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Cooperative Agreement
DEVELOPMENT & DEPLOYMENT OF INNOVATIVE ASPHALT PAVEMENT TECHNOLOGIES (DDIAPT2)

Innovative Area: A. Materials
A.3: Other New & Innovative Materials as Agreed Upon
Statement of Work A.3.1: Use of High Polymer Modified Asphalt (HP) Binders and Mixtures Gap Analysis

Memorandum D
Summary of Virtual Site Visit with the Utah Department of Transportation

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Use of High Polymer Modified Asphalt (HP) Binders and Mixtures Gap Analysis Virtual Site Visit

State:	Utah	District/Region:	Utah DOT
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Visit Type:	Asphalt Materials and Pavements	Visit Date:	August 28, 2024
In Company With: Howard Anderson and Scott Nussbaum (UDOT) Dave Johnson (AI) Elie Hajj (UNR)		Federal Project Number(s):	Cooperative Agreement No. 693JJ32350026
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☐ PODI

☒ Scheduled/Requested Visit? Activity requested by FHWA

☐ Unscheduled Review?

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Background

Polymer modification of asphalt binders is not a new concept and has become progressively more common over the past several decades. Over the past 50 years, asphalt binders have been modified with various components such as polymers, ground tire rubber, chemicals (e.g., acids), and recycled engine oils to enhance the properties of asphalt mixtures (Habbouche et al., 2020; Habbouche et al., 2021a). Several State departments of transportation (DOTs) have recognized the benefits of polymer-modified asphalt mixtures in resisting multiple modes of load- and climate-induced distress in flexible pavements (Habbouche et al., 2019). The most commonly used polymer-modified asphalt (PMA) binders (referred to herein as PMA binders) have rarely exceeded a polymer content of approximately 3.5% due to practical issues such as mixing, storage, and workability. However, a new polymer structure has allowed for its use in asphalt binders at much higher levels (approximately 7.5%), referred to herein as high polymer (HP) binders. The Utah Department of Transportation (UDOT) does not specify this polymer content and estimates that the HP polymer content is approximately 5%. These binders exhibit significantly greater elasticity, which may help mitigate some of the pavement failure modes that concern agencies (Bowers et al., 2017 and 2018).

HP binders offer additional advantages when used in asphalt mixtures subjected to heavy and slow-moving traffic. This application aligns with the Federal Highway Administration (FHWA)'s commitment to advancing resilient and high-performing infrastructure. The effectiveness of this technology was highlighted as a promising tool in the Every Day Counts (EDC)-6: Targeted Overlay Pavement Solutions (TOPS) program toolbox, featured alongside other asphalt overlay products (FHWA, 2021). Its inclusion aimed to enhance safety, improve performance, preserve investments, and realize cost savings. However, available information on mixtures utilizing HP binders (referred to herein as HP mixtures) is limited to specific field trials conducted in selected States. In addition, the use of HP binders has been limited to specific paving applications, primarily focusing on dense and open-graded mixtures, neglecting their use in gap-graded mixtures (e.g., stone matrix asphalt [SMA] mixtures). The development of specifications to characterize HP binders remains State-specific, lacking information related to defining and accepting such specialized binders. Information, lessons learned, and positive practices on the use of recycled materials and additives in HP mixtures are also limited. A recent study from Virginia Transportation Research Council (VTRC) indicated that 21 agencies have engaged in or constructed pilot projects involving HP mixtures (Habbouche et al., 2021b). As part of the FHWA EDC-6 TOPS Program, a case study highlighting Florida's experience with HP binders and mixtures provided helpful insights into research, construction considerations, and cost factors (Vargas et al., 2022). However, limited information on field performance was provided, and possibly missing practices from other States that use different raw materials and experience diverse climates.

The "Development and Deployment of Innovative Asphalt Pavement Technologies" program, referred to herein as the Asphalt | Innovate | Enlighten | Implement (AIEI) Program, is a five-year cooperative agreement with FHWA (9/23–9/28). The purpose of this program is to address the ongoing challenges faced by the transportation community to adopt new technologies and reduce the time to implement them in business practices, specifications, and construction methods relating design, production, testing, control, construction, and investigation of asphalt pavements. This project also supports the overall goals of advancing 21st-century solutions and improving performance and safety to keep America moving forward. Multiple efforts were undertaken as part of Year 1 of this effort. Among these, the effort entitled

"Use of High Polymer Modified Asphalt (HP) Binders and Mixtures – Gap Analysis", was undertaken (SOW A.3.1).

Objective

The overarching objective of this effort is to facilitate and conduct a comprehensive gap analysis on the use of HP binders and mixtures and identify critical limitations, gaps, and needs through Strengths-Weaknesses-Opportunities-Threats (S.W.O.T) analysis. In addition to addressing these limitations, the scope includes identifying and putting forth effective practices and lessons learned by DOTs. This will provide DOTs with valuable information for designing, constructing, and accepting HP binders and mixtures, and will complement the work completed under the FHWA EDC-6: TOPS program. To accomplish this objective, information was collected through virtual site visits and other means with five key agencies. UDOT graciously agreed to host a virtual site visit.

Scope and Outcomes

The scope of each virtual site visit included:

- Watching a short pre-recorded kick-off webinar that expanded on the objectives of the effort.
- Completing a comprehensive data-gathering form developed by the Team, which consisted of 30 questions divided into nine modules.
- Attending a 2-hour meeting to discuss the agency's responses and address any additional follow-up questions or requests for information.

The outcomes of each virtual site visit included a summary of meeting notes, the recorded virtual site visit with the agency, and a brief summary memorandum to each FHWA Division Office and the agencies visited, outlining the observations and any recommendations identified.

This document serves as the brief summary memorandum on the observations and findings identified through the UDOT virtual site visit.

Practice and Usage

UDOT currently specifies and allows the use of HP mixtures for standard maintenance and construction projects. UDOT defines HP binders as those that meet the specifications for performance grade (PG) 76-34 in accordance with AASHTO M 320, along with several additional requirements (UDOT, 2024a). These requirements include minimum elastic recovery and limits on the complex shear modulus (G^*), phase angle (δ), creep stiffness (S), slope (m-value), and the difference in critical low temperatures (ΔT_c), for binders with a useful temperature interval (UTI) of 110°C and above, as summarized in Table 1. The UTI for asphalt binders is a metric that measures the effective temperature range over which a binder performs adequately without experiencing significant rutting at high temperatures or cracking at low temperatures. It is typically calculated as the difference between the binder's high- and low- temperature PG. The type and amount of polymer used in these binders are not explicitly specified.

For the first two projects, UDOT substituted the typical PMA binder (PG 64-34) with an HP binder while maintaining the same asphalt mix design, including the asphalt binder content determined at 3.5% air voids. However, the results did not meet expectations. Subsequently, special provisions were developed to define a mixture incorporating an HP binder that is referred to in Utah as a Highly-Modified Asphalt Mix (HiMod mixture) (UDOT, 2024b).

Table 1. Specifications for HP PG 76-34 Asphalt Binders in Utah

Property	Specification Limit
Original Binder	
G* at high grade temperature (76°C), kPa	1.30 Min
δ at high grade temperature (76°C), °	71.0 Max
RTFO Residue – Original binder further aged in a rolling thin film oven (RTFO)	
G*/sinδ, kPa	2.20 Min
Elastic recovery at high grade temperature (76°C), %	90 Min
PAV Residue – RTFO Residue further aged in a pressure aging vessel (PAV)	
G*sinδ, kPa	5,000 Max
Stiffness (S) at low grade temperature +10°C (-24°C), MPa	300 Max
Slope (m-value) at low grade temperature +10°C (-24°C)	0.300 Min
ΔTc, °C	-1.0 Min

HP = high polymer asphalt; PG = performance grade; Min = minimum; Max = maximum; G* = complex shear modulus; δ = phase angle; and ΔTc = difference in critical low temperatures.

UDOT has been using HP binders and mixtures for over nine years. The initial projects were completed in 2015 and 2016, with the PG 76-34 binder substituted directly for the regular PG 64-34 at the design content, while maintaining the same asphalt mix design, including the asphalt binder content determined at 3.5% air voids. In June 2021, a project at the Wendover Port of Entry was the first to be designed specifically to utilize the PG 76-34 binder. This project implemented the HiMod mixture, characterized by low air void designs and high in-place densities, which remained part of the specification.

HiMod mixtures are specified and allowed in a range of applications to address various structural and functional requirements. These applications include structural overlays and functional overlays with thicknesses of 1.5, 2.0, and 3.0 inches. The 1.5-inch functional overlay is particularly notable as part of UDOT's preservation program, aimed at extending pavement life while maintaining cost efficiency. A HiMod mixture is also proposed for use as an interlayer to mitigate reflective cracking, particularly on Portland cement concrete pavement (PCCP), paired with a stone matrix asphalt (SMA) layer placed on top, proposed on Interstate route I-215.

Additionally, HiMod mixtures have been employed in thick asphalt concrete layers, such as a 5- or 6-inch layers placed on existing asphalt or on an aggregate base, demonstrating their suitability for robust structural designs. The HiMod mixtures are also specified for new construction projects to ensure long-lasting pavement performance under challenging conditions. Notably, HiMod mixtures have also been used as an alternative to SMA in some applications.

In the case mentioned above, a HiMod mixture is proposed for rehabilitating old PCCP. The test project on I-215 proposes to overlay a rubblized concrete layer with a HiMod mixture (HiMod lane leveling of 1.5 inches with a 4-inch-thick required single lift on top). This approach may avoid a full replacement of the PCCP, resulting in significant cost savings of approximately $40 million.

Bridge overlays represent another critical application, particularly in UDOT Region 1 and 2, where achieving high-density levels without vibration during compaction is essential. A density level of 97% is targeted and achieved. Although no specific permeability requirements are enforced, the achieved density indirectly ensures adequate performance. A minimum binder content of 6.2% is specified for bridge deck overlays, further enhancing durability and resistance to environmental and traffic-induced stresses.

Since 2021, UDOT has used approximately 27,595 tons of HiMod mixtures on State projects, with about 525,000 tons (equivalent to approximately 600 lane miles) scheduled to go out to bid in 2024. Some of these mixtures are expected to be placed in 2025.

Over the past decade, UDOT's annual HiMod paving program has shown significant variability in lane miles and tonnage, influenced by project size, the availability of alternative technologies, and the overall scope of the program. Table 2 provides a detailed breakdown of the approximate annual tonnage of HiMod mixtures placed by UDOT. The volume of HP/HiMod mixtures used has increased significantly based on the experience and confidence gained in utilizing this technology.

Table 2. UDOT Estimates of Annual Tonnage and Approximate Prices of HiMod Mixtures Used.

Year	Approximate quantity of HiMod mixtures placed (tons)	Approximate price for HiMod mixtures placed ($ per ton)	Approximate difference in price from conventional PMA mixtures ($ per ton)
2021	330	150.00	N/A
2022	3,000	150.00	N/A
2023	24,265	110.00	N/A
2024	525,000	152.00	Median cost is between typical HMA and SMA mixtures

UDOT = Utah Department of Transportation; HiMod = high-modified asphalt mixture; PMA = conventional polymer-modified asphalt; N/A = not available; HMA = hot mix asphalt; SMA = stone matrix asphalt.

In terms of cost, Table 2 summarizes the approximate price per ton of HiMod mixtures; however, no corresponding price difference compared to conventional PMA mixtures was provided. The prices started relatively high because of the perceived risks, averaging about $150.00 per ton in 2021, and dropped to $110.00 with a significant increase in tonnage (considered as a competitive price). With over 500,000 tons of HiMod scheduled for 2024 and 2025, UDOT reported an average price of $150.00 per ton, which falls between the typical prices for HMA and SMA mixtures. For example, in Parleys Canyon on I-80, near Salt Lake City, the cost was approximately $105.00 per ton. The cost increases with greater trucking distances. It is important to note that cost data can vary significantly depending on factors such as project type, tonnage, plant adjustments, project location, and the bidding process. Therefore, comparisons are to be made cautiously, ensuring that projects of similar scope are used to assess the price differential properly.

UDOT primarily uses HiMod mixtures to prevent rutting, mitigate bottom-up and top-down fatigue cracking, address reflective cracking—particularly those induced by PCCPs covered with asphalt overlays—and to develop longer-lasting mixtures suitable for full-depth applications. The agency is also exploring other potential applications of HP binders and mixtures, including their use in open-graded friction courses (OGFC) in Region 2; however, this has not yet been implemented. UDOT has reported that it has never discontinued the use of HP binders and/or HiMod mixtures at any time.

Specifications

As mentioned previously, HP binders and HiMod mixtures are specified using the standard UDOT HMA specifications with certain modifications (UDOT, 2024a). HP binders are specified as those meeting PG 76-34 specifications in accordance with AASHTO M 320, along with additional requirements detailed in

Table 1 (UDOT, 2024a). For HiMod mixtures, the aggregate gradations and material properties remain consistent with typical mixtures; however, an aggregate polishing requirement has been added to reflect the use of these mixtures as a surface course for thin lifts. A draindown requirement was initially included but is now being removed from the specifications, as internal evaluations demonstrated it to be unnecessary (AASHTO T 305). In addition, the requirement for a material transfer vehicle (MTV) or shuttle buggy has been incorporated. Smoothness requirements remain unchanged, although additional grinding for thicker lifts is of less concern due to the tightness of the mat after smoothness corrections.

In terms of gyrations, 50 gyrations are now specified instead of 75. This adjustment was validated through extensive Hamburg Wheel Tracking Testing (HWTT), which confirmed the goal of achieving a very low void mix relative to the previous effort at 75 gyrations. At 50 gyrations, specifications require 1.0% air voids, with a minimum voids in mineral aggregates (VMA) of 15.0% and a voids filled with asphalt (VFA) range of 90.0% to 95.0%. These mixtures approach zero voids at 75 gyrations, which is specified as the Nmax. HWTT is conducted at a target air void level of 4.0%, with an allowable variation of ±0.5%, rather than the traditional 7.0%. This adjustment accounts for the fact that the 4 % is representative of the in-place air voids after construction in the field. The test water temperature is set at 54°C, based on research conducted by the University of Utah.

Field acceptance testing methods remain unchanged, although target values have been modified. The in-place density target is now 96.0%, with a lower limit of 94.0% and an upper limit of 99.0%. For comparison, the standard HMA in-place density target has been 93.5%, with a tolerance of ±2.0%. The minimum binder content for the mix design follows SMA minimum binder content requirements, which are based on G_{sb} (dry). A maximum of 15% RAP is permitted in the mixture, though RAP is not allowed in SMA mixtures.

The observations in the field indicate that these mixtures compact with less effort and exhibit no issues with tenderness. They are particularly well-suited for thick lifts, as demonstrated in various paving applications.

The quality of HP binders is verified to meet specification requirements. At least annually, every binder formulation is tested at the UDOT Central Laboratory for approved use in mix designs. At the plant, binder samples are taken daily during mixing operations, with testing performed randomly at least once per paving week.

Acceptance procedures for HP binders have not been specifically altered to address the recommended shorter storage times before plant production, as shorter times have not been observed. However, challenges related to this issue were encountered during the initial project in 2015, when a minimum polymer content of 7.0% was specified, and the rotational viscosity requirement was waived. This approach led to complications, resulting in the conclusion that specifying polymer content and omitting the rotational viscosity requirement are inadvisable. Binder suppliers were instead allowed to develop formulations that meet the specified criteria while maintaining a maximum rotational viscosity of 3.0 Pa·s. It is believed that suppliers typically use styrene-butadiene-styrene (SBS) polymers at approximately 5% by weight of the binder to meet HP requirements in Utah.

In terms of quality control, no modifications to current programs or practices have been implemented specifically for HP/HiMod projects. Similarly, the acceptance program has undergone minimal changes, apart from adjustments to density and air void targets, as mentioned previously.

UDOT now lists four binder suppliers on its Approved Products List (APL), reflecting a competitive market within the State. For HiMod mixtures, the use of warm-mix asphalt (WMA) as a compaction aid has become standard. Typical mixing temperatures range from 330°F to 340°F, with field compaction temperatures maintained between 275°F and 300°F.

Regarding the use of RAP, incorporation has been allowed in dense-graded HiMod mixtures but not in SMA or OGFC. This exclusion is due to the premium nature of SMA mixtures, which rely on stone-on-stone interlock, and the necessity of using the highest-quality materials for surface applications. For typical dense-graded asphalt mixtures, binder contents have increased over time, from approximately 4.5% in previous years to current levels around 5.0%. HiMod mixtures retain binder contents comparable to SMA, with an additional 1.0% or more binder included.

No significant challenges have been noted in measuring the theoretical maximum specific gravity (Gmm) for these mixtures. The practices and procedures currently in place have proven sufficient to ensure compliance with project specifications and performance requirements.

Mixture Design and Performance

UDOT employs the Superpave mix design methodology for HiMod mixtures, incorporating HWTT during both the design and production stages. This testing is conducted on slabs or pucks compacted to a target of 4% air voids. UDOT refers to this approach as a "Balanced Mix Design (BMD) on steroids," as the Superpave procedure has been adapted to achieve a mix with minimal air voids.

Several modifications have been made to the mix design parameters. UDOT reduced the number of gyrations from 75 to 50 and lowered the air void requirements from 3.5% to 1.0%. The minimum VMA for a 1/2 and 3/8 inch nominal maximum aggregate size (NMAS) mixtures were increased from 14.0% to 15.0% and from 15.0% to 16.0%, respectively. The VFA range was raised from 70–80% to 90.0–95.0% for both mixtures. In addition, the air voids in the HWTT slabs or pucks were reduced from 7.0% to 4.0%. The rutting requirement for HiMod mixtures remained consistent with that used for SMA mixtures: a maximum rut depth of 10 mm after 20,000 passes in the HWTT, conducted at a water temperature of 54°C. These changes were implemented following evidence confirming the mixture's exceptional resistance to rutting. A summary of these adjustments is presented in Table 3. UDOT mandates the use of hydrated lime for all asphalt mixtures.

For structural design, HiMod mixtures are generally treated similarly to conventional asphalt mixtures for the same applications. However, the structural coefficient for HiMod mixtures is acknowledged to be higher, though the exact value has not been determined. UDOT pavement design team is currently evaluating this aspect. A project on I-215 scheduled for the following year will involve installing strain gauges beneath a thick HiMod lift and the fractured PCCP. This will provide critical data to better understand the structural behavior of HiMod mixtures. Advanced testing is being conducted to further evaluate the performance of HiMod mixtures.

No significant differences in surface preparation practices have been observed when placing HiMod mixtures compared to conventional asphalt mixtures. For full-depth applications, the stronger HiMod pavements eliminate concerns about milling into another layer and needing to adjust milling depths. In addition, tack coats are not required between layers in full-depth HiMod pavements, which simplifies the construction process.

Table 3. HiMod Mix Design Requirements in Utah

Property	Properties for Mix Design	
NMAS, inch	½	3/8
Asphalt mix design mixing and compaction temperatures	Provided by the approved mix design	
Compaction Parameters		
$N_{initial}$, gyrations / % of G_{mm}	5 / ≤91.50	
N_{design}, gyrations / % of G_{mm}	50 / ≤98.75	
N_{max}, gyrations / % of G_{mm}	75 / ≤100.00	
Volumetric Properties		
Asphalt Binder Content, % by mix mass	The minimum asphalt binder content is function of the combined aggregate bulk specific gravity including lime (G_{sb})	
VMA, %	15.0-17.0	16.0-18.0
VFA, %	90.0 – 95.0	
Dust Proportion Range	0.60 – 1.40	
Performance Properties		
Hamburg Wheel Tracker on Slab or Pucks with 3.5-4.5% air voids after 20,000 cycles with water Temperature of 54°C, mm	< 10.0 mm	
Draindown	0.3 maximum	

HiMod = Highly-modified asphalt mixture; NMAS = nominal maximum aggregate size; N = number of gyrations; VMA = voids in mineral aggregates; VFA = voids filled with asphalt.

HWTT is the primary performance measure recommended for evaluating the quality of HiMod pavements. The indirect tensile cracking test, known as IDEAL-CT, is also conducted for informational purposes, with typical results around 500, which aligns with values observed for SMA mixtures. Other advanced performance tests include the four-point bending beam fatigue test and the five freeze-thaw cycles Lottman test, all of which have shown promising results for durability and resistance to fatigue. To standardize testing, a two-hour oven aging protocol has been used for IDEAL-CT testing.

No issues related to binder "crawling" out of RTFO jars have been reported, and the use of HiMod mixtures in conjunction with windrow paving techniques has been unproblematic. HiMod mixtures have shown no issues with blistering or drain-down, even with their higher binder content. One contractor reported challenges with joint density during late-season night paving, when cooler temperatures at high altitudes were a factor. It is believed that the paving temperatures were outside the specified limits.

Current construction practices for HiMod mixtures do not differ significantly from those for conventional mixtures. No special requirements for test strips or trial sections are mandated, and standard practices have proven sufficient.

Restrictions and Limitations

UDOT reported no special practices or enforcement of specific safety or health restrictions when using HP binders in asphalt mixtures. In cases where specific practices are warranted, these are typically based on the recommendations of binder suppliers and polymer manufacturers. No changes have been implemented, as binder suppliers have indicated the use of similar SBS polymers, albeit at a higher percentage. The binders are subjected to PAV aging protocols followed by Bending Beam Rheometer (BBR) testing, providing a reliable understanding of their aging behavior in the field. Field aging is expected to be reduced due to higher target for in-place density of the mat and thicker asphalt films on the aggregate. Traffic control measures ensure proper protection of vehicles, particularly at the edges when a thicker lift is placed.

UDOT initially identified the reluctance of industry to adopt changes as the primary factor likely to limit the use of HiMod mixtures. Contractors initially expressed reluctance due to risks and concerns related to low air voids design and stability during construction, but they have largely adapted and now prefer using HiMod mixtures. As mentioned previously, the cost of HiMod is positioned between regular HMA and SMA mixtures. For agencies already utilizing SMA, transitioning to HiMod represents a cost saving. Contractors have, on occasion, requested to substitute SMA with HiMod, resulting in cost reductions and savings to the State.

HiMod mixtures eliminate the need for gap-graded aggregates required by SMA mixtures, making them more efficient for contractors' crushing operations. In addition, they do not require the use of fillers or fibers. HiMod mixtures allow for the inclusion of up to 15% RAP content, unlike SMA mixtures, in which RAP is not permitted.

Research Projects

In terms of research efforts, UDOT has not yet engaged any research institutions to assess and evaluate HiMod mixtures. However, a formal report will be produced for the I-215 project, scheduled for construction in 2025, which will be instrumented with strain gauges. This research effort is to be performed by the University of Utah.

The Asphalt Institute has conducted complementary bending beam fatigue testing on plant produced asphalt mixtures to compare the fatigue life of HiMod mixtures produced with PG 76-34 against conventional Utah Superpave mixtures produced with PG 64-34 under controlled laboratory conditions.

Long-term aging of the mixtures was simulated following the National Cooperative Highway Research Program (NCHRP) Project 09-54 procedure, which involved aging loose mixtures at 95°C for three days to replicate 8–16 years of field aging in Utah's climate. Beams were then compacted to specific densities—96% (4% air voids) for the HiMod mixture and 93% (7% air voids) for the conventional mixture—to replicate field conditions. The G_{mm} was determined per AASHTO T 209-23 to calculate the material mass required for compaction. Fatigue life testing, conducted in accordance with AASHTO T 321-22, was performed on beams compacted to target air voids, with testing at 15°C (adjusted for binder grade). Strain levels were varied to generate overlapping data for analysis.

The results demonstrated that the HiMod mixture consistently exhibited higher cycles to failure across all strain levels compared to the typical mixture. The superior performance of the HiMod mixture was attributed to three factors: the use of the polymer-modified asphalt binder (PG 76-34), which enhances fatigue resistance, the significantly higher binder content enabled by the stability of the HP binder, and the higher in-place density of the HiMod mixture, reflected in its lower air void content. The HiMod mixture outperformed the conventional mixture in terms of laboratory fatigue resistance, underscoring its potential for enhanced durability and performance in Utah's asphalt pavements. These findings support the adoption of the HiMod mixture for applications requiring improved resistance to cracking and deformation under repeated traffic loading.

Other resources include numerous articles about UDOT's use of HiMod, published on prominent websites and in magazines, including *Asphalt Magazine* by the Asphalt Institute (AsphaltPro, 2021; Johnson and Anderson, 2021; UAPA, 2024; UDOT, 2024c).

Cost and Benefits

UDOT reported that there is no information on life cycle costs or benefit-cost ratios for HiMod mixtures. They stated that it is difficult to determine these metrics until more tonnage is placed. However, UDOT strongly believes that if HiMod mixtures are cheaper than SMA mixtures and perform as well as or even better than SMA mixtures, then they are undoubtedly more cost-effective and offer a better return on investment.

Implementation Plan

UDOT has progressively implemented the use of HP binders and HiMod mixtures throughout the State. While no formal implementation plan was initially created, UDOT has incorporated HP mixtures (not HiMod) into couple projects in 2015 and 2016, and HiMod mixtures into various projects since 2021, with statewide application now in place when deemed appropriate.

Pilot projects featuring HiMod mixtures were constructed, but not always alongside control test sections with conventional asphalt mixtures typically used in Utah. Following the demonstrated success of these pilot projects, HiMod mixtures were approved for statewide use. Over the past nine years, the use of HiMod mixtures has grown steadily, culminating in full implementation in 2024. As of this year (2024), projects utilizing HiMod are issued directly for bids rather than as change orders.

Region-specific applications highlight the versatility of HiMod mixtures:

- **Region 1** has extensively used HiMod mixtures for bridge decks, replacing SMA mixtures in five to six projects.
- **Region 2** applies HiMod mixtures for thin-lift overlays.
- **Region 3** has implemented HiMod mixtures for both 2-inch and 4- to 5-inch pavement lifts.
- **Region 4** has adopted HiMod mixtures for larger-scale applications, including 200,000-ton projects involving 2-inch overlay, and a proposed project with a 7-inch lift.

Although UDOT has made significant progress, the agency continues to refine its approach and anticipates further insights into the performance and optimization of HiMod mixtures. The transition to full implementation reflects UDOT's confidence in the enhanced durability and performance of HiMod mixtures across various roadway applications.

Additional Information

Regarding the use of HP binders and HiMod mixtures, several lessons learned, challenges, positive practices, and gaps have emerged in the application of these materials in Utah.

Lessons Learned: One important lesson is the need to fully leverage the potential of HP binders by increasing binder content. When using such binders, it is crucial to conduct mix designs at lower voids and to set higher in-place density requirements. This approach allows for the placement of both thick and full-depth layers as well as thinner layers with high-density targets. Utilizing HP binders while adhering to standard Superpave design targets, however, does not fully unlock the binder's potential and can result in inefficient use of the material.

Challenges: A significant challenge has been the need for binder suppliers to refine their formulation processes to ensure stability. Without proper stabilization, the binder can undergo changes or even gel in the contractor's tank, leading to operational difficulties. Fortunately, local suppliers have worked to address this issue. Another challenge involves educating the local industry on the differences between HP binders and conventional materials. It is essential for the industry to understand that design targets have to be adjusted to optimize the performance of these binders.

Positive Practices: Cooperation with the State asphalt pavement association for education and collaboration has been a major contributor to the successful application of these materials. The use of an MTV has been a positive practice in ensuring the consistency and quality of the mixture. In addition, implementing proper controls for sampling at the contractor's hot plant has proven beneficial in maintaining quality assurance throughout the process.

Gaps: Trucking logistics, such as the size of the hopper, have become a concern when requesting thicker lifts. Long-term field performance data is still pending, which presents a challenge for assessing the durability and longevity of HiMod mixtures. Recent Lottman testing has demonstrated the increased durability of the HiMod mixtures over conventional HMA materials. Another gap is the limited attention given to storage in silos; while contractors have expressed some concerns, this aspect has not been extensively studied. Lastly, constructability, particularly in terms of paver performance and binder cleanup, has shown that HiMod mixtures perform better than SMA mixtures in terms of workability and easier cleanup by technicians.

These insights highlight both the potential and the challenges associated with HP asphalt binders and HiMod mixtures, as well as the need for continued collaboration, education, and refinement of practices in their use.

As previously discussed, HiMod mixtures offer several advantages over SMA mixtures, particularly in terms of expected performance and cost efficiency. UDOT plans to monitor ongoing projects that utilize HiMod mixtures and compare their long-term performance with other materials currently in use, including traditional HMA mixtures. Based on UDOT's experience, SMA mixtures tend to have a significantly longer lifespan than regular HMA mixtures, and UDOT anticipates that HiMod mixtures will demonstrate similar longevity while offering a more cost-effective and high-performing alternative.

One area UDOT is considering for future evaluation is the recyclability of HiMod materials. UDOT hopes to explore how these binders and mixtures interact with RAP stockpiles and their potential benefits in the future, especially as the availability of RAP increases. The future focus will likely be on how to ensure the binder's compatibility with RAP, as this could contribute to more durable paving practices.

Acknowledgement

The team greatly appreciates the time, effort, and information provided by UDOT staff. This concludes the summary of the virtual visit with UDOT.

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