

# Material Requirements to Meet Perpetual Pavement Performance Expectations

Ohio Department of Transportation



**ODOT Office of Materials Management**



# Projects:

**Wayne US 30 – 11.83  
(ODOT District 3)**

**Summit, Stark I 77 – 17.61  
(ODOT District 4)**



# Additional Projects

ODOT 020467 STA-77-12.76

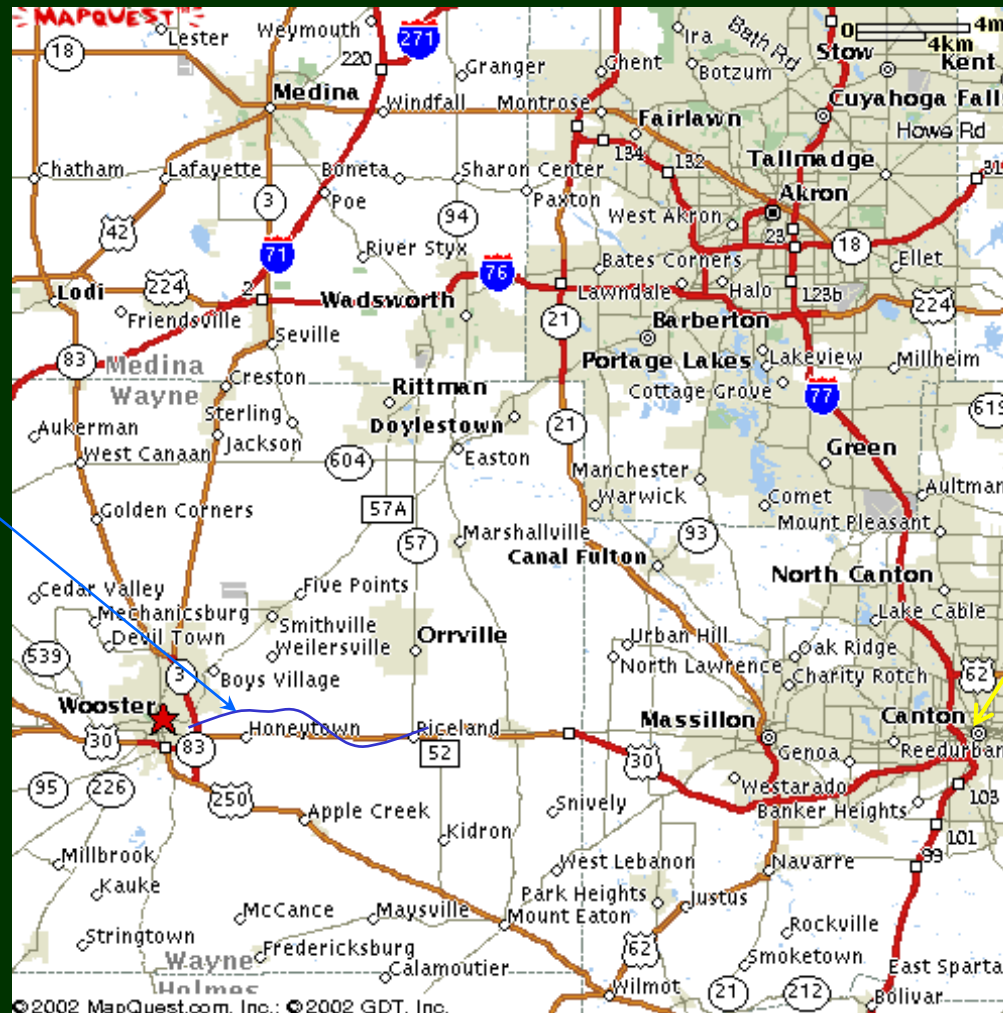
ODOT 040532 STA-77/98-14.8-16.68-5.40

ODOT 050583 STA-77-10.33



Wayne US 30

Stark I 77



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# Wayne US 30 – 11.83



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# Perpetual Pavement Committee Development of Wayne US 30 Criteria

- Fatigue resistant durable bottom layer
- High performance surface
- Economical and durable Asphalt Base
- Thickness to maintain critical strain less than 70 microstrains at bottom of asphalt



# US 30 Asphalt Pavement Materials

| Thickness<br>(inches) | Material   | Design Air<br>Voids (%) | PG Binder | Target<br>Density (%) |
|-----------------------|--|-------------------------|-----------|-----------------------|
| 1.50                  | 856, Stone Matrix<br>Asphalt Concr, 12.5mm             | 3.5                     | 76-22M    | 93-97                 |
| 1.75                  | 442, Asphalt Concrete<br>Inter. Course, 19mm<br>Type A | 4.0                     | 76-22M    | 93-97                 |
| 9                     | 302, Asphalt Concrete<br>Base                          | 4.5                     | 64-22     | 93-96                 |
| 4                     | 302, Special Fatigue<br>Resistant Base Layer           | 3.0                     | 64-22     | 94-97                 |
| 6                     | 304, Aggregate Base                                    |                         |           |                       |



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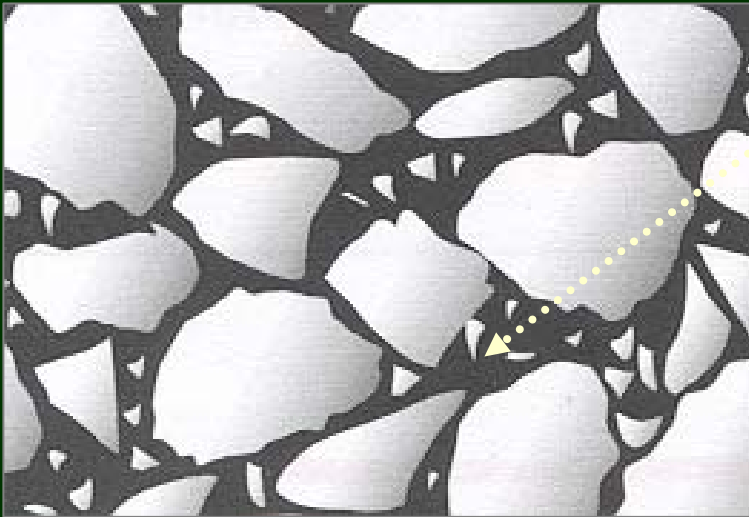
# US 30 Asphalt Gradation Requirements

| Sieve<br>% Passing | SMA 12.5 mm<br>Surface | Superpave<br>19mm<br>Intermediate | 302 Base and<br>Fatigue Layer |
|--------------------|------------------------|-----------------------------------|-------------------------------|
| 2.00 in            |                        |                                   | 100                           |
| 1.50 in            |                        | 100                               | 85 -100                       |
| .75 in             | 100                    | 85 - 100                          | 56 - 80                       |
| .50 in             | 85 - 98                | 90 max                            | 44 - 68                       |
| No. 4              | 20 - 30                |                                   | 22 - 45                       |
| No. 8              | 15 - 26                | 28 - 45                           | 14 - 35                       |
| No. 200            | 9 - 12                 | 2 - 6                             | 2 - 6                         |





# SS 856, Stone Matrix Asphalt Concrete Surface Course



Binder Mastic Consisting of:

- a. PG 76-22 Binder
- b. Cellulose or Mineral Fiber
- c. Aggregate Fines including 10% dust



# SS 856, Stone Matrix Asphalt Concrete Surface Course

- 10 Years of experience with SMA in Ohio
- More durable than dense mixes when produced and placed well
- Updated to include additional aggregate/ voids and binder/ mastic design testing to ensure maximum performance
- Use a 76-22M PG binder per SS 908
  - Elastic recovery of 75 minimum



# 442 19mm Superpave Intermediate Course

- As of July 2001 is the standard ODOT intermediate mix for most high traffic situations
  - Very rut resistant
  - Type A aggregate requirements
  - Economical
- First used in 1994, Over 200 19mm mixes placed.



# 302 Asphalt Concrete Base

- Standard ODOT Asphalt Base for higher traffic applications
- Performance experience adequate but lack of data to support all design assumptions
  - Ohio University tested cores from new 302 on Stark-62, Erie-2 and Erie-250 to determine if chosen design modulus was adequate
    - Test core data ranged from 460 to 785 ksi which confirmed the design value of 500 ksi was valid



# 302 Asphalt Concrete Base, Con't

- Industry collected Indirect Tensile, Unconfined Compressive Strength and Absorbed Energy Value on different mix types but of particular interest was the 302 due to it's performance expectations.
- AEV is determined from data from the AASHTO T 283 stripping potential test.



# 302 Special Fatigue Resistant Layer

- A fatigue layer exists to minimize the start of and propagation of cracks from the bottom of the pavement.
- Based on experiences with fatigue layers in projects in other states it was decided by the committee to increase the binder content in the 302 Base mix. This was done by using a design voids of 3.0% which will yield at least 0.5% more binder in the 302 mix.



# Way-30 Quality Control Requirements

- In addition to standard QC testing of gradation, binder content, and voids analysis Absorbed Energy, Indirect Tensile, and Unconfined Compressive Strength tests were to be conducted to validate produced material properties meet the design assumptions.
- Additional samples were taken and held for ODOT analysis.
- For both 302 mixes the contractor took and tested cores to verify density.



# Way-30 Additional Construction Requirements

- Truck bed cleaning of surface and intermediate mix off of project
- Watch for flushing from hauling on 302 Fatigue Layer
- 19 mm Intermediate Course Superpave to have minimum 93.0% density per 446
- SMA per 446





# Structural and Performance Checks

## Criteria Adopted by the Committee

- Goal: Try a simple testing approach to obtain basic actual material properties to compare with calculated structural properties to determine if chosen mixes and thickness are in the right ballpark.
- Suggested comparison limits based on history of various dense mixes but limited for SMA, Superpave and high polymer PG binders.
- Mix testing performed by Shelly and Sands, Valley Asphalt
- Structural analysis and comparison by Dr. Sangsoo Kim.



# Comparison Criteria for Structure and Performance

- 1) Shear stress not to exceed  $\frac{2}{3}$  of the indirect tensile strength of the material.
- 2) Compressive stress not to exceed  $\frac{1}{2}$  of the unconfined strength of the material.
- 3) Tensile stress not to exceed  $\frac{1}{2}$  of the indirect tensile strength of the material.
- 4) Compressive strains not to exceed 175 microns at subgrade.
- 5) Tensile strains not to exceed 65 microns.
- 6) Check the absorbed energy value (AEV) of the HMA.



# Structural Material Comparison by Dr. Sangsoo Kim

|   | Property                 | Material  | Maximum | Criteria         | Pass trial criteria? |
|---|--------------------------|-----------|---------|------------------|----------------------|
| 1 | Shear stress (psi)       | SMA       | 20      | 110 <sup>1</sup> | Yes                  |
|   |                          | 442 Super | 24      | 160              | Yes                  |
|   |                          | 302       | 24      | 128              | Yes                  |
| 2 | Compressive stress (psi) | SMA       | 127     | 269 <sup>2</sup> | Yes                  |
|   |                          | 442 Super | 96      | 480              | Yes                  |
|   |                          | 302       | 85      | 520              | Yes                  |
| 3 | Tensile Stress (psi)     | SMA       | 0       | 83 <sup>3</sup>  | Yes                  |
|   |                          | 442 Super | 0       | 121              | Yes                  |
|   |                          | 302       | 42      | 81               | Yes                  |

Note 1: < 2/3 ITS

Note 2: < ½ S<sub>u</sub>

Note 3: < 1/2 ITS



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# Structural Material Comparison by Dr. Sang-Soo Kim

|   | Property   | Material                | Maximum   | Criteria                                 | Pass trial criteria?                      |
|---|--|-------------------------|---|--|---|
| 4 | Compressive strain (F <sub>g</sub> )                   | Subgrade                | 156 (20kip S)<br><b><u>187 (24kip S)</u></b><br>159 (34kip T) | < 175<br><b><u>&lt; 175</u></b><br>< 175 | < 200F <sub>g</sub><br>Monosmith and Long |
| 5 | Tensile strain (F <sub>g</sub> )                       | Bottom of AC            | 62 (20kip S)<br><b><u>74 (24kip S)</u></b><br>54 (34kip T)    | < 65<br><b><u>&lt; 65</u></b><br>< 65    | Yes<br><b><u>No</u></b><br>Yes            |
| 6 | Absorbed Energy Value (lbs-in per in) Uncond/Condition | SMA<br>442 Super<br>302 | 79/ 122<br>97/ 127<br>73/ 94                                  | Check                                    | Check                                     |



# US 30 Perpetual Pavement Research

- Determination of Mechanical Properties of Materials used in WAY-30 Test Pavements
- Instrumentation of WAY-30 Test Pavements
- Validation of Design Procedures used for the WAY-30 Test Pavements



# Summit, Stark I 77

- PJT 454-01
- No cost change to Perpetual Pavement Design
- 64557 CY Item 880 warranty
- 7 year Warranty still applies
- Maintain plan thickness
- 302 Fatigue Layer at 3.0% voids
- 302 density requirement



# 454-01 Summit, Stark I 77

## Asphalt Pavement Materials

| Thickness<br>(inches) | Material<br>(first 4 inches is<br>contractor option) | Design<br>Voids<br>(%) | PG Binder | Target<br>Density (%) |
|-----------------------|--|------------------------|-----------|-----------------------|
| 1.50                  | 442 Superpave 12.5mm<br>ACBF slag required           | 3.5%                   | 76-22M    | 93 – 97%              |
| 1.75                  | 442 Superpave 19mm                                   | 4.0%                   | 76-22M    | 93 – 97%              |
| 10                    | 302, Asphalt Concrete<br>Base, 30% RAP               | 4.0                    | 58-28     | Remove <<br>91.0%     |
| 4                     | 302, Special Fatigue<br>Resistant Base Layer         | 3.0                    | 58-28     | Remove <<br>92.0%     |
| 6                     | 304, Aggregate Base                                  |                        |           |                       |



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# Additional I 77 Perpetual Pavement Projects

ODOT 020467 STA-77-12.76:

6"-304 Aggregate Base

4"-302 Asphalt Base "Fatigue Resistant Layer" (Substituted for ATFDDB)

5.5"-302/880 Asphalt Base & 4"-302/880 Asphalt Base

1.75"-442/880 19mm Intermediate & 1.5"-442/880 12.5mm Surface

ODOT 040532 STA-77/98-14.8-16.68-5.40-Parts 1, 2 & 3:

6"-304 Aggregate Base

4"-302 Asphalt Base "Fatigue Resistant Layer" As Per Plan Note

5.5"-302/880 Asphalt Base & 4"-302/880 Asphalt Base

1.75"-442/880 19mm Intermediate & 1.5"-442/880 12.5mm Surface





# Additional I 77 Perpetual Pavement Projects

ODOT 050583 STA-77-10.33:

6"-304 Aggregate Base

3.75"-302/880 Asphalt Base "Fatigue Resistant Layer"

3.75"-302/880 Asphalt Base & 3.75"-302/880 Asphalt Base

1.75"-442/880 19mm Intermediate &

1.25"-442/880 12.5mm Surface



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# Questions?



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