

Accelerating innovation in Vermont through the SHRP2 Solution: *Performance Specifications for Rapid Renewal (R07)*



Photos courtesy: Gallivan Consulting Inc., David Peshkin

After experiencing performance challenges when using in-place recycling technologies, the Vermont Agency of Transportation (VTrans) was looking for alternative approaches for developing performance specifications for reclaimed pavements and bases that are stabilized with cement. Therefore in 2013, the agency began using *Performance Specifications for Rapid Renewal (R07)*, a product developed by the second Strategic Highway Research Program (SHRP2). The agency used guidance from the SHRP2 R07 product to develop specifications for a construction project which demonstrated positive results.

VTrans ultimate goal is to be able to make acceptance decisions based on the measurement of the finished products using fundamental engineering properties that predict the long-term performance of the structure. In addition, over the next two years VTrans plans to reclaim another 90 miles of pavement using the technology if performance issues can be resolved with specifications that work.

VTrans is one of five state departments of transportation currently implementing *Performance Specifications for Rapid Renewal (R07)* through the SHRP2 Implementation Assistance Program (IAP), administered by the Federal Highway Administration (FHWA) and the American Association of State Highways and Transportation Officials (AASHTO). VTrans was awarded implementation assistance in 2013 in the Lead Adopter Incentive category, which helps offset costs associated with product implementation and risk mitigation.

Through the SHRP2 IAP program, VTrans receives technical assistance to support the move towards the use of Performance-Based Specifications. As part of that technical assistance, a subject matter expert (SME) works with VTrans to understand the agency's processes, priorities, and challenges in maintaining its highway network.

VTrans Background Information

What are Performance Specifications for Rapid Renewal (R07)?

To help transportation agencies develop and implement performance specifications, SHRP2 created *Performance Specifications for Rapid Renewal (R07)*. These model performance specifications address various project types (pavements, geotechnical, bridges, etc.) and project delivery methods (design-bid-build, design-build, design-build-warranty, and design-build-operate-maintain).

The conventional approach to highway construction, places the burden on the owners of the facilities to design, specify, and control the work. Performance specifications, on the other hand, shifts some of the agencies responsibilities to contractors and empowers them to look for new solutions to save time, minimize disruptions, and enhance safety and quality while meeting the specific goals of the project.

Included in the R07 product are:

- Model performance specifications;
- Ranking grids;
- Step-by-step instructions for developing performance specifications

VTrans uses the Full Depth Reclamation (FDR) process for reclaimed pavements and bases. Over the past several years, premature and reoccurring problems resulted in a significant reduction in the performance of rehabilitated pavements.

The FDR process is a proven in-place recycling technology that produces a uniform roadway foundation by pulverizing and stabilization of the existing subbase, base, and asphalt pavement to perform 10-20 years without subsequent major treatments. The FDR pulverizing and stabilization with cement is a process that is intended to provide the necessary support in the subbase materials to create a long-lasting pavement that will perform for years to come.

VTrans Specifications

Developed years ago, VTrans specifications were considered to be very prescriptive in nature and VTrans retains most of the responsibility in project mixture development, field testing, construction operations, and subsequent pavement evaluation and performance. Early failures of the roadways, which typically occurs in the spring time, has been found to be directly related to early cracking in the treated subbase materials that contain cement in the stabilized materials.

VTrans specifications (Reclaimed Stabilized Bases (RSB) with cement) include a two-step process: pulverization of the pavement to a specified depth of typically 8-14 inches and then stabilizing the loose mixture with cement. Specific VTrans requirements also include specifying contractor's equipment, weather conditions for operations as well as:

Mix Designs

- VTrans developed the project mix design and determines the optimum percent of cement based on an average of in-situ conditions throughout the length of the project.

Strength

- VTrans targets reclaimed base materials to have a strength of less than 300 psi. Prior to the pulverization, VTrans may also require the cold-planing (milling) of the pavement or in specific areas such as horizontal curves.

Gradation

- VTrans requires a specified gradation following pulverization operations.

Compaction

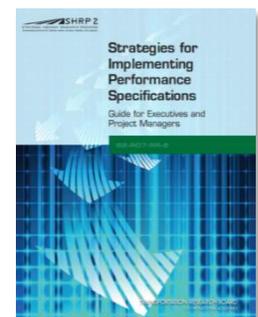
- VTrans requires a specified compaction operations following the stabilization operations.

Curing

- VTrans includes specific requirements for curing the treated subbase.

Challenges Facing VTrans

VTrans acknowledged that various problems exist with their in-place recycling program and they have targeted improving their construction specifications first. One of the challenges for VTrans is understanding what they are asking for in regards to implementing performance specifications in Vermont. Established definitions for performance specifications are addressed in the SHRP2 R07 guidance documents, *Strategies for Implementing Performance Specifications*, *Performance Specifications for Rapid Highway Renewal*, and the Transportation Research Board Circular E-173 (sixth edition, 2013) which published the *Glossary of Construction Quality Assurance Terms*.



The SHRP2 R07 guidance documents provide recommended approaches to the development of performance specifications and strategies to accelerate construction, minimize disruption of traffic and communities,

and produce long-lasting roadways. Understanding the differences between Performance-Related vs Performance-Based specifications are paramount in setting the direction for Vermont. (See the [Appendix](#) to learn about why states are now moving toward performance specifications.)

Implementation Activities

To assist VTrans in its efforts to develop performance specifications, in the spring of 2015, VTrans hosted an introductory meeting with the R07 SME and the SHRP2/AASHTO/FHWA team. The meeting included representatives from multiple agency divisions, including Research, Construction, Materials, and Design. During the multi-day kick-off meeting, *Performance Specifications for Rapid Renewal* were discussed at length, as well as the various definitions of performance specifications and how they relate to current VTrans specifications. As a result of the meeting, VTrans restated their goals and settled on developing Performance-Related Specifications for their FDR operations. See the [Appendix](#) for performance specifications definitions.

VTrans also developed the following goals as part of the development and implementation of the new specifications:

- **DURABILITY**—The updated specifications must provide for the anticipated service life of the pavement
- **CONSISTENT**—The updated specifications must be applicable for varying site conditions and contractors
- **TRAVELING PUBLIC** – Long-term ride ability, performance of the roadway, recyclability, and cost effectiveness
- **RISK APPORTIONMENT** – The updated specifications need to share the inherent risk of the new program between VTrans and the Contractors
- **SEQUENCING** – The updated specifications must include the proper sequencing of the work and testing requirements by VTrans and the Contractors
- **SAFETY** – The updated specifications must ensure that the project is safe for the onsite personnel and the general public who might be using the facility during construction periods
- **RECOVERY** – Recovery of Capital Expenditures by VTrans and the Contractor have to be considered in the updated specifications
- **TRAINING** – Necessary training of field personnel regarding the new construction procedures and/or testing equipment

It was concluded that VTrans was not ready to make the jump from prescriptive method specifications to full performance specifications in a single step and therefore, set an intermediate goal to incorporate improved technologies into the FDR process by staging the implementation in the field. This approach is intended to allow for VTrans and contractors time to receive the training and to understand the new construction and materials testing requirements.

VTrans representatives worked with the SME to incorporate most of the recommended changes in the initial project. After construction, the SME worked with VTrans personnel to incorporate specific issues into the new specifications, including Intelligent Compaction.

Specifications were developed by VTrans and incorporated into a 2015 pilot project (Randolph-Roxbury ER STP 0187(11)) that partially addressed the move to performance specifications. The project was a continuing effort to improve the specifications and the constructed results of a cement stabilized FDR project.

The specifications were further revised to include Percent-Within-Limits (PWL) acceptance criteria, Intelligent Compaction, lots and sublots, as well as changes to the compaction and curing requirements and minimum equipment requirements. VTrans further advanced the specifications as a shadow project to allow VTrans and contractors

additional time to adjust prior to implementing the new requirements. The performance specifications were developed to address all the original VTrans objectives and the additional factors.

VTrans shared information about their R07 project with other state Departments of Transportation during an R07 Peer Exchange they hosted in Burlington, Vt. in September 2016. The Peer Exchange was sponsored by AASHTO and FHWA and offered states the opportunity to hear how their peers are developing and using performance specifications.

Results of the Project

Results of testing during the pilot construction project proved promising. Key target specification requirements were met. The contractor acted as a partner in the project and some modifications were jointly made to the contract with VTrans' support to ensure the goals of the project were met.

In addition to obtaining key specification requirements, periodic on-site discussions concerning project quality assurance requirements were held at various junctures throughout the construction season to further emphasize construction criteria and the required attention to detail. From a construction perspective on the part of VTrans and the contractor, the project can most certainly be deemed a success because it achieved all of the specified requirements. The successes of the project will lead to further improvements in the specifications and future projects.



Photo credit: Mark Woolaver, VTrans

Lessons learned from VTrans Efforts

- To assist the state DOTs, AASHTO through the SHRP2 program has developed three documents (see the [Appendix](#) for details) that provide the baseline understanding of performance specifications. At a minimum, the *Guide for Executives and Project Managers* needs to be part of the process for developing updated or performance specifications.
- All states differ in how they process new or updated specifications within their individual agencies. It is recommended that an internal peer-to-peer meeting be held within the agency to fully understand the level of effort needed to initiate and develop performance specification programs and performance specifications themselves.
- Currently, states are utilizing various types of specifications in different programs within the agency. It is recommended that agencies need to have a better understanding of the basic definition of Method, End Result, and Quality Assurance specifications.
- State agencies need to develop realistic goals and expectations for incorporating performance specifications. Short and long-term goals/objectives are recommended.
- Weakness/inexperience within the state on writing new or updated specifications was noted within VTrans. To help states with this, it may be helpful to offer the FHWA/NHI training course on writing specifications. Multiple representatives in the agency, including management, should participate in the training. *Please note that the SHRP2 program has made available to states, through the Cooperative Agreement work order, a specification writer that they can use as part of their technical assistance.*
- Development of new or updated specifications is a challenge for most agencies, as the dedication of staff time to accomplish this task can be difficult.

Benefits and Value of Moving Towards Performance Specifications

Short and long-term benefits to the agencies will differ but moving towards performance specifications has been demonstrated to make a difference in the rapid renewal of projects. Performance specifications can be used for a number of operations, other than for pavement renewal. VTrans' efforts in the reclamation area has demonstrated the power and the adaptability of performance specifications to achieve project specific goals and to satisfy user needs.

Next Steps

VTrans plans to further advance performance specifications FDR operations with cement to include Intelligent Compaction technologies, Percent With-In Limits, and new Field Density Testing protocols.

For more Information:

To learn more about VTrans' use of *Performance Specifications for Rapid Renewal* (R07), contact Mark Woolaver at Mark.Woolaver@vermont.gov.

To learn more about SHRP2 and the R07 product, contact Jennifer Balis, FHWA, at jennifer.balis@dot.gov or Keith Platte, AASHTO, at kplatte@ashto.org.

FHWA GoSHRP2 Website:

http://www.fhwa.dot.gov/goshrp2/Solutions/Renewal/R07/Performance_Specifications_for_Rapid_Renewal

AASHTO SHRP2 Website:

http://shrp2.transportation.org/Pages/R07_PerformanceSpecificationsforRapidRenewal.aspx

AASHTO's product page offers case studies, training modules, presentations, factsheets, guidance documents, and a list of other states implementing the R07 product.

References

Asphalt Recycling and Reclaiming Association, *Basic Asphalt Recycling Manual- Second Edition*, Annapolis, MD, FHWA-HIF-14-001, 2014

Title 23, Code of Federal Regulations, Part 635, Subpart D, Section 413, *Guaranty and Warranty Clauses*, August 25, 1995, amended on December 10, 2002 and August 14, 2007

Federal Highway Administration (FHWA). *Performance Specifications – Strategic Road Map*, Washington, D.C., 2004
<http://www.fhwa.dot.gov/construction/pssr04.pdf>

Transportation Research Board, *Transportation Research Circular, Glossary of Transportation Construction Quality Assurance Terms – Sixth Edition*, No. E-C173, Washington DC, June 2013

Transportation Research Board, (SHRP2), *Performance Specifications for Rapid Highway Renewal, Washington D.C.*, Report S2-R07-RR-1, 2014

Transportation Research Board, (SHRP2), *Strategies for Implementing Performance Specifications, i.e. Guide for Executives and Project Manager, Washington DC, Report S2-R07-RR-2, 2014*

Transportation Research Board, (SHRP2), *Framework for Performance Specifications, i.e. Guide for Specifications Writers,*

Washington DC, Report S2-R07-RR-3, 2014

VTrans, Randolph-Roxbury ER STP 0187(11), Cold Mixed Recycled Bituminous Pavement, Portland Cement, Montpelier, Vermont, 2015

VTrans, Full Depth Reclamation (FDR) with Cement revised construction specifications, Montpelier, Vermont, 2016

Appendix

Understanding Performance Specifications

Performance specifications are part of a development continuum process by the states to make improvements in construction operations to meet or exceed the design and performance goals of the projects. Over a hundred years ago, most states were developing prescriptive or recipe/method type specifications with the intent to provide a stable level of understanding between the agencies and the contractors on what was expected. Nearly fifty years ago significant changes to the standard project delivery methods began to take form with the movement towards quality where End-Results type specifications were and still are used today across the country. Forty years ago, Quality Assurance type specifications were developed to better communicate the project's criteria and requirements with contractors and made significant changes on how the "quality" of the project was measured and accepted by the introduction of statistics in the processes to highway agencies. Performance Type Warranty specifications were first introduced in 1995 by changes in federal legislation to allow warranties on Federal Aid Projects and were developed to enable the sharing of responsibilities for the construction of pavements with the contractors. Highway agencies have now moved towards the use of Performance Specifications. In 2014, the Transportation Research Board in partnership with the FHWA and AASHTO developed the SHRP2 R07 guidance documents.

The SHRP2 guidance documents provide recommended approaches towards the development of performance specifications and strategies to accelerate construction, minimize disruption of traffic and communities and produce long-life facilities on our national roadways.

The conventional approach to highway construction, places the burden on the owners of the facilities to design, specify, and control the work. Over the decades, advances in the construction processes have advanced over the control of traditional prescriptive specifications. Furthermore, most agencies have been experiencing reduction of personnel in the design and construction fields and at the same time, an expansion in the projects and new requirements due to high-speed construction, night time construction and/or extensive rehabilitation.

The traditional way of doing business has been demonstrated to not fully endorse the quality demands of today's projects. Performance specifications, on the other hand, shifts some of the agencies responsibilities to contractors and empowers them to look for new solutions to save time, minimize disruptions and enhance safety and quality in the interest of rapid renewal while meeting the project specific goals of the project.

Performance Specifications Definitions

There are varying types of Performance Specifications. Performance Specifications describe how the finished product should perform over time. For highways, performance is typically described in terms of changes in the physical condition of the surface and its response to load, or in terms of the cumulative traffic required to bring the pavement to a condition defined as "failure." Specifications containing warranty/guarantee clauses are a form of performance specifications.

Other than the warranty/guarantee type, performance specifications have not been used for major highway pavement components (e.g., subgrades, bases, and riding surfaces) due to a lack of suitable nondestructive tests to measure long-term performance immediately after construction. They have been used for some products (e.g., highway lighting, electrical components, and joint sealant materials) for which there are suitable tests of performance.

Performance-Related Specifications

These type of specifications describe the desired levels of key materials and construction quality characteristics that have been found to correlate with fundamental engineering properties that predict performance. These characteristics (for example, air voids in asphalt concrete (AC) and compressive strength of PCC) are amenable to acceptance testing at the time of construction. True performance-related specifications not only describe the desired levels of quality characteristics but also employ the quantified relationships containing the characteristics to predict as-constructed pavement performance. They provide the basis for rational acceptance/pay adjustment decisions.

Performance-Based Specifications

Performance-based specifications describe the desired levels of fundamental engineering properties (e.g., resilient modulus, creep properties, and fatigue properties) that are predictors of performance and appear in primary prediction relationships (i.e., models that can be used to predict pavement stress, distress, or performance from combinations of predictors that represent traffic, environmental, roadbed, and structural conditions). Because most fundamental engineering properties associated with pavements are currently not amenable to timely acceptance testing, performance-based specifications have not found application in transportation construction.

Reclamation Technology

Full Depth Reclamation (FDR) is a technology that has been available since the early 1970's that will uniformly pulverize and blend 6 to 12 inches of subbase, base, and asphalt pavement resulting in a homogeneous stabilized roadway. The FDR pulverizing and stabilization is a process that removes all surface and base deficiencies within the pavement structure and creates a long lasting base that will perform for years to come. Subsequent surface treatments, depending on the purpose and traffic loading, will provide a rehabilitated roadway that will perform 10-20 years without subsequent major treatments.

Often, this blend of material alone, without any additional stabilizing agents, is sufficient to act as the base for a new surface course. However, if after proper project evaluation it is determined that the reclaimed materials need improvement or modification, there are three different methods of stabilization that can be used including Mechanical, Chemical or Bituminous materials. (BARM, 2014) FDR technology was first introduced in the mid 1970's and has undergone multiple advancements in the technology and in the equipment. The development of large, high horse-powered, self-propelled reclaiming machines has increased the use of FDR due to greater treatment depths, higher productivity and more sophisticated metering systems for the controlled addition of stabilizing agents and additives.

SHRP2 Guidance Documents

- [*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, \(i.e. Guide for Specifications Writers, Report S2-R07-RR-3\)*](#)