

# **CMT ENGINEERING** **LABORATORIES**

Geotechnical • Materials Testing • Special Inspections • Chemical Analysis

## **MARSHALL METHOD BITUMINOUS MIX DESIGN ASTM D-1559 AND ASPHALT INSTITUTE MS-2**

**Prepared for: Asphalt Materials Inc**

**Mix Design: 1/2" Asphalt PG 64-28**

**RAP: 15 %**

**Date Prepared: April 08, 2020**

**Blows: 50**



| <b>Bulk Unit Weight</b> | <b>Max Unit Weight (Voidless / Rice)</b> |
|-------------------------|--|
| <b>143.0</b>            | <b>148.2</b>                             |

## MARSHALL METHOD BITUMINOUS MIX DESIGN ASTM D-1559 AND ASPHALT INSTITUTE MS-2

Prepared for: Asphalt Materials

Lab #: 826256

Project: Various Projects

Date: April 8, 2020

Product: 2017 APWA DM-1/2" 15% Rap

Max Size: 1/2

Project #: 5648

Gentlemen:

CMT Engineering Labs performed an Asphalt Mix Design in accordance with ASTM D-1559 and Asphalt Institute MS-2, to determine the optimum binder content for the Job Mix Target listed below.

The aggregate physical properties were determined and are listed on page 2, the asphalt physical properties were measured and are provided on page 3.

### RECOMMENDED DESIGN CRITERIA

|                            |      |                          |        |
|----------------------------|------|--------------------------|--------|
| Stability:                 | 3231 | Recommended Oil Content: | 5.80   |
| Flow:                      | 14   | Virgin Oil Content:      | 5.03   |
| Air Voids:                 | 3.5  | Lottman (TSR):           | 97%    |
| VMA:                       | 15.0 | Binder Supplier:         | Peak   |
| Anti-Strip:                |      | Virgin Binder Grade: PG  | 64 -28 |
| Voids Filled VFA:          | 76.5 | Final Binder Grade: PG   | 64 -28 |
| Dust Asphalt Ratio:        | 1.41 | No. of Blows:            | 50     |
| Effective Asphalt Content: | 4.96 | Max. Unit Weight (Rice): | 148.2  |
|                            |      | Bulk Unit Weight:        | 143.0  |

### Job Mix Formula

| (inch) | (mm)  | Percent Passing | DM-1/2"   |
|--------|-------|-----------------|-----------|
| 1      | 25    | 100             |           |
| 3/4"   | 19    | 100             |           |
| 1/2"   | 12.5  | 100             | 100 - 100 |
| 3/8"   | 9.5   | 95              |           |
| #4     | 4.75  | 65              | 60 - 80   |
| #8     | 2.36  | 41              |           |
| #16    | 1.18  | 29              | 28 - 42   |
| #30    | 0.6   | 23              |           |
| #50    | 0.3   | 19              | 11 - 23   |
| #100   | 0.15  | 13              |           |
| #200   | 0.075 | 7.0             | 3 - 7     |

**Aggregate Source Proportions**

| Aggregate Source  | Product Name | Proportions (%) |
|-------------------|--------------|-----------------|
| WJ Pit            | 3/4"         | 0               |
| Point of Mountain | 1/2"         | 17              |
| Point of Mountain | 1/4"         | 28              |
| Point of Mountain | Sand         | 40              |
| Point of Mountain | 0.00         | 0               |
| WJ Pit            | Course Rap   | 15              |
| WJ Pit            | Fine Rap     | 0               |
| None              | Lime         | 0               |
| Total             |              | 100             |

**Aggregate Blend Physical Properties**

| Test Method                                 | Results     | Specification |
|---|-------------|---------------|
| MgSo4 Soundness (coarse) ASTM C-88          | 0.50        | 16 % Max.     |
| MgSo4 Soundness (fine) ASTM C-88            | 1.50        | 16 % Max.     |
| Dry Rodded Unit Weight ASTM C-29            | 120.1       | 75 Min.       |
| Fracture Face Count - Two Face's            | 91.8        | 50% Min.      |
| Los Angeles Wear ASTM C-131                 | 22          | 40% Max.      |
| Sand Equivelent ASTM D-2419                 | 81          | 45 MIN        |
| Clay Lumps and Friable Particles ASTM C-142 | 0.0         | 2 max         |
| Flat or Elongated Particles ASTM D-4791     | 0.0         | 20%Max        |
| Plastic Index ASTM D-4318                   | Non-Plastic | 6 Max.        |
| Liquid Limit ASTM D-4316                    | Non-Plastic | 25 Max        |

**Specific Gravity of Aggregates**

| Product Name | Bulk Specific Gravities | Apparent Specific Gravities | Water Absorption | Proportion |
|--------------|-------------------------|-----------------------------|------------------|------------|
| 3/4"         | 2.671                   | 2.717                       | 0.63             | 0          |
| 1/2"         | 2.477                   | 2.592                       | 1.80             | 17         |
| 1/4"         | 2.473                   | 2.573                       | 1.59             | 28         |
| Sand         | 2.603                   | 2.669                       | 1.30             | 40         |
| 0            | 0.000                   | 0.000                       | 0.00             | 0          |
| Course Rap   | 2.623                   | 2.715                       | 1.29             | 15         |
| Fine Rap     | 0                       | 0                           | 0                | 0          |
| None         | 0                       | 0                           | 0                | 0          |
| Blend Totals | 2.546                   | 2.635                       | 1.46             | 100        |



**Summary of Paving Mixture Properties**

| Asphalt Content | Bulk Specific Gravity | Bulk Unit Weight | Stability | Flow | Air Voids | VMA  | VFA   | Max Specific Gravity | Max Unit Wt. (Rice) |
|-----------------|-----------------------|------------------|-----------|------|-----------|------|-------|----------------------|---------------------|
| 5.30            | 2.265                 | 141.0            | 3533      | 10   | 5.6       | 15.8 | 64.49 | 2.399                | 149.3               |
| 5.50            | 2.287                 | 142.4            | 3508      | 12   | 4.4       | 15.1 | 71.04 | 2.392                | 148.9               |
| 5.75            | 2.296                 | 142.9            | 3277      | 13   | 3.7       | 15.0 | 75.63 | 2.383                | 148.3               |
| 6.00            | 2.314                 | 144.0            | 3265      | 16   | 2.6       | 14.6 | 82.47 | 2.375                | 147.8               |
|                 |                       |                  |           |      |           |      |       |                      |                     |

**Summary of Paving Mixture Properties @ Recommended Oil Content**

| Asphalt Content | Bulk Specific Gravity | Bulk Unit Weight | Stability | Flow | Air Voids | VMA  | VFA  | Max Specific Gravity | Max Unit Wt. (Rice) |
|-----------------|-----------------------|------------------|-----------|------|-----------|------|------|----------------------|---------------------|
| 5.80            | 2.298                 | 143.0            | 3231      | 14   | 3.5       | 15.0 | 76.5 | 2.381                | 148.2               |

**RAP, M323 Properties**

|   |       |
|---|-------|
| Asphalt contribution from RAP           | 0.77  |
| Total Binder Recommendation             | 5.80  |
| Percent Binder from RAP                 | 13.32 |
| Max. Allowable Binder Contribution M323 | 0.00  |
| AASHTO M323 Compliant                   | N/A   |

**Paving Mixture Properties**

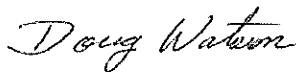
|                          |      |
|--------------------------|------|
| Mixing Temp              | 233  |
| Compaction Temp          | 295  |
| Dust to Asphalt Ratio    | 1.41 |
| Hamburg Loaded Wheel Tes | N/A  |

**Asphalt Water Susceptibility**

Lottman AASHTO T-283-89:

Immersion Compression  
ASTM C-1074, 1075

| Test Specimen          | Tensile Strength (PSI) | Retained Strength % | Stripping Index | Dry Strength (PSI) | Retained Strength % |
|------------------------|------------------------|---------------------|-----------------|--------------------|---------------------|
| Dry Controls           | 108.1                  |                     |                 |                    |                     |
| Wet Controls           | 104.5                  | 96.7%               |                 |                    |                     |
| 1/4% Liquid Anti-Strip |                        |                     |                 |                    |                     |
| 1% Lime                |                        |                     |                 |                    |                     |
| 1.5% Lime              |                        |                     |                 |                    |                     |




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 Douglas Watson

