2020 Bituminous Concrete Mix Design Submittal Policy
(updated May 15, 2020)

1. Definition of Terms: The definitions outlined in Subsection 101.02 of the 2011 Standard Specifications for Construction, Subsection 101.02 of the 2018 Standard Specifications for Construction, the Quality Assurance Program (QAP), the Materials Sampling Manual (MSM), and the Doc Express Contractors User Manual apply to this policy, in addition to the following:

**Bituminous Concrete Materials Unit** – Agency unit responsible for the Quality Assurance of HMA materials. The unit consists of an Engineering unit, HMA field inspection unit, PG binder laboratory, HMA laboratory and HMA Core laboratory.

**Bituminous Concrete Field Unit Supervisor** – Authorized representative of the Agency responsible for overseeing the quality assurance activities associated with the field-testing of HMA materials at HMA production facilities; AOT.HMAField@vermont.gov.

**Bituminous Concrete Materials Engineer** – Authorized representative of the Agency responsible for reviewing and approving mix design submittals and letters of intent in accordance with the Contract documents.

**Doc Express** – Web based document management program to be used for submitting Project Specific Mix Designs and letters of intent. For more information regarding usage and to create an account, see the information at the following link: https://outside.vermont.gov/agency/vtrans/external/docs/construction/Contracting/DocExpressOverviewforContractors.docx

**Flexibility Index Test (FIT)** – Test method completed for Superpave mix designs to analyze cracking susceptibility in accordance with AASHTO TP 124. **Modifications to the AASHTO procedure are included in Appendix B of this Policy.**

**Hamburg Wheel Tracker Test (HWTT)** – Test method completed for Superpave mix designs in analyze rutting and moisture susceptibility in accordance with AASHTO T 324. **Modifications to the AASHTO procedure are included in Appendix A of this Policy.**

**HMA Producer** – Production facility responsible for the manufacturing of HMA materials

**Master Mix Design** – Mix design submitted for general use and intended for use on multiple projects and/or multiple contracts.

**Non – Performance (NP)** – Superpave mix design without HWTT and FIT results intended for use in hand-placed applications and District Paving projects.

**Performance (P)** – Superpave mix design with HWTT and FIT results intended for use on mainline paving applications.
PG Binder Supplier – Final entity providing the Certificate of Analysis (COA) for PG binder.

Project Specific Mix Design – Mix design specifically intended for exclusive usage on one or more projects under the same contract; required submittal for any mix designs designated as a Section 900 Special Provision pay item as evident in the contract plans and/or contract documents. Must be submitted through Doc Express.

VTrans Construction Paving Engineer – The duly authorized representative for providing technical expertise in pavement operations to the Resident Engineer.

VTrans Mix Design Mailbox – Email address to which Master Mix Designs must be submitted; AOT.VTransMixDesigns@vermont.gov.

VTrans State Maintenance Engineer – The duly authorized representative for providing technical expertise in District mix designs within the VTrans Maintenance Bureau.

WMA – Warm mix asphalt; approved technology meant to lower the placement and mixing temperatures of bituminous concrete.

2. Applicability of Mix Designs: The contents of this submittal policy apply to the following mix design methods and procedures:
   a) Marshall Mix Design
   b) Superpave Mix Design
   c) Paver Placed Surface Treatment Mix Design/Bonded Wearing Course
   d) WMA Mix Designs
   e) Tensile Strength Ratio (TSR)

Mix design methods and procedures not covered under this submittal policy will be handled on a project-by-project basis.

3. Mix Design Contents & Submittal Process: Submittal packets for each mix design method are available on the Bituminous Concrete Materials Unit website and shall be submitted using the appropriate procedure for Master or Project – Specific Mix Designs. Each submittal must include the contents outlined below at a minimum. Mix designs must be submitted for each grade of performance-graded binder found in the project plans or within the project contract. Hyperlinks to each mix design workbook are provided in the descriptions below.

a) Marshall Mix Design – Must be submitted for each type of mix. Unless designated as a project specific design, all mix design submittals will be considered as “MASTER MIX DESIGNS” and shall be indicated this way where appropriate on the cover sheet (Marshall Mix Design). Before a design can be approved for use on a specific project/contract, a letter of intent which indicates its intended use shall be submitted as dictated in the Doc Express Contractors User Manual
   i) Design of bituminous concrete mixtures (Cover sheet)
   ii) Marshall test property curves (Sheet 1)
   iii) Marshall design analysis (Sheet 2)
   iv) Particle distribution curve (Sheet 3)
   v) Production Action & Suspension Limits (Sheet 4)

b) Superpave Mix Design - Must be submitted for each type of mix. Unless designated as a project specific design, all mix design submittals will be considered as “MASTER MIX
DESIGNS” and shall be indicated this way where appropriate on the cover sheet (Superpave Mix Design). Before a design can be approved for use on a specific project/contract, a letter of intent which indicates its intended use shall be submitted as dictated in the Doc Express Contractor User Manual

i) Superpave Bituminous Concrete Mixture Design (Cover sheet)
ii) Superpave test property curve(s) (Sheet 2a)
iii) Superpave mix points design analysis (Sheet 3)
iv) RAP and Aggregate property worksheet. (Sheet 4)
v) Recycled Asphalt Pavement properties Worksheet. (Rap_Test_Sheet). This sheet is required only with designs listing RAP as an aggregate source.
vi) Production Action & Suspension Limits (Sheet 5)

vii) Analysis of specimen gyrated to N_max worksheet. (Sheet 6)
viii) Hamburg Wheel Tracker Test (HWTT) and Flexibility Index Test (FIT) worksheet (Sheet 7) (required for projects advertised with the General Special Provisions July 23rd, 2019)*
x) Copies of HWTT and FIT graphs and reports (required for projects advertised with the General Special Provisions dated July 23rd, 2019)*

*Superpave mix designs that are intended for use in hand-placed applications and/or District paving projects do not require Hamburg and FIT results to be submitted for approval.

c) Bonded Wearing Course Mix Design – Must be submitted for each type of mix. All mix design submittals under the 2011 Standard Specifications for Construction will be considered as “PROJECT SPECIFIC” and will require the project name and project number to be indicated where appropriate on the cover sheet, and will also need to be submitted in Doc Express. Mix design submittals under the 2018 Standard Specifications for Construction will be considered as “MASTER MIX DESIGNS” and shall be indicated this way where appropriate on the cover sheet. A letter of intent is not required for Paver Placed Surface Treatment Mix Design submittals under the 2011 Standard Specifications for Construction, but a letter of intent shall be submitted indicating its intended use on a specific project/contract under the 2018 Standard Specifications for Construction (Bonded Wearing Course Mix Design).

i) Paver Placed/Bonded Wearing Course Bituminous Concrete Mixture Design (cover sheet)
ii) Aggregate property worksheet. (Sheet 2)
iii) Aggregate test results (Sheet 3)
iv) Minimum PG binder content worksheet (Sheet 4)

d) WMA Mix Design – In addition to the contents outlined in parts a & b above, the percentage and type of WMA product/application must be included where appropriate on the Performance Graded Binder section of the cover sheet. The percentage and type must also be indicated on the Tensile Strength Ratio (TSR) test results submitted in accordance with part e) below. The product/application must be approved by the Agency prior to being included in a mix design submittal.

i) Marshall Mix Design (Marshall Mix Design WMA)
ii) Superpave Mix Design (Superpave Mix Design WMA)

Note that mix design submittals will not be formally approved for use if any of the following components have not been inspected and/or approved for use by Agency representatives:

i) PG Binder Source(s)
ii) Aggregate Source(s)
iii) Production Facility
4. **Changes to JMF**: Once a mix design is used in production, jurisdiction is transferred to the Bituminous Concrete Field Unit Supervisor (AOT.HMAField@vermont.gov). The contractor may adjust the original JMF design binder content up to ± 0.1% at their discretion. All other requests to change the JMF shall be submitted electronically to the Bituminous Concrete Field Unit Supervisor for review/approval. Supporting data/documentation shall be included that substantiates each request. Approved requests will be applied proactively. The Agency may request a new mix design submittal if it is in the best interest of the project.

5. **Trial Drops**: The Agency currently does not require trial drops as part of mix design approval. However, trial drops performed for corrective action during Method Spec production are still required **and are the responsibility of the hot mix producer**.

Trial drops shall contain at minimum the following information and the raw data used to calculate all values:

   a. Copy of batch slip  
   b. JMF  
   c. Volumetric properties (air voids, VMA, effective asphalt content, maximum specific gravity, bulk specific gravity, and dust/binder ratio)  
   d. Gradation (dry sieve only)  
   e. Marshall flow & stability values (for Marshall Mix Design)  
   f. Copy of gyratory height printout for specimen gyrated to N_{design} (for Superpave Mix Design)  
   g. Date & time sampled and tested

6. **Carryover of Mix Designs**: Prior to each paving season, contractors must submit a letter and supporting data electronically to the VTrans Mix Design Mailbox (AOT.VTransMixDesigns@vermont.gov) requesting a list of designs approved during the previous season to be carried over for the upcoming construction season. It is the intent that contractors will submit requests during the off-season to allow VTrans appropriate time to review. The Bituminous Concrete Materials Engineer will review and provide a formal response for each request. Approval will be dependent but not limited to each design’s past performance and the following factors below:

   a. The origin of materials (approved aggregate, recycled materials, approved PG binder and additives) shall be unchanged from the original design. Additionally, no significant changes have taken place that would affect material properties from the previous year’s operation, i.e. change in crushing operation or plant operation. If deemed necessary, the **Agency reserves the right to request submittal of production or trial drop data to substantiate the review**.

   b. No significant changes to the JMF have taken place. The mix design reviewer will review all requested aim changes to each design and determine if changes are significant enough to warrant a new design, i.e. Gradation – aim change on 4 or more sieves and/or > ± 5% on any one sieve or > ± 0.5% on the #200 sieve. Deviations of the binder content during production beyond ± 0.2% of the original design binder content will be significant enough to require a new design.

   c. Designs must exhibit acceptable past performance both plant and field. A review of production (QC and QA) and field performance data will be conducted to determine acceptable performance. Designs meeting criteria a&b above, have a plant pass/fail ratio above 85% and have exhibited reasonably acceptable field performance will be eligible for carryover. Designs meeting criteria a&b above with a plant pass/fail ratio between 70-85% will be further reviewed on a case-by-case basis. A detailed review of the design’s history may need to be performed to make the proper assessment. Designs that have a plant pass/fail ratio less than 70% will not be considered for carry-over unless it is determined that it qualifies as a “limited use” design as explained in part (d) below.
d. Designs with “limited use” within the past 5 years, i.e. less than 15 sample points; The Agency reserves the right to request additional information to substantiate the review.

e. District Designs: Because certified contractor test results are used for acceptance of district paving projects that are QAP Level 4, contractors shall submit a summary of each design’s QC plant data to aid in the review of the design’s past plant performance. To evaluate field performance, the VTrans State Maintenance Engineer or designee will be consulted with for the design’s eligibility for carry-over.

f. The mix design meets the criterion set forth under both the 2011 Standard Specifications for Construction and the 2018 Standard Specifications for Construction. For projects that were issued with the General Special Provisions dated July 23rd, 2019, mix designs deemed eligible for carryover will be allowed for use if satisfactory HWT and FIT results are submitted. Results must represent specimens fabricated in accordance with the guidance provided in Appendices A & B, and under no circumstances will Agency test results be allowed or substituted for Contractor test results.

7. Letters of Intent: A letter of intent for each project/contract shall be submitted at a minimum of 10 working days prior to the start of production identifying the approved mix designs intended to be used for that particular project/contract. Letters of intent shall be submitted through Doc Express in accordance with the latest edition of the Doc Express Contractor User Manual and, in addition to the project name and project number, include the mix design number, mix type, PG binder grade, and percent amount of RAP if present. The Bituminous Concrete Materials Engineer will review the request and relevant project plans to ensure the mix design is eligible; in addition, the project Resident Engineer and VTrans Construction Paving Engineer will be consulted with if questions arise. Usage of the mix design on Agency projects will not be authorized without the letter of intent being approved in writing by the Bituminous Concrete Materials Engineer and the approval letter having been uploaded into Doc Express by the project Resident Engineer.

Note: If the HMA Producer is a Subcontractor on an Agency project, then the HMA Producer must either a. be assigned “Associate” permission by the Prime Contractor in order to submit a letter of intent into Doc Express, or b. have the Prime Contractor submit the letter on behalf of the HMA Producer.

All of the forms referenced in this policy can be found on the Bituminous Concrete Materials Unit website (http://vtrans.vermont.gov/highway/construct-material/test-cert/bitum-concrete).
Appendix A: Laboratory Testing of Hamburg Wheel Tester (HWT) Samples at VAOT

Specimen Preparation - Lab Produced Mixtures
Lab produced HWT samples shall be fabricated in accordance with the procedures outlined in AASHTO T 324, with the following modifications:

- Upon mixing the constituent materials to ensure all aggregates are coated, test samples shall be conditioned at the appropriate temperature in accordance with the short-term conditioning procedure for mechanical properties in AASHTO R 30 (4 hours at 135°C).
- A Superpave Gyratory Compactor (SGC) shall be used for specimen fabrication. The SGC shall be operated in height mode to achieve specimens 62 ± 1 mm tall. Four specimens shall be fabricated.
- SGC specimens shall be paired to create HWT specimens by matching up specimens with the closest air voids. Air void values will be calculated in accordance with AASHTO T 269 to two decimal places for the purpose of pairing specimens. The target air void content for each specimen shall be 7.0 ± 0.5%.

Specimen Preparation - Field Produced Mixtures
Field produced HWT samples shall consist of loose mix obtained via box samples in accordance with AASHTO R 97. Specimens shall be fabricated in accordance with the procedures outlined in AASHTO T 324, with the following modifications:

- Loose mix box samples must be reheated to provide separation of particles specified in AASHTO T-209 (max sp gr) procedure that particles of fines shall be no larger than ¼”. Box samples shall be reheated in an oven set at 110 ± 5 °C. No HWT sample shall remain in the oven for more than 2 hours. Generally, HWT samples will remain in the oven for 45 min to 1 hour (or 1 ¼ hours for samples with modified binders) to allow for proper separation of particles.
- Loose mix samples are required to split down to appropriate size for SGC specimens using adequately sized riffle splitter(s).
- Prior to compaction, mixture for SGC specimens will be conditioned according to AASHTO R 30, “mixture conditioning for volumetric mixture design”. This specifies heating the mixture at compaction temperature ± 3 °C for 2 h ± 5 min. At 1 h ± 5 min, the mixture will be removed from the oven and stirred. The time the mixture is out of the oven for stirring should be as short as possible.
- A Superpave Gyratory Compactor (SGC) shall be used for specimen fabrication. The SGC shall be operated in height mode to achieve specimens 62 ± 1 mm tall. Four specimens shall be fabricated.
- SGC specimens shall be paired to create HWT specimens by matching up specimens with the closest air voids. Air void values will be calculated in accordance with AASHTO T 269 to two decimal places for the purpose of pairing specimens. The target air void content for each specimen shall be 7.0 ± 0.5%.

Test Setup & Procedure
HWT testing shall be performed in accordance with AASHTO T 324 and the equipment manufacturer’s instructions, with the following modifications:

- The test temperature for all HWT specimens shall be 45°C.
- Specimens shall be conditioned for 45 minutes after achieving the test temperature. Specimens shall not be submerged for more than 60 minutes prior to test initiation.
- The maximum number of passes shall be set to 20,000 passes (or 10,000 cycles depending on the testing device). The equipment shall also be set such that the test will end once a maximum rut depth of 12.5 mm (0.50 inches) is reached for both pairs of specimens.
• Equipment shall be set to record the LVDT displacement at the following sensor locations along the specimen: -92 mm (-3.6 inches), -46 mm (-1.8 inches), 0 mm (0 inches) (middle between two gyratory specimens), +46 mm (+1.8 inches), and +92 mm (+3.6 inches). The data acquisition shall be set to record deformation location at each of the five locations at every two passes.

**Reporting & Calculations**

The HWT report of test results must include the following for each set of specimens (each side of the HWT machine):

- HMA production (field or lab)
- Number of passes to failure
- Maximum impression (across all sensor locations)
- Test temperature
- Specimen(s) air voids
- Type and amount of anti-strip or additive (if used)
- Creep slope (in mm/1,000 passes)
- Strip slope (in mm/1,000 passes)
- Stripping inflection point (SIP)

HWT reports for the purpose of mix design approval and verification shall combine the data from the left and right side of the HWT machine to create one deformation curve. The maximum deformation for each side will be determined at each pass count and then averaged with the maximum deformation value from the opposite side value at the same pass count. The following measures will be reported for the combined deformation curve and represent the final values for the mix design approval and verification sample:

- Number of passes to failure
- Maximum impression (across all sensor locations)
- Creep slope (in mm/1,000 passes)
- Strip slope (in mm/1,000 passes)
- Stripping inflection point

The HWT test will be deemed inconclusive if the maximum deformation difference between the two sets of specimens (from each side of the HWT machine) exceeds 6 mm (0.25 inches).
Appendix B: Laboratory Testing of Flexibility Index Test (FIT) Samples at VAOT

Specimen Preparation - Lab Produced Mixtures
Lab produced FIT samples shall be fabricated in accordance with the procedures outlined in AASHTO TP 124, with the following modifications:

- Upon mixing the constituent materials to ensure all aggregates are coated, test samples shall be conditioned at the appropriate temperature in accordance with the short-term conditioning procedure for mechanical properties in AASHTO R 30 (4 hours at 135°C). Enough material should be mixed to yield a minimum of five (5) half-moon specimens in case more than one (1) half-moon specimen is outside the dimensional tolerances prescribed in AASHTO TP 124.
- A Superpave Gyratory Compactor (SGC) shall be used for specimen fabrication. The SGC shall be operated in height mode to achieve a specimen 160 ± 1 mm tall. Two (2) cylindrical 50 ± 1 mm thick discs shall be saw cut from the middle of the tall specimen.
  - If the SGC being used is unable to achieve a specimen 160 ± 1 mm tall, then two (2) specimens 115 ± 1 mm tall shall be fabricated. One (1) cylindrical 50 ± 1 mm thick disc shall be saw cut from the middle of each gyrated specimen.
- Air void values for the discs obtained will be calculated in accordance with AASHTO T 269. The target air void content for each specimen shall be 7.0 ± 1.0 %.
- Cut each 50 ± 1 mm thick disc into two (2) identical halves, resulting in four (4) half-moon specimens.
- For cutting the 15 ± 1 mm notch in each individual half-moon specimen, it is recommended that a tile saw be used.
- Double check the final specimen dimensions to ensure the specimens are within the dimensional tolerances prescribed in AASHTO TP 124. Note that a minimum of three (3) half-moon specimens are required for a valid FIT result per AASHTO TP 124.
- If two (2) or more half-moon specimens are outside the dimensional tolerances prescribed in AASHTO TP 124, then the specimen fabrication process shall be repeated.

Specimen Preparation - Field Produced Mixtures
Field produced FIT samples shall consist of loose mix obtained via box samples in accordance with AASHTO R 97. Specimens shall be fabricated in accordance with the procedures outlined in AASHTO TP 124, with the following modifications:

- Enough material should be contained within the box samples to yield a minimum of five (5) half-moon specimens in case more than one (1) half-moon specimen is outside the dimensional tolerances prescribed in AASHTO TP 124.
- Loose mix box samples must be reheated to provide separation of particles specified in AASHTO T-209 (max sp gr) procedure that particles of fines shall be no larger than ¼”. Box samples shall be reheated in an oven set at 110 ± 5 °C. No FIT sample shall remain in the oven for more than 2 hours. Generally, FIT samples will remain in the oven for 45 min to 1 hour (or 1 ¼ hours for samples with modified binders) to allow for proper separation of particles.
- Loose mix samples are required to split down to appropriate size for SGC specimens using adequately sized riffle splitter(s).
- Prior to compaction, mixture for SGC specimens will be conditioned according to AASHTO R 30, “mixture conditioning for volumetric mixture design”. This specifies heating the mixture at compaction temperature ± 3 °C for 2 h ± 5 min. At 1 h ± 5 min, the mixture will be removed from the oven and stirred. The time the mixture is out of the oven for stirring should be as short as possible.
- A Superpave Gyratory Compactor (SGC) shall be used for specimen fabrication. The SGC shall be operated in height mode to achieve a specimen 160 ± 1 mm tall. Two (2) cylindrical 50 ± 1 mm thick discs shall be saw cut from the middle of the tall specimen.
If the SGC being used is unable to achieve a specimen 160 ± 1 mm tall, then two (2) specimens 115 ± 1 mm tall shall be fabricated. One (1) cylindrical 50 ± 1 mm thick disc shall be saw cut from the middle of each gyrated specimen.

- Air void values for the discs obtained will be calculated in accordance with AASHTO T 269. The target air void content for each specimen shall be 7.0 ± 1.0 %.
- Cut each 50 ± 1 mm thick disc into two (2) identical halves, resulting in four (4) half-moon specimens.
- For cutting the 15 ± 1 mm notch in each individual half-moon specimen, it is recommended that a tile saw be used.
- Double check the final specimen dimensions to ensure the specimens are within the dimensional tolerances prescribed in AASHTO TP 124. Note that a minimum of three (3) half-moon specimens are required for a valid FIT result per AASHTO TP 124.
- If two (2) or more half-moon specimens are outside the dimensional tolerances prescribed in AASHTO TP 124, then the specimen fabrication process shall be repeated.

**Test Setup & Procedure**

FIT testing shall be performed in accordance with AASHTO TP 124 and the equipment manufacturer’s instructions, with the following modifications:

- The half-moon specimens shall be conditioned in a water bath or an environmental chamber at 25 ± 0.5°C for 2 hours ± 10 minutes. The specimens shall be placed in bags if the water bath method is used.
- Specimens shall be tested within five (5) minutes of being removed from the conditioning vessel.
- Enter the information for each half-moon specimen per the equipment manufacturer’s instructions prior to initiation of the test. If the radius of the half-moon specimens wasn’t measured, 75 mm may be assumed for the purposes of calculating the ligament length.
  - **NOTE:** If using a Troxler/TestQuip I-FIT, I-FIT Plus, or IDEAL-CT Plus test apparatus, be careful not to transpose the notch depth and ligament length measurements when entering the dimensions of each half-moon specimen in the machine software. Transposing these measurements will result in an invalid Flexibility Index (FI) result corresponding to the specimen tested.
- The Flexibility Index (FI) result for each half-moon specimen shall be calculated using the software provided by the equipment manufacturer or the latest version of the Illinois Center for Transportation (ICT) software. This software is available on the internet through the ICT website.

**Reporting & Calculations**

The Flexibility Index (FI) result for each half-moon specimen shall be calculated using the software provided by the equipment manufacturer or the latest version of the Illinois Center for Transportation (ICT) software. This software is available on the internet through the ICT website. The FIT report of results must also include the following:

- HMA production (field or lab)
- Specimen bulk specific gravity
- Specimen air voids
- Specimen thickness
- Specimen notch length
- Specimen ligament length
- Average and coefficient of variation (COV) of the peak load
- Average and COV of load – line displacement (LLD) at the peak load
- Average and COV of critical displacement
- Average and COV of post – peak slope
- Average and COV of Fracture Energy
- Average and COV of FI

FIT results will be deemed inconclusive if there are less than three (3) half-moon specimens meeting the dimensional tolerances specified in AASHTO TP 124.