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# Prediction of Performance and Evaluation of Flexible Pavement Rehabilitation Strategies

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Original Research Paper

# Prediction of performance and evaluation of flexible pavement rehabilitation strategies

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## HIGHLIGHTS

- A test section is established with five full depth reclamation (FDR) strategies.
- Five FDR strategies (control, calcium chloride, Portland cement, asphalt emulsion, and geogrid) are introduced.
- Prediction of FDR performance is made by using AASHTOWare Pavement ME Design (Pavement ME).
- Evaluation of FDR performance is made with different additives and strategies.
- Portland cement appears to be the best based on limited prediction and evaluation.

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## ABSTRACT

Five test sections with different additives and strategies were established to rehabilitate a State-maintained highway more effectively in Rhode Island (RI): control, calcium chloride, asphalt emulsion, Portland cement and geogrid. Resilient moduli of subgrade soils and subbase materials before and after full depth rehabilitation were employed as input parameters to predict the performance of pavement structures using AASHTOWare Pavement ME Design (Pavement ME) software in terms of rutting, cracking and roughness. It was attempted to use Level 1 input (which includes traffic full spectrum data, climate data and structural layer properties) for Pavement ME. Traffic data was obtained from a Weigh-in-Motion (WIM) instrument and Providence station was used for collecting climatic data. Volumetric properties, dynamic modulus and creep compliance were used as input parameters for 19 mm (0.75 in.) warm mix asphalt (WMA) base and 12.5 mm (0.5 in.) WMA surface layer. The results indicated that all test sections observed AC top-down (longitudinal) cracking except Portland cement section which passed for all criteria. The order in terms of performance (best to worst) for all test sections by Pavement ME was Portland cement, calcium chloride, control, geogrid, and asphalt emulsion. It was also observed that all test sections passed for both bottom up and top down fatigue cracking by increasing thickness of either of the two top asphalt layers. Test sections with five different base/subbase materials were evaluated in last two years through visual condition survey and measurements of deflection and roughness to confirm the prediction, but there was no serious distress and roughness. Thus these experiments allowed selecting the best rehabilitation/reconstruction techniques for the particular and/or similar highway, and a framework was formulated to select an optimal technique and/or strategy for future

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rehabilitation/reconstruction projects. Finally, guidelines for long-term evaluation were developed to verify short-term prediction and performance.

## 1. Introduction

It has been estimated that the amount of miles of truck traffic on our highways will be increasing and surpassing all other modes of freight shipments in the near future. Tractor trailers and heavy vehicles account for a majority of the damage on highways (Lee and Peckham, 1990). The States, especially Rhode Island (RI), are having a hard time keeping up with and paying for maintenance and rehabilitation (M & R). This means there will be more wear on our highways than ever before, and the States will have to do more M & R with less funding. To meet upcoming highway demand, the Rhode Island Department of Transportation (RIDOT) has been testing alternative subbase materials as reclamation strategies, and has been expanding their use. To meet up best rehabilitation strategy/technique for a pavement, it is necessary to predict its performance over a certain number of years.

In the 1980's, RIDOT had a program to reclaim pavements throughout the State. The reclamation of the roads restored bearing capacity that has been lost over the years of use. Route 165 was one of the roads and was programmed to be re-reclaimed using four different strategies and a control in 2013 as shown in Fig. 1.

### 1.1. *Significance of study*

Asphalt or flexible pavements are usually designed for 20 years' usage, and generally consist of four layers (i.e., subgrade soils, granular subbase, granular or asphalt base, and asphalt surface). With the pass of time the top asphalt surface of pavement deteriorates quickly due to heavy truck traffic, if not properly designed, and end up having different kinds of asphalt distresses, e.g., rutting, fatigue cracking, thermal cracking, and roughness. To maintain and rehabilitate pavement, there should be a solution or strategy to meet up the 20 years of designed life. RIDOT used different rehabilitation strategies in the past for M & R, such as use of reclaimed asphalt pavement (RAP), reclamation, subbase stabilization, and geo reinforcement etc. In the present study, different types of reclamation and subbase stabilization strategies used on RI Highway (i.e., Route 165 in Exeter) were focused.

**Fig. 1 – A view of Route 165 before rehabilitation in 2013.**

### 1.2. *Background and history*

Route 165 was last reconstructed in 1986. The roadway was reclaimed to a depth of five inches (5 in.) and mixed with calcium chloride. The pavement thickness, after resurfacing, was one and a half inches (1.5 in.) of bituminous surface course and two and a half inches (2.5 in.) of bituminous modified type binder course over a five inches (5 in.) cold recycled base layer mixed with a ratio of 1:2 bituminous pavement/gravel and eight inches (8 in.) of existing gravel subbase layer (Fig. 2).

A geotechnical engineering exploration and analysis were conducted for the request of RIDOT by V.A. Nacci and associates, soil and foundation consulting engineers (Nacci, 1987). It may be noted that, Route 165 was originally built on soft deposits (swamp). Depending on the nature of the soft deposit, original construction dealt with this in one of two ways: one was by removal of the unsuitable material and the other was by floating the embankment on the soft soil, often with considerable settlement (Nacci, 1987). Eleven tests were completed for the reconstruction, which found embankments consisting of sand, some gravel, silt, fibrous organic deposits (peat), and organic silt (USDA, 1981). Other tests indicated that Route 165 was built on glacial till and stratified kame deposits (RIDOT, 2013). There were pockets in the granite bedrock near the surface, which contributed to a high water table. An exploration and analysis found

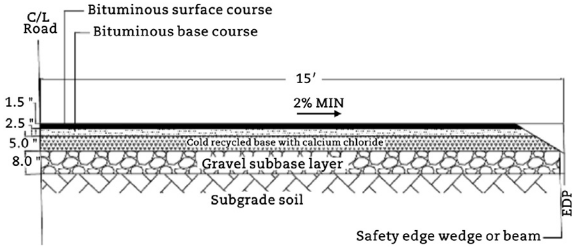

**Fig. 2 – Cross section of Route 165 after rehabilitation in 1986.**

additional seven areas of swamp deposits. The soil within Route 165 has a low shrink-swell potential but has a potential for frost action. Plasticity index is not presented, therefore, the soil is not comprised of any clay material. Areas of Route 165 that contain Adrian, Walpole, and Ridge bury have severe wetness, low strength, and severe frost action.

## 2. Construction materials

In 2012, the RIDOT, in conjunction with Department of Civil and Environmental Engineering of University of Rhode Island (URI) performed testing on the unbound materials from five sample areas within Route 165. Twelve field samples were taken between November 27, 2012 and December 6, 2012. Nuclear gauge readings were taken at the sample areas at same time to measure in-situ dry density, wet density, water contents, and percent moisture. Stationing, utility pole numbers, and planned treatment areas were recorded to ensure future samples would be taken in the same locations. The 2012 samples were taken to URI for resilient modulus testing, and the resilient modulus results from URITC Project Number 000154 research project were being used as parameters for the Pavement ME program (Bradshaw et al., 2015a,b).

A test road (i.e., Route 165) was rehabilitated in Exeter and used to predict and evaluate the performance of different strategies. Four test sections used the full depth eight-inch FDR base/subbase and three sections were stabilized with Portland cement, calcium chloride, and asphalt emulsion. The fourth test section was reconstructed with geogrid and six inches of filter stone sandwiched between the layers. All four tests and one control section were paved with 2.5 in. thick Class 19 WMA and 2 in. thick Class 12.5 WMA. Based on the RIDOT job specifications, each of the reclaimed test sections and the geogrid section were designed to confirm to the same material gradation with 95%–100% passing a 3 in. sieve and 2%–15% passing a number 200 sieve to achieve a comparable performance between the test sections. The contractor had to comply with not having any stone, rock, cobble, or asphalt material being more than four inches in width or length. Cross sections of control test section are shown in Fig. 3.

## 3. Methods to predict performance of rehabilitated pavement

Previously, RI used the 1993 AASHTO Guide for design of pavement structures to design the HMA and subbase layers (AASHTO, 1993; Lee et al., 2003). The guide used graphs to calculate traffic equivalency values, freeze-thaw factors, and resilient modulus to find a design structural number. The new updated method uses truck traffic spectrum, climate data, HMA mixture and subbase material properties for a mechanistic empirical design. There are three hierarchical levels in Pavement ME (AASHTO, 2015):

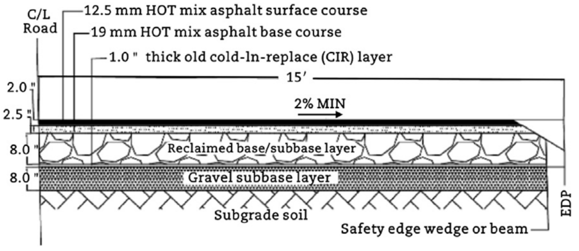

**Fig. 3 – Cross section of Route 165 with control test section.**

1. Level 1: uses laboratory results (i.e., resilient modulus, HMA mixture properties) that are project specific or a library of test materials results.
2. Level 2: input values are estimated for correlations and regression equations.
3. Level 3: input parameters are estimated or global defaults are used.

There are several HMA properties that are inputs into the Pavement ME program to perform a Level 1 design. The RIDOT performs nineteen AASHTO and ASTM tests on its materials and WMA for all its construction projects. These tests are the Pavement ME inputs that are needed to predict longitudinal cracking, alligator cracking, transverse cracking, rutting or other permanent deformation, International Roughness Index (IRI), and reflection cracking over a selected design life.

### 3.1. *Structural layer inputs*

Resilient moduli of subgrade soils were collected under the aforementioned URI study (Bradshaw et al., 2015a,b) during construction for testing. Another URI study reported Mr Values for RI subgrade soils ranged from 7506 psi to 9304 psi (Lee et al., 2003).

Before the FDR, four inches of asphalt pavement were removed from the roadbed for ten test sections located throughout the length of the road. Approximately twelve inches of existing subbase layer including five inches of previously recycled material were collected. It should be noted that the collected samples were mixed with seven inches of the existing gravel borrow and the five inches of previously reclaimed material. The five inches of previously reclaimed material was not tested separately. Resilient moduli of the ten subbase test sections were determined by using triaxial chamber apparatus per AASHTO T 307-99 procedure. The laboratory resilient moduli values varied from 17, 000 psi to 74,000 psi.

In construction, four inches of old asphalt surface and base layers were reclaimed into four inches of previously reclaimed subbase, and a new eight-inch homogeneous FDR base/subbase layer was formed. Samples were taken before the new construction. FDR base/subbase layers were mixed with the three different strategies and taken to URI for testing. Before triaxial testing, four samples were mixed with additives in the lab per RIDOT specifications for Route 165. Out of the six samples, two samples were mixed with Portland cement, one sample with Calcium chloride, and one with asphalt emulsion. Two control FDR samples were tested without additives. The resilient moduli of FDR base/subbase layer were determined by using AASHTO T307-99 (FHWA, 2006, 2012).

The project used two and one half inches of Class 19 WMA for the base layer and two inches of Class 12.5 WMA for the

**Table 1 – Monthly traffic counts of Route 165 from Dec, 2014 to Nov, 2015.**

| Date | Vehicle class | | | | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | |
| Dec, 2014 | 28 | 1333 | 298 | 93 | 202 | 1625 | 13 | 1 | 12 | 0 | 3605 |
| Jan, 2015 | 17 | 1168 | 298 | 84 | 139 | 1301 | 4 | 1 | 84 | 0 | 3096 |
| Feb, 2015 | 19 | 1466 | 371 | 103 | 155 | 1495 | 2 | 2 | 38 | 0 | 3651 |
| Mar, 2015 | 22 | 1389 | 229 | 22 | 245 | 1966 | 11 | 1 | 49 | 3 | 3937 |
| Apr, 2015 | 38 | 1691 | 250 | 46 | 261 | 2136 | 13 | 0 | 30 | 1 | 4466 |
| May, 2015 | 41 | 2116 | 335 | 140 | 261 | 2015 | 12 | 4 | 41 | 1 | 4966 |
| June, 2015 | 64 | 2109 | 319 | 105 | 339 | 2180 | 25 | 5 | 65 | 1 | 5212 |
| July, 2015 | 37 | 2432 | 387 | 106 | 407 | 2115 | 20 | 1 | 56 | 2 | 5563 |
| Aug, 2015 | 43 | 2523 | 452 | 214 | 466 | 2064 | 16 | 6 | 45 | 1 | 5830 |
| Sept, 2015 | 34 | 2408 | 285 | 63 | 353 | 2234 | 20 | 0 | 78 | 0 | 5475 |
| Oct, 2015 | 24 | 1899 | 395 | 145 | 418 | 2144 | 7 | 2 | 64 | 0 | 5098 |
| Nov, 2015 | 36 | 1296 | 296 | 119 | 281 | 1781 | 23 | 0 | 66 | 2 | 3900 |
| Total | 407 | 21,835 | 3921 | 1247 | 3535 | 23,065 | 176 | 34 | 640 | 24 | 54,884 |
| Vehicle class distribution (%) | 0.74 | 39.81 | 7.14 | 2.27 | 6.44 | 42.05 | 0.31 | 0.05 | 1.16 | 0.03 | 100.00 |

surface layer. Mechanical properties of WMA including dynamic modulus ($E^*$) for the surface and base layers were acquired from Villanova University and Cardi Corporation.

Creep compliance was acquired from a URI study, and used as an input parameter for the Pavement ME software (Lee et al., 2014). The creep compliance results are used for new pavement layer only and for evaluating thermal cracking.

### 3.2. *Traffic spectrum data*

All truck traffic data inputted into the Pavement ME software came from a WIM station on Route 165, and was obtained from RIDOT's traffic research section. Data included average annual daily traffic (AADT) which is broken down into vehicle classification, monthly adjustment factors, hourly adjustment factors and daily vehicle counts. The average annual daily truck traffic (AADTT) is calculated for Class 4 to Class 13 vehicles of FHWA classification chart. The AADTT from December, 2014 to November, 2015 is 150 trucks per day as shown in Table 1.

### 3.3. *Climate input*

Climate is an important parameter in the Pavement ME and has to be downloaded from (.hcd) files from the website www.me-design.com. The download from the website is comprised of climate data for all 50 states of United States from 1997 to 2005 (AASHTO is in the process of updating their files to current climate data this spring). The closest active weather station to Route 165 is at TF Green Airport, Warwick. The downloaded climate data includes monthly temperature, precipitation, sunshine, air temperature, maximum frost depth and wind speed. The Pavement ME uses the climate data for transverse cracks (non-load cracks), an enhanced integrated climate model (EICM) to calculate the WMA temperatures on an hourly basis and the Pavement ME uses those hourly temperatures to estimate the WMA properties (creep compliance and indirect tensile strength) and to calculate the tensile stress throughout the WMA surface (AASHTO, 2015).

## 4. Performance prediction results

### 4.1. *Design criteria and reliability level*

Design performance and design reliability greatly affect deterioration of an adequately performing pavement. Performance criteria are used to ensure that a pavement design will perform satisfactorily over its designed life. The designer selects performance threshold distress values to judge the adequacy of a trail design. Designer also specifies the desired level of reliability for each distress type and smoothness. The level of design reliability could be based on the general consequences of reaching the terminal condition earlier than designed life. For RI Route 165, design criteria and reliability level are shown in Table 2.

### 4.2. *Performance prediction outputs of pavement ME*

Performance distress prediction outputs includes terminal IRI (in./mi), permanent deformation, AC bottom-up fatigue cracking, AC top-down fatigue cracking, AC thermal cracking and permanent deformation-AC only. As the aforementioned

**Table 2 – Design criteria or threshold values and reliability level for RI Route 165.**

| Distress type | Performance criteria | Reliability level (%) |
|---|---|---|
| Permanent deflection-total pavement (in.) | 0.75 | 90 |
| Asphalt concrete bottom-up fatigue cracking (percent lane area) | 25 | 90 |
| Asphalt concrete thermal fracture (ft./mi) | 1000 | 90 |
| Asphalt concrete top-down fatigue cracking (ft./mi) | 2000 | 90 |
| Permanent deformation asphalt concrete only (in.) | 0.25 | 90 |
| Terminal IRI (in./mi) | 172 | 90 |

**Table 3 – Comparison of performance predictions of five test sections of Route 165.**

| Design outputs | Target | Prediction | | | | |
|---|---|---|---|---|---|---|
| | | Control | Calcium chloride | Emulsion | Cement | Geogrid |
| Permanent deformation (in.) | 0.75 | 0.50 | 0.50 | 0.50 | 0.43 | 0.45 |
| AC bottom-up fatigue cracking (%) | 25.0 | 2.3 | 2.0 | 8.3 | 1.7 | 2.5 |
| AC top-down fatigue cracking (ACTDFC) (ft./mi) | 2000.0 | 2492.7 | 2086.5 | 3155.6 | 1448.9 | 2637.2 |
| Permanent deformation-AC only (in.) | 0.25 | 0.05 | 0.05 | 0.07 | 0.05 | 0.04 |
| AC thermal cracking (ft./mi) | 1000.0 | 84.3 | 84.3 | 84.3 | 84.3 | 84.3 |
| Terminal IRI (in./mi) | 172.0 | 144.7 | 144.0 | 145.3 | 142.7 | 144.0 |
| Years to predict threshold distress ACTDFC | 20 | 11 | 18 | 5 | 29 | 9 |

information, distress types are compared with targeted value specified by standard and selected reliability level. If the predicted distresses and achieved reliability are within the target values it shows the criterion as pass otherwise fail. To achieve good results and longer life for pavement, all distress type should pass the criterion. Five sections of RI Route 165 were analyzed with Pavement ME by using all the above-mentioned inputs.

### 4.3. *Comparison of all test sections of route 165*

The comparison of outputs obtained from Pavement ME software between the control and the other four test sections is shown in Table 3. The most -prevalent distress, in the four test sections, is in AC top down fatigue cracking (longitudinal cracking) for the control, $CaCl_2$, asphalt emulsion and geogrid. The Portland cement section is the only test section that does not have any predicted distresses. The higher the resilient modulus is, the better the results for less distress are. Having AC top down fatigue cracking (longitudinal cracking) means the pavement layer of four and one half inches is not thick enough for this road. Either the Class 12.5 HMA or the Class 19 HMA should have been thicker. The test sections in order of best performance are: Portland cement, $CaCl_2$, control, geogrid and asphalt emulsion with the smallest amount of cracking and highest predicted threshold distresses in years. All the test sections predict that there will not be any permanent deformation in the subbase or AC layer, or AC bottom-up fatigue cracking (alligator cracking). The higher resilient modulus, the better the results for less distresses.

## 5. Evaluation of performance of rehabilitated asphalt pavement

Pavement performance is a function of its relative ability to serve traffic over a period of time. Originally, pavement's relative ability to serve traffic was determined quite subjectively by visual inspection and experience. Typically, a system of objective measurements is used to quantify pavement's condition and performance. These systems are used to aid in making the following types of decisions.

(1) Establishing maintenance priorities.

Condition data such as roughness, surface distress, and deflection are used to establish the projects most in the need of maintenance and rehabilitation. Once identified, the projects in the poorest condition are more closely evaluated to determine repair strategies.

(2) Determining maintenance and rehabilitation strategies.

Data from surface distress surveys are used to develop an action plan on a year-to-year basis such as which strategy (patching, BSTs, overlays, recycling, etc.) is most appropriate for a given pavement condition.

(3) Predicting pavement performance.

Data, such as roughness, skid resistance, surface distress, or a combined rating, are projected into the future to assist in preparing long-range budget or estimating the condition of the pavements in a network given a fixed budget.

### 5.1. *Surface distresses and field condition survey of Route 165*

On December 21, 2015, pavement windshield surveys were conducted on Route 165 by URI research team. Five pavement sections (10 feet wide × 100 feet length) were selected near utility poles, previous FWD testing sites, and permanent land markers, for ease of identification. The pavement sections did not show any low, moderate or severe pavement distresses such as rutting or cracking but there were signs of minor raveling of the pavement. No major defects were expected since the pavement was recently placed in the summer of 2014. Thus, these December field surveys would become the base line for continuous monitoring of this road by URI students. Route 165 view after rehabilitation in 2014 is shown in Fig. 4.

### 5.2. *Comparative analysis between performance prediction and evaluation*

The Pavement ME output showed AC top-down fatigue cracking (longitudinal cracking) as the only output distress in four of the five test sections (Table 2). The predicted distress was over the target or threshold value. The target value represents the amount of distress that would trigger some type of major rehabilitation activity (AASHTO, 2015). According to the Pavement ME report, using the asphalt emulsion and Portland cement test sections, for example, it would take five years to reach the two thousand feet per mile for AC top-down cracking for the asphalt emulsion but

**Fig. 4 – Route 165 view after rehabilitation in 2014.**

twenty years for Portland cement. AC top-down cracking is caused by the pavement layer being too thin and a low resilient modulus. In the test sections, extra pavement thickness, cost analysis, and years to failure, Pavement ME inputs were re-run to see what would cause the predicted AC top-down cracking to go below the two thousand target threshold.

Thus, based on the aforementioned, it is known that it will take a number of years before the threshold distress can be predicted for the five test sections (i.e., control, $CaCl_2$, asphalt emulsion, Portland cement, and geogrid). And year number eight is the "unofficial" time where pavements start showing distress and will most likely need to receive some form of maintenance treatment (e.g., crack sealing, chip seal). That said, the asphalt emulsion and geogrid test sections are predicted to the need of treatment in four and five years in this study, with predicted AC top-down cracking of 3502 ft./mi and 3367 ft./mi. It was surprising to see how high the AC top-down fatigue cracking number in the asphalt emulsion test section because the material has been successfully used as an FDR additive in many states.

### 5.3. *Selection of best alternatives based on short-term evaluation*

Pavement ME can fit within the States' preservation system by using performance indicators that DTIMS does not. For instance, DTIMS catalogues IRI, rutting, cracking and deformation through yearly field surveys, while Pavement ME uses AADTT, resilient modulus, pavement layer make-up, HMA properties, and climate to predict the same pavement distresses over time. DTIMS surveys the surface course and Pavement ME predicts the subsurface conditions. Thus, Pavement ME predictions can be adjusted accordingly.

### 5.4. *Optimal strategies for rehabilitation*

One finding of the Pavement ME, is determining the right combination of subbase Mr to pavement thickness. Pavement ME makes it very easy to run multiple models for the worst and the best case scenarios. Resurfacings and reclamations should have Mr Values checked before construction to find if an additive would benefit the subbase stiffness. Monitoring pavement structural health index (PSHI) could identify a road for rehabilitation before it deteriorates too far, but the subbase Mr should be evaluated before treatment is determined. For example, too many times RIDOT has milled two inches and put back two inches of pavement on a road only to have the pavement break up in a short amount of time. The Pavement ME output could show how longitudinal cracking can be a sign of a pavement being too thin.

### 5.5. *Guidelines for long-term evaluation and optimal rehabilitation design strategies*

A material database consisting of resilient moduli, pavement core data and sieve analysis needs to be created for easy reference for design engineers. The RIDOT has years of collected data but unfortunately no "on-line" database. URI, on the other hand, has already done extensive resilient moduli testing with seasonal variations on subbase and subgrade materials and needs to incorporate these results into the state's database. The results of the testing should be included in one main database along with any new testing done (Jin et al., 1994; Lee et al., 1994).

LTPP currently has a Microsoft Excel Program that uses falling weight deflectometer (FWD) deflections to predict resilient moduli of the asphalt layers, subbase and subgrade materials. The program, however, requires pavement and subbase thicknesses as input parameters which a GPR can provide. FWD testing has already been performed on state highways and this information should be appropriately documented and compiled into a database. RIDOT's Pavement Committee, currently made up personnel from the materials, design, and construction sections, and oversees all pavement designs on both reconstruction and resurfacing projects.

## 6. Conclusions and recommendations

Pavement rehabilitation is defined as a resurfacing or restoration of existing pavement to extend its service life. It can be done by milling and/or overlay of the existing pavement. Pavement rehabilitation can be done after assessing the initial condition of the pavement. It is highly recommended to predict the performance of pavement before rehabilitation to avoid maintenance costs and efforts. To encounter this fact a research study was done on RI Route 165 located in Exeter with five different full depth reclamation (FDR) rehabilitation strategies (i.e., control, calcium chloride, Portland cement, asphalt emulsion, and geogrid).

The ultimate goal of the present study was to predict and evaluate the performance of test sections by using Pavement ME. The basic approach of Pavement ME is to select a trail design by incorporating traffic, climate, and material properties as input parameters and to predict the amount of distresses in terms of rutting, cracking and roughness. Traffic data is obtained from RIDOT traffic section and calculated the AADTT value required by Pavement ME. Climate data for all United States stations is embedded in Pavement ME, and Providence, RI station was used for the present study. Material properties included volumetric properties determined by

Superpave technologies and mechanistic properties, e.g., resilient modulus, dynamic modulus, and creep compliance).

The results of the present study showed that all test sections observed AC top-down (longitudinal) cracking except Portland cement section which passed for all criteria. Pavement ME also predicted the amount of years to show threshold distresses. The order in terms of performance (best to worst) for all test sections by Pavement ME was Portland cement, calcium chloride, control, geogrid, and asphalt emulsion.

It was also observed that AC top-down (longitudinal) cracking occurs due to thin top layer of asphalt. So, it was recommended that to provide additional one inch asphalt layer (i.e., 19 mm Class WMA) to avoid AC top-down cracking. Pavement ME didn't predict any distress type for all test sections with increased layer thicknesses.

It was also observed that higher the resilient modulus of pavement layer increases the stiffness of the material, hence the outcomes predicted by Pavement ME didn't show any distresses. This was confirmed because of the Portland cement section which has higher Mr Value didn't show any distress for almost 25 years.

Although Portland cement appears to be an excellent additive, the curing time can be a problem on narrow roads like Route 165 where detours are not possible. Detours drive up the costs for the project because of the additional traffic control and the delays to the traveling public. Portland cement should be considered for future projects only where a detour is feasible. Route 165 has 150 heavy trucks per day, and would benefit greatly from a more durable pavement like Portland cement. However this roadway could not support a detour, therefore, used alternating traffic for construction. It was recommended that conducting condition survey time to time can be used to verify the Pavement ME predictions. For that purpose, RIDOT will track all the performance data of all test sections of Route 165. Finally it will be interesting to see in the coming years that how well the Pavement ME predictions for the test sections come to be.

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