Chapter 400
Asphalt - 24

This chapter is not part of the Project specifications but is a guide for project personnel in interpreting CDOT specifications, understanding ASTM, AASHTO, and Colorado test procedures, and for completing CDOT forms.

Bituminous Mixtures & Binders

Bituminous materials are used by CDOT for a variety of purposes. The bituminous material (normally referred to as asphalt cement or binder) may be combined with aggregate to bind the aggregate together and thus form a durable pavement. Binder may also be sprayed on a surface to protect the surface. Binders at room temperature are too viscous (stiff) to mix with aggregate or to be sprayed. Mixing is achieved by reducing viscosity by one of three approaches: Hot Mix Asphalt (HMA) is produced by heating the binder, to reduce viscosity, then combining the hot binder with hot, dry aggregate. Until 2004 HMA was referred to as HBP or Hot Bituminous Pavement by CDOT. Colorado changed to be consistent with the current national terminology. A second method for lowering viscosity to improve mixing involves combining binder, water and emulsifier to produce an emulsion. In the third approach, asphalt cement is combined with solvent to produce lower viscosity material called cutback asphalt. Cutback can be readily mixed with aggregate. Heating, emulsification, or solvents may also be used to facilitate spraying of a binder.

HMA

Of the three mixing approaches, HMA provides the strongest and most durable pavements. Combining hot asphalt cement with hot dry aggregate provides the strongest bond between the binder and aggregate. However, drying the aggregate plus heating the aggregate and binder requires considerable energy. In addition, the HMA must be transported, placed and compacted before it becomes too cool for proper compaction.

Emulsions

Emulsions can be stored and used at lower temperatures than binder for use in HMA. Emulsions can also be used with wet, cool aggregate. These emulsion properties allow energy savings and more flexibility in application.

Cutbacks

Cutbacks contain solvents, which could be used for fuel, petrochemicals, or more effective uses of a non-renewable resource. A more serious problem with cutbacks is that the solvents can be absorbed through the skin or may be breathed after evaporation. Many solvents used in cutbacks present health hazards and some solvents are highly flammable and thus are a fire hazard. Solvents in cutbacks also contribute to air pollution and the formation of ozone. Health, safety, and environmental regulations have eliminated almost all use of cutbacks for highway construction by CDOT.

ITEM 403 - HOT MIX ASPHALT

Superpave - The Strategic Highway Research Program (SHRP) was established by Congress in 1987 as a five-year research program to improve the performance and durability of U.S. roads and to make those roads safer for both motorists and highway workers. $50 million of the SHRP research funds were used for the development of performance-based asphalt specifications that directly relate laboratory analysis with field performance.

Superpave (Superior Performing Asphalt Pavements) is a product of the SHRP asphalt research. The Superpave system represents an improved system for specifying asphalt binders, mineral aggregates, developing asphalt mix designs, analyzing, and establishing pavement performance prediction. The Superpave binder specifications and mix design system include various test equipment, test methods, and materials criteria.

Superpave is a performance-based system. The tests and analysis have direct relationships to field performance.

ITEM 403 - SUPERPAVE MIX DESIGN

One outcome of the SHRP research was the development of the Superpave gyratory compactor (SGC). The SGC compacts mixtures in a 100mm mold, at an exterior angle of 1.25°, which has been determined to better simulate field compaction.

Mixes that are designed with the SGC consider the amount of traffic the roadway is expected to experience throughout its design life. Binder selection is based on climate, traffic loading, and traffic flow. The asphalt content that yields 4% air voids at the design number of gyration, N_{design}, becomes the target asphalt content.

An excellent discussion of the Superpave mix design can be found in the Asphalt Institute Manual SP-2, *Superpave Mix Design*. When using the 0.45 Power-Chart, CDOT defines the maximum density gradation line as a straight line passing from the origin to one sieve size larger than the nominal maximum aggregate size.

ITEM 411 - PERFORMANCE GRADED BINDERS (PG BINDERS)

Asphalt cements under the Superpave system are called binders because the intent of the specifications was to address both modified and unmodified asphalt cements. Binders must meet the same criteria, but the temperature at which they meet the criteria is related to the climate in the project area. For instance, using the Superpave specifications binders can be chosen to address low temperature cracking in the high mountains, or rut resistance in the eastern plains. Binder test values would be the same, but the test temperature would differ to reflect the different project climates. For example, a performance graded binder designation PG 58-28 means that the binder will meet the high service temperature requirements (rutting) up to a pavement temperature of 58°C and that the binder will meet the low temperature requirements (cracking) down to a pavement service temperature of -28°C.
The recommended pavement service temperatures for all Colorado weather stations can be found in CDOT's Pavement Design Manual along with instructions for the selection of PG binders.

Some of the tests and equipment in the Superpave system are as follows:

Dynamic Shear Rheometer (DSR) - Used to measure rut resistance properties at high pavement service temperatures, and fatigue cracking properties at intermediate service temperatures.

Bending Beam Rheometer (BBR) - Used to measure binder properties at low temperatures to determine if a binder has the required properties for resistance to thermal cracking.

Direct Tension Device (DTD) - Used to measure binder strength at low temperatures to determine resistance to low temperature cracking.

Rolling Thin Film Oven (RTFO) - Used to simulate the aging, which occurs to the asphalt binder in the mixing plant. Most of the rut resistance measurements are made on the binder in this condition.

Pressure Aging Vessel (PAV) - Used to age asphalt binder in the lab to simulate the aging, which takes place in the pavement after 5 to 7 years. Most of the measurements to determine fatigue and thermal cracking resistance are made on samples following this aging procedure.

An excellent discussion of the background and testing of PG binders is found in the Asphalt Institute Manual SP-1, *Superpave Asphalt Binder Specification*.

ITEM 403 - HOT MIX ASPHALT

European Rutting Machines

Rutting and stripping data from project produced mixes is being gathered to identify good and poor performing mixes, as well as to develop specifications to help determine and produce better performing mixes for Colorado.

Two different pieces of equipment are being used in the Central Laboratory to measure rutting potential, the Hamburg Wheel-Tracking Device and the French Rutting Tester. The Hamburg Device also provides a severe test for stripping. As reflected in the Schedule for Sampling and Testing (Item 403), the choice of which rut tester to use is determined by the Region Materials Engineer.

The following are descriptions of the two rutting devices.

Hamburg Wheel-Tracking Device (HWTD)

The Hamburg Wheel-Tracking Device was obtained following the European Tour in 1990 by CDOT and has been used in a large quantity of research concerning stripping by CDOT. The HWTD was manufactured by Helmut-Wind Inc. of Hamburg Germany and is a very severe test for stripping and rutting of an asphalt mix.

A pair of samples (lab compacted slabs or field cores of 10" diameter) are tested simultaneously. The slabs/cores are submerged under water with the temperature varying from 45° to 55°C (113° to 131°F) depending on the PG binder. A steel wheel, 47 mm (1.85 in) wide, loads the samples with 705 N (158 lbs) and then makes 50 passes over each sample per minute. The maximum velocity of the wheel is 340 mm/sec (1.1 ft/sec) in the center of the sample. Each sample is loaded for 10,000 passes or until 15 mm of deformation occurs. Approximately 3 1/2 hours are required for a test.

The results from the HWTD include the creep slope, stripping slope, and the stripping inflection point. The creep slope relates to rutting from plastic flow. It is the inverse of the rate of deformation in the linear region of the deformation curve, after post compaction effects have ended and before the onset of stripping. The stripping slope is the inverse of the rate of deformation in the linear region of the deformation curve, after stripping begins and until the end of the test. It is the number of passes required to create a 1 mm impression from stripping and is related to moisture damage. The stripping inflection point is the number of passes at the intersection of the creep slope and the stripping slope. It is also related to moisture damage.

The CDOT specification is a maximum impression of 4 mm after 10,000 passes. The Figure 400-1 shows a plot of a Hamburg sample.

French Rutting Tester (FRT)

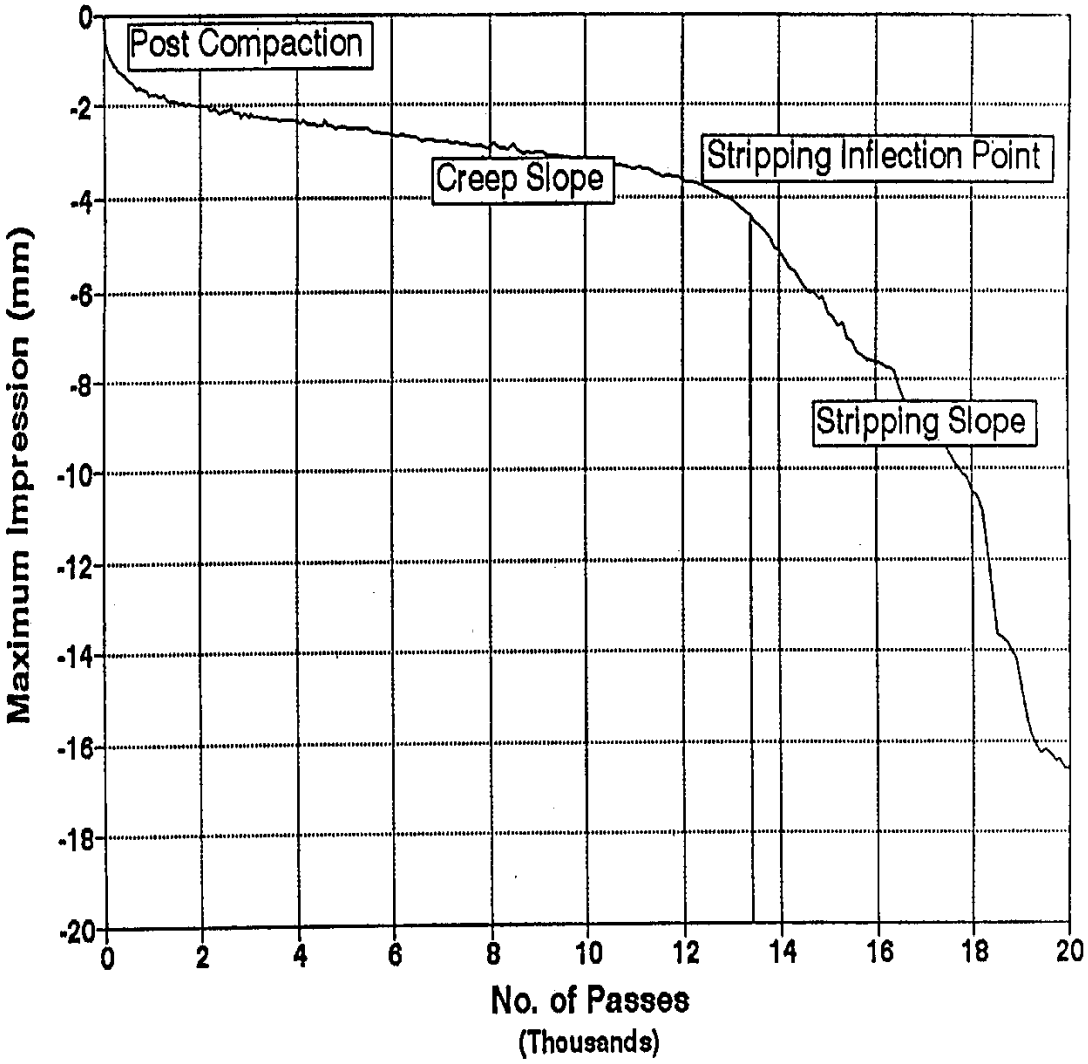
The French Rutting Tester was also obtained following the European Tour in 1990 and has been used extensively to predict rutting. The research on 33 pavements with known rutting performance has shown that this equipment is excellent at predicting rutting from plastic flow. The FRT test slabs 500 mm by 180 mm (19.7 x 7.1 inches), which can be 20 to 100 mm thick (0.8 to 3.9 inches).

Two slabs can be tested simultaneously. The slabs are loaded by a pneumatic tire inflated to 87 psi (0.6 Mpa). The tire loads the sample at 1 cycle per second (one cycle is two passes).

The entire chamber is heated to a temperature range between 113° to 140°F (45° to 60°C), depending on the PG binder.

FRT tests can be made on lab compacted slabs, or field slabs of 8" x 20" cut from the roadway. The rut depth is calculated as the difference between the original slab height and the slab height after testing is completed. It is reported in millimeters. The CDOT specification is less than 5 mm rutting in 10,000 cycles.

The FRT has been shown to be a very good predictor of rut susceptibility from plastic flow when the test temperature is adjusted to the conditions found in the project area.



Definition of the Hamburg Wheel-Tracking Results.

FIGURE 400-1

Asphalt Mixture Performance Test (AMPT)

A Pooled Fund Study Launched in 2008 by the FHWA offered the State Agencies the opportunity to obtain and therefore train on using the AMPT which is used to evaluate Superpave mixtures. The AMPT was developed to specifically perform three types of tests.

1. Dynamic Modulus
2. Repeated Load Test
3. Creep Test: (Measures flow time and flow number used to evaluate rutting and fatigue cracking.)

Reference Material:

- AASHTO TP 79
- AASHTO PP 60
- AASHTO PP 61

Report:
Dynamic Modulus: $E^* = \frac{\text{Peak Stress}}{\text{Peak Strain}}$
Phase Angle: The time lag between stress and strain.

ITEM 411 - ASPHALT MATERIALS

Acceptance Procedure for Asphalt Cements / Performance Graded Asphalt Binders, Liquid Asphalt Materials, Emulsified Asphalts, and Asphalt Rejuvenating Agents. Wherever the word Asphalt Cements is used, it is construed to mean either, Asphalt Cements or Performance Graded Asphalt Binders.

It is the responsibility of project personnel to set up a predetermined random sampling schedule. All samples, whether QA or IA, are to be submitted to the Central Laboratory and accompanied by the appropriate form.

Note: All sample containers must be properly labeled (CDOT Form 634) with the following:

Contract ID
Field Sheet #
Sample ID
Material Type
Lot #
Material Code
Can #
Lab Ref. #

Asphalt and binder acceptance/verification (QA) samples shall be taken at the contractor's plant.

Samples of these materials will normally be taken by the Contractor’s personnel in the presence of the CDOT project personnel or their designated agent for acceptance/verification.

Note: Reference to Independent Assurance sampling and testing has been deleted.

Samples shall be taken from the pipeline(s) through which the material is flowing by insertion of a sampling device or other similar efficient method immediately prior or before discharge into the HMA final mixing area or apparatus. The sampling device should be conveniently located for sampling access by contractor's project personnel. See AASHTO T 40 for additional information about sampling of AC type material. Note: The sampling device would normally be located in the line from the storage tank to the HMA plant mixing area.

Random Sampling and the Lot System

Statistical methods are employed to evaluate quality assurance of materials because it is impractical, if not impossible, to test all the materials incorporated into a highway project. To meet the requirements of the CDOT statistical acceptance procedure the following method will be utilized:

Normally, samples 1 through 5 will be designated Lot No. 1, samples 6 through 10 will be designated Lot No. 2, samples 11 through 15 will be designated Lot No. 3, etc. At the discretion of the Project Engineer, a lot may be assigned as stated in the "Establishing Lots and Process Control on the Project" in the Appendix Chapter and also they may refer to the CP 75, Stratified Random Sampling of Materials, and the section "Sampling and Testing Definitions."

In the Central Laboratory a sample from each lot will be randomly selected to represent that lot. If the tested sample conforms to specification requirements, the lot is acceptable. If the tested sample fails to meet specification requirements, then the other samples of that lot will be tested.

The test results for the lot will then be analyzed by the Project Engineer for acceptance at full contract price, price reduction, or rejection according to Subsection 105.03 of the Standard Specifications.

Do not use the price reduction formulas shown in Subsection 105.03 of the Standard Specifications on metric projects unless the specific metric notation is included.

Reporting Project Acceptance/Verification Samples for <u>Undiluted</u> Emulsion

Under this program, the field tester will continue to collect a COC for the material delivered to the project and file it in the project files. The tester will fill in the pertinent field data on CDOT Form 411, PG Binder/Emulsion Submittal Form.

Asphalt Emulsion Overview

Binder and water do not normally mix well. Even if thoroughly mixed, the droplets of binder quickly recombine (coalesce) to become separate from the water. The mixture of binder and water are made more permanent by using an emulsifier to suspend the binder droplets within the water. The emulsifier bonds to the surface of the binder droplets, causing them to repel each other and thus not coalesce.

Emulsions are manufactured to yield a viscosity low enough for the emulsion to disperse throughout an aggregate or be sprayed on a surface. After application, the emulsion sets or breaks as the asphalt droplets coalesce, the water evaporates, and the binder coats the aggregate or sprayed surface. Time required for the emulsion to break is influenced by many factors including emulsion characteristics, temperature, humidity, aggregate gradation, and aggregate surface properties.

Emulsion Production

Emulsions are produced by mixing binder with water containing an emulsifier in a colloid mill. The mill contains a moving rotor and a stationary stator separated by a small gap. The mill creates small droplets of binder, kept separate by the emulsifier, and dispersed in the water. This process is augmented by heating both the binder and the water. In some cases, the water is heated above boiling, requiring the process to take place under pressure. Additional additives may be added during the process to modify the properties of the emulsion, or the residual binder left after curing. Polymers and adhesion promoters are added to improve the performance of the residual binder. For example, polymers improve binder properties such as cohesion, resistance to cracking at low temperatures, and resistance to flow at high temperatures. Thickeners and several other chemicals may be added to improve the properties of the emulsion. For the most part, these chemicals stabilize emulsion viscosity or reduce settlement.

TABLE 400-1

COMPARISON OF EMULSION PROPERTIES		
Property	**Anionic Emulsion**	**Cationic Emulsion**
Breaking Time	Long	Short
Adhesion of Deposited Bitumen	Bad, except on calcareous aggregates	Excellent on all aggregates
Condition of Aggregate	Must be dry	Must be wet

Emulsion Testing

Testing of emulsions serves several purposes. Some of the tests such as charge and reactivity are used to classify emulsions. Classification allows the user to choose the right emulsion for the intended application. Other tests ensure that the storage and handling of the emulsion will not be a problem. Still other tests evaluate performance related properties of the emulsion. Some of these performance related test results are also used in classification. Tests can be conducted on the emulsion or on the binder that remains when the water is removed. The common tests conducted on emulsions used by CDOT are the following:

1. Particle Charge

Emulsions are classified as anionic (negatively charged) or cationic (positively charged) depending on the charge of the particles surrounding the binder droplets. Particle charge is determined by inserting electrodes into the emulsion, applying a current, and noting which electrode is coated by binder. Emulsion charge can influence how the emulsion residue coats aggregate of certain mineral composition.

2. Reactivity

Emulsions are classified as rapid-setting, medium-setting, or slow-setting based on how quickly they set or break. Rapid-setting emulsions set quickly when applied to clean, relatively large aggregate, such as chips used in chip seals. Medium-setting emulsions set more slowly when applied to clean relatively large aggregate. Medium-setting emulsions can be mixed with aggregates low in fines such as open-graded mixes. Slow-setting emulsions set slowly when combined with aggregates containing substantial amounts of fines. These emulsions can be used to produce cold mixes using uniformly graded aggregates similar to those used in HMA.

Reactivity can be measured in several ways. The emulsion can be mixed with standard aggregates and the amount of coating determined. Coalescence when exposed to fine quartz sand or cement also indicates reactivity. In another reactivity test, solutions that cause emulsions to break are added in increments. The amount of solution required to cause coalescence or breaking indicates reactivity and is called “demulsibility”.

3. Sieve Test

The sieve test determines if there are large particles in the emulsion, which could clog spray nozzles. The amount of binder retained on the No. 20 sieve is determined. The maximum allowed amount is normally 0.1%.

4. Storage Stability

If the density of the binder droplets is different from the water density, the droplets will tend to float to the top or settle to the bottom (more typical). If this is excessive, the non-uniformity can cause construction problems. Glass cylinders are filled with emulsion and allowed to sit for 24 hours. Samples are obtained from the top and bottom of the cylinder and the residue percentage compared to the percentage for the entire cylinder. The percentage of binder residue for the top and bottom cannot vary from the overall by more than 1%.

5. Emulsion Viscosity

The viscosity of the emulsion affects handling and use. The emulsion must be pumpable and flow easily through pipes. It must also coat aggregate effectively, without being too thick to coat or so thin that it runs off too quickly.

Emulsion viscosity is measured by determining the time required for flow of the emulsion out of a cup with a standard opening. The test is called Saybolt Furol. The temperature for this test is determined by the class of emulsion and relates to the temperature of typical use of a given class.

Examination of Emulsion Residue

The percentage and properties of the residue remaining when the water is removed from the emulsion are critical to performance. There must be an adequate amount of binder with the correct physical properties for the emulsion to perform well. The water may be removed by evaporation or by distillation. CDOT determines the percent residue and obtains residue for testing by evaporation. If the emulsion fails any test, this process is repeated using distillation for water removal. The CDOT approach parallels the AASHTO standards, which allow evaporation for acceptance only.

Penetration is determined for binder residue of all emulsions. Ductility is determined for binder residue of all non-polymerized emulsions. Toughness and tenacity are usually determined for polymerized cationic emulsions. The float test is conducted only on high float emulsions. For polymerized, high-float emulsions, the ductility and elastic recovery are determined.

1. Binder Content

The emulsion must have an adequate amount of residual binder remaining after the water evaporates. This residue does the job, the water is just a carrier, which evaporates or runs off. Normally, minimum binder residue is 57% for slow-setting emulsions and 65% for both rapid-setting and medium-setting emulsions.

2. Penetration

The penetration test is a measure of the consistency of binder. This test measures the depth of penetration of a standard, loaded needle in a fixed time. Stiff binders have a lower penetration because the needle penetrates less.

3. Solubility in Trichloroethylene

Solubility in trichloroethylene is a measure of the purity of the binder. The soluble portion of the binder provides the cementing properties. The insoluble portion is composed of salts, free carbon, or minerals, which do not help in binding. In this test, the binder is dissolved in trichloroethylene and filtering separates the soluble and insoluble portions.

4. **Ductility**

Ductility is a measure of the ability of a binder to be extended into a fine thread. A standard sized briquette is extended under controlled conditions until the thread breaks. The elongation when the thread breaks is the ductility. Binders with inadequate ductility are too brittle and result in mixtures that are more susceptible to cracking, raveling, or poor bonding.

5. Elastic Recovery

Elastic recovery is a test used by CDOT (CP-L 2211) to measure the elasticity of the residue for polymerized, anionic emulsions. The Methods A and B prescribe elongating the specimen to specified lengths, and at a specified rate. The sample is then cut either immediately, or after five minutes, and allowed to recover for a one-hour period. Percent of elongation recovered by this contraction is the elastic recovery. Failure of this test indicates the polymer is ineffective.

6. Toughness & Tenacity

The toughness and tenacity test is used by CDOT (CP-L 2210) to measure stretching properties imparted to the residue of cationic emulsion by polymers. A tension head is lowered into a heated sample of the binder and the combination is cooled in a water bath to a standard temperature. The head is then pulled upward until the binder forms a long, thin thread, which finally breaks. The areas under two portions of the stress-strain curve are used to calculate the toughness and tenacity. Failure of this test indicates the polymer is ineffective.

7. Float Test

The float test measures the ability of a binder to resist softening at a high temperature (60ºC). In this test, a hole in a small test "boat" is plugged with the binder being tested. The boat is floated on a hot water bath causing the plug of asphalt to soften, allowing entry of water, which sinks the boat. The time in seconds, required for the boat to sink, is the float test result. High float emulsions must have a minimum float time of 1200 seconds (20 minutes).

Classification Nomenclature for Emulsions

The series of letters and numbers used to classify emulsions contain a wealth of information about the properties of the emulsion. These properties determine the appropriate use for each emulsion.

For example, consider the emulsions classified as:

a - "CSS-1h"
b - "HFMS-2sP"

- **a** - **C** in this location would indicate a cationic emulsion. All cationic emulsions start with a "C", if there is not a "C", the emulsion is anionic or non-ionic.
- **b - HF** indicates the float properties of the emulsion. All high float emulsions must pass the float test. No letter C in this location would indicate that this is not a cationic emulsion; hence b above is an anionic emulsion.
- **a** - **SS** indicates a slow setting emulsion. An **RS** in this location would indicate a rapid setting emulsion and a **MS** in this location would indicate a medium setting emulsion, such as b listed above.
- The **1** or **2** following the **SS** and the **MS** in the above examples give an indication of the emulsion viscosity (Saybolt-Furol). **2** indicates a higher viscosity than a **1**.
- **h** indicates the binder residue is hard, as measured by the penetration test on the residue. **s** indicates the binder residue is soft and no letter indicates a penetration range between an **s** and an **h**.
- **P** indicates the binder is polymerized. No **P** at the end indicates a non-polymer modified binder.
- **R** indicates the binder is modified with latex. No **R** at the end indicates a non-latex modified binder.

Emulsion Applications

Tack Coats

Tack coats are used on lower lifts of HMA to provide a bond to the HMA layer above and to avoid slippage. Slippage can cause severe distress for pavements, so an effective tack coat is critical. CDOT specifies CSS-1h and SS-1h for tack coats. Other asphalt emulsions may be used for tack coats. However, it is very important that the tack coat results in sufficient residual binder to provide a good bond. In addition, there should not be an excessive delay between application of the tack coat and paving. During the delay traffic can pick up the binder or track dirt on the binder, which will reduce bonding. Pave as soon as possible after the emulsion has set to prevent contamination (dust, dirt, etc.) or pickup by tires.

Prime Coats

Prime coats are used on aggregate base courses to provide good adhesion to the HMA layer placed above. Property requirements for prime coats are in the Specification Book. (The material to be used for prime coats is specified in the project plans, and historically both cutback and emulsified asphalts have been used. Emulsions are becoming the most common because of the environmental problems with cutback asphalts.)

Chip Seals

A chip seal (cover coat) consists of a spray bar application of emulsion, topped by chips dropped by a spreader. Light, pneumatic tire rolling seats the chips. The chips are clean, 3/8" aggregate. Single-sized, hard aggregates are desirable for chip seals. A fog seal, applied after the chip seal has completely cured, provides a uniform appearance and better chip retention. CRS-2P and HFRS-2P emulsions are used for chip seals. The rapid set (RS) grabs the chip quickly and the polymer (P) in the binder holds the chip better. It is desirable to use the same emulsion for the fog coat that was used in the chip seal for better compatibility and chip retention.

Cold In-Place Recycling

Cold in-place recycling consists of 1) Roto-milling off the surface of an existing pavement, 2) adding additional binder to the millings, 3) mixing and then spreading the combination on the surface, and finally 4) compacting to an adequate density. HMA is normally placed over the cold in-place recycle layer. Emulsions are used to add the binder since this is a cold process. HFMS-2sP is normally used for cold in-place recycle. The soft binder(s) helps soften the hard oxidized existing pavement and the polymer (P) helps with adhesion and crack resistance.

Specification Requirements for Emulsion Properties

Specifications for properties of emulsions used by CDOT are found in three locations:

1. **Standard Specifications**
   Specifications for some commonly used emulsions are found in tables in Subsection 702.02 of the Specification Book as modified by the Standard Special Provisions. These include seal coats, prime coats, and penetrating priming stabilizers, recycling agents, and rejuvenating agents.

2. **AASHTO (American Association of State Highway and Transportation Officials)**
   AASHTO standards apply for all non-polymer emulsions used by CDOT. These are referenced in the Specification Book, Standard Special Provision, or Project Special Provisions. Note that some of the references include modifications of the AASHTO standards.

3. **Maintenance Bid Table**

   Each year, binder suppliers bid for the privilege of supplying binders for CDOT maintenance use (Maintenance Bid). Bids are based on binder property specifications provided by CDOT. Non-polymer emulsions are based on reference to AASHTO. Property specifications for polymer emulsions are defined in detail in the Maintenance Bid. These specifications are now organized into a table. An example of that table follows. Note that this table is revised each year. Specific requirements for a particular year should be determined by obtaining a copy of the Maintenance Bid for that year.

Examples of Emulsion Property Tables

The following pages include examples of emulsion property tables. These are examples only and should not be used to determine specification compliance. Property requirements for non-polymer emulsions should be obtained by reference to the applicable year of AASHTO. Property requirements for emulsions used by CDOT Maintenance should be obtained by reference to the applicable Maintenance Bid.

Colorado DOT Emulsion Requirements*

Property		Cationic				Anionic		AASHTO
		CSS-1h	**CQS-1hL**	**CQS-1hP**	**CRS-2**	**AEP**	**SS-1h**	
Tests on Emulsion:								
Viscosity Sabolt- Furol, s	**Temp, ºC**	25	25	25	50	50	25	T-59
	min	20	15	15	50	20	20	
	max	100	100	100	450	150	100	
Storage stability, 24 hr, % max		1	1	1	1		1	T-59
Particle Charge		Positive	Positive	Positive	Positive			T-59
Sieve test, % max		0.1	0.1	0.1	0.1		0.1	T-59
Residue by distillation, % min		57	62	62	65	65	57	T-59
Tests on residue:								
Penetration, 25ºC, 100g, 5s, min		40	40	40	70		40	T-49
Penetration, 25ºC, 100g, 5s, max		120	150	150	150		120	
Ductility, 25ºC, 5 cm/min, cm, min		40	50	50	40		40	T-51
Solubility, in trichloroethylene% min		97.5	97.5	97.5	97.5	97.5	97.5	T-44
Typical Use		**Tack Coat**	Slurry Seal & Micro-surfacing	Slurry Seal & Micro-surfacing	MTCE	Prime	**Tack Coat**	

* Partial list of requirements for quick reference only. Refer to AASHTO M140 and M 208 for complete requirements.

TABLE 400-2

Note: The TABLE 400-3 that existed on this page prior to the 2017 FMM has been deleted in its entirety.

Colorado DOT Specifications for Polymer Modified Emulsions

Polymerized emulsions shall be an emulsified blend of polymerized asphalt, water, and emulsifiers. The asphalt cement shall be polymerized prior to emulsification and shall contain a minimum of three (3.0) percent polymer by weight of asphalt cement. The emulsion standing undisturbed for a minimum of 24 hours shall show no white, milky separation but shall be smooth and homogeneous throughout. The emulsion shall be pumpable and suitable for application through a distributor. The emulsified blend shall conform to the requirements listed in the table of properties below. The "Standard" column of the table lists the American Association of State Highway and Transportation Officials (AASHTO) or Colorado Procedure-Laboratory standard that defines the procedure for the test on that line. For example: T 59 is an AASHTO standard, and CP-L 2211 is a Colorado Procedure-Laboratory (CP-L) standard. CP-Ls are found in the Colorado Department of Transportation's (CDOT's) Laboratory Manual of Test Procedures.

Footnotes for Table 400-4

[1] CP-L 2212 is a rapid evaporation test for determining percent residue of an emulsion and providing material for tests on residue. CP-L 2212 is for acceptance only. If the percent residue or any test on the residue fails to meet specifications, the tests will be repeated using the distillation test in accordance with AASHTO T 59 to determine acceptability.

[2] For high float emulsions the distillation and evaporation tests will be in accordance with AASHTO T 59 or CP-L 2112 respectively with modifications to include 205°C ± 5° (400°F ± 10°) maximum temperature to be held for 15 minutes.

[3] When CRS-2P is used for chip seals, compatibility of the aggregate (chips) and the emulsion may be determined for information in accordance with CP-L 2213. This test is a visual estimate of the coating of the aggregate by the emulsion binder after mixing of the emulsion and aggregate.

Properties for CDOT Polymer Modified Emulsions

Property		CRS-2R[3]	CRS-2P[3]	HFMS-2P	HFMS-2Sp	Standard
Tests on emulsion:						
Viscosity, Sabolt- Furol @ 50º at 50ºC, s	**min**	50	50	50	50	T-59
	max	450	450	450	450	
Storage stability, 24 hr., % max		1.0	1.0	1.0	1.0	T-59
Particle Charge Test		Positive	Positive	Positive		T-59
Sieve Test, % Max		0.10	0.10	0.10	0.10	T-59
Demulsibility, 0.02 N $CaCl_2$, % min			40			T-59
Oil Distillate by volume, % max or range		3.0	3.0	3.0	1.0-7.0	T-59
Residue by distillation/ evaporation[1], % min		65	65	65[2]	65[2]	T-59 CPL-2212
Tests on residue:						
Penetration, 25ºC, 100g, 5s, min		70	70	70	150	T-49
Penetration, 25ºC, 100g, 5s, max		150	150	150	300	
Ductility, 25ºC, 5 cm/min, cm, min				75		T-51
Solubility, in trichloroethylene% ***min***		97.5	97.5	97.5	97.5	T-44
Elastic Recovery Min.	**Test Temp ºC**			58 / 25	50 / 4	CPL-2211
Float Test, 60ºC, s min				1200	1200	T-50
Toughness, in-lbs., min		90	70			CPL-2210
Tenacity, in-lbs., min		45	45			CPL-2210
Typical Use		Chipseal	Chipseal 3	MTCE	In-place Recycle	

TABLE 400-4

HOLLYFRONTIER®

Straight Bill Of Lading -
Short Form Original - Not Negotiable
Asphalt

BOL Number:
MoT: TRUCK
Transaction
Loader:

The property described below, in apparent good order, except as noted (contents and condition of contents of packages unknown), marked, consigned, and destined as indicated below, which said carrier (the word carrier being understood throughout the contract as meaning any person or corporation in possession of the property under the contract) agrees to carry to its usual place delivery at said destination, if on its route, otherwise to deliver to another carrier on the route to said destination. It is mutually agreed, as to each carrier of all or any of said property over all or any portion of said route to destination, and as to each party at any time interested in all or any of said property, that every service to be performed hereunder shall be subject to all the terms and conditions of the Uniform Domestic Straight Bill of Lading set forth(1) in Uniform Freight Classifications in effect on the date hereof, if this is a rail or a rail-water shipment, or (2) in the applicable motor carrier classification or tariff if this is a motor carrier shipment.

Shipper's Info:
HollyFrontier Refining and Marketing LLC
300 MORRIE AVENUE
CHEYENNE,WY 82007
Ship-to Info:

Ship Date: _____ Time In: _____ Time Out: _____
Carrier: _____ Planned Order _____
Vehicle:: _____ Customer PO _____ Tare Weight: _____
Trailer _____ Gross Weight: _____
Incoterms _____ Net Weight: _____

Consignee Signature: _____

Cert Num:
Seals 1 & 2:
Seals 3 & 4:

The loader by signing this Bill-of-Lading hereby certifies that transport was loaded as specifies.

(Signature of Loader) _____

Items:-

Item	Material	Material Description	Weight	UoM	Net Qty	UoM	Temp	Gravity	Tank
10	100030	1 T/T UN3257,ELEVATED TEMPERATURE LIQUID, N.O.S., (ASPHALT),9,III ASPHALT PG 58-28,4961605		STO		UG6		6.00	TK1-52

For Transportation Emergency - Spill, Leak, Fire, Exposure, or Accident, call 800-424-9300, In District of Columbia 202-483-7616, In Mexico call 703-527-3887 Chemtrec Account: CCN201319

The driver by signing this Bill-of-Lading hereby certifies that transport was loaded as specifies. The carrier certifies that the cargo tank supplied for this shipment is a proper container for the transportation of this commodity as described by shipper.

Driver Name: _ Driver Signature:

This is to certify that the here-in named materials are properly classified, described, packaged, marked, and labeled, and are in proper condition for transportation according to the applicable regulations of the department of transportation.

KELLI WILBER

If the shipment moves between two ports by a carrier by water, the law requires that the bill of lading shall state whether it is "carrier's or shipper's weight".
NOTE: Where the rate is dependent on the value, shippers are required to state specifically in the writing the agreed or declared value of the property. **The agreed or declared value of the property is hereby specifically stated by the shipper to be not exceeding.**

Bill of Lading Example

CDOT Materials Forms
Applicable for Flexible Pavements, Bituminous, European laboratories

https://www.codot.gov/library/forms/form-numbers-broken-down

Materials Forms, Instructions & Examples Chapter

Form	Title
157	Field Report for Sample Identification or Materials Identification
6	Field Tests of Base Aggregates, Fillers, Paving and Miscellaneous Aggregates
43	Job Mix Formula [*computer output*] SiteManager
58	Field Report of Asphalt Content & Maximum Specific Gravity of Hot Mix Asphalt
67	Asphalt Cement Results and Final Quantity [*computer output*] SiteManager
69	Field Report of Hot Mix Asphalt Density
106	Asphalt Tests
360	Project Produced Hot Mix Asphalt [*computer output*] SiteManager
411	PG Binder / Emulsion Submittal Form
429	Laboratory Design for HMA - SuperPave Gyratory Compactor [*computer output*] SiteManager
582	Hot Mix Asphalt Density Test
N/A	Ignition Furnace Correction Factor Worksheet (Laboratory Worksheet)
626	Field Laboratory Test Results
634	Sample Label (cans)
1094	Asphalt Mix Design Graph
1290	Longitudinal Joint Data
1304	HMA Sample Submittal
1346	HMA Segregation Data

FS# = (Contract ID-Seq.#)

COLORADO DEPARTMENT OF TRANSPORTATION **FIELD REPORT FOR SAMPLE IDENTIFICATION OR MATERIALS DOCUMENTATION**	Region	
	Contract ID	Date Submitted
	Project No.	
	Project Location	

Material Type			Field Lab phone	Cell Phone
Material Code (LIMS)	Item	Class	Grading	Special Provisions ☐ yes
Previously used on Project No.:		Previous CDOT Form #157 F/S No.(s):		☐ CDOT Form #633 (sack) ☐ CDOT Form #634 (can)

- Sample Identification: Quantity & Unit of material submitted, describe tests required, precise location sample remove from (Stationing). etc.
- Materials Documentation: Field inspected (describe appearance, weight/dimensions, model/serial number), COC &/or CTR provided etc.

Central Lab use only:

Sample ID (#1)	Sample ID (#2)	Sample ID (#3)
Sample ID (#4)	Sample ID (#5)	Sample ID (#6)

APL/QML Acceptance: APL Ref. No.	Product name:	Date checked:
APL/QML Acceptance: APL Ref. No.	Product name:	Date checked:

Preliminary ☐	Construction ☐	Maintenance ☐	Emergency ☐	Date needed

Contractor	Supplier
Sampled from (Pit, roadway, windrow, stock, etc.)	Pit name or owner

Quantity represented	Previous quantity	Total quantity to date

Sample submitted: ☐ Yes ☐ No	Shipped specified quantity to: ___ ☐ Central lab ___ ☐ Region lab ___ ☐ Consultant lab	Date

Sampled or inspected by (print name)	Title	E-mail
Supervisor (Pro./Res./Matls. Engr./Maint. Supt.) (print name)	Title	Residency

Distribution: Chemical Lab: cdot_chemlab@state.co.us
Concrete Lab: cdot_conc.lab@state.co.us
Flexible Pavement: cdot_flex.lab@state.co.us
Physical Properties: cdot_phpr.lab@state.co.us
Soils Lab: cdot_soils.lab@state.co.us
Region Labs: Send completed form with sample

Previous editions are obsolete and may not be used. **CDOT Form #167 04/18**

Project File: SMM – Upload completed form into the attachment icon on the sample record

FS# = (Contract ID-Seq.#)

COLORADO DEPARTMENT OF TRANSPORTATION

FIELD TESTS OF BASE AGGREGATES, FILLERS, PAVING AND MISCELLANEOUS AGGREGATES

Contract ID	Region	
Project No.		Date Submitted
Project Location		Item

SMM/LIMS Sample ID (or Test # [Date])	Station	Tons (t) or Yards (y)	Field density	Lab max density	% Rel. Comp.	Total moist.					#4	#8	#30	#50	#100	#200	L.L.	P.I.
	Sheet Total		Specifications:															
	Previous Total																	
	Total to Date																	

Final report: yes ☐ no ☐

Spec. deviations: yes ☐ ☐

Items:
206 Structure Backfill Class 1 _____
206 Filter Material Class_____
304 ABC Class_____
307 Treated Subgrade_____
403 HMA Grading_____
403 SMA_____
409 Cover Coat_____
Other Material:

P=_____% for lot # _____

Remarks

Source (pit)	
Project Tester (print name)	Title
PE Approved by (print name)	Title

Distribution: SMM/LIMS: Form is not required to be completed
Non-LIMS: Completed form in project material book

Previous editions are obsolete and may not be used

CDOT Form #8 11/17

FS# = (Contract ID-Seq.#

COLORADO DEPARTMENT OF TRANSPORTATION

FIELD REPORT OF ASPHALT CONTENT AND MAXIMUM SPECIFIC GRAVITY (RICE) OF HOT MIX ASPHALT

Contract ID	_ _ _ _ _ _ _ _ _ _ _ _
Project No.	Date Submitted
Project Location	

CDOT Form 43 number:		CDOT Form 43 date:		Asphalt mix formula reference:
Report #/ Page #	Region	Item #	Grading	% recycled

CP 85 (nuclear) ☐ CP-L 5120 (ignition) ☐ Other _____

Job mix formula percent AC	Range	Final report ☐ yes ☐ no

SMM/LIMS Sample ID (or Test # [Date])	Station or location	Fractured faces	Max Specific Gravity (RICE - CP 51)	Percent asphalt

	QA Test	IA Test
% Voids		
VMA		
VFA		
Stability		

Specification deviation ☐ no ☐ yes

P=_____% for tests_____ thru_____

Action taken:

QA Tester (print name)	Title
IA Tester (print name)	Title
Approved by (print name)	Title

Distribution: Original: Project file **Previous editions are obsolete and may not be used** **CDOT Form #58 4/17**

FS# = (Contract ID-Seq.#

COLORADO DEPARTMENT OF TRANSPORTATION

FIELD REPORT OF BITUMINOUS PAVEMENT AND JOINT DENSITY

Contract ID		Region:	_ _ _ _ _ _ _ _ _ _ _ _
Project No.		Form #43 No.:	Form #43 Date:
Project location:		Item #:	Grading:

SMM/LIMS Sample ID (or Test # [Date])	Station or Location	IA	Distance from Control line	Mat (M) or Joint (J)	CP 81	CP 44 B	CP 44 C	CP 44 L	Field Wet Density (Corrected)	Core Specific Gravity	Daily Rice	Max Wet Density (Daily Rice x 62.4)	% Rel. Comp.	Project Spec	In Spec? (Y/N)

Remarks:	Action taken:	Tester: (print name)	Title:
		Supervisor: (Project Engineer)	Title:
		Final report: ☐ Yes ☐ No	

Distribution: Original - Project file

Previous editions are obsolete and may not be used.

CDOT Form #69 11/17

COLORADO DEPARTMENT OF TRANSPORTATION
ASPHALT TESTS

Contract ID	Date Submitted
Project No.	
Project Location	

AC gauge No:	Correlation No:	Correlation temp.	Base weight:
Supplier:	Item / Material Code:	Grading:	Course:
Form 43 No:	Background cnt.:	IAT No: MV:	INFO:

Sample ID (AC Test)		Sample ID (Gradation Test)	
Date:	Time:	Date:	Time:
Tons:	Ticket:	Tons:	Ticket:
Station:	Lane:	Station:	Lane:

Asphalt content test #:		**Gradation Test #:**	
Job Mix % AC:		Pan ID:	
Meas. count:		Tare:	
Gauge % AC:		Wet wt.:	
% Moisture:		Dry wt.:	
Corr. % AC:		Loss:	
		% Moisture:	
Dry aggregate count:			
CDOT Form 43 Max. specific gravity:			

Maximum Specific Gravity

Flask ID:		
Mass of Dry Specimen (g):		
Mass of flask, water & lid (g):		
Mass of filled flask, specimen & lid (g):		
Temperature of water in flask (F°):		
(A+D)-E:		
Specific Gravity A/(A+D-E):		

Temperature of watermust be 77°F, if not, correct results using Equation 2 in CP 51

SPECS: Individual flask SpG must be within 0.011 of each other

Average Specific Gravity:

Comments:

Sampled by: (print name)	Date
Tested By: (Printe Name)	Date
Company	

Sieve analysis

[_____ (Wet wt.) (100 + _____ (% moisture)]] x 100 = _____ Dry wt. (before wash)

Sieve Weight	Weight	% Ret.	% Pass	Spec
1				
3/4				
1/2				
3/8				
#4				
#8				
#16				
#30				
#50				
#100				
#200				
minus #200				
		Total Sieve wt. (TSW)		

Dry weight (after wash): _____

% difference= (Dry wt. - TSW) / Dry wt. x 100 = _____ %

Fractured Faces (FF)	Moisture correction for Aggregates
A) Total weight:	Pan ID:
B) Fractured Aggregate:	Tare:
(B/A) x 100 = _____ %FF	Wet weight:
	Dry weight:
	Loss:
	% Moisture:
CDOT Form 43 %Aggregate Absorption	

CDOT Form 106 4/1/2020

COLORADO DEPARTMENT OF TRANSPORTATION

PG BINDER/EMULSION SUBMITTAL

Contract ID	Only one Type (Binder or Emulsion) material for each 411 BINDER ◯ Emulsion ◉	Refinery Code See Page 2 For Code	Lot No.	Region	FS# = (Contract ID-Seq.#)

Project number	Project Location	Bid Plan Quantity	Date submitted
		◯ T ◯ G	

SMM/LIMS Sample ID	Can #	Tons or gallons	Emulsion Batch Date	Date sampled M	D	Y

Previous sheet: total tons or gallons (a) ◯T or ◯G

This sheet: total tons or gallons (b) ◯T or ◯G

Total: (a+b) ◯T or ◯G

☐ Final lot for this material

Special provisions applicable:
yes ◯ no ◯
If yes, attach a copy to this submittal.

Submitted by: (print name)

Cell Phone:

Email (Project Tester):

CDOT Project Engineer ◯ Consultant PE ◯
Name:

IA Tester Name:

IA Sample/Witness Yes ◯ No ◯

IA/Witness Can #

Remarks

IA statement here:

Send completed form to: cdot_bit.lab@state.co.us

Electronic Signature of IA Personnel

Distribution: ProjectShare Folder

Previous editions of this form are obsolete and may not be used.

CDOT Form 411 01/2021

INSTRUCTIONS

Form shall be emailed to cdot_bit.lab@state.co.us when complete for the lot. Complete the Form, use Save As, name the Form to identify it with Field Sheet # - Lot #. Example C18180 - 4022 Lot 1.
See CDOT website at this link for examples of creating project FS#s. https://www.codot.gov/library/forms/materials-forms-serialized

Contract ID - Enter the number assigned to the project (previously referred to as the project code).

Material Type - Only 1 (Binder or Emulsion)Type of Material for each Form 411. All CDOT Non-Standard Material not listed must be approved prior to submittal.

Refinery name and location - See list below for Code.

		CODE
Aggregate Ind. / West Central	Sedalia, CO	AGISC
Cobitco Inc.	Denver, CO	COBIT
Ergon Asphalt & Emulsions,Inc.	El Dorado, KS	ERGED
Ergon Asphalt & Emulsion, Inc.	Woods Cross, UT	ERGWC
HollyFrontier Refinery	Cheyenne, WY	HFRWY
Holly R&M, LLC	Albuquerque, NM	HANM
Jebro Incorporated	Cheyenne, WY	JEBCH
Jebro Incorporated	Sioux City, IA	JEBSC
Peak Asphalt, LLC	Rawlins, WY	PEAKR
Peak Asphalt, LLC	Woods Cross, UT	PEAKW

		CODE
Sinclair Wyoming Refining Co.	Sinclair, WY	SINSIN
Suncor Energy – Commodity	Commerce City, CO	SUNCCC
Suncor Energy –Emulsion /BKEP	Commerce City, CO	SUNCCE
Suncor Energy –Polymer /BKEP	Commerce City, CO	SUNCCP
Suncor Energy –Commodity	Fruita, CO	SUNFR
Suncor Energy-BKEP	Grand Junction, CO	SUNGJ
Suncor Energy-BKEP	Pueblo, CO	SUNPU
Western States Asphalt	Cheyenne, WY	WSA
Western Emulsions	Woods Cross UT	WEWC
Western Emulsions	N. Salt Lake UT	WENSL

Lot No. - The number of the lot represented. See the Field Materials Manual, Ch 400 and Appendix.

Date Submitted - This is the date the samples are submitted, not the date the samples were obtained.

SMM / LIMS Sample ID - This cell is used for projects utilizing Site Manager for sample submittal. Each sample must have its own sample ID. Leave this cell blank if project is not a Site Manager Materials project.

Can # - All projects will use the Can# column.Can numbers must run sequentially for each binder type or emulsion. **Example** - If project quantity is 25,000 tons of HMA (PG 64-22), can numbers will be from Can #1 to Can #25. Project has 95,125 gallons of emulsion, sample each load, can numbers would be from 1-19 approximately, assuming 19 loads delivered.

Tons or gallons - Binder - One sample per 1000 Tons of HMA or SMA produced.
Emulsion - Gallons - Sample each load, record the gallons from the bill of lading.

Emulsion Batch Date - From the Bill of Lading, record the date the material was made.

Note 1: Independent Assurance (IA) samples - Please note on Form #411 and on Label #634 (sample label for cans) which can # is also the IA sample. IA samples must be indicated on this form.

Note 2: All sample containers must be properly labeled utilizing CDOT Label #634.

Contract ID **Field Sheet #**
Sample ID
Material Type **Lot #**
Material Code **Can #**
Lab Ref. #

Instructions for SMM/LIMS sample creation
Basic Sample Data tab

1) Sample Type must be Quality Acceptance
2) Material code begins with 702.01 for binders, and 702.03 through 702.05 for emulsions
Must use material code from the OA Checklist for the project
3) The Lab Reference Number cell must be the last four digits of the Field Sheet number followed by LT#. This is the lot number, Ex= 1234LT6

Additional Sample Data tab

1) Use the Seal Number cell to designate the Lot #, Can #, & number of samples in the lot
LT5C17of5= lot#5, can#17, and 5 cans submitted in this lot

Field sheet with IA witnessed sample

Lab Reference Number cell shall be last four digits of the field sheet, followed by LT#IA, Ex=1234LT6IA
Seal Number cell shall be LT#C#IAT. This is the Lot # followed by can # that was witnessed by the IA

CDOT #411 Page 2 06/2020

COLORADO DEPARTMENT OF TRANSPORTATION Bulk Specific Gravity and Percent Relative Compaction of **HMA / SMA CP 44**	Project no.	Region	Contract ID
	Project Location		
	Form #43 No.	Grading	

Sample ID			
Test number			
Station			
Distance Rt. or Lt. of CL			
Course			
Date placed			
Date retrieved (sampled)			
Pan Number			
Pan Weight			
Weight in H_2O (C)			
Sat. surf. dry wt. (B)			
Dry weight in air (A)			
Pan & Core-dry@ Constant mass			
Bulk Specific Gravity			
Ave. Daily Rice			
% Relative Compaction			
Sample ID (for IAT)			
IA Test #			

Sample ID			Place IA stamp here:
Test number			
Station			
Distance Rt. or Lt. of CL			
Course			
Date placed			
Date retrieved (sampled)			
Pan Number			
Pan Weight			
Weight in H_2O (C)			
Sat. surf. dry wt. (B)			
Dry weight in air (A)			
Pan & Core-dry@ Constant mass			
Bulk Specific Gravity			
Ave. Daily Rice			
% Relative Compaction			IA Electronic Signature
Sample ID (for IAT)			
IA Test #			

Bulk Specific Gravity = $\frac{A}{B-C}$

Sampled by (print name)	Tested by (print name)	Company Name or CDOT

Previous editions are obsolete and may not be used. CDOT Form #582 4/18

COLORADO DEPARTMENT OF TRANSPORTATION
FIELD LABORATORY TEST RESULTS

Project No.	Contract ID
Project Location	

Contractor/Supplier:	Item	Class	Lot
Attention:			

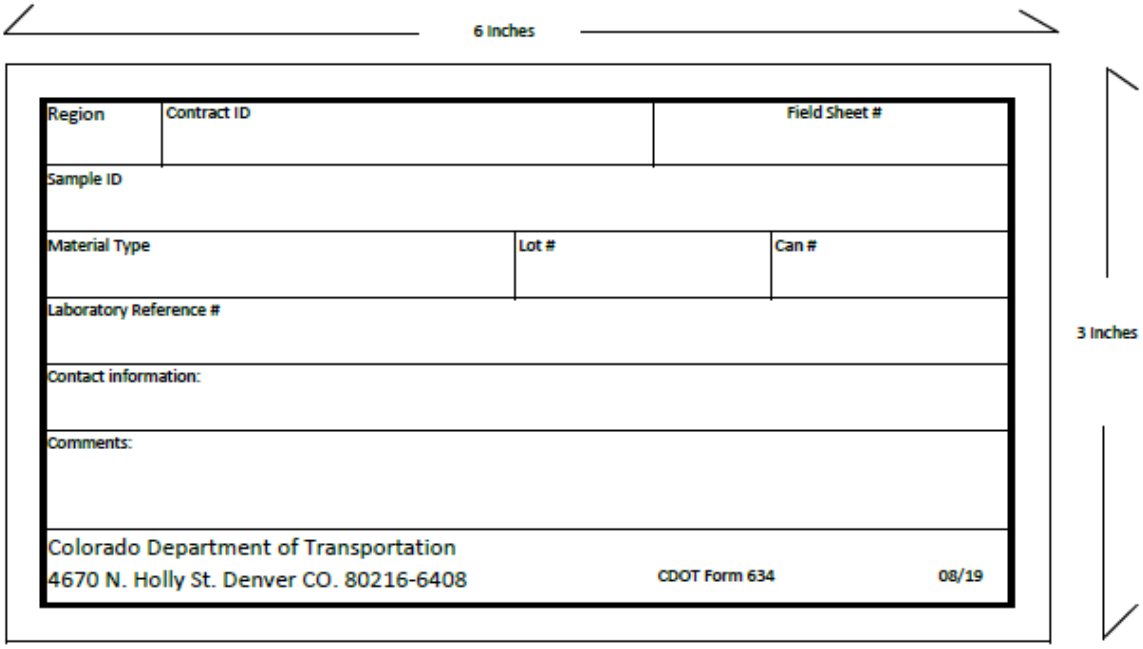
TEST NO.						Item Description	
DATE							
STATION							
LOCATION						Specs	Failing Test #
QUANTITY							
Sieve							
Sieve							
Sieve							
Sieve							
Sieve							
Sieve							
Sieve							
Sieve							
Sieve							
Sieve							
Sieve							
Sieve							
L.L.							
P.I.							
% Bitumen							
Max SpG							
Voids							
VMA							
% Rel. Comp.							
% Moisture							
Slump							
% Air							
Flex/Cyl PSI							
Other:							

Note: Record "Test No." of the corresponding Sample ID (SM/LIMS).

Remarks (below):

CDOT Representative (print name)	CDOT Representative Electronic Signature
Contractor's Representative (print name)	Contractor's Representative Electronic Signature

Previous editions are obsolete and may not be used. CDOT Form #626 6/18

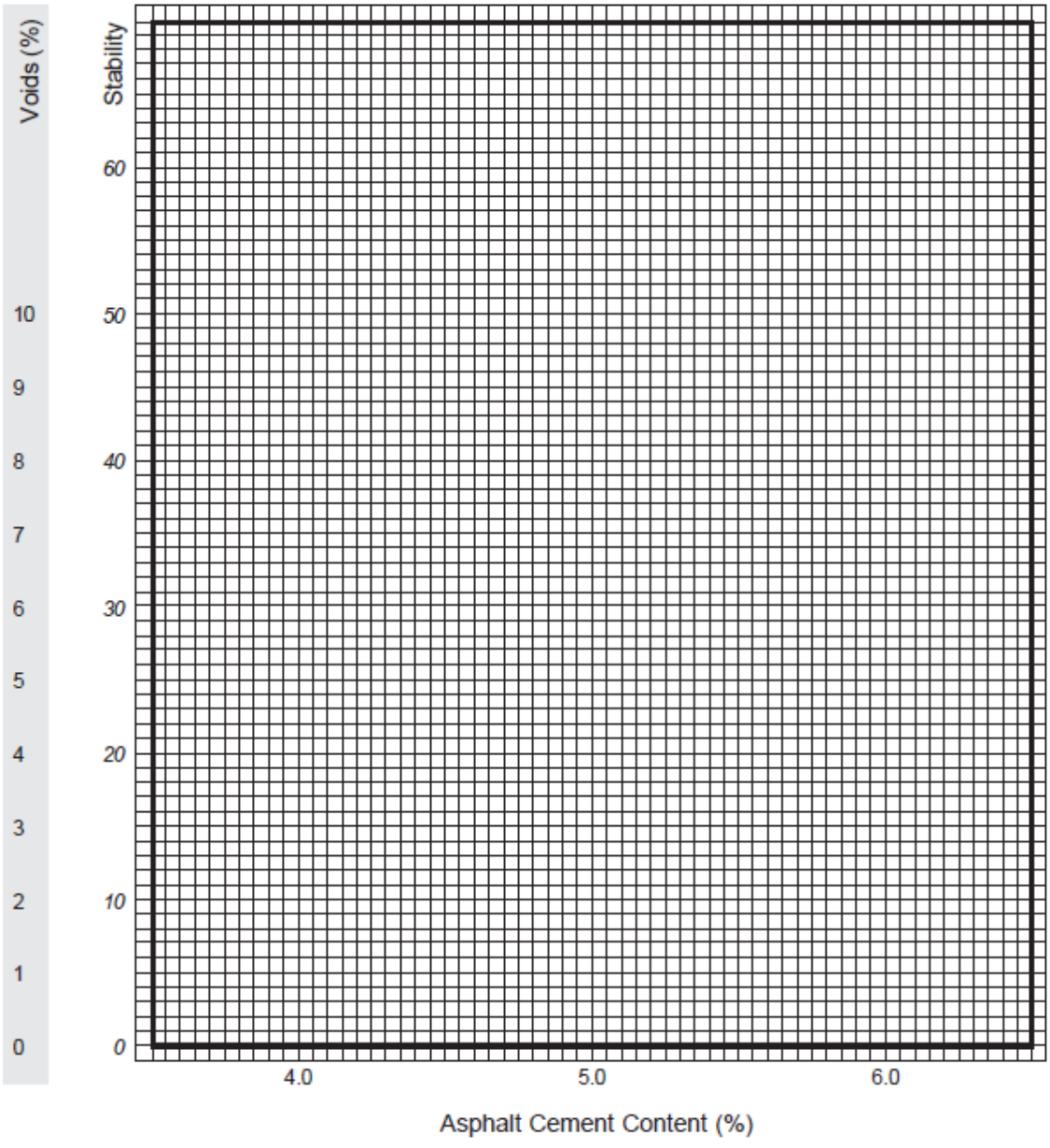


CDOT Form 634 Label (Stick-on Label with high heat durability)

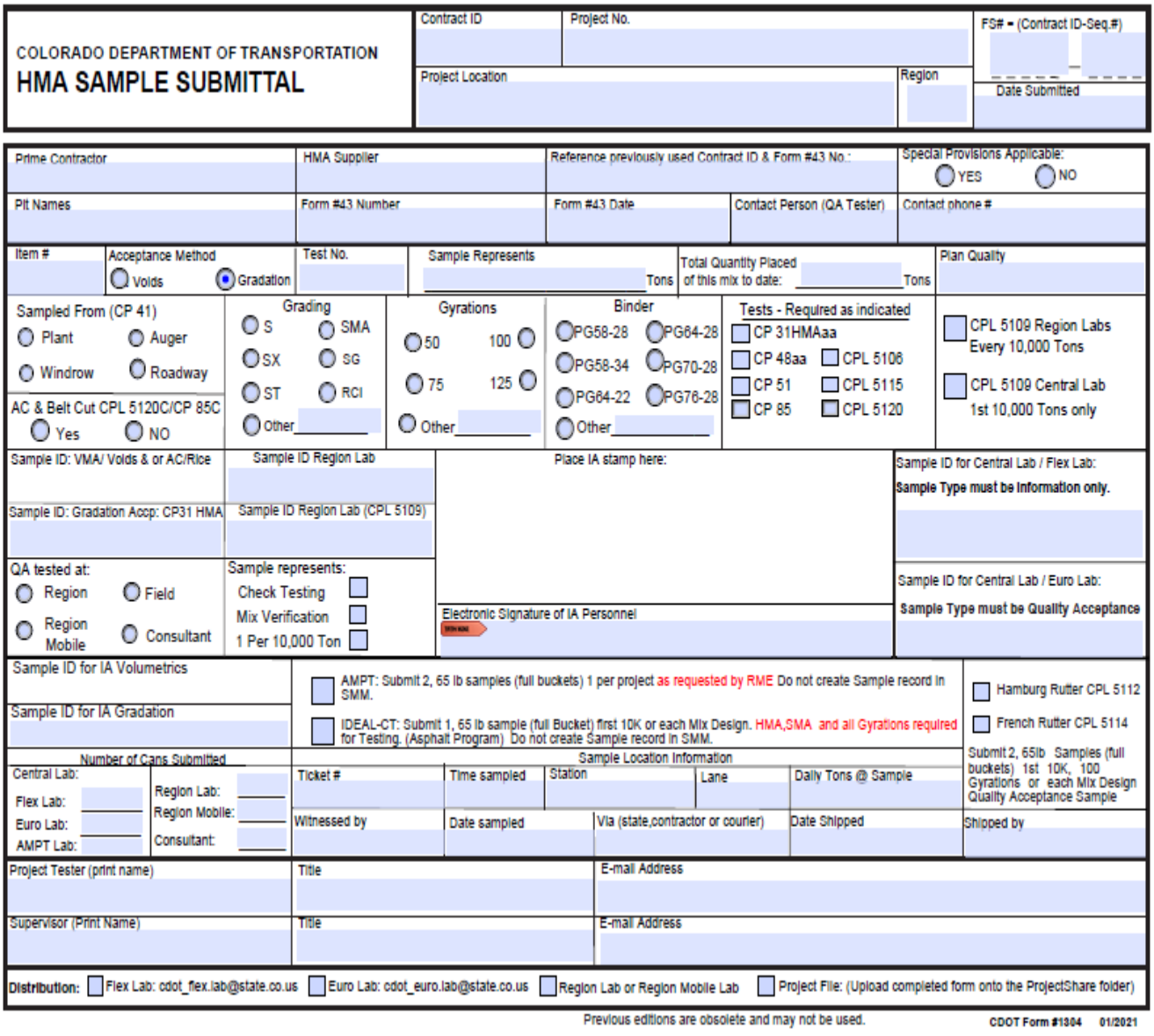
COLORADO DEPARTMENT OF TRANSPORTATION

ASPHALT MIX DESIGN GRAPH

Project no.	Contract ID
Proj. location	Field sheet no.



Previous editions are obsolete and may not be used. **CDOT Form #1094 4/14**



COLORADO DEPARTMENT OF TRANSPORTATION

HMA SAMPLE SUBMITTAL

Contract ID	Project No.		FS# = (Contract ID-Seq.#)
Project Location		Region	Date Submitted
Prime Contractor	HMA Supplier	Reference previously used Contract ID & Form #43 No.:	Special Provisions Applicable: ◯ YES ◯ NO
Pit Names	Form #43 Number	Form #43 Date	Contact Person (QA Tester) / Contact phone #

Item #	Acceptance Method: ◯ Voids ◉ Gradation	Test No.	Sample Represents _____ Tons	Total Quantity Placed of this mix to date: _____ Tons
Plan Quality				

Sampled From (CP 41): ◯ Plant ◯ Auger ◯ Windrow ◯ Roadway	Grading: ◯ S ◯ SMA ◯ SX ◯ SG ◯ ST ◯ RCI ◯ Other	Gyrations: ◯ 50 ◯ 100 ◯ 75 ◯ 125 ◯ Other	Binder: ◯ PG58-28 ◯ PG64-28 ◯ PG58-34 ◯ PG70-28 ◯ PG64-22 ◯ PG76-28 ◯ Other	Tests - Required as indicated: ☐ CP 31HMAaa ☐ CP 48aa ☐ CPL 5106 ☐ CP 51 ☐ CPL 5115 ☐ CP 85 ☐ CPL 5120
AC & Belt Cut CPL 5120C/CP 85C: ◯ Yes ◯ NO				☐ CPL 5109 Region Labs Every 10,000 Tons ☐ CPL 5109 Central Lab 1st 10,000 Tons only

Sample ID: VMA/ Voids & or AC/Rice	Sample ID Region Lab	Place IA stamp here:	Sample ID for Central Lab / Flex Lab: **Sample Type must be Information only.**
Sample ID: Gradation Accp: CP31 HMA	Sample ID Region Lab (CPL 5109)		
QA tested at: ◯ Region ◯ Field ◯ Region Mobile ◯ Consultant	Sample represents: ☐ Check Testing ☐ Mix Verification ☐ 1 Per 10,000 Ton	Electronic Signature of IA Personnel	Sample ID for Central Lab / Euro Lab: **Sample Type must be Quality Acceptance**

Sample ID for IA Volumetrics / Sample ID for IA Gradation	☐ AMPT: Submit 2, 65 lb samples (full buckets) 1 per project as requested by RME Do not create Sample record in SMM. ☐ IDEAL-CT: Submit 1, 65 lb sample (full Bucket) first 10K or each Mix Design. HMA,SMA and all Gyrations required for Testing. (Asphalt Program) Do not create Sample record in SMM.					☐ Hamburg Rutter CPL 5112 ☐ French Rutter CPL 5114
Number of Cans Submitted: Central Lab: Flex Lab: Euro Lab: AMPT Lab: / Region Lab: Region Mobile: Consultant:	Sample Location Information: Ticket #	Time sampled	Station	Lane	Daily Tons @ Sample	Submit 2, 65lb Samples (full buckets) 1st 10K, 100 Gyrations or each Mix Design Quality Acceptance Sample
	Witnessed by	Date sampled	Via (state,contractor or courier)		Date Shipped	Shipped by

Project Tester (print name)	Title	E-mail Address
Supervisor (Print Name)	Title	E-mail Address

Distribution: ☐ Flex Lab: cdot_flex.lab@state.co.us ☐ Euro Lab: cdot_euro.lab@state.co.us ☐ Region Lab or Region Mobile Lab ☐ Project File: (Upload completed form onto the ProjectShare folder)

Previous editions are obsolete and may not be used. **CDOT Form #1304 01/2021**

COLORADO DEPARTMENT OF TRANSPORTATION

HMA SEGREGATION DATA

Contract ID	Mix design	Region	Date	Ave. lift thickness

Paving contractor	HMA grading (S, SX, SMA)	Gyrations (50, 75, 100)	Binder grade (58-25, 64-22, etc.)

Truck type	Delivery system make and model	Paver make and model

Look for a temperature difference of 25°F or more across the width of the mat at 3 foot intervals behind the paver. Exclude outside 1 foot of mat.
Only one area per delivered truck will be counted toward the number of low density areas.
Mark where you start taking readings. There's no penalty unless there are 4 areas within 500 tons of mix, so tonnage must be tracked.
If you don't track the tickets and want to calculate tonnage, use 110 pounds per square yard per inch.
Tonnage of starting ticket:_____ or mark for start of study:_____
Approximate length of paving per truck: Length in feet = (tonnage on truck)/[(width in feet)(depth in inches)(.0061)]
Industry best practices are listed on the back of this worksheet.
Temperature readings are taken before the breakdown roller compacts the area.

Identifying mark of "cold" area	Location of "cold" area from CL or edge of pavement	Station	Temperature of "cold" area	Temperature of adjacent "hot" area	% Relative Compaction of "cold" area (from CDOT Form #428)	Notes

Notes:

CDOT Tester (print name) Title	Phone number (include area code)	CDOT Supervisor

Previous editions are obsolete and may not be used. Page 1 of 2 CDOT Form #1346 4/14