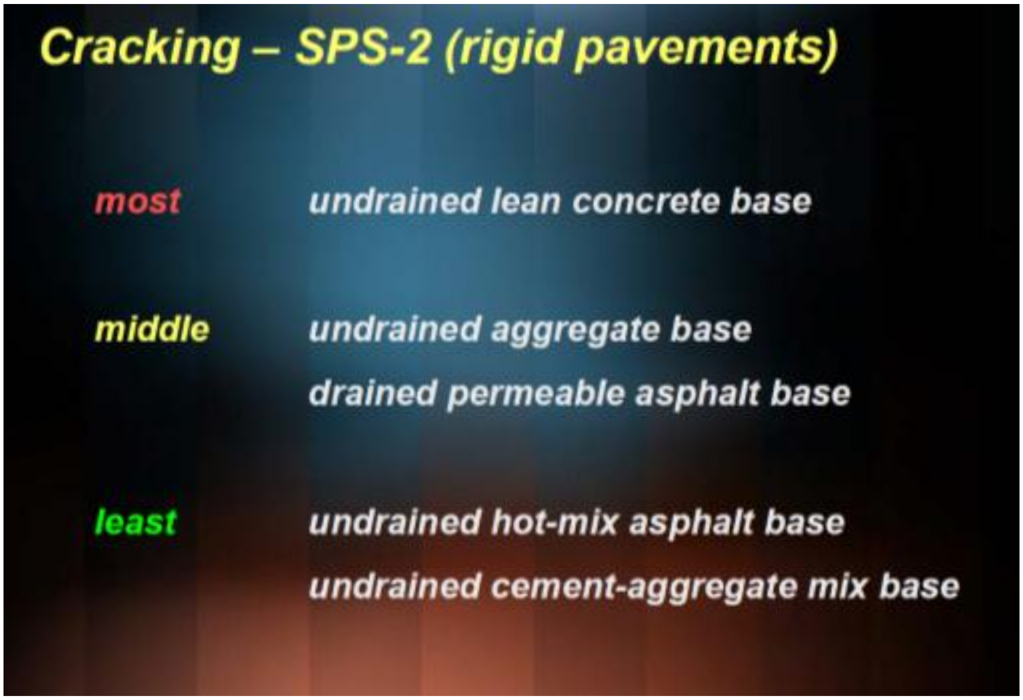


Figure 5-3 SPS-2 Crack Levels as a Function of Base Type (3)