X. Appendix

Superpave (Gyratory Mix Design) Discussion

In 1987, the Strategic Highway Research Program (SHRP) began developing a new system for specifying asphaltic materials. The final product of the SHRP asphalt research program is a new system called Superpave, which is short for Superior Performing Asphalt Pavements. Superpave represents an improved system for specifying asphalt binders and mineral aggregates, developing HMA mixture design, and analyzing and establishing pavement performance prediction. The system was developed to provide the tools necessary to design HMA mixes that will perform better under heavy traffic and extreme temperatures. The goal is to provide pavements that are resistant to rutting, fatigue cracking, and low temperature cracking. The Superpave asphalt binder specification and mix design system include various test equipment, test methods, and criteria.

The unique feature of Superpave system is that it is a performance-based specification system. The tests and analyses have direct relationships to field performance. The Superpave asphalt binder tests measure physical properties that can be related directly to field performance by engineering principles.

Superpave mixes tend to be more coarse than conventional mixes. The coarse-graded Superpave designed mixtures with high coarse aggregate content do typically act differently than the fine-graded mixtures, and this must be considered during compaction. Coarse-graded mixtures often tend to cool more quickly, resulting in less time available for rolling. This may require that additional rollers be provided, and closer attention be paid to pavement compaction temperature.

It is important that the personnel working at the laydown site communicate with the plant personnel. If the mixture is acting differently underneath the rollers, then something may have changed at the plant. One of the most common changes in the plant-produced mixture is moisture content. A change in moisture content will have a significant effect on the handling and compaction characteristics of a Hot Mix Asphalt (HMA) mixture. Sometimes very small changes at the plant can cause significant changes during compaction. So, if the mixture appears to be acting differently, call the plant and see if something has changed.

The contractor must understand mixtures and their relationship to compaction. This understanding can be gained with experience, but only if one learns from the past mistakes and from procedures that have been successful.

Equipment should be selected specifically for a project. Different mixtures require different compaction techniques. A set of rollers and a rolling pattern that worked on one project may not be satisfactory for another project. This can be evaluated during construction of a test strip.

Rollers should generally stay close behind the paver. If the mix begins to shove when rolled, additional rolling with steel-wheel rollers will likely be detrimental. The shoving mixture can usually be rolled with a rubber-tire roller without detrimental movement. When modifiers are used in a mixture, rubber-tire rollers may tend to pick up the asphalt and thus may have to be removed from the project.

If the contact pressure is too low, it may be difficult or impossible to meet density requirements. The contact pressure can be increased in steel-wheel rollers by increasing the weight of the roller. The contact pressure can be increased in rubber-tired rollers by increasing the tire pressure and/or increasing the weight.

On some Superpave designed mixtures, a tender zone has been identified in temperature ranges of approximately 200-240 F. The mixture can be satisfactorily compacted above this range or below this range, but the mixture is tender within the temperature range and cannot be adequately compacted. This is not true for all mixtures, but it has been observed for some Superpave designed mixtures. The mix can often be satisfactorily rolled with rubber-tire rollers within this tender range but may experience pick-up problems when modifier binders are used.

When a mixture is being produced that is tender within the mid-temperature range, the preferred compaction method is to obtain density prior to cooling to the tender zone. This may require additional rollers, or in some cases, the mixture temperature may be increased slightly to provide more compaction time.

It has been suggested that tenderness at mid-range temperatures may be due to incomplete drying of the aggregate in the mix. Moisture trapped in the cracks and fissures of the stone is ultimately released by manipulation of the mix, causing the mix to become more fluid (tender). While this theory has not been conclusively proven, it does suggest that close attention be paid to the aggregate drying process. In addition, use of proper stockpiling and aggregate handling procedures will help minimize the potential for excess moisture in the mix.

Hot Mix Asphalt (HMA) Paving In Iowa – A Brief History

Historically, the state was the designer and inspector of hot mix asphalt mixes. The contractor's role back then was simple: to use a recipe given to them by the state, mix the materials in their plant and place it on the roadway. The Department of Transportation would do inspection and take samples of the mix for laboratory testing. The next day, or several days later, the results of the lab testing would indicate whether the mix met contract specifications. At that point in time, the roadway was already in place, leaving perhaps miles of deficient work.

Quality Management Asphalt (QMA):
During the 1980's and 1990's the construction industry and the Iowa Department of Transportation worked together to improve the quality of the HMA and the methods by which project testing was accomplished. In 1992, the Quality Management - Asphalt (QMA) program was implemented on all projects over 5000 tons. Quality Management changed the way that HMA pavements were designed and placed. Components of QMA are still in place today.

Under QMA, the contractor's personnel develop the mix design using aggregate that keeps them competitive (often local sources), and creating a mix they believe will be economical and long lasting. The mix design is then submitted to the DOT for acceptance. During construction, the contractor's personnel are responsible for process (quality) control testing (with random samples done several times daily). If something unusual is occurring to the mix, it can be monitored instantly, and changes can be made to ensure that poor quality mix does not get to the roadway. The morning test results are available to the quality control technician within hours of starting up the plant, giving the contractor information right away to affect the quality of mix being produced. Under this agreement, the contractor retains controls of their product and process. The contractor does random sampling on their materials and tests them multiple times each day. The agency receives split samples of the materials and tests them on a less frequent basis to verify the contractor's work. Verification is done by comparing the contractor's test results to the agency's test results (on the same sample) and assuring that it correlates. This quality assurance is an important check on the contractor's work. QMA looks at individual test results to determine if they are in specification, and sometimes looks at running average's (an average of the last 4 tests) to determine if the trend in the test data is good.

Under the old QMA system (1992-2010), contractors could incur penalties if their mix was not up to specification but could not earn incentive pay for laboratory test results that were very good.

Percent Within Limits (PWL):
Beginning with the October 2010 letting, the Iowa DOT implemented the new *Section 2303* of the *Standard Specifications*. This specification takes the next step beyond QMA and provides incentives to the contractor to produce HMA that is consistently within specification and on target.

To accomplish this, methods were developed to analyze the test data and determine the amount of material that complies with the specifications. The result of the analysis is called the "Percent Within Limits" or PWL. The previous QMA specification did not provide for incentive payments to the contractor for providing a superior quality product, only disincentives for poor quality. The PWL specification provides incentive payments for field voids up to a maximum of 4% and lab voids up to a maximum of 3%. The contractor can earn these bonuses by controlling the production and construction operations to provide a consistent mixture on target – and a mat compaction that is both consistent and thorough. The goal is to "make quality pay" for those contractors that provide the best product.

Both incentive and disincentive are based on equations that provide a more smooth and continuous payment schedule than the stepped price adjustment schedules used in the past. Field voids are analyzed daily, with eight core density values that are obtained each day. Lab voids require grouping of days or lots to obtain a minimum of eight test values before the PWL incentive/ disincentive pay factors will be calculated. It is important that a minimum of 8 test results are used, to ensure valid results from the statistical formulas involved in PWL. Less than 8 test results are not sufficient to perform a statistical analysis.

The HMA Plant Report Program and the Quality Control charting Program were modified from the existing QMA version to the new PWL version, to accumulate the needed test data and calculate the pay factors for the mix.

Average Absolute Deviation (AAD):
Average Absolute Deviation (AAD) is a statistical term meaning the average of the "deviation from target". It's a statistical average. When there are not 8 test results (as mentioned above) to conduct PWL analysis, an AAD analysis is done instead on mainline paving. This was part of the PWL program initiated in 2010. In 2012**,** the specification changed so that AAD is the method of analysis for all non-mainline paving, and mainline paving with less than 8 total test results. AAD allows the contractor to be penalized for poor results but does not provide incentive for superior results.

In Summary:
The industry continues to involve. The test results have not changed much in the last 30 years, but the method of analyzing test data and reporting requirements have changed significantly over the past 10 years. Technicians involved in Hot Mix Asphalt projects need to be familiar with PWL, AAD, control charts, reporting, specification compliance, etc., and the effect that these items will make to the contractor's operations and to contract administration.

The table on the following pages contains a comparison of Former (non-PWL) to Current (PWL) specification requirements. Its inclusion here is to illustrate both the differences and similarities resulting from the most recent evolution of the specification.

Comparison of Former (non-PWL) to Current (PWL) Specifications

Type	Former (non-PWL) Spec.	Current (PWL) Spec.
General	Contractor QC required for contracts with 5000 tons or more of HMA.	Contractor QC required for bid items with more than 1000 tons of HMA.
General	Class 1A, 1B and 1C compaction requiring 96%, 95% and 94% of lab density (G_{mb}) respectively.	Class 1 compaction requiring a minimum of 91.5% of maximum specific gravity (G_{mm}) for all mainline paving.
General	Average percent field air voids on cores shall not exceed 8.0%.	No maximum **average** field air voids. QI and PWL calculated for field voids based on 8.5% maximum and 3.5% minimum field voids limits.
General	Test strips required for intermediate and surface courses on Interstate highways and surface courses on Primary highways.	Test strips required same as non-PWL, with additional test strips optional for the contractor. 9.0% maximum field voids limit for test strips.
General	Test strips limited to 750 tons for lift thicknesses of 2 inches or less or 1000 tons for lifts greater than 2 inches.	Test strips limited to one half of a day's normal production.
General	No contractor testing plan required.	Contractor testing plan required prior to pre-con as per IM 511, Appendix D.
Sampling	7 cores required per lot.	8 cores required per lot.
Sampling	30 pounds minimum HMA sample.	40 pounds minimum HMA sample.
Sampling	Cold-feed aggregate samples directed and witnessed by the Engineer daily.	Cold-feed aggregate samples directed and witnessed by the Engineer on the first day only.
Sampling	Contractor must obtain samples within 15 minutes of being notified to sample.	Sampling must be initiated within 15 minutes and completed within 30 minutes of being notified to sample.

<table>
<tr><th>Type</th><th>Former (non-PWL) Spec.</th><th>Current (PWL) Spec.</th></tr>
<tr><td>Sampling</td><td>Loose HMA samples for lots of 2000 tons or greater will be obtained from sublots.

The first sublot will be 500 tons, with three additional sublots determined by dividing the remainder by three.

For lots less than 2000 tons, the first sublot will be 500 tons and the remaining sublots will be 750 tons each.</td><td>Equal sublots determined by dividing the estimated tonnage by the number of sublots in following table:
<table>
<tr><th>Estimated Tons (Mg)</th><th>No. of Sublots</th></tr>
<tr><td>101-500</td><td>1</td></tr>
<tr><td>501-1250</td><td>2</td></tr>
<tr><td>1251-2000</td><td>3</td></tr>
<tr><td>2001-4500</td><td>4</td></tr>
<tr><td>Over 4500</td><td>5</td></tr>
</table></td></tr>
<tr><td>Testing</td><td>Lab voids (P_a) shall be maintained within a tolerance of -0.5 to +1.0 from the target value.</td><td>Tolerances for lab voids (P_a) are ±1.0% from the target value.</td></tr>
<tr><td>Testing</td><td>Moving average of four tests used for lab voids acceptance. Shut-down required if moving average is outside the tolerances.</td><td>Weekly lots of lab voids used to calculate PWL if 8 tests or more are run. Weeks may be grouped to obtain 8 tests. AAD calculated for bid items with less than 8 lab voids tests. No shut-down required.</td></tr>
<tr><td>Testing</td><td>Validation of contractor’s cold-feed gradation by the District Lab is performed on split samples.</td><td>Validation of contractor’s cold-feed gradation by the District Lab is performed by comparing the contractor’s results to an ignition oven gradation.</td></tr>
<tr><td>Testing</td><td>No gradation correction factors required.</td><td>Correction factors determined on first day of production by comparing DOT gradation test results on a cold-feed sample to DOT gradation results on an ignition oven sample.</td></tr>
<tr><td>Payment</td><td>If lot average gradation is outside tolerances, price adjustment schedule is applied.</td><td>No price adjustment for gradation. Target change or JMF adjustment required if gradation is outside tolerances.</td></tr>
</table>

Type	Former (non-PWL) Spec.	Current (PWL) Spec.
Payment	If filler/bitumen ratio is outside the tolerances, price adjustment schedule is applied.	No price adjustment for filler/bitumen ratio. If filler/bitumen ratio is outside the tolerances, contractor must adjust to start production the next day.
Payment	If QI for field density cores is less than 0.00, 75% maximum pay or the Engineer may declare the lot or parts of the lot defective.	If PWL for field voids is less than 50%, 75% maximum pay or the Engineer may declare the lot or parts of the lot deficient or unacceptable.
Payment	Outliers for cores removed if 1.80 standard deviations or greater from the mean.	Outliers for cores removed if 1.80 standard deviations or greater from the mean (same as non-PWL).
Payment	No incentive paid for field density. Price adjustments based on 4-step QI pay schedule.	Incentive paid for field voids PWL greater than 95%, up to a maximum of 4%. Price adjustments based on equations.
Payment	No price adjustments or incentive paid for lab voids.	Incentive paid for lab voids PWL greater than 95%, up to a maximum of 3%. Price adjustments based on equations. If fewer than 8 lab voids results are available for a bid item, price adjustments based on AAD schedule with no incentive pay.
Payment	If the percent of asphalt binder in the mix is outside the tolerances, price adjustment schedule is applied.	No price adjustment for binder content. Contractor may adjust binder content as needed to achieve a uniform mix.
Payment	Test strips paid for same as rest of mix.	Special pay schedules for test strips.

Factors Influencing Compaction

Item	Effect	Corrections*
Aggregate		
Smooth Surfaces	Low interparticle friction	Use light rollers; lower mix temperature
Rough Surfaced	High interparticle friction	Use heavy rollers
Unsound	Breaks under steel-wheeled rollers	Use sound aggregate; use pneumatic rollers
Absorptive	Dries mix – difficult to compact	Increase asphalt in mix
Asphalt		
Viscosity		
– High	Particle movement restricted	Use heavy rollers; increase temperature
– Low	Particles move easily during compaction	Use light rollers; decrease temperature
Quantity		
– High	Unstable & plastic under roller	Decrease asphalt in mix
– Low	Reduced lubrication – difficult compaction	Increase asphalt in mix; use heavy rollers
Mix		
Excess Coarse Aggregate	Harsh mix – difficult to compact	Reduce coarse aggregate; use heavy rollers
Oversanded	Too workable – difficult to compact	Reduce sand in mix; use light rollers
Too Much Filler	Stiffens mix – difficult to compact	Reduce filler in mix; use heavy rollers
Too Little Filler	Low cohesion – mix may come apart	Increase filler in mix
Mix Temperature		
High	Difficult to compact – mix lacks cohesion	Decrease mixing temperature
Low	Difficult to compact – mix too stiff	Increase mixing temperature
Course Thickness		
Thick Lifts	Hold heat – more time to compact	Roll normally
Thin Lifts	Lose heat – less time to compact	Roll before mix cools; increase mix temperature
Weather Conditions		
Low Air Temperature	Cools mix rapidly	Roll before mix cools
Low Surface Temperature	Cools mix rapidly	Increase mix temperature
Wind	Cools mix – crusts surface	Increase lift thickness

* Corrections may be made on a trial basis at the plant or job site. Additional remedies may be derived from changes in mix design.

Mat Problem Trouble-Shooting Guide

Problem \ Causes	Fluctuating Head of Material	Feeder Screws Overloaded	Finisher Speed Too Fast	Too Much Lead Crown in Screed	Too Little Lead Crown in Screed	Overcorrecting Thickness Control Screws	Excessive Play in Screed Mechanical Connection	Screed Riding on Lift Cylinders	Screed Plates Worn Out or Warped	Screed Plates Not Tight	Cold Screed	Moldboard on Strikeoff Too Low	Running Hopper Empty Between Loads	Feeder Gates Set Incorrectly	Kicker Screws Worn Out or Mounted Incorrectly	Incorrect Nulling of Screed	Screed Starting Blocks Too Short	Screed Extensions Installed Incorrectly	Vibrators Running Too Slow	Grade Control Mounted Incorrectly	Grade Control Hunting (Sensitivity Too High)	Grade Control Wand Bouncing on Reference	Grade Reference Inadequate	Sitting Long Period Between Loads	Improper Joint Overlap	Improper Mat Thickness for Maximum Aggregate Size	Trucks Bumping Finisher	Truck Holding Brakes	Improper Base Preparation	Improper Rolling Operation	Reversing or Turning Too Fast of Rollers	Parking Roller on Hot Mat	Improper Mix Design (Aggregate)	Improper Mix Design (Asphalt)	Mix Segregation	Moisture in Mix	Variation of Mix Temperature	Cold Mix Temperature
Wavy Surface – Short Waves (Ripples)	✔	✔	✔				✔	✔		✔										✔	✔	✔	✔						✘	✘			✘	✘	✘	✘	✘	
Wavy Surface – Long Waves	✔	✔				✔	✔	✔					✔	✔						✔			✔	✔			✘	✘	✘		✘	✘			✘		✘	
Tearing of Mat – Full Width			✔						✔		✔															✘							✘	✘	✘	✘	✘	✘
Tearing of Mat – Center Streak					✔				✔		✔			✔	✔																							✘
Tearing of Mat – Outside Streaks				✔					✔		✔	✔		✔				✔																				✘
Mat Texture – Nonuniform	✔	✔	✔					✔	✔	✔	✔		✔					✔	✔					✔		✘			✘				✘	✘	✘		✘	✘
Screed Marks							✔																				✘	✘										
Screed Not Responding to Correction			✔				✔	✔		✔										✔						✘							✘	✘	✘		✘	✘
Auger Shadows		✔																																				
Poor Precompaction			✔					✔											✔							✘			✘									✘
Poor Longitudinal Joint	✔	✔				✔		✔												✔	✔	✔			✔					✘								✘
Poor Transverse Joint		✔					✔	✔		✔						✔	✔													✘								✘
Transverse Cracking (Checking)																													✘	✘			✘	✘		✘	✘	
Mat Shoving Under Roller																													✘	✘	✘		✘	✘		✘	✘	
Roller Marks																													✘	✘	✘	✘					✘	
Poor Mix Compaction																													✘	✘	✘	✘	✘	✘		✘	✘	✘

Procedure for Using Table
1. Find problem above.
2. Checks indicate causes related to the paver.
   X's indicate other problems to be investigated.

NOTE: Many times a problem can be caused by more than one item, therefore, it is important that each cause listed be eliminated to assure solving the problem.

Asphalt Terminology (Glossary)

Absorption
The property of an aggregate particle to take in and hold a fluid.
For our purposes, usually asphalt binder or water.

Aggregate
Any hard, inert, mineral material used for mixing in graduated fragments.
It includes sand, gravel, crushed stone, and slag.

Aggregate Storage Bins
Bins that store the necessary aggregate sizes and feed them to the dryer in substantially the same proportions as are required in the finished mix.

Air Voids
Internal spaces in a compacted mix surrounded by asphalt-coated particles, expressed as a percentage by volume of the total compacted mix.

Alligator Cracks
Interconnected cracks forming a series of small blocks resembling an alligator's skin, caused by excessive deflection of the surface over unstable subgrade or lower courses of the pavement.

Asphalt Binder
A dark brown to black cementitious material, which occurs in nature or is obtained in petroleum processing. Asphalt binder is classified according to the *Standard Specification for Performance Graded Asphalt Binder, AASHTO Designation MP1*. It is also commonly referred to as Asphalt Cement.

Asphalt Binder Content
A measurement (by weight) of the asphalt binder in the mix, usually expressed as a percentage.

Asphalt Cement – See **Asphalt Binder**

Asphalt Cement Concrete – See **Hot Mix Asphalt**

Asphalt Distributor
A truck or a trailer having an insulated tank, heating system and distribution system. The distributor applies asphalt to a surface at a uniform rate.

Asphalt Emulsion
An emulsion of asphalt binder and water that contains a small amount of an emulsifying agent. Emulsified asphalt droplets may be of either the anionic (negative charge), cationic (positive charge), or nonionic (neutral).

Asphalt Joint Sealer
An asphalt product used for sealing cracks and joints in pavements and other structures.

Asphalt (Flexible) Pavements
Pavements consisting of a surface course of asphalt concrete over supporting courses such as asphalt concrete bases, crushed stone, slag, gravel, Portland Cement Concrete (PCC), brick, or block pavement.

Asphalt Primer
Low viscosity asphalt (highly liquid) that penetrates into a non-bituminous surface upon application.

Average Absolute Deviation (AAD)
The absolute value of the difference of a test result from a specified value, averaged for a specified set of values.

Base Course
Lift(s) of HMA pavement placed on the subgrade or subbase on which successive layers are placed.

Batch Plant
This type of HMA production plant is used to produce individual batches of mix by making use of a pugmill (see *IM 508* for additional information).

Binder Course – See **Intermediate Course**

Bitumen – See **Asphalt Binder**

Bleeding or Flushing Asphalt
The upward migration of asphalt binder in an asphalt pavement, resulting in the formation of asphalt film on the surface.

Blow-Up
The localized buckling or upward movement of a PCC pavement caused primarily by excessive expansion.

Break and Seat
A fractured slab technique used in the rehabilitation of Reinforced Concrete Pavement (RCP) that minimizes slab action by fracturing the PCC layer into smaller segments. This reduction in slab length (and debonding from the reinforcement steel) minimizes reflective cracking in new HMA overlays.

Breaking
The phenomenon when asphalt and water separate in an asphalt emulsion beginning the curing process. The rate of breaking is controlled primarily by the emulsifying agent, and somewhat dependent on environmental conditions.

Certified Plant Inspection (CPI)
A specified method of quality control using a Certified Plant Inspector (see *Section 2521* of the *Standard Specifications* for additional information).

Coarse Aggregate
The aggregate particles retained on the #4 (4.75 mm) sieve.

Coarse-Graded Aggregate
A blend of aggregate particles having a continuous grading in sizes of particles from coarse through fine with a predominance of coarse sizes. A gradation below the maximum density line.

Cohesion
Bonding of aggregates by asphalt binder in HMA, increasing stability of the mixture.

Cold-Feed Gradation
The aggregate proportioning system employing calibrated bins to deliver aggregate to the dryer (see *IM 508* for additional information).

Cold In-Place Recycling (CIR)
A method of rehabilitating the HMA surface by milling, adding a stabilizing agent, relaying and compacting in a continuous operation (see *IM 504* for additional information).

Cold In-Place Recycling Train
A unit consisting of a large milling machine towing a screening/crushing plant and pugmill mixer for the addition of rejuvenating agent and production of cold mix base.

Compaction
The act of compressing a given volume of material into a smaller volume.

Consensus Properties
Aggregate characteristics that must follow certain criteria to satisfy a Superpave mix design. Specified test values for these properties are not source specific but widely agreed upon. They include Coarse Aggregate Angularity, Fine Aggregate Angularity, Flat or Elongated Particles, and Clay Content.

Consistency (Asphalt Binder)
The degree of fluidity of asphalt binder (cement) at any particular temperature. The consistency of asphalt binder varies with its temperature; therefore, it is necessary to use a common or standard temperature when comparing the consistency of one asphalt binder with another.

Corrugations (Washboarding) and Shoving
A type of pavement distortion, typically occurring on HMA layers that lack stability. Corrugation is a form of plastic deformation typified by ripples across the pavement surface. These distortions usually occur at points where traffic starts and stops, on hills where vehicles brake on the downgrade, on sharp curves, or where bumps cause vehicles to bounce up and down.

Crack
An approximately vertical random cleavage of the pavement caused by traffic loading, thermal stresses and/or aging of the binder.

Crack and Seat
A fractured slab technique used in the rehabilitation of PCC pavements, that minimizes slab action in a jointed concrete pavement by fracturing the PCC layer into smaller segments. This reduction in slab length minimizes reflective cracking in HMA overlays.

Crack-Relief Layer
An open-graded asphalt mixture placed over a distressed pavement that minimizes reflective cracking by absorbing the energy produced by movement in the underlying pavement.

Curing
The development of the mechanical properties of the asphalt binder. This occurs after the emulsion has broken and the emulsion particles coalesce and bond to the aggregate.

Cutback Asphalt
Liquid asphalt composed of asphalt binder and a petroleum solvent. Cutback asphalts have three types (Rapid Curing (RC), Medium Curing (MC), and Slow Curing (SC)). The petroleum solvent, also called diluents, can have high volatility (RC) to low volatility (SC).

Deep Strength Asphalt Pavement
Pavement containing at least four inches on HMA over non-stabilized base courses.

Deflection
A load-induced, downward movement of a pavement section.

Delivery Tolerances
Permissible variations from the exact desired proportions of aggregate and bituminous material as manufactured by an asphalt plant.

Dense-Graded Aggregate
An aggregate that has a particle size distribution such that when it is compacted, the resulting voids between the aggregate particles, expressed as a percentage of the total space occupied by the material, are less the 10%.

Densification
The act of increasing the density of a mixture during the compaction process.

Density
The unit weight or the weight of a specific volume of mix.

Design ESAL
The total number of equivalent 80-kN (18,000-lb.), single-axle load applications (equivalent single axle loads) expected throughout the design period.

Design Lane
The lane on which the greatest number of equivalent 80-kN (18,000-lb.) single axle loads (ESAL) is expected. This will normally be either lane of a two-lane roadway of the outside lane of a multi-lane highway.

Design Period
The number of years from the initial application of traffic until the first planned major resurfacing or overlay. This term should not be confused with pavement life or analysis period. Adding HMA overlays as required will extend pavement life indefinitely or until geometric considerations (or other factors) make the pavement obsolete.

Disintegration
The breaking up of a pavement into small, loose fragments caused by traffic or weathering.

Distortion
Any change of a pavement surface from its original shape.

Drum Mix (Continuous) Plant
This type of HMA production plant is a continuously operating plant, which mixes the aggregate, asphalt binder and RAP (if used) in the drum (See *IM 508* for additional information).

Dryer
An apparatus that will dry the aggregates and heat them to the specified temperatures.

Durability
The property of an asphalt paving mixture that describes its ability to resist the detrimental effects of air, water and temperature. Included under weathering are changes in the characteristics of asphalt, such as oxidation and volatilization, and changes in the pavement and aggregate due to the action of water, including freezing and thawing.

Edge Joint Cracks
The separation of the joint between the pavement and the shoulder, commonly caused by the alternate wetting and drying beneath the shoulder surface. Other causes are shoulder settlement, mix shrinkage, and trucks straddling the joint.

Effective Thickness
The ratio of the thickness of an existing pavement material compared to the equivalent thickness of a new HMA later.

Emulsified Asphalt
Composed of asphalt binder and water, and a small quantity of emulsifying agent, which is similar to detergent. They may be of either the Anionic, electro-negatively-charged asphalt globules, or Cationic, electro-positively-charged asphalt globules types, depending upon the emulsifying agent. Emulsified asphalt is produced in three grades (Rapid-Setting (RS), Medium-Setting (MS), and Slow-Setting (SS)).

Emulsifying Agent or Emulsifier
The chemical added to the water and asphalt that keeps the asphalt in stable suspension in the water. The emulsifier determines the charge of the emulsion and controls the breaking rate.

ESAL (Equivalent Single Axle Loads)
The effect on pavement performance of any combination of axle loads of varying magnitude equated to the number of 80-kN (18,000-lb.) single-axle loads that are required to produce an equivalent effect.

Fault
A difference in elevation of two slabs at a joint or crack.

Fatigue Resistance
The ability of asphalt pavement to withstand repeated flexing caused by the passage of wheel loads.

Field Density
The density ($G_{mb\ (field)}$) of HMA based on field roller compaction.

Field Voids
The percent by volume of air voids in cores cut from the finished pavement.

Fine Aggregate
Aggregate particles passing the #4 (4.75 mm) sieve.

Fine-Graded Aggregate
A blend of aggregate particles having a continuous grading in sizes of particles from coarse through fine with a predominance of fine sizes. A gradation above the maximum density line.

Flexibility
The ability of an asphalt paving mixture to be able to bend slightly, without cracking, and to conform to gradual settlements and movements of the base and subgrade.

Foamed Asphalt
A combination of high temperature asphalt binder and water to produce foaming.

Fog Seal
A light application of emulsion diluted with water that is applied without mineral aggregate cover.

Flux or Flux Oil
A thick, relatively nonvolatile fraction of petroleum, which may be used to soften asphalt binder to a desired consistency.

Fractured Slab Techniques
Processes used to rehabilitate PCC pavements by eliminating slab action through the reduction of slab size (Crack/Break and Seat) or the pulverization of the PCC slab (Rubblization) into essentially a granular base.

Full-Depth® Asphalt Pavement
The term Full-Depth® certifies that the pavement is one in which asphalt mixtures are employed for all courses above the prepared subgrade or subbase. A Full-Depth® asphalt pavement is laid directly on the prepared subgrade or subbase.

Gilsonite
A form of natural asphalt, hard and brittle, which is mined.

Gradation
The description given to the proportions of aggregate on a series of sieves. Usually defined in terms of the % passing successive sieve sizes.

Grade Depressions
Localized low areas of limited size.

Hot Mix Asphalt (HMA)
Asphalt binder/aggregate mixture produced at a batch or drum-mixing facility that must be spread and compacted while at an elevated temperature. To dry the aggregate and obtain sufficient fluidity of the binder, both must be heated prior to mixing – giving origin to the term “hot mix.”

Hot Mix Asphalt (HMA) Overlay
One or more lifts of HMA constructed on an existing pavement. The overlay may include a leveling course or scarification to correct the contour of the old pavement, followed by uniform course or courses to provide needed thickness.

Impermeability
The resistance an asphalt pavement has to the passage of air and water into or through the pavement.

Intermediate Course
An HMA pavement course between a base course and a surface course.

Job Mix Formula (JMF)
The JMF is the mix design used to begin a HMA project. It is also used as the basis for the control of plant produced mixture. It sets the proportions of the aggregate and amount of asphalt binder.

Kinematic Viscosity
A measure of the viscosity of asphalt, measured in centistokes, conducted at a temperature of 135ºC (275ºF).

Lab Density
The density ($G_{mb\ (lab)}$) of HMA based on laboratory compaction.

Lab Voids
The percent by volume of air voids in laboratory compacted specimens.

Lane Joint Cracks
Longitudinal separations along the seam between two paving lanes.

Leveling Course
A course of hot mix asphalt of variable thickness used to eliminate irregularities in the contour of an existing surface prior to placing the subsequent course.

Lift
A layer or course of paving material applied to a base or a previous layer.

Lime
A product used to enhance the bond between aggregate and asphalt binder. It is composed of dust from crushed limestone. Hydrated lime is often specified for surface mixes.

Load Equivalency Factor
The number of 80-kN (18,000-lb.) single-axle load applications (ESAL) contributed by one passage of an axle.

Longitudinal Crack
A vertical crack in the pavement that follows a course approximately parallel to the centerline.

Maintenance Mix
A mixture of asphalt emulsion and mineral aggregate for use in relatively small areas to patch holes, depressions, and distressed areas in existing pavements. Appropriate hand or mechanical methods are used in placing and compacting the mix.

Manufactured Sand
The predominately minus #4 (4.75 mm) material produced from crushing ledge rock or gravel.

Mechanical Spreaders
Spreader boxes that are mounted on wheels. The spreaders are attached to and pushed by dump trucks (HMA boxes are pulled and chip spreaders are pushed).

Medium-Curing (MC) Asphalt
Cutback asphalt composed of asphalt cement and a diluent of medium volatility.

Mesh
The square opening of a sieve.

Microsurfacing
A mixture of polymer modified asphalt emulsion, crushed dense graded aggregate, mineral filler, additives, and water. It provides a resurfacing of 10 to 20 mm (3/8 to 3/4 inch) to the pavement.

Milling Machine
A self-propelled unit having a cutting head equipped with carbide-tipped tools for the pulverization and removal of layers of asphalt materials from pavements.

Mineral Dust
The portion of the fine aggregate passing the 0.075 mm (No. 200) sieve.

Mineral Filler
A finely divided mineral product at least 70 percent of which will pass a #200 (75 μm) sieve. Pulverized limestone is the most commonly manufactured filler, although other stone dust, hydrated lime, Portland cement, fly ash and certain natural deposits of finely divided mineral matter are also used.

Mixed-In-Place (Road Mix)
An HMA course produced by mixing mineral aggregate and cutback or emulsified asphalt at the road site by means of travel plants, motor graders, or special road-mixing equipment.

Modified Binder
These are asphalt binders, which have been physically- and/or chemically-altered (usually with an additive) to bring the characteristics of the binder to what is desired for the application. This process includes polymer modification.

Natural (Native) Asphalt
Asphalt occurring in nature, which has been derived from petroleum through natural processes of evaporation of volatile fractions, leaving the asphalt fractions. The native asphalt of most importance is found in the Trinidad and Bermudez Lake deposits. Asphalt from these sources is often called lake asphalt.

Natural Sand
A loose, granular material found in natural deposits.

Nondestructive Testing (NDT)
In the context of pavement evaluation, NDT is deflection testing, without destruction to the pavement, to determine a pavement's response to pavement loading.

Open-Graded Aggregate
A blend of aggregate particles containing little or no fine aggregate and mineral filler and the void spaces in the compacted aggregate are relatively large

Overlay
The placement of hot asphalt over existing asphalt bound with a tack coat. Otherwise referred to as Resurfacing.

Pay Factor
A calculated multiplier used to determine adjustments to payment to the contractor. Pay factors greater than 1.000 are referred to as “incentive” and pay factors less than 1.000 are referred to as “disincentive” or “penalties”

Pavement Structure
The entire pavement system of selected materials from subgrade to the surface.

Percent Within Limits (PWL)
A statistical estimation of the percentage of a material that falls between specified limits based on sampling and testing of the material. PWL is used to calculate the pay factor.

Performance Graded Asphalt (PG)
The identification associated with the grading of the binder. Prior identification methods have been penetration and viscosity grading. For example, a PG 64-22 would indicate a performance-graded binder with a high temperature confidence of 64°C and a low temperature confidence of -22°C.

Permeability
The resistance that an asphalt pavement has to the passage of air and water into or through the pavement.

Planned Stage Construction
A construction process where stages of the project are performed sequentially according to design and a predetermined time schedule.

Plant Screens
Screens located between the dryer and hot bins, which separate heated aggregates into proper hot bin sizes.

Plant (Cold) Mix
A mixture, produced in an asphalt mixing facility that consists of mineral aggregate uniformly coated with asphalt binder, emulsified asphalt, or cutback asphalt.

Pneumatic-Tire Roller
A compactor with a number of tires spaced so their tracks overlap delivering a kneading type of compaction.

Polished Aggregate
Aggregate particles in a pavement surface that have been worn smooth by traffic.

Polymer-Modified Asphalt Binder
Conventional asphalt cement to which one or more polymer compounds have been added to improve resistance to deformation at high pavement temperatures and often cracking resistance at low temperatures.

Potholes
Bowl-shaped openings in the pavement resulting from localized disintegration.

Power Sweeper
A power operated rotary broom used to clean loose material from the pavement surface.

Present Serviceability
The ability of a specific section of pavement to serve its intended use in its existing condition.

Prime Coat
An application of asphalt primer to an absorbent surface. It is used to prepare an untreated base for an asphalt surface. The prime penetrates or is mixed into the surface of the base and plugs the voids, hardens the top and helps bind it to the overlying asphalt course.

Pumping
Slab deflection under passing loads sometimes resulting in the discharge of water and subgrade soils along joints, cracks, and pavement edges.

Quality Management of Asphalt (QMA)
A specified quality control procedure where the contractor is responsible for the mix design and the control of the mix properties during production (see *IM 511* for additional information). The agency is responsible for quality assurance and verification.

Rapid-Curing (RC) Asphalt
Cutback asphalt composed of asphalt cement and a naphtha or gasoline-type diluent of high volatility.

Raveling
The progressive separation of aggregate particles in a pavement from the surface downward or from the edges inward.

Reclaiming Machine
A self-propelled unit having a transverse cutting and mixing head inside a closed chamber, for the pulverization and mixing of existing pavement materials with asphalt emulsion. Asphalt emulsion (and mixing water) may be added directly through the machine by a liquid additive system and spray bar.

Recycled Asphalt Mix
A mixture produced after processing existing asphalt pavement materials. The recycled mix may be produced by hot or cold mixing at a plant, or by processing the materials cold and in-place.

Recycled Asphalt Pavement (RAP)
HMA removed and processed, generally by milling. This material may be stored and used in mixtures in addition to virgin aggregate and binder. This is also referred to as Reclaimed Asphalt Pavement.

Recycled Asphalt Shingles (RAS)
Roofing shingles, either waste from a shingle manufacturer or tear off shingles from reroofing operations. Shingles contain a high percentage of asphalt as well as fibers and fine aggregate. Shingles are processed into a fine material and handled similar to RAP.

Reflection Cracks
Cracks in asphalt overlays (usually over deteriorated PCC pavements) that reflect the crack or joint pattern in the pavement structure below it.

Residue
The asphalt binder that remains from an asphalt emulsion after the emulsifying agent has broken and cured, or the remains of a cutback after the volatiles have cured.

Resilient Modulus of Elasticity
A laboratory measurement of the behavior of pavement materials to characterize their stiffness and resiliency. A confined or unconfined test specimen (core or recompacted) is repeatedly loaded and unloaded at a prescribed rate. The resilient modulus is a function of load duration, load frequency, and number of loading cycles.

Roadway
All facilities on which motor vehicles are intended to travel, such as Interstate highways, secondary roads, and city streets.

Rubblization
The pulverization of a Portland cement concrete pavement into smaller particles, reducing the existing pavement layer to a sound, structural base that will be compatible with subsequent asphalt overlay.

Rutting (Channeling)
Channeled depressions that sometimes develop in the wheel paths of an asphalt pavement, usually due to extreme temperatures combined with high wheel loads.

Sand
Fine aggregate (any fraction below a No. 8 sieve), resulting from natural disintegration and abrasion or processing of rock.

Sand Asphalt
A mixture of sand and asphalt binder, cutback, or emulsified asphalt. It may be prepared with or without special control of aggregate grading and may or may not contain mineral filler. Either mixed-in-place or plant-mix construction may be employed.

Saw-Cut and Seal
A method of controlling reflective cracking in HMA overlays that involves construction of joints in the new overlay exactly over the joints in the existing pavement.

Scaling
The peeling away or disintegrating of the surface of Portland cement concrete.

Seal Coat
A thin asphalt surface treatment used to waterproof and improve the texture of an asphalt wearing surface. Depending on the purpose, seal coats may or may not be covered with aggregate. The main types of seal coats are aggregate seals, fog seals, emulsion slurry seals and sand seals.

Self-Propelled Spreaders
Spreaders having their own power units and two hoppers. The spreader pulls the truck as it dumps its load into the receiving hopper. Conveyor belts move the aggregate forward to the spreading hopper.

Sheet Asphalt
A hot mixture of binder with clean angular, graded sand and mineral filler.

Shoving
A form of plastic movement resulting in localized bulging of the pavement.

Shrinkage Cracks
Interconnected cracks forming a series of large blocks, usually with sharp corners or angles.

Sieve
An apparatus for laboratory work in which the openings in the mesh are square for separating sizes of material.

Skid Hazard
Any condition that might contribute to the reduction of friction forces on the pavement surface.

Skid Resistance
The ability of a paved surface, particularly when wet, to resist to tire slipping or skidding. Proper asphalt content and aggregate with a rough surface texture are the greatest contributors. The aggregate must also resist polishing.

Slag
A nonmetallic byproduct, consisting essentially of silicates and aluminosilicates of lime and of other bases that develops simultaneously with iron in a blast furnace, during steel production.

Slippage Cracks
Crescent-shaped cracks resulting from traffic-induced horizontal forces that are open in the direction of the thrust of wheels of the pavement surface. They result when severe or repeated shear stresses are applied to the surface and there is a lack of bond between the surface layer and the course beneath.

Slurry Seal
A mixture of emulsified asphalt, fine aggregate, and mineral filler, with water added to produce flowing consistency.

Soil/Cement Base
A hardened material formed by curing a mechanically mixed and compacted mixture of pulverized soil, Portland cement and water used as a layer in a pavement system to reinforce and protect the subgrade.

Solubility
A measure of the purity of asphalt binder (cement). The ability of the portion of the asphalt binder that is soluble to be dissolved in a specified solvent.

Source Properties
Aggregate characteristics that must follow certain criteria to satisfy a Superpave mix design. They include Toughness, Soundness, and Deleterious Materials.

Spalling
The breaking or chipping of a PCC pavement at joints, cracks, or edges, usually resulting in fragments with featheredges.

Specific Gravity
The weight to volume relationship of material in relation to water.

Stability
The ability of asphalt paving mixtures to resist deformation from imposed loads. Unstable pavements are marked by channeling (ruts), and corrugations (washboarding). Stability is dependent upon both internal friction and cohesion.

Stationary Plants
Asphalt plants that are so constructed that moving them is not considered economically feasible.

Steel-Wheel Static Rollers
Tandem or three-wheel rollers with cylindrical steel rolls that apply their weight directly to the pavement.

Steel-Wheel Vibratory Rollers
A compactor having single or double cylindrical steel rolls that applies compactive effort with weight and vibration. The amount of compactive force is adjusted by changing the frequency and amplitude of vibration.

Structural Overlay
An HMA overlay constructed for the purpose of increasing the structural value and ride quality of the pavement system.

Subbase
The course in the asphalt pavement structure immediately below the base course.

Subgrade
The soil prepared to support a pavement structure or a pavement system. It is the foundation of the pavement structure.

Subgrade, Improved
Subgrade that has been improved as a working platform by the incorporation of granular materials or stabilizers such as asphalt, lime, or Portland cement into the subgrade soil.

Superpave
Short for "Superior Performing Asphalt Pavement", a pavement-based system for selecting and specifying asphalt binders and for designing asphalt mixtures.

Superpave Gyratory Compactor
A device used during Superpave mix design or quality control activities for compacting samples of hot mix asphalt into specimens used for volumetric analysis. Continuous densification of the specimen is measured during the compaction process.

Superpave Mix Design
An asphalt mixture design system that integrates the selection of materials (asphalt, aggregate) and volumetric proportioning with the project's climate and design traffic.

Surface Course
The top lift(s) of HMA pavement, sometimes called asphalt wearing course.

Surface Treatments
A broad term embracing several types of asphalt or asphalt-aggregate applications, usually less than 1 in. (25 mm) thick, to a road surface. The types range from a light application of emulsified or cutback asphalt (Fog seal) to a single or multiple surface layers made up of alternating applications of asphalt and aggregate (chip seal).

Tack Coat
A very light application of asphalt, usually asphalt emulsion diluted with water. It is used to ensure a bond between the existing pavement surface and the overlay.

Transverse Crack
A crack that follows a course approximately at right angles to the centerline.

Travel Plants
Self-propelled pugmill plants that proportion and mix aggregates and asphalt as they move along the road.

Truck Factor
The number of ESALs contributed by one passage of a vehicle. Truck Factors can apply to vehicles of a single type or class or to a group of vehicles of different types.

Upheaval
The localized upward displacement of a pavement, due to swelling of the subgrade or some portion of the pavement structure.

Viscosity
A measure of a liquid's resistance to flow with respect to time. The higher the viscosity, the greater the resistance to flow.

Voids in the Mineral Aggregate (VMA)
Void spaces that exist between the aggregate particles in the compacted mix, including spaces filled with asphalt binder. It represents the space available to accommodate effective volume of asphalt binder and air voids in the compacted mix.

Warm Mix Asphalt (WMA)
A group of technologies which allow a reduction in the temperatures at which asphalt mixtures are produced and placed. The most common technologies are foaming, organic (wax) additives and chemical (emulsions), all of which act to reduce viscosity and increase workability of asphalt binder at a given temperature. WMA is fundamentally the same as HMA.

Well-Graded Aggregate
Aggregate that is uniformly graded from coarse to fine.
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Wet Mixing Period
The interval of time between the beginning of application of asphalt materials into a pugmill and the opening of the discharge gate.

Workability
The ease with which paving mixtures may be placed and compacted.

HMA Paving Field Inspection Checklist

Duty	Frequency	Specification / Resource	Commentary
Prior to HMA Placement			
Check material certifications	As needed	Materials IMs	Check for accuracy and timeliness of required certification submittals. Do not allow incorporation of materials without required certifications.
Check proof rolling of subgrade	Everywhere, prior to final subgrade trimming. (when applicable)	Specification 2109.03, A, 10 Specification 2115.03, B, 2 Modified Subbase	All subgrades should be proof rolled with a sheep's foot roller no more than 1 week prior to trimming of the final grade. In addition, when Modified Subbase is used, the subgrade is to be proof rolled with a loaded truck to identify soft spots, etc.
Check trimmed subgrade	10/mile (when applicable)	Specification 2109.03, A, 10 (plus or minus 0.05 foot) IM 204	Check to ensure subgrade is trimmed to the proper cross slope and elevation. Usual check is by placing string across subgrade from stringline to stringline and measuring down to top of subgrade. When stringline is not available, a survey rod and level may be used. Laser levels have been used but are less common. GPS rovers have also been used, but are not accurate enough to measure within the specification tolerances.
Check trimmed subbase (modified)	10/mile (when applicable)	Modified Subbase Specification 2115.03 (plus 0 and minus 0.05 foot) IM 204 Appendix C	Check to ensure subbase is trimmed to the proper cross slope and elevation. This, along with the subgrade checks, will ensure proper subbase thickness. Usually checked by placing string across subbase from stringline to stringline and measuring down to top of subbase. When stringline is not available, a level may be used. Laser levels have been used but are less common. The width of the subbase should also be checked at this time to ensure that the proper placement width is being achieved.
Check slab fracturing of existing PCC pavement	Periodically (when applicable)	Specification section 2216 Specification section 2217	<u>Cracking and Seating</u>: Use test section to ensure process used to fracture PCC slab results in specified crack spacing and consistency. Rolling must be adequate to ensure contact/support by underlying base without damage to aggregate interlock. <u>Rubblization</u>: Ensure equipment and process used to fracture pavement results in uniform and appropriate size fragments, based on visual inspection of surface. Verify multiple passes with a vibratory roller to compact and seat the fragments, as well as remove distortion prior to HMA overlay.
Check pavement scarification	Periodically	Specification section 2214	Verify equipment to be used is wide enough and suitable for the method of operation. Check that the scarification is to the specified depth, and results in a cross-section that is true within the specification tolerance. Ensure that all millings are removed and stored / stockpiled in compliance with contract documents.
Sampling & Testing RAP	First Day + One per week	Specification 2318.02 IM 204 App. K	Determine frequency / timing of random sampling; Take 10 lb. sample & test to determine maximum RAP size. Ensure top size does not exceed 50% of the depth of the compacted recycled mat.
Sampling CIR stabilizing agent (foamed asphalt)	One per day (First day + one per week to District lab)	Specification 2318.03, I, 2 IM 204 App. K Form 820193	Determine frequency / timing of random sampling. Take 1 qt. sample (or direct & witness sampling by contractor) & deliver to DME lab for verification testing (maintain agency custody) or, Identify (Form 820193) and secure samples for transportation by others.

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HMA Paving Field Inspection Checklist

Duty	Frequency	Specification / Resource	Commentary
Sampling CIR stabilizing agent (standard emulsion)	One per day (First day + one per week to District lab)	Specification 2318.03, I, 2 IM 204 App. K IM 360 Form 820193	Determine frequency / timing of random sampling. Take 1 qt. sample in a plastic bottle (or direct & witness sampling by contractor) & deliver to DME lab for verification testing (maintain agency custody) or, Identify (Form 820193) and secure samples for transportation by others.
Sampling uncompacted CIR mixture	One per lot	Specification 2318.03, I, 6 IM 204 App. K IM 504 Form 820193	Determine frequency / timing & location of random sampling. Take 40 lb. sample in a sealed container (or direct & witness contractor sampling) & deliver to DME lab for verification testing (maintain agency custody) or, Identify (Form 820193) and secure samples for transportation by others.
Direct & witness moisture & density testing on compacted CIR layer	10 per lot	Specification 2318.03, I, 6 IM 204 App. K IM 504	Determine & layout moisture and density test random locations. Direct & witness contractor performing nuclear gauge moisture & density testing within 24 hours of completing each lot. Recompact sublots that do not achieve minimum required density.
Check preparation of existing surface	Periodically + prior to HMA overlay	Specification 2212.03, B, 1 Specification 2303.03, C, 2	Check repair/patching of existing base pavement is as required by specification, plans or as otherwise directed by Engineer. Prior to HMA resurfacing, ensure that the base pavement is free from all foreign materials & debris.
Check / Inspect contractor's equipment (general)	Daily, or as needed	Specification 1107.08 Specification Section 2001	Before use on project, ensure that equipment to be used is of the type & size (and has required features) necessary to meet the specifications and perform the work intended; While in use, be sure that the equipment is properly operated and maintained to insure the safety of workers, inspectors and traveling public.
Check / Inspect haul trucks	Initial use & as needed	Specifications 2001.01 & 2001.03	Haul trucks must have tight metal or metal-lined bodies. Haul trucks must be equipped with a tarp, but are not typically required to be used between May 15 & October 1. Truck bodies are to be kept clean by heating, scraping, or use of approved release agents. Check trucks for fluid leaks and remove from service if necessary.
Check for proper use of release agents	Daily, or as needed	Specification 2001.01, D IM 491.15	Approved release agents are listed in IM 491.15. Diesel fuel, distillates or solvents are not acceptable release agents. Trucks found to have used improper release agents shall be removed from service and allowed to drain for a minimum of 5 hours before subsequent use hauling HMA. Do not allow cleaning solutions to be carried on a paver while in operation.
Check / Observe loading of HMA haul trucks at plant	Periodically	Specification 2303.03, C, 3, d	Check for signs of overheated mix (blue smoke). Check for clumps of cold mix remaining from previous load. Check mixing time and mix appearance for proper coating of aggregate. Check for proper and uniform mix temperature. Check that multiple drops of mix from the silo are used to minimize segregation (roll-down) of mix in trucks.
Check existing pavement surface temperature	Daily, before start-up	Specification 2303.03, C, 4	HMA shall not be placed when temperature of the shaded portion of road is less than shown in specification. Minimum temperature is based on thickness and location of lift to be placed. The Engineer may further limit placement if other conditions exist that would be detrimental to quality work.

HMA Paving Field Inspection Checklist

Duty	Frequency	Specification / Resource	Commentary
Check stringline	Daily, or as needed	Specification 2303.03, C, 4, f	Check for proper placement of stringline to identify centerline, guide paver and maintain alignment. Stringline should be held in place by nails; Additional nails, at reduced spacing, should be used to produce a smooth transition (reduce the "chord" effect) through horizontal curves. Check and correct edge alignment irregularities immediately, to minimize mismatched joints and other resulting problems.
Check for approval and proper use of MTV	Prior to initial use on project, and then periodically while in use	Construction Manual section 8.80	Before material transfer vehicles (MTVs) may be used on a DOT project, approvals must be obtained from the Office of Design and Office of Bridges & Structures. Conditions on approval must be observed, and MTV use monitored by inspector. If cracking or distress in the underlying pavement occurs, the equipment must be removed from the project and appropriate repairs made at the contractor's expense.
Check / Inspect tack distributor	Once each distributor	Specification 2001.12	Check that distributor is equipped with an accurate thermometer, burner & means of circulating the material, as well as manufacturer's instructions for use. Check that distributor has either been calibrated, or has a valid annual certification of calibration. Check for fluid leaks.
Check / Inspect HMA paver	Once each paver, and when modifications made	Specification 2001.19 Specification 2303.03, B, 2	Check that paver is of type and size capable of placing and initially compacting an HMA mixture. Check that paver is equipped with well-matched screed sections, with vibration along its entire length (including extensions). Ensure that paver is equipped with automatic screed controls to regulate thickness and crown, along with grade and slope control system and approved grade referencing system.
Check / Inspect HMA rollers	Once each roller, and when modifications made	Specification 2001.05 Specification 2303.03, B, 3	Steel Drum: Ensure proper drum size, equipped with properly operating water system and scraper bars. Vibratory: Should be operating at high frequency / low amplitude (can verify frequency of vibration using a Reed tachometer, if desired), with both drums vibrating similarly. Pneumatic: Tire size and tire (contact) pressures as specified. Check all rollers for fluid leaks.
Check tack coat application for uniformity, coverage & curing	Daily	Specification 2303.03, C, 2, b	Check that tack coat application coverage is uniform. Make sure that all spray nozzles are functioning, and providing a fan-shaped spray with uniform overlap. The tack application is properly cured when it feels "tacky" vs. slick underfoot, and its appearance changes from a brownish cast to black.
Check tack coat application rate (yield)	Daily, or as needed	Specification 2303.03, C, 2, b	Compare daily quantity available from Plant Report or Plant Monitor with area covered with tack coat to verify the application rate is within specification range.
Check for wet or damp existing pavement surface	As conditions warrant	Specification 2303.03, C, 4	HMA paving should not start if wet conditions exist, or rainfall is imminent. If paving is underway and rainfall begins, paving must stop. Paving may resume provided pavement is dry, tack coat is undamaged, and delivered HMA is of sufficient temperature.

HMA Paving Field Inspection Checklist

Duty	Frequency	Specification / Resource	Commentary
During HMA Placement			
Collect individual HMA load tickets	Periodically	Specification 2001.07, B	Ensure that all HMA load tickets are accounted for, and periodically check actual mix quantities (vs. plans) to guard against unexpected project over-runs.
Check HMA placement operation (general)	Periodically	Specification 2303.03, C, 3, d Specification 2303.03, C, 4	HMA should be supplied to the paver in a uniform and continuous manner, resulting in a minimal number of paver stoppages. HMA placement operation shall produce a mat with uniform temperature and composition, minimizing segregation to the extent that it is not visibly observed in the compacted surface.
Check / Observe unloading of truck into paver hopper	Periodically	Specification 2303.03, C, 3, d	Check for signs of overheated mix (blue smoke). Check for clumps of cold mix remaining from previous loads. Ensure proper dumping procedures used to keep mix flowing as a mass, to minimize coarse aggregate roll-down (segregation).
Check / Observe proper placement of mix into windrow	Periodically	Specification 2303.03, C, 3, d	Check that windrow is centered in lane to be placed. Check for uniformity of windrow size & shape. Check for excessive mix drop heights, leading to coarse aggregate segregation at base of windrow. Check for clumps of cold mix near end of loads. Ensure that haul trucks are not allowed to drive over (compact) existing windrow.
Check for uniform material flow through paver	Periodically	Specification 2303.03, C, 3, d	Restrictions to uniform flow of mix will result in segregation. Non-uniform head of material at the screed will result in waves in the mat, as well as variations in density. Check for uniform head of material in the paver hopper (typically 25 to 75% full), through the flow gates, along length of augers, and ahead of the screed.
Check temperature of uncompacted mat behind paver	Every two hours, or as needed	Specification 2303.03, C, 3, d	Check that temperature of mat is above applicable specification minimum for the location and thickness of lift being placed. Consistent mat temperatures are needed to ensure uniform compaction and resulting density.
Check / Observe uncompacted mat quality behind paver	Periodically	Specification 2303.03, C, 3, d	Check for non-uniform appearance (streaking, coarse / open texture, screed marks). Check for evidence of leaking fluids from equipment and take immediate action to remove equipment from operation if discovered.
Check / Observe loose (uncompacted) lift depth checks	Periodically	Specification 2303.03, C, 4	Ensure that the HMA mixture is spread at a depth such that, when compacted, will result in the required thickness. More frequent checks should be made on the first lift over an uneven surface, and following an adjustment to the screed. After adjusting screed, allow time for the screed to level out (approx. 5X tow arm length) before making subsequent checks.
Check / Observe HMA compaction (roller) operation	Periodically	Specification 2303.03, C, 5	Check for proper equipment and procedures. Check for consistent mat temperature & rolling pattern (with special attention to Class II compaction areas); Check surface for roller marks, mix pick-up, waves in mat, and possible segregation.
Check mat width & cross-slope	Periodically, and when plan width or cross-slope changes	Project plans	Periodically check both the uncompacted and compacted mat width and adjust, as necessary, to account for "roll out". More frequent checks should be made when the plan width changes. Checks of mat cross-slope should be made periodically, with additional emphasis in transition areas of super-elevated curves.

HMA Paving Field Inspection Checklist

Duty	Frequency	Specification / Resource	Commentary
Check longitudinal joints	Periodically	Specification 2303.03, C, 6	Check for proper overlap (typically 1" within 1/2" tolerance) and procedures used for longitudinal joint construction. Pavement edges should be carefully aligned and loose lift thickness set to result in well-matched centerline joint. Check for adequate mix at end of screed to reduce potential for segregation and mismatched joint.
Check longitudinal pavement runouts	As needed	Specification 2303.03, C, 6 Project plans	Check for proper runout at structures, existing pavement, and at end of day headers. For a transverse construction joint open to traffic, the runout is 10 ft. in length per inch of lift thickness. For permanent runouts, the length is shown on the plans, based on posted speed and overlay thickness. Check that runout design fits existing conditions.
Check transverse joints	As needed	Specification 2303.03, C, 6	Ensure header is sawed in straight line at right angles to provide a full depth vertical edge to match at joint. Check transverse joint off header at start-up for smoothness, using a 10 ft. straight edge. Corrections may be required before continued paving.
Check mix quantities & yields	Every two hours recommended	Project plans	Comparison should be made between the tons of HMA delivered/placed and the plan quantity (tons) of HMA calculated for a given area of pavement. Typically, the quantity placed will be within 5% of the quantity calculated using the plan rate.
Direct & witness sampling of asphalt binder	Daily	Specification 2303.03, D, 3, b, 1 IM 204 App. F IM 323 Form 820193	Direct & witness random sampling procedures by contractor personnel. Take possession of sample & deliver to field lab for testing (maintain agency custody) or, Identify (Form 820193) and secure samples for transportation by others.
Direct & witness sampling of aggregates (cold-feed)	First day	Specification 2303.03, D, 3, b, 2 IM 204 App. F IM 301 Form 820193	Direct & witness random sampling procedures by contractor personnel. Take possession of sample & deliver to field lab for testing (maintain agency custody) or, Identify (Form 820193) and secure samples for transportation by others.
Direct & witness sampling of loose / uncompacted mix (hot box)	One per sublot (up to 5 per day)	Specification 2303.03, D, 5, b IM 204 App. F IM 322 Form 820193	Determine frequency / timing of random sampling & notify contractor. Direct & witness sampling procedures by contractor personnel. Take possession of sample & deliver to field lab for testing (maintain agency custody) or, Identify (Form 820193) and secure samples for transportation by others.
Direct & witness sampling of compacted mix (field density cores)	Daily (min. 8 cores per lot)	Specification 2303.03, D, 4, a IM 204 App. F IM 320 Construction Manual Section 8.13 Form 820193	Determine & layout density core random locations. Direct & witness core drilling. Measure & inspect cores for defects & proper dimensions. Take possession of cores & deliver to field lab for testing (maintain agency custody) or, Identify (Form 820193) and secure samples for transportation by others.
Perform testing on compacted field density cores	Daily (min. 8 cores per lot)	Specification 2303.03, D, 5, c IM 204 App. F IMs 321 and 337	Following contractor preparation (cutting / trimming) of the core samples for testing, the cores are measured and tested (weighed) by inspection personnel to determine field density. Results should be agreed to by inspection and contractor personnel to avoid disputes later.

HMA Paving Field Inspection Checklist

Duty	Frequency	Specification / Resource	Commentary
After HMA Placement			
Check for Safety Edge or temporary granular fillet at pavement edge	Each time (prior to removing traffic control)	Specification 2305.03, A Specification 2121.03, C, 4, b	Safety Edge or temporary granular fillet is required to mitigate dropoff at pavement edge prior to moving traffic control and opening an adjacent lane to traffic.
Check completed pavement section visually for uniformity	Daily, or as needed	Construction Manual Section 2.53 Form 830245 Construction Manual App. 2-34(K)	Daily visual examination of mat surface is recommended to detect mix segregation as soon as possible, allowing timely changes in equipment or procedures to be made in order to minimize future occurrences. If segregation is suspected, the inspector should inform his supervisor and the contractor. A Noncompliance Notice (Form 830245) and subsequent price adjustment may follow, if warranted.
Check milled rumble strip placement	Periodically	Road Standards PV-12 and PV-13 Specification Section 2548	Milled rumble strips may be placed on the shoulder or centerline of the roadway. They are placed in the compacted HMA after mat has sufficiently cooled to resist tearing. Rumble strip placement should be checked to ensure proper spacing, depth, and location requirements are being met.
Check fog seal application coverage, uniformity & rate	Periodically	Specification 2548.03, C Specification 2308.03, D	Ensure that asphalt emulsion is not placed on a wet or damp surface. The fog seal application must uniformly cover the entire milled rumble strip, at the rate specified.
Review initial contractor smoothness information	Daily, until 3 consecutive days of 100% pay or better	Specification 2317 Specification 2316 IM 341	The contractor is required to submit smoothness information daily until they have paved for three consecutive days resulting in 100% payment or better. There are several reasons for this requirement. First is to identify if there are equipment or process issues causing placement problems in the paving operation. It is not desirable to allow the contractor to continue paving if acceptable smoothness levels are not being achieved. This requirement also may identify problems in the contractor's smoothness evaluation. It also gives inspection staff the opportunity to review the contractor's profilograph settings to make sure they are correct.
Review final contractor smoothness information	After submittal of final profilograph reports and traces	Specification 2317 Specification 2316 IM 341	The contractor is required to submit all final profilograph reports and traces to the Engineer within 14 days after completion of paving. After receipt of all final reports and traces, the information should be reviewed to ensure that all sections of pavement have been evaluated. In addition, the smoothness information should be evaluated to determine if the incentive or disincentive requested by the contractor is accurate.

HMA Paving Field Inspection Checklist

Duty	Frequency	Specification / Resource	Commentary
General			
Check for contractor compliance with Public Convenience and Safety requirements	Daily	Specification 1107.08	Check for compliance with on-the-road and off-the-road times (30 minutes after sunrise & 30 minutes before sunset, unless state otherwise in contract documents). Check that contractor operates equipment and performs their operations in a manner that provides safety for workers and traveling public.
Check traffic control	When approaching or travelling within work zone	Specification Section 2528 Project plans	Even though traffic control checks are a responsibility of the contractor, if problems or deficiencies are observed, inform the contractor when the observations are made so that corrections can be made in a timely manner. Specific areas to observe include traffic control, work zone length, flaggers, signing and pilot car operation.
Check contractor's traffic control daily diary	As needed	Specification 2528.1, C	The contractor is required to check traffic control and record significant information. It is a good practice to review the contractor's diary occasionally to ensure that documentation is being recorded as required. For instance, after noting damaged signing or deficiencies in the traffic control devices or setup, review the daily diary to ensure the deficiencies and the remedies are recorded.
Monitor the project for fugitive dust	Daily	Specification 1107.07, E	The contractor is responsible for controlling fugitive dust on the project. When dust is being generated and leaving the project site, the contractor should be reminded of their responsibility to control dust and a request should be made to take measures to do so. In urban areas, it is even more critical that dust be controlled as property owners will be more sensitive to dust generated by the project.
Monitor contractor haul roads	Daily	Construction Manual 2.12	The contractor is required to submit a request for haul road designation for roads used to haul materials for the project. Once designated as a haul route, the contractor is expected to use the haul route for the designated purpose. The contractor's operations should be observed daily to ensure that haul traffic is using the appropriate, approved haul routes.
Check for compliance with winter shutdown requirements	When applicable	Specification 2121.03, C Specification 2214.03, D Specification 2303.03, C, 6 Specification 2318.03, J Specification 2527.03	Ensure that following requirements are met prior to end of season on projects with winter shutdown period: Granular shoulder brought up to edge of pavement at design slope and width; All scarified surfaces covered with at least one full HMA lift; Headers shall be located across from each other; Temporary runouts shall be located adjacent to each other and be 25 feet in length per inch of lift thickness; Cold in-place recycled surfaces shall be covered with at least one full lift of HMA; All pavement markings completed (including edge lines and symbols).
Issue Noncompliance Notice	As required	Construction Manual Section 3.21 Form 830245	The owner is obligated to notify the contractor in writing when noncompliance occurs. This is done using Form 830245. Noncompliance Notices should be issued as quickly as practical after observation of the noncompliance to give the contractor ample time to take corrective action. The Noncompliance Notice also provides a written record of notification being provided to the contractor.