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MAP Brief Winter 2026

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SPS-2 Test Sections of the Long-Term Pavement Performance (LTPP) Program

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PROJECT TITLE
SPS-2 Test Sections of the Long-Term Pavement Performance (LTPP) Program

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Introduction

The Long-Term Pavement Performance (LTPP) program is a large-scale research project comprised of two fundamental classes of studies and several smaller studies whose overarching goal is to investigate specific details critical to pavement performance. The fundamental classes of studies—which include the General Pavement Studies (GPS) and the Specific Pavement Studies (SPS)— encompass over 2,500 test sections located on in-service highways throughout the United States and Canada.

This MAP brief describes the test sections constructed for the SPS-2 experiment, the nation's largest study of concrete pavement performance. It also outlines a transportation pooled fund (TPF) project established to further study the SPS-2 test sections with a focus on future pavement preservation strategies. Key activities completed under the pooled fund are described, including a series of SPS-2 Tech Days events and several additional studies.

LTPP Program Background

The LTPP program was established in 1987 as part of the original Strategic Highway Research Program (SHRP) to determine how and why in-service pavements perform the way they do, and the program was transitioned to Federal Highway Administration (FHWA) management in 1992. Operating continuously since then, the LTPP program is the world's most comprehensive study of in-service pavements. The program has evolved considerably over this time, and all relevant data collected are available via the InfoPave™ portal (https://infopave.fhwa.dot.gov/). These data include not only research-quality performance measurements collected at regular intervals but also detailed traffic loading, materials, and climatic data, all of which facilitate modeling and model development.

The LTPP program was the primary data source used in developing the AASHTOWare Pavement ME Design (PMED) software, and the program's data continue to be used to improve PMED's ability to predict field performance. Thanks to leadership in this and other areas, as well as critical support from state and provincial highway agencies (SHAs) and countless volunteers in both academia and industry, the LTPP program is helping answer the following important question: How can we optimize our investment in pavements?

Many LTPP test sections were in active service at the time the LTPP program began and were included as part of the GPS. An additional round of studies, the SPS, was designed to examine maintenance and rehabilitation strategies and the impacts of design features on new construction. Both rigid and flexible test sections are included in the LTPP program. The rigid pavement experiments consist of the following studies:

- GPS-3—Jointed Plain Concrete Pavements
- GPS-4—Jointed Reinforced Concrete Pavements
- GPS-5—Continuously Reinforced Concrete Pavements

- GPS-8—Unbonded Portland Cement Concrete Overlay of Portland Cement Concrete Pavements
- SPS-2—Strategic Study of Structural Factors for Rigid Pavements
- SPS-4—Preventive Maintenance Effectiveness of Rigid Pavements
- SPS-6—Rehabilitation of Jointed Portland Cement Concrete Pavements
- SPS-8—Study of Environmental Effects in the Absence of Heavy Loads (both asphalt concrete [AC] and portland cement concrete [PCC] pavements)

SPS-2 Test Sections

The SPS-2 study has yielded the most comprehensive set of long-term concrete pavement performance data in the United States. The experiment included 208 test sections initially and was designed to study the performance impacts of construction features, flexural strength, lane width, PCC thickness, base type, and drainage. Table 1 lists all of the experimental parameters, including environmental factors. Traffic was not included as a parameter, but all sections were required to experience a minimum of 200,000 equivalent single axel loads (ESALs) per year to be accepted as part of the study.

In addition to test sections built to evaluate these experimental factors, supplemental sections were built by many of the SHAs participating in SPS-2. These sections typically represented the agencies' standard designs, and many SHAs opted to construct additional supplemental test sections to assess design factors of their choosing.

The standard experimental factors were compiled into a factorial experiment, resulting in 192 factor-level combinations. A full factorial experiment would have required 24 sections constructed at each site. Recognizing the cost implications of building a full factorial design at a given location, it was decided each SPS-2 project would have 12 test sections and projects with similar environmental conditions would be linked. This experimental plan worked for some factor-level combinations, while other combinations had gaps. SPS-2 projects were built in 14 states between 1992 and 2000, with the first project constructed in Kansas. Figure 1 presents the location and year of construction of each SPS-2 project.

An LTPP test section is typically considered out-of-study when it reaches the end of its performance cycle or when it is rehabilitated in a way inconsistent with the original study protocols. Of the 208 SPS-2 test sections initially constructed, 107 (51%) are still active as of 2025 (Figure 2), which is by far the highest survivability of any original GPS or SPS experiment.

Table 1. Experimental factors considered in the original SPS-2 experiment

Type of Experimental Factor	Variables Affected	Experimental Factor	Levels
Environmental	Site-Specific	Traffic	N/A
		Climate	Wet-Freeze
			Wet-No Freeze
			Dry-Freeze
			Dry-No Freeze
		Subgrade	Fine
			Coarse
Structural	Base/Subbase	Base Type	Dense-Graded Untreated Unbound Aggregate Base (Dense-Graded Aggregate Base [DGAB])
			Lean Concrete Base (LCB)
			Open-Graded Permeable Asphalt-Stabilized Base (Permeable Asphalt-Treated Base [PATB])
		Drainage Type	Open-Graded Permeable Asphalt Drainage Layer (PATB)
			No Drainage Layer
	Pavement Surface	PCC Thickness	8 in.
			11 in.
		PCC Flexural Strength	550 psi
			900 psi
		Lane Width	12 ft
			14 ft

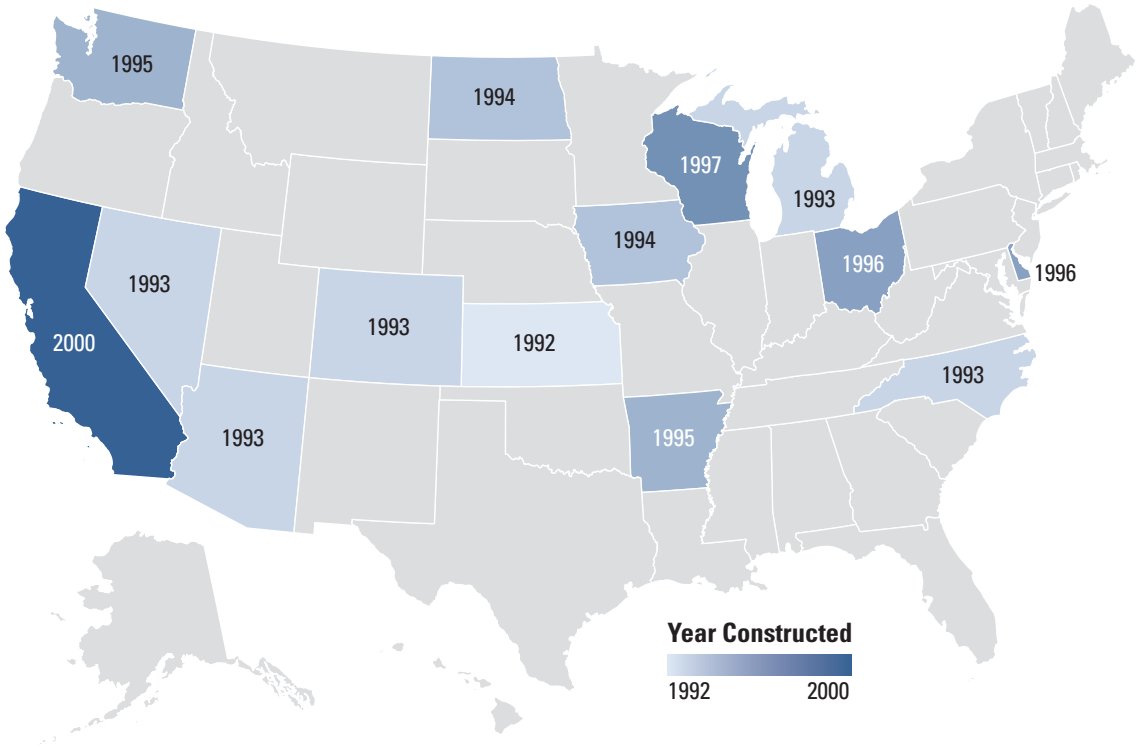

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Figure 1. Location and year of construction of each LTPP SPS-2 site

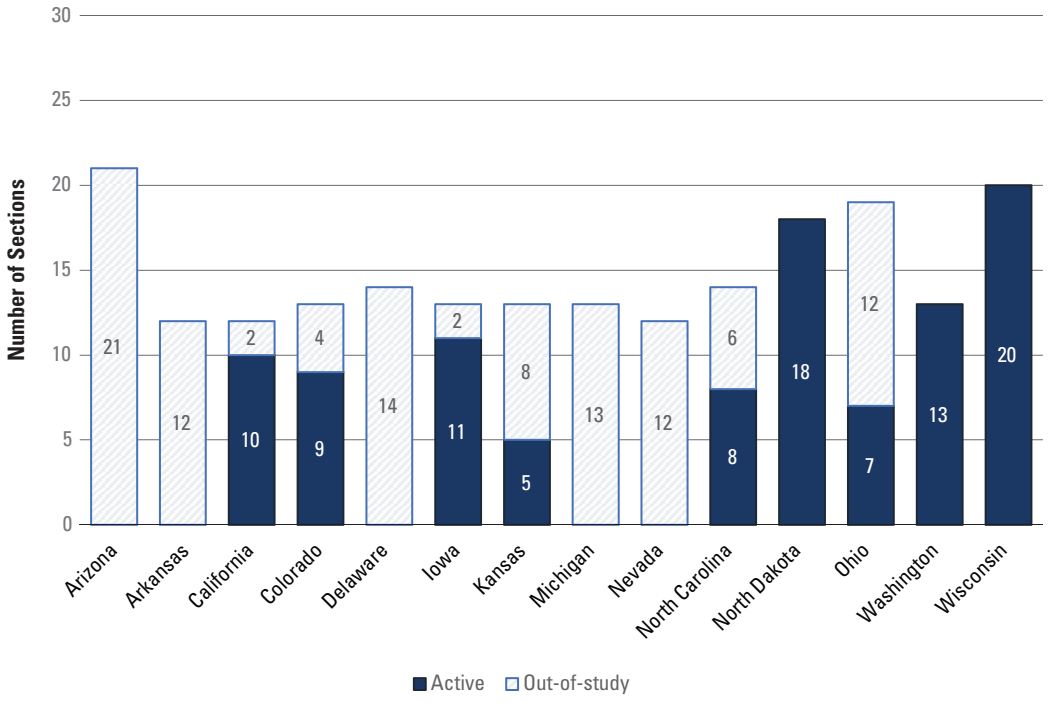

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Figure 2. Active versus out-of-study SPS-2 test sections in 2025

Detailed construction records were produced for each SPS-2 project, and all construction reports can be found on the InfoPave™ portal (https://infopave.fhwa.dot.gov/). Data on materials, traffic loading, climatic conditions, and pavement performance are also available through the portal. The pavement performance data include time series measurements of International Roughness Index (IRI), pavement distress, faulting, and deflection testing conducted mid-panel, at the pavement edges, and at joints.

SPS-2 Pavement Preservation Pooled Fund TPF-5(291)

Given the age of the SPS-2 projects and the relatively good condition of most test sections, the SPS-2 test sections were identified in the early 2010s as excellent candidates for a study of pavement preservation. TPF-5(291), Development of an SPS-2 Pavement Preservation Experiment, was established for this purpose. The focus of TPF-5(291) was to examine the optimal timing for routine application of pavement preservation treatments to extend pavement life at the lowest cost, as well as to study the functional improvements resulting from pavement preservation. Washington served as the lead state, with Arizona, California, Colorado, Georgia, Kansas, and North Carolina as supporting states. The project initiation meeting was held on January 6, 2014, and the first panel meeting occurred on March 11, 2016.

The first TPF-5(291) project report summarized the existing status of the various LTPP experiments and provided options to the pooled fund panel for implementing a pavement preservation field study using the active SPS-2 test sections. Based on input from the panel, there was a desire to determine whether predicted pavement performance and actual pavement performance matched sufficiently to use predicted performance as a control for test sections receiving a pavement preservation treatment. A contract modification was issued to perform a series of PMED software runs and compare predictions to actual performance. Using these analyses, it was determined the predictions were not sufficiently accurate to serve as control sections, given that the average deterioration rates tended to be higher in measured performance curves than in predicted performance curves.

An extremely successful activity undertaken as part of the pooled fund was the SPS-2 Tech Day event series. To date, 14 Tech Days have been held (4 of which preceded TPF-5(291)), with the most recent being a return to the Iowa SPS-2 project site in 2025. Discussion during these Tech Days led to several additional studies and other project activities performed between 2019 and 2021. The SPS-2 Tech Days event series and the reports resulting from the additional studies/activities are summarized in the remainder of this MAP brief.

SPS-2 Tech Days

The intent of the SPS-2 Tech Days is to inform a broader audience about the SPS-2 projects and the pooled fund itself and to solicit input regarding potential future activities. Conducting the Tech Days involves support from not only the pooled fund partners but also the hosting SHAs, industry, and the LTPP program. A typical Tech Day attracts approximately 40 attendees. Table 2 lists the location and year of each of the 14 Tech Days held to date.

Tech Days include a classroom component (Figure 3) consisting of presentations reviewing the LTPP program, the SPS-2 experiments, and details on the construction of the SPS-2 project in that state. Presentations have also included topics such as local approaches to pavement preservation, complimentary research at the local and national levels, and details specific to TPF-5(291).

Table 2. SPS-2 Tech Days

State	City	Date(s)
Arizona	Phoenix	2013, 2018
Colorado	Denver	2013, 2018
Delaware	Dover	2014
Washington	Ritzville	2018
Iowa	Pleasant Hill	2018, 2025
Kansas	Abeline	2013, 2018
North Dakota	Bismark/Fargo	2018
California	Stockton/Delhi	2019
Arkansas	Little Rock	2019
Ohio	Columbus	2019

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Figure 3. Classroom presentation at the 2025 Iowa SPS-2 Tech Day

Classroom presentations are typically followed by field walks (Figure 4). The field walks have been particularly enlightening, as participants have been struck by differences in performance between design features revealed over the course of more than 30 years. Frequent observations have included how well many of the test sections were performing, why some were performing better or worse than others, and how beneficial attendees found the assessment experience to be. In some instances, the contractors who built the projects were present to talk about the original construction and to answer questions.

In surveys of participants at the end of each Tech Day, the overwhelming response has been that the event was extremely valuable. Some reasons provided by participants have included the following:

- The event offered a rare opportunity to know exactly what was built and to be able to observe the resulting performance after more than 30 years.
- Attendees saw how well many of the test sections are performing.
- Attendees were able to observe sections that are not performing as well as others and to discuss with other attendees the possible reasons why.
- Attendees learned about the LTPP program and the types of resources available through it.
- Attendees gained a better understanding of agency and contractor practices and saw how they have evolved over the years.

Spotlight on the 2025 Iowa SPS-2 Tech Day

The most recent Tech Day was held in Pleasant Hill, Iowa, on September 17, 2025. There were over 30 attendees, including Iowa Department of Transportation (Iowa DOT) personnel, local city and county engineers, academics, consultants, and pavement contractors. This Tech Day was well timed because the Iowa SPS-2 test sections were also the subject of a desktop study as part of the forensic pooled fund study TPF-5(500), which sought to understand how and why the sections have performed as they did (https://pooledfund.org/Details/Study/729). Thirteen SPS-2 test sections (Figure 5) had originally been constructed in Iowa, with eleven of them remaining active as of 2025. The state's test sections have been in service for 30 years and are located in the northbound lane of US 65 in central Iowa, northeast of Des Moines.

The classroom portion of the Tech Day featured presentations highlighting key results from the SPS-2 study. The well-rounded agenda included presentations on the LTPP program as a whole and the history of the SPS-2 experiment, the construction and performance of Iowa's SPS-2 test sections, and typical Iowa pavement practices. The classroom portion was followed by the field review. The site layout given to participants (Figure 6) depicted the order of the test sections along with the section-specific experimental factors. Once on site, the participants walked the project (Figures 7 and 8) and were encouraged to provide recommendations for appropriate preservation treatments for each test section. An interesting finding from the field walk was the confirmation of the existence of dowel bars in the state's supplemental section using an MIT-SCAN device (Figure 9); the presence of dowel bars had been an open question based on existing documentation.

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Figure 4. Field walk during the 2025 Iowa SPS-2 Tech Day

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Figure 5. Drone image of Iowa SPS-2 test sections during 2025 Tech Day

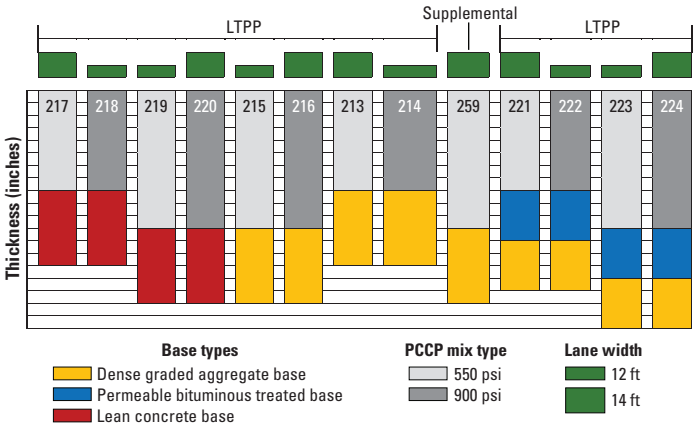

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Figure 6. Site layout for Iowa SPS-2 test sections

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Figure 7. Iowa SPS-2 test section

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Figure 8. 2025 Iowa SPS-2 Tech Day participants during the field walk

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Figure 9. 2025 Iowa SPS-2 Tech Day participant, Todd Hanson, conducting a test using an MIT SCAN device

Observations from the field walk included the following:

- Most sections were in good condition. Several sections had undergone diamond grinding, along with some patching.
- Unlike many of the other SPS-2 test sections, no shrinkage cracking was observed at the surface of the 900 psi sections.
- Typical of most SPS-2 test sections, the 550 psi sections had polished aggregates at the surface. It should be noted this polished aggregate was not observed during the 2018 Iowa SPS-2 Tech Day.
- Some corner breaks had occurred since the 2018 Iowa SPS-2 Tech Day.
- The interface between the truck lane and the AC shoulder was in poor condition, with substantial settlement in areas.
- The depth of tining varied between sections, with no obvious cause. This variation may have resulted from differences among sections in the time between when paving was finished and when tining began.

Consistent with previous Tech Days, the participants were engaged both in the classroom portion and during the field walk, and the feedback was overwhelmingly positive.

Reports Produced under TPF-5(291)

In addition to broadening knowledge of the SPS-2 experiment, the SPS-2 Tech Days also served as an excellent source of ideas regarding additional analyses beneficial to the pavement community. As a result, an array of additional studies and other project activities were performed between 2019 and 2021. The titles of the resulting reports and the studies' subject matter are as follows:

- *Final Report – Evaluating the Impact of Design Features on Pavement Performance:* Utilized existing performance data (falling weight deflectometer, distress, and longitudinal profile) to assess the impact of initial smoothness on performance, the impact of shoulder type on performance, and the impact of design features on load transfer efficiency (LTE); began investigating the availability of existing data among non-LTPP data sources (e.g., through the respective SHAs), though this activity was stopped following the survey phase because planned visits to selected SHAs were not practical due to COVID-19.
- *Final Report – Analysis of Impact of Joint Score and ALR on Pavement Performance:* Leveraged two existing LTPP research reports and expanded the following metrics with regard to SPS-2 test sections: areas of localized roughness (ALR) and joint score.
- *Final Report – Updating Previous LTPP Analyses and the SPS-2 Experimental Matrix:* Assessed previous analyses of SPS-2 projects and updated them with additional performance data collected since the original work was completed.

- *Final Report – Evaluating the Impact of Non-experimental Factors on Pavement Performance:* A combined report documenting performance trends at each SPS-2 experiment, assessing the impact of construction and materials issues on test section performance, reviewing early failures of SPS-2 test sections, and evaluating each state supplemental test section; supplemental test sections were selected and designed in addition to the core test sections by many of the SHAs.
- *Final Report – Impact of Changes in Climate, Traffic, Distress, and Maintenance on Deterioration Rate:* Assessed the impact of changes in climate, traffic, and overall condition on deterioration rate.
- *Final Report – Comparison of SPS-8 and SPS-2 Performance:* Compared the performance of SPS-2 test sections to that of similar test sections as part of the SPS-8 experiment, including a review of the previous FHWA report evaluating the performance of SPS-8 test sections.
- *Final Report – Diurnal Changes in Roughness:* Evaluated the results of recent diurnal measurements of longitudinal profile to see whether a neutral temperature could be developed for each project and whether it relates to the time of paving.
- *Final Report – Service Life Evaluation:* Estimated the age of a pavement at the time of failure based on projections of performance measures and selected failure criteria.
- *Final Report – Evaluating the Impact of Mix Design on Performance:* Analyzed SPS-2 concrete mixtures using modern evaluation and design methods such as Shilstone and assessed whether factors such as paste volume, void ratio, and other mix design parameters impacted constructability and performance.
- *Final Report – MEPDG Analysis of the PCC-Base Friction Loss:* Assessed whether PMED predictions improve based on the assumed PCC/LCB bond condition (unbonded versus full friction loss at 240 months); this expanded into assessing the impact of these assumptions on all base types and determining whether a different reliability value improves predictions.
- *Final Report – Evaluation of Transverse Joint Opening Width:* For SPS-2 sections included in the seasonal monitoring program (SMP), regular joint width measurements were performed; tools comparing predicted movements were evaluated against field data as well as against smoothness, faulting, and LTE.

Highlighted Findings on SPS-2 Test Section Performance

Selected findings from the reports produced under the pooled fund study are presented in this section. The impacts of experimental design features, mixture design, and project-specific factors (traffic, climate, distress, and maintenance) on pavement performance for the SPS-2 test sections were evaluated. Table 3 summarizes the impact of several design features on pavement performance measures. The impact of a given design feature was more significant in some cases than in others. However, the key conclusions are that pavement thickness, base type, and drainage had clear impacts, PCC strength and lane width had mixed results, and shoulder type was inconclusive (Punnackal and Senn 2021a).

Table 3. Impact of design features on the deterioration of SPS-2 test sections

SPS-2 Design Feature	Design Feature Type	Pavement Performance Measure Deterioration Over Time								
		IRI	Faulting	Transverse Cracking	Longitudinal Cracking	Shoulder Dropoff	LTE	Mid-slab Deflection	AREA Value	Joint Condition
PCC Thickness	Thick (11 in.)	👍	👍	👍	👍	NA	👍	👍	✕	👍
	Thin (8 in.)	👎	👎	👎	👎	NA	👎	👎	✕	👎
Base Type	DGAB	✕	✕	✕	👍	NA	✕	✕	✕	👍
	PATB	👍	👍	👍	👍	NA	✕	✕	✕	👍
	LCB	👎	👎	👎	👎	NA	✕	✕	✕	👎
PCC Strength	High	✕	👍	👎	👍	NA	👍	✕	✕	✕
	Low	✕	👎	👍	👎	NA	👎	✕	✕	✕
Lane Width	12 ft	✕	👎	👎	👍	NA	👎	✕	✕	👍
	14 ft	✕	👍	👍	👎	NA	👍	✕	✕	👎
Drainage	Drainage blanket / longitudinal drains	👍	✕	👍	👍	NA	✕	✕	✕	👍
	No subsurface drainage	👎	✕	👎	👎	NA	✕	✕	✕	👎
Shoulder Type	AC	👎	NA	NA	✕	👎	✕	NA	NA	NA
	PCC	👍	NA	NA	✕	👍	✕	NA	NA	NA

👍 *:relatively positive impact on deterioration rate or performance measure*
👎 *:relatively negative impact on deterioration rate or performance measure*
✕ *: no clearly observable impact or impact varies significantly from project to project*
NA *:impact on performance measure not applicable to design feature*

The following conclusions were drawn regarding the impact of mix design on the performance of the SPS-2 test sections (Dufalla and Senn 2021):

- A **lower paste volume** was observed to improve the performance of test sections with respect to **cracking** and **roughness**. A significant difference in performance was not observed with respect to faulting.
- A **lower water to cementitious materials (w/cm) ratio** was observed to improve the performance of test sections with respect to **cracking**. A **higher w/cm ratio** was observed to improve the performance of test sections with respect to **roughness**. A **midpoint w/cm ratio** was observed to improve the performance of test sections with respect to **faulting**.
- A **higher total cementitious materials content** was observed to decrease the performance of test sections with respect to **roughness** and **faulting** but improve performance with respect to **cracking**.

The impact of traffic, climate, distress, and maintenance on pavement performance was challenging to quantify. The following was found (Punnackal and Senn 2021b):

- **Traffic** was found to be the most influential project-specific factor. With a few exceptions (Nevada, Michigan, and Ohio), test sections with higher traffic loading deteriorated faster than test sections with lower traffic loading.
- Concerning **climate**, test sections in non-freeze climates deteriorated more quickly than those in freeze climates, and test sections in dry climates deteriorated more quickly than those in wet climates. However, this trend was biased in that the sites with heavier traffic loading were in non-freeze climates and the sites with minimal traffic loading were in wet climates.
- The common thread between the **distress** and **maintenance** analyses was that pavement performance, in terms of mean roughness index (MRI), was immediately affected by the presence of potholes or the extensive repair of potholes, along with longitudinal and transverse cracking. Scaling, polishing, and map cracking did not have a consistent impact on MRI.

Additionally, the estimated beneficial impact on service life was assessed for four design factors (Table 4). The design factor with the greatest impact on service life was pavement thickness, followed by base type, PCC strength, and lane width. The relative service life benefit from design factors was significantly reduced in projects with lower traffic loading. Since traffic loading is a primary cause of pavement deterioration, lower traffic loading typically means longer service life. Therefore, the benefit from design factors in further extending that service life would take longer to manifest (Punnackal and Senn 2021c).

A survival analysis was conducted comparing the survivability of the SPS-2 test sections to that of SPS-1 test sections (Figure 10). As stated previously, the SPS-2 test sections have a PCC layer ranging from 8 to 11 in., a base layer thickness of 6 to 11 in., and a minimum traffic loading greater than 200,000 ESALs per lane per year. The SPS-1 test sections have an AC layer ranging in thickness from 4 to 7 in., a base layer thickness of 8 to 16 in., and a minimum traffic loading greater than 100,000 ESALs per lane per year. Despite the much higher traffic loading and thinner average base layer thicknesses of the SPS-2 test sections, over 60% of those sections had survived as of 2022. In comparison, all SPS-1 test sections were out-of-study by 2018.

Table 4. Summary of the impact of design factors on service life

Design Factor	Relative Service Life Improvement	
	Regular Traffic	Lower Traffic
Thick Pavements	4 years (15% to 20%)	2 years (10% to 15%)
PATB Base Type	2 years (10% to 15%)	<0.5 years
High-Strength PCC	1 to 2 years (10%)	<0.5 years
Widened Lanes	<0.5 years	N/A

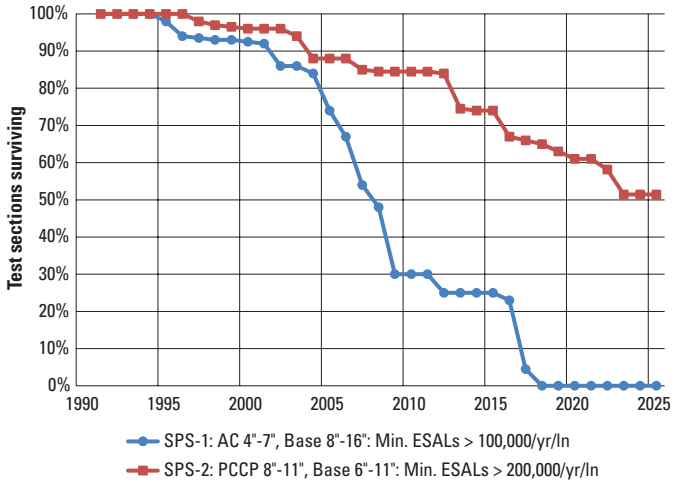

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Figure 10. Survivability of SPS-1 versus SPS-2 test sections

Concluding Remarks

The LTPP SPS-2 experiment, which began in the early 1990s, represents the most comprehensive concrete pavement dataset in the United States. Due to the age of the test sections and the fact they were in relatively good condition, a pooled fund study (TPF 5-(291)) focusing on pavement preservation was initiated in the 2010s. As part of this pooled fund study, 14 successful SPS-2 Tech Days have been held, facilitating knowledge sharing and providing a setting where additional analyses beneficial to the pavement community could be identified and conducted. This led to an array of additional studies and other project activities, as detailed in the list of reports provided in this MAP brief.

It is recommended additional Tech Days be considered, given many SPS-2 projects are still telling their stories. Given the successes of the SPS-2 experiment, consideration should also be given to additional long-term monitoring experiments and to continued monitoring of all existing test sections through the end of their performance lives.

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