INDIANA DEPARTMENT OF TRANSPORTATION

Driving Indiana's Economic Growth

Design Memorandum No. 11-25
Technical Advisory

December 22, 2011

TO: **All Design, Operations, and District Personnel, and Consultants**

FROM: ***/s/ Todd Shields***
Todd Shields
Manager, Office of Systems Assessment
Technical Services Division

SUBJECT: **Ultrathin Bonded Wearing Course**

REVISES: **Indiana Design Manual Section 52-11.01, item 5**

EFFECTIVE: **April 13, 2012, Letting**

The locations of existing surface irregularities, including bumps, to be addressed, should be shown on the plans. Quantities should be determined and incorporated into the milling or patching quantities.

If a public road or other approach requires an ultrathin bonded wearing course, separate quantities should be determined and identified as ultrathin bonded wearing course for approaches.

Mainline ESALs should be shown on the title sheet's traffic-data block, as the type of aggregate used is dependent on ESALs.

A lane-rental cost should be determined. See Indiana Design Manual Section 81-3.02 item 5. Figure 81-3D part II. B. includes the calculations which can be used to determine the hourly lane-rental rates. Once this information is known, it should be incorporated into Recurring Special Provision 414-R-590, as the closure-period rate. The provision should then be called for in the contract set. It is attached herewith.

Attachment
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414-R-590 ULTRATHIN BONDED WEARING COURSE, WARRANTED

(Adopted 11-16-11)

The Standard Specifications are revised as follows:

SECTION 414, BEGIN LINE 1, INSERT AS FOLLOWS:

SECTION 414 - ULTRATHIN BONDED WEARING COURSE, WARRANTED

414.01 Description

This work shall consist of furnishing materials and the placement of warranted Ultrathin Bonded Wearing Course, UBWC, in accordance with 105.03. The UBWC shall consist of surface preparation, application of asphalt emulsion and asphalt mixture. Asphalt mixture shall be produced by a Certified Hot Mix Asphalt Producer.

The Contractor shall be responsible for the warranted UBWC in accordance with 414.14.

MATERIALS

414.02 Materials

Materials shall be in accordance with the following:

Asphalt Emulsion ..... 414.02(a)
Asphalt Materials
PG Binder, PG 64-22, PG 70-22 ..... 902.01(a) and 414.02(b)
PG Binder Grade ..... 414.02(b)
Coarse Aggregates, Class A or Higher ..... 904.03 and 414.02(c)
Fine Aggregates 904.02
Mineral Filler ..... 904.02(f)

(a) Asphalt Emulsion

The requirements for asphalt emulsion shall be in accordance with the following:

Characteristic		*AASHTO Test Method*	*Min.*	*Max.*
Tests on Emulsion				
Viscosity, Saybolt Furol @ 77°F (25°C), s		*T 59*	*20*	*100*
Storage Stability Test, 24 h, % (Note 1)		*T 59*		*1*
Sieve Test, %		*T 59*		*0.05*
Residue by Distillation, % (Note 2)		*T 59*	*63*	
Oil Distillate by Distillation, %		*T 59*		*2*
Demulsibility, %	*w/35 mL, 0.02 N $CaCl_2$ or*	*T 59*	*60*	
	w/35 mL 0.8% DSS	*T 59*		
Tests on Residue from Distillation				
Penetration (0.1 mm) at 25°C, 100g, 5 s		*T 49*	*90*	*150*
Elastic Recovery @ 39°F (4°C), %		*T 301*	*58*	

Notes: 1. After 24 h, the emulsion shall be a homogeneous color
2. Except maximum temperature of 400 ± 10°F (200 ± 5°C)
3. Organic solvent shall be from the list of Approved Solvents

(b) Asphalt Materials

The PG binder grade shall be selected based on the following requirements:

PG Binder	*ESAL*
64-22	*< 10,000,000*
70-22	*≥ 10,000,000*

Additional requirements for the PG 70-22 binder as follows:

Characteristic	*AASHTO Test Method*	*Min.*	*Max.*
Separation, % prepared by ASTM D 7173	*T 53*		*6℃*
Elastic Recovery, @ 39℉ (4℃), %	*T 301*	*60*	

(c) Coarse Aggregates

Additional requirements for coarse aggregate shall also be as follows:

Characteristic	*Method*	*Min.*	*Max.*
Coarse Aggregate Angularity	*ASTM D 5821*	*95/85**	
Micro-Deval Abrasion, % loss	*AASHTO T 327*		*18*

** Denotes 2 faced crush requirements.*

414.03 Job Mix Formula

The Job Mix Formula, JMF, shall be determined for each mixture prepared by an Approved Mix Design Laboratory in accordance with 414.04. The Contractor shall submit a JMF for each mixture to the Engineer one week prior to use. The JMF shall state the maximum particle size in the mixture, and the application rate for any anti-stripping additives. No mixture will be accepted until the JMF is approved.

414.04 Mix Design

The binder content and the percentage of aggregate passing each sieve shall be in accordance with the following requirements:

Mixture Designation – Control Point (Percent Passing)			
	12.5 mm	*9.5 mm*	*4.75 mm*
Sieve Size			
3/4 in. (19.0 mm)	*100.0*		
1/2 in. (12.5 mm)	*85.0 - 100.0*	*100.0*	
3/8 in. (9.5 mm)	*55.0 - 80.0*	*85.0 - 100.0*	*100.0*
No. 4 (4.75 mm)	*22.0 - 38.0*	*22.0 - 38.0*	*40.0 - 55.0*
No. 8 (2.36 mm)	*19.0 - 32.0*	*19.0 - 32.0*	*20.0 - 32.0*
No. 16 (1.18 mm)	*15.0 - 24.0*	*15.0 - 24.0*	*15.0 - 24.0*
No. 30 (600 µm)	*11.0 - 18.0*	*11.0 - 18.0*	*11.0 - 18.0*
No. 50 (300 µm)	*8.0 - 14.0*	*8.0 - 14.0*	*8.0 - 14.0*
No. 100 (150 µm)	*5.0 - 10.0*	*5.0 - 10.0*	*5.0 - 10.0*
No. 200 (75 µm)	*4.0 - 5.5*	*4.0 - 5.5*	*4.0 - 5.5*

Binder Content, %,	*4.6 - 6.1*	*4.8 - 6.1*	*5.0 - 6.3*
*Plan Lay Rate (lb/sq yd)**	*90*	*75*	*65*
** Plan lay rates are based on 100 lb/sq yd/in. using a mixture with a specific gravity of 2.5. Mixtures with different specific gravity will require an adjusted equivalent lay rate.*			

The binder film thickness shall be a minimum of 0.4 mil. The binder content of the mix shall be determined by calculating the binder film thickness in accordance with ITM 589.

Draindown from the loose mixture shall not exceed 0.10% when tested in accordance with AASHTO T 305.

The tensile strength ratio, TSR, shall meet or exceed 80% when tested in accordance with AASHTO T 283[(1)]. Specimens for AASHTO T 283 shall be 6 in. in diameter by 3 3/4 ± 1/4 in. height and compacted in accordance with AASHTO T 312, except the specimens shall be compacted to 100 gyrations and resultant air voids reported for information purposes only. The compaction temperatures shall be 300 ± 10°F.

[(1)] Follow AASHTO T 283 with the following exceptions:

- *(a) Condition the mixture for 2 h in accordance with AASHTO R 30, Section 7.1*
- *(b) Compact the Superpave Gyratory Compactor, SGC, specimens to 100 gyrations*
- *(c) Extrude the samples as soon as possible without damage to the sample*
- *(d) Use AASHTO T 269 to determine the void content*
- *(e) Record the void content of the specimens*
- *(f) If less than 55% saturation is achieved, the procedure does not need to be repeated unless the difference in tensile strength between duplicate specimens is greater than 25 lbs/sq in.*

414.05 Use of Recycled Materials

Recycled materials may consist of reclaimed asphalt pavement, RAP, or reclaimed asphalt shingles, RAS or a blend of both. RAP shall be the product resulting from the cold milling or crushing of an existing HMA pavement. The RAP shall be processed so that 100% will pass the 2 in. (50 mm) sieve when entering the HMA plant. RAS shall be 100% passing the 1/2 in. (12.5 mm) sieve. RAP shall be 100% passing the 3/8 in. (9.5 mm) sieve and 95 to 100% passing the No. 4 (4.75 mm) sieve.

Recycled materials may be used as a substitute for a portion of the new materials required to produce UBWC mixtures. The amount of total binder replaced by binder in the recycled material shall be computed as follows:

$$\text{Binder Replacement, \%} = \frac{(A \times B) + (C \times D)}{E} \times 100\%$$

where:

A = RAP, % Binder Content
B = RAP, % in Mixture
C = RAS, % Binder Content
D = RAS, % in Mixture
E = Total, % Binder Content in Mixture

RAS may be obtained from either pre-consumer or post-consumer asphalt shingles. Post-consumer asphalt shingles shall be in accordance with AASHTO MP 15 and prepared by a processing company with an IDEM Legitimate Use Approval letter. A copy of this letter shall be submitted to the Engineer. Deleterious material present in post-consumer asphalt shingles shall be limited to the percentages stated in AASHTO MP 15. Pre-consumer and post-consumer asphalt shingles shall not be blended for use in UBWC mixtures and shall be stockpiled separately from other materials.

The recycled material percentages shall be as specified on the JMF. UBWC mixtures utilizing recycled materials shall be limited to 25% binder replacement and shall use the specified binder grade.

The combined aggregate properties shall be in accordance with 904. The combined aggregate bulk specific gravity shall be determined in accordance with ITM 584 and the combined aggregate gradation shall be in accordance with 414.04.

414.06 Quality Control

The Contractor shall produce a mixture in compliance with the JMF within the limits of the quality control tolerances. The Contractor shall maintain all quality control documentation and make a copy available to the Engineer upon request or at completion of work.

The Contractor shall sample the mix a minimum once per day in accordance with ITM 580, section 8.6 Truck Samples, Dense Graded HMA Mixture. The sample shall be tested for binder content and gradation prior to the next day's production.

The Contractor shall take corrective action when the binder content exceeds ± 0.5% from that stated in the JMF as tested in accordance with ITM 586.

The Contractor shall take corrective action when the aggregate gradation exceeds the following values from that stated in the JMF as tested in accordance with AASHTO T 30.

Sieve Size	*Quality Control Tolerances (±), %*		
	Mixture Designation - Tolerances		
	12.5 mm	*9.5 mm*	*4.75 mm*
3/4 in. (19 mm)			
1/2 in. (12.5 mm)	*5.0*		
3/8 in. (9.5 mm)		*5.0*	
No. 4 (4.75 mm)	*4.0*	*4.0*	*5.0*
No. 8 (2.36 mm)	*4.0*	*4.0*	*4.0*
No. 16 (1.18 mm)			*4.0*

No. 200 (75 µm)	*1.0*	*1.0*	*1.0*

CONSTRUCTION REQUIREMENTS

414.07 Equipment

The equipment shall be in accordance with 409.01, 409.02(a), 409.03(b) and 409.03(d)1 except as follows:

The paver shall be self-priming, designed and built for applying the UBWC. The paver shall have a receiving hopper, feed system, asphalt emulsion storage tank, a calibrated metering system for measuring the emulsion volume applied, spray bar and a heated, variable width, combination vibratory screed or a combination vibratory-tamping bar screed. The paver shall be capable of spraying the asphalt emulsion, applying the asphalt mix and leveling the surface of the mat in one pass. The screed shall have the ability to crown the pavement at the center.

414.08 Preparation of Surface

The Contractor shall be responsible for all surface preparation to meet the requirements for warranted UBWC. All castings and detector housings not identified on the plans as being reset shall be protected prior to the application of material in accordance with 404.07, except that raised pavement markers shall be removed.

414.09 Asphalt Emulsion

The asphalt emulsion shall be applied at a temperature recommended by the emulsion supplier. The asphalt emulsion shall be applied uniformly across the entire width of pavement to be overlaid. Equipment shall not operate on the applied asphalt emulsion before the asphalt mix is placed.

The recommended plan application rates of the asphalt emulsion are as shown in the table below. Determination of actual application rates shall be the responsibility of the Contractor.

Recommended Asphalt Emulsion Application Rate and Adjustment Factors For Surface Conditions			
	Mixture Designation		
	12.5 mm	*9.5 mm*	*4.75 mm*
General application rate, gal./sq yd	*0.20*	*0.17*	*0.14*
Existing Surface Condition	*Recommended adjustment to application rate, gal./sq yd*		
PCCP, smooth or polished	*-0.03*	*-0.03*	*-0.03*
PCCP, broomed or textured	*0*	*0*	*0*
Flushed asphalt concrete surface	*-0.02*	*-0.03*	*-0.03*
Dense, unaged asphalt concrete surface	*0*	*0*	*0*
Open textured, dry, aged or oxidized asphalt concrete surface	*+0.02*	*+0.01*	*+0.01*
Milled asphalt concrete surface	*+0.02*	*+0.01*	*+0.01*

414.10 Pre-Paving Meeting

A pre-paving meeting between the Engineer and Contractor will be held on-site prior to beginning work. The following shall be reviewed:

(a) work schedule
(b) traffic control plan
(c) equipment calibrations and adjustments
(d) inspection and evaluation of the condition and adequacy of equipment, including units for transport of materials
(e) Job Mix Formula
(f) Contractor's proposed emulsion and mix application rates
(g) Quality Control Plan in accordance with ITM 803
(h) Contractor's authorized representative

414.11 Mixture Placement

The UBWC shall be prepared and placed at temperatures recommended by the binder supplier. Fracturing of aggregates shall be avoided.

414.12 Mixture Finishing

Three passes of rollers capable of exerting at least 150 lb/in. and in conformance with 409.03(d)1 shall be applied to the UBWC before the material has cooled below 185°F. A release agent may be added to the water system of the rollers to prevent adhesion of the material to the roller drum. Rollers shall not operate in vibratory mode.

414.13 Smoothness

All finished surface irregularities in excess of 1/8 in. measured with a 10 ft straightedge shall be corrected.

The lane edge shall have no more than 2 in. of horizontal variance in 100 ft.

414.14 Warranty

A warranty bond is to insure completion of required warranty work, including payments for all labor, materials, equipment, and incidentals necessary or convenient to the successful completion of the project and the carrying out of the duties and obligations imposed by the contract used to remediate any warranted distresses.

The Contractor shall provide a warranty bond equal to 100% of the contract total for the warranted UBWC pay items. The warranty bond shall be in effect for 3 years from the date of substantial completion. The warranty bond shall be properly executed by a surety satisfactory to the Department and be payable to the State of Indiana and submitted with the Contractor's bid.

Upon the final acceptance of the project, the contractual obligations of the Contractor are satisfied as long as the UBWC continues to meet or exceed the warranted values as defined herein.

All warranty work shall be accomplished in accordance with 414.16. At the end of the warranty period, the Contractor will be released from further warranty work or

responsibility, provided all previous warranty work has been satisfactorily completed and approved by the Department.

414.15 Conflict Resolution Team

The scope of work for the conflict resolution team includes all issues concerning the warranted pavement relative to the quality control plan, material selection, warranted pavement evaluations, distress indicators, remedial action, and remediation plans.

The team will consist of 2 Contractor representatives, 2 Department representatives, and an additional person mutually agreed upon by both the Department and the Contractor. All costs for the additional person will be equally shared by the Department and the Contractor.

The team members will be identified in writing when needed and will be knowledgeable in the terms and conditions of this warranty and the methods used in the measurement and calculation of pavement distress. The team will render a final recommendation to the Chief Engineer by a majority vote. Each member has an equal vote.

414.16 Warranty Work

Elective work is performed by the Contractor at its discretion to meet the performance requirements of warranted UBWC prior to direction from the Department for the Contractor to perform remedial work.

Remedial work is performed as a result of pavement distress surveys performed by the Department.

During the warranty period, elective work and remedial work shall be performed at no cost to the Department. Elective work shall be at the Contractor's option. The scope of all elective work or remedial work to be performed as well as materials to be used shall be proposed by the Contractor and shall be subject to approval by the Department. Prior to proceeding with any warranty work or monitoring, all necessary permits shall be obtained from the Department.

Elective work during the warranty period will not be assessed a lane closure fee. For remedial work, costs for closure periods will be applied using the following closure period rates:

From _____ to _____ : .....$_____/lane/hour
From _____ to _____ : .....$_____/lane/hour

During the warranty period, the Contractor may monitor the warranted UBWC using non-destructive procedures.

Coring, milling or other destructive procedures may not be performed by the Contractor, without prior consent of the Department. The Contractor will not be

responsible for damages to the pavement as a result of coring, milling or other destructive procedures conducted by the Department.

The Contractor has the first option to perform the remedial work. If the problem requires immediate attention, as determined by the Engineer, for safety of the traveling public and the Contractor cannot perform the remedial work within 24 h of notification, the Department will perform the remedial work. The Contractor shall be responsible for all costs incurred by the Department for remedial work performed by the Department. Remedial work performed by the Department will not alter the requirements, responsibilities, or obligations of the warranty.

414.17 Pavement Distress Indicators, Thresholds and Remedial Action

The Department will use the following pavement distress indicators throughout the warranty period:

(a) Delamination - physical separation of the UBWC that exposes the underlying surface
(b) Rutting - transverse displacement of the UBWC
(c) Raveling - wearing away of the UBWC
(d) Skid Resistance - friction number as measured by ASTM E 274 and E 524

The pavement threshold values for the pavement distress indicators will be evaluated for the entire length of the project for each lane. The threshold values for the pavement distress indicators are listed below:

Distress	*Single Location*	*Multiple Locations*
Delamination/Raveling	*1/2 sq yd*	*1 sq yd/mi*
Rut Depth	*1/4 in.*	*average 1/4 in./mi*
*Friction Number**	*no less than 30*	*average 35*

** Individual friction tests will be performed in each lane every 1/2 mi for the length of the project.*

The Department may evaluate the warranted UBWC during the warranty period. A final condition survey will be made by the Department and the Contractor will be notified in writing of all sections exceeding the warranty threshold at least 90 days in advance of the expiration of the warranty period.

If the Department determines that any threshold level has been met or exceeded and remedial work is required, the Contractor shall submit a work plan and schedule to the Engineer for approval. The Contractor shall perform the remedial work within 30 calendar days of notification of approval by the Engineer.

If, anytime during the warranty period, 30% or more of the project requires, or has received remedial work, remedial work as determined by the Department shall be performed on the entire project.

If remedial or elective work performed by the Contractor necessitates repair or replacement of pavement markings, adjacent lanes or roadway shoulders, the required work shall be the responsibility of the Contractor.

Warranty requirements for all elective and remedial work will be limited to the life of the original contract warranty.

414.18 Department Maintenance

The Department may perform routine maintenance operations during the warranty period including, but not limited to, plowing, applying de-icing chemicals, repairs to safety appurtenances, pavement markings, mowing and sign maintenance. The Department, during the warranty period, will perform no routine pavement surface maintenance activities.

414.19 Method of Measurement

Ultrathin bonded wearing course, of the type specified, will be measured by the square yard in accordance with 109.01.

414.20 Basis of Payment

Ultrathin bonded wearing course, of the type specified, will be paid for at the contract unit price per square yard.

Payment will be made under:

Pay Item	***Pay Unit Symbol***
Ultrathin Bonded Wearing Course for Approaches, _____mm (size)	*SYS*
Ultrathin Bonded Wearing Course, _____mm (size)	*SYS*

The cost of all incidentals including, but not limited to, surface preparation, meeting smoothness requirements, and warranty bond shall be included in the cost of the pay items.

414.21 Final Warranty Acceptance

The Engineer will review the project in the field for any general defects not addressed in the indicators and recommend a Final Warranty Acceptance. The Department will issue the Contractor a Final Warranty Acceptance letter upon completion of the warranty period and all required remedial work.