Section 4YY

Construction Guide Specification for UltraThin Bonded Wearing Courses

4YY.1 DESCRIPTION

This guide specification is intended to provide information needed for owners or contractors to construct UltraThin Bonded Wearing Courses (UTBWCs). UTBWCs are a combination of polymer modified emulsified asphalt and open graded asphalt mixture placed using a spray paver. This guide specification refers to materials, construction, measurement, warranty, and payment used to construct UTBWC, it's main purpose is to provide guidance for the construction of UTBWCs.

All units of measurement are expressed in US Customary units and Standard International (SI) units. Note that conversions are provided where appropriate.

Commentaries are included in this guide specification to 1) emphasize and further explain the section, 2) present options to be considered by the user, or 3) provide sources of additional information. An example of these commentaries is shown below:

Commentary

This guide specification covers construction of UltraThin Bonded Wearing Courses (UTBWCs). An UTBWC is a pavement preservation treatment used to extend the life of a structurally sound asphalt pavement (low to medium severity distresses such as rutting, bleeding, raveling, polished aggregates, friction loss) or Portland cement concrete pavement (spalling of longitudinal and transverse joints, corner breaks).

4YY.2 REFERENCED DOCUMENTS

4YY.2.1 AASHTO Standards

- M 17, Mineral Filler for Bituminous Paving Mixtures
- M 295, Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
- M 303, Lime for Asphalt Mixtures
- M 316, Polymer-Modified Cationic Emulsified Asphalt
- M 320, Performance-Graded Asphalt Binder
- M 332, Performance-Graded Asphalt Binder Using Multiple Stress Creep Recovery (MSCR) Test
- M 346, Materials for Ultrathin Bonded Wearing Course
- R 108, Ultrathin Bonded Wearing Course Design
- T 305, Determination of Draindown Characteristics in Uncompacted Asphalt Mixtures
- AASHTO Guide Specifications for Highway Construction, 10th Edition, 2020

4YY.2.2 Other Documents

- Martin, R. S., Jr., "Chip Seal Practice", Proceedings of the 26th Paving and Transportation Conference, Department of Civil Engineering, University of New Mexico, Albuquerque, New Mexico, January 1989.
- Missouri UTBWC. Ultrathin Bonded Asphalt Wearing Surface, Section 413.30, Missouri Highways and Transportation Commission, Obtained February 2023.

4YY.3 TERMINOLOGY

4YY.3.1 *Asphalt mixture* –The primary function of the ultra-thin bonded wearing course is to provide a durable, friction resistant surface on an existing flexible pavement. Specifications generally require one of three gradations. The gradation should be based on the traffic level, and the surface condition of the roadway. The thickness is approximately 1.5 times the maximum aggregate size.

4YY.3.2 *Emulsified asphalt* – asphalt binder suspended in water with the help of emulsifiers that is applied at temperatures to ensure a consistent and homogeneous flow from the distributor. For UTBWC, the emulsified asphalt acts as both an impermeable surface treatment and a thick tack coat. For the sake of this document, it will be only referred to as a tack coat.

Table 1—Recommended Emulsified Asphalt Application Rates based on Nominal Maximum Aggregate Size (NMAS), gal/yd^2 (L/m^2) (from MoDOT, 2023)

Mixture Lift Thickness	3/16" (4.75 mm) NMAS Mixture	3/8" (9.5 mm) NMAS Mixture	1/2" (12.5 mm) NMAS Mixture
1/2" (12.5 mm)	0.15 (0.70)	0.19 (0.85)	-
3/4" (19 mm)	0.18 (0.83)	0.22 (0.98)	0.22 (1.00)
1.0" (25 mm)	-	0.25 (1.11)	0.25 (1.13)

4YY.3.3 *Ultrathin bonded wearing course (UTBWC)* – The UTBWC shall be a 1/2- to 1-in. (12.5- to 25.4-mm) thick mix and consist of a polymer-modified emulsified asphalt membrane followed immediately with an ultrathin open-graded asphalt mixture. Table 1 shows the recommended mixture lift thickness based on the nominal maximum aggregate size. The UTBWC shall be placed using an integrated distributor-paver (spray paver) to apply the bonded wearing course.

4YY.3.4 *Spray paver* – A spray paver combines the processes of the asphalt paver and tack distributor into one piece of equipment. The spray bar is located between the paver's wheel or track and the paver's screed, so that the emulsified asphalt is sprayed immediately ahead of placing the asphalt mixture.

4YY.4 MATERIALS

Commentary

The material summaries for asphalt binder, aggregate, asphalt mixture, and emulsified asphalt are meant for a broad understanding of the material components of UTBWCs. Users should reference M 346 when considering materials for UTBWC. However, additional information is provided here beyond the information in M 346.

4YY.4.1 *Asphalt binder* – asphalt binder for the asphalt mixture shall meet the requirements of M 320 or M 322. The binder grade shall be recommended based on the climatic and traffic conditions of the project.

Commentary

While not explicitly required, it is recommended that the asphalt binder is polymer modified to increase the cohesion of the asphalt mixture and adhesion of the binder to the aggregate. Elastic polymers are preferred, and rubber may be added using the wet process.

4YY.4.2 *Aggregate* – shall be 90% crushed on two or more faces for the coarse aggregate. Only manufactured fine aggregate (material passing the #8 sieve) is allowed.

Mineral filler used in the UTBWC mix design may be lime, fly ash, or baghouse fines collected during the mixing process or other approved filler that meets the requirements in M 17, M 295, or M 303.

Commentary

It is recommended that the LA Abrasion value be less than 30%, the absorption of the aggregate be less than 2%, and the fine aggregate angularity be greater than 45. All other values in Tables 3 and 4 of M 346 are appropriate. It is not recommended to use Reclaimed Asphalt Pavement (RAP), Recycled Asphalt Shingles (RAS, neither tear-off nor manufacture waste), nor rubber in the dry form. It is recommended that 2-4% P200 is used.

4YY.4.3 *Asphalt mixture* – a open-graded mixture that includes a large portion (70 to 80%) of a single-sized crushed coarse aggregate that is bound with a mastic composed of manufactured sand, filler (if needed) and asphalt binder. The binder content is a minimum of 4.8% depending on the aggregate gradation, traffic, climate, lift thickness, and other existing characteristics of the existing pavement.

4YY.4.4 *Emulsified asphalt*— the polymer modified emulsified asphalt for UTBWC shall meet the requirements of rapid-setting (RS-1P) or cationic rapid setting (CRS-1P) type emulsified asphalt. The emulsified asphalt classification is determined by the owner agency based on regional climatic and traffic conditions.

Commentary

There are two types of asphalt emulsion used in UTBWC: RS-1P (anionic, rapid set, low viscosity, polymer modified) and CRS-1P (cationic, rapid set, low viscosity, polymer modified).

4YY.4.5 *Other additives*— anti-strip additives can be added to reduce stripping. Cellulose fiber may be added to meet the draindown requitement.

Commentary

While these two additives may be added to meet the specification , neither are required if asphalt mixtures are performing according to specification. Other additives that agencies have found to improve mixture performance, may be considered.

4YY.4.6 *UTBWC design*— is a combination of a specification on the asphalt binder for the open-graded mixture, specification on the polymer modified emulsion for the emulsion tack/bonding layer, and a job mix formula (JMF) for the asphalt mixtures design that contains aggregate quality, aggregate gradation requirements, lab compaction to determine asphalt content, and a test to evaluate moisture resistance.

A mix design job mix formula (JMF) shall be developed to comply with mix design criteria. Submit the JMF for approval prior to starting the mix production.

Commentary

The design summary above for UTBWC is meant for a broad understanding, however, users should reference R 108 when considering design of UTBWC. It is recommended that the draindown test (T 305) be run on the optimal asphalt binder content and +0.5% of the optimal asphalt binder content, and draindown shall not exceed 0.10% for either of these binder content levels.

Other performance tests may be considered include the Cantabro abrasion test (Tex-245-F) on both unaged and long-term aged samples (R 30). If the unaged asphalt mixture's abrasion loss

is greater than 20%, more binder should be added. If the aged asphalt mixture's abrasion loss is greater than 30%, more binder should be added or binder additives should be changed.

UTBWC mixtures undergo more stress and than typical surface mixtures due to their thin-lift and rock-on-rock contact. The user should take caution to not use inferior materials or practices with this mixture.

4YY.5 CONSTRUCTION

4YY.5.1 *Weather limitations* —Construct UTBWC per the following conditions:

- Ambient or pavement surface temperatures shall be 50°F (10°C) and rising;
- The road surface shall be dry or moist, there shall be no standing water;
- Suspend UTBWC operations when rain is expected; and
- Sustained winds are less than or equal to 10 mph (16.1 kph).

4YY.5.2 *Preconstruction meeting*—Coordinate a preconstruction meeting prior to construction with the project manager, project engineer, inspector, material tester, representatives of prime contractor, each sub-contractor, material suppliers, and others as necessary to discuss the following topics:

- UTBWC design
- Construction process
- Materials control, sampling, and measurement
- Equipment calibration, required to be submitted
- Traffic control plan
- Staging area
- Project inspection
- Project documentation
- Test strip
- Temporary and permanent pavement markings
- Unique project conditions
- Expectations
- Safety procedures
- Schedule
- Public notification
- Payment
- Quality assurance plan (including quality control, quality acceptance, and independent assurance)

4YY.5.3 *Road Surface Preparations*

4YY.5.3.1 *Stripe removal*— Pavement raised markers and thermoplastic pavement marking shall be removed by grinding or other approved methods prior to UTBWC applications. Other pavement marking paint may be left in place.

4YY.5.3.2 *Preparing pavement*— All incompressible materials shall be removed from joints/cracks greater than 1.5 in (38.1 mm) wide; all cracks great than 0.5 in (12.7 mm) shall be sealed. Allow crack sealant material to cure for a minimum of 30 days on pavement surfaces that have been crack sealed before application of the UTBWC. Waive this requirement if a compatible crack sealant is used that does not require a cure time. In addition, ensure that all patches are flush with clean edges and the entire pavement section is structurally sound and no patch is less than 30 days old.

4YY.5.3.3 *Cleaning pavement*—Clean the roadway surface by sweeping no more than 30 min prior to application of the UTBWC. However, this 30 min window may be extended if authorized by the engineer in cases where extending the time does not jeopardize a clean surface prior to tack coat operations. Sweep the pavement with a motorized broom to remove loose material. Clean depressions not reached by the motorized broom with a hand broom. Clean the outer edges of the pavement to be sealed including an adjacent paved shoulder.

4YY.5.3.4 *Protecting accessories*—Cover utility castings (manholes, gate valve covers, catch basins, traffic sensors, etc.) to prevent coating with UTBWC. Suitable coverings include plywood disks, Kraft paper, roofing felt, or other approved methods. Remove the protective coverings after placing the UTBWC before opening the road to traffic.

4YY.5.4 *Equipment*

4YY.5.4.1 *Asphalt mixing plant* —Attention should be paid to asphalt mixture plant adjustments before production because of the one-sized nature of the open-graded mixture. Typical procedures used for open-graded mixtures shall be used, including adding screening capacity at a batch plant to accommodate the single-size aggregate mixture. In addition, there may be a need for a mineral filler or cellulous fiber feed device, which will increase the mixing time in a batch plant. The asphalt mixture should not be stored in surge bins or silos for extended periods of time as the asphalt mixture is susceptible to draindown.

4YY.5.4.2 *Hauling equipment* —For hauling asphalt mixture, furnish equipment with tight, clean, smooth metal beds. Keep beds free of petroleum oils, solvents, or other materials that would adversely affect the mixture. Apply a thin coat of approved release agent to beds as necessary to prevent mixture adherence. Be prepared to cover and insulate hauling beds.

For hauling emulsified asphalt, load emulsified asphalt into a clean trailer, or load emulsified asphalt into a trailer that last transported a compatible emulsified asphalt. Do not mix anionic and cationic emulsified asphalt. Do not store emulsified asphalt in the trailer and minimize the pumping of the emulsified asphalt.

4YY.5.4.3 *Brooms*—Motorized brooms with a positive means of controlling vertical pressure shall be used to clean the road surface prior to spraying emulsified asphalt.

Commentary

Vacuum brooms are preferred in urban or residential areas, but push brooms are acceptable in rural areas where debris scattered off the roadway does not pose a hazard to pedestrians or vehicles.

4YY.5.4.5 *Material transfer vehicle (MTV)*— Use and MTV to remix the asphalt mixture before placing in the paver and provide continuous paving.

Commentary

MTVs are especially important for open-graded asphalt mixture to reduce physical and thermal segregation.

4YY.5.4.5 *Paver with spray bar*— a spray paver is used primarily for ultrathin bonded wearing courses. It is a traditional asphalt paver with a spray bar installed just before the screed. The asphalt paver portion shall conform to the Hot Mix Asphalt Pavement (Guide Specifications for Highway Construction, Section 401, 2020).

The storage tank for emulsified asphalt shall be capable of maintaining the emulsified asphalt at the specified temperature. The spray bar nozzles shall produce a uniform double or triple lap application fan spray, and the shutoff shall be instantaneous, with no dripping. All nozzles shall be

oriented at the same angle between 15 and 30 degrees, using the wrench supplied by the distributor manufacturer and as described below in Section 4YY.5.5.1. The minimum tolerance for application cannot vary more than 0.02 gal/yd^2 (0.11 L/m^2).

Commentary

A skirt can be attached to the paver with spray bar in the case winds are above 10 mph to prevent the emulsified asphalt from blowing onto passing vehicles.

4YY.5.4.6 *Steel wheel rollers* - Roll mix with a minimum of two steel wheel rollers of at least 9 metric tons in static mode.

Commentary

Additional rollers may be necessary during night paving on cooler nights.

4YY.5.5 *Equipment calibration*

The contractor shall provide proof of calibration of the spray paver, with both the asphalt mixture paver and spray bar showing calibration. Calibration shall be conducted no earlier than five days prior to the UTBWC application. The contractor shall submit the results of the calibration procedure to the Engineer.

Flow from each nozzle in the asphalt distributor and the spray paver must be within ±10 percent of the average flow of all nozzles as measured by the procedure described below.

Commentary

Calibration is very important to assure the quantity of emulsified asphalt and asphalt mixture to the pavement is correct. Although many modern spray pavers are computer controlled, calibration is required to tell the computer how much of each material is being applied. This quantity must be checked prior to spraying emulsified asphalt and placing asphalt mixture and checked against the quantity the computer (if the spray paver is so equipped) indicates is being applied.

4YY.5.5.1 *Spray bar of spray paver*

All nozzles shall be the same size, provide the same flow rate, be oriented in the same direction, and be the same distance above the pavement.

Commentary

The spray bar of a spray paver applies emulsified asphalt to the pavement surface. This application must be done uniformly both transverse and longitudinal to the centerline of the pavement.

When lower application rates are determined necessary or shown in the plans, smaller nozzles shall be inserted in the spray bar where the emulsified asphalt rate is reduced.

4YY.5.5.1.1 *Nozzle angle*

Nozzles shall be positioned at an angle of 15 to 30 degrees from the horizontal of the spray bar in accordance with the manufacturer's recommendation. All nozzles shall spray a full fan except for the right and left edge nozzles. The right and left edge nozzle shall be adjusted to a half fan such that the spray stays to the inside of the spray bar.

Commentary

The next step in calibrating the distributor is adjustment of the spray bar nozzle angles. Each nozzle has a slot cut across the face of the nozzle. When the nozzle is threaded into the spray bar, the slot should all be positioned at an angle of 15 to 30 degrees to the direction of the spray bar as shown in Figure 1. This angle provides the best position for achieving uniformity in the spray

and the triple overlap coverage. The angle should be adjusted using the wrench supplied with the distributor. This wrench is designed when used properly to set the correct angles for each nozzle. Any wrench that fits the hexagonal nozzle can adjust the nozzle angle, but correctness of the angle would have to be visually verified.

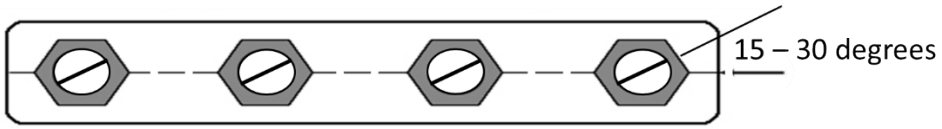

Figure 1—Spray Bar Nozzle Orientation in Spray Bar

4YY.5.5.1.2 *Spray bar height*

The spray bar height must be adjusted so that the emulsified asphalt provides exactly two or three overlaps across the entire spray width.

Commentary

Inproper bonding of the emulsified asphalt will occur if the spray bar is set too high or too low as shown in Figures 2 and 3.

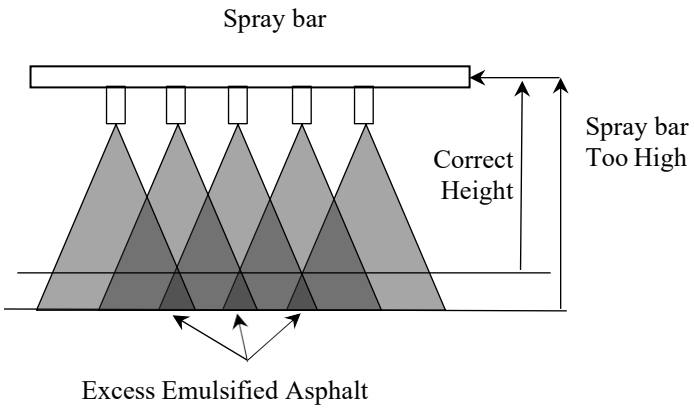

Figure 2—Streaks with Spray Bar Too High for Double Overlap

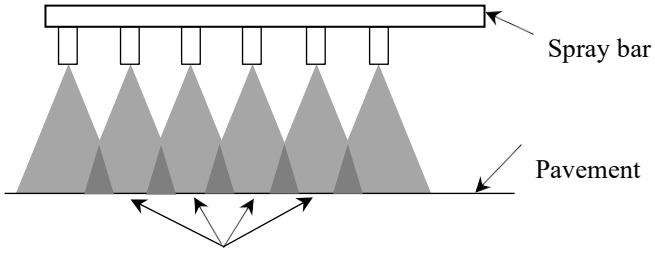

Figure 3—Streaks with Spray Bar Too Low for Double Overlap

To avoid potential improper bonding, the bar must be adjusted to the correct height. This adjustment process is accomplished by shutting off nozzles to determine where the spray pattern contacts the pavement as shown in Figures 4 and 5.

4YY.5.5.1.2.1 Bar height adjustment to achieve double lap

Every other nozzle shall be turned off when a double lap application is desired as shown in Figure 4. The distributor operator shall spray emulsified asphalt onto the pavement surface for as short an interval as possible while an observer watches where the emulsified asphalt hits the pavement from each nozzle left open. If there is overlap of emulsified asphalt from adjacent nozzles, the bar is too high. If there is a lack of emulsified asphalt from adjacent nozzles, the bar is too low.

Once it is confirmed that the bar height is correct, the nozzles that were turned off can be turned back on and a double application of emulsified asphalt will result when spraying resumes.

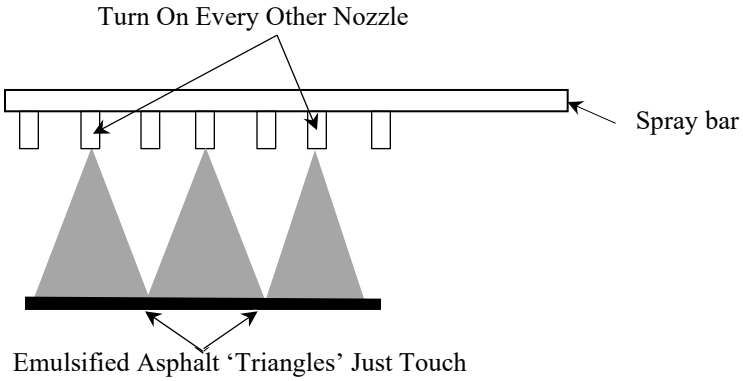

Figure 4—Adjustment of Spray Bar Height for Double Overlap

4YY.5.5.1.2.2 Triple lap application bar height adjustment

Every third nozzle shall be turned off when a triple lap application is desired as shown in Figure 5. The distributor operator shall spray emulsified asphalt onto the pavement surface for as short an interval as possible while an observer watches where it hits the pavement from each nozzle left open. If there is overlap of emulsified asphalt from adjacent nozzles, the bar is too high. If there is a lack of emulsified asphalt from adjacent nozzles, the bar is too low.

Once it is confirmed the bar height is correct, the nozzles that were turned off can be turned back on and a triple application of emulsified asphalt will result when spraying resumes.

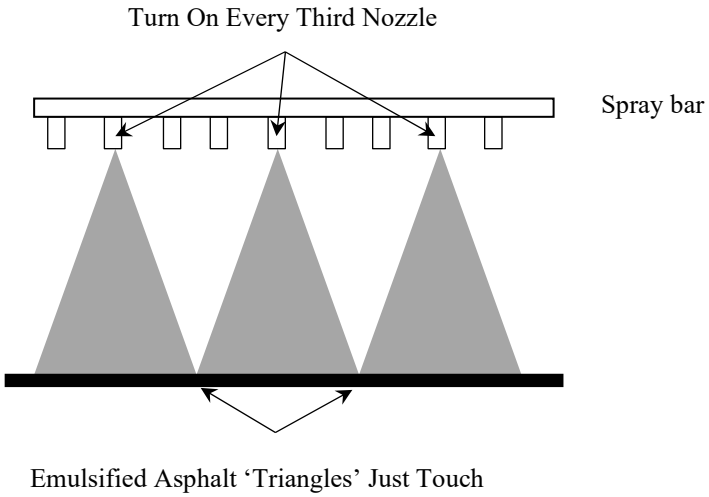

Figure 5—Adjustment of Spray Bar Height for Triple Overlap

4YY.5.5.1.3 *Transverse flow rate*—The flow rate across the spray bar shall be uniform with each nozzle spraying within ±10 percent of the average flow rate.

Commentary

The flow rate of a nozzle can be estimated by measuring the width of the slot in the nozzle and by measuring the orifice diameter. Also, some nozzles are labeled by the manufacturer. Manufacturers supply a list of nozzles in the owner's document describing which nozzles shall be used for various application rates or on a placard mounted on the equipment.

However, nozzles of the same apparent size have been measured with different flow rates. Therefore, it is recommended that all nozzles be checked for flow rate before spray paver operations begin. This is easily accomplished by fabricating a flow apparatus (Martin, 1989). This apparatus consists of a pipe to which each nozzle can be fitted, in turn, on one end and a water source can be fitted to the other end. The flow of water through each nozzle shall be measured by filling a 1-gal container in a measured period. This shall be done for each nozzle to be used on the project. If the flow rate of any of the nozzles is greater than plus or minus 10 percent of the average of all the nozzles to be used, the noncompliant nozzles shall be discarded, or modified to flow within the 10 percent tolerance.

Determination of uniform lateral flow from the spray bar is determined by collecting a measured volume of emulsified asphalt in containers placed under each nozzle. This process is practical using standard 6-in. (15.2 cm) by 12-in. (30.4 cm) concrete cylinder molds lined with 1-gal (3.8 L) zip-lock freezer bags. The cylinder molds can be reused, and the zip-lock bags discarded appropriately with the contents.

4YY.5.5.1.4 *Longitudinal flow rate*

The longitudinal spray rate shall be accomplished by measuring the volume of emulsified asphalt in the emulsified asphalt tank before and after spraying enough emulsified asphalt to reduce the volume of liquid in the tank by 70 to 90 percent.

Commentary

The longitudinal flow rate must be measured with all nozzles inserted in the distributor bar. First, the quantity of emulsified asphalt in the tank must be determined. Although there is a volume indicator on the rear of most modern spray pavers, these are not calibrated in small enough increments to be of use for longitudinal flow rate calibration and shall not be used for this purpose. Instead, the dipstick supplied with the spray paver must be used. This dipstick is usually carried on the top of the tank near the inspection hatch. Prior to shooting emulsified asphalt take a volume reading with the dipstick. NOTE – carefully follow all safety protocol when taking a dipstick reading for either emulsified asphalt.

Pay attention to how the dipstick is used. Many dipsticks are not intended to be submerged in the emulsified asphalt but instead are inserted into the top of the tank only until the tip of the dipstick touches the surface of the emulsified asphalt. Then, the volume in the tank is read by indexing the top of the inspection cover to the reading on the dipstick.

- *Record this volume as "beginning volume."*
- *Set up the spray paver to shoot emulsified asphalt and shoot a minimum of 3000 ft (914 m) by 12 ft (3.66 m) of emulsified asphalt at the design rate using the gallon per minute pump flow volume and spray paver speed required by the manufacturer to attain this flow rate.*
- *Take a second dipstick reading.*
- *Record this reading as "ending volume."*
- *Subtract ending volume from beginning volume and record this as "volume used."*
- *Determine the area emulsified asphalt sprayed. Divide volume used by the area sprayed in square yards. This is the gallons per square yard applied to the pavement.*
- *This value shall then be compared to the spray paver computer, if equipped, to evaluate the accuracy of the computer.*

- *A correction factor may then be applied to the computer output, if needed, and used for the remainder of the day. This calibration shall be accomplished each day.*

An example of this calibration is presented below:

Given:

1800-gal capacity asphalt distributor 12-ft-wide spray width
Trial spray distance = 7500 ft
0.15-gal/yd^2 design spray rate
Dipstick reading beginning of shot = 1765 gal
Dipstick reading end of shot = 265 gal
NOTE: 1 gal = 3.785 L, 1 ft = 0.30 m, 1 gal/yd^2 = 4.53 L/m^2

Calculations:

1. *Check to see if enough volume shot. 1765 – 265 = 1500 gal*
2. *1500/1765 = 85 percent > 70 percent and < 90 percent. OK, enough applied to be valid*
3. *Calculate spray rate = 1500 gal/ (12 × 7500/9) = 0.15 gal/yd^2*

Therefore, distributor is set up correctly.

4YY.5.5.2 *Asphalt mixture paver* - Provide self-propelled asphalt mixture pavers with activated heated screed assemblies to spread and finish to the specified section widths and thicknesses. Ensure the paver's distribution system places the mixture uniformly in front of the screed. Screed or strike-off the surface without tearing, shoving, or gouging the mixture. Operate the paver at consistent speeds to apply the material in an even, continuous layer. Avoid stop and go operation. Equip pavers with automatic screed controls that are capable of operating from a reference line or a ski and that are capable of operating from either or both sides of the paver. Control the screed to maintain the transverse slope according to plan. The Contractor may operate equipment manually in irregularly shaped and minor areas. If automatic controls fail, operate equipment manually only for the remainder of the work day and only if specified results are obtained. Suspend paving if the specified surface tolerances are not met. Resume only after correcting the situation. Use best practices to prevent segregation such as dumping the mix load smoothly, running the augers and conveyors consistently and on automatic controls, maintain the mix level in the paver hooper over the gates, and do not empty the paver wings between loads.

Commentary

The optimal paver speed is 30-90 feet per minute.

4YY.5.6 *Test Strip*—Construct a 500-ft (152.4 m) test strip and adjust the application rate as needed to assure a uniform application of the emulsified asphalt and asphalt mixture. The application rate shall not result in an excess of emulsified asphalt that could run off the pavement area. Special attention shall be paid to the nozzles and spray bar as discussed in Section 4YY.5.5.1. Select compacting methods to meet the specified density. The Engineer will take random core samples to verify compliance with job mix requirements. Reconstruct the test strip if the job mix formula, the compacting method, or compacting equipment changes, or if results do not meet specifications.

4YY.5.6.1 *Verify on application rates*

The general application rate for emulsified asphalt tack coat shall be between 0.14 gal/yd^2 (0.63 L/m^2) to 0.20 gal/yd^2 (0.91 L/m^2). A full summary of recommended application rates is shown in Table 1. The actual rate used for a specific pavement shall be determined using a test strip.

Guide on field adjustment of emulsified asphalt

Although the emulsified asphalt application rate is determined by the tests strip, roads can change over the length of a job. Therefore, there may be a need to slightly increase the application rate when traveling along older, more aged pavement than the test strip, or decrease the amount of tack coat when traveling along bleeding surfaces. This emphasizes the need for examining any unique project conditions during the preconstruction meeting, to be aware of these sections before the start of work.

Table 2—Recommended General Emulsified Asphalt Tack Coat Application Rate and Adjustment Factors for Surface Conditions (from R 108)

	Mixture Designation		
	$^1/_2$ in. (12.5 mm)	$^3/_8$ in. (9.5 mm)	#4 (4.75 mm)
General Application Rate, gal/yd² (L/m²)	0.20 (0.91)	0.18 (0.81)	0.14 (0.63)
Recommended Adjustments to Application Rate, gal/yd² (L/m²), by Existing Surface Condition			
PCCP, Smooth or Polished	–0.03 (–0.14)	–0.03 (–0.14)	–0.03 (–0.14)
PCCP, Broomed or Textured	0	0	0
Flushed Asphalt Concrete Surface	–0.02 (–0.09)	–0.03 (–0.14)	–0.03 (–0.14)
Dense, Unaged Asphalt Concrete	0	0	0
Open Textured, Dry, Aged or Oxidized	+0.02 (+0.09)	+0.01 (+0.05)	+0.01 (+0.05)
Milled Asphalt Concrete Surface	+0.02 (+0.09)	+0.01 (+0.05)	+0.01 (+0.05)

A tolerance of ±0.02 gal/yd² (0.09 L/m²) shall be applied to the final target application rate.

All design work will be carried out using the emulsified asphalt to be used on the job site or from equivalent material from the same source and having substantially the same material properties.

4YY.5.6.2 *Verify equipment and workmanship* - Contractor shall provide documentation that equipment has been calibrated in the current construction season. All equipment shall be checked during the test strip construction. Verify that workmanship follows requirements in Section *4YY.5.10* for surface preparation, UTBWC application, and seating of the asphalt mixture.

4YY.5.7 *Traffic Control*— Traffic shall not be placed on a tack coat and construction traffic shall be minimized. Barricades, signage, and traffic control shall follow the current Manual on Uniform Traffic Control Devices (MUTCD) standards.

4YY.5.8 *Application of emulsified asphalt*

Apply the emulsified asphalt at the rate determined by the test strip within ±5 percent. The temperature of the emulsified asphalt at the time of application shall be above 120°F (48.9°C).

Commentary

If the temperature of the emulsified asphalt is lower than 120°F (48.9°C), there is risk of less material being applied than desired due to high viscosity.

4YY.5.9 *Application of asphalt mixture*

Spread and finish the mixture with asphalt pavers to specified grade and thickness. Maintain a consistent supply of mixture to ensure uninterrupted paving. Minimize inconvenience to traffic and protect existing and finished surfaces. Leave only short lane sections, normally less than [26 ft (8 m)], where the abutting lane is not placed the same day, unless otherwise specified.

4YY.5.9.1 *Guide on field adjustment of asphalt mixture*

The amount of asphalt mixture placed shall not be adjusted in the field.

4YY.5.10 *Workmanship*

When placing an UTBWC, the longitudinal and transverse joints shall be uniform, neat in appearance, and shall not contain material build-up or uncovered areas. Longitudinal joints shall be placed on lane lines, edge lines, or shoulder lines or slightly overlapping to offset the joint. Longitudinal joints shall be straight in appearance. All transverse joints shall be clean and straight. At the start of each day(s) of production and at approaches, place a 5 ft. (1.5 m) minimum width of paper/plastic on the existing pavement. Cover all bridge ends with paper/plastic to ensure no tack coat is placed on the bridge. Remove the paper/plastic once the tack coat has cured and properly dispose of the excess material from the project site. Place and spread all courses as continuously as possible, keeping the number of construction transverse joints to a minimum. Once the end of the mat and a straight line is created, the spray paver screed shall be lifted, and the remaining material shall be removed and properly disposed of from the project site.

Longitudinal lines at shoulders shall be straight to provide a good appearance. Longitudinal edge lines shall not vary by more than ±2 in. (50.8 mm) in 100 linear ft (30.5 m). If the contractor is unable to meet this requirement, they shall be required to establish a pilot line.

The finished surface shall have a uniform texture free from excessive surface defects, 0.25 in. (6.35 mm) vertical space for longitudinal joints, and no more than 0.25 in. (6.35 mm) for a transverse joint between the pavement surface and a 10-ft (3.05 m) straightedge placed perpendicular to the joint. If these criteria are exceeded, the contractor shall stop work and correct them.

4YY.5.11 *Longitudinal joints* – Create the longitudinal joint in the UTBWC along the centerline of two-lane highways or at the lane lines of roadways with more than two lanes. Offset longitudinal joints [6 to 12 in. (150 to 300 mm)] from the joint in the layer immediately below. Longitudinal joints shall be constructed by placing mix ~1/16 in. above previously placed/compacted lane. The edge of screed must follow join exactly.

Longitudinal joints may be constructed as butt joints that are well bonded and sealed. Longitudinal joints should be straight on tangent sections and uniformly follow the traffic lane on curve sections. Longitudinal joints shall be smooth, particularly on roadways with high-speed traffic.

4YY.5.12 *Transverse construction joints* – When beginning a new application of the UTBWC transversely abutting the previously placed UTBWC a transverse paper/plastic joint shall be used so excess emulsified asphalt is not placed at the joint. The transverse paper joint shall be formed by placing 36-in. (91.4 cm) wide paper/plastic on top of the previously applied UTBWC so the edge of the paper/plastic aligns with the joint that will be formed when the previously placed UTBWC meets the newly applied UTBWC. The spray paver shall begin applying emulsified asphalt by starting the application on top of the paper/plastic. After the spray paver moves forward and over the joint, the paper shall be removed.

Transitions at the transverse joints must be smooth to avoid creating a bump in the surface. The joints must be butted to avoid these bumps. Care must be taken during compaction in order to ensure proper density is achieved at all cold-joints.

Commentary

Ideally, the paper/plastic should also be placed at the end of the spray paver shot as well. This creates a clean, edge with the correct emulsified asphalt quantity at the joint. The placement of the paper is calculated based on the emulsified asphalt shot rate and the quantity of emulsified asphalt in the spray paver. The distance the spray paver travels before encountering the paper/plastic and turning off the bar should be approximately

equivalent to 80 percent of the spray paver tank volume. This assures the spray paver does not spray until empty which can result in less emulsified asphalt applied than desired at the end of the shot.

A desired method of placing transverse joints is to start with the screed one foot behind existing transverse joint, and lay screen flat on the existing open-graded mat. The hot open-graded mix should be augured in front of screed, and drug off the new joint when travelling begins. The joint should be cross rolled with steel wheel breakdown roller.

4YY.5.13 *Rolling operations* – The roller shall stay within 50 feet (15.2 m) of the paver and should only complete 1-2 passes on the mat. The roller shall not stop on the freshly placed mat and make smooth transitions of direction to avoid bumps in the mat.

Commentary

The rolling process is designed to seat the aggregate rather than compact or densify the open-graded asphalt mixture. The rolling operation is intended to lock the aggregate structure similar to a chip seal rolling operation and not crush the aggregate. It is not the intent to achieve a specified density.

4YY.5.14 *Protection of motor vehicles*—The Contractor is responsible for claims of damage to vehicles until the traffic control has been removed from the roadway.

4YY.5.15 *Sequence of work*

Construct the UTBWC so that adjacent lanes are sealed on the same day when possible. If the adjacent lane(s) has not been sealed sweep all loose debris from the unsealed lane(s) before traffic is allowed on the surface without traffic control.

Permanent pavement markings shall not be placed for 24 h after placing the UTBWC.

4YY.5.16 *Project documentation*

The contractor shall supply daily documentation to the Agency that includes the following:

- Aggregate used for asphalt mixture, tons (Mg) in dry condition
- Asphalt binder used for asphalt mixture, gallons (L)
- Asphalt mixture used for open-graded mix, tons (Mg)
- Emulsified asphalt used for tack coat, gallons (L)
- Surface area completed, square yards (square meter)

4YY.5.17 *Quality assurance*

Referred to UTBWC quality assurance guide developed during NCHRP 14-48.

4YY.6 MEASUREMENT

The Engineer will measure the acceptably completed UTBWC as specified in the "AASHTO Guide Specifications for Highway Construction" (2020) or as specified in Sections 4YY.6.1, 4YY.6.2, 4YY.6.3, 4YY.6.4, or 4YY.6.5.

4YY.6.1 *Aggregate* —the amount of aggregate consumed during manufacturing of asphalt mixture, tons (metric tons).

4YY.6.2 *Asphalt binder* —the amount of asphalt binder consumed during manufacturing of asphalt mixture, tons (metric tons).

4YY.6.3 *Emulsified asphalt* —the amount of emulsified asphalt by volume, at 60°F (15.6°C), gal (L), at 60°F.

4YY.6.4 *Area treated with UTBWC* —the total area treated with UTBWC application, yd^2(m^2).

4YY.7 Warranty

4YY.7.1 *Warranty*

When specified in the plans, or special provisions, warrant the UTBWC product for the period specified such as one year or two years. The warrant process shall follow the Guide Specifications for Highway Construction, Appendix X1 – Generic Warranty. Perform any required remedial work to correct deficiencies identified in periodic evaluations and maintain the product during the warranty period. When specified, provide acceptable warranty bonds for the warranty period as specified in Subsection 1.2 of Appendix X1 (AASHTO, 2020).

Develop and obtain the Agency's approval of remedial action(s) for those parts of the warranted UTBWC that do not meet specified standards of performance. Complete the approved remedial work, as specified in Subsection 1.3(D) of Appendix X1, at no additional cost to the Agency.

A Conflict Resolution Team will be formed to resolve any disagreements associated with the warranty work as specified in Subsection 1.6 of Appendix X1.

4YY.7.2 *Final Warranty Acceptance*

The Agency will evaluate the pavement performance within 30 days of the completion of the warranty term. Perform any required remedial work based on the results of the final survey in accordance with Subsection 1.3 (D) of the Appendix X1. The Agency will issue a final warranty acceptance letter or and equivalent certification and release final payment (retainage) upon verification that all required performance thresholds are met.

4YY.8 PAYMENT

Payment for UTBWC will be made by either paying for the materials as unit costs, or for the completed UTBWC by area of pavement sealed.

Commentary

The advantage of payment by the square yard for a completed UTBWC is simplicity if the area is easily defined. The disadvantage is that an incentive is created to reduce material quantities. Reduced emulsified asphalt quantities can lead to delamination or asphalt binder quantities can lead

to raveling. A good practice could be to pay the Contractor by the square yard for the ton of the aggregate, gallon of the asphalt binder, and gallon of the emulsified asphalt to ensure enough binding material is supplied on the job.

4YY.8.1 *Payment by unit price of materials*—The Agency will pay for accepted quantities at the contract price as follows:

1. Payment for the accepted quantity of aggregate, asphalt binder, and emulsified asphalt at the contract bid price of measure is compensation in full for all costs of furnishing and applying the material as specified.
2. Payment will be made in accordance with the schedule set forth below at the Contract bid price for the specified unit of measure.

Item No.	Item	Unit
State ##	Aggregate for asphalt mixture	ton (Mg)
State ##	Asphalt binder for asphalt mixture	gal (L)
State ##	Emulsified asphalt for tack coat	gal (L)

4YY.8.2 *Payment for completed UTBWC*

Payment for the accepted quantity of the UTBWC at the Contract bid unit price of measure is compensation in full for all costs of furnishing and applying the material as specified, including cleaning the existing pavement, stationing, purchase of materials, delivery of materials, all labor, equipment, and materials necessary for the placement of the UTBWC for full lane coverage, sweeping of any debris after construction and other requirements as specified. Either 4YY.8.2.1 or 4YY.8.2.2. can be selected to pay the Contractor.

4YY.8.2.1 Payment will be made in accordance with the schedule set forth below at the Contract bid price for the specified unit of measure.

Item No.	Item	Unit
State ##	UTBWC	yd^2 (m^2)

4YY.8.2.2 Payment will be made in accordance with the schedule set forth below at the Contract bid price for the specified unit of measure.

Item No.	Item	Unit
State ##	Aggregate for asphalt mixture	ton (Mg)
State ##	Asphalt binder for asphalt mixture	gal (L)
State ##	Emulsified asphalt for tack coat	gal (L)

Such payment is full compensation for furnishing all materials, equipment, labor, and incidentals to complete the work as specified.