New Jersey Department of Transportation
1035 Parkway Avenue, PO Box 600, Trenton, New Jersey 08625-0600

Baseline Document Change Announcement

Modified Open Graded Friction Course (MOGFC)

BDC04S-11

March 18, 2005

SUBJECT: Revision to Subsections 403.01, 403.02, 403.03, 403.04, 403.05, & 403.07 and addition of three new test methods B-10, B-11 & B-12 to Section 990 of the 2001 Standard Specifications in both English and Metric units regarding Modified Open Graded Friction Course (MOGFC)

Subsections 403.01, 403.02, 403.03, 403.04, 403.05, & 403.07 have been revised and three new test methods B-10, B-11 & B-12 have been added to Section 990 to introduce Modified Open Graded Friction Course (MOGFC) and delete specifications for Dense graded friction course from the 2001 Standard Specifications.

The following revisions have been incorporated in both the English unit *Standard Input SI2001E1* and Metric unit *Standard Input SI2001M1* as of March 18, 2005.

The following revisions are incorporated in the English unit Standard Input *SI2001E1:*

SECTION 403 – HOT MIX ASPHALT FRICTION COURSE

403.01 Description.
THE ENTIRE SUBSECTION TEXT IS CHANGED TO:

This work includes the construction of Open Graded Friction Course (OGFC), and Modified Open Graded Friction Course (MOGFC). The MOGFC shall contain polymer modified asphalt binder and stabilizing fibers.

403.02 Materials.
THE ENTIRE SUBSECTION TEXT IS CHANGED TO:

The materials and their use shall conform to Subsection 404.02 except as follows:

1. Aggregate for OGFC and MOGFC shall conform to Subsection 901.10; except that coarse aggregate shall be broken stone of gneiss, granite, quartzite, or trap rock. RAP will not be allowed.
2. Asphalt binder for OGFC shall be PG64-22 as specified in 904.01 and asphalt binder for MOGFC shall be PG76-22 as specified in 904.01.
3. For MOGFC, a stabilizing additive consisting of mineral fiber or cellulose fiber shall be added to the mix. The stabilizing additive shall conform to the requirements for stabilizing additives in AASHTO MP 8. Only one type shall be used per mix design. If using mineral fibers, the dosage rate shall be 0.4 percent

by weight of total mix. If using cellulose fibers, the dosage rate shall be 0.3 percent by weight of total mix. The dosage rate may be increased, as necessary, to prevent draindown as measured by the Visual Draindown Asphalt Content in Section 990, NJDOT B-11. Control shall be provided for accurately proportioning the fibers into the mixture within +/- 10 percent of the required weight, and the equipment shall ensure uniform dispersion of the fibers. Fibers shall be stored in a dry location with a storage temperature not to exceed 120° F. The supplier of the cellulose or mineral fibers shall certify according to Subsection 106.04 that the material supplied complies with AASHTO MP 8. A technical representative from the additive supplier shall be on the site for the first full day of construction for technical assistance.

403.03 Composition and Preparation of Mixtures.
THE ENTIRE SUBSECTION TEXT IS CHANGED TO:

A job mix formula (JMF) for each mixture shall be submitted on forms supplied by the Department, which shall include a statement naming the source of each component and a report showing the results meet the criteria specified in Table 403-1.

The JMF for each mixture shall establish the percentage of dry weight of aggregate passing each required sieve size and an optimum percentage of asphalt binder based upon the weight of the total mix. The optimum asphalt content for OGFC will be determined according to Section 990, NJDOT B-12. The optimum asphalt content for MOGFC will be determined according to Section 990, NJDOT B-11. The JMF shall be within the design range specified in Table 403-1.

The Contractor shall prepare compacted test specimens for submittal to the Department Laboratory at least four weeks prior to the initial production date. These specimens shall be prepared from material mixed according to the final JMF, using 50 gyrations of the Superpave gyratory compactor according to AASHTO T 312. Two specimens will be tested to verify that the final JMF produces a mixture that has a minimum air void content as specified in Table 403-1. Percent air voids will be determined using AASHTO T 209 and either Section 990, NJDOT B-6 or AASHTO TP 69.

If required by the Regional Materials Engineer (RME), six specimens will be tested according to AASHTO T 283. For MOGFC, the freeze-thaw option will be utilized. The minimum tensile strength ratio (TSR) will be 80 percent. Should the ratio fall below this minimum, adjust the mixture so as to satisfy the minimum requirement. Adjustments may include the use of anti-stripping agents.

For MOGFC only, two test specimens will be tested for abrasion and impact resistance using a modified L.A. Abrasion Test as per Section 990, NJDOT B-11, Section C.6. The maximum loss as calculated by this method shall not be more than 30 percent.

The JMF for each mixture shall be in effect until modification is approved.

During production, one random acceptance sample will be taken from each lot of 300 tons to verify composition. Air voids and draindown tests shall be conducted as directed by the Engineer.

If the composition testing results are out of the production control tolerances specified in Table 403-2 for an acceptance sample, the Contractor shall determine if a plant adjustment is needed and immediately run a quality control sample. If the quality control sample is also out of the control tolerances in Table 403-2, corrective action shall be taken immediately. Additional quality control samples shall be taken after the corrective action to ensure that the mix is under control. If two consecutive acceptance samples are outside the tolerances specified in Table 403-2, production shall stop immediately. A plant correction shall be made prior to resuming production. Upon restarting production, no mixture shall be transported to the project before the results of a quality control sample from the mixture indicate that the mixture meets JMF tolerances. Any mixture produced at initial restarting that does not meet tolerances will be rejected.

Sampling will be performed according to Section 990, NJDOT B-2 or ASTM D 3665. Testing for composition will be performed according to AASHTO T 164, AASHTO T 308, or Section 990, NJDOT B-5. Testing for draindown will be performed according to Section 990, NJDOT B-11 or B-12

Table 403-1
Open Graded Friction Course
Job Mix Formula Design Ranges and Mixture Requirements

Mixture Designations				
	OGFC	**MOGFC-1**	**MOGFC-2**	**MOGFC-3**
Sieve Sizes	**% Passing**			
¾"		100	100	
½"	100	85-100	90-100	100
3/8"	85-100	35-60	65-85	85-100
#4	20-40	10-25	15-25	20-40
#8	5-10	5-10	5-10	5-10
#200	2-4	2-5	2-4	2-4
Minimum asphalt binder	5.5%	5.7%	5.7%	6.0%
Min % Air Voids, design	15%	20%	18%	18%
Min lift Thickness, design	¾"	1 ¼"	1"	¾"

Note 1: Aggregate % passing to be determined based on dry aggregate weight. Asphalt Binder content to be determined based on total weight of mix.

Table 403-2
Production Control Tolerances for OGFC and MOGFC Mixtures

Production Control Tolerances	Sieve Sizes
± 6.0	1/2"
± 5.5	3/8"
± 5.5	#4
± 4.5	#8
± 2.0	#200
± 0.25	Asphalt binder, % (AASHTO T 308 or T 164)
± 0.15	Asphalt binder, % (Section 990, NJDOT B-5)

403.04 Equipment.
THE ENTIRE SUBSECTION TEXT IS CHANGED TO:

The equipment shall be as provided in section 404 except that OGFC and MOGFC mixes shall be transported in clean vehicles with smooth dump beds that have been sprayed with a non-petroleum release agent. Truckloads of mixture without the specified cover, or that contain lumps, crusting or segregation shall be rejected. The time between the loading of the truck and lay down shall not exceed 90 minutes.

403.05 Construction Requirements.
THE FIRST PARAGRAPH IS CHANGED TO:

The construction requirements shall be as specified in Section 404 except as follows for OGFC and MOGFC:

1. Hand placing shall be avoided except where necessary.
2. Laying temperature for OGFC mix shall not be less than 225°F; laying temperature for MOGFC shall be as per binder manufacturers recommendations.
3. Ambient temperature shall be 60°F minimum.
4. Thickness for OGFC mix shall be ¾ ± ¼ inch; thickness for MOGFC shall conform to Table 403-1.

5. Temperature at discharge from the plant shall be maintained from 240°F to 270°F for OGFC; temperature at discharge from the plant for MOGFC shall be within the binder manufacturer's recommended mixing range.

403.07 Basis of Payment.
THE FOLLOWING PAY ITEM IS ADDED:

Pay Item	*Pay Unit*
MODIFIED OPEN-GRADED FRICTION COURSE, MIXTURE MOGFC__	TON

THE FOLLOWING PAY ITEM IS DELETED:

Pay Item	*Pay Unit*
DENSE-GRADED FRICTION COURSE, MIX__	TON

SECTION 990 - METHODS OF TESTS

THE FOLLOWING TEST METHODS ARE ADDED:

B-10 TEST METHOD TO DETERMINE ASPHALT CONTENT FOR MODIFIED OPEN GRADED FRICTION (MOGFC) COURSES BY AGGREGATE SURFACE AREA

A. Scope.

This test method is used to determine the percentage of asphalt to be used in MOGFC mixes based on the surface area of the aggregate. This percentage is averaged with asphalt contents determined as per Section 990, NJDOT B-11 to arrive at a design asphalt content for a MOGFC mix design.

B. Apparatus and Materials.

1. Ovens capable of maintaining temperatures of 140 ± 5 °F (60 ± 3 °C) and 230 ± 9 °F (110 ± 5 °C).
2. Balance meeting the requirements of AASHTO M 231, Class D.
3. Two metal funnels having minimum dimensions of 3 ½ in. (90 mm) top diameter, 4 ½ in. (115mm) high and ½ in. (13 mm) orifice. The funnels shall have a metal strainer soldered where the base of the cone connects to the top of the spout. The equivalent size of the strainer shall not be larger than No. 10 (2.00 mm) sieve.
4. A 3/8 in. (9.5 mm) sieve and a No. 4 (4.75 mm) sieve.
5. S.A.E. No. 10 lubricating oil.
6. Two rubber stoppers to fit the funnel outlets.
7. Ring stand to support the funnels during testing.

C. Procedure.

OIL RETENTION

1. Through quartering, obtain two samples weighing approximately 105 g representative of the material passing the 3/8 in. (9.5 mm) sieve and retained on the No. 4 (4.75 mm) sieve.
2. Dry the sample in the 230 °F (110 °C) oven to a constant weight and allow to cool to room temperature.
3. Weigh out 100.0 g of the material and place in the metal funnel.
4. Place a stopper in the funnel outlet and fill funnel with S.A.E. No. 10 oil, completely immersing the aggregate.
5. After 5 minutes, remove the stopper and allow the oil to drain for 2 minutes.
6. Place the funnel containing the aggregate in the oven maintained at 140 °F (60 °C) for 15 minutes of additional draining.
7. Remove the sample from the funnel, cool to room temperature, reweigh to the nearest 0.1 g and record.

SPECIFIC GRAVITY

1. Determine the Apparent Specific Gravity of the aggregate passing the 3/8 in. (9.5 mm) sieve and retained on the No. 4 (4.85 mm) sieve according to AASHTO T 85.

D. Calculations.

1. Calculate the percent oil retained for each sample as follows:

$$R = \frac{B - A}{A} \times 100$$

where:
R = percent oil retained
A = weight of sample before test
B = weight of sample after test

2. Using the average percent oil retained of the two samples, calculate the corrected percent oil retained as follows:

$$R_c = \frac{R \times G_a}{2.65}$$

where:
R_c = corrected percent oil retained
G_a = apparent specific gravity of aggregate
2.65 = constant

3. Using the corrected percent oil retained, determine the surface constant (K_c) from the attached chart.

4. Calculate the design asphalt content as follows:

$$\text{Design Asphalt Content} = \frac{(2.0\ K_c + 4.0) \times 2.65}{G_a}$$

DETERMINATION OF SURFACE CONSTANT K_c

CORR. %OIL	K_c	CORR. %OIL	K_c	CORR. %OIL	K_c	CORR. %OIL	K_c
0.1	0.1	2.6	1.2	5.1	2.2	7.6	3.1
0.2	0.1	2.7	1.2	5.2	2.2	7.7	3.1
0.3	0.2	2.8	1.2	5.3	2.2	7.8	3.2
0.4	0.2	2.9	1.3	5.4	2.3	7.9	3.2
0.5	0.3	3.0	1.3	5.5	2.3	8.0	3.2
0.6	0.3	3.1	1.4	5.6	2.3	8.1	3.3
0.7	0.4	3.2	1.4	5.7	2.4	8.2	3.3
0.8	0.4	3.3	1.4	5.8	2.4	8.3	3.4
0.9	0.4	3.4	1.5	5.9	2.5	8.4	3.4
1.0	0.5	3.5	1.5	6.0	2.5	8.5	3.4
1.1	0.5	3.6	1.6	6.1	2.5	8.6	3.5
1.2	0.6	3.7	1.6	6.2	2.6	8.7	3.5
1.3	0.6	3.8	1.6	6.3	2.6	8.8	3.5
1.4	0.7	3.9	1.7	6.4	2.6	8.9	3.6
1.5	0.7	4.0	1.7	6.5	2.7	9.0	3.6
1.6	0.7	4.1	1.8	6.6	2.7	9.1	3.6
1.7	0.8	4.2	1.8	6.7	2.8	9.2	3.7
1.8	0.8	4.3	1.8	6.8	2.8	9.3	3.7
1.9	0.9	4.4	1.9	6.9	2.8	9.4	3.8
2.0	0.9	4.5	1.9	7.0	2.9	9.5	3.8
2.1	1.0	4.6	2.0	7.1	2.9	9.6	3.8
2.2	1.0	4.7	2.0	7.2	2.9	9.7	3.9
2.3	1.0	4.8	2.0	7.3	3.0	9.8	3.9
2.4	1.1	4.9	2.1	7.4	3.0	9.9	3.9
2.5	1.1	5.0	2.1	7.5	3.1	10.0	4.0

B-11 TEST METHOD TO DETERMINE THE OPTIMUM ASPHALT CONTENT FOR MODIFIED OPEN GRADED FRICTION COURSE (MOGFC) MIXES.

A. Scope.

This test method is used to determine gradation and the percentage of asphalt in a MOGFC mixture using polymer modified binder and stabilizing fibers. The gradation is verified to ensure stone-on-stone contact, and the impact resistance of the final job mix formula (JMF) is verified. The optimum asphalt content (AC) is determined from: (1) aggregate surface area, (2) relative Voids in Mineral Aggregate (VMA), and (3) visual drain-down determination of asphalt content. A simple average of these three criteria is used to determine the JMF asphalt content.

B. Apparatus.

1. Equipment as needed for AASHTO T 19
2. Equipment as needed for Superpave mix design as specified in AASHTO R 35 and T 312.
3. Equipment as needed for Section 990, NJDOT B-10.
4. Ovens capable of maintaining temperatures as specified in this method.
5. Clear, glass (Pyrex) 9" diameter pie pans.
6. L.A. Abrasion Machine conforming to AASHTO T 96.

C. Procedure.

1. **Verification of Stone-On-Stone Contact -** The design gradation is chosen to meet minimum air void requirements and to ensure that the aggregate skeleton exhibits stone-on-stone contact.

1.1 For the selected JMF gradation determine the unit weight G_{uwca} of the coarse aggregate fraction of the aggregate using the dry rodding technique according to AASHTO T 19. The coarse aggregate fraction is the aggregate from the final JMF retained on the No. 4 sieve. From G_{uwca} calculate voids in coarse aggregate fraction VCA_{drc}.

1.2 For the selected JMF determine the voids in the coarse aggregate of the mix,(VCA_{mix}).

1.3 Calculations:

$VCA_{drc} = 100 (G_{sbca} - G_{uwca}) / G_{sbca}$

Where:

VCA_{drc} = the voids in the coarse aggregate fraction of the JMF aggregate skeleton.

G_{sbca} = the bulk specific gravity of the coarse aggregate fraction as determined by AASHTO T 85.

G_{uwca} = the unit weight of the coarse aggregate fraction (expressed in kilograms per cubic meter) as determined by AASHTO T 19.

$VCA_{mix} = 100 - (P_{ca} \times G_{mb} / G_{sbca})$

Where:

VCA_{mix} = the voids in the coarse aggregate fraction of the mix. The coarse aggregate fraction of the aggregate is that portion of the JMF aggregate skeleton not passing the 4.75-millimeter sieve.

P_{ca} = the percent of the coarse aggregate fraction by weight of total mix.

G_{mb} = the bulk specific gravity of the mix at the design AC content as determined by Section 3.4.

G_{sbca} = the bulk specific gravity of the coarse aggregate fraction as determined by AASHTO T 85.

1.4 For stone-on-stone contact VCA_{mix} must be less than VCA_{drc}

2. Surface Area Asphalt Content

2.1 Determine "surface area" asphalt content according to Section 990, NJDOT B-10.

3. Relative VMA Asphalt Content

Note steps 3.1, 3.2 & 3.3 shall be done using a batch plant or mixing in the laboratory.

3.1 Heat aggregate to 25°F (14°C) above binder producer recommended compaction temperature. Heat molds to 50°F (28°C) above recommended compaction temperature. Heat binder to recommended mixing temperature.

3.2 Mix aggregate with asphalt and fiber at five asphalt contents (one at the estimated JMF asphalt content, one each at + and - 0.5% and one each at + and – 1.0% of the estimated JMF asphalt content). After mixing, return sample to the oven if necessary, and when at the recommended compaction temperature, compact the specimens. Three specimens will be compacted at each asphalt content using a Superpave Gyratory Compactor (50 gyrations).

3.3 When compacted, cool to room temperature before removing from mold.

3.4 Determine the bulk specific gravity, Gmb from each specimen's dry mass (grams) and volume in cubic centimeters. The volume is determined from the diameter of the plug and the height as determined from four equidistant measurements using a caliper accurate to 0.02 cm.

$G_{mb} = w / (\pi r^2 h / 0.99707)$

Where:

w = dry mass (measured to a tenth of gram)

π = 3.1416

r = radius in cm (measure to 0.01" or 0.0254 CM)

h = height in cm as determined from 4 equidistant measurements.

0.99707 = density of water @ 25°C (77°F)

3.5 Determine maximum specific gravity, G_{mm}, of each specimen at each asphalt content according to AASHTO T 209.

3.6 From G_{mb}, G_{mm}, and each known asphalt content; calculate volumetric information as follows.

% AC by wt of Total mix = b

Volume of air = % air voids = $V_a = (1 - G_{mb} / G_{mm}) \times 100$

% by Volume of asphalt cement = $V_b = (b \times G_{mb})$

Relative VMA = $V_a + V_b$

Note: The volume of the fiber, absorbed asphalt, and Specific Gravity of asphalt binder are not accounted for in this procedure. This procedure measures "relative VMA".

3.7 Plot asphalt content versus "relative VMA" and select the asphalt content at the lowest point on the curve.

4. Visual Draindown Asphalt Content

4.1 Prepare 1000 gram samples of the uncompacted mix for each of the asphalt contents as detailed in Sections 3.1 and 3.2 above.

4.2 Place each sample into a clean, clear glass (Pyrex) 9 inch pie pans.

4.3 Place samples in oven for one hour at the binder manufacturer's recommended mixing temperature. Remove and let cool for one hour at room temperature.

4.4 Visually observe the amount of liquid asphalt on the bottom of each pan.

4.5 Select AC content where ample bonding is evident, without having excessive drainage as evidenced by an appearance of unconnected pools of asphalt binder around aggregate points of contact.

5. Select Asphalt content for job mix formula (JMF)

5.1 Determine the JMF asphalt content by averaging the results from the three methods (surface area, relative VMA, and draindown).

$AC_{jmf} = (AC_{sc} + AC_{vma} + AC_{dd}) / 3$

Where:

AC_{jmf} = the design JMF

AC_{sc} = the asphalt content determined by the surface area in Section 2 above.

AC_{vma} = the asphalt content determined by relative VMA in Section 3 above.

AC_{dd} = the asphalt content determined by draindown in Section 4 above.

6. Verification of Abrasion and Impact Resistance of JMF

6.1 Age at least two JMF specimens (plugs compacted with the same effort used during the design process) for 7 days ± 8 hours in an oven capable of maintaining 140 ± 5°F.

6.2 Utilizing a Los Angeles Machine conforming to AASHTO T 96, without the charge of steel balls, subject the aged samples of known weight (A) to 300 revolutions at 30 to 33 revolutions per minute. After the 300 revolutions reweigh the samples (B).

6.3 Calculate the Percent Loss

$P_{loss} = 100 \times (A-B) / A$

Where:

P_{loss} = the loss expressed as percent of aged sample before L.A. Abrasion Machine treatment.

A = the weight of the samples before modified L.A. Abrasion test.

B = the weight of the samples after modified L.A. Abrasion test.

B-12 TEST METHOD TO DETERMINE THE OPTIMUM ASPHALT CONTENT FOR OPEN GRADED FRICTION COURSE (OGFC).

A. Scope.

This test method is used to determine the optimum percentage of asphalt in a OGFC mixture. The test method uses a visual draindown analysis to determine optimum asphalt content.

B. Apparatus.

1. Ovens capable of maintaining temperatures as specified in this method.
2. Clear glass (Pyrex) 9" diameter pie pans.

C. Procedure.

1. Heat aggregate to 275°F. Heat molds to 275°F. Heat binder to recommended mixing temperature.
2. Using 1000 gram batches, mix aggregate with asphalt at a minimum of 3 asphalt contents (one at the estimated job mix formula (JMF) asphalt content and one each at + and - 0.5% of the estimated JMF asphalt content). After mixing, check the temperature to ensure that it is 250 ± 10°F. Cool or reheat as necessary to meet the temperature tolerance.
3. Place each 1000 gram batch into a clean, clear glass (Pyrex) 9 inch pie pans.
4. Place samples in an oven at 255 ± 5°F for one hour. Remove and let cool for one hour at room temperature.
5. Visually observe the amount of liquid asphalt on the bottom of each pan.
6. Select the asphalt content where ample bonding is evident, without having excessive drainage as evidenced by an appearance of unconnected pools of asphalt binder around aggregate points of contact.

The following revisions are incorporated in the Metric unit *Standard Input SI2001M1:*

SECTION 403 – HOT MIX ASPHALT FRICTION COURSE

403.01 Description.
THE ENTIRE SUBSECTION TEXT IS CHANGED TO:

This work includes the construction of Open Graded Friction Course (OGFC), and Modified Open Graded Friction Course (MOGFC). The MOGFC shall contain polymer modified asphalt binder and stabilizing fibers.

403.02 Materials.
THE ENTIRE SUBSECTION TEXT IS CHANGED TO:

The materials and their use shall conform to Subsection 404.02 except as follows:

1. Aggregate for OGFC and MOGFC shall conform to Subsection 901.10; except that coarse aggregate shall be broken stone of gneiss, granite, quartzite, or trap rock. RAP will not be allowed.
2. Asphalt binder for OGFC shall be PG64-22 as specified in 904.01 and asphalt binder for MOGFC shall be PG76-22 as specified in 904.01.
3. For MOGFC, a stabilizing additive consisting of mineral fiber or cellulose fiber shall be added to the mix. The stabilizing additive shall conform to the requirements for stabilizing additives in AASHTO MP 8. Only one type shall be used per mix design. If using mineral fibers, the dosage rate shall be 0.4 percent by weight of total mix. If using cellulose fibers, the dosage rate shall be 0.3 percent by weight of total mix. The dosage rate may be increased, as necessary, to prevent draindown as measured by the Visual Draindown Asphalt Content in Section 990, NJDOT B-11. Control shall be provided for accurately proportioning the fibers into the mixture within +/- 10 percent of the required weight, and the equipment shall ensure uniform dispersion of the fibers. Fibers shall be stored in a dry location with a storage temperature not to exceed 49° C. The supplier of the cellulose or mineral fibers shall certify according to Subsection 106.04 that the material supplied complies with AASHTO MP 8. A technical representative from the additive supplier shall be on the site for the first full day of construction for technical assistance.

403.03 Composition and Preparation of Mixtures.
THE ENTIRE SUBSECTION TEXT IS CHANGED TO:

A job mix formula (JMF) for each mixture shall be submitted on forms supplied by the Department, which shall include a statement naming the source of each component and a report showing the results meet the criteria specified in Table 403-1.

The JMF for each mixture shall establish the percentage of dry weight of aggregate passing each required sieve size and an optimum percentage of asphalt binder based upon the weight of the total mix. The optimum asphalt content for OGFC will be determined according to Section 990, NJDOT B-12. The optimum asphalt content for MOGFC will be determined according to Section 990, NJDOT B-11. The JMF shall be within the design range specified in Table 403-1.

The Contractor shall prepare compacted test specimens for submittal to the Department Laboratory at least four weeks prior to the initial production date. These specimens shall be prepared from material mixed according to the final JMF, using 50 gyrations of the Superpave gyratory compactor according to AASHTO T 312. Two specimens will be tested to verify that the final JMF produces a mixture that has a minimum air void content as specified in Table 403-1. Percent air voids will be determined using AASHTO T 209 and either Section 990, NJDOT B-6 or AASHTO TP 69.

If required by the Regional Materials Engineer (RME), six specimens will be tested according to AASHTO T 283. For MOGFC, the freeze-thaw option will be utilized. The minimum tensile strength ratio (TSR) will be 80 percent. Should the ratio fall below this minimum, adjust the mixture so as to satisfy the minimum requirement. Adjustments may include the use of anti-stripping agents.

For MOGFC only, two test specimens will be tested for abrasion and impact resistance using a modified L.A. Abrasion Test as per Section 990, NJDOT B-11, Section C.6. The maximum loss as calculated by this method shall not be more than 30 percent.

The JMF for each mixture shall be in effect until modification is approved.

During production, one random acceptance sample will be taken from each lot of 300 megagrams to verify composition. Air voids and draindown tests shall be conducted as directed by the Engineer.

If the composition testing results are out of the production control tolerances specified in Table 403-2 for an acceptance sample, the Contractor shall determine if a plant adjustment is needed and immediately run a quality control sample. If the quality control sample is also out of the control tolerances in Table 403-2, corrective action shall be taken immediately. Additional quality control samples shall be taken after the corrective action to ensure that the mix is under control. If two consecutive acceptance samples are outside the tolerances specified in Table 403-2, production shall stop immediately. A plant correction shall be made prior to resuming production. Upon restarting production, no mixture shall be transported to the project before the results of a quality control sample from the mixture indicate that the mixture meets JMF tolerances. Any mixture produced at initial restarting that does not meet tolerances will be rejected.

Sampling will be performed according to Section 990, NJDOT B-2 or ASTM D 3665. Testing for composition will be performed according to AASHTO T 164, AASHTO T 308, or Section 990, NJDOT B-5. Testing for draindown will be performed according to Section 990, NJDOT B-11 or B-12

Table 403-1
Open Graded Friction Course
Job Mix Formula Design Ranges and Mixture Requirements

Mixture Designations				
	OGFC	**MOGFC-1**	**MOGFC-2**	**MOGFC-3**
Sieve Sizes	**% Passing**			
19.0 mm		100	100	
12.5 mm	100	85-100	90-100	100
9.5 mm	85-100	35-60	65-85	85-100
4.75 mm	20-40	10-25	15-25	20-40
2.36 mm	5-10	5-10	5-10	5-10
0.075 mm	2-4	2-5	2-4	2-4
Minimum asphalt binder	5.5%	5.7%	5.7%	6.0%
Min % Air Voids, design	15%	20%	18%	18%
Min lift Thickness, design	20 mm	30 mm	25 mm	20 mm

Note 1: Aggregate % passing to be determined based on dry aggregate weight. Asphalt Binder content to be determined based on total weight of mix.

Table 403-2
Production Control Tolerances for OGFC and MOGFC Mixtures

Production Control Tolerances	**Sieve Sizes**
± 6.0	12.5 mm
± 5.5	9.5 mm
± 5.5	4.75 mm
± 4.5	2.36 mm
± 2.0	0.075 mm
± 0.25	Asphalt binder, % (AASHTO T 308 or T 164)
± 0.15	Asphalt binder, % (Section 990, NJDOT B-5)

403.04 Equipment.
THE ENTIRE SUBSECTION TEXT IS CHANGED TO:

The equipment shall be as provided in section 404 except that OGFC and MOGFC mixes shall be transported in clean vehicles with smooth dump beds that have been sprayed with a non-petroleum release agent. Truckloads of mixture without the specified cover, or that contain lumps, crusting or segregation shall be rejected. The time between the loading of the truck and lay down shall not exceed 90 minutes.

403.05 Construction Requirements.
THE FIRST PARAGRAPH IS CHANGED TO:

The construction requirements shall be as specified in Section 404 except as follows for OGFC and MOGFC:

1. Hand placing shall be avoided except where necessary.
2. Laying temperature for OGFC mix shall not be less than 107°C; laying temperature for MOGFC shall be as per binder manufacturers recommendations.
3. Ambient temperature shall be 16°C minimum.
4. Thickness for OGFC mix shall be 20 ± 5millimeters; thickness for MOGFC shall conform to Table 403-1.
5. Temperature at discharge from the plant shall be maintained from 116°C to 132°C for OGFC; temperature at discharge from the plant for MOGFC shall be within the binder manufacturer's recommended mixing range.

403.07 Basis of Payment.
THE FOLLOWING PAY ITEM IS ADDED:

Pay Item	*Pay Unit*
MODIFIED OPEN-GRADED FRICTION COURSE, MIXTURE MOGFC__	MEGAGRAM

THE FOLLOWING PAY ITEM IS DELETED:

Pay Item	*Pay Unit*
DENSE-GRADED FRICTION COURSE, MIX__	MEGAGRAM

SECTION 990 - METHODS OF TESTS

THE FOLLOWING TEST METHODS ARE ADDED:

B-10 TEST METHOD TO DETERMINE ASPHALT CONTENT FOR MODIFIED OPEN GRADED FRICTION (MOGFC) COURSES BY AGGREGATE SURFACE AREA

A. Scope.

This test method is used to determine the percentage of asphalt to be used in MOGFC mixes based on the surface area of the aggregate. This percentage is averaged with asphalt contents determined as per Section 990, NJDOT B-11 to arrive at a design asphalt content for a MOGFC mix design.

B. Apparatus and Materials.

1. Ovens capable of maintaining temperatures of 140 ± 5 °F (60 ± 3 °C) and 230 ± 9 °F (110 ± 5 °C).
2. Balance meeting the requirements of AASHTO M 231, Class D.
3. Two metal funnels having minimum dimensions of 3 ½ in. (90 mm) top diameter, 4 ½ in. (115mm) high and ½ in. (13 mm) orifice. The funnels shall have a metal strainer soldered where the base of the cone connects to the top of the spout. The equivalent size of the strainer shall not be larger than No. 10 (2.00 mm) sieve.
4. A 3/8 in. (9.5 mm) sieve and a No. 4 (4.75 mm) sieve.

5. S.A.E. No. 10 lubricating oil.
6. Two rubber stoppers to fit the funnel outlets.
7. Ring stand to support the funnels during testing.

C. Procedure.

OIL RETENTION

1. Through quartering, obtain two samples weighing approximately 105 g representative of the material passing the 3/8 in. (9.5 mm) sieve and retained on the No. 4 (4.75 mm) sieve.
2. Dry the sample in the 230 °F (110 °C) oven to a constant weight and allow to cool to room temperature.
3. Weigh out 100.0 g of the material and place in the metal funnel.
4. Place a stopper in the funnel outlet and fill funnel with S.A.E. No. 10 oil, completely immersing the aggregate.
5. After 5 minutes, remove the stopper and allow the oil to drain for 2 minutes.
6. Place the funnel containing the aggregate in the oven maintained at 140 °F (60 °C) for 15 minutes of additional draining.
7. Remove the sample from the funnel, cool to room temperature, reweigh to the nearest 0.1 g and record.

SPECIFIC GRAVITY

1. Determine the Apparent Specific Gravity of the aggregate passing the 3/8 in. (9.5 mm) sieve and retained on the No. 4 (4.85 mm) sieve according to AASHTO T 85.

D. Calculations.

1. Calculate the percent oil retained for each sample as follows:

$$R = \frac{B - A}{A} \times 100$$

where:
R = percent oil retained
A = weight of sample before test
B = weight of sample after test

2. Using the average percent oil retained of the two samples, calculate the corrected percent oil retained as follows:

$$R_c = \frac{R \times G_a}{2.65}$$

where:
R_c = corrected percent oil retained
G_a = apparent specific gravity of aggregate
2.65 = constant

3. Using the corrected percent oil retained, determine the surface constant (K_c) from the attached chart.

4. Calculate the design asphalt content as follows:

$$\text{Design Asphalt Content} = \frac{(2.0\ K_c + 4.0) \times 2.65}{G_a}$$

DETERMINATION OF SURFACE CONSTANT K_c

CORR. %OIL	K_c	CORR. %OIL	K_c	CORR. %OIL	K_c	CORR. %OIL	K_c
0.1	0.1	2.6	1.2	5.1	2.2	7.6	3.1
0.2	0.1	2.7	1.2	5.2	2.2	7.7	3.1
0.3	0.2	2.8	1.2	5.3	2.2	7.8	3.2
0.4	0.2	2.9	1.3	5.4	2.3	7.9	3.2
0.5	0.3	3.0	1.3	5.5	2.3	8.0	3.2
0.6	0.3	3.1	1.4	5.6	2.3	8.1	3.3
0.7	0.4	3.2	1.4	5.7	2.4	8.2	3.3
0.8	0.4	3.3	1.4	5.8	2.4	8.3	3.4
0.9	0.4	3.4	1.5	5.9	2.5	8.4	3.4
1.0	0.5	3.5	1.5	6.0	2.5	8.5	3.4
1.1	0.5	3.6	1.6	6.1	2.5	8.6	3.5
1.2	0.6	3.7	1.6	6.2	2.6	8.7	3.5
1.3	0.6	3.8	1.6	6.3	2.6	8.8	3.5
1.4	0.7	3.9	1.7	6.4	2.6	8.9	3.6
1.5	0.7	4.0	1.7	6.5	2.7	9.0	3.6
1.6	0.7	4.1	1.8	6.6	2.7	9.1	3.6
1.7	0.8	4.2	1.8	6.7	2.8	9.2	3.7
1.8	0.8	4.3	1.8	6.8	2.8	9.3	3.7
1.9	0.9	4.4	1.9	6.9	2.8	9.4	3.8
2.0	0.9	4.5	1.9	7.0	2.9	9.5	3.8
2.1	1.0	4.6	2.0	7.1	2.9	9.6	3.8
2.2	1.0	4.7	2.0	7.2	2.9	9.7	3.9
2.3	1.0	4.8	2.0	7.3	3.0	9.8	3.9
2.4	1.1	4.9	2.1	7.4	3.0	9.9	3.9
2.5	1.1	5.0	2.1	7.5	3.1	10.0	4.0

B-11 TEST METHOD TO DETERMINE THE OPTIMUM ASPHALT CONTENT FOR MODIFIED OPEN GRADED FRICTION COURSE (MOGFC) MIXES.

A. Scope.

This test method is used to determine gradation and the percentage of asphalt in a MOGFC mixture using polymer modified binder and stabilizing fibers. The gradation is verified to ensure stone-on-stone contact, and the impact resistance of the final job mix formula (JMF) is verified. The optimum asphalt content (AC) is determined from: (1) aggregate surface area, (2) relative Voids in Mineral Aggregate (VMA), and (3) visual drain-down determination of asphalt content. A simple average of these three criteria is used to determine the JMF asphalt content.

B. Apparatus.

1. Equipment as needed for AASHTO T 19
2. Equipment as needed for Superpave mix design as specified in AASHTO R 35 and T 312.
3. Equipment as needed for Section 990, NJDOT B-10.
4. Ovens capable of maintaining temperatures as specified in this method.
5. Clear, glass (Pyrex) 9" diameter pie pans.
6. L.A. Abrasion Machine conforming to AASHTO T 96.

C. Procedure.

1. **Verification of Stone-On-Stone Contact -** The design gradation is chosen to meet minimum air void requirements and to ensure that the aggregate skeleton exhibits stone-on-stone contact.

1.1 For the selected JMF gradation determine the unit weight G_{uwca} of the coarse aggregate fraction of the aggregate using the dry rodding technique according to AASHTO T 19. The coarse aggregate fraction is the aggregate from the final JMF retained on the No. 4 sieve. From G_{uwca} calculate voids in coarse aggregate fraction VCA_{drc}.

1.2 For the selected JMF determine the voids in the coarse aggregate of the mix,(VCA_{mix}).

1.3 Calculations:

$VCA_{drc} = 100 (G_{sbca} - G_{uwca}) / G_{sbca}$

Where:

VCA_{drc} = the voids in the coarse aggregate fraction of the JMF aggregate skeleton.

G_{sbca} = the bulk specific gravity of the coarse aggregate fraction as determined by AASHTO T 85.

G_{uwca} = the unit weight of the coarse aggregate fraction (expressed in kilograms per cubic meter) as determined by AASHTO T 19.

$VCA_{mix} = 100 - (P_{ca} \times G_{mb} / G_{sbca})$

Where:

VCA_{mix} = the voids in the coarse aggregate fraction of the mix. The coarse aggregate fraction of the aggregate is that portion of the JMF aggregate skeleton not passing the 4.75-millimeter sieve.

P_{ca} = the percent of the coarse aggregate fraction by weight of total mix.

G_{mb} = the bulk specific gravity of the mix at the design AC content as determined by Section 3.4.

G_{sbca} = the bulk specific gravity of the coarse aggregate fraction as determined by AASHTO T 85.

1.4 For stone-on-stone contact VCA_{mix} must be less than VCA_{drc}

2. Surface Area Asphalt Content

2.1 Determine "surface area" asphalt content according to Section 990, NJDOT B-10.

3. Relative VMA Asphalt Content

Note steps 3.1, 3.2 & 3.3 shall be done using a batch plant or mixing in the laboratory.

3.1 Heat aggregate to 25°F (14°C) above binder producer recommended compaction temperature. Heat molds to 50°F (28°C) above recommended compaction temperature. Heat binder to recommended mixing temperature.

3.2 Mix aggregate with asphalt and fiber at five asphalt contents (one at the estimated JMF asphalt content, one each at + and - 0.5% and one each at + and – 1.0% of the estimated JMF asphalt content). After mixing, return sample to the oven if necessary, and when at the recommended compaction temperature, compact the specimens. Three specimens will be compacted at each asphalt content using a Superpave Gyratory Compactor (50 gyrations).

3.3 When compacted, cool to room temperature before removing from mold.

3.4 Determine the bulk specific gravity, Gmb from each specimen's dry mass (grams) and volume in cubic centimeters. The volume is determined from the diameter of the plug and the height as determined from four equidistant measurements using a caliper accurate to 0.02 cm.

$G_{mb} = w / (\pi r^2 h / 0.99707)$

Where:

w = dry mass (measured to a tenth of gram)

π = 3.1416

r = radius in cm (measure to 0.01" or 0.0254 CM)

h = height in cm as determined from 4 equidistant measurements.

0.99707 = density of water @ 25°C (77°F)

3.5 Determine maximum specific gravity, G_{mm}, of each specimen at each asphalt content according to AASHTO T 209.

3.6 From G_{mb}, G_{mm}, and each known asphalt content; calculate volumetric information as follows.

% AC by wt of Total mix = b

Volume of air = % air voids = $V_a = (1 - G_{mb} / G_{mm}) \times 100$

% by Volume of asphalt cement = $V_b = (b \times G_{mb})$

Relative VMA = $V_a + V_b$

Note: The volume of the fiber, absorbed asphalt, and Specific Gravity of asphalt binder are not accounted for in this procedure. This procedure measures "relative VMA".

3.7 Plot asphalt content versus "relative VMA" and select the asphalt content at the lowest point on the curve.

4. Visual Draindown Asphalt Content

4.1 Prepare 1000 gram samples of the uncompacted mix for each of the asphalt contents as detailed in Sections 3.1 and 3.2 above.

4.2 Place each sample into a clean, clear glass (Pyrex) 9 inch pie pans.

4.3 Place samples in oven for one hour at the binder manufacturer's recommended mixing temperature. Remove and let cool for one hour at room temperature.

4.4 Visually observe the amount of liquid asphalt on the bottom of each pan.

4.5 Select AC content where ample bonding is evident, without having excessive drainage as evidenced by an appearance of unconnected pools of asphalt binder around aggregate points of contact.

5. Select Asphalt content for job mix formula (JMF)

5.1 Determine the JMF asphalt content by averaging the results from the three methods (surface area, relative VMA, and draindown).

$AC_{jmf} = (AC_{sc} + AC_{vma} + AC_{dd}) / 3$

Where:

AC_{jmf} = the design JMF

AC_{sc} = the asphalt content determined by the surface area in Section 2 above.

AC_{vma} = the asphalt content determined by relative VMA in Section 3 above.

AC_{dd} = the asphalt content determined by draindown in Section 4 above.

6. Verification of Abrasion and Impact Resistance of JMF

6.1 Age at least two JMF specimens (plugs compacted with the same effort used during the design process) for 7 days ± 8 hours in an oven capable of maintaining 140 ± 5°F.

6.2 Utilizing a Los Angeles Machine conforming to AASHTO T 96, without the charge of steel balls, subject the aged samples of known weight (A) to 300 revolutions at 30 to 33 revolutions per minute. After the 300 revolutions reweigh the samples (B).

6.3 Calculate the Percent Loss

$P_{loss} = 100 \times (A-B) / A$

Where:

P_{loss} = the loss expressed as percent of aged sample before L.A. Abrasion Machine treatment.

A = the weight of the samples before modified L.A. Abrasion test.

B = the weight of the samples after modified L.A. Abrasion test.

B-12 TEST METHOD TO DETERMINE THE OPTIMUM ASPHALT CONTENT FOR OPEN GRADED FRICTION COURSE (OGFC).

A. Scope.

This test method is used to determine the optimum percentage of asphalt in a OGFC mixture. The test method uses a visual draindown analysis to determine optimum asphalt content.

B. Apparatus.

1. Ovens capable of maintaining temperatures as specified in this method.
2. Clear glass (Pyrex) 9" diameter pie pans.

C. Procedure.

1. Heat aggregate to 275°F. Heat molds to 275°F. Heat binder to recommended mixing temperature.
2. Using 1000 gram batches, mix aggregate with asphalt at a minimum of 3 asphalt contents (one at the estimated job mix formula (JMF) asphalt content and one each at + and - 0.5% of the estimated JMF asphalt content). After mixing, check the temperature to ensure that it is 250 ± 10°F. Cool or reheat as necessary to meet the temperature tolerance.
3. Place each 1000 gram batch into a clean, clear glass (Pyrex) 9 inch pie pans.
4. Place samples in an oven at 255 ± 5°F for one hour. Remove and let cool for one hour at room temperature.
5. Visually observe the amount of liquid asphalt on the bottom of each pan.
6. Select the asphalt content where ample bonding is evident, without having excessive drainage as evidenced by an appearance of unconnected pools of asphalt binder around aggregate points of contact.

Implementation Code R (ROUTINE)

Changes must be implemented in all applicable Department projects scheduled for Final Design Submission at least one month after the date of the BDC announcement. This will allow designers to make necessary plan, specifications, and estimate/proposal changes without requiring the need for an addenda or postponement of advertisement or receipt of bids.

Recommended By:

ORIGINAL SIGNED

Lynn D. Rich
Director,
Quality Management Services

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Capital Program Management

LDR:KS:HVP
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