

SECTION 32 12 16.16

HOT-MIX ASPHALT (HMA) FOR ROADS
08/09

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

JAPANESE STANDARDS ASSOCIATION (JSA)

JIS A 1110	(2006) Methods of Test for Density and Water Absorption of Coarse Aggregates
JIS A 1121	(2007) Method of Test for Resistance to Abrasion of Coarse Aggregate by Use of the Los Angeles Machine
JIS A 1122	(2014) Method of Test for Soundness of Aggregate by Use of Sodium Sulfate
JIS A 1137	(2014) Method of Test for Clay Lumps Contained in Aggregates
JIS A 5001	(2008) Crushed Stone for Road Construction
JIS A 5008	(2008) Limestone Filler for Bituminous Paving Mixtures
JIS K 2207	(2006) Petroleum Asphalts

JAPAN ROAD ASSOCIATION (JARA)

JRA HAP	(2019) Handbook for Asphalt Pavement
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1.2 GENERAL REQUIREMENTS

All materials, equipment, and construction procedures of hot-mix asphalt pavement for this project shall be in accordance with the Japan Road Association standards per publication identified in this specification.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Mix Design; G
Quality Control; G
Material Acceptance; G
SD-06 Test Reports
Aggregates; G
QC Monitoring

1.4 ENVIRONMENTAL REQUIREMENTS

Do not place the hot-mix asphalt upon a wet surface or when the surface temperature of the underlying course is less than specified in Table 3. The temperature requirements may be waived by the Contracting Officer, if requested; however, meet all other requirements, including compaction.

Table 3. Surface Temperature Limitations of Underlying Course	
Mat Thickness, mm	Degrees C
75 or greater	4
Less than 75	7

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Perform the work consisting of pavement courses composed of mineral aggregate and asphalt material heated and mixed in a central mixing plant and placed on a prepared course. HMA designed and constructed in accordance with this section shall conform to the lines, grades, thicknesses, and typical cross sections indicated. Construct each course to the depth, section, or elevation required by the drawings and roll, finish, and approve it before the placement of the next course.

2.2 AGGREGATES

Provide aggregates consisting of crushed stone, crushed gravel, crushed slag, screenings, natural sand and mineral filler, as required. The portion of material retained on the 5 mm sieve is coarse aggregate. The portion of material passing the 5 mm sieve and retained on the 0.074 mm sieve is fine aggregate. The portion passing the 0.074 mm sieve is defined as mineral filler. Submit all aggregate test results and samples to the Contracting Officer at least 14 days prior to start of construction.

2.2.1 Coarse Aggregate

Provide coarse aggregate consisting of sound, tough, durable particles, free from films of material that would prevent thorough coating and bonding with the asphalt material and free from organic matter and other deleterious substances and conforming to JIS A 5001. All individual coarse aggregate sources shall meet the following requirements:

Percent Passing (by Weight)

Sieve Size (mm)	S-20 (20-13 mm)	S-13 (13-5 mm)	S-5 (5-2.5 mm)
25	100	-	-
20	85 - 100	100	-
13	0 - 15	85 - 100	100
5	-	0 - 15	85 - 100
2.5	-	-	0 - 25

- a. At least 75 percent by weight of the aggregate shall have two or more fractured faces in accordance with JRA HAP
- b. It shall be of uniform quality, clean, hard and durable, and shall not contain deleterious substances over the maximum percent by weight, such as clay or loam (0.25% maximum), soft stone pieces (5.0% maximum), and flat or elongated stone pieces (10.0% maximum) in accordance with JRA HAP.
- c. Specific gravity shall be 2.45 or more when tested with JIS A 1110, water absorption shall be 3.0 percent or less when tested with JIS A 1110, and wear shall be not more than 30 percent when tested with JIS A 1121.
- d. Soundness of aggregate shall be not more than 12 percent when tested with JIS A 1122.

2.2.2 Fine Aggregate

Fine aggregate shall consist of natural or manufactured sand, and screenings conforming to JIS A 5001, except as modified herein. Fine aggregate shall meet requirements for wear and soundness specified for coarse aggregate. Since screenings may contain deleterious substances, such as silt and clay, it is necessary to perform sufficient examination before use. Clay lumps content shall be less than 0.25% when tested with JIS A 1137. Gradation of fine aggregate shall be as follows:

Sieve Size (mm)	Percent Passing (by Weight)
5	100
2.5	85 - 100
0.6	25 - 55
0.3	15 - 40
0.15	7 - 28

Sieve Size (mm)	Percent Passing (by Weight)
0.074	0 - 20

2.2.3 Mineral Filler

Mineral filler shall be pulverized limestone or igneous rock that is sufficiently dry and free of lumps and meeting the requirements of JIS A 5008. Moisture content shall be less than 1.0 percent, and specific gravity shall be more than 2.60 percent. Gradation of mineral filler shall be as follows:

Sieve Size (mm)	Percent Passing (by Weight)
0.6	100
0.15	Over 90
0.074	Over 70

2.2.4 Composition of Hot-Mix Asphalt Mixture

2.2.4.1 Aggregate Gradation

The combined aggregate gradation shall conform to gradations specified in Table 1 and shall not vary from the low limit on one sieve to the high limit on the adjacent sieve or vice versa, but grade uniformly from coarse to fine.

Table 1

Total Percent Passing (By Weight)

Sieve Size (mm)	Binder Course (Max. 20 mm)	Wearing Course (Max. 20 mm)	Wearing Course (Max. 13 mm)
25	100	100	-
20	95 - 100	95 - 100	100
13	70 - 90	75 - 90	95 - 100
5	35 - 55	45 - 65	55 - 70
2.5	20 - 35	35 - 50	35 - 50
0.6	11 - 23	18 - 30	18 - 30

Sieve Size (mm)	Binder Course (Max. 20 mm)	Wearing Course (Max. 20 mm)	Wearing Course (Max. 13 mm)
0.3	5 - 16	10 - 21	10 - 21
0.15	4 - 12	6 - 16	6 - 16
0.074	2 - 7	4 - 8	4 - 8

2.2.4.2 Quantity of Asphalt Cement

Mix asphalt cement with aggregates of corresponding mixes in the following proportions:

Asphalt Cement Percent by Weight of Total Mix	
Binder Course	Wearing Course
4.5 - 6	5 - 7

2.3 ASPHALT CEMENT

Asphalt cement shall conform to JIS K 2207, penetration grade 40-60 (high traffic areas), 60-80 (general traffic conditions), 80-100 (snowy regions), and 100-120 (extremely cold places).

2.4 MIX DESIGN

- a. Develop the mix design. The asphalt mix shall be composed of a mixture of well-graded aggregate, mineral filler if required, and asphalt material. The aggregate fractions shall be sized, handled in separate size groups, and combined in such proportions that the resulting mixture meets the grading requirements of the job mix formula (JMF). Submit proposed JMF; do not produce hot-mix asphalt for payment until a JMF has been approved. The hot-mix asphalt shall be designed in accordance with Chapter 5 of the JRA HAP - Handbook for Asphalt Pavement and the criteria shown in Table 2.

2.4.1 JMF Requirements

Submit in writing the job mix formula for approval at least 14 days prior to the start of the test section including as a minimum:

- a. Source and proportions, percent by weight, of each ingredient of the mixture.
- b. Correct gradation, the percentages passing each size sieve listed in the specification for the mixture to be used, for the aggregate and mineral filler from each separate source and from each different size to be used in the mixture and for the composite mixture.
- c. Amount of material passing the JIS 0.074 mm sieve as determined by dry sieving.
- d. Number of blows of hammer compaction per side of molded specimen.

- e. Temperature viscosity relationship of the asphalt pavement.
- f. Stability, flow, percent voids in mineral aggregate, percent air voids, and unit weight.
- g. Asphalt absorption by the aggregate.
- h. Effective asphalt content as percent by weight of total mix.
- i. Temperature of the mixture immediately upon completion of mixing.
- j. Asphalt viscosity grade and/or penetration range.
- k. Curves for the binder and wearing courses.

2.4.1.1 Marshall Test

Marshall test specimen of hot-mix asphalt mixture shall be prepared in a laboratory to determine the optimum composition of aggregates and the optimum quantity of asphalt cement. Aggregate gradation and asphalt cement content used in the mixtures shall be within the limits specified. Standard value for Marshall test shall be as follows:

Table 2. Mix Design Criteria		
Type of Mixture	Binder Course	Wearing Course
Number of Blows (Traffic Classification C or heavier)	75	75
Number of Blows (Traffic Classification B or lighter)	50	50
Percentage of Air Voids (%)	3-7	3-6
Voids Filled with Asphalt (%)	65-85	70-85
Marshall Stability (kgf)	500 or more	750 or more
Flow Value (1/100cm)	20-40	20-40

2.4.2 Adjustments to Field JMF

Keep the Laboratory JMF for each mixture in effect until a new formula is approved in writing by the Contracting Officer. Should a change in sources of any materials be made, perform a new laboratory jmf design and a new JMF approved before the new material is used. The Contractor will be allowed to adjust the Laboratory JMF within the limits specified below

to optimize mix volumetric properties with the approval of the Contracting Officer. Adjustments to the Laboratory JMF shall be applied to the field (plant) established JMF and limited to those values as shown. Adjustments shall be targeted to produce or nearly produce 4 percent voids total mix (VTM).

TABLE 3. Field (Plant) Established JMF Tolerances	
Sieves, mm	Adjustments (plus or minus), percent
13	3
5	3
2.5	3
0.074	1
Binder Content	0.4

If adjustments are needed that exceed these limits, develop a new mix design. Tolerances given above may permit the aggregate grading to be outside the limits shown in Table 1; while not desirable, this is acceptable, except for the 0.074 mm sieve, which shall remain within the aggregate grading of Table 1.

2.5 RECYCLED HOT MIX ASPHALT

Recycled HMA shall consist of reclaimed asphalt pavement (RAP), coarse aggregate, fine aggregate, mineral filler, and asphalt cement to produce a consistent gradation and asphalt content and properties. When RAP is fed into the plant, the maximum RAP chunk size shall not exceed 50 mm. The amount of RAP shall not exceed 30 percent.

PART 3 EXECUTION

3.1 PREPARATION OF ASPHALT BINDER MATERIAL

Heat the asphalt cement material avoiding local overheating and providing a continuous supply of the asphalt material to the mixer at a uniform temperature. The temperature of unmodified asphalts shall be no more than 160 degrees C when added to the aggregates.

3.2 PREPARATION OF MINERAL AGGREGATE

Heat and dry the aggregate for the mixture prior to mixing. No damage shall occur to the aggregates due to the maximum temperature and rate of heating used. The temperature of the aggregate and mineral filler shall not exceed 175 degrees C when the asphalt cement is added. The temperature shall not be lower than is required to obtain complete coating and uniform distribution on the aggregate particles and to provide a mixture of satisfactory workability.

3.3 PREPARATION OF HOT-MIX ASPHALT MIXTURE

Accurately weigh or gauge the aggregates and the dry mineral filler and convey into the mixer in the proportionate amounts of each aggregate size

required to meet the job-mix formula. Introduce required amount of asphalt into the mixer at a temperature at which it can be applied uniformly to the aggregate but not to exceed 163 degrees C. In batch mixing, after the aggregates and mineral filler have been introduced into the mixer and mixed for not less than 15 seconds, add asphalt by spraying or other approved methods, and continue mixing for a period of not less than 20 seconds or as much longer as may be required to obtain a homogeneous mixture. The time required to add or spray the asphalt into the mixer will not be added to the total wet-mixing time provided this operation does not exceed 10 seconds and a homogeneous mixture is obtained. The additional mixing time, when required, will be as directed. The temperature of the mixture at the time of discharge shall not exceed 168 degrees C. The temperature of the aggregate and mineral filler in the mixer shall not exceed 177 degrees C when the asphalt is added. When the mixture is prepared in a twin-pugmill mixer, the volume of the aggregates, mineral filler, and asphalt shall not extend above the tips of the mixer blades when the blades are in a vertical position. Overheated and carbonized mixtures, or mixtures that foam or show indication of free moisture, will be rejected. When free moisture is detected in batch mix plant produced mixture, withdraw the aggregates in the hot bins immediately and return to the respective stockpiles.

3.4 PREPARATION OF THE UNDERLYING SURFACE

Immediately before placing the hot mix asphalt, clean the underlying course of dust and debris. Apply a [prime coat] [and/or] [tack coat] in accordance with the contract specifications.

3.4.1 Raising of Existing Manhole, Handhole, Valve Box and Catch Basin

If there are existing manhole, handhole, valve box and catch basins in existing asphalt concrete pavement to be overlaid, those shall be raised up to flush with the finished surface of new hot-mix asphalt pavement before new asphalt concrete is placed. Existing mortar leveling course under the manhole, handhole and valve box shall be replaced with new up to new level to provide a flush setting.

3.5 TESTING LABORATORY

Submit laboratory certification issued by the local prefectoral or central government (Japan Ministry of Land, Infrastructure, Transport and Tourism (MLIT)). Use a laboratory to develop the JMF. The Government will inspect the laboratory equipment and test procedures prior to the start of hot mix operations. The laboratory shall maintain a valid certification for the duration of the project. A statement signed by the manager of the laboratory stating that it meets these requirements or clearly listing all deficiencies shall be submitted to the Contracting Officer prior to the start of construction. The statement shall contain as a minimum:

- a. Qualifications of personnel; laboratory manager, supervising technician, and testing technicians.
- b. A listing of equipment to be used in developing the job mix.
- c. A copy of the laboratory's quality control system.

3.6 TRANSPORTING AND PLACING

3.6.1 Transporting

Transport the hot-mix asphalt from the mixing plant to the site in clean, tight vehicles. Schedule deliveries so that placing and compacting of mixture is uniform with minimum stopping and starting of the paver. Provide adequate artificial lighting for night placements. Hauling over freshly placed material will not be permitted until the material has been compacted as specified, and allowed to cool to 60 degrees C. To deliver mix to the paver, use a material transfer vehicle operated to produce continuous forward motion of the paver.

3.6.2 Placing

Place and compact the mix at a temperature suitable for obtaining density, surface smoothness, and other specified requirements. Upon arrival, place the mixture to the full width by an asphalt paver; it shall be struck off in a uniform layer of such depth that, when the work is completed, it will have the required thickness and conform to the grade and contour indicated. Regulate the speed of the paver to eliminate pulling and tearing of the asphalt mat. Unless otherwise permitted, placement of the mixture shall begin along the centerline of a crowned section or on the high side of areas with a one-way slope. Place the mixture in consecutive adjacent strips having a minimum width of 3 m. The longitudinal joint in one course shall offset the longitudinal joint in the course immediately below by at least 300 mm; however, the joint in the surface course shall be at the centerline of the pavement. Transverse joints in one course shall be offset by at least 3 m from transverse joints in the previous course. Transverse joints in adjacent lanes shall be offset a minimum of 3 m. On isolated areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impractical, the mixture may be spread and luted by hand tools.

3.7 COMPACTION OF MIXTURE

After placing, the mixture shall be thoroughly and uniformly compacted by rolling. Compact the surface as soon as possible without causing displacement, cracking or shoving. The sequence of rolling operations and the type of rollers used shall be at the discretion of the Contractor. The speed of the roller shall, at all times, be sufficiently slow to avoid displacement of the hot mixture and be effective in compaction. Any displacement occurring as a result of reversing the direction of the roller, or from any other cause, shall be corrected at once. Furnish sufficient rollers to handle the output of the plant. Continue rolling until the surface is of uniform texture, true to grade and cross section, and the required field density is obtained. To prevent adhesion of the mixture to the roller, keep the wheels properly moistened but excessive water will not be permitted. In areas not accessible to the roller, the mixture shall be thoroughly compacted with hand tampers. Any mixture that becomes loose and broken, mixed with dirt, contains check-cracking, or is in any way defective shall be removed full depth, replaced with fresh hot mixture and immediately compacted to conform to the surrounding area. This work shall be done at the Contractor's expense. Skin patching will not be allowed.

3.8 JOINTS

The formation of joints shall be performed ensuring a continuous bond

between the courses and to obtain the required density. All joints shall have the same texture as other sections of the course and meet the requirements for smoothness and grade.

3.8.1 Transverse Joints

Do not pass the roller over the unprotected end of the freshly laid mixture, except when necessary to form a transverse joint. When necessary to form a transverse joint, it shall be made by means of placing a bulkhead or by tapering the course. The tapered edge shall be cut back to its full depth and width on a straight line to expose a vertical face prior to placing material at the joint. Remove the cutback material from the project. In both methods, all contact surfaces shall be given a light tack coat of asphalt material before placing any fresh mixture against the joint.

3.8.2 Longitudinal Joints

Longitudinal joints which are irregular, damaged, uncompacted, cold (less than 80 degrees C at the time of placing adjacent lanes), or otherwise defective, shall be cut back a maximum of 75 mm from the top of the course with a cutting wheel to expose a clean, sound vertical surface for the full depth of the course. All cutback material shall be removed from the project. All contact surfaces shall be given a light tack coat of asphalt material prior to placing any fresh mixture against the joint. The Contractor will be allowed to use an alternate method if it can be demonstrated that density, smoothness, and texture can be met.

3.9 Finishing at Edge and Limit of Paving

Overlay of new hot-mix asphalt mixture shall be finished evenly in the same thickness indicated. Overlay shall be finished in gentle slope so that the edge of new overlaying pavement shall meet the edge elevation of existing asphalt concrete pavement. And where the drawing indicates "Limit of Paving," overlay shall be finished to provide a smooth transition to existing concrete pavement.

3.10 Compacted Earth Shoulder

Place and compact earth at edges of course for at least 30 cm of the shoulder.

3.11 QUALITY CONTROL

3.11.1 General Quality Control Requirements

Develop and submit an approved Quality Control Plan. Submit aggregate and QC test results. Do not produce hot-mix asphalt for payment until the quality control plan has been approved addressing all elements which affect the quality of the pavement including, but not limited to:

- a. Mix Design
- b. Aggregate Grading
- c. Quality of Materials
- d. Stockpile Management

- e. Proportioning
- f. Mixing and Transportation
- g. Mixture Volumetrics
- h. Moisture Content of Mixtures
- i. Placing and Finishing
- j. Joints
- k. Compaction
- l. Surface Smoothness

3.11.2 Testing Laboratory

Provide a fully equipped asphalt laboratory located at the plant or job site. Laboratory facilities shall be kept clean and all equipment maintained in proper working condition. The Contracting Officer shall be permitted unrestricted access to inspect the Contractor's laboratory facility, to witness quality control activities, and to perform any check testing desired. The Contracting Officer will advise the Contractor in writing of any noted deficiencies concerning the laboratory facility, equipment, supplies, or testing personnel and procedures. When the deficiencies are serious enough to adversely affect test results, the incorporation of the materials into the work shall be suspended immediately and will not be permitted to resume until the deficiencies are corrected.

3.11.3 Quality Control Testing

Perform all quality control tests applicable to these specifications in accordance with the testing criteria and frequency requirements as set forth in Chapter 6 of the JRA HAP - Handbook for Asphalt Pavement. Develop a Quality Control Testing Plan as part of a Quality Control Program. The testing program shall include, but shall not be limited to, tests for the control of asphalt content, aggregate gradation, temperatures, aggregate moisture, moisture in the asphalt mixture, laboratory air voids, stability (, flow , in-place density, grade and smoothness.

3.11.3.1 Additional Testing

Any additional testing, which the Contractor deems necessary to control the process, may be performed at the Contractor's option.

3.11.3.2 QC Monitoring

Submit all QC test results to the Contracting Officer on a daily basis as the tests are performed. The Contracting Officer reserves the right to monitor any of the Contractor's quality control testing and to perform duplicate testing as a check to the Contractor's quality control testing.

3.11.4 Sampling

When directed by the Contracting Officer, sample and test any material which appears inconsistent with similar material being produced, unless such material is voluntarily removed and replaced or deficiencies

corrected by the Contractor. All sampling shall be in accordance with standard procedures specified.

3.12 MATERIAL ACCEPTANCE

3.12.1 Grade

The final wearing surface of pavement shall conform to the elevations and cross sections shown and shall vary not more than 15 mm from the plan grade established and approved at site of work. Finished surfaces at juncture with other pavements shall coincide with finished surfaces of abutting pavements. Deviation from the plan elevation will not be permitted in areas of pavements where closer conformance with planned elevation is required for the proper functioning of drainage and other appurtenant structures involved. The grade will be determined by running lines of levels at intervals of 7.6 m, or less, longitudinally and transversely, to determine the elevation of the completed pavement surface. Within 5 working days, after the completion of a particular lot incorporating the final wearing surface, test the final wearing surface of the pavement for conformance with the specified plan grade. Diamond grinding may be used to remove high spots to meet grade requirements. Skin patching for correcting low areas or planing or milling for correcting high areas will not be permitted.

3.12.2 Surface Smoothness

Perform all testing in the presence of the Contracting Officer. Keep detailed notes of the results of the testing and furnish a copy to the Government immediately after each day's testing. Use the profilograph method for all longitudinal testing, except where the runs would be less than 60 m in length and the ends where the straightedge will be used.

3.12.2.1 Smoothness Requirements

3.12.2.1.1 Straightedge Testing

The finished surfaces of the pavements shall have no abrupt change of 6 mm or more, and all pavements shall be within the tolerances of 6 mm in both the longitudinal and transverse directions, when tested with an approved 3 m straightedge.

3.12.2.1.2 Profilograph Testing

The finished surfaces of the pavements shall have no abrupt change of 3 mm or more, and each 0.1 km segment of each pavement lot shall have a Profile Index not greater than 140 mm/km when tested with an approved Japanese construction practice using profilometer. If the extent of the pavement in either direction is less than 60 m, that direction shall be tested by the straightedge method and shall meet requirements specified above.

3.12.2.2 Testing Method

After the final rolling, but not later than 24 hours after placement, test the surface of the pavement in each entire lot in such a manner as to reveal all surface irregularities exceeding the tolerances specified above. Separate testing of individual sublots is not required. If any pavement areas are ground, these areas shall be retested immediately after grinding. Test each lot of the pavement in both a longitudinal and a transverse direction on parallel lines. Set the transverse lines 4.5 m or

less apart, as directed. The longitudinal lines shall be at the centerline of each paving lane for lanes less than 6.1 m wide and at the third points for lanes 6.1 m or wider. Also test other areas having obvious deviations. Longitudinal testing lines shall be continuous across all joints.

3.12.2.2.1 Straightedge Testing

Hold the straightedge in contact with the surface and move it ahead one-half the length of the straightedge for each successive measurement. Determine the amount of surface irregularity by placing the freestanding (unleveled) straightedge on the pavement surface and allowing it to rest upon the two highest spots covered by its length, and measuring the maximum gap between the straightedge and the pavement surface in the area between these two high points.

3.12.2.2.2 Profilograph Testing

Perform profilograph testing using approved equipment and procedures. The equipment shall utilize electronic recording and automatic computerized reduction of data to indicate "must-grind" bumps and the Profile Index for each 0.1 km segment of each pavement lot. Grade breaks on parking lots shall be accommodated by breaking the profile segment into shorter sections and repositioning the blanking band on each segment. The "blanking band" shall be 5 mm wide and the "bump template" shall span 25 mm with an offset of 7.5 mm. Compute the Profile Index for each pass of the profilograph in each 0.1 km segment. The Profile Index for each segment shall be the average of the Profile Indices for each pass in each segment. Furnish a copy of the reduced tapes to the Government at the end of each day's testing.

-- End of Section --