SECTION 02741

HOT MIX ASPHALT (HMA)

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Products and procedures for laying, and compacting a surface course of one or more layers of HMA comprised of aggregate, asphalt binder, lime and other additives.

B. Mix materials at a central mixing plant.

1.2 RELATED SECTIONS

A. Section 01452: Profilograph and Pavement Smoothness

B. Section 02742S: Project Specific Surfacing Requirements

C. Section 02745: Asphalt Material

D. Section 02746: Hydrated Lime

E. Section 02748: Prime Coat/Tack Coat

F. Section 02969: Optional Use of Reclaimed Asphalt Pavement (PG Binder Projects Only)

1.3 REFERENCES

A. AASHTO R 35: Standard Practice for Superpave Volumetric Design for Hot-Mix Asphalt (HMA)

B. AASHTO T 11: Materials Finer Than 75 Fm (No. 200) Sieve in Mineral Aggregates by Washing

C. AASHTO T 19: Unit Weights and Voids in Aggregate

D. AASHTO T 27: Sieve Analysis of Fine and Coarse Aggregates

E. AASHTO T 30: Mechanical Analysis of Extracted Aggregate

F. AASHTO T 85: Specific Gravity and Absorption of Coarse Aggregate

G. AASHTO T 89: Determining the Liquid Limit of Soils

H. AASHTO T 90: Determining the Plastic Limit and Plasticity Index of Soils

I. AASHTO T 96: Resistance to Abrasion of Small Size Coarse Aggregate by Use of the Los Angeles Machine

J. AASHTO T 104: Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate

K. AASHTO T 112: Clay Lumps and Friable Particles in Aggregate

L. AASHTO T 166: Bulk Specific Gravity of Compacted Bituminous Mixtures Using Saturated-Surface Dry Specimens

M. AASHTO T 176: Plastic Fines in Graded Aggregates and Soils by Use of the Sand Equivalent Test

N. AASHTO T 195: Determining Degree of Particle Coating of Bituminous-Aggregate Mixtures

O. AASHTO T 209: Maximum Specific Gravity of Bituminous Paving Mixtures

P. AASHTO T 255: Total Moisture Content of Aggregate by Drying

Q. AASHTO T 304: Uncompacted Void Content of Fine Aggregate

R. AASHTO T 308: Determining the Asphalt Binder Content of Hot-Mix Asphalt (HMA) by the Ignition Method

S. AASHTO T 312: Method for Preparing and Determining the Density of Hot-Mix Asphalt (HMA) Specimens by Means of the Superpave Gyratory Compactor

T. AASHTO T 324: Hamburg Wheel-Track testing of Compacted Hot-Mix Asphalt (HMA).

U. AASHTO TP 61: Determining the Percentage of Fractured Particles in Coarse Aggregate

V. AASHTO TP 62: Determining Dynamic Modulus of Hot-Mix Asphalt Concrete Mixtures

W. ASTM D 2950: Test Method for Density of Bituminous Concrete in Place by Nuclear Method

X. ASTM D 3549: Thickness or Height of Compacted Bituminous Paving Mixture Specimens

Y. ASTM D 3666: Specification for Minimum Requirements for Agencies Testing and Inspecting Bituminous Paving Materials

Z. ASTM D 4561: Practice for Quality Control Systems for Organizations Producing and Applying Bituminous Paving Materials

AA. ASTM D 5506: Standard Practice for Organizations Engaged in the Certification of Personnel Testing and Inspecting Bituminous Paving Materials

BB. ASTM E 178: Practice for Dealing with Outlying Observations

CC. ASTM E 1274: Standard Test Method for Measuring Pavement Roughness Using a Profilograph

DD. UDOT Materials Manual of Instruction, Part 8

EE. UDOT Minimum Sampling and Testing Guide

FF. UDOT Performance Data Products Listing (PDPL)

1.4 ACCEPTANCE

A. A lot equals the number of tons of HMA placed during each production day. The Department will:
   1. Divide each lot into four sublots based on the scheduled production day.
   2. Take random samples behind the paver before any further compaction (UDOT Materials Manual of Instruction Part 8-984: Sampling Methods), and determine random numbers/locations from a random numbers table or generator. (UDOT Materials Manual of Instruction Part 8-981: Random Sampling)
      a. Dispute Resolution Sampling – Increase sample sizes to accommodate paired-T testing. Split additional material with contractor-designated lab and continue until testing discrepancies between labs are identified and resolved, as defined in article 1.6. (UDOT Materials Manual of Instruction Part 8: Chapter 4, Appendix C)
   3. Inform the Contractor of the time and place for the sample not more than 15 minutes prior to the sampling.

4. Conduct the following tests:
    a. Asphalt Binder Content: One per sublot using ignition oven. AASHTO T 308
    b. Aggregate gradation: One test per sublot on the residue of the ignition oven tests. AASHTO T 30.
    c. VMA: 3 tests per lot. AASHTO T 312
    d. Maximum Specific Gravity: Three per lot in conjunction with VMA determination. AASHTO T 209
5. Use the average of the Maximum Specific Gravity tests for each lot to determine density of cores.
6. Determine thickness of cores according to ASTM D 3549.
7. Add the lot to the previous day's production if the minimum number of samples cannot be obtained for the final day's production and evaluate with the appropriate sample size.
8. Add the lot to the next day's production if the minimum number of samples cannot be obtained, and evaluate with the appropriate sample size.
9. Retest the lot if an individual test from a sublot is deemed an outlier based on ASTM E 178, with 90 percent confidence.

B. The Engineer conducts the acceptance testing for asphalt binder content (AASHTO T 308), gradation (AASHTO T 30), VMA (AASHTO T 312), density (AASHTO T 166), and thickness (ASTM D 3549). For small projects with plan quantities of HMA less than 3000 tons or for work such as utility work, traffic signals, detours, lane leveling, etc., the Engineer may elect to accept material based upon visual inspection.
    1. When acceptance is intended to be based upon visual inspection, the Engineer reserves the option of conducting any acceptance tests necessary to determine the material and workmanship meets the project requirements.

C. Obtain samples for density and thickness.
    1. Divide the lot into five sublots of approximately equal sizes.
    2. Obtain two cores per sublot, for a total of ten cores per lot, randomly as instructed, and in the presence of the Engineer within two days after the pavement is placed.(UDOT Materials Manual of Instruction Part 8-981: Random Sampling, UDOT Materials Manual of Instruction Part 8-984: Sampling Methods)
    3. If the random location for cores falls within one foot of the edge of the overall pavement section (outer part of shoulders), then move transversely to a point one foot from the edge of the pavement.
    4. Fill core holes with Hot Mix Asphalt or high AC content cold mix and compact.
    5. The Department takes possession of the cores immediately, and begins testing the cores within 24 hours for density acceptance.

D. Density: The in-place target density for determining acceptance and incentive/disincentive is 93.5 percent of Maximum Specific Gravity density, AASHTO T 209, for projects where design overlay thickness is greater than 2 inches. For projects where design overlay thickness is 2 inches or less, in-place target density for determining acceptance and incentive/ disincentive is 92.5 percent of Maximum Specific Gravity density, AASHTO T 209. In-place density is based on cores obtained in paragraph C and tested in accordance with AASHTO T 166. For small projects, with plan quantities of HMA less than 3000 tons or for work such as utility work, traffic signals, detours, or lane leveling, and when material is to be accepted on the basis of visual inspection per article 1.4, paragraph B, acceptance for density may be based upon establishing and maintaining a roller pattern to obtain maximum density without over-stressing the pavement.

1. Use Table 4 with n = 10 to determine PT for density.
2. When samples for gradation, asphalt binder content and VMA from lots are combined in order to obtain an appropriate sample size for evaluation, a lot for density determination is defined as the combined production days.

E. Thickness: Base acceptance on the average thickness of a lot. A thickness lot equals a density lot.

1. The same core samples taken for density will be used for thickness verification. ASTM D 3549.
2. The Department accepts a lot when:
   a. The average thickness of all sublots is not more than 1/2 inch greater nor 1/4 inch less than the total thickness specified.
   b. No individual sublot shows a deficient thickness of more than 3/8 inch.
   c. Place additional materials where lots or sublots are deficient in thickness. The minimum depth of compacted surface for correcting deficient thickness is 3 times the nominal maximum aggregate size.
   d. The Department pays for the quantity of additional material to bring the surface to design grade.
   e. The Department does not pay for the quantity of additional material above the design grade due to the minimum paving thickness required.
   f. The Engineer may allow excess thickness to remain in place or may order its removal. Remove and replace the entire depth of the course, if it is necessary to remove portions of the course.
   g. The Department pays for 50 percent of the mix in excess of the +1/2 inch tolerance when excess thickness is allowed to remain in place.
   h. The thickness tolerances established above do not apply to leveling courses. However, check final surfaces in stage construction.

i. Thickness acceptance for thin lift projects (2 inches or less) consists of checking thickness regularly with a depth probe during placement and taking corrective action as necessary.

F. Smoothness Tests
1. Determine acceptance and correct in accordance with Section 01452.

G. Cease production
1. When any two out of three consecutive lots meet one of the following criteria:
   a. A net disincentive
   b. Air voids at N_{des} averaged for each lot are less than 2.5 or greater than 4.5 percent
2. Before production continues, submit a corrective action plan to the Engineer indicating the changes in production procedures that will be implemented to correct the deficiencies.

H. The Department pays incentive/disincentive on the assessed quantities of HMA according to Table 1 Incentive/Disincentive for Gradation, Asphalt Binder Content and Density or Table 2 Incentive/Disincentive for VMA. Base the incentive/disincentive on Percent Within Limit (PT) computation using Tables 3, 4, and 5. Use lowest single value combined for gradation (each of the sieves) and asphalt binder content for calculating the gradation/asphalt binder content incentive/disincentive in Table 1.
1. Meet PT of 88 or greater for density for eligibility for incentive in gradation/asphalt binder content and VMA. The Department does not pay incentive for gradation/asphalt binder content and VMA if the Contractor does not meet this condition.
2. Incentives do not apply to the following:
   a. Small projects with plan quantities of HMA less than 3000 tons
   b. Work such as utility work, traffic signals, detours, or lane leveling.
3. Incentives/Disincentives do not apply to material accepted on the basis of visual inspection per article 1.4.

I. The Department rejects the lot if the Percent Within Limits (PT) for any individual measurement is less than 60 percent. Disincentive for reject lots is $15.00/Ton deduction.

J. To reduce over-testing of small quantity production days such as ramps or bridgework, the Engineer may, in concurrence with the Contractor, choose to combine production from several days to form a single lot.

Table 1 Incentive/Disincentive for Gradation, Asphalt Binder Content and Density	
PT Based on Min. Four Samples	**Incentive/Disincentive (Dollars/Ton)**
> 99	0.91
96-99	0.74
92-95	0.41
88-91	0.07
84-87	-0.26
80-83	-0.60
76-79	-0.93
72-75	-1.27
68-71	-1.60
64-67	-1.93
60-63	-2.27
<60	Reject

Table 2 Incentive/Disincentive for VMA	
PT Based on Minimum Three Samples	**Incentive/Disincentive (Dollars/Ton)**
> 99	0.49
96-99	0.39
92-95	0.18
88-91	-0.03
84-87	-0.24
80-83	-0.44
76-79	-0.64
72-75	-0.85
68-71	-1.06
64-67	-1.27
60-63	-1.47
<60	Reject

Table 3 Upper and Lower Limit Determination	
Parameter	**UL and LL**
3/4 inch sieve for 1 inch HMA 1/2 inch sieve for 3/4 inch HMA 3/8 inch sieve for 1/2 inch HMA No. 4 sieve for 3/8 inch HMA	Target Value ± 6.0%
No. 8 sieve	Target Value ± 5.0%
No.50 sieve	Target Value ± 3.0%
No. 200 sieve	Target Value ± 2.0%
Asphalt Binder Content	Target Value ± 0.35%
VMA Production Range Target Range (Field) Target (Design)	Field Target Value ± 1.25% 12.5 % - 13.5 % for 1 inch 13.5 % - 14.5 % for ¾ inch 14.5 % - 15.5 % for ½ inch 15.5 % - 16.5 % for 3/8 inch Modified as necessary to meet field target range
Density	Lower Limit: Target Value - 2.0% Upper Limit: Target Value + 3.0%

Table 4 Quality Index Values for Estimating Percent Within Limits										
PU/PL	**n=3**	**n=4**	**n=5**	**n=6**	**n=7**	**n=8**	**n=10**	**n=12**	**n=15**	**n=20**
100	1.16	1.50	1.75	1.91	2.06	2.15	2.29	2.35	2.47	2.56
99	1.16	1.47	1.68	1.79	1.89	1.95	2.04	2.09	2.14	2.19
98	1.15	1.44	1.61	1.70	1.77	1.80	1.86	1.89	1.93	1.97
97	1.15	1.41	1.55	1.62	1.67	1.69	1.74	1.77	1.80	1.82
96	1.15	1.38	1.49	1.55	1.59	1.61	1.64	1.66	1.69	1.70
95	1.14	1.35	1.45	1.49	1.52	1.54	1.56	1.57	1.59	1.61
94	1.13	1.32	1.40	1.44	1.46	1.47	1.49	1.50	1.51	1.53
93	1.12	1.29	1.36	1.38	1.40	1.41	1.43	1.43	1.44	1.46
92	1.11	1.26	1.31	1.33	1.35	1.36	1.37	1.37	1.38	1.39
91	1.10	1.23	1.27	1.29	1.30	1.31	1.32	1.32	1.32	1.33
90	1.09	1.20	1.23	1.24	1.25	1.25	1.26	1.26	1.27	1.27
89	1.08	1.17	1.20	1.21	1.21	1.21	1.21	1.21	1.22	1.22
88	1.07	1.14	1.16	1.17	1.17	1.17	1.17	1.17	1.17	1.17
87	1.06	1.11	1.12.	1.12	1.12	1.13	1.13	1.13	1.13	1.13
86	1.05	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08
85	1.03	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04
84	1.02	1.02	1.02	1.01	1.01	1.01	1.00	1.00	1.00	1.00
83	1.00	0.99	0.98	0.97	0.97	0.96	0.96	0.96	0.96	0.96
82	0.98	0.96	0.95	0.94	0.94	0.93	0.93	0.92	0.92	0.92
81	0.96	0.93	0.92	0.91	0.90	0.90	0.89	0.89	0.89	0.88
80	0.94	0.90	0.88	0.87	0.86	0.86	0.85	0.85	0.85	0.85
79	0.92	0.87	0.85	0.84	0.83	0.83	0.82	0.82	0.82	0.81
78	0.89	0.84	0.82	0.81	0.80	0.79	0.79	0.78	0.78	0.78
77	0.87	0.81	0.79	.0.78	0.77	0.76	0.76	0.75	0.75	0.75
76	0.84	0.78	0.76	0.75	0.74	0.73	0.72	0.72	0.72	0.72
75	0.82	0.75	0.73	0.72	0.71	0.70	0.69	0.69	0.69	0.68
74	0.79	0.72	0.70	0.68	0.67	0.67	0.66	0.66	0.66	0.65
73	0.77	0.69	0.67	0.65	0.64	0.64	0.62	0.62	0.62	0.62
72	0.74	0.66	0.64	0.62	0.61	0.61	0.60	0.59	0.59	0.59
71	0.71	0.63	0.60	0.59	0.58	0.58	0.57	0.56	0.56	0.56
70	0.68	0.60	0.58	0.56	0.55	0.55	0.54	0.54	0.54	0.53
69	0.65	0.57	0.55	0.54	0.53	0.52	0.51	0.51	0.51	0.50
68	0.62	0.54	0.52	0.51	0.50	0.50	0.48	0.48	0.48	0.48
67	0.59	0.51	0.49	0.48	0.47	0.47	0.46	0.45	0.45	0.45
66	0.56	0.48	0.46	0.45	0.44	0.44	0.43	0.42	0.42	0.42
65	0.53	0.45	0.43	0.42	0.41	0.41	0.40	0.40	0.40	0.39
64	0.49	0.42	0.40	0.39	0.38	0.38	0.37	0.37	0.37	0.37
63	0.46	0.39	0.37	0.36	0.35	0.35	0.35	0.34	0.34	0.34
62	0.43	0.36	0.34	0.33	0.33	0.33	0.32	0.31	0.31	0.31
61	0.39	0.33	0.31	0.30	0.30	0.30	0.29	0.29	0.29	0.28
60	0.36	0.30	0.28	0.27	0.26	0.26	0.25	0.25	0.25	0.25
<60	≤ 0.35	≤ 0.29	≤ 0.27	≤ 0.26	≤ 0.25	≤ 0.25	≤ 0.24	≤ 0.24	≤ 0.24	≤ 0.24

Enter table in the appropriate sample size column and round down to the nearest value.

Table 5 Definitions, Abbreviations, and Formulas for Acceptance	
Term	**Explanation**
Target Value (TV)	The target values for gradation, asphalt binder content and VMA are given in the Contractor's volumetric mix design. See article 1.4, D., for density target values.
Average (AVE)	The sum of the lot's test results for a measured characteristic divided by the number of test results; the arithmetic mean.
Standard Deviation (s)	The square root of the value formed by summing the squared difference between the individual test results of a measured characteristic and AVE, divided by the number of test results minus one. This statement does not limit the methods of calculations of s; other methods that obtain the same value may be used.
Upper Limit (UL)	The value above the TV of each measured characteristic that defines the upper limit of acceptable production. (Table 3)
Lower Limit (LL)	The value below the TV of each measured characteristic that defines the lower limit of acceptable production (Table 3)
Upper Quality Index (QU)	QU = (UL - AVE)/s
Lower Quality Index (QL)	QL = (AVE - LL)/s
Percentage of Lot Within UL (PU)	Determined by entering Table 4 with QU.
Percentage of Lot Within LL (PL)	Determined by entering Table 4 with QL.
Total Percentage of Lot (PL) Within UL and LL (PT)	PT = (PU + PL) - 100
Incentive/Disincentive	Determined by entering Table 1 and 2 with PT or PL.

All values for AVE, s, QU, and QL will be calculated to a minimum of four decimal place accuracy, which will be carried through all further calculations. Rounding to lower accuracy is not allowed.

1.5 LABORATORY CORRELATION

A. To be eligible for dispute resolution, perform the following:
   1. Perform split-sample, paired-T testing with the Department based on project quality control testing using UDOT TTQP qualified lab.
      a. Perform split-sample, paired-T analysis on all mix acceptance tests related to volumetric properties and the following background testing:
         1) Maximum Specific Gravity of Mix, AASHTO T 209
         2) Bulk Specific Gravity of Mix, AASHTO T 166
         3) Bulk Specific Gravity of Coarse Aggregates, AASHTO T 85
      b. Continue until attaining successful Paired-T test results, meeting $\alpha = 0.05$, for a minimum of two consecutive production days. (UDOT Materials Manual of Instruction Part 8: Chapter 4, Appendix C)

B. Submit a detailed report showing tabular summaries of daily test data, paired–T calculations and any corrections made to account for failed comparisons.

C. Submit summary prior to submitting engineering analysis for dispute resolution.

1.6 DISPUTE RESOLUTION

A. When disputing the validity of the Department's acceptance tests, submit an engineering analysis within one week of receipt of test results. Engineering Analyses will be accepted if based on test results performed by an AASHTO accredited lab that has performed a split-sample process with the Department.

B. At a minimum, include the following items in the engineering analysis:
   1. Data supporting the Contractor's test results. Data must be based on project quality control testing.
      a. Split-sample testing performed within the applicable contract
      b. Test data disputed along with:
         1) Maximum Specific Gravity of Mix, AASHTO T 209
         2) Bulk Specific Gravity of Mix, AASHTO T 166
         3) Bulk Specific Gravity of Coarse Aggregates, AASHTO T 85
      c. Successful Laboratory Correlation information, Article 1.5
   2. Procedures or issues leading to disputed acceptance test results.

3. Determination of volumetric, durability and long-term structural properties from one or more of the following tests:
    a. Hamburg Wheel Track Testing of Compacted Bituminous Mixtures; AASHTO T 324
    b. Resistance of Compacted Bituminous Mixture to Moisture Damage; UDOT Materials Manual of Instruction Part 8-957.
    c. Standard Test Method for Determining Rutting Susceptibility Using the Pavement Analyzer; UDOT Materials Manual of Instruction Part 8-958.
    d. Dynamic Modulus Evaluation, AASHTO TP 62
    e. PG Asphalt Binder Tests
    f. AASHTO T 312
4. Incentive/Disincentive calculations based on Contractor and Department test values.
5. Recommendations for price adjustment based on expected long-term performance.

C. When paving plans indicate that a reject lot will be covered within 48 hours, the Department immediately reviews the analysis to identify possible discrepancies that can be resolved through validation testing based on the following:
1. Department performs repeat testing on remaining material from original Department test.
2. Department personnel perform repeat testing in the presence of Contractor representative within a 24 hour time period.
3. Use results to validate or invalidate original Department result. Validation test results may not be used in lieu of acceptance results.
4. Base validation on results within two standard deviations (project acceptance samples) of original acceptance result. Remove invalidated test results from acceptance lot and reevaluate lot based on reduced sample size.
5. The Engineer reviews the results and notifies the Contractor of any findings that affect the reject status of the lot along with the Department's position on whether the lot is to be removed or may remain in place at the $15.00/ton deduction for Reject Lot.

D. Within three working days of receipt, the Resident Engineer, Region Materials Engineer, and Region Construction Engineer review the analysis and notify the Contractor in writing of acceptance or rejection. Notification of rejection includes the following:
1. Engineering basis for rejecting the Contractor's analysis, including specific points of objection.
2. Department data and analysis to justify Department position.
3. Time frame for removal of material or pay adjustment to be applied to the lot.

E. When the Department concludes the engineering analysis has merit, the Department, in conjunction with the Contractor, immediately begins a review of the acceptance test results. The review includes, but is not be limited, to the following:

1. Independent Assurance review of all equipment and procedures and methods used for sampling, splitting, and testing.
2. A review of the Department and Contractor's raw test data and calculations for documentation or calculation errors.
3. Production and testing of additional correlation samples.
4. Cross-witnessing of test procedures by Contractor Quality Control and Department personnel.
5. Distribution of any other pertinent information.
6. Discussion of other possible means for variation.

Note: If engineering analysis is initiated due to failure of statistical methods to verify Contractor testing and there is no net difference between incentive/disincentive based on Contractor or Department testing, the Engineer may verify contractor test values based on engineering analysis.

F. Do not continue production without concurrence from the Engineer or until differences in the test results are resolved.

G. If errors in testing or reporting are discovered, the Department corrects the applicable test results and re-applies the acceptance/pay adjustment procedures.

1. If errors are identified that cannot be corrected and the quality of the lot is in question, the Department may choose to evaluate the lot using the Hamburg Wheel Tracker (AASHTO T 324), or the Asphalt Pavement Analyzer (UDOT Materials Manual of Instruction Part 8-958: Standard Test Method for Determining Rutting Susceptibility using the Pavement Analyzer).
    a. Use 5 stratified random samples cut from the roadway
    b. The Region Materials Engineer and Resident Engineer decide, in conjunction with the Contractor, the status of the lot and associated pay adjustment, based on the following:
        1) Fatigue Life
        2) Stripping Potential
        3) Rutting Potential
        4) Expected Pavement Performance Period vs. Design Life
2. Errors that are identified within the Department's testing result in a review of the Contractor's schedule and if appropriate, make adjustments to the CPM.

H. If errors in testing cannot be identified, select an Independent Third Party (Agreed upon by the Department and the Contractor) to witness sample splitting and testing by both the Contractor and the Department. The Independent Third Party identifies/produces additional material for split-sample testing.

I. If testing errors are identified by the Third Party, the Department makes appropriate adjustments to the acceptance test results and re-applies the acceptance/pay adjustment procedures.

J. The party responsible for the identified error pays for the services of the Independent Third Party.

K. If no errors are identified, the Department evaluates the lot using the original testing results.

PART 2 PRODUCTS

2.1 ASPHALT BINDER

A. Refer to Section 02742S, Project Specific Surfacing Requirements.

B. Asphalt Material as per Section 02745.

C. Adhere to UDOT Minimum Sampling and Testing Guide Quality Management Plan 509: Asphalt Binder Quality Management System sampling, testing and handling of Asphalt Binder.

2.2 AGGREGATE

A. Refer to the UDOT Minimum Sampling and Testing Guide for testing frequencies.

B. Crusher processed virgin aggregate material consisting of crushed stone, gravel, or slag. Conform to Section 02969 for recycled mixes.

C. Use the following requirements, including Table 6, to determine the suitability of the aggregate.
   1. Coarse aggregates:
      a. Retained on No. 4 sieve.
   2. Fine aggregates:
      a. Clean, hard grained, and angular.
      b. Passing the No. 4 sieve.

Table 6 Aggregate Properties - HMA			
Test Method	**Test No.**	**Category 1**	**Category 2**
One Fractured Face	AASHTO TP 61	95% min.	85% min. (1 inch and 3/4 inch), and 90% min. (1/2 inch and 3/8 inch)
Two Fractured Face	AASHTO TP 61	90% min.	80% min. (1 inch and 3/4 inch), and 90% min. (1/2 inch and 3/8 inch)
Fine Aggregate Angularity	AASHTO T 304	45 min.	45 min.
Flakiness Index	UDOT MOI 933 (Based on 3/8 inch sieve and above)	17% max.	17% max.
L.A. Wear	AASHTO T 96	35% max.	40% max.
Sand Equivalent	AASHTO T 176 (Pre-wet method)	60 min.	45 min.
Plasticity Index	AASHTO T 89 and T 90	0	0
Unit Weight	AASHTO T 19	min. 75 lb/cu. ft.	min. 75 lb/cu. ft.
Soundness (sodium sulfate)	AASHTO T 104	16 % max. loss with five cycles	16 % max. loss with five cycles
Clay Lumps and Friable Particles	AASHTO T 112	2% max	2% max.
Natural Fines	N/A	0%	10% max.
Category 1: National Highway System and Truck Routes - Table 11. Category 2: All Other Routes			

D. Meet gradation requirements in Table 7. AASHTO T 27/T 11

Table 7 Aggregate Gradations (Percent Passing by Dry Weight of Aggregate)					
Sieve Size		**1 inch (SHRP 25 mm)**	**3/4 inch (SHRP 19 mm)**	**1/2 inch (SHRP 12.5 mm)**	**3/8 inch (SHRP 9.5 mm)**
Control Sieves	**1-1/2 inch**	100.0	-	-	-
	1 inch	90.0 - 100.0	100.0	-	-
	3/4 inch	<90	90.0 - 100.0	100.0	-
	1/2 inch	-	<90	90.0 - 100.0	100.0
	3/8 inch	-	-	<90	90.0 - 100.0
	No. 4	-	-	-	< 90
	No. 8	19.0 - 45.0	23.0 - 49.0	28.0 - 58.0	32.0 - 67.0
	No. 200	1.0 - 7.0	2.0 - 8.0	2.0 - 10.0	2.0 - 10.0

2.3 HYDRATED LIME

A. Meet the requirements of Section 02746.

2.4 VOLUMETRIC DESIGN

A. Comply with all requirements for Superpave Volumetric Mix Design according to UDOT Materials Manual of Instruction Part 8-964: Guidelines for Superpave Volumetric Mix Design and the following:
   1. Meet the requirements of Table 8 and Table 9.
   2. Use a laboratory qualified by UDOT Central Materials in the use of the Superpave Gyratory Compactor.
   3. Use a Superpave Gyratory Compactor approved in accordance with UDOT Materials Manual of Instruction Part 8-961: Guidelines for Superpave Gyratory Compactor Protocol.
   4. Meet all volumetric mix design requirements for the selected target gradation.

B. Submit the Volumetric Mix Design data for verification at least 10 working days before beginning paving. Do not begin paving until verification is complete.
   1. Include all information regarding selection of design aggregate structure showing the target values of percent passing on all sieves listed in Table 3 and Table 7, and the design asphalt binder content.
   2. Provide information that aggregate proposed for use meet the requirements of Table 6.

3. Supply QC data for target job mix gradation selection. Use those target values for price adjustments.
4. After the design is complete, run four sets of two Gyratory specimens at the design asphalt binder content to verify the optimum asphalt and all other design requirements.

C. Moisture Susceptibility
1. Incorporate hydrated lime into all volumetric designs. Use 1 percent, minimum, for Method A and 1½ percent, minimum for Method B (Section 02746).

D. Designate asphalt binder supplier.

E. Use gyratory mixing and compaction temperatures supplied by the Engineer.

F. The Department Region Materials Lab verifies the Volumetric Mix Design. UDOT Materials Manual of Instruction Part 8-960: Guidelines for Superpave Volumetric Mix Design. For small projects with plan quantities of HMA less than 3000 tons, or for work such as utility work, traffic signals, detours, or lane leveling, the Region Materials Engineer may accept the Volumetric Mix Design from data submitted with the proposed mix design or from a previous mix design. The Region Materials Engineer reserves the right to verify any mix design submitted.

G. Comply with the following requirements for Superpave volumetric mix design:

Table 8
Volumetric Design Gyrations

20 Years Design ESALS (Million)	**Compaction Parameters**			**Voids Filled with Asphalt (VFA) (%)**
	$N_{initial}$ /% of G_{mm}*	**N_{design} /% of G_{mm}***	**N_{max} /% of G_{mm}***	
0.3	6/≤ 91.5	50/ ≥ 96.5	75/≤ 98	70 - 80 **
0.3 to <3	7/≤ 90.5	75/ ≥ 96.5	115/≤ 98	70 - 80
3 to < 30	8/≤ 89	100/ ≥ 96.5	160/≤ 98	70 - 80
≥ 30	9/≤ 89	125/ ≥ 96.5	205/≤ 98	70 - 80

* G_{mm}: Maximum specific gravity of Mix. (Rice Method)
** 67 percent specified lower limit VFA for 1 inch nominal maximum size mixture.

Table 9 Volumetric Design Requirements	
HMA design mixing and compaction temperatures	Provided by the Engineer
Dust Proportion Range	0.6 - 1.40
Voids in Mineral Aggregate (VMA) at N_{design} AASHTO R 35.9.2, using G_{sb} at SSD. Equation based on percent of total mix.	Select Design Target such that Field Performance meets Field Target requirements (Submit calculations or documentation to substantiate)
Hamburg Wheel Tracker AASHTO T-324	Maximum 10 mm impression at 20,000 cycles.

H. Prepare and submit two sets (five samples each) of ignition oven calibration samples.
   1. Department uses these samples to determine the correction factors for the Region and Field lab ignition oven.
   2. Submit samples a minimum of three working days prior to paving.

2.5 CONTRACTOR INITIATED CHANGES IN MIX DESIGN

A. Submit all requests, in writing to Engineer, at least 12 hours prior to incorporating changes into production.

B. Submit a field volumetric mix design for all target changes with the exception of the initial establishment of VMA field target. Field target for VMA may be adjusted once, without submission of new mix design, after production of first paving lot.
   1. Include documentation supporting correlation between suggested target changes and mix design volumetric requirements. Department acceptance and/or Contractor QC testing data is acceptable.
   2. Field volumetric mix design verification consists of three sets of two gyratory specimens run at the new target gradation and/or asphalt binder content. The Department's previous acceptance tests are acceptable for field verification.
   3. If the field volumetric mix design meets the volumetric requirements, the Engineer, in consultation with the Region Materials Engineer, provides written concurrence of the verified field volumetric mix design.
   4. If the field volumetric mix verification does not meet the volumetric requirements, submit a new laboratory volumetric mix design from a laboratory qualified by UDOT Central Materials. Allow at least four working days for verification.

5. The Department performs up to two volumetric mix design verifications at no cost to the Contractor. The Department charges $3000 for each additional laboratory and/or field verification required, including all laboratory or field volumetric mix design verifications required due to contractor initiated target changes.

C. Submit a new laboratory volumetric mix design if changes occur in the aggregate source, asphalt binder source or grade.

D. Do not make changes to production mix until request is reviewed and verified.

PART 3 EXECUTION

3.1 ADDING HYDRATED LIME

A. Method A, Lime Slurry; or Method B, Lime Slurry Marination: Refer to Section 02746.

3.2 HMA

A. Dry aggregate to an average moisture content of not more than 0.2 percent by weight. Verified by AASHTO T 255. Adjust burners to avoid damage or soot contamination of the aggregate.

B. Coat with asphalt binder 100 percent of the particles passing and 98 percent of the particles retained on the No. 4 sieve.
1. Verified by AASHTO T 195.
2. Discontinue operation and make necessary corrections if material is not properly coated.

C. Maintain temperature of the HMA between identified limits for mixing and compaction, as defined on Volumetric Mix Design Verification Letter.
1. Department rejects materials heated over the identified limits.
2. Remove all material rejected by the Department for overheating.

3.3 HMA PLANT

A. Provide:
1. Positive means to determine the moisture content of aggregate.
2. Positive means to sample all material components.
3. Sensors to measure the temperature of the HMA at discharge.

4. The ability to maintain discharge temperature of the mix in accordance with the mix design.

B. Asphalt Binder Storage Tanks:
   1. Provide calibrated tanks so the quantity of material remaining in the tank can be determined at any time.
   2. Provide a positive means of sampling the asphalt binder from the tanks.

3.4 SURFACE PREPARATION

A. Locate, reference, and protect all utility covers, monuments, curb and gutter, and other components affected by the paving operations.

B. Remove all moisture, dirt, sand, leaves, and other objectionable material from the prepared surface before placing the mix.

C. Complete spot leveling 48 hours before placing pavement courses.
   1. Place, spread, and compact leveling mix on portions of the existing surface.
   2. Fill and compact any localized potholes more than 1 inch deep.

D. Allow sufficient cure time for prime coat/tack coat prior to placing HMA. Refer to Section 02748.

3.5 SURFACE PLACEMENT

A. When full-width or echelon paving is impractical and more than one pass is required, provide a 3:1 (horizontal to vertical) sloped edge adjacent to the next lane to be paved.

B. Adjust the production of the mixing plant and material delivery until a steady paver speed is maintained.

C. Offset longitudinal joints 6 to 12 inches in succeeding courses.
   1. Place top course joint within one foot of the centerline or lane line.
   2. If the previous pass has cooled below 175 degrees F, tack the longitudinal edge before placing the adjacent pass.

D. Offset transverse construction joints at least 6 ft longitudinally to avoid a vertical joint through more than one course.

E. Do not allow construction vehicles, general traffic, or rollers to pass over the uncompacted end or edge of freshly placed mix until the mat temperature drops to a point where damage or differential compaction will not occur.

F. Taper the end of a course subjected to traffic at approximately 50:1 (horizontal to vertical).
   1. Make a transverse joint by saw or wheel cutting and removing the portion of the pass that contains the tapered end.
   2. Tack the contact surfaces before fresh mix is placed against the compacted mix.

G. Use a motor grader, spreader box, or other approved spreading methods for projects under 180 yd^2, irregular areas, or for miscellaneous construction such as detours, sidewalks, and leveling courses.

3.6 COMPACTION

A. Use a small compactor or vibratory roller in addition to normal rolling at structures.

B. Operate in a transverse direction next to the back wall and approach slab.

3.7 LIMITATIONS

A. Do not place HMA on frozen base or subbase.

B. Use a UDOT approved release agent for all equipment and hand tools used to mix, haul, and place the HMA. Select from the Performance Data Products Listing (PDPL) maintained by the UDOT Research Division.

C. Do not place HMA during adverse climatic conditions, such as precipitation, or when roadway surface is icy or wet.

D. Place HMA from April 15, and October 15, and when the air temperature in the shade and the roadway surface temperature are above 50 degrees F.
   1. The Department determines if it is feasible to place HMA outside the above limits. Obtain written approval from the Engineer prior to paving from October 15, to April 15.

3.8 CONTRACTOR QUALITY CONTROL

A. General
   1. Reference the following standards for qualification, control, and guidelines:
      a. ASTM D 3666
      b. ASTM D 4561
      c. ASTM D 5506

2. Include the following tests in ASTM D 5506, Part 2, "Referenced Documents," for the following:
    a. AASHTO T 308
    b. AASHTO T 312, PP 28
    c. ASTM E 1274
3. Establish and maintain a quality control system providing assurance that materials and completed construction conform to Contract requirements.
4. Identify the Quality Control Manager by name. The Quality Control Manager implements and maintains the Quality Control Plan.
5. Provide the Engineer a certification stating that all the testing equipment to be used is properly calibrated and meets the specifications applicable for the specified test procedures. Provide evidence that Technicians are UDOT TTQP qualified. The Engineer may require the Contractor's technician to perform testing of samples to demonstrate an acceptable level of performance.

B. Quality Control Plan (QCP)

1. Provide and maintain a Quality Control Plan covering all personnel, equipment, supplies, and facilities necessary to obtain samples, perform and document tests, and otherwise provide a quality product.
2. Submit the written QCP to the Engineer at least 10 days before beginning operations, or at the Preconstruction Conference.
3. The Department makes no partial payments for materials that are subject to specific quality control requirements without a QCP.
4. The Contractor or independent organization may operate the QCP. However, the Contractor is responsible for the QCP's administration, including compliance with the QCP and any modifications.
5. Address the following minimum items:
    a. Quality control organization chart and area of responsibility and authority of each individual.
    b. Names and qualifications of personnel as required by this Article.
    c. Provide a description of outside organizations and their services (such as testing laboratories) if employed.
    d. Tests required to be performed, the frequency of testing, sampling locations, and location of the testing facilities.
    e. Documentation of test procedures verifying that tests are conducted in accordance with the testing plan, and that proper corrective actions are taken when required.
    f. Procedures for verifying that testing equipment is available, complies with specified standards, and is calibrated against certified standards.
    g. Procedures for verifying that tests are conducted in accordance with the appropriate ASTM and AASHTO standards.
    h. Procedures for submitting test results to the Engineer daily.

6. QCP elements: address all elements that affect the quality of the HMA including:
    a. Mix Design
    b. Aggregate Grading
    c. Quality of Materials
    d. Stockpile Management
    e. Proportioning
    f. Mixing
    g. Placing and Finishing
    h. Sampling and Testing Procedures
    i. Joints
    j. Compaction
    k. Surface smoothness

C. Quality Control Organization
1. Implement the QCP by:
    a. Establishing a separate Quality Control Organization.
    b. Developing an organization chart to show all quality control personnel and how these personnel integrate with other management, production, and construction functions and personnel.
2. Identify all quality control staff on the organization chart by name and function, and indicate the total staff required to implement all elements of the quality control programs, including inspection and testing functions for different items of work.
3. If an outside organization or laboratory is used to implement all or part of the QCP, the personnel assigned are subject to the qualification requirements of this Section. Indicate on the organization chart which personnel are contractor employees and which are provided by an outside organization.

D. Quality Control Organization Personnel Requirements
1. As outlined in ASTM D 3666, Part 7, with the following modifications. Quality Control Manager:
    a. Institutes any actions necessary to successfully operate the QCP in compliance with specifications.
    b. Reports directly to a responsible officer in the Contractor's organization.
    c. May supervise the QCP on more than one project provided that the Quality Control Manager can be at the job site within one hour after being notified of a problem.

2. Qualification of Personnel. As outlined in ASTM D 3666 with the following changes:
    a. Provide a sufficient number of quality control technicians to adequately implement the QCP. These personnel will be either engineers or engineering technicians qualified by UDOT TTQP.
3. Quality Control Technicians:
    a. Report directly to the Quality Control Manager.
    b. Inspect all plant equipment used in proportioning and mixing to verify proper calibration and operating condition.
    c. Perform quality control tests necessary to adjust and control mix proportioning in accordance with the job mix formula.
    d. Inspect all equipment used in placing, finishing, and compaction to verify proper operating condition.
    e. Inspect all construction operations to verify conformance with the specifications.
    f. Perform all quality control testing as required within this article.
    g. Detail the criteria to be used in initiating correction of unsatisfactory production processes and construction practices.

E. Quality Control Testing Laboratory
1. Reference ASTM D 4561 with the following additions:
    a. Provide a fully equipped asphalt laboratory located within 30 minutes travel time of the plant or job site.
    b. Keep laboratory facilities clean and all equipment maintained in proper working condition.
    c. Permit the Engineer unrestricted access to inspect the quality control testing laboratory facility and witness quality control activities. The Department advises in writing of any noted deficiencies concerning the laboratory facility, equipment, supplies or testing personnel and procedures.
    d. Suspend work when test results indicate materials are out of specification tolerances. Resume only when the deficiencies are corrected.
        1) Perform quality audits under this standard.
        2) Refer to UDOT Quality Assurance Manual.
2. Sampling:
    a. Use a statistically based procedure of random sampling, independent of UODT's random acceptance sampling determinations. (UDOT Materials Manual of Instruction Part 8-981: Random Sampling)
    b. The Engineer has the right to witness all sampling.

3. Noncompliance:
    a. When quality control activities do not comply with either the Quality Control Program or the Contract provisions, or failure to properly operate and maintain an effective Quality Control Program, the Engineer may:
        1) Order replacement of ineffective or unqualified personnel.
        2) Carry out the functions and operation of the approved Quality Control Program.
        3) Deduct costs incurred by the Department to operate the program or otherwise remedy the noncompliance from the total amount due the Contractor.

F. Quality Control Testing
1. Perform all quality control tests necessary to control the production and construction processes applicable to these specifications and listed in the QCP.
2. Establish a testing program to control as a minimum: asphalt binder content, aggregate gradation, VMA, temperatures, aggregate moisture, field compaction, and surface smoothness.
3. Monitoring: The Department reserves the right to monitor any QC testing.
4. Follow the requirements of Table 10, and conduct any additional testing to control the process.

Table 10 Quality Control Testing for HMA	
Testing Method/ Acceptance Documentation	**Testing Frequency**
AASHTO T 308 **Asphalt binder content**: by the ignition method	Minimum 4 tests per lot **
AASHTO T 30 **Gradation**: Mechanical analysis of the remains of the Ignition test.	Minimum 4 tests per lot
AASHTO T 255 **Moisture content**: of aggregate used in production by drying	Minimum One test per lot
Temperature for: dryer, bitumen in the storage tank, mixture at the plant, and mixture at the job site.	Record at least four times per lot
ASTM D 2950 **In-place Density Monitoring** Conduct all testing necessary to meet density requirements.	Minimum 10 density determinations per lot
AASHTO T 312, R 35 **Field Gyratory Specimens** Verify mix design parameters meet Job-mix requirements, and adjust mix as needed to meet parameters. Mold field gyratory specimens at mix design temperatures determined by the Engineer.	Minimum of one determination (two Gyratory specimens each) of VMA and Air Voids for each lot.

** A lot is defined in article 1.4

G. Control Charts

1. Maintain daily linear control charts both for mean and range. Include in charts aggregate gradation, asphalt binder content, stockpile gradation, VMA, density and in-place air voids.
2. Post control charts daily in a location satisfactory to the Engineer. As a minimum, identify:
    a. Project number
    b. Contract item number
    c. Test number
    d. Each test parameter
    e. Test results
3. Use the control charts as part of a process control system for identifying potential problems and assignable causes before they occur. If the projected data during production indicates a problem and no corrective action is taken, the Engineer may suspend production or acceptance of the material.

H. Quality Control Reports

1. Maintain records and submit daily reports of quality control activities.

Table 11 National Highway System and Truck Routes Category 1		
Interstate Routes	**Beginning**	**Ending**
1-15	Arizona State Line	Idaho State Line
1-70	Jct I-70 - Cove Fort	Colorado State Line
1-80	Nevada State Line	Wyoming State Line
1-84	Idaho State Line	Jct I-80 - Coalville
1-215	Jct I-80 - Parleys Canyon	Jct I -15 - North Salt Lake
US Routes		
US-6	Nevada State Line	Jct US-50 - Delta
US-6	Jct I-15 - Spanish Fork	Jct I-70 - Green River
US-40	Jct I-80 - Park City	Colorado State Line
US-50	Jct US-6 - Delta	Jct I-15 - Holden
US-89	Arizona State Line	Jct I-70 - Sevier
US-89	Jct I-70 - Salina	Jct SR-28 - Gunnison
US-89	Jct US-6 - Spanish Fork	Jct SR-73 - Lehi
US-89	SR-71 - Draper	Jct SR-269 - 5th and 6th South
US-89	Jct I-15 - Farmington	Jct I-80 - Uintah
US-89	Jct I-84 - Uintah	Jct SR-134 - North Ogden
US-89	Jct US-91 - Logan	Idaho State Line
US-91	Jct I-15 - Brigham City	Jct US-89 - Logan
US-189	Jct I-15 - South Provo	Jct US-40 - Heber City
US-191	Arizona State Line	Jct I-70 - Thompson
US-666	Jct US-191 - Monticello	Colorado State Line

State Routes	Beginning	Ending
SR-9 - Zions Park		
SR-10 - Castle Valley	Jct I-70 - Fremont Jct	Jct US-6 - Price
SR-12 - Bryce Canyon	Jct US-89 - Panguitch	Jct SR-63 - Bryce Canyon
SR-26 – Riverdale Road	Jct I-15 - Exit 342	Jct US-89 - Ogden
SR-28 - Levan Desert	Jct US-89 - Gunnison	Jct I-15 - South Nephi
SR-31 - Huntington	Mile Post 33	Mile Post 49
SR-36 - Tooele Access	Jct entrance - Tooele Army Depot	Jct I-80 - Tooele Interchange
SR-39 - 20th and 21st Odgen	Jct I-15 - Exit 344	Jct SR-203 - Harrison Blvd
SR-52 - 8th North, Orem	Jct 1-15 - Orem	Jct US -189 - Olmstead Jct
SR-57 - Orangeville Bypass	Jct SR-10 - Hunter Power Plant	Entrance - Wilberg Coal Mine
SR-71 - 7th and 9th East Street, Salt Lake City	Jct SR0-209 - 90th South Street	Jct SR-186 - 4th South Street
SR-73 - Lehi Connection	Jct I-15 - South Lehi	Jct US-89 - South Lehi
SR-79 - 12th Street Ogden	Jct I-15 - Exit 347	Jct SR-203 - Harrison Blvd.
SR-96 - Scofield Access	Mile Post 3	Mile Post 4
SR-111 - Bacchus Highway	Jct SR-48 - Bingham Highway	Jct SR-201 - 21st South Expressway
SR-134 - 2700 North	Jct I-15 - North Ogden, Exit 352	Jct US-89 - North Ogden
SR-152 - Van Winkle Expressway	Jct SR-71 - 9th East Street	Jct I-215 - East (Exit 8)
SR-154 - Bangerter Highway	Jct I-15 - Draper	Jct I-80 - Salt Lake Intl Airport
SR-171 - 33rd and 35th South, Salt Lake City	Jct SR-172 - 56th West Street	Jct I-215 - East, Exit 3
SR-172 - 56th West Street Salt Lake City	Jct 6200 South - Kearns	Jct I-80 - International Center
SR-186 Foothill Blvd	Jct SR-71 - 7th East Street, SLC	Jct I-215 - East (Exit 1)
SR-190 - Big Cottonwood	Jct I 215 - East, Exit 7, SLC	Jct SR-210 - Little Cottonwood
SR-201 - 21st South Expressway	Jct I-80 - Lake Point	Jct I-15 - South Salt Lake
SR-203 - Harrison Blvd	Jct US-89 - South Ogden	Jct SR-39 - 12th Street

State Routes	Beginning	Ending
SR-209 - 90th & 94th South	Jct SR-68 - Redwood Road (SLC)	Jct SR-210 - Little Cottonwood
SR-210 - Little Cottonwood	Jct SR-190 - Big Cottonwood	Jct SR-209 - 90th and 96th South
SR-264 - Skyline Mine Road	Mile Post 12	Mile Post 15
SR-265 - University Parkway	Jct I-15 - Exit 272	Jct I-215 East, Exit 5
SR-266 - 45th & 47th South Taylorsville	Jct I-215 - West, Exit 15	Jct I-215 - East, Exit 5
SR-269 - 5th & 6th South Salt Lake City	Jct I-215, Exit 310	Jct SR-71 - 7th East Street

END OF SECTION