

PennDOT Asphalt Balanced Mix Design Implementation

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Pavement Materials Engineer

BALANCED MIX DESIGN

**THE JOURNEY OF 1000 MILES BEGINS
WITH ONE STEP.**

LAU TZU



PREVIOUS BULLETIN 27 CHANGES THAT ARE INCLUDED THE BMD CHANGE

- Gyration Levels: (SOL 481-21-02)
 - Old:
 - 50, 75, and 100 gyrations
 - New:
 - 75 and 100 gyrations
- VMA Change: (SOL 481-21-02)
 - Old:
 - 0.5% above AASTO M 323
 - New:
 - 1.0% above AASHTO M 323
- Minimum Asphalt (Feb. 11, 2015 - Memo)
 - Incorporated into the BMD change to Bulletin 27, so there is no more need for an SSP in every contract.
- Moisture susceptibility (SOL 481-16-06)
 - (Mandatory anti-strip) Requirements:



WHAT CHANGES ARE BEING MADE?

- Adding Performance Testing: **(No required limits yet)**
 - Hamburg Wheel Track Testing (HWT, AASHTO T 324):
 - Rutting
 - Cracking Tolerance Index (CT-Index, ASTM D8225):
 - Cracking
 - Delta Tc (ΔT_c , AASHTO PP 78):
 - Only for JMFs over RBR of 0.35 and above
 - High RAP/RAS/Recycled mixtures cracking.
- Incentives:
 - N_{design} Air Voids:
 - Possible 3.0% to 4.1% allowed limit.
 - AASHTO T 283 Testing:
 - Possible waiving of TSR testing and anti-strip requirements.
 - PG grade bumping:
 - Possible to meet all performance requirements.



TABLE 9 - PERFORMANCE TESTING LIMITS FOR INFORMATION ONLY - WITH INCENTIVE

TABLE 9 - Performance Testing Limits

Specification	AASHTO T 324, Hamburg Wheel Track				ASTM D8225, CT _{Index}	AASHTO PP 78 ^(1, 2) , ΔTc
Property	Traffic Level (Millions of ESALs)	Maximum Rut Depth at 20,000 Passes (mm)	SIP (minimum passes)	Minimum Passes at 12.5mm Rut Depth	CT _{Index} ⁽³⁾	ΔTc
	<3	≤15	N/A	N/A		
		≤20	14,000	10,000		

Wearing Courses Only

Cracking ⁽³⁾	<3	>70
	3 and <10	>80
	≥10	>90

High RAP / RAS (≥ 0.35 RBR) ⁽¹⁾	All	>-5.0C
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(1) Only applies to JMFs with an RBR greater than or equal to 0.35
 Recycled Binder Ratio (RBR) = $((Pb_{RAP} \times P_{RAP}) + (Pb_{RAS} \times P_{RAS})) / (100 \times Pb_{Total})$
 Where:

Pb_{RAP} = Percent Asphalt in the RAP
 P_{RAP} = Percent of RAP by weight in the JMF
 Pb_{RAS} = Percent asphalt in the RAS
 P_{RAS} = Percent RAS by weight in the JMF
 Pb_{Total} = Total Percent of asphalt in the JMF

(2) Compute ΔTc according to AASHTO PP 78, Section 7.2, using Section 7.6 Procedure for Evaluating Specific Mixtures .

(3) ASTM D8225 CT_{Index} tests with an average peak load result of less than 75 psi is a failing test.



TABLE 10 – EXCEPTION TO CURRENT MIX DESIGN REQUIREMENTS IF PERFORMANCE LIMITS MET

TABLE 10 - Exceptions for JMFs that Meet All Table 9 Requirements

Property	AASHTO Specification	Existing PA Specification Requirement	Specification Requirement if Table 9 Limits are Met
Percent Air Voids at N_{Design}	R 35 Table 2	4.0	3.0 to 4.1
Moisture Susceptibility	R 35 - Sect. 4.4, M 323 - Sect. 7.3, & T 283	<0.80 AASHTO T 283 TSR, mandatory anti-strip	AASHTO T 283 and mandatory anti-strip waived
Asphalt PG Grade	M 323 Sect. 5, and as specified	As specified	PG grade bumping to meet all performance testing limits allowed

Note: The DME/DMM may allow or disallow any or all of the exceptions in Table 10 for any JMF.

Note: The DME/DMM may allow or disallow any or all of the exceptions in Table 10 for any JMF.



IMPLEMENTATION PHASES

- **Less than 0.3 Million ESAL (50 gyration) wearing course JMFs** submitted for the 2023 design year. **(Next year)**
 - Will **require** performance testing to be input into eCAMMS for information only.
 - DMEs **may** approve less than 0.3 million ESAL wearing course JMFs without performance testing on a case-by-case basis. (The data still needs to be input.)
- **All wearing course JMFs** submitted for the 2024 JMF design year.
(2 Years)
 - Performance testing entry into eCAMMS is **required before JMF approval is given.**
- **Only effects wearing course mixtures.**
- After the 2024 construction season either limits will be set or the data acquisition process will be adjusted and continued so that **meaningful and achievable limits** can be established.



JOB MIX FORMULA MAINTENANCE: GENERAL

Job Mix Formula Menu

Add New

Copy

Attachments

Save As Draft

Validate

Approve

Return

DESIGN TYPE: BITUMINOUS
SUPPLIER CODE:
JMF YEAR:

JMF/Mix DESIGN NUMBER:
JMF MATERIAL CLASS:
JMF STATUS: DISTRICT ENTRY

General

Pick "Design" Tab

Design Type:

Supplier:

Plant Type:

Plant Size:

JMF Year:

JMF/Mix Design Number:

Supplier JMF/Design Number:

Material Class:

New JMF Existing JMF

Designed By:

Designed By NECEPT Certification ID:

Designed Date:

Copy Designed By to Submitted By

Submitted By:

Submitted By NECEPT Certification ID:

Submitted Date:

Approved By:

Approved By NECEPT Certification ID:

Approved Date:

Conditional Approval:

Delete

ECAMMS

Home Sample JMF ESB Product Evaluation Maintenance Jobs TR-447 Ref # Sample # Search

JOB MIX FORMULA MAINTENANCE: DESIGN

Job Mix Formula Menu Add New Copy Attachments Save As Draft Validate Approve Return

DESIGN TYPE: BITUMINOUS JMF Mix Design Number: 1
SUPPLIER CODE: HR114A1 JMF MATERIAL CLASS: WR9.5
JMF YEAR: 2022 JMF STATUS: DISTINCT ENTRY

Bituminous

General

Asphalt Mix Type: [dropdown]
Design ESAL Range: [dropdown]
Agg. Skid Resistance Level (SRL): [dropdown]
Mixture Final Asphalt Binder Grade: [dropdown]
Gradation Classification: N/A

Ignition Furnace Information

Asphalt Content Test Method: [dropdown]
External Party Oven: [dropdown]
Ignition Furnace Set Temperature: °C [input]
Sample Size Used for Correction Factor: g [input]

Asphalt Binder Information

Total % Reclaimed Asphalt from RAP: [input]
Total % Reclaimed Asphalt from RAS: [input]
Reclaimed Binder Ratio from RAP: [input]
Reclaimed Binder Ratio from RAS: [input]
Total Reclaimed Asphalt Binder Ratio: [input]
Binder/Asphalt (B/A) Ratio: [input]
Calculated Asphalt Film Thickness, microns: [input]

Gyrotory Information and Mixture Characteristics

Gyrotory Mold Diameter, mm: [input]
Mixture Mass to Compact, g: [input]
Gyrotions at NInitial: [input]
% Air Voids at NInitial: [input]
Gyrotions at NDesign: [input]
% Air Voids at NDesign: [input]
Gyrotions at Nmaximum: [input]
% Air Voids at Nmaximum: [input]
Bulk Sp. Gr. of Combined Agg. (Gsb): [input]
Voids in Mineral Agg. (VMA), %: [input]
Voids Filled with Asphalt (VFA), %: [input]
Theoretical Max Sp. Gravity (Gmm): [input]
Theoretical Maximum Density (bs/ft³): [input]
Bulk Sp. Gravity of Mixture (Gmb): [input]
Bulk Density of Mixture (bs/ft³): [input]

Batch Plant Mix Times

Mix Time - Dry (s): [input]
Mix Time - Wet (s): [input]

Marshal Mix Design Method

Number of Blows: [input]
Stability: [input]
Flow: [input]

Aggregate Information

	Result from Trial Blend	Calc. Wt. Avg. of Ind. Agg.
Sand Equivalency, %	[input]	[input]
Fine Agg. Angularity, %	[input]	[input]
Coarse Agg. % 1 Face Crush	[input]	[input]
Coarse Agg. % 2 Face Crush	[input]	[input]
Flat/Elongated Particles 5:1	[input]	[input]
Flat/Elongated Particles 3:1	[input]	[input]

RAP/RAS

Total % RAP in Mixture (by wt. of mixture): [input]
Total % RAS in Mixture (by wt. of mixture): [input]
Total % Reclaimed Aggregate from RAP/RAS: [input]
Virgin PG Binder Grade in Mixture: [dropdown]

+ Add Reference Data

Reference Data Type	Reference Data	Edit	Delete
No records to display			

Pick "+ Add Reference Data"



ECAMMS

Stability:

Flow:

wt. of mixture):

Total % RAS in Mixture (by
wt. of mixture):

Total % Reclaimed
Aggregate from RAP/RAS:

Virgin PG Binder Grade in
Mixture:

+ Add Reference Data

Reference Data Type	Reference Data	Edit	Delete
No records to display.			



Marshal Mix Design Method

- Nu
- CT-Index: CTI Cracking Index
- CT-Index: Gf (joules/m²)
- CT-Index: LTS (mm)
- CT-Index: M75 Slope (N/m)
- CT-Index: Wf (joules)
- HWT: 10K Impression (mm)
- HWT: 12.5 mm Passes
- HWT: 20K Impression (mm)
- HWT: SiP Passes

RAP/RAS

Total % RAP in Mixture (by wt. of mixture):

Total % RAS in Mixture (by wt. of mixture):

Total % Reclaimed Aggregate from RAP/RAS:

Virgin PG Binder Grade in Mixture:

+ Add Reference Data

Reference Data Type

Reference Data Type

Reference Data	Edit	Delete
No records to display.		

Click Here for data type

Save Cancel



+ Add Reference Data

Reference Data Type


Reference Data

Edit

Delete

Reference Data Type: ▼

Reference Data:

 Save

 Cancel

No records to display.



ECAMMS

+ Add Reference Data

Reference Data Type	Reference Data	Edit	Delete
Reference Data Type: CT-Index: CTI Cracking Index ▼	Reference Data: 100		

Click Save

Input Data Here

Save Cancel

No records to display.



ECAMMS

INITIALS:



















+ Add Reference Data

Reference Data Type	Reference Data	Edit	Delete
CT-Index: CTI Cracking Index	100		



ECAMMS

Mixture:

+ Add Reference Data			
Reference Data Type	Reference Data	Edit	Delete
CT-Index: CTI Cracking Index	100		
CT-Index: Gf (joules/m ²)	1000		
CT-Index: L75 (mm)	4		
CT-Index: M75 Slope (N/m)	0.0012		
CT-Index: Wf (joules)	2300		
HWT: 10K Impression (mm)	3.5		
HWT: 12.5 mm Passes	18000		
HWT: 20K Impression (mm)	13		
HWT: SIP Passes	10000		



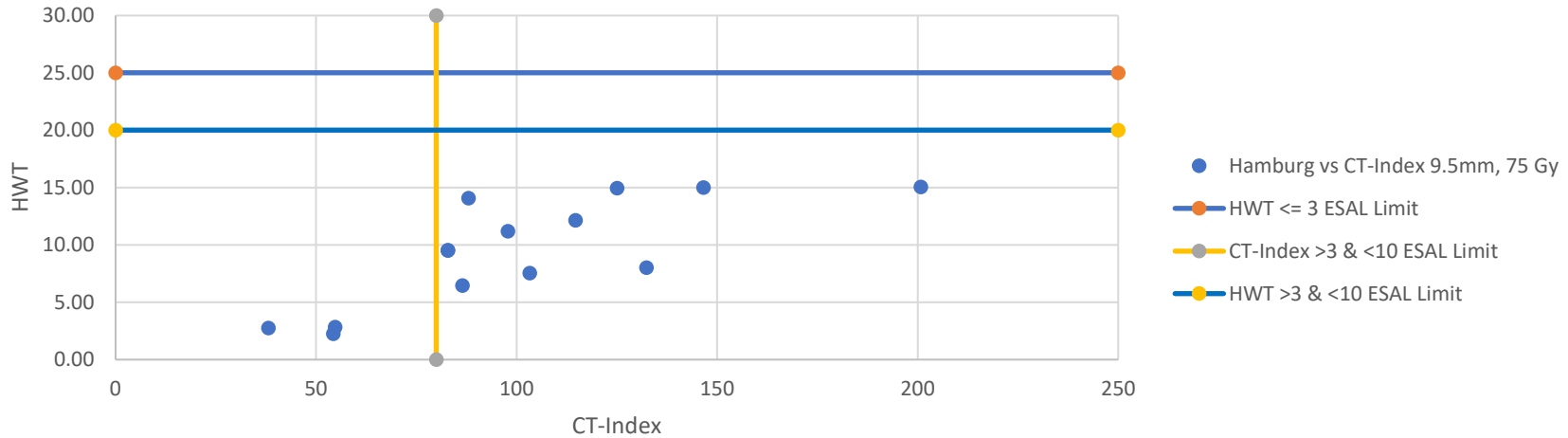
2020 PILOT PROJECT DATA

Number of passes at Max. impression	Max. Impression (Rut depth) (mm)	Number of Passes at 12.5mm Rut Depsth
10550	14.94	9600
18198 / 20000	15 / 6.488	17256 / NA
20000	7.544	N/A
8158 / 10600	15	7372 / 9800
20000	12.146	NA
20000 / 16208	7.391 / 15	NA / 15572
20000	2.228	NA
15.00 / 13.146	13462 / 20000	15970
20000	2.8315	NA
20000	9.5195	NA
20000	9.5195	NA
20000	2.731	NA
20000	8.01	NA
17109	15.04	15516

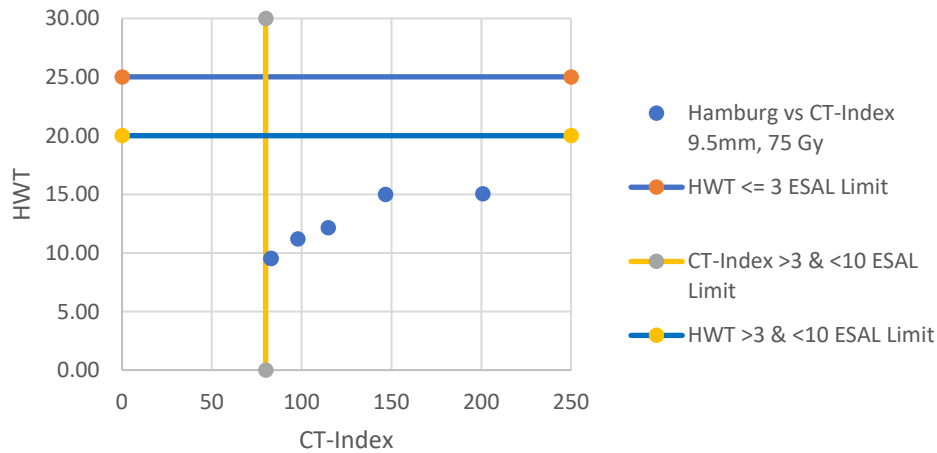


2020 PILOT PROJECT DATA

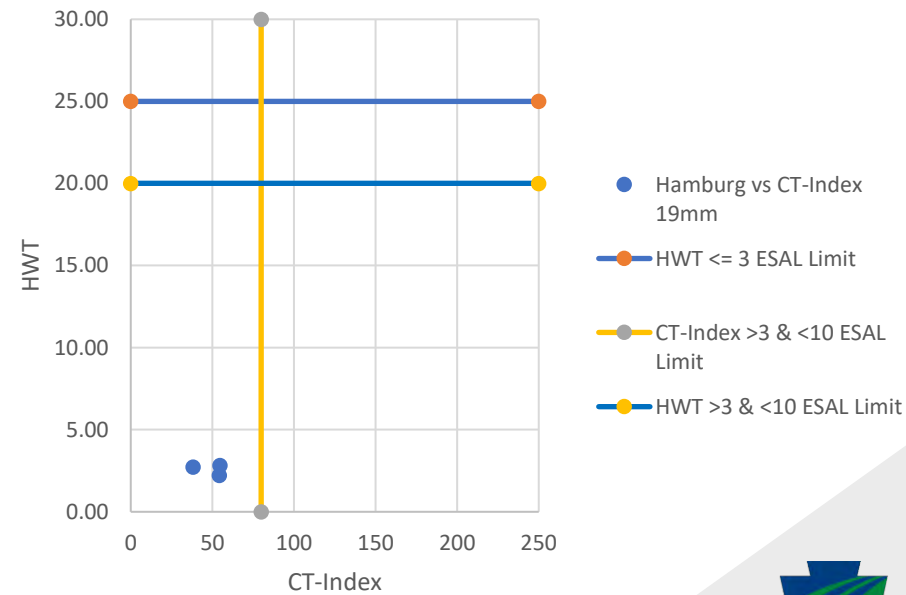
HWT vs CT-Index, All Data



HWT vs CT-Index, 9.5mm, 75 Gytrations, No Polymers



HWT vs CT-Index, 19mm



QUESTIONS???????

PERFECTION IS THE ENEMY OF PROGRESS!

**THE MAXIM - NOTHING AVAILS BUT
PERFECTION MAY BE SPELT SHORTER:
“PARALYSIS”**

WINSTON CHURCHILL

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