# SPS-2 Pooled Fund Opportunities

## 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. 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**

| | 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. 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. 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 and the structural sections vary within the experiment, 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. 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. In 2001 an analysis of the early results of the material properties were evaluated for specimens up to 500 days in age. 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.