State of Florida
Department of Transportation

Effect of Asphalt Rubber Membrane Interlayer (ARMI) on Instability Rutting and Reflection Cracking of Asphalt Mixture

FDOT Office
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Authors
James Greene
Sungho Kim
Sanghyun Chun
Bouzid Choubane

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ABSTRACT

When an extensively cracked flexible or rigid pavement is overlaid with asphalt concrete, it is only a matter of time before the underlying cracks propagate into the overlay resulting in reflective cracking. Approximately 20 years ago, the Florida Department of Transportation (FDOT) began using an asphalt rubber membrane interlayer (ARMI) to mitigate reflection cracking on rehabilitation projects where existing cracks could not be entirely removed by milling and for asphalt overlays of concrete pavements. An ARMI is a specific type of stress absorbing membrane interlayer (SAMI) constructed of a single application of a No.6 stone seated into a layer of asphalt rubber binder. Today, an ARMI is the primary reflection crack mitigation technique used by FDOT.

In general, FDOT's experience with ARMIs has been mixed and construction quality is a universal concern among District Engineers. In addition to questioning the effectiveness of an ARMI to mitigate reflective cracking, some District Engineers suspect that an ARMI may contribute to instability rutting. The performance of an ARMI has been evaluated through an Accelerated Pavement Testing (APT) study and several long-term monitoring and experimental projects. As a result of these studies, FDOT has decided to seek an alternative reflective crack mitigation strategy. This report describes the studies that led to this decision, with a focus on the APT study.

INTRODUCTION

Background

When an extensively cracked flexible or rigid pavement is overlaid with asphalt concrete, it is only a matter of time before the existing distresses exhibited in the original pavement reflect through the new overlay. More than 30 years ago, the Florida Department of Transportation (FDOT) first studied the use of an asphalt rubber membrane interlayer (ARMI) to mitigate reflective cracking and began using an ARMI as the primary reflection cracking mitigation method approximately 20 years ago *(1)*.

An ARMI is a specific type of stress absorbing membrane interlayer (SAMI) constructed of a single application of stone seated into a layer of asphalt rubber binder (ARB). The ARB includes a minimum of 20 percent ground tire rubber (ARB-20). FDOT specifies a PG64-22 base binder and a 20, 40, or 80 mesh ground tire rubber. The ARB-20 is placed at a rate of 0.6 to 0.8 gal/yd^2 and uniformly covered with a No.6 stone at a rate of 0.26 to 0.33 ft^3/yd^2. Finally, a pneumatic tire roller is used to seat the stone into the ARB-20. A minimum initial overlay thickness of 1.5 inches is required to provide sufficient heat to properly bond the ARMI with the overlay.

Discussions with FDOT's District Engineers have revealed mixed experiences with ARMIs. In addition to questioning the effectiveness of an ARMI to mitigate reflective cracking, some District Engineers have suspected that an ARMI may contribute to instability rutting. The performance of an ARMI has been evaluated through an Accelerated Pavement Testing (APT) study and several long-term monitoring and experimental projects. As a result of these studies, FDOT has decided to seek an alternative reflective crack mitigation strategy. This report describes the studies that led to this decision, with a focus on the APT study.

Objectives and Scope

The primary objectives of this study were to assess the contribution of an ARMI to instability rutting and to determine the effectiveness of an ARMI to mitigate reflective cracking. To allow for a faster and a more practical assessment under closely simulated in-service conditions, APT was considered to address the study objectives. APT is generally defined as a controlled application of a realistic wheel loading to a pavement system simulating long-term, in-service loading conditions. This allows the monitoring of a pavement system's performance and response to accumulation of damage within a much shorter time frame. Pavement performance data from several long-term monitoring and experimental projects was also examined to support the APT data.

FDOT FIELD EXPERIENCE

Since the majority of FDOT's state maintained roadway system consists of flexible pavements, an ARMI is most often used when cracks cannot be entirely removed during a mill and overlay operation. However, ARMIs have also been used to mitigate reflection cracking of rigid pavement joints. Each of FDOT's Districts has utilized ARMs with varying degrees since an ARMI has become the primary reflective cracking mitigation strategy. An informal survey of District Bituminous Engineers (DBE) was conducted to determine the depth of District experience. In general, there was a wide range of experience. A summary of the survey is presented below:

- Younger DBEs and those who recently joined FDOT have limited experience with an ARMI since many roadways already include an ARMI from previous rehabilitation efforts. In addition, ARMIs are expensive and the perceived benefit does not always justify the cost, particularly in the current economy.
- Construction quality was a concern among all Districts. A competent contractor with proper equipment and trained personnel is essential.
- Some Districts reported localized increases in rutting when an ARMI was used. Limited studies have been performed, but have generally been inconclusive. When considering the use of an ARMI, it was noted that intersections should receive special consideration.
- Good performance, in terms of reflection cracking, is possible if the pavement system (including ARMI) is designed and constructed properly. Some DBEs felt that an ARMI was most successful when it was used on a rigid pavement, particularly over a cracked-and-seated concrete prior to the asphalt overlay.

FDOT has implemented four monitoring projects over the years that included an ARMI. Pavement performance monitoring typically included annual surveys to determine the extent of cracking, rut depth, deflection, and roughness. The following sections include brief descriptions of these efforts.

State Road 60, Hillsborough County

The first experimental investigating of an ARMI was completed in 1978 on State Road (SR) 60 in Hillsborough County *(1)*. This short-term project investigated ten 1,000 foot sections. Four of the structures included an ARMI, two received an asphalt rubber seal coat, and the other four consisted of standard constructions with variable thicknesses. The ARMI was located directly below an open graded friction course (OGFC) in two of the sections. An ARMI, leveling course, and a 1.5 or 2.5 inch overlay were placed above the existing pavement in the other two sections. After a six month period, extensive rutting and bleeding was observed in the wheel paths of the sections with an ARMI placed below the OGFC. No significant rutting or other distresses were found in the sections with the ARMI placed below the structural and leveling courses during the six month evaluation.

I-10 Rehabilitation

Starting in 1993 and extending through 1995, FDOT initiated the rehabilitation of seven deteriorating concrete pavement sections along the I-10 corridor in the northern part of Florida. The original 9 inch plain jointed concrete pavement included a 20-foot joint spacing and was placed on a 12 inch cement stabilized base. A crack-and-seat process was used to crack the concrete slabs into pieces no larger than 36 inches. An ARMI, 4 inches of typical FDOT structural asphalt mixture, and a 0.5 inch OGFC was constructed over the cracked-and-seated concrete. The pavement sections were monitored annually for 10 years to evaluate performance *(2)*. Cracks were first observed within five to seven years. Five out of the seven sections exhibited average rut depths of approximately 0.35 inches after 10 years. Two sections were resurfaced due to excessive rutting in 2000 and 2001. The excessive rutting was thought to be related to asphalt mixture issues. Overall, the pavement performance was thought to be satisfactory.

State Road 2, Baker County

An experimental project was established in 1998 on SR 2 in Baker County. Four of the experimental sections included a 2.5 inch overlay. An overbuild course was included on two of these sections. An ARMI was placed on one of the sections without the overbuild and above the overbuild on another section. A fifth section with a 3.5 inch overlay was also constructed with no ARMI. The experimental sections are still in service and have been monitored annually since construction. Nearly 1 million ESALs have been applied over the 14 years that the pavement has been in service. Rut depth and ride quality remain in acceptable ranges. Initial cracks were observed in each of the test sections within 4 to 5 years. Cracks were found primarily in the wheel paths and were typically oriented in the longitudinal direction. Unfortunately, a detailed crack map prior to construction of the experimental project is unavailable to determine if observed surface cracks were reflected from existing cracks and it is unclear how many cracks originated from the surface. At any rate, cores showed that some full-depth cracks did extended through the ARMI and performance data showed that sections that included an ARMI had a similar or a greater amount of cracking than the sections without an ARMI.

State Road 10, Gadsden County

An experimental project built during 2009 on SR 10 in Gadsden County consists of five sections constructed over a rigid pavement. Four sections include a 1.5 inch Superpave structural layer and a 1 inch dense graded friction course (DGFC). One of these sections includes an ARMI and another has a 1 inch open-graded crack relief layer (OGCRL). A 2.5 inch structural layer and 1 inch DGFC was placed on the fifth section. To date, slightly less than 200,000 ESALs have been applied to the experimental sections. The section with the ARMI was found to have some reflection cracks during the first annual evaluation. Cracks were also observed on two of the sections without a crack relief layer during the second annual evaluation. Currently, the section with an ARMI has at least twice as much reflection cracking as any other section. It is too early to form long term conclusions regarding the performance of the ARMI or the OGCRL.

Forensic Investigations

Several forensic investigations have been conducted that have identified an ARMI as a contributing factor to excessive rutting. Often, the actual condition of the ARMI is difficult to discern even in good performing sections but excessive ARB and an inconsistent stone layer evident in cores indicate poor construction quality. District engineers have suggested that an ARMI may contribute to excessive rutting by acting as a slip plane and/or through migration of ARB into the bottom lift of the overlay. Some examples of forensic investigations of excessive rutting thought to be at least partly due to an ARMI are listed below. Many of the investigations are found at intersections.

- SR 37 & Sheperd Rd intersection, Polk County
- US 27 & SR 540 intersection, Polk County
- SR 77 & US 90 intersection, Washington County
- I10, Okaloosa & Washington County

ACCELERATED PAVEMENT TESTING

In FDOT’s APT program, accelerated loading is performed using a Heavy Vehicle Simulator (HVS), Mark IV model. The HVS can apply wheel loads between 7 and 45 kips along a 20-foot test strip. The HVS is electrically powered (using an external electric power source or electricity from an on-board diesel generator), fully automated, and mobile. A complete description of the test facility has been presented elsewhere *(3)*. The HVS and test tracks are shown in FIGURE 1.

FIGURE 1 FDOT'S HVS and APT test tracks.

APT Experiment Design

Five test lanes were designed and constructed to evaluate an ARMI's role in instability rutting. The existing asphalt was milled from four lanes so that only 1 inch remained. An ARMI was placed on the milled surface of three of the lanes. Hot mix asphalt (HMA) overlays of 2, 3, and 4 inches were then placed over the ARMI. A 4 inch overlay was placed without an ARMI as a control lane. In addition, a new 2 inch HMA pavement was built with an identical base and subgrade. The HMA was designed as a 12.5 mm Superpave mixture and included granite aggregate and 5.1 percent PG76-22 asphalt binder.

Two additional HMA overlays were constructed over a 9 inch plain jointed concrete pavement to investigate reflection cracking mitigation. The original slabs had a joint spacing of 12 to 16 feet. Additional joints were cut so that each test section would include 4 to 5 joints. An ARMI and 1.5 inch HMA overlay using the same design previously discussed was placed over one concrete lane and a HMA overlay without an ARMI was placed over the second concrete lane. FIGURE 2 illustrates each of the pavement structures evaluated for instability rutting and reflection cracking.

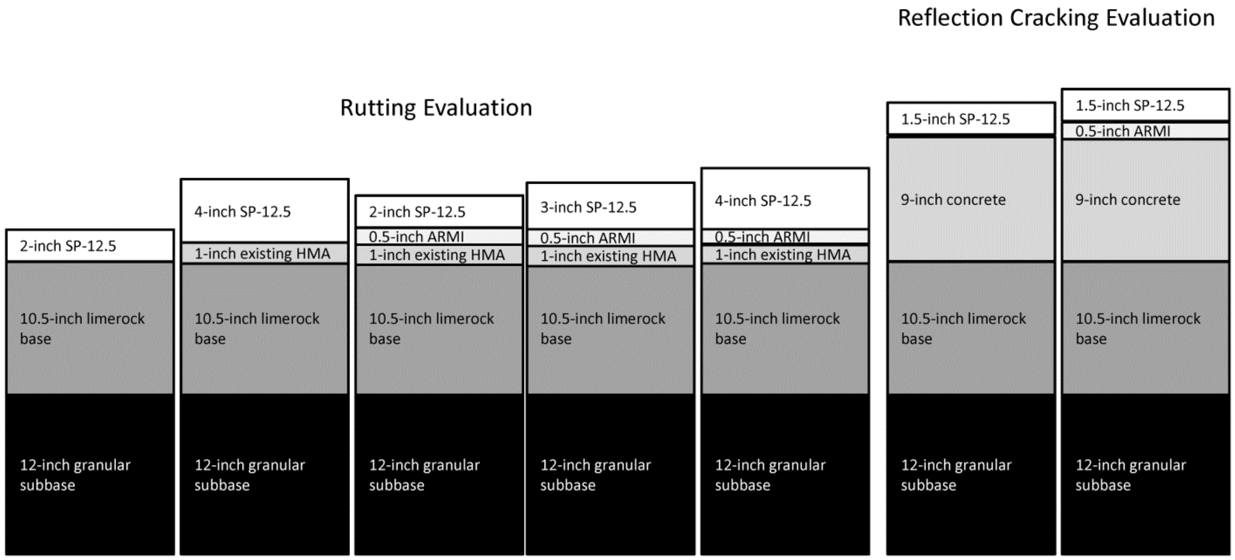


FIGURE 2 Pavement structures evaluated in the APT study.

APT INVESTIGATION OF INSTABILITY RUTTING

During HVS testing, the pavement was heated to 120 °F and trafficked with a 455 mm wide base single tire (Michelin X One XDA-HT Plus 455/55R22.5) loaded to 9,000-pounds and inflated to 100 psi. A wheel wander of 4 inches was used for each test. A previous FDOT study showed that when compared to a standard dual tire, the 455 mm wide base single tire produced similar rut depths but less shear stress at the tire edge *(4)*. Three randomly sequenced tests of each lane with an ARMI and the 4 inch control lane were performed to account for construction variability. Due to time constraints, only one test was conducted on the new 2 inch thick pavement.

Rut depth measurements were obtained periodically using a laser-based profiling system mounted on the underside of the HVS wheel carriage.

FIGURE 3 shows the average rut history for each test lane. The APT rut profile data showed that the rate of rutting increased considerably when an ARMI was present. On average, all test lanes with an ARMI exhibited a 0.5 inch rut depth within 15,000 HVS repetitions while tests on the control lanes without an ARMI were projected to reach a 0.5 inch rut depth after approximately 250,000 passes. Given this projection, the test lane with the 2-inch overlay with an ARMI attained the critical rut depth (i.e. 0.5 inch rut depth) 50 times faster than control lanes. The test sections of 3-inch and 4-inch overlays with an ARMI reached the critical rut depth approximately 20 times faster than control lanes.

To assess the influence of pavement temperature, an additional test was performed on the section with a 4 inch overlay and ARMI. The test was initiated at 105 ^{o}F and then increased to 115 ^{o}F. The test temperature was measured at a depth of 4 inches which corresponded to the location of the ARMI.

FIGURE 4 shows that rutting increased significantly when the temperature increased from 105 ^{o}F to 115 ^{o}F. Thermocouples were placed in the 4 inch overlay section with an ARMI and monitored at depths of 2 inches and 4 inches during the month of August to assess how frequent the in-depth asphalt pavement reaches this critical temperature during the summer. Pavement temperatures were found to be greater than 115 ^{o}F for 25 and 30 percent of the day at depths of 4 inches and 2 inches, respectively. Furthermore, pavement temperatures were greater than 120 ^{o}F for 8 and 19 percent of the day at depths of 4 inches and 2 inches, respectively.

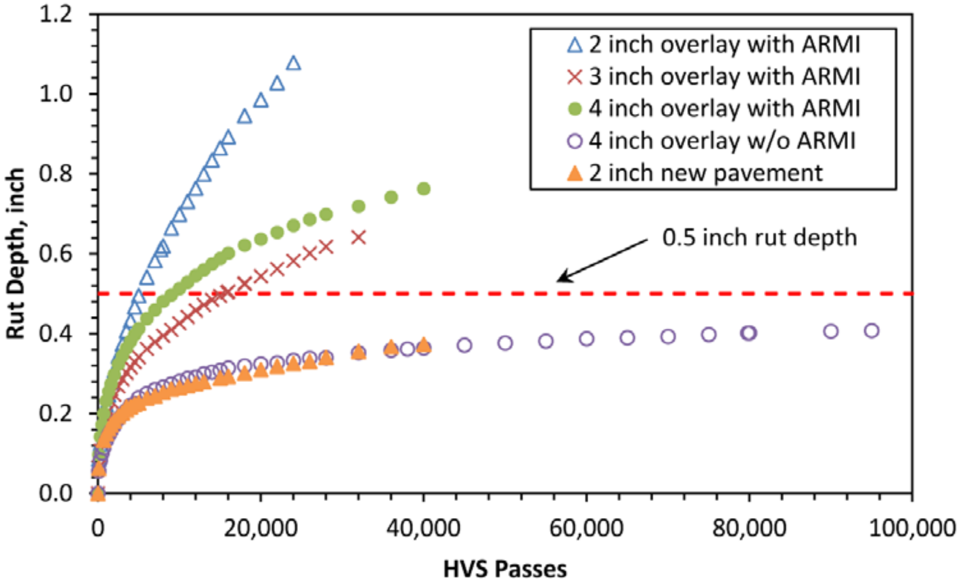


FIGURE 3 APT rut profiles.

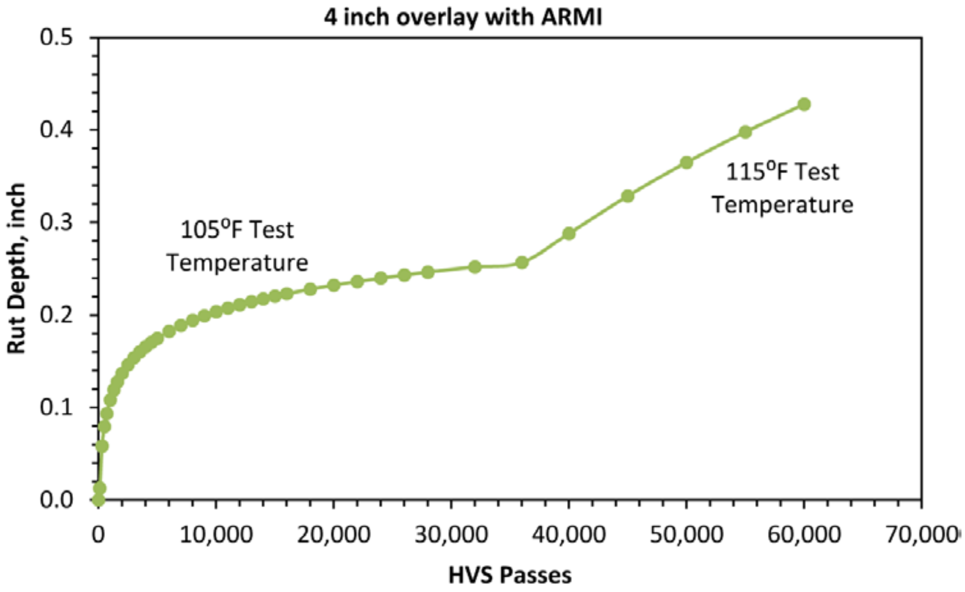
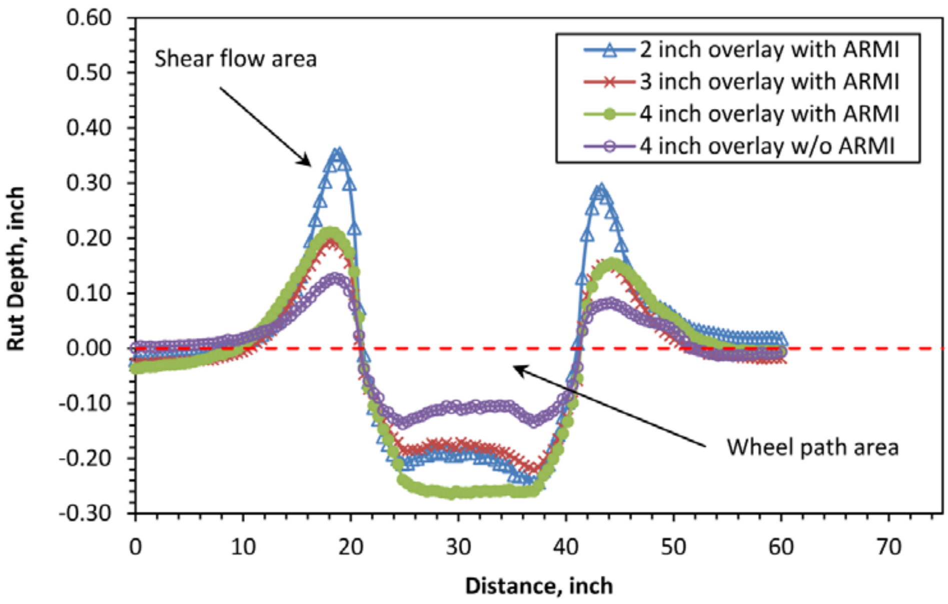


FIGURE 4 Temperature effect on instability rutting due to an ARMI.

The portion of rutting due to shear, or instability, may be estimated within a transverse rut profile by estimating the area of accumulated material at the edge of the rutted wheel path and comparing the sheared area to the empty area or volume below the wheel path *(5, 6, 7)*. For instance, a larger shear to wheel path area ratio indicates a greater portion of rutting is due to shear flow and mixture instability as opposed to densification. FIGURE 5 shows transverse rut profiles for each pavement section except for the 2 inch new pavement at 10,000 passes and summarizes the rut and shear information for several other pass levels. The new 2 inch pavement was not included since only one test was conducted and the general trend appeared to be similar to that of the 4 inch overlay without an ARMI. The sections with an ARMI had larger shear to wheel path area ratios indicating a greater portion of rutting is due to instability.

Lane slices were performed on one pavement section from each lane. Layer interfaces of the overlay were difficult to discern, but the lane slices indicated that rutting occurred in the layers above the ARMI. A popular theory forwarded by field personnel to explain instability rutting of pavement sections with an ARMI suggested that asphalt rubber binder from the ARMI may be migrating into the overlay when subjected to traffic, creating an instable mixture. Asphalt content determined from cores in the rutted wheel path and unloaded sections nearby the test lanes indicated that ARB-20 did not migrate into the lower structural layer.



Pass Number	2 inch Overlay w/ ARMI		3 inch Overlay w/ ARMI		4 inch Overlay w/ ARMI		4 inch Overlay w/o ARMI	
	Rut, inch	Shear Area /WP Area	Rut, inch	Shear Area /WP Area	Rut, inch	Shear Area /WP Area	Rut, inch	Shear Area /WP Area
100	0.09	0.84	0.07	0.54	0.10	0.59	0.06	0.23
5,000	0.50	1.00	0.34	0.80	0.41	0.74	0.24	0.59
10,000	0.70	1.00	0.43	0.82	0.51	0.77	0.28	0.63
20,000	0.99	1.00	0.54	0.84	0.64	0.73	0.32	0.64
100,000	N/A	N/A	NA	N/A	N/A	N/A	0.41	0.73

FIGURE 5 Transverse rut profiles after 10,000 passes.

Effect of an ARMI on Pavement Stress States

Historically, many design approaches associated the rut potential of a flexible pavement system with the subgrade vertical strain *(8, 9)*. These procedures assumed that surface rutting could be controlled by limiting the vertical subgrade strain as long as the structure was well designed and the materials placed above the subgrade were of good quality. Other procedures such as the Mechanistic-Empirical Pavement Design Guide (MEPDG) use the vertical strain of each pavement layer to predict the total accumulated rut depth *(9)*. Several recent studies have associated the contact stress of radial tires with near surface pavement distresses including instability rutting and top-down cracking *(10, 11)*. These studies used Mohr-Coulomb failure criteria and finite element models to investigate the near surface three dimensional stress states. Shear stresses near the tire edges or under the grooves between adjacent tire ribs were found to be critical in the formation of instability rutting.

The commercial software ADINA was used for Finite Element (FE) modeling of the pavement structure and tire contact stress. A symmetrical geometry about the x- and y-axis (transverse and longitudinal directions) was used to reduce the number of elements for a three-dimensional model without compromising the analysis. To minimize the effect of boundary conditions, the model dimensions were 100 inches wide by 100 inches in length. A 3D element with 10 nodes was used as the element type. The Delaunay technique was used to create a finer mesh near the loaded area and the x-axis, while a relatively coarser mesh was used at the boundaries.

The modeled pavement structures included the 2 and 4 inch overlay sections with an ARMI and the 4-inch overlay without an ARMI. The asphalt modulus was estimated using deflection analysis of the pavement lanes and confirmed with laboratory resilient modulus testing. The modulus of ARMI was estimated based on a composite modulus method *(12)*. The stabilized subgrade and embankment were combined in the model to simplify the analysis. In order to more accurately model the true tire contact area, the imprint of the 455 mm tire tread was measured at the load and inflation pressure used during testing (9 kip and 100 psi). Vertical contact stresses of each tread were taken from another. *(13)*. An image of the imprint and the contact stresses used are shown in FIGURE 6.

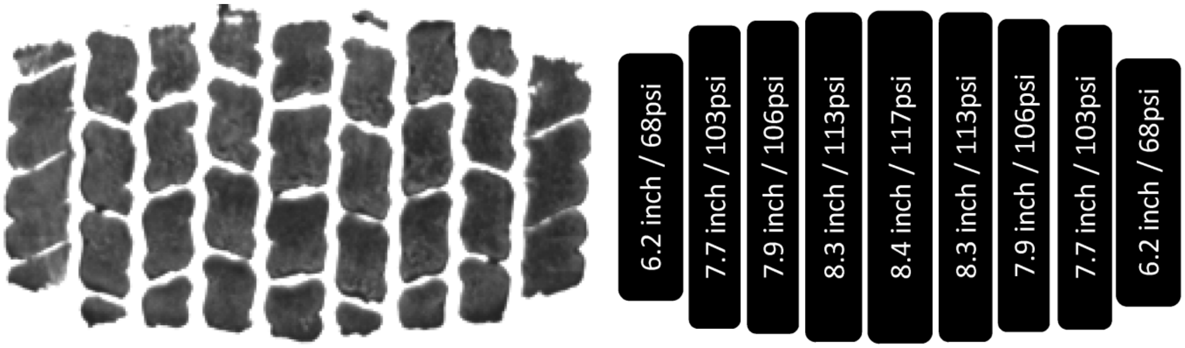
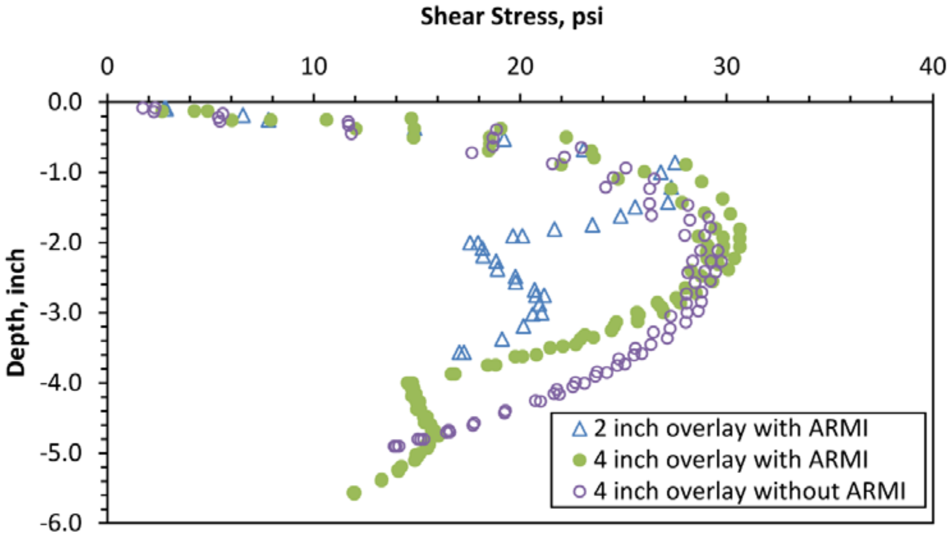
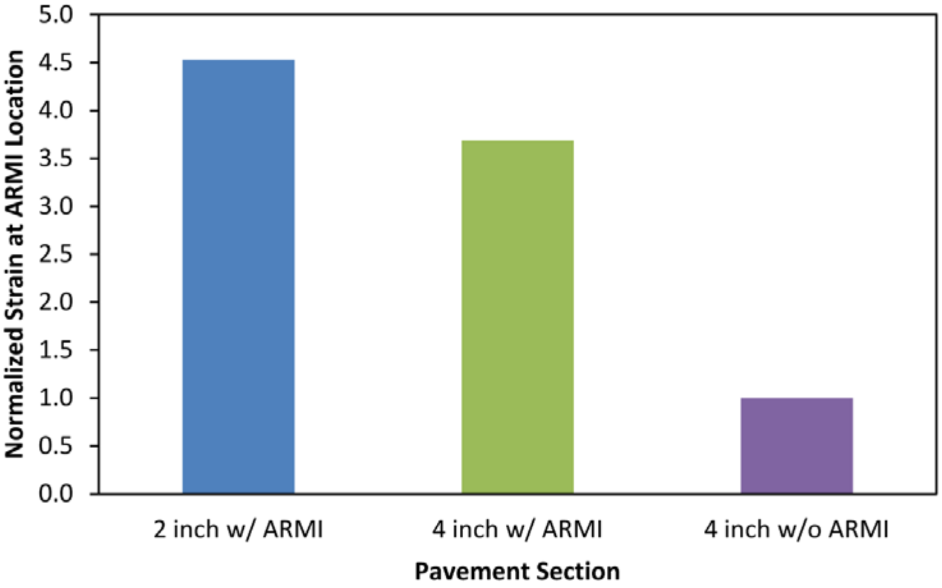


FIGURE 6 Tire imprint and contact stress.

The FE model showed that the maximum shear stresses occurred just above the ARMI and below the outside tire edge. Shear stress below the tire edge increased with depth and reached a maximum at approximately 2 inches for the 4 inch overlays with and without an ARMI and approximately 1 inch for the 2 inch overlay with an ARMI. Instability rutting usually refers to rutting in the top two to three inches of the asphalt layer. However, since the ARMI was placed 4 inches in depth, stress states for the total pavement thickness above the ARMI were calculated. Stress states were also determined for the top 4 inches of the asphalt in the control pavement without an ARMI. FIGURE 7 shows the shear stress at the tire edge and the normalized transverse strain at the location of the ARMI at 120 °F. Based on FIGURE 7, it was found that the 2 inch and 4 inch overlay sections with ARMI exhibit approximately 4.5 and 3.7 times greater transverse strain at the location of the ARMI, respectively.



(a) Shear stress at tire edge



(b) Normalized strain at ARMI

FIGURE 7 Shear stress at the tire edge and normalized strain at the ARMI location.

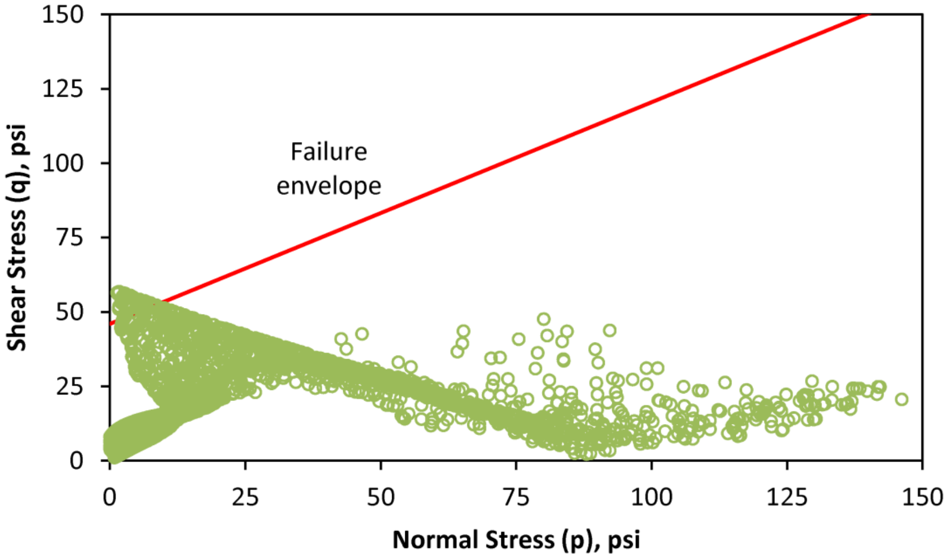
Critical Stress States and Locations

Shear strength of asphalt mixture is primarily developed due to the adhesion of the binder and the interlocking frictional component of the aggregate matrix. Mohr-Coulomb failure theory is often used to describe stress states within a soil system *(14)*. Several recent studies have utilized Mohr-Coulomb failure criteria and FE models to investigate the near surface three dimensional stress states associated with instability rutting and top-down cracking *(10, 11)*.

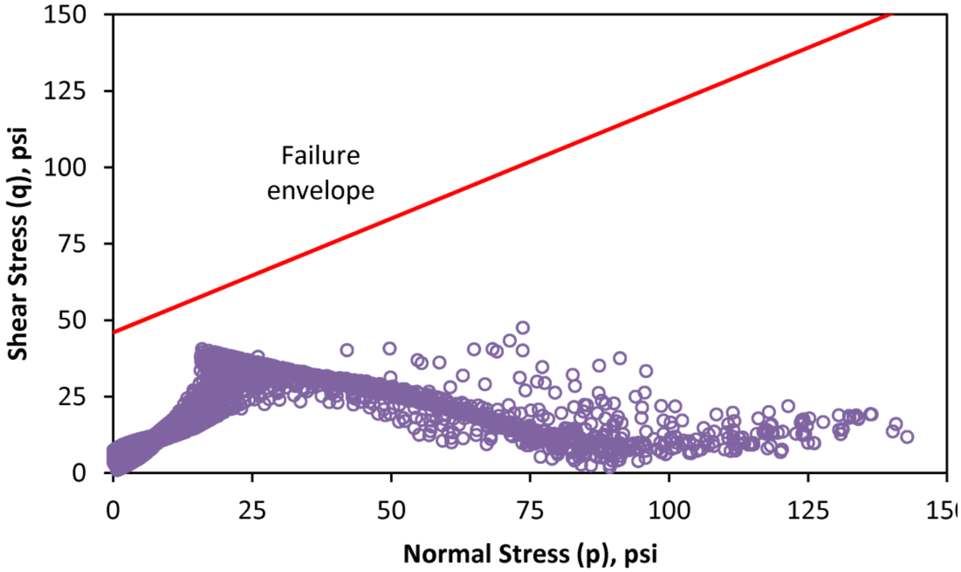
The Mohr-Coulomb failure envelope is characterized by the mixture's internal angle of friction and the normal and shear stress at failure. The radius and center of the Mohr's circle, the graphical technique to express the stress states of a loaded material, are determined by the maximum and minimum principal stresses applied to the material. The material becomes unstable when combinations of principal stresses form a circle that approach or intersect the failure envelope. It is often more convenient to plot multiple stress states using a p-q diagram, where p and q represent the normal and shear stresses, respectively. Correspondingly, the traditional Mohr-Coulomb failure envelop can be plotted in p-q space through simple relationships.

Research has shown that the friction angle of HMA is independent of temperature while the cohesion is greatly dependent on temperature *(15)*. A literature review found that a friction angle of 40° and cohesion of 60 psi at 120 °F are reasonable assumptions for typical asphalt mixtures *(10, 15)*. FIGURE 7 shows the stress state as a p-q diagram for the 4-inch overlay section with an ARMI and control section without an ARMI at 120 °F. This pavement temperature represents a typical Florida summer day and is also the same temperature that HVS testing was conducted at. Based on the p-q diagram presented in FIGURE 8, the magnitude of shear stress is greater for the section with an ARMI than the section without an ARMI. The combinations of shear stress and confining stress induce a more critical stress state for the section with an ARMI. Critical locations correspond to areas with low confining stress and high shear stress.

The concept of stress ratio (i.e. yield ratio) can be used to determine the degree of criticality of each stress state. The Mohr-Coulomb criterion assumes that the material will fail if q is equal to $q_{failure}$ (i.e. stress ratio is equal to 1). Since the stress states are symmetrical with respect to the tire center, only half of the pavement section is shown with half of the tire treads indicated in the top left corner of each figure. FIGURE 9 illustrates the ratios for the estimated stress and stress at failure using Mohr-Coulomb criteria for the 4-inch overlay sections with and without an ARMI at 120 °F. Critical stress ratios are found just above the ARMI and just outside of the tire edge for the section with an ARMI.



(a) 4 inch overlay with ARMI



(b) 4 inch overlay without ARMI

FIGURE 8 p-q diagram of the 4 inch overlay with and without ARMI

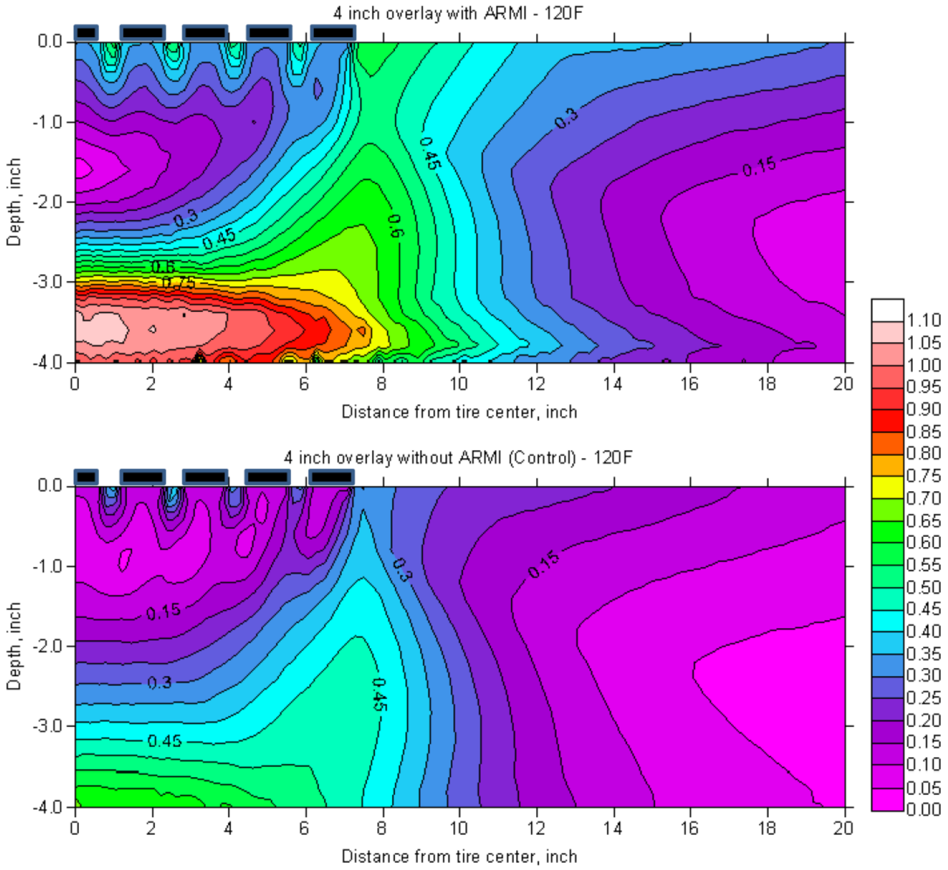


FIGURE 9 Stress ratios ($q/q_{failure}$) of the 4-inch overlay with ARMI and without ARMI

APT INVESTIGATION OF REFLECTION CRACKING

Reflection cracking test sections were intended to be monitored for development of cracks reflected from the differential movement of the concrete slab joints under HVS loading. However, within two weeks after placement of the overlay, reflection cracks appeared on all of the joints on the test lane without an ARMI and approximately 25 percent of the joints on the test lane with an ARMI. Three weeks after construction, 50 percent of the joints on the test lane with an ARMI had reflection cracks. Cores showed that the cracks were shallow and originated from the surface, indicating that excessive tensile stress due to curling of the concrete slabs initiated the surface cracks. Literature has shown that top-down reflection cracking can be caused by a combination of thermal contraction and curling of the pavement as indicated in FIGURE 10 (*16*).

Linear variable differential transducers (LVDTs) were installed at several joint edges to measure the average horizontal and vertical movement of the concrete slabs during the months of

June and July. During this time period, the average maximum daily horizontal and vertical movement was 0.29 mm and 0.07 mm, respectively. FIGURE 11 shows the movement of the concrete joint due to thermal change.

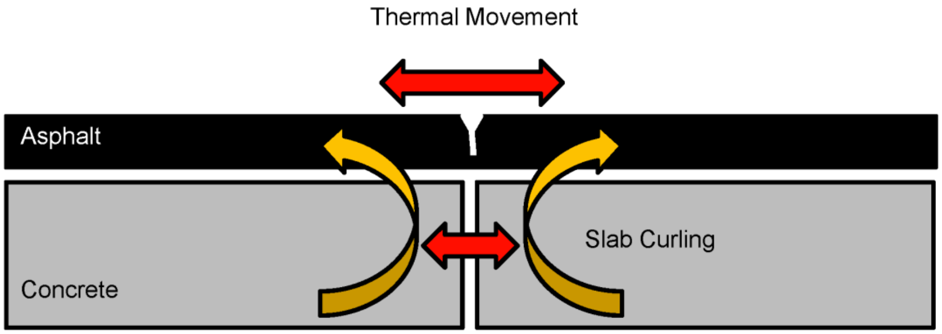
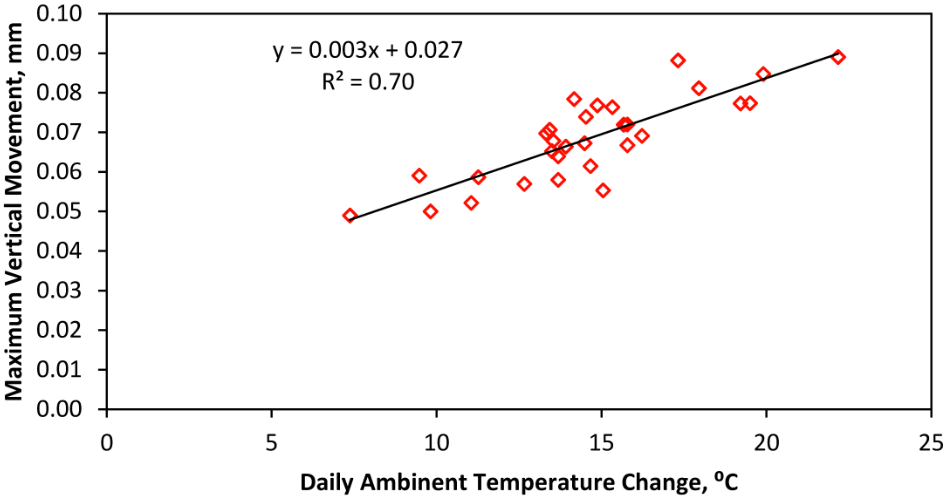
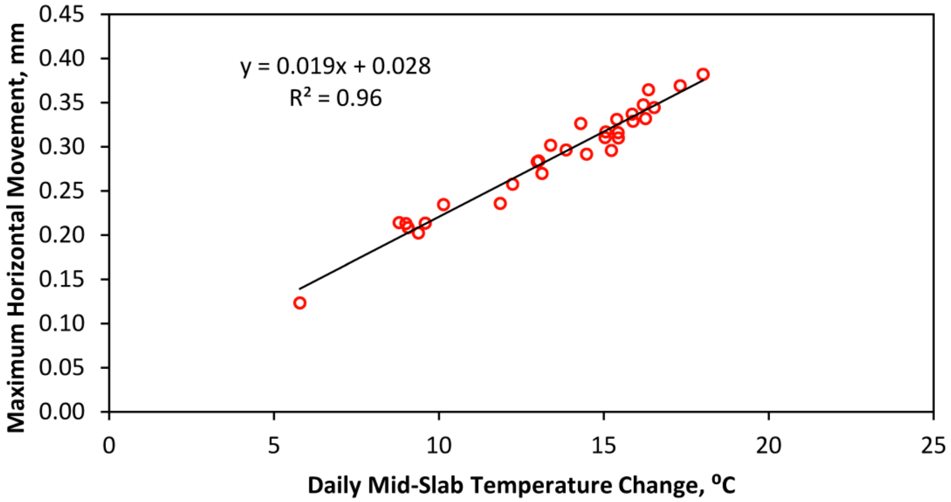


FIGURE 10 Top-down reflection cracking due to thermal movement.



(a) Daily vertical movement



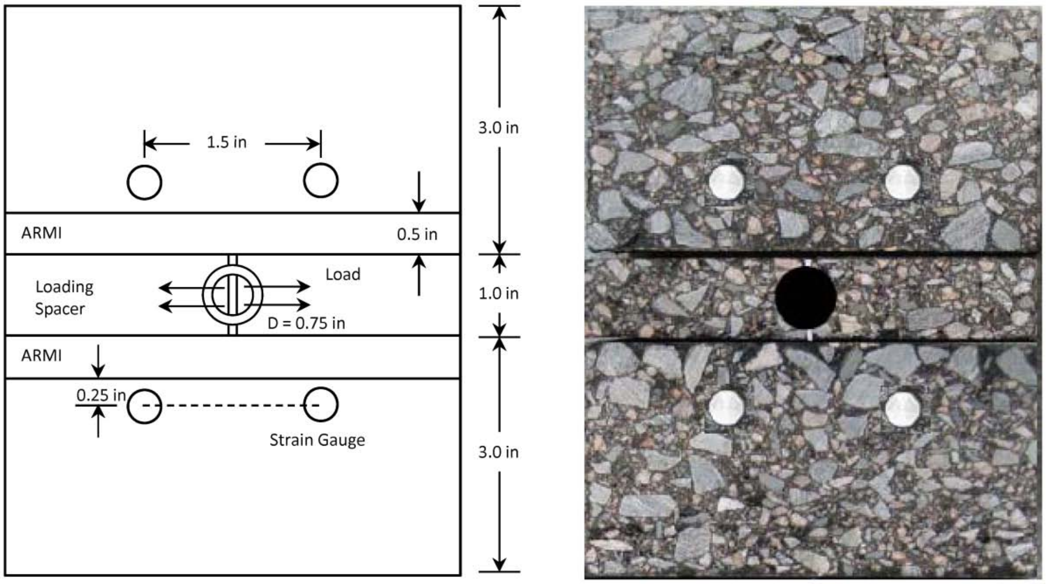
(b) Daily horizontal movement

FIGURE 11 Concrete joint movement due to thermal change.

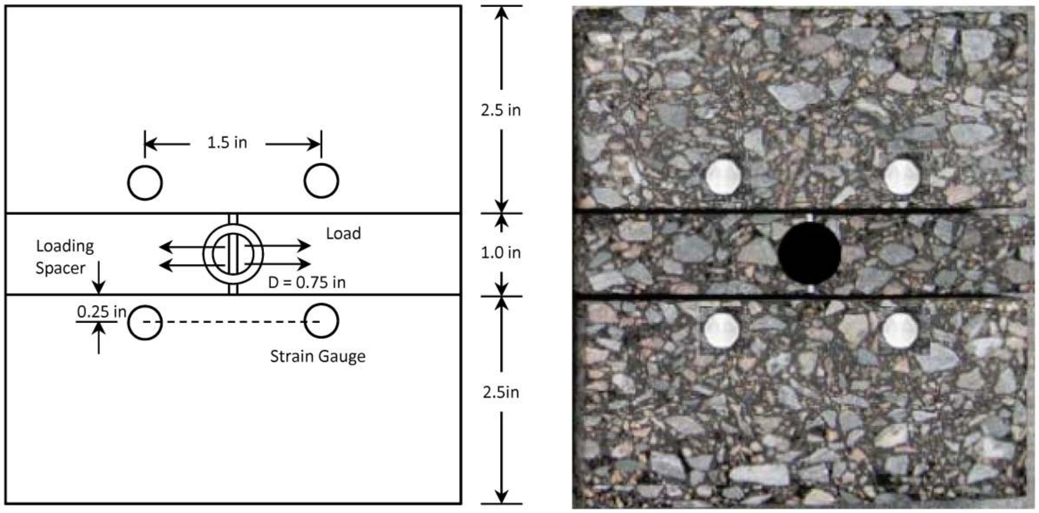
Reflection Cracking Assessment Using the CSIC Test

The Composite Specimen Interface Cracking (CSIC) test recently developed at the University of Florida was used to evaluate the reflective cracking mitigation potential of the pavement sections constructed with and without an ARMI *(17)*. The CSIC test was developed to simulate crack initiation and propagation of bonded interface conditions (*18*). The test monitors the damage rate (reduction in stiffness) on composite specimens subjected to repeated tensile loading. A complete description of the test procedure is presented elsewhere (*17*, *18*). The CSIC tests were conducted with field cores obtained from the test tracks that included a 4 inch overlay with and without an ARMI. The cores were trimmed to remove the original existing asphalt pavement. A 1 inch layer was cut from the top parts of cores and used as central loading spacer. Two half specimens were epoxied to the central loading spacer to form a completely symmetrical composite specimen as shown in FIGURE 12. A Teflon spacer was introduced to represent an existing crack, which more effectively concentrated stress at the interface. A diamond-tip coring tool was used to create a 3/4-inch hole through which loading was applied. The specimen's curved ends were reinforced with carbon fiber to eliminate a potential bending failure.

Repeated load fracture tests were performed on three composite specimens for each section with and without an ARMI using the same peak load. The load level was selected such that damage and fracture developed gradually (i.e. not catastrophically) to optimize the ability to identify the effects of an ARMI layer on damage and fracture. To eliminate specimen-to specimen variations, recoverable deformation was normalized to its value at the beginning of the test. Since the recoverable deformation measurement is inversely related to the stiffness, the change in recoverable deformation can be used to monitor damage. FIGURE 13 shows a typical plot of a recoverable deformation versus time. FIGURE 14 summarizes the test results including the number of loading cycles to failure and damage rate. It was found that specimens without an ARMI generally exhibited better performance than specimens with an ARMI in terms of reflective cracking resistance. This type of performance matches the mixed field observations and suggests that an ARMI is often not effective in mitigating reflection cracks.



(a) Composite specimen with an ARMI layer.



(b) Composite specimen without an ARMI layer.

FIGURE 12 CSIC test specimens with and without an ARMI layer

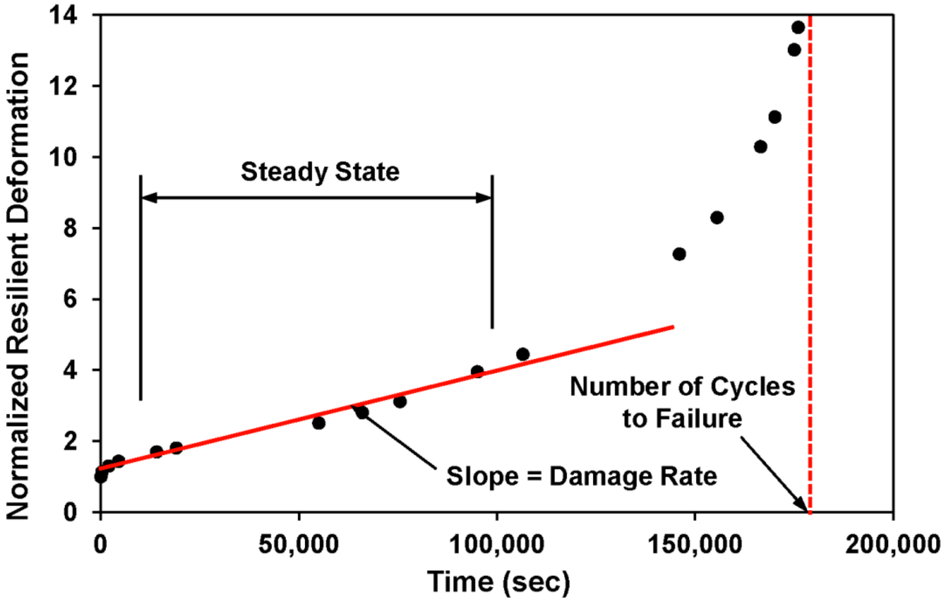
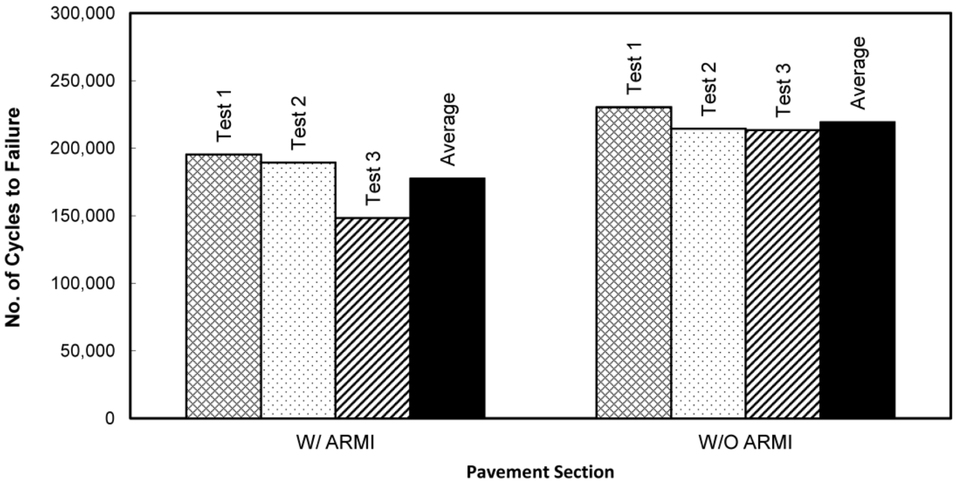
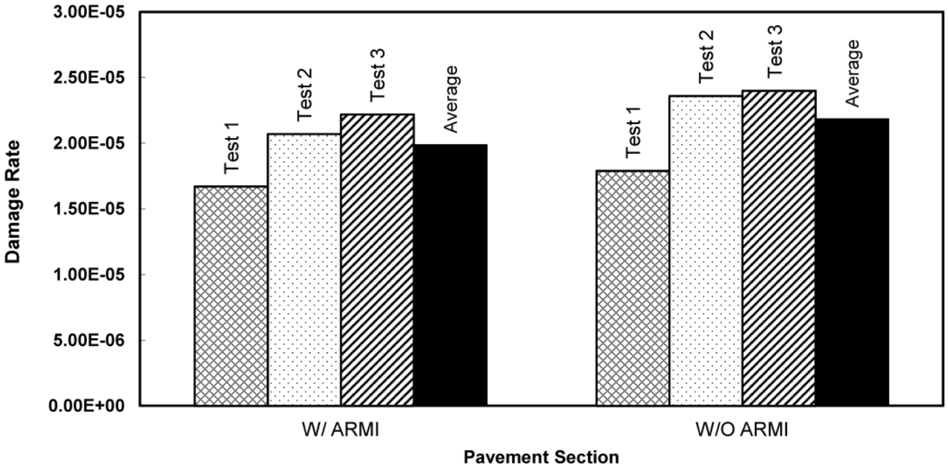


FIGURE 13 Typical recoverable deformation and damage rate.



(a) Number of cycles to failure



(b) Damage rate

FIGURE 14 CSIC test results.

SUMMARY AND CONCLUSIONS

An APT study and field observations have shown that an ARMI has the potential to instigate instability rutting and is often not effective in mitigating reflection cracking. A summary of the findings are presented below:

- An APT study found that an ARMI placed as deep as 4 inches contributed to instability rutting when subjected to a combination of slow moving truck loads and in-depth pavement temperatures that exceeded 115 °F. It is not uncommon for in-depth pavement temperatures to reach this temperature during the summer.
- The pavements with an ARMI reached a rut depth of 0.5 inches 20 to 50 times faster than the pavements without an ARMI.
- Transverse rut profiles indicated that all sections with an ARMI exhibited greater shear flow and mixture instability than sections without an ARMI.
- FE analysis indicated that the combination of shear stress and confining stress induces a more critical stress state for pavements that include an ARMI. Critical stress ratios were found just above the ARMI and just outside of the tire edge for the sections with an ARMI.

- Long-term monitoring projects, experimental projects, and APT test sections indicated that an ARMI did not effectively mitigate reflection cracking. The performance of an ARMI was found satisfactory when applied over a cracked-and-seated concrete pavement.
- Laboratory tests (CSIC test) indicated that cracking was initiated within the ARMI and propagated through the ARMI and into the overlay. Laboratory specimens without an ARMI generally exhibited better reflective cracking resistance than specimens with an ARMI.

Based on the findings presented in this report, FDOT has initiated a research project to seek an alternative reflection cracking mitigation strategy. An ARMI will continue to be available for use, but is no longer considered the primary strategy to mitigate reflection cracking.

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