SHRP2 PERFORMANCE SPECIFICATIONS FOR RAPID RENEWAL (R07) PEER EXCHANGE, MONTGOMERY, AL

TO	Jennifer Balis, Richard Duval, Evan Rothblatt, Pam Hutton
COPY	Sam Rosenblum
PREPARED BY	Natalia Martinez and Lee Gallivan
MEETING DATE	Nov. 5-6th, 2015
LOCATION	Bureau of Materials and Tests, Montgomery, Alabama

Purpose

The SHRP2 *Performance Specifications for Rapid Renewal* (R07) Peer-to-Peer Exchange was intended to be an open exchange of current practices and lessons learned in performance specifications between states currently using the SHRP2 product. The goal was to present the latest techniques, discuss the benefits and challenges of using performance specifications and to provide suggestions to improve the AASHTO SHRP2 process and the performance specifications technology.

Attendees

- American Association of State Highway and Transportation Officials (AASHTO) – Evan Rothblatt, Associate Program Manager, Materials
- Federal Highway Administration (FHWA) – Jennifer Balis, Project Manager; Richard Duval, Construction Research Engineer; Brian Hogge, Assistant Division Administrator, Alabama Division; Kristy Harris, Program Analyst/Pavement and Materials, Alabama Division
- Alabama Department of Transportation (ALDOT) - Ron Baldwin, Chief Engineer; Lyndi Blackburn, Assistant State Materials and Tests Engineer; John Lucas, Specifications Engineer
- Maine Department of Transportation (MaineDOT) - Derek Nener-Plante, Pavement Design/Quality Engineer; Bruce Yeaton, SHRP2 Coordinator
- Missouri Department of Transportation (MoDOT) - Bill Stone, Research Administrator; Daniel Oesch, Field Materials Engineer
- North Carolina Department of Transportation (NCDOT) - Jack Cowsert, State Materials Quality Engineer
- Vermont Agency of Transportation (VTrans) - Bill Ahern, Research Program Manager; Mark Woolavar, Construction Paving Engineer; Mike Fowler, Pavement Design Engineer
- CH2M HILL – Lee Gallivan, Consultant; Natalia Martinez, Associate Manager, Marketing and Communications

Invited Guests:

- Dr. Shreenath Rao, Principal Engineer and Research Group Leader, Applied Research Associates (ARA)
- Dr. Steve Gillen, Deputy Program Manager, Materials Manager, Illinois Tollway Authority
- Dr. Richard Kim, Professor, North Carolina State University
- Dr. Nelson Gibson, Materials Research Engineer, FHWA
- Sharleen Smith, Facilitator, Troy University

Executive Summary

The SHRP2 *Performance Specifications for Rapid Renewal* (R07) product was established to advance the development of performance specifications across the country. Through the Implementation Assistance Program (IAP), administered by FHWA and AASHTO, Alabama, Maine, Missouri, Pennsylvania and Vermont receive support to implement this SHRP2 product. To help support the individual state activities, a two-day Peer-to-Peer Exchange was organized and held in Montgomery, AL to further the development of the program not only within the participating states, but nationally. All but one IAP state – Pennsylvania – participated in the Peer Exchange.

It was reported during the Peer Exchange that most of the states were not aware of the SHRP2 guidance documents and/or the details contained within. The guidance documents referred to include:

- *Performance Specifications for Rapid Highway Renewal* (Report S2-R07-RR-1)
- *Strategies for Implementing Performance Specifications* (i.e. *Guide for Executives and Project Managers* Report S2-R07-RR-2)
- *Framework for Performance Specifications* (i.e. *Guide for Specifications Writers* Report S2-R07-RR-3)

It was suggested that additional efforts by FHWA/AASHTO are needed in marketing the information, such as a checklist for the development of performance specifications and webinars. Opportunities for further advancing the program are contained in the brainstorming session in the appendix.

The Peer-to-Peer Exchange was successful in creating opportunities for the transportation agencies and invited guests to openly discuss the experiences and challenges each were having regarding the development of performance specifications within their respective states. A facilitated brainstorming session was effective at eliciting detailed feedback from participants on the R07 program, ranging from suggestions for improving the product to ideas of what transportation agencies really need to advance *Performance Specifications for Rapid Renewal* in their respective states. For example, participants said in order to advance performance specifications, they need documented examples of the benefits of shifting from method to performance specifications, and a simple, easy-to-read flow diagram illustrating the implementation of performance specifications. They also need support and buy-in from agency management. The complete responses of the brainstorming sessions are included in the appendix.

Each state provided a summary of their efforts including challenges to implement performance specifications. All participating agencies indicated the need for additional support from AASHTO to help advance *Performance Specifications for Rapid Renewal*, however, it was acknowledged that each state has their own institutional issues to address. AASHTO is limited in what they can do since the process to develop specifications varies by state. All of the presentations have been made available on the SHRP2 website for downloading.

It was suggested that Peer-to-Peer Meetings, such as this one, could be of assistance in addressing some of the institutional issues within each of the states. CH2M HILL can provide a boiler plate agenda and provide necessary information for such opportunities. Additionally, participants recommended further marketing efforts such as the development of a flowchart, videos, a whiteboard, webinars, and information on shadow specifications and state efforts in expanding *Performance Specifications for Rapid Renewal* beyond pavements.

During the Peer Exchange, there were several presentations about the development of performance mixture design programs for asphalt materials, which were very helpful in explaining the status of the *Performance Specifications for Rapid Renewal* product and the developing opportunities for states. Dr. Steven Gillen, from the Illinois Tollway Authority, and an agency consultant, provided real time experiences regarding the development and implementation of performance specifications. To help participants further understand points brought up

during Gillen's presentation, after the meeting FHWA shared the draft report, entitled *Implementation of JPCP PRS by State Highway Agencies: Volume III—Development of a Shadow Performance-Related Specification for Illinois Tollway* (FHWA Contract No.: DTFH61- DTFH61-08-C-00029).

The summary evaluations illustrated a marked improvement (131 percent) regarding knowledge of the R07 program. Before the exchange, the mean score of participants' knowledge level was 6.36 percent, compared to 8.36 percent after the exchange. It's clear from the results of the meeting evaluations, that the Peer Exchange helped participants gain a better understanding of the *Performance Specifications for Rapid Renewal* product. The full evaluation report and the responses to all of these questions are included in the appendix. To help address many of the issues brought up during the Peer Exchange, a subsequent Peer-to-Peer Exchange is being tentatively planned for Vermont in the fall of 2016.

Overview of Peer Exchange

The two-day *Performance Specifications for Rapid Renewal* Alabama Peer Exchange was attended by 22 representatives, most of whom represented transportation agencies currently implementing the R07 product. The intent was to promote the exchange of experiences and challenges using the SHRP2 *Performance Specifications for Rapid Renewal* product.

On the first day, national experts Richard Duval, FHWA and Lee Gallivan, CH2M HILL provided an overview on the SHRP2 *Performance Specifications for Rapid Renewal* program and established the baseline definition for performance specifications. Representatives from Vermont, Missouri, Maine, Alabama, and North Carolina then presented their experiences with this SHRP2 product and responded to questions from their peers. The day also included a brainstorming session facilitated by Sharleen Smith from Troy University. The brainstorming session allowed participants to share thoughts on what has worked well and what hasn't, what agencies need to advance *Performance Specifications for Rapid Renewal*, lessons learned, how to improve this SHRP2 product, and ways to better market the program.

The second day featured a presentation about the Illinois experience using *Performance Specifications for Rapid Renewal* for concrete pavement construction along the Illinois tollway by Dr. Steven Gillen, Illinois Tollway Authority, and Dr. Shreenath Rao, Applied Research Associates. The day concluded with two presentations by researchers. The first, by Dr. Richard Kim, North Carolina University, presented on Performance Specifications for Asphalt Materials Mixture Designs, and the second presentation was given by Dr. Nelson Gibson, FHWA, about Performance Based Mix Designs. The interactive format allowed for open discussions, revealing similarities among the issues/challenges facing the implementation of *Performance Specifications for Rapid Renewal* within the states and providing helpful observations and possible solutions.

Summary of Presentations

The following are some key points from each presentation. The meeting was opened by Ron Baldwin, Chief Engineer, ALDOT; Brian Hogge, Assistant Division Engineer, FHWA, Alabama Division Office; and local host, Lyndi Blackburn, Assistant Materials Engineer, ALDOT.

Richard Duval, FHWA, SHRP2 *Performance Specifications for Rapid Renewal* Presentation

- Performance specs tend to give more control to contractor. They allow for innovation. State will create criteria but they will expect contractor to perform.

- Challenge – conventional approaches to highway construction use prescriptive requirements and place burden/risks on owners.
- Specifications have different risk profiles. Risk is an important part of performance specs. A DOT should not assume all the risk, but share the risk with your contractor and this is how performance specs help.
- Performance specs represent progression toward increased use of higher level acceptance parameters that are more indicative of how the finished product will perform over time.

Lee Gallivan, CH2M HILL, Performance Specifications Product and Purpose of Peer Exchange

- The Implementation Guidelines for *Performance Specifications for Rapid Renewal* were written for 52 entities but each state will need to customize/modify them to their specific needs.
- The original definition of Performance Specifications came from TRB's *Glossary of Transportation Construction Quality Assurance Terms: Sixth Edition*. In order to fix the process, it's important to understand what Performance Specifications are, and where they originated from.
- *Performance Specifications for Rapid Renewal* includes method specs, end result specs, performance related specs and performance based specs. There are key differences between performance related specifications and performance based specifications. These specifications can also include quality assurance and warranty concepts. Some states don't use warranties. There is a way to address that in states that have legal issues with warranties.
- Materials and Methods Specifications are sometimes called recipe specifications, or prescriptive specifications. These are specifications that require the contractor to use specified materials and specific types of equipment and methods to place the materials. Each step is directed by a representative from the transportation agency.
- End Result Specifications requires contractor to take entire responsibility for supplying a product or an item of construction. Some products are applicable to End Result Specifications.
- Quality Assurance Specifications are specifications where the final acceptance of the product is based on a statistical sampling of the measured quality level for key quality characteristics. This is a process by which a state can get better product and contractors get more money because they know what they're trying to do and make that additional work. It does work.
- Performance Specifications describe how the finished product should perform over time. How do we want this to perform in 15 years? We need to have an idea of what we're talking about. This should address the needs of the overall opportunity. Suggest specifications, warranties and guarantees as a way to do that.
- To implement *Performance Specifications of Rapid Renewal* use the *Framework for Developing Performance Specifications Guide for Specification Writers*. This covers eight elements needed for performance specifications. You will need to understand where you want to go. You will also need to know these items to make the decision on which performance specification language is best for you.

Bill Ahearn, VTrans, Vermont State Experience/Lessons Learned

- Initially, VTrans had a mixed spec with both prescriptive and weak performance components and limited acceptance criteria. Specs moved across all areas but none of them well. So, the group came up with key areas to discuss: Risk assignment, execution, enforceability practicality and certainty of success. Risk assignment became the key issue. Execution of the work is an issue on our current spec. VTrans didn't have a clearly defined acceptance criteria. We said how to do it and what you would do it with.
- VTrans wrote a specification because we were trying to transfer some of the responsibility to the contractor. We prescribed a design strength, defined the site investigation methods, and compaction requirements. VTrans got some very poor performances in some cases using this approach. Public outcry was rapidly worsening. Over the past winter, four years later, the International Roughness Index (IRI) was over 300 and resulted in suspension of use for the technology in VT.

- All had the same spec, but they weren't within the project or across the profile. The one we used initially was the one that had worse correlation and it did not work.
- Performance parameters considered included capacity, uniformity, durability, safety and comfort.
- Uniformity actually became one of our performance criteria.
- VTrans changed the process and revised the design method. We became more prescriptive in some cases. We transferred design to VTrans and established field feedback techniques to compress timeframe and provide timely feedback. Prescriptive equipment standards for moisture control were required.

Bill Stone, MoDOT, Missouri State Experience/Lessons Learned

- Developing model specification for section 200 (grading) of the MoDOT spec book.
- Pilot project selected to incorporate into R07 research – route 141, St Louis County.
- IC Results from Route 141 pilot testing – this pilot project incorporated a quality management plan. For every nuclear density test, we completed a quality assurance on one of those points. This effort resulted in a higher competence level to reduce the subsequent number of quality assurance tests.
- Incorporated quality management – all of our projects now have quality management plan. There is a quality manager who must be on site.
- In 2014, we had an Intelligent Compaction (IC) workshop and equipment demonstration. At the workshop, various contractor's made presentations. Caterpillar and Hamm Roller were there and we had a Trimble equipment demonstrations. There were 60 attendees at the workshop.
- Proof of Concept IC project (4 day test) – route 63. The project used 2 breakdown rollers and a finish roller as well as the MOBA Infrared scanner. Collected all the data. Contractor said they really liked it. We received data from this proof of concept. Had issues with data – format didn't work for us. That was a setback for us.
- R07 Proposal to develop Performance Specs: developed IC Specs team. IC specs will include: soil-base compaction, asphalt compaction, asphalt mix design-new. MoDOT will solicit a consultant to develop specs and incorporate into our standard procedures. We need to develop data management process/protocols for IC data. We have identified 10 projects for the IC work. We need further education on benefits/processes. Our chief engineer is extremely interested in this.
- MODOT is interested in adding Performance Mixture Designs to the R07 program. A Request has been submitted to FHWA.

Derek Nener-Plante, MaineDOT, Maine State Experience/Lessons Learned

- HMA Performance Specs: Maine has been doing Performance related specs for over 15 years. HMA is accepted based on QA spec with PWL related to measures: VMA, Voids, Asphalt Content, and density.
- We have additional specs, such as ride specifications on high priority roadways.
- Current initiative to gain durability has not been achieved with the current process. We are looking to improve performance by using performance based specs. The measures aren't discerning between good and mixed performers at this time.
- We have erosion of our pavement down to the underlying layers. But they still passed based on all the measures.
- Starting a phased-in implementation.
- What we've learned: slow getting into it. Getting industry buy-in is important. Shadow specs were instrumental. We put a lot of stock in QC plans and QC activity by the contractors and we hold them to it. We have stiff QC violation penalties – you tell us how you're going to control your process and we're going to hold you to it.
- Finding the right measures is challenging, we have at times used a good pay factor that buys a poor product. We don't want to incentivize contractor to give us something that fails.

- Demonstration IC and IR Projects in 2015. Data collected needs to be analyzed. Need training in beta data analysis. Analyzing data has been a challenge.
- Barriers to performance specifications implementation: IC and IR technologies are complex. How are values calculated? Some contractors view some of these technologies as a black box. More difficult for smaller contractors. Worried that some of these new things will drive smaller contractors out of business. For HMA mixes – contractors don't have APA, Hamburg, MIST device, or AMPT devices and for Concrete – contractors need to validate GPR results.
- Goals: pilots for IR/IC, shadow testing for mix performance. In the long term, we are looking at more advanced performance mix design.

Lyndi Blackburn, ALDOT, Alabama State Experience/Lessons Learned

- Our experience with performance specs – semi performance, structural/concrete. Looking to become more soil cement-base oriented.
- Our mix designs require an APA.
- With our *Performance Specifications for Rapid Renewal* project, many steps had to get into place before we could implement performance-based specs.
- We have a lack of experience in people who can write performance specs within the Alabama DOT. We want to tell the contractor exactly what to do. I try to explain that if we tell the contractor exactly what to do, we take on all the risk. If something goes wrong, we have to fix it.
- There is lack of true predictive testing for long term performance. Difficult to implement performance specs when you're still testing at the same time.
- Getting buy-in from others – both up the ladder and down the ladder – is difficult. Huge issue for us!

Jack Cowsert, NCDOT, North Carolina State Experience/Lessons Learned

- Has some performance measures but pavement design methods and minimum criteria requirements are specified in contract documents.
- There is a minimum pavement condition that must be met by the contractor.
- QC testing methods and frequency by DOT is similar to normal DBB projects.
- In 2017, we will try to get some shadow specs in a contract.

Dr. Steven Gillen, Illinois Tollway Authority & Dr. Shreenath Rao, Applied Research Associates, Illinois Tollway Use of Performance Specifications

- Performance-related specs help improve quality and life of roadways – by putting more emphasis on good workmanship and consistency and revising aggregate concrete, life of roadways will improve dramatically.
- Specifications have different risk profiles. To transfer risk from agency to contractor. Agency's risk goes down as you move towards performance specs but there is a price to pay for that.
- Shadow Performance Specs – develop and evaluate like full implementation, does not impact contractor pay for the shadow project. Point is to test process and to see how process will work and to fine tune implementation.
- Shadow implementation is a learning and pre-implementation tool.
- Performance specs applied to larger concrete paving projects starting in 2015 – project would have at least 10 sublots. Will be evaluated and determined by Tollway. Pay factors will be different by corridor (different designs for different portions of the tollway). Performance is relevant to your design.
- Performance specs means you have to figure out some kind of model – how do I construct it and how will it perform in the future?

- Steps for implementation of performance specs:
  1 – conduct project coordination meetings: select location, gather info, develop sampling, testing plan.
  2 – collect and analyze historical data: AQCs, M&R criteria
  3 – develop and evaluation pay factors: PaveSpec, software designed to help agencies develop and demonstrate performance-related specifications for jointed plain concrete pavements.
  4 – prepare for implementation on project: layout of lots & sublots, sampling and testing details
  5 – develop special provisions
  6 – conduct field sampling and testing: database management, dispute resolutions
  7 – evaluate PRS results: incentives/disincentives for each lot

Dr. Nelson Gibson, FHWA, Performance Based Mixed Designs

- Project objective: document performance changes with variations in volumetric proportions of a fixed set of component materials. Test them in lab and predict performance; provide tools and guidance.
- Figure out "where you are". The current network performance from pavement management systems (PMS). Pavement life to cracking, pavement life to rutting.
- Figure out "where you want to go". Establish a new criteria if you need to. Represents desire to increase pavement life by X number of year or improve performance by certain percentage.
  Example: I think our state's mixes are dry. How do I increase binder content?
- Figure out "how to get there". Adjust mix designs as necessary to meet your targets.
- Developed performance rules-of-thumb for mix design volumetric targets
  - Rutting and cracking performance trends are inversed. In other words, changes to mixes that improve rutting have the effect of hurting fatigue cracking and vice-versa
  - Every 1 percent increase in VMA mix design target decreases cracking by 73 percent and increases rutting by 32 percent
  - Every 1 percent increase in Air Void mix design target increases cracking by 40 percent and decreases rutting by 22 percent
  - Better compaction in the field by every 1 percent results in 19 percent decrease in cracking and 10 percent decrease in rutting
- Expanding the data set with mixtures from WesTrack that will provide a second dense graded mix and one fine graded mix; the same rules-of-thumb described above will be reexamined to determine how universal the trends are. This will finalize the recommendations for generic rules for performance based mix design.

Dr. Richard Kim, North Carolina University, Performance Specifications for Asphalt Materials Mixture Designs

- Challenges in PRS Acceptance – testing has to be simple and efficient. Can't run single mix for a month. This has been completed thanks to FHWA's involvement.
- Test methods must be standard.
- Reliable performance prediction models – we are penalizing contractors and we can't use just index properties. It has to be based on performance, so models to predict that performance should be reliable and have scientific basis.
- Predictive relationships between AQCs and performance prediction model parameters.
- Same principles and methods between mix design and PRS. Mixes have to be designed using same principles they will be evaluated.
- Performance Based Mixed Designs Laboratory Tests – All together, it will take about 11 specimens and 3.5 days.

- Just need to run a few tests to get a few material relationships and estimate everything else in other conditions.
- Pavement performance prediction – Layered Viscoelastic Continuum Damage (LVECD) program currently under alpha testing.
- Validation/Calibration Project III – RAP Pavements, in the field 50 percent Rap, soft binder didn't make any difference.

Richard Duval, FHWA, Comments Following Peer-to-Peer Exchange

In response to feedback provided from states during the Alabama Peer Exchange, Richard Duval, FHWA, provided the following comments about what FHWA is looking for from states when considering Performance Specifications for Asphalt Materials Mixture Designs:

- Performance Specifications for Mix Designs is evolving through FHWA research and is ongoing. It is anticipated that the first steps a state transportation agency should undertake include becoming proficient in Asphalt Mixture Performance Tester, instituting the collection of data on projects and conducting shadow projects. Data collection is necessary to better understand the technology which is to be used in addition to the standard volumetric testing protocols in asphalt pavement mix designs, to become proficient in AMPT testing, and to better understand the results of such testing. This is not a calibration but a starting point to develop a historical and knowledge-based database of performance using AMPT and the standard SUPERPAVE volumetric testing.
- From this, a state transportation agency can then develop their initial Acceptable Quality Characteristics (AQC). The introduction of fatigue and rut testing by the AMPT (note some DOT's will want to use rut testers which are not predictors of long term pavement performance and are not part of Performance Related Specification models for pavements) may be different than what they are currently using. The key is that the Performance Mix Design will determine/provide with more certainty whether the pavement will perform for the entire pavement design life. With this data available, states could then start implementing the process into their mix design procedures and future performance specifications for higher quality and final acceptance of pavement.
- It was suggested that the states need to go back and look at their entire highway program for considerations when updating Performance Specifications. They need to address the 'low hanging fruit' first to advance the program.
- States need to initiate shadow projects first to gather the data to begin conversations with industry. Having data in hand could then lead to changes working with contractors on performance specifications.

Facilitated Agency Brainstorming Session

Six questions were identified where feedback was needed to further advance the SHRP2 *Performance Specifications for Rapid Renewal* product. The brainstorming session fostered a rich discussion among state participants and consultants. The full list of responses are documented in the appendix. Below is a snapshot of some of the most pertinent responses from the Brainstorming Session:

- **What has worked well and what hasn't worked well?**
  Worked well-
  - Developing a bridge between theory and practice – need meaningful specs
  - Shadow specs with incentives/disincentives to prove concept to industry
  - R07 research provides a starting point

  Not well-
  - Writing performance specifications
  - Doing the same thing we've always done and expecting different results

  - Agency culture and change philosophy – hard to change institutional and believed knowledge
  - Lack of knowledge across all parties (agency & Industry) that is needed for buy-in
  - Interpreting IC data from the field
- What do agencies really need to advance performance specifications?
  - Project specific published successes (performance related)
  - Having to invest in specs development, testing resources and equipment
  - Realizing economic benefits of Performance Related Specifications
  - National support from AASHTO – having example specs, and experts to call
  - Fresh and clear marketing tools for national consumption
- Lessons learned to date from the SHRP2 Program?
  - There's a whole lot more learning to be had
  - Getting started/one bite at a time
  - Realization that all agencies have similar problems with implementation and we can build off other's experiences
  - Need buy-in from management that leads to support and commitment
  - Can be used for many other areas besides asphalt pavements
- Advancing specification development and what is really needed?
  - Support from all players (management) in the agencies
  - The use of national experts or champions in shepherding the development of the specifications
  - Agency willingness to make the changes to develop and then review and advance the specifications
  - An agency champion that can accomplish success
  - Willingness to reach out for advice from others with the expertise in developing performance specifications
- How to improve performance specification products?
  - Need more details without having to read the full document; Need easily digestible information with key elements to developing performance specifications
  - Need documented examples of the benefits from the shift from method to performance specifications
  - Need readable/simple/understandable flow diagram regarding the implementation of performance specifications
  - Need Life-cycle cost analysis is selling point to agency management
  - Need phasing in *Performance Specifications for Rapid Renewal* with low hanging fruit
- Marketing materials and what is needed to better market the program?
  - Webinars, videos of highlighted case studies
  - Develop a checklist for the development of performance specifications
  - Future workshops with case studies
  - Marketing materials to target incentives to states
  - Better fact sheets
  - Include industry in showcases and events so they can understand the benefits
  - Case studies/examples of success
  - Tech briefs targeted to the development, implementation, excitation, and analysis of *Performance Specifications for Rapid Renewal*
  - AASHTO to provide additional support to included internal peer-to-peer meetings
  - Need additional SME support to facilitate agency meetings

Appendix A – Detailed Notes of Presentations and Comments

The following are detailed notes from the Alabama *Performance Specifications for Rapid Renewal* Peer Exchange.

Welcoming Remarks

- Welcome from Ron Baldwin, ALDOT: Welcome to Alabama. Thank you for what you're doing. Very hopeful you'll be successful because I think we need it.
- Brian Hogge, FHWA: Excited to see this occurring now. Something I pushed for a long time ago when I was with the CT DOT. There was an issue with control – not wanting to trust the contractor. Now we're learning that if we can write the specs correctly it can work out.
- Lyndi Blackburn, ALDOT: Moving into SuperPave and taking off in that direction was painful. Everybody loved their Marshall mixes but we refined all of that a good bit and we have good technology and know what we're doing. Got the industry geared toward quality assurance and how performance specifications might work. I'm the assistant state materials and test engineer. Been in this position for 10 plus years now. We have a huge gap at ALDOT. I have the most experience with asphalt pavements here at the AL DOT and I've only been dealing with that for 10 years. I'm excited to hear the discussions.

Richard Duval, FHWA, SHRP2 Performance Specifications for Rapid Renewal Presentation

- SHRP2 is a partnership between AASHTO and FHWA.
- SHRP2 is about saving lives, saving money, saving time. The products were developed from credible research. There are more than 275 SHRP2 projects nationwide. They include solutions that respond to transportation community challenges. We recognize institutional challenges out there and how you phase in performance specifications. Can take time to get industry to accept it.
- Performance specs tend to give more control to contractor. They allow for innovation. State will create criteria but they will expect contractor to perform.
- Challenge – conventional approaches to highway construction use prescriptive requirements and place burden on owners.
- When we're working with states I see a lot of getting to that end result, but really not getting into performance. If you have good quality assurance in organization, than moving to PRS may not be that big of a deal.
- Specifications have different risk profiles. Risk is an important part of performance specs. You're going to share the risk with your contractor.
- Performance specs represent progression toward increased use of higher level acceptance parameters that are more indicative of how the finished product will perform over time.
- They attempt to shift performance risk to contractor in exchange for limiting prescriptive requirements related to selection of materials, techniques and procedures.
- By relaxing requirements, performance specs have the potential to foster contractor innovation and improve the quality of economy.
- Various performance specs research products available, final research report. Highly recommend you look at them, especially *Developing and Drafting Effective Performance Specifications: A Guide for Specification Writers*. Can print PDF from website.
- *Implementation Guidelines* is helpful. Offers rationale for using performance specs, industry considerations, etc.
- Implementation Strategies: promote decision support guide for performance specs, provide peer technical support, maintain library of applied research.

- FHWA Work to Date on Pavements: SHRP2 R07 implementation, helped develop performance specs framework; Implementation of Jointed Plain concrete Pavement Performance Related Specs by State Highway Agencies; Hot Mix Asphalt Performance Related Specs.
- SHRP2 R07 is looking at performance specifications as a whole and not just pavements even though the current research is focused on pavements. States may be using performance specification in other areas of highway construction currently. Furthermore, the SHRP 2 R07 tools can help implement performance specification in other items of work for highway design and construction.
- Current FHWA research is "Developing and Deploying Performance-Related Specifications for Pavement Construction". That's where FHWA is now. Working with various organizations and universities on this.

Lee Gallivan, CH2M HILL, Performance Specifications Product and Purpose of Peer Exchange

- Quality is key.
- The Implementation Guidelines were written for 52 entities but you will need to customize/modify them.
- Origin of performance specifications definitions – TRB glossary of transportation construction quality assurance terms – 6th edition.
- Includes method specs, end results, performance related and performance based. Key difference between performance related and performance based. Also includes quality assurance and warranty. Some states don't use warranties. There is a way to address that in states that have legal issues with warranties.
- Materials and Methods Specifications – recipe specs, or prescriptive specs. Specifications that require the contractor to use specified materials and specific type of equipment and methods to place the materials.
- Each step is directed by a rep from the transportation agency. The agency is willing to accept whatever comes out the back door. You don't have a choice.
- End Result Specifications – requires contractor to take entire responsibility for supplying a product or an item of construction. Some products are applicable to End Result.
- Quality Assurance Specifications – final acceptance of product is based on statistical sampling of the measured quality level for key quality characteristics. Process by which state can get better product and contractors get more money because they know what they're trying to do and make that additional work. It does work.
- Performance Specifications – describe how finished product should perform over time. How do we want this to do in 15 years? We need to have an idea of what we're talking about. Address the needs of overall opportunity. Suggest specifications, warranties and guarantees are a way to do that.
- One of the reasons the industry didn't jump into performance specs is because there hasn't been suitable nondestructive tests to measure long-term performance immediately after construction. They have been used for some products – highway lighting electrical components, etc.
- Performance-Bases Specifications – describe desired levels of fundamental engineering properties – resilient modules, creep properties and fatigue properties. We're not there yet.
- Performance-related Specifications – describe desired levels of key materials and construction quality characteristics that have been found to correlate with fundamental engineering properties that predict performance. Agencies have reasons and tools to make decision.
- Warranty Specifications – guarantees integrity of a product and assigns responsibility for repair or replacement of defects to the contractor. Not universally used but another tool in your tool box. Most states have used or are using short term performance – 5-10 years.
- Performance Specifications Continuum:
  End results are based on current timeframes, not future timeframes.
  There is debate about where end results should fall on the continuum.
- In general, these specs types represent progression toward increased use of higher level of acceptance parameters that are more indicative of how finished product will perform over time.
- They all attempt to shift performance risk to contractor in exchange for limiting prescriptive requirements related to selection of materials, techniques and procedures.

- By relaxing requirements, this fosters contractor innovation and improve quality or economy or both of the end product.
- Our product is for the user and we should keep in our specs that we understand that we work for the user.
- Advantages and Disadvantages of Performance Specifications: promote contractor innovation, contractor assumes more performance risk and have flexibility to select materials, techniques, etc. All performance specs can provide more rational mechanism for adjusting payment on the basis of quality or performance. By which you can utility incentives and disincentives.
- Disadvantages: The agency can exert less control, opportunities for smaller, local construction firms may be reduced; identifying all parameters critical to performance can be challenging.
- Performance specs can also serve as a worthy adjunct to other management philosophies, such as lean construction. They eliminate unnecessary and non-value-added requirements.
- Interactive "test" with participants asking them to identify what each example is. Method, End Result, Performance Specifications or Combination?
- What's missing? Need to have independent testing of construction operations that represents performance of roadway. No single test exists today.
- Advances that allow for key materials and construction quality characteristics that have been found to correlate with fundamental engineering properties. Not there yet for performance based tests. Advances in SHRP2 products can now be used.
- Implementing Performance Specifications: It's hard. Use the Framework for Developing Performance Specifications Guide for Specification Writers. Covers 8 elements needed for performance specs. Need to understand where you want to go. Need to know these 8 items to make that decision on performance specification language.

Bill Ahearn, Vermont Transportation Agency, Vermont State Experience/Lessons Learned

- On the road to performance – we convened our stakeholders. They generally agreed on what the issues were. Confirmed the issues. Highlight a few changes. Coalesce engineers on high priority change.
- Initially, VTrans had a mixed spec with both prescriptive and weak performance components and limited acceptance criteria. Specs moved across all areas but none of them well. So, the group came up with key areas to discuss: Risk assignment, execution, enforceability practicality and certainty of success. Risk assignment became key issue. Execution of the work is an issue on our current spec. Did not have a clear and well defined acceptance criteria so we said how to do it and what you would do it with.
- Wrote specification because we were trying to transfer some of the responsibility to the contractor so we prescribed a design strength. Defined site investigation, method, compaction requirement. What we got out of that were some very poor performance in some cases. Public outcry at rapid worsening. Our winter IRI four years later was over 300. This resulted in suspension of use for technology in VT.
- Our project testing ended up with strengths over 1000 -1500 PSI where we were targeting 300.
- All had the same spec, but they weren't within the project or across the profile. The one we used initially was the one that had worse correlation and it did not work.
- Performance parameters – capacity, uniformity, durability, safety and comfort.
- Uniformity actually became one of our performance criteria.
- Process has changed. Revised design method. We became more prescriptive in some cases. Transferred design to VTrans. Established field feedback technique to compress timeframe and make it timely feedback. Prescriptive equipment standards for moisture control.
- Discussion led us to talk about performance survey.
- Contractor control of construction still opportunity area.

- Made changes based on what we thought will help but still have ways to do – incentive/disincentive pay system being evaluated; 3-day QC data supplied to contractor; revised supplemental materials with design accommodations.
- Reexamine density targets and frequency; address moisture relationships.
- Seeking input on how far we can go and how fast we can get there; independent layer reactions; revised design objectives (wearing, binder and base course response); durability performance measures (accelerated tests, indirect indices-cure strain measurement; by layer).
- When we looked at durability we don't have a test that works. How are you looking at durability?
- Steve Gillen, Illinois Tollway Authority, said they are looking at resistivity measures (measures uniformity and consistency throughout), which are critical on any cementitious materials. Bill stone, Missouri Department of Transportation, said they are doing the same in Missouri – it's quick, easy and nondestructive.
- Lyndi Blackburn, ALDOT, said on my specs, I'm lacking on durability and acceptance criteria.

Bill Stone, Missouri DOT, Missouri State Experience/Lessons Learned

- Developing model specification for section 200 (grading) of the MODOT spec book.
- Pilot project selected to incorporate into R07 research – route 141, St Louis County.
- We were concerned we might not get the right contractor. This project had a good contractor. Worked with Dr. White/SHRP2 team to get some rollers out there. Contractor said they would only use Caterpillar equipment. Availability of rollers can be challenging too.
- Test Trailer – did typical GeoTech tests. One of things we were interested in was getting rid of nuclear density gauges.
- IC Results from Route 141 pilot testing – this pilot incorporated quality management plan. For every nuclear density test, we did quality assurance on one of those points. Gave use competence level to reduce that number.
- Incorporated quality management – all of our projects now have quality management plan. There is a quality manager who must be on site.
- In 2014, we had Intelligent Compaction (IC) workshop and equipment demo. At workshop, had contractor give presentation. Caterpillar and Hamm Roller were there and we had a Trimble equipment demo. 60 attendees.
- Proof of Concept IC project (4 day test) – route 63. 2 breakdown rollers and finish roller; MOBA Infrared scanner. Collected all the data. Contractor said they really liked it. We received data from this proof of concept. Had issues with data – format didn't work for us. That was a setback for us.
- R07 Proposal to develop Performance Specs: developed IC Specs team. IC specs will include: soil-base compaction, asphalt compaction, asphalt mix design-new. Will solicit consultant to develop specs and incorporate those. Develop data management process/protocols for IC data. We have identified 10 projects for the IC work. Need further education on benefits/processes. Our chief engineer is extremely interested in this.
- Many factors affecting mixture cracking potential – low temperatures, etc.
- Who is using mechanical tests? For the most part, we are not.
- Ultimately we are exploring what tests we can use to test performance. Looking at DCT, SCB, IDT for low temperature cracking.

Derek Nener-Plante, Maine DOT, Maine State Experience/Lessons Learned

- 3 year rotating work plan that we update each year. $2 billion, 1600 work items
- $244M for rehab and highway construction
- $213M, 714 miles of pavement preservation

- HMA Performance Specs: Maine has been doing Performance related specs for over 15 years. HMA is accepted based on QA spec with PWL related to measures: VMA, Voids, Asphalt Content, and density.
- We have additional specs, such as ride specification on high priority roadways.
- Current initiative to gain durability not achieved with current process. Looking to improve performance-based specs. All measures aren't discerning between good and mixed performers at this time.
- We have erosion of our pavement down to underlying layers. But that still passed based on all the measures.
- Starting a phased in implementation.
- Concrete Performance Specs Experience – 20 years of QA specs: permeability, air content, compressive strength, rebar cover.
- We have two R07 implementation assistance projects. The first one includes two components, HMA pavements and concrete bridge decks.
  R07 Project #1:
  Part I - asphalt pavement – IC and IR profiling systems. See great potential in those projects to use IR bar and IC. GPR profiles get 100 percent coverage on density as well as some other potential avenues here.
  Part II - Concrete Bridge Deck- Handheld Surface Resistivity Testing in the field for permeability. Compare field collected SRT to lab SRT values.
- Project #2 – The Maine Department of Transportation currently uses the SuperPave volumetric mix design system for asphalt mix designs. While SuperPave is an improvement over previous mix design methods, it does not include any testing that is predictive of the actual performance of the resulting asphalt mix, and it is also fairly prescriptive in that the agency typically specifies the design gyration level, binder grade, and gradation limits. Additionally, with recent changes such as increased use of recycled asphalt pavement (RAP), reclaimed asphalt shingles (RAS), crumb rubber, and changes to asphalt binder production, it can no longer be assumed that a proper volumetric design will result in acceptable pavement performance. MaineDOT has seen an overall decrease in pavement life in recent years, including some cases of severe pavement failures within five years of placement. A new approach to mix design evaluation is needed. The SHRP2 R07 Guide Performance Specifications describes potential tools that could be used to implement a performance-based mix design method.
- Potential performance measures include the following: Rutting potential by means of the Flow Number and Asphalt Pavement Analyzer; fatigue cracking prediction using Simplified Viscoelastic Continuum Damage (S-VECD) measurement; moisture damage potential using the Hamburg wheel tracker and the Moisture Induced Stress Tester.
- MaineDOT either owns or has access to the required equipment, and would perform testing on current mixes to develop mix design requirements for use in a future performance-based design system.
- What we've learned: slow getting into it. Getting industry buy-in is important. Shadow specs were instrumental. We put a lot of stock in QC plans and QC activity by the contractors and we hold them to it.
- We have approx. 20 years of experience with QA specs, QC/QA. Requiring contractor quality control plans gives them more control and flexibility and gives agency a way to require changes/shut downs if contractor not following the QC plan. We have stiff QC violation penalties – you tell us how you're going to control your process and we're going to hold you to it.
- Finding the right measures is challenging, have at times good pay factor buy poor product. We don't want to incentivize contractor to give us something that fails.
- Demonstration IC and IR Projects in 2015. Data collected needs to be analyzed. Need training in beta and analysis. Analyzing data has been a challenge.
- Barriers to performance specifications implementation: IC and IR technologies are complex. How are values calculated?
- We need training on both IC and IR including data management, how results are computed, and limitations.
- Smaller contractors may struggle with upfront investments of equipment such as IC and IR.

- HMA mix – contractors don't have APA, Hamburg, MIST device, AMPT.
- Concrete – GPR appears to be very accurate and consistent. However, according to experts requires some calibration process.
- Goals: pilots for IR/IC, shadow testing for mix performance. In the long term, we are looking at more advanced performance mix design.

Lyndi Blackburn, Alabama DOT, Alabama State Experience/Lessons Learned

- Asphalt pavement state. Total construction budget just under $1 billion.
- Our experience with performance specs – semi performance, structural/concrete. Looking to become more soil cement base oriented.
- Our asphalt pavement is performance related.
- In our mixed designs we require an APA.
- We do a variety of soil mill walls. Performance related. We do pullout tests, proof testing.
- R07 Performance Specs project - So many steps had to get in to place before we could implement performance-based specs.
- We've got lack of experience in people who can write performance specs within the DOT. We want to tell the contractor exactly what to do. I try to explain that if we tell contractor exactly what to do, we take on all the risk. If something goes wrong, we have to fix it.
- Lack of true predictive testing for long term performance. Difficult to implement performance specs when you're still testing at the same time.
- Buy-in by other both up the ladder and down the ladder.
- Still hunting for a decent project for performance specs.

Jack Cowsert, North Carolina DOT, North Carolina State Experience/Lessons Learned

- Total construction budget - $1.9 billion
- Mainly asphalt state – 74, 248
- Pavements budget: $474M
- I-77 projects Charlotte Express Lane
- 50 year operation and maintenance agreement
- Has some performance measures but pavement design methods and minimum criteria requirements are specified in contract documents.
- There is a minimum pavement condition that will be met.
- QC testing methods and frequency by DOT similar to normal DBB projects.
- In 2017, we will try to get some shadow specs in a contract.

Steven Gillen, Illinois Tollway Authority & Dr. Shreenath Rao, Applied Research Associates, Illinois Tollway Use of Performance Specifications

- 286 mile system comprised of four tollways
- Carries more than 1.4M vehicles per day
- User-fee system – no state or federal gas tax dollars used for maintenance and operations
- Congestion-relief program – nearly $6 billion committed. 99.9 percent complete
- Move Illinois Capital Program – Jane Addams Memorial Tollway, $2.5 Billion. Reconstructing and widening.
- Move Illinois – cleanest and greenest program in tollway's history. Minimizes environmental impact of new roadway construction by recycling existing pavements and reusing materials.

- Recycled 24,000 tons of asphalt shingles, 659,000 tons of recycled asphalt, 540,000 tons of recycled concrete.
- Performance related specs helps improve quality and life of roadways – by putting more emphasis on good workmanship and consistency, by revising aggregate concrete, life of roadways will improve dramatically.
- Specifications have different risk profiles. To transfer risk from agency to contractor. Agency's risk goes down as you move towards performance specs but there is a price to pay for that.
- Implementation of performance specs steps they took:
  Agency partnered with ARA several years ago. In summer to fall 2013, did shadow implementation. That's when we tested our procedures.
  March 2014 – presentations with Tollway Engineering to get approval to move forward with full implementation of performance specs on tollway.
  March to May 2014 – developed specification framework – who does what, what do we need to do.
  July 2014 – 1st meeting with industry to provide overview of PRS and present concept/ideas. Presented our plan.
  July 2014 – first draft of special provisions. Every word in that document is important. Will be scrutinized at legal level so it's very important.
  Fall to winter 2014 – multiple meetings revising and changing SP. Long process.
  April 2015 – Training on testing and procedures
  May 2015 to current – performance specifications in effect at tollway.
- Shadow Performance Specs – develop and evaluate like full implementation, does not impact contractor pay for the shadow project. Point is to test process and to see how process will work and to fine tune implementation.
- Shadow implementation is a learning and pre-implementation tool.
- That's what we used as the learning process to develop performance specs for tollway.
- Performance specs applied to larger concrete paving projects starting in 2015 – project would have at least 10 sublots. Will be evaluated and determined by Tollway. Pay factors will be different by corridor (different designs for different portions of the tollway). Performance is relevant to your design.
- Performance specs means you have to figure out some kind of model – how do I construct it and how will it perform in the future.
- Steps for implementation of performance specs:
  1 – conduct project coordination meetings: select location, gather info, develop sampling, testing plan.
  2 – collect and analyze historical data: AQCs, M&R criteria
  3 – develop and evaluation pay factors: PaveSpec
  4 – prepare for implementation on project: layout of lots & sublots, sampling and testing details
  5 -- develop special provisions
  6 -- conduct field sampling and testing: database management, dispute resolutions
  7 – evaluate PRS results: incentives/disincentives for each lot
- Pay Factors development steps: Pavement design (establish performance criteria), Planning (identify AQCs and target values), PaveSpec, M&R Plan, Pay Factor
- Use pay factors – incorporate pay tables into specs, followed by pavement construction sampling and testing.
- How do you select Acceptance Quality Characteristics (AQCs):
  Has to be measurable, Must correlate with performance (prediction models), Are under contractor's control
- AQCs: five AQCs were used – compressive strength, air, thickness, smoothness, dowel alignment. Each has target, rejectable level, and maximum level.
- All AQC tests must be tested with random sampling

- Levels of pavement quality – target quality level at target 100 percent pay, near target pay adjustment Rejectable quality level – point at which you don't want to give more incentives
- Maximum quality level
- Lots and sublots: lot defined as all mainline concrete. Sublot – division of a lot for testing and sampling Sublot limits marked on plans (by lane). This is where sublot starts and ends. All predefined.
- Payment is made on lot basis.
- Rejection is made on sublot basis. Sublot is small enough so that 1-2 values can be assumed to be sublot.
- Retesting outliers. Rejection means I can't live with this so I want to make sure that this is an anomaly or something. If outlier is on the positive side, then I can live with that.
- Collect historical data from tollway – means and standard deviations, etc.
- PaveSpec models: For concrete, we're looking at distresses and trying to model performance
- Pavement ME-MEPDG is really the engine behind the models. That's imputed into model.
- ISLAB2000 – rapid solution to figure out how pavement will crack, fault over time.
- PaveSpec – you have traffic, climate, structure, maintenance and rehab plan. All of it goes into PaveSpec.
- Predicts cracking, smoothness, etc. Calculate distresses.
- Why use performance modeling for PF? We need to model performance and to do that you need to know what your design is.
- Specs include what tests we're doing, how many cylinders (two cylinders per sublot).
- Standard deviation key measure, impacts strength of pay factor curve. If standard dev is lower, you get a small incentive. If your standard dev. is higher, you get about a 1 percent disincentive.
- Slab thickness – when you go down, you start seeing real effect on performance.
- In the end all the different pay factors are combined to get one pay factor.
- There are a lot of logistical issues involved – have to collect and store information. Use spreadsheet to track construction quality data. Data distributed to all through Ebuilder.
- Performance specs started with tollway concrete material specs for patching. In 2008, hundreds of long life full depth PCC patches were required on a Chicago area tollway expressway.
- CTL Group was hired to come up with solution to make them fast but long life. They suggested Performance Engineered Mixes.
- Today, developing more rapid patching mixes – accelerated HES weekend patching mixes
- Mass concrete PCC mixes for structures, HPC bridge deck/approach slab PCC mixes
- All still in place still 2008. Only one saw a crack develop.
- Started ternary black rock PCC mixes for composite pavement through our pilot project. Recycled asphalt pavement was used in this successfully.
- Performance requirements for HPC deck mixes – various test methods.
- Since 2012, 28 HPC bridge decks replaced along I-90. Many more coming this year. Only found isolated shrinkage cracks on one of the bridges. Isolated restraint cracks found on only 12 of the 28 decks. Next, want to see if we can make the specs stricter.
- Recommendations to agencies on developing PEM specs: Reach out to experts for ideas; collaborate with your local roadbuilders like road and bridge builders associations and local ACPA chapters; train field staff for testing; Most importantly, get your supply industry involved in this – develop specs through local concrete suppliers and chapter ACI group or NRMCA. Don't wait for the professors! You can do these tests now.
- Between 2014-2026, we have more than a million cubic yards of performance related ternary pavement mixes to be produced for new Chicago expressways.
- Mixes will require a minimum of 35 percent SCMs except with cold weather placements.
- Blended cements allowed in all our mixes. Washed chips critical.
- Implementation of Performance Specs on Tollway: This year, applied to nine I-90 reconstruction and widening projects with 13" JPCP. Approx. 300K square yards placed to this date.

- Results to date: all showing progress – highest pay factor was 105. Lowest was 85.
- Issues encountered or lessons learned: establishing accurate strength curve for specification is key.
- Important that you have understanding of how curve will work on particular job. We had to make modifications on the fly as project proceeded because early age was a factor.
- Allow for slight mix design adjustments to be quickly approved (within 7 days).
- Be prepared for many trial batches. Nearly 100 trial batches were done over last 5 months. They continually tweak them and try to improve them.
- Make contractor responsible for preparing and delivering compressive strength cylinders.
- Make sure agency's labs cure and test properly.
- Plan for hand pours or manual placements.
- Smoothness measurements delayed when new pavement is used as a haul road in narrow work zones.
- Don't let contractor sneak in his own QC data.
- Possibly account for cold weather placements.
- Revisions to specs: Mix design adjustments, 3-day strengths, reduced to 2500 psi
- Benefits to performance specs: cost savings have been phenomenal. Average price down to $50 a square yard on future projects. Clearer distinction in roles and responsibilities, improved quality focus. Improved and focused testing by all parties.
- Lessons learned:
  Specify most objective procedures for measuring of quality characteristics to minimize dispute.
  Be prepared for agency to be totally responsible for taking measurements on those cylinders.
  Allow for 1-3 year warranties to still be used, with promise to the industry to reduce them or eliminate them should PRS show improvements down the road.
  Shadow current projects to establish database to base future PRS quality characteristics.
- Next project: develop PRS for continuously reinforced concrete pavements

Dr. Nelson Gibson, Federal Highway Administration, Performance Based Mixed Designs

- Objective: document performance changes with variations in volumetric proportions of a fixed set of component materials. Test them in lab and predict performance; provide tools and guidance.
- Building a performance map
- Figure out 'where you are'. Current network performance from pavement management systems (PMS).
- Pavement life to cracking, pavement life to rutting.
- Figure out 'where you want to go'. Establish new criteria if you need to. Represents desire to increase pavement life by X number of year or improve performance by certain percentage.
- Example: I think our state's mixes are dry. How do I increase binder content?
- Figure out 'how to get there' Adjust mix designs as necessary to meet your targets.
- Mix designs based on 2013 FHWA ALF. At each condition, we looked at 3 compaction levels.
- If you fix your design VMA and you look at what happens if you change design air void content and change compaction air void, you help both rutting and cracking. If you decrease design air void content, you're getting a trade-off between rutting and cracking.
- If you make cracking better, you're making rutting a little worse and vice versa.
- Performance of all 21 mixes. On average, if you improve compaction by 1 percent air void yields, you get…
- For every 1 percent increase in design air void there is a 22 percent decrease in rutting
- For every 1 percent increase in design air void there is a 40 percent increase in cracking.
- For every 1 percent increase in design VMA there is a 32 percent increase in rutting and 73 percent decrease in cracking.
- These relationships can be expanded and sharpened rather than the single general rule.
  Can be defined for different pavement structural configurations.

- Utilities: adjusting mix design volumetrics before the project. Quickly adjusting expected performance due to ordinary variations in production volumetric and compaction.
- Adding WesTrack Materials – the relationships we developed are not intended to be “global”/”universal”. They are intended to be relativistic rules. You can use these rules to say, where do I want to go, how much better cracking do I want, etc.
- Checking these relationships with WesTrack materials.

Dr. Richard Kim, North Carolina University, Performance Specifications for Asphalt Materials Mixture Designs

- Challenges in PRS Acceptance – testing has to be simple and efficient. Can’t run single mix for a month.
- This has been completed thanks to FHWA’s involvement.
- Test methods must be standard.
- Reliable performance prediction models – we are penalizing contractors and we can’t use just index properties. It has to base on performance so models to predict that performance should be reliable and have scientific basis.
- Predictive relationships between AQCs and performance prediction model parameters.
- Same principles and methods between mix design and PRS. Mixes have to be designed using same principles they will be evaluated.
- PBMD Laboratory Tests – All together, it will take about 11 specimens and 3.5 days.
- Just need to run a few tests to get a few material relationships and estimate everything else in other conditions.
- Pavement performance prediction – LVECD Program currently under alpha testing.
- Validation/Calibration Project III – Manitoba RAP Pavements, in the field 50 percent Rap, soft binder didn’t make any difference.
- When I put all of them together, LEVCD data was along the lines with the field data.
- LVECD vs. Pavement ME – pavement ME does decent job but when we try to determine incentives and disincentives and defend the approach in the court, we need something better. LVECD did a better job overall.
- Testing can be done using 11 tests. Very straightforward process.
- For PRS we have to look at performance as function of time. Accuracy of models have to be a lot better than just pass/fail.
- Contractor actions needed – they review bidding specs and determine initial job mix formulas. They evaluate their risk in meeting specs. They make QA plan. Submit bid.
- Agency awards contract. Winning contractor submits their JMFs to agency. Agency reviews JMF. Control strips may be used to verify properties.
- Agency applies their AQ procedures for project monitoring. Project is constructed. Contractor pay is based on AQC data in pay tables in specs.
- Calibration set doesn’t change. It’s one set based on many projects.
- Do verification tests every 2 weeks/periodically, not necessarily for every sublot. Over the years, predictive relationship will become stronger and stronger.

Appendix B – Agency (Full Text) Brainstorming Session

Agency Brainstorming Session, Facilitated by Sharleen Smith, Troy University

Question #1-What has worked well and what hasn't worked well?

What has worked well?

- Participation with the group/conversations
- Willingness to listen to what is being said and accept.
- Interest in advancing technology
- Education
- States understand need for quality through performance, understanding their institutional challenges
- Contractors improving and controlling the process, improvement in overall quality.
- Funding to increase interest and/or participation
- Sharing of specs
- Hope to see some positive change in our pavement – quality
- Required to bridge between theory and practice – need meaningful specs
- On demand videos
- DOT has FHWA contacts to assist with spec development
- Workshops to help facilitate ideas
- Field showcases for technology for education of personnel
- Shadow specs with incentives/disincentives to prove concept to industry
- National standards that provide a framework
- Communication
- Get input from industry
- Separating and allowing mixed specs – prescriptive, performance
- R07 research provides a starting point
- Info sharing among the group
- Implementing ideas that are well funded
- Using outside experts to make the case
- Implementing performance related specs and tests for properties known to be indicators of long-term performance.
- Following a planned process
- Willingness of contractors to participate in pilot/proof of concept project
- Once they are aware they will not be penalized by data
- IC workshop and equipment demo
- Learning from experience of others.
- Contractor has been receptive to contract modification to include IC
- For asphalt mix designs – Hamburg wheel, DCT tester for fracture energy is reliable
- For PCC pavements – T2 thickness gauges, MIT scanners, IRI profilers work well.

What hasn't worked well?

- Real training in writing specs
- Real training in intelligent compaction
- Autonomous revisions
- Winging it
- Doing same thing we've always done and expecting different result

- States implementing any type of performance specs; Making their first move towards performance specs
- Meetings where one set of parties outnumber the other parties (i.e. agency vs. industry)
- Agency culture and change philosophy – hard to change institutional knowledge
- Hard to convince decision makers
- Time and effort to understand what needs to be done
- Data needs pre-work isn't well understood
- Industry's reluctance to change
- Lack of understanding in performance models
- Lack of knowledge across all parties that are needed for buy-in
- Interpreting IR data from field project
- Testing technology not being fully developed
- Forcing spec to inappropriate project, causing failure
- With PCC mixed designs – air meters
- Lack of opportunities to directly update management on progress
- With PCC mixed design – required number of trial batches
- IC data collection due to lack of education and operational procedures
- Resources aren't well advertised
- Analyzing IC data from field project.
- It's difficult the concept fully in writing specs (hard to convince decision makers)
- Lack of standards, multiple manufacturers
- Doing the same thing and expecting different result
- Time dedicated to actually develop specs
- Difficult to correlate tests to field performance in short timeframe
- Getting spec writers interest, reassigning roles to volunteers
- Proselytizing stakeholders
- Getting industry buy-in for performance related testing that they are not familiar with.
- Data analysis for IC
- Analysis IC/IR in beta without significant data

Question # 2-What do the agencies really need to advance performance specifications?

- Project specific published successes (performance related)
- Internal staffing – ability to analyze some of this data, IC/IR, who's going to look at it, how will they be able to do this.
- Culture of change
- Well-developed test and test methods
- Recognition that specs have to be living. They're supposed to be.
- Good quality data from pavement management system
- Have to invest in testing resources and equipment
- Have to have a champion at a high level and at a working level
- Money/funding
- Training on everything
- Buy-in from the industry
- Removal of black box perception both from industry and internally – you get a whole bunch of data from a machine. Are you willing to accept it? How to advance performance specs. Lack of understanding is viewed as a black box.
- Mind-altering persuasion – when you try to sell new idea, have to have a hook and deliver sales pitch at level audience accepts it.
- Fresh, clear marketing
- Integration of various databases – mature database, PMS

- Realizing economic benefits of Performance Related Specifications
- Dependable (and defensible) procedures and protocols
- National support – having example specs, having experts to call on.
- Verification for your state conditions. How do you do that in a timely manner and ability to do that?
- Expertise and guidance
- Key staff involved – you need people who are construction inspectors, design staff, surveying crews.
- Who's going to keep the data? Key stakeholders within your department need to be involved.
- Competence in deploying specs – across all fields of involvement – contractors, inspectors and designers.
- Scale support to how important performance specs is. SuperPave is gold standard. We need to decide how much balance.
- Willingness to do pilot projects.
- Collaborative effort to develop specs and get buy-in.
- Lessons learned, case studies.
- Project-level logistics – guidance, tools, training.
- Not overly complicated.
- A cookbook for performance specs. Having a checklist or sequence that people who are going to write performance spec can use.
- Breaking down internal institutional barriers.
- Communicate at all levels.
- Lots of tools in the toolbox. Look for different options, whether it's testing methods or products.
- Project-specific published successes.
- Internal staffing
- Understanding of test giving data
- Good quality data from PMS
- Recognition that specs should be living data

Question # 3-Lessons learned to date from SHRP2 program

- Specs have different levels, including performance elements. Knowing there's a continuum has been helpful in shaping the work.
- There's a whole lot more learning to be had.
- Understanding entire process from spec development all the way to construction. Research also key.
- How rapid the pace is during construction.
- More than just spec writers and construction.
- Nontraditional engineer thinking
- R07 has enough tools to get you started, which is half the battle.
- You just need to get started/one bite at a time.
- State implementers have their day job. This is extra work for them.
- We do all have similar problems with implementation and we can build off other's experiences.
- IC issues to watch out for.
- Level of research that you have to do, especially on manufacturers capabilities, is lengthy. Have to know what's out there.
- Start out with minimal standards and build out.
- Be able to draw from other states' experiences.
- Reinforced need for industry buy-in or acceptance. Can't make it complicated and have to have the right persuasion to get them to try it.
- Need buy-in from management, support and commitment.
- Different level of interpretations. Need to be clarified to help the states.
- There is even less understanding of what SHRP2 is then I realized.
- Can be used for many dimensions than asphalt

- There are many examples that can be used to coach people.

Question # 4-Advancing specification development; what is really needed?

- Support from all players
- Chosen expert or leader or champion in shepherding development
- Clear idea of what you want to accomplish
- Review and support from all parties involved (design, materials, construction, industry)
- Local state knowledge and experience
- Participation by industry
- Guidelines, sample specs, lessons learned from other agencies
- Willingness to make the changes
- Tests that predict field performance
- Change in mindset within agency
- Time or resources from DOT to review and process specs
- DOTs need to develop importance of the progress
- Opportunities to work with industry
- Strong correlations to field performance for justification of test methods/measures
- Experts to assist with implementation
- Have states assist each other with best practices that just prevents reinventing the wheel
- Proof that performance prediction models do predict field performance reliably
- Standard test methods and DOT/contractors familiarity with methods
- A champion with state dot that can accomplish success
- Clear concise guidance/assistance on perf specs
- Success stories
- Focused responsible level of effort
- Good quality
- Network distress data (LTPP data)
- Data to write proper spec requirements
- Input from all affected stakeholders
- Testing equipment ID (which equipment do we pursue)
- Consultant to assist and guide spec development
- Industry feedback of draft specs
- Management acceptance of draft specs
- Checklist of steps
- Model specs or other state specs that can be used as a template
- Proven systems and tests that stand on their own and are known to increase long-term performance
- Examples of good specs
- Willingness to reach out for advice from others with experience writing them
- Aggressiveness to try them or initiate them in a pilot project

Question # 5-How to improve performance specification products

- Need more detail without having to read the document
- Others read them and think they are already doing their job.
- What's missing is the next steps. Does not lead into what you need from the states.
- It's knowing who all do you need to involve, how to pick projects.
- Need checklist
- How to get started with implementing a new one in a new area
- Better fact sheets
- Product is actually the process that's described in different pieces.

- Flow diagram to get states on board.
- Hard to read entire document. Need easily digestible information with key elements to developing performance specs.
- Interactive map
- Would also be useful to have documented examples of shift in a spec from method to performance, or whatever, that show benefits.
- Triggers are different depending on the audience. For Alabama DOT, saving money is the trigger.
- There's no up-front identification of incentive to do it or the reward when you do it. Whether it's financial to the contractor, to the state, etc.
- Life-cycle cost analysis is selling point to upper management.
- How do you know when it's going to show improvement – compare results from this year to project we shadowed the year before.
- You might run into the fact that the spec that you want cannot be met in majority of situations.
- You can phase into performance specs.
- Economic benefits only come with volume. Start with massive jobs first.
- For next push, try to get focus on non-pavement spec. (guardrail) there are all kinds of things out there that aren't as difficult to implement.

Question # 6-Marketing materials; what is needed to better market the program?

- Videos of test methods
- Whiteboard animations of perf specs
- Social media/Twitter
- Case study video
- Webinars the next steps of implementation
- Develop checklist for any perf specs
- SharePoint library for perf specs
- Awards for best implementation of a perf specs
- Future workshops with case studies
- Money – grants to states, possible incentives to contractors
- Marketing materials to target incentives to states
- Tools for better networking
- Implementation cheat sheet
- Better fact sheets
- Published success stories
- Better targeting inside agencies
- Better variety of sample applications
- Bring in non-participators to the workshop
- Include industry in showcases and events where product is being promoted so they can understand why it's valuable
- Case studies of success
- Examples of applications
- Sample flow charts, lists
- Tech brief of individual components, methods, models, trials (different media)
- Examples of consequences of costs of not using PRS
- Materials like Train the trainer
- Internal peer-to-peer meeting within agency
- Need outside broker when you're having internal meeting
- AASHTO collaboration with other organizations, such as NCAD, NCI, Corps of Engineers
- Better variety of sample publications

Appendix C – Evaluation Report Results

EVALUATION RESULTS
***SHRP2 Performance Specifications for Rapid Renewal* (R07) Peer Workshop**
Montgomery, Alabama, Nov. 5-6, 2015

1. What was your subject knowledge level of the SHRP2 *Performance Specifications for Rapid Renewal prior to* this workshop?

1 2 3 4 5 6 7 8 9 10
(no knowledge) (moderate knowledge) (extensive knowledge)

1	
2	**1**
3	
4	**1**
5	
6	**3**
7	**2**
8	**4**
9	
10	

2. What was your subject knowledge level of the SHRP2 *Performance Specifications for Rapid Renewal after* this workshop?

1 2 3 4 5 6 7 8 9 10
(no knowledge) (moderate knowledge) (extensive knowledge)

1	
2	
3	
4	
5	**1**
6	
7	**1**
8	**3**
9	**4**
10	**2**

3. How would you rate the effectiveness of the following elements of the workshop?

a. Overall workshop content

1 2 3 4 5 6 7 8 9 10
(low) (high)

1	
2	

3	
4	
5	
6	
7	**1**
8	**2**
9	**5**
10	**3**

b. Peer presentations on *Performance Specifications for Rapid Renewal*, successes, and challenges

1 2 3 4 5 6 7 8 9 10
(low) (high)

1	
2	
3	
4	
5	
6	
7	**1**
8	**1**
9	**6**
10	**3**

4. Please indicate your level of agreement with the following statements:

a. This workshop provided me with a better understanding of *Performance Specifications for Rapid Renewal*.

1 2 3 4 5 6 7 8 9 10
(strongly disagree) (strongly agree)

1	
2	
3	
4	
5	
6	
7	**1**
8	**4**
9	**3**
10	**3**

b. I understand how *Performance Specifications for Rapid Renewal* can benefit my agency and program.

1 2 3 4 5 6 7 8 9 10
(strongly disagree) (strongly agree)

1	
2	
3	
4	
5	
6	
7	
8	**4**
9	**5**
10	**2**

c. I found the format of the workshop encouraged active participation.

1 2 3 4 5 6 7 8 9 10
(strongly disagree) (strongly agree)

1	
2	
3	
4	
5	
6	
7	
8	**4**
9	**2**
10	**5**

d. My participation in this workshop was worthwhile.

1 2 3 4 5 6 7 8 9 10
(strongly disagree) (strongly agree)

1	
2	
3	
4	
5	
6	
7	
8	**5**
9	**4**
10	**2**

7. My expectations for what I would learn in the event were met.

1 2 3 4 5 6 7 8 9 10
(strongly disagree) (strongly agree)

1	
2	
3	
4	
5	
6	
7	**1**
8	**3**
9	**5**
10	**2**

8. The presenters delivered clear information.

1 2 3 4 5 6 7 8 9 10
(strongly disagree) (strongly agree)

1	
2	
3	
4	
5	
6	
7	**2**
8	**2**
9	**5**
10	**2**

9. What were the most important ideas you learned from the workshop?

- The case studies presented on 2nd day – outstanding. State presentations – very good – confirm what our experiences were. Not just us.
- I design philosophies were very helpful.
- Mixed designs
- Implementation
- That support for spec development is available to me.
- Other states are having similar issues with performance specs implementation. Friday presentations were excellent.
- Design values for life cycle assessments should be utilized to develop performance specs.
- Asphalt and IC issues
- Promoting performance spec development as a continuum, useful analogy to continuous improvement.
- The advantages of using performance related specs.

10. Are there questions or issues you wished the workshop had addressed that it didn't?

- Would like to have seen specific specification presentation from start to finish – to see actual wording.
- More IC would have been good as well.
- Good coverage for time allowed.
- Asphalt case studies

11. What else could the Federal Highway Administration do to support you or your agency in learning more about SHRP2 *Performance Specifications for Rapid Renewal* and its implementation in day to day practice?

- Continue with their assistance.
- Specific step by step for utilizing some of the various performance related models.
- Provide more support for the states.
- Continue to provide support.
- Need contacts and training of several topics.
- References and case studies provided.
- Consider offering a constructive specification review service to states for performance criteria.

12. How might AASHTO further support you or your agency in learning more about SHRP2 *Performance Specifications for Rapid Renewal* and its use in day to day practice?

- Provide resource to share case studies and PRS status from agencies as the update and improve their PRS. (i.e. Illinois Tollway – Asphalt PRS made available when it rolls out prior to next R07 workshop)
- More specific case study info from states on what is working.
- Provide more support for the states.
- Provide opportunities for upper management to be exposed to briefings on the advantages of the program.
- Send updated info and spec advances to state reps.
- Webinars
- Consider using subcommittee mailings with targeted products for each audience; markings/retro for Safety, structural coatings for Bridge; traffic maintenance for Operations; winter performance criteria for Maintenance (for private contracts assistance).

13. Additional comments, feedback, or ideas related to this event or future SHRP2 events:

- Jennifer Balis asked would we be willing to provide feedback on checklist PRS. Absolutely would be willing.
- I enjoyed the discussion and learned a lot from the other states as well as the presenters.
- I really like the time and look forward to next year.
- In hindsight, probably should have had more time for final presentations.
- Keep communication options open for all interested parties.
- The brainstorming/facilitated discussion was helpful – it was unforced and yielded some consensus findings to the group.