Chapter 400

Asphalt - 18

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 with 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 some other more effective use 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 and mineral aggregates, developing asphalt mix designs, and 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 at an angle of 1.25º, which has been determined to better simulate field compaction.

Mixes that are designed with the SGC take into account 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)

The asphalt cements under the Superpave system are called binders because the intent of the specifications was to address both modified and unmodified asphalt cements. One feature of the Superpave binder specification is that all of the binders have to 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 with the same test values, but the test temperature would be different to reflect the different project climates. For example, a performance binder designation listed as PG 58-28 would mean 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 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) is 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 the wheel 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.1

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.

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.

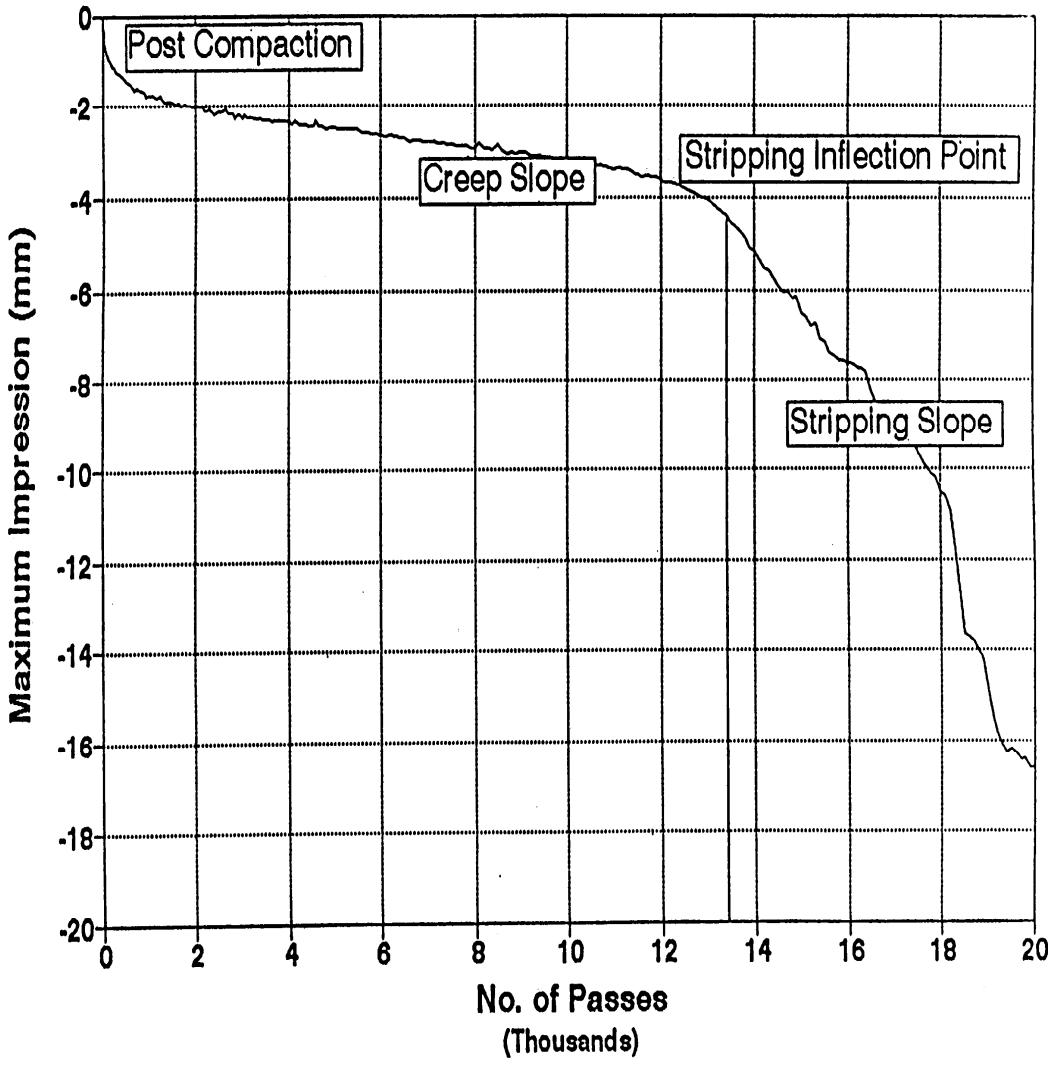
1) Dynamic Modulus
2) Repeated Load Test
3) Creep Test: (Measures flow time and flow number used to evaluate rutting and fatigue cracking.)

Reference Material:
AASHTO TP 79
AASHTO PP 60
AASHTO PP 61

Dynamic Modulus: $\frac{|E^*| \text{ Peak Stress}}{\text{Peak Strain}}$

Phase Angle: The time lag between stress and strain.

1 Report #CDOT-DTD-94-1



Definition of the Hamburg Wheel-Tracking Results.

FIGURE 400-1

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

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 Undiluted 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.

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

TABLE 400-1

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 702.03 of the Specification Book as modified by the Standard Special Provisions. These include: seal coats, prime coats, 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

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 in be in accordance with AASHTO T 59 or CP-L 2112 respectively with modifications to include 205ºC ± 5º (400ºF ± 10º) 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, Saybolt-Furol @ 50°	**min**	50	50	50	50		T-59
	max	450	450	450	450		
Storage stability, 24		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		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	**Test Temp ºC**			58	25	50	4	CPL-2211
Min.							
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

KOCH CONTROL NUMBER ONLY 807304 NOT A BILL OF LADING NUMBER

STRAIGHT BILL OF LADING XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX

In Emergency call Chemtrec at: (800) 424-93(Reference ERG for Emergency Response Informatic

This is to certify that the below 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.

Signature By _____

If this shipment is to be delivered to the consignee without recourse on the consignor, the consignor shall sign the following statement: The carrier shall not make delivery of this shipment without payment of freight and other lawful charges.

Signature of Consignor _____

Cargo Tank Supplied By Carrier/Carrier Compliance to Laws - Where the cargo tank is supplied by the carrier, the carrier hereby certifies that the cargo tank supplied for this shipment is a proper container for the transportation of this commodity. This is to acknowledge that the carrier has in his possession or has been offered and accepted the required hazard materials placards and/or emergency response information.

The property described herein in apparent good order is received by the carrier shown on this Bill of Lading and the carrier agrees to transport the property to the consignee and the destination set forth herein subject to the classifications and tariffs, and the terms and conditions of the Uniform Domestic Straight Bill of Lading found in National Motor Freight Classification, in effect on the date of issuance of this Bill of Lading or the applicable contract with shipper. It is further agreed by the carrier that the transportation of this shipment will be performed in compliance with all applicable rules, regulations and laws.

Signature of Motor Carrier _____

ORIGIN	SHIPPER	CARRIER
KCA DENVER-C, CO	KOCH PERFORMANCE ASPHA	GROENDYKE TRANSPORT

SOLD TO	CONSIGNEE/DESTINATION
BRANNAN SAND & GRAVEL CO LLC ATTN FRANCIS 2500 E BRANNAN WAY DENVER, CO 80229	BRANNAN SAND & GRAVEL CO LLC CNTY: DENVER CITY: DENVER, ST/PROV: CO

BILL OF LADING	SHIP DATE	FREIGHT
4011117388	04/04/2005	FREIGHT COLLECT

Original BOL: **Order #:** 529 **Agreement #:** 60145
Time In: 0919 **Time Out:** 1046 **Customer PO#:**

Order Level Comments
TANK #: 310 TRACTOR #:4009 TRAILER#: 4010

Proj #: NH 0021-026 **Proj Name:** ADAMS COUNTY **Reference:**

Product/Desc/Class	Temp	Gross Vol	Net Vol	Weights		
4655	352 F	7585.661 GAL	6840.749 GAL	Gross	82740 LBS	37530 KG
	178 C	28715.521 LT	25895.657 LT	Tare	24320 LBS	11031 KG
PG 76-28				Net	58420 LBS	26499 KG
					29.210 TON	26.499 MT

Proper Shipping Description
Elevated Temperature Liquid, n.o.s., (Asphalt), 9, UN3257,III

Pounds per Gallon: 8.540 Kilograms per Liter 1.023
Specific Gravity: 1.024

This is to certify that the materials provided under this bill of lading shall meet the standards of and were tested in accord with the Quality Control Plan that Company or its affiliates provided to the State and thereby conforms to th State of Colorado's specifications. Per the Agency Plan provided to the State. "We will follow procedures that make a reasonable attempt to prevent contamination of materials, and inquire as to the contents of our customers's tank trucks or cars".
Authorized Signature: K Palmer
AIAP DUES

I hereby certify under penalty of perjury that the material listed in this Certificate of Compliance represents 29.210T (quantity) of pay item 411 (pay item number and Description) for installation on project number 01234

Contractor _____ Date 7/3/06

A bill of lading may be used as a COC if the box at the bottom of this example is attached and properly completed.

Bill of Lading Example

CDOT Forms - Applicable for Flexible Pavements, Bituminous, and the Eurolab, Examples and Instructions

ATTENTION!

All of the referenced CDOT Materials Forms above, except those indicated as "*computer output*", have been revised in 2014. All of these forms state: *Previous editions are obsolete and may not be used*. The use of Materials Forms older than what is indicated in Appendix O of the FMM is not authorized!

The examples of completed forms will be revised as necessary and as time permits in future FMM's.

Instructions for *Manually Developing the Field Sheet Numbers for CDOT Forms* is presented in Appendix O. In Chapter 400 the forms that utilize a Field Sheet are bolded above.

COLORADO DEPARTMENT OF TRANSPORTATION

FIELD REPORT FOR SAMPLE IDENTIFICATION OR MATERIALS DOCUMENTATION

Metric units ☐ yes ☑ no

Region: 1	Field sheet #: 210351
Contract ID: C18180	Date Submitted: 02/02/2015
Project No.: FBR 0404 050	
Project Location: US 40 Over Sand Creek	

Material Type: AGGREGATES and RAP			Field Lab phone: 719-555-2525	Cell Phone: 719-555-5353
Material Code (LIMS): SEE BELOW	Item: 403	Class:	Grading: S(100)	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 removed from (stationing), etc.
- Materials Documentation: Field inspected (describe appearance, weight/dimensions, model/serial number), COC &/or CTR provided , etc.

Submitting (7) canvas bags of aggregates and (1) canvas bag of RAP for testing per CP 52.

(#1) 2 Bags 3/4" Rock-Aggregate Industries-Morrison Pit	Perform the following tests:
(#2) 2 Bags 1/2" Rock-Aggregate Industries-Morrison Pit	CP31, T84, T85 & T90
(#3) 1 Bag Crusher Fines-Aggregate Industries-Morrison Pit	Per RME-CP-L4211 & T96
(#4) 1 Bag Crusher Fines-Aggregate Industries-Platte River Pit	NOTE: Extra bag of 3/4" & 1/2" for above tests.
(#5) 1 Bag Natural Fines-Aggregate Industries-Platte River Pit	(#6) 1 Bag 3/4" RAP Agg. Ind.-Dahlia Street

User ID: KOCHISL

Sample ID (#1): 1522135756 (703.04.03.03)	Sample ID (#2): 1522140510 (703.04.03.04)	Sample ID (#3): 1522141535 (703.04.03.09)
Sample ID (#4): 1522140045 (703.04.03.09)	Sample ID (#5): 1522141028 (703.04.03.10)	Sample ID (#6): 1522142403 (703.04.03.14)

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: 02/20/2015

Contractor: HAMON CONTRACTORS, INC.	Supplier: AGGREGATE INDUSTRIES-DAHLIA STREET
Sampled from (Pit, roadway, windrow, stock, etc.): STOCKPILES	Pit name or owner: MORRISON/PLATTE RIVER/DAHLIA STREET

Quantity represented: MIX DESIGN VERIFICATION per CP52	Previous quantity:	Total quantity to date: 1 PER SOURCE

Sample submitted: ☑ Yes ☐ No	Shipped specified quantity to: 8 ☑ Central lab ___ ☐ Region lab	Via: CDOT-R. LOCKHART	Date: 02/03/2015

Sampled or inspected by (print name): LESLIE KOCHIS	Title: EPST III	E-mail: leslie.kochis@state.co.us
Supervisor (Pro./Res./Matls. Engr./Maint. Supt.) (print name): KARL LARSON	Title: CEPM I	Residency: LIMON

Distribution: White copy - CDOT Central Laboratory (submit white copy only if sample or information is directed to Staff Materials)
Canary copy - Region Materials Engineer
Pink copy - Resident Engineer

CDOT Form #157 4/14

Previous editions are obsolete and may not be used.

CDOT Form #157, HMA Mix Design

Notes: Sample Tags (CDOT Form # 633): Sack # from Field Sheet must be listed.
Please send two full sacks of aggregate (three for grading SG).
Fill in all blanks on this form.
CDOT must witness sampling, and Contractor samples the material.

COLORADO DEPARTMENT OF TRANSPORTATION

FIELD REPORT FOR SAMPLE IDENTIFICATION OR MATERIALS DOCUMENTATION

Metric units ☐ yes ☑ no

Region: 1	Field sheet #: 210352
Contract ID: C18180	Date Submitted: 03/17/2015
Project No.: FBR 0404 050	
Project Location: US 40 Over Sand Creek	

Material Type: Hydrated Lime			Field Lab phone: 719-555-2525	Cell Phone: 719-555-5353
Material Code (LIMS): 712.03.01.00	Item: 403	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 removed from (stationing), etc.
- Materials Documentation: Field inspected (describe appearance, weight/dimensions, model/serial number), COC &/or CTR provided , etc.

Submitting (1) plastic bag (>2 lbs.) Hydrated Lime for testing per CP-L4209.

Material used in HMA.

User ID: KOCHISL

Sample ID (#1): 153H150948	Sample ID (#2):	Sample ID (#3):
Sample ID (#4):	Sample ID (#5):	Sample ID (#6):

APL/QML Acceptance: APL Ref. No.: 3278-11	Product name: Hydrated Lime (Rapid City)	Date checked: 03/17/2015
APL/QML Acceptance: APL Ref. No.:	Product name:	Date checked:

Preliminary ☐ Construction ☑ Maintenance ☐ Emergency ☐ — Date needed:

Contractor: Hamon Contractors	Supplier: Aggregate Industries-Dahlia St./Pete Lien & Sons
Sampled from (Pit, roadway, windrow, stock, etc.): Storage Silo	Pit name or owner:

Quantity represented: 100 tons Lime/10,000 tons HMA	Previous quantity: 0	Total quantity to date: 10,000 Tons HMA	
Sample submitted: ☑ Yes ☐ No	Shipped specified quantity to: 1 ☑ Central lab ___ ☐ Region lab	Via: CDOT T. Mayhew	Date: 03/18/2015

Sampled or inspected by (print name): LESLIE KOCHIS	Title: EPST III	E-mail: leslie.kochis@state.co.us
Supervisor (Pro./Res./Matls. Engr./Maint. Supt.) (print name): KARL LARSON	Title: CEPM I	Residency: LIMON

Distribution: White copy - CDOT Central Laboratory
(submit white copy only if sample or information is directed to Staff Materials)
Canary copy - Region Materials Engineer
Pink copy - Resident Engineer

CDOT Form #157 4/14

Previous editions are obsolete and may not be used.

CDOT Form #157

COLORADO DEPARTMENT OF TRANSPORTATION

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

Project No. IM 0253-151			Field sheet # 120997
Project code (SA#) 11925	Region 4		Item # (Check appropriate item below) 403
Proj. location I-25, SH 7 to WCR 16			Date 7/7/03

Test #	Date 20 03	Station taken	Tons (t) or Yards (m)	Field density	Lab max density	% Rel. Comp.	Total moist.	2" (50mm)	1½" (37.5mm)	1" (25.0mm)	¾" (19.0mm)	#4	#8	#30	#50	#100	#200	L.L.	P.I.
1	7/5	Belt Cut	2000	134.1	136.2	98.5	2.5	100	100	100	100	59	48	28	19	13	8.2	18	2
2	7/7	Belt Cut	2000	134.9	138.8	97.2	2.7	100	100	100	100	61	50	30	21	14	9.1	19	3
	Sheet Total		4000	Specifications:						100	90-100	61-71	44-54		18-26		3.1-.7.1		
	Previous Total		0																
	Total to Date		4000																

Final report: ☐ yes ☒ no

Spec. deviations: ☒ yes ☐ no

P=__________ % for lot # __________

Action taken:

Items:
206 Structure Backfill Class 1 ________
206 Filter Material Class ________
304 ABC Class ________
307 Filler Type ________
403 HMA Grading S(75)
409 Cover Coat ________
410 Plant Mix SC Type ________
Other Material:

Remarks

Source (pit): Agg. Industries

Tester: Fidel Gonzales — Title: E/PS Tech III

Approved by: Corey Stewart — Title: P.E. I

Distribution: Original - Project File

Previous editions are obsolete and may not be used

CDOT Form #6 3/05

CDOT Form #6

INSTRUCTIONS FOR CDOT FORM #43

PURPOSE: To authorize a Job Mix Formula for the HMA specified in the Contract Special Provisions or to make a change during construction from a previously authorized CDOT Form #43.

AUTHORITY FOR THIS REPORT:

Subsection 401.02 of the Standard Specifications authorizes the Engineer to modify in writing the Job Mix Formula specified in the Contract Special Provisions and, when necessary, to establish a new Job Mix Formula.

METHOD OF PREPARATION:

An approved asphalt mix design obtained in accordance with CP 52 is used to write a Form #43.

If aggregates are submitted to the Central Lab for a mix design check, please follow the steps listed in CP 52.

Upon receipt of an approved asphalt mix design the Region Materials Engineer and the Engineer will prepare a Form #43 and distribute for signatures.

If the Region Materials Engineer and the Engineer make a change in the Form #43 from the mix design, the change shall be discussed with the Central Laboratory and the date of such discussion entered on the Form #43. The Form #43 shall then be completed and the signatures of Region Materials Engineer and the Engineer obtained. Then it shall be delivered to the Contractor's authorized representative whose signature documents that the Contractor received and agrees with the Form #43.

If, after the initial Form #43 has been distributed and the construction of the pavement has begun, there develops a sound reason why the Engineer should establish a new Job Mix Formula, such shall be done by filling out another Form #43. Consultation will be made with all CDOT personnel concerned before making this second change.

The Job Mix Formula shall be made out in its entirety and distributed as a matter of documentation before the Contractor begins the production of HMA.

COLORADO DEPARTMENT OF TRANSPORTATION
PROJECT PRODUCED JOB MIX FORMULA

Project: NH0505-046
Location: US 50 HASTY AND MCCLAVE - C
Region: 02 Project Code (SA#): 18242

Mix Design: 18242A
Date: 11/16/2012

From Project No:
From Project SA#:

This Job Mix Formula defines the specified gradation, asphalt cement content, and admixture dosage for the grading and project shown.

Contractor: A&S
Supplier: A&S
Plant: Hasty (Mobile Plant)
Pit: Hasty/Hardscrabble
Grading & Compaction: SX 100
% RAP: 20.00 % Lime: 1.00

Components:

1. 19 5/8" Hasty Rock
2. 35 Hasty Crusher Fines
3. 25 Hardscrabble Sand
4. 20 Hasty RAP
5. 1 Pete Lien Lime
6.
7.
8.

Remarks: Percent AC in RAP = 4.8

Gradation (% Passing)

☐ Specification ☒ Voids Acceptance

Seive mm (in)	% Pass Min	% Pass Max
37.5 (1 1/2):	100	100
25.0 (1):	100	100
19.0 (3/4):	100	100
12.5 (1/2):	90	100
9.5 (3/8):	83	95
4.75 - #4:	67	77
2.36 - #8:	48	58
1.18 - #16:		
600 mic - #30:	22	30
300 mic - #50:		
150 mic - #100:		
75 mic - #200:	4.00	8.00

Property	Voids Data at Nds Target Value	Tolerance
Stability	30	Minimum
% Voids	3.50	+/- 1.2
% VMA	min 13.4	max 15.8
% VFA	min 65	max 80

% AC: 5.40 +/- .3
Grade of AC: PG 64-22
Source of AC: SUNCOR
Max. Sp. Gr. at % AC: 2.429 +/- .01
Bulk Sp. Gr. of Combined Agg: 2.597
Bulk Sp. Gr. of Fine Agg: 2.601
Angularity (T 304): 45.0
% Agg Absorp (SSD): 1

☐ New Mix Design With Changes
☐ Mix Design Modified
☒ New Mix design with no change

Signed _____ Date _____
Project Engineer: Terry Woodward

Signed _____ Date _____
Regional Materials Engineer: Craig Wieden

Signed _____ Date _____
Contractors Representative:

Distribution:
Staff Materials
Region Materials Engineer
Resident Engineer (2)
Contractor

CDOT Form #43 01/07

CDOT Form # 43

Field Sheet #

COLORADO DEPARTMENT OF TRANSPORTATION

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

Project # IM 0253-151	Project code (SA#) 11925
Location I-25, SH7 to WCR 16	
Region 4	Date 10/5/03

CDOT Form #43 number: 119317A	CDOT Form #43 date: 9/5/03	Asphalt mix formula reference:	
Report #/ Page # 01	Item # 403	Grading S (75)	% recycled 0
CP 85 (nuclear) _____	CP-L 5120 (ignition) X	Other _____	
Job mix formula percent AC 5.2%		Range 4.9-5.2	Final report ☐ yes ☒ no

Test #	Date	Station or location	Fractured faces	Max Specific Gravity (RICE - CP 51)	Percent asphalt
1	10/2/03	4+160 Rt.		2.474	5.30
2	10/2/03	3+960 Rt.		2.475	5.46
3	10/3/03	4+380 Rt.		2.455	4.92
4	10/4/03	2+740 Rt.		2.480	5.16
5	10/5/03	3+020 Rt.		2.481	5.20

	QA Test	IA Test
% Voids		
VMA		
VFA		
Stability		

Specification deviation ☐ no ☐ yes

P=_____% for tests_____ thru_____

Action taken:

QA Tester Dave Moore	Title E/ps Tech I
IA Tester	Title
Approved by Fidel Gonzales	Title E/PS Tech III

Distribution: Original: Project file
Canary: Region Matls Section

Previous editions are obsolete and may not be used

CDOT Form #58 4/05

CDOT Form #58

Asphalt Cement Results and Final Quantity - PG 64-28

Subaccount: ***11925PG64-28A***
Project: IM 0253-151
Location: I-25, SH-7 TO WCR-16
Region: 4
Grade: PG64-28
Refinery: KOCH DENVER

Colorado Department of Transportation
Bituminous Unit 303-398-6529
4670 Holly St. Unit A
Denver, Co. 80216-6408

Test Methods: AASHTO-ASTM

FS#	Lot#	# of Cans	Samp #	Ass	Date Samp	Spec Grav	Brook Visc	DSR	Duct	Tough	Tenac	LOH	RTFO DSR	RTFO Duct	BBR S	BBR m	Dir Tens
AASHTO Specification							Max 3pa-s	Min 1.00 kPa	Min 50	Min 110i/p	Min 75i/p	Max loss 1.00	Min 2.20 kPa	Min 20	Max 300 MPa	Min 0.300	Min 1.0
31177	1	5	2		5/27/2003			1.40		241.0	222.0		2.54	20.0	118	.353	

Total number of samples on this project: 5
Total number of assurance samples on this project: 0
Total tons of Mix / Binder covered: 5000

Final pay quantity:_____ tons of Mix / Binder

Approved by:_____

Distribution: Region Materials Engineer
Region Documentation Unit
Project File

COLORADO DEPARTMENT OF TRANSPORTATION
FIELD REPORT OF BITUMINOUS PAVEMENT AND JOINT DENSITY

Project No.: IM-0253-151
Project code: 11926
Form #43 No.:
Form #43 No. Date: 9/4/2010
Field sheet #
Project location: I-25, SH 7 to WCR 16
Region: 4
Date: 9/4/2010
Item #: 403
Class: S (100)
Grading: PG 64-28

Test #	Date	Station taken	Distance from C or Control line	Mat (M) or Joint (J)	CP 81	CP 44 B	CP 44 C	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)	IA? (Y/N)
1	9/6/10	3+800	Rt.		■							92.8	92-96 %		
2	9/6/10	3+520	Rt.		■							93.3	92-96%		
3	9/6/10	2+980	Rt.		■							93.4	92-96%		
4	9/7/10	3+860	Rt.		■							93.4	92-96%		

Remarks:

Action taken:

Tester: David Johanssen
Title: EIPS Tech III

Supervisor: (Project Engineer) David Forsyth
Title: P.E.

Final report: ❑ Yes ❑ No

Distribution: Original - Project file

Previous editions are obsolete and may not be used

CDOT Form #69 1/10

CDOT Form #69

COLORADO DEPARTMENT OF TRANSPORTATION
ASPHALT TESTS

Contract ID: C18180	Date Submitted: 03/10/2015	
Project No.: FBR 0404-050		
Project Location: US 40 Over Sand Creek		

AC gauge #: 3536	Correlation #: 10023	Correlation temp.: 260	Base weight: 7000
Supplier: Agg. Industries	Item / Material Code: 403.02.01.48	Grading: S(100)(64-22)	Course: Bottom
User ID: KOCHISL	Background cnt.: 2231	IAT#: NO	MV: DAY-1 INFO: NO

Sample ID (AC Test)	Sample ID (Gradation Test)
1539162225	1539162538
Date: 03/09/2015 Time: 3:15PM	Date: 03/09/2015 Time: 2:30PM
Tons: 385 Ticket: 22587	Tons: 155 Ticket: 22581
Station: 100+25 Lane: WB	Station: N/A Lane: N/A
Asphalt content test #: 1	Gradation Test #: 1

Job Mix % AC:	5.00	Pan ID:	12
Meas. count:	3526	Tare:	125.6
Gauge % AC:	4.85	Wet wt.:	503.6
% Moisture:	0.02	Dry wt.:	503.5
Corr. % AC:	4.83	Loss:	0.1
		% Moisture:	0.02

Dry aggregate count: 2587

Form #43 Max. specific gravity: 2.488

	Flask #1	Flask #2
A) Sample weight	763.6	763.2
B) Flask + water + lid	3375.4	3373.9
C) Sample + flask + water + lid	3832.4	3830.2
RICE (Max SpG)	2.491	2.487

RICE average 2.489 [A/(A + B - C) = Max SpG]

Remarks:
Split Sample submitted to the region lab for Mix Verification taken to the dock at 5:30PM 3/10 by RL-CDOT

Sampled by: (print name) RICHARD LOCKHART	Title: EPST II
Company: CDOT	
Tested by: (print name) LESLIE KOCHIS	Title: EPST III
Company: CDOT	

Sieve analysis

[2180.9 Wet wt. / (100 + 3.2 % moisture)] x 100 = 2113.3 Dry wt. (before wash)

Sieve	Weight	% Ret.	% Pass	Specs
1				
3/4	11.5	0.6	99	90-100
1/2	278.4	13.2	87	80-92
3/8	508.3	24.1	76	71-83
#4	844.2	40.0	60	58-68
#8	1121.1	53.1	47	44-54
#16	1411.3	66.8	33	
#30	1611.7	76.3	24	22-30
#50	1790.9	84.7	15	
#100	1910.1	90.4	10	
#200	1981.1	93.7	6.3	4.0-8.0
-#200	1996.0			
	1996.0	Total sieve wt. (TSW)		

Dry weight (after wash): 1996.5

% difference=
(Dry wt. - TSW) / Dry wt. x 100 = 0.03 %

Fractured Faces (FF)

A) Total wt.	335.9
B) Fract. agg.	335.9
(B/A) x 100 =	100 %FF

Moisture correction for Aggregates

Pan ID:	15
Tare:	112.8
Wet wt.:	505.6
Dry wt.:	490.1
Loss:	15.5
% Moisture:	3.2

Form #43 %Aggregate absorption: 0.5

Previous editions are obsolete and may not be used. CDOT Form #106 5/14

CDOT Form #106

Colorado Department of Transportation
PROJECT PRODUCED HOT MIX ASPHALT

Sample No: 1
Field Sheet No: 144734
Date Received: 5/27/2003 07:45:00
Sample Desc: 1st Rep, FS #144734
Remarks: Final Report

Project No: IM0253-151
Location: SH 7 TO WCR 16
SubAcct. No: 11925
Mix Design: New
Region: 04
Tested By: R4 Lab

SuperPave Item 403

Form 43 Date: 4/25/2003
Form 43 No: 142011
Grading: S
N(des): 75

Refinery: KOCH
Binder: PG 64-28
Contractor: Kraemer and Sons
Pit: Lyons Quarry/Morrison Quarry/[illegible]

Voids Properties

Excluded Specimen No: 0

	Specimen:	Status	Specifications
% AC:	5.97	Pass	5.90 +/- 0.3
Max Sp. Gr.:	2.429	Inside Band	2.441 +/- 0.01

	Specimen 1:	Specimen 2:	Specimen 3:	Average	Status	Specifications
Bulk SG:	2.370	2.380	2.377	2.376		
Ht. N (Design):	62.3	62.2	62.2	62.2		
Voids @ N(des):	2.4	2.0	2.2	2.2	Pass	3.00 +/- 1.2
VMA @ N(des):	15.0	14.7	14.8	14.8	Pass	13.8 - 16.2
VFA @ N(des):	83.8	86.3	85.4	85.2	Fail	65 - 80

Gradation Results

Testing: Specification Aggregate Correction: No

	Job Mix		Test Results	
Sieve mm (in)	% Pass Min	% Pass Max	Status	% Pass
37.5 (1 1/2)			N/A	100
25.0 (1)	100.00	100.00	Pass	100
19.0 (3/4)	90.00	100.00	Pass	98
12.5 (1/2)	77.00	89.00	Pass	80
9.5 (3/8)	66.00	78.00	Pass	72
4.75 - #4	55.00	65.00	Pass	60
2.36 - #8	44.00	54.00	Pass	49
1.18 - #16			N/A	37
600 mic. - #30	22.00	30.00	Pass	25
300 mic. - #50			N/A	15
150 mic. - #100			N/A	10
75 mic. - #200	4.10	8.10	Pass	7.1

Aggregate Properties

N(des): 75 Gradation By: SB/LI

	Test Result	Status	Job Mix
Angularity T 304:	45.1	Pass	45.0
Bulk SG of Aggregate:	2.623		
Bulk SG of Fine Aggregate:	2.632		

Stability Results

Excluded Specimen No: 0
Stability Compacted By: DT
Stabilometer Run By: SB

		Status
Specimen 1:	38	
Specimen 2:	40	
Specimen 3:	40	
Average:	39	Pass

Lottman Results

Lottman Compacted By: IRETONL
Lottman Loads By: SB

	Average	Status	Job Mix
Wet Avg. T.S.:	61.0		
Dry Avg. T.S.:	58.3	Pass	30
% Voids:	6.8		
% Saturation:	95		
T.S. Retained:	105	Pass	70

CDOT Form #360 01/2007

CDOT Form #360

CDOT Form #411, Instructions as printed on the back.

INSTRUCTIONS:

Project number - Enter the project code number assigned to the project.

Date submitted D, M, Y - Date the samples are submitted.

Material - Grade of the material such as 58-28 or HFMS-2P.

Refinery name and location - See list below for abbreviations.

Cobitco Inc.	Denver, CO	COBIT
Ergon Asphalt & Emulsion	El Dorado, KS	ERGON
HollyFrontier Companies	Cheyenne, WY	HOFRO
Jebro Incorporated	Sioux City, IA	JEBSC
Jebro Incorporated	Cheyenne, WY	JEBCH
Mountain States Materials	Cheyenne, WY	MSM
NuStar LLC	Pena Blanca, NM	NUSTAR
Paramount Asphalt Company	Fernley, NV	PARA
Peak Asphalt, LLC	Rawlins, WY	PEAKR
Peak Asphalt, LLC	Woods Cross, UT	PEAKW
Sinclair Wyoming Refining Co.	Casper, WY	SINCAS
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
Valero Energy Corp.	Santa Fe, NM	VALNM
Valero Energy Corp.	Sunray, TX	VALTX
Western Refining	El Paso, TX	WESTTX

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

Sample no. - These numbers will run consecutively throughout the project. Assurance samples will be numbered consecutively by the Region Materials personnel. Note which field sample correlates to the assurance sample.

Tons or gallons - 1000 tons per sample for PG binders; 5000 gallons minimum per sample or amount shown on contractor's bill of lading for emulsions.

Tank - For emulsions, enter tank number, if available.

Date sampled or batch no. - Date the PG sample is taken; date the refinery made the sample of emulsion, or date sample is taken.

Fill in field tester's name, Resident Engineer's or consultant's name, address and phone numbers.

Note 1: Assurance samples - Please note on the field sheet and can label which Field Sample is also the Assurance Sample. Assurance samples must be signed on fieldsheets.

Note 2: All sample containers must be properly labeled (CDOT Form #634) or identified by permanent ink marker with the following:
(See shaded areas of CDOT Form #411)

- ▲ **Project code #**
- ▲ **Field sheet #**
- ▲ **Can #**
- ▲ **Date sampled**
- ▲ **Material type**
- ▲ **Lot #**

COLORADO DEPARTMENT OF TRANSPORTATION

PG BINDER/EMULSION SUBMITTAL

Project number	Location	Region	Field sheet 119002
IM-0253-151	I-25, SH 7 to WCR 16	4	

Project Code (SA#)	Date submitted D	M	Y	Material	Refinery name & location	Field lot no.
11925	4	6	10	64-22	SS	2

	Sample no.	Tons or gallons	Tank (Emuls)	Date submitted or Batch no. D	M	Y
1	7	1000		13	3	10
2	8	1000		13	3	10
3	9	1000		13	3	10
4						
5						
6						
7						

Previous sheet: 6000 ☒ T or ☐ G

This sheet: 3000 ☒ T or ☐ G

Total: 4500 ☒ T or ☐ G

☐ Final (please check when final)

Special provisions applicable:

☐ yes ☐ no

If yes, attach a copy to this submittal.

Submitted by: **Fidel Gonzales**

CDOT Resident Engineer/Consultant: **Corey Stewart**

Address: **1050 Lee Hill Rd. Boulder, Co. 80302**

Phone: **303-817-2631**

FAX #: **970-330-2097**

Remarks

Distribution: White - Central Lab w/sample
Canary - Region Materials Engineer
Pink - Project file

Previous editions of this form and CDOT Form #413 are obsolete and may not be used.

CDOT Form #411 1/10

CDOT Form #411 Note: The revised form will also have a sampled date.

COLORADO DEPARTMENT OF TRANSPORTATION

PG BINDER/EMULSION SUBMITTAL

Project number	Location	Region	Field sheet
IM-0253-151	I-25, SH 7 to WCR 16	4	119002

Project Code (SA#)	Date submitted D	M	Y	Material	Refinery name & location	Field lot no.
11925	4	6	10	64-22	SS	2

	Sample no.	Tons or gallons	Tank (Emuls)	Date submitted or Batch no. D	M	Y
1	7	1000		13	3	10
2	*8	1000		13	3	10
3	9	1000		13	3	10
4						
5						
6						
7						

Previous sheet: 6000 ☒T or ☐G

This sheet: 3000 ☒T or ☐G

Total: 9000 ☒T or ☐G

☐ Final (please check when final)

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

Submitted by: Fidel Gonzales
CDOT Resident Engineer/Consultant: Corey Stewart
Address: 1050 Lee Hill Rd, Boulder, Co. 80302
Phone: 303-817-2631
FAX #: 970-330-2097

Remarks

Sample #8 Witnessed by IA Tester

ASSURANCE TEST
By Matt Hull
Date 4/27/2018
CDOT Region 6 Materials Lab

Distribution: White - Central Lab w/sample
Canary - Region Materials Engineer
Pink - Project file

Previous editions of this form and CDOT Form #413 are obsolete and may not be used.

CDOT Form #411 1/10

CDOT Form #411

Directions for CDOT Form # 429

Form # 429 was written in Excel 97 and consists of six pages of information that is pertinent to asphalt mix designs. Shaded areas will require input. Other areas contain standard information or information that will be calculated from the data that is input.

Worksheets

Page 1 deals with aggregate information.

1) The goal of the 2012 revision was to consolidate the previous worksheets into one master worksheet and make the majority of the calculations automatic.
2) Drop-down lists for Region #, HMA Grading, NMAS, Design Gradations, and Grade of Binder were added. The NMAS controls the maximum density line on the 0.45 gradation figure, and the HMA grading changes the control points in the aggregate data and on the 0.45 gradation figure. Design gyrations change the VFA specifications on page 2.
3) Aggregate data has been updated to include 6 columns for natural products and 3 columns for recycled (reclaimed) products. Please note the area for AC Content below the Recycled Products.
4) Sodium Sulfate Soundness has been added to the bottom of the Agg. Data area.

Page 2 will carry over the Lab name from the first page. The Maximum Specific Gravity will be automatically calculated at different asphalt contents if the maximum specific gravity at the optimum asphalt content is supplied. Much of the information on this page will be automatically calculated. Remember, shaded areas must be input.

1) Optimum point data has been moved in columnar form to the right side of the mix design area. Calculation for total binder replacement if recycled (reclaimed) products are used has been added.
2) SMA calculation for VCA has been added. You will need to input Unit Weight of Stone and Break Point Sieve. The spreadsheet performs a VCA ratio check.
3) Plasticity of Mineral Filler, Calcium Oxide Content, and Modified Rigden Voids has been added to the bottom of the SMA Specific Input and Calculations area.

Check the specifications for accuracy. Some of the specifications are dependent on the traffic ESALs and will vary within a Superpave gradation.

Graphs

The graphs will be created automatically from the input information.

Miscellaneous

The unshaded fields are protected with a password.

An optional worksheet entitled Ignition Furnace Correction Factor Determination Form #429 example.

A-1 Asphalt | **Lab Mix No.:** | **Test Mix**

Laboratory Design for Asphalt | **CDOT Form 429 02/12**

Sample Identification: | Date Received: 5/24/2011 | Region: 3

Field Sheet No. | Project: STA 0361-095

Subaccount No.: 17619 | Location: US 36 Boulder East

Item 403: Contractor/Supplier: ASCI | Grading: SX | Nominal Max Agg. Size: 1/2 | Gyr. (N_{design}): 75 | WMA: ☐ Yes ☐ No

Pit Name: Frei; Everist | AC source: Suncor | Grade: 64-28 | % Fibers (SMA, if used): | WMA Additive: Evotherm

Antistrip Additive (other than lime if used), %: | Antistrip Additive Material:

Aggregate Data (CP-31 A & B): | **Aggregate Sampled by (CP-30)**

				Natural Products					Recycled Products						Control Points	
Type of Aggregate		1/2" Rock	Fines	Squeegee	Lime	Sand			RAP	RAP	RAS					
Aggregate Source		Frei	Frei	LG Everist	Pete Lien	LG Everist			AC Content	AC Content	AC Content				Minimum	Maximum
									5		18					
								Virgin	Gradation	Gradation	Gradation	Combined				
								Gradation				Gradation				
Percent in Mix		32	19	10	1	20	82	100	15		3	100				
Passing	1 1/2 (37.5)	100	100	100	100	100		100	100		100	100				
Passing	1 (25.0)	100	100	100	100	100		100	100		100	100				
Passing	3/4 (19.0)	100	100	100	100	100		100	100		100	100				100
Passing	1/2 (12.5)	86	100	100	100	100		95	100		100	96			90	100
Passing	3/8 (9.5)	52	100	100	100	100		81	98		100	84				
Passing	#4 (4.75)	10	90	83	100	100		60	82		95	65				
Passing	#8 (2.36)	7	69	28	100	95		47	67		93	51			28	58
Passing	#16 (1.18)	6	56	4	100	67		33	52		72	37				
Passing	#30 (0.60)	6	47	1	100	36		23	38		53	26				
Passing	#50 (0.30)	5	36	1	100	16		16	26		45	18				
Passing	#100 (0.15)	4	23	1	98	5		9	16		33	11				
Passing	#200 (0.075)	2.8	12.0	0.2	97.0	1.8		5.5	9.7		24.8	6.7			2.0	10.0
Plastic or Non-Plastic (T-90)		NP	NP	NP		NP										Specs:
Aggregate Bulk SpG(T-84 & T-85)		2.722	2.792	2.579	2.380	2.594			2.704		2.754	2.688				
Aggregate App. SpG(T-84 & T85))		2.786	2.832	2.634	2.380	2.694			2.704		2.754	2.742				
Agg Water Abs (%) (T-84 & T85)		0.9%	0.6%	0.8%		1.4%						0.800				
Aggregate Eff. SpG(T-84 & T-85)												2.724				
Fine Agg. Bulk SpG. (T-84)												2.672				
Coarse Agg. Bulk SpG. (T-85)												2.716				
Binder SpG.												1.031				
Fractured Faces (CP-45)												100%				70 min.
Sand Equivalent (T-176) **WMA/HMA Only**												78			For Info	45 min
LA Abrasion (T-96)																45 max
Fine Aggregate Angularity (T-304) **WMA/HMA Only**												46.2				45.0 min
Sodium Sulfate Soundness (T 104) **SMA Only**																12 max.
Micro Deval (CP-L 4211)								15.5								18 max.

CDOT Form #429

Earth Engineering
Laboratory Design for Asphalt

Lab No. ABC
CDOT Form 429 02/13

Mix Design A.C. Content Determination Results:

Rice = 2.510 @	5.20	%AC							Optimum Point Data
A.C. Content (percent)			4.60	5.10	5.60	6.10	%		5.20 A.C.
Rice Data (CP-51)			2.533	2.514	2.495	2.476			2.510 Rice
Specimen SpG. Data (CP-L 5115 & CP-L 5106):									
Bulks at Ndes			2.388	2.408	2.422	2.430			2.410 Bulk S.G.
Height at Ndes			65.1	64.8	63.6	62.8			
Voids Data:								**Voids Specs:**	
Voids at Ndes			5.7	4.2	2.9	1.9	%	3.5% to 4.5%	4 Voids
Other Data:								**Specs:**	
VMA at Ndes (CP-48)			16.0	15.7	15.7	15.8	%	>14.7%	15.7 VMA
VFA at Ndes (percent)			64	73	81	88	%	65-75%	75 VFA
Aggregate Eff. SpG(T-84 & T-85)			2.724	2.724	2.724	2.724			5.02 Effective AC
Effective Asphalt Content			4.42	4.92	5.42	5.92			
Dust to A.C. Ratio (CP-50)			1.30	1.16	1.06	0.97		0.6-1.2 Fine, 0.8-1.6 Coarse	1.14 D/A Ratio
Stability (CP-L 5106)**(Grade S and SX Only)**			48	48	47	44		30	48 Stability
								≤30% RAS	≤30% RAS
Total Binder Replaced			32.2	29.0	26.3	24.1		≤23% RAP	28.4 ≤23% RAP

Lottman Moisture Sensitivity Results (CP-L 5109, Method B) — **Lottman Specs:**

Asphalt Content (percent)	5.20			
Tensile Strength Retained	88	%		>80%
Avg. Dry Tensile Strength (psi)	137		(372KPa)	> 30
Avg. Cond. Tensile Strength (psi)	120		(291KPpa)	
Avg. Specimen Voids (percent)	7.7			6.0% - 8.0%
Avg. Saturation (percent)	90			

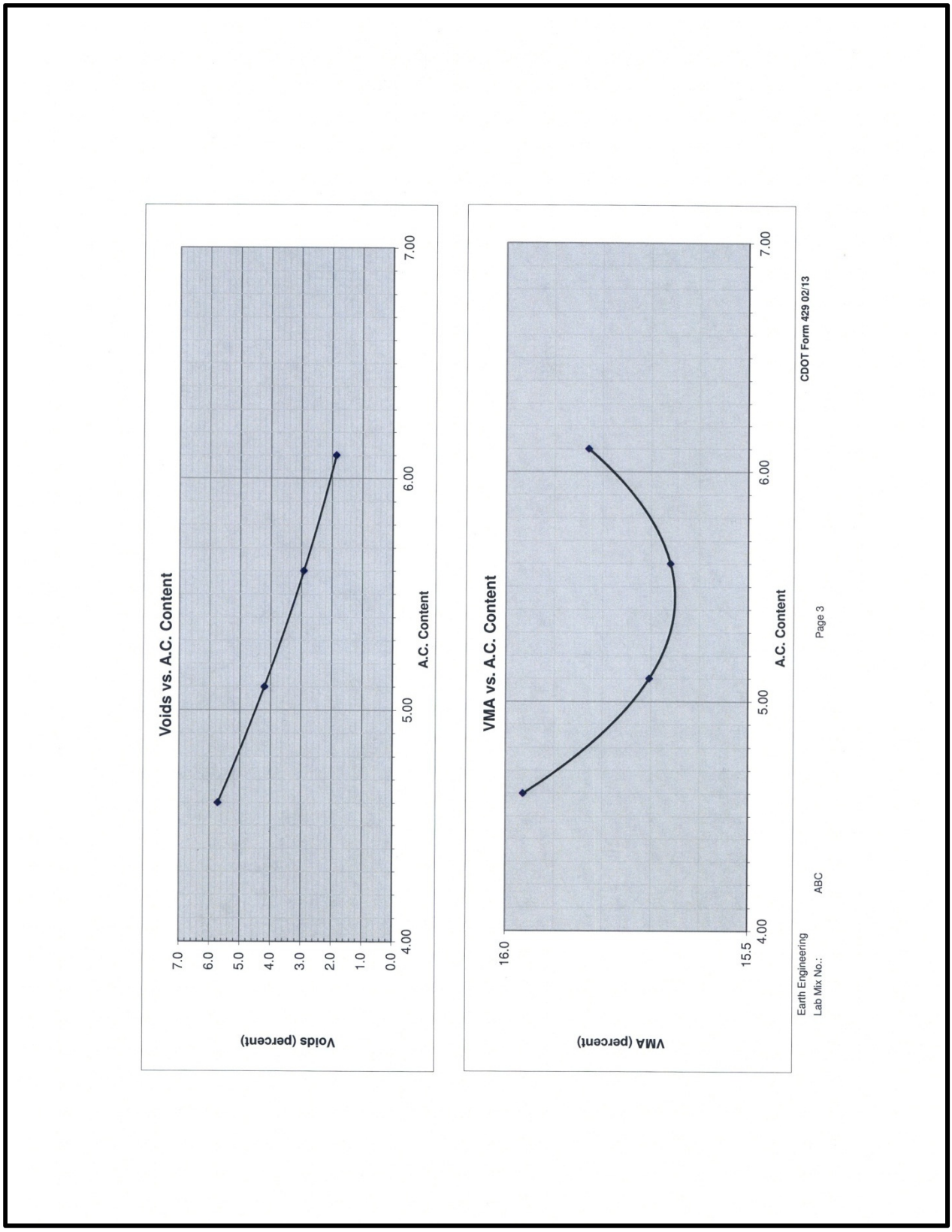
SMA Specific Input and Calculations

Bulk Specific Gravity at Optimum AC (Gmb)	2.410			Break Point Sieve
Bulk Specific Gravity of Coarse Agg (Gca)	2.755		Percent Aggregate retained on the breakpoint Sieve	#N/A
Percent of Coarse Agg (Pca)	#N/A			
Voids Coarse Agg (VCAmix)	#N/A		VCAmix < VCAdrc to ensure stone on stone contact	
Unit Weight of Stone (γs)			VCA Ratio Check	#N/A Yes passes, No fails
Voids Coarse Agg DRC (VCAdrc)	100.0			
Plasticity of Mineral Filler (T-90)		4% max.		
Calcium Oxide Content (ASTM C25)		22% max.		
Modified Rigden Voids (NAPS IS-101)		≤50		

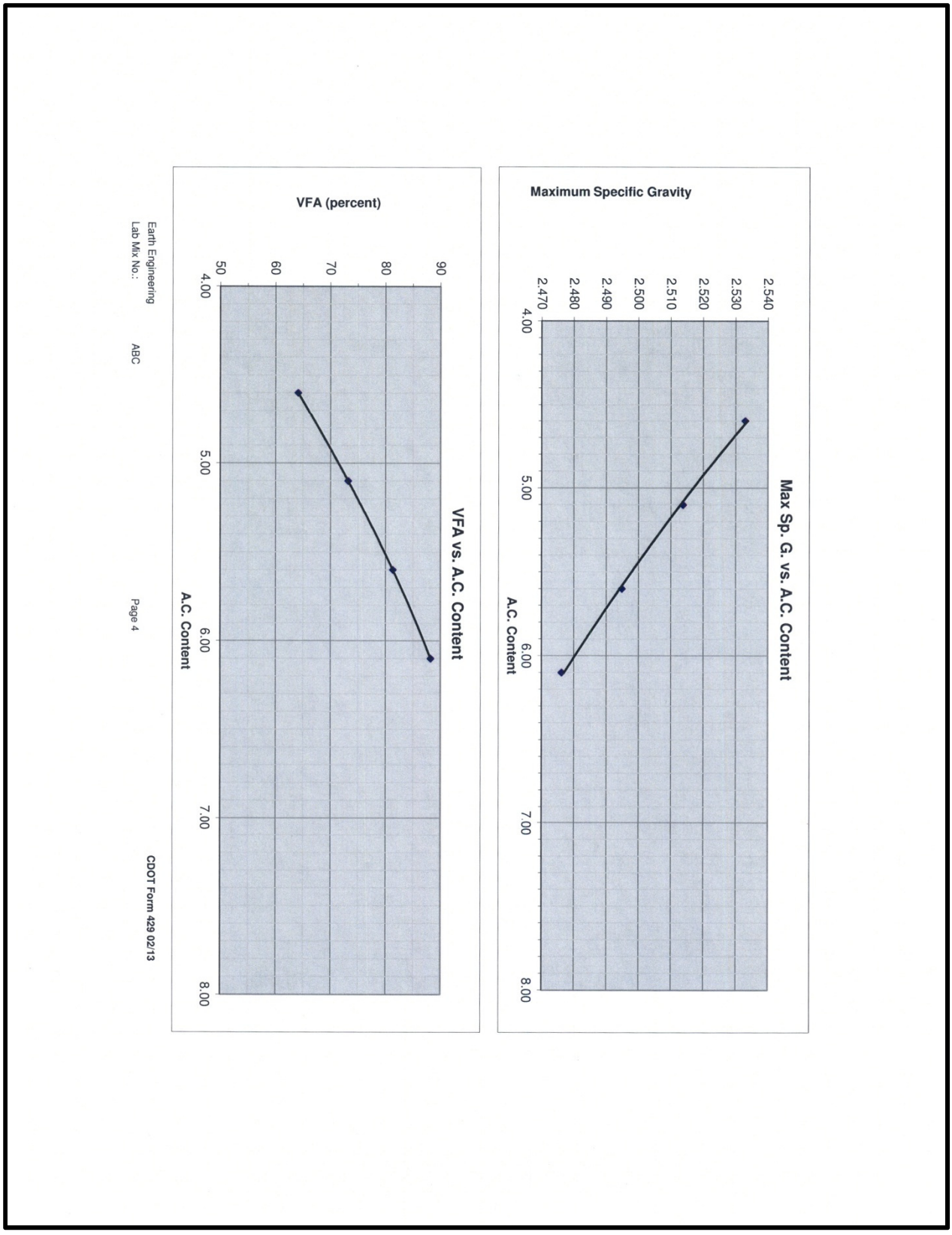
Distribution: **RME** **Report Date** 4/18/2012
HQ

Asphalt Pavement Engineer Page 2

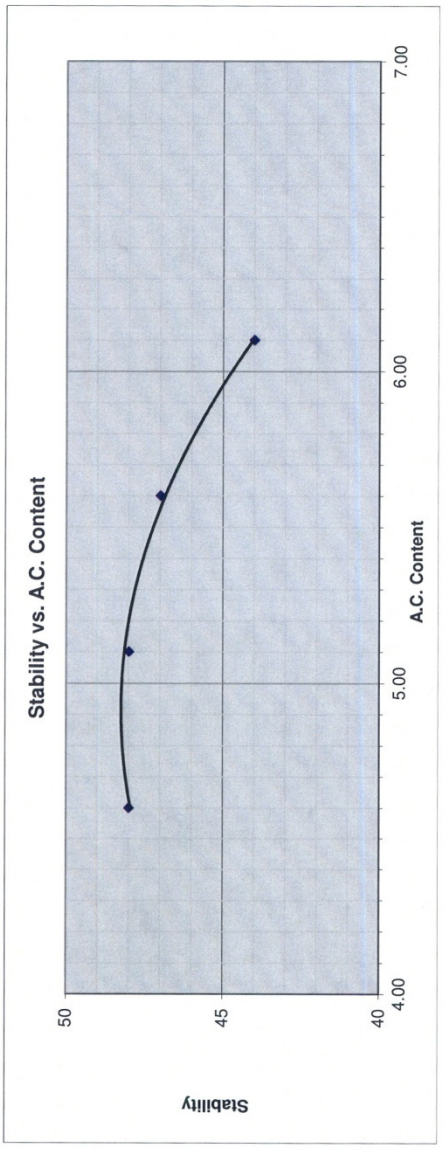
CDOT Form #429



CDOT Form #429



CDOT Form #429

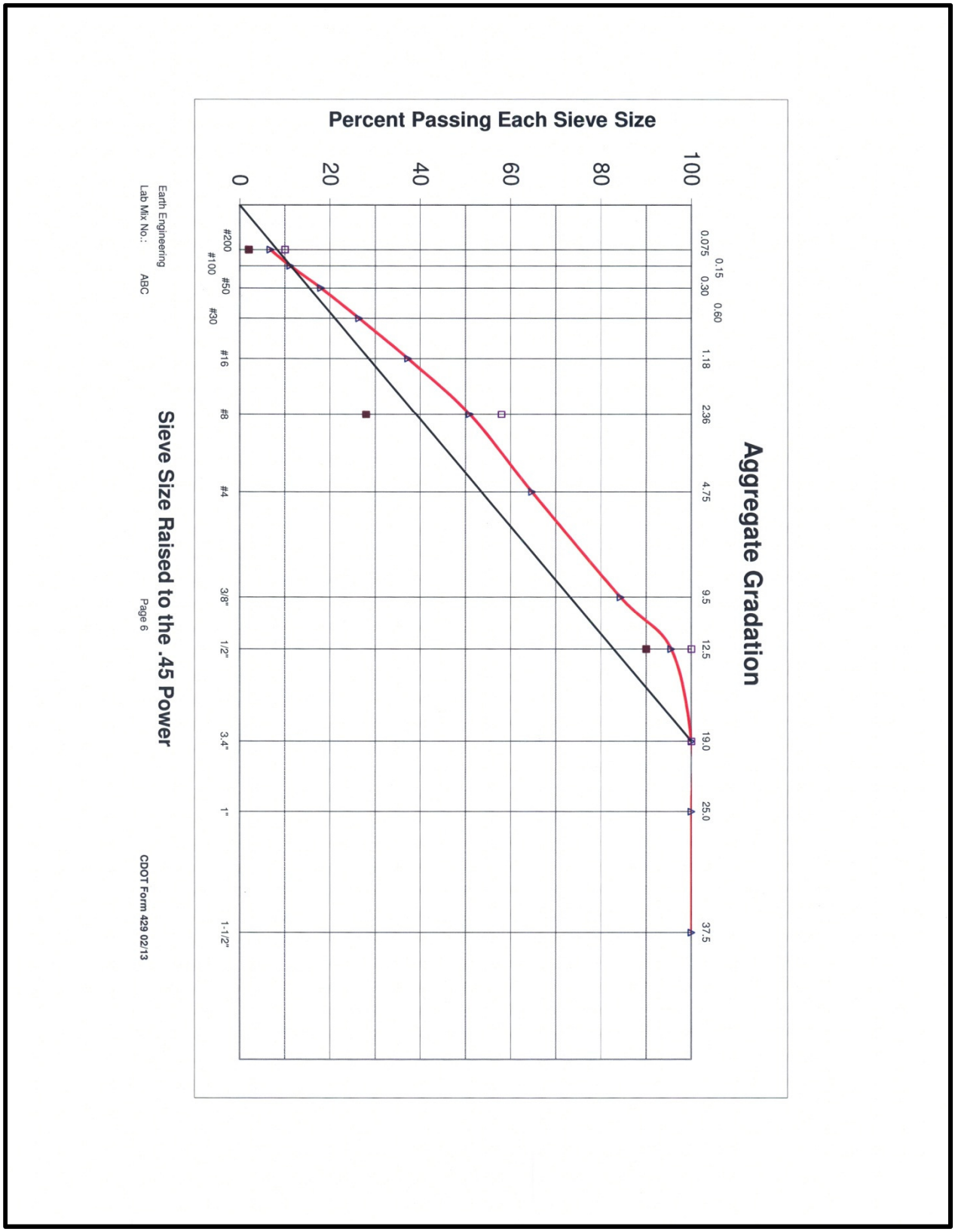


CDOT Form 429 02/13

Page 5

Earth Engineering
Lab Mix No.: ABC

CDOT Form #429



CDOT Form #429

COLORADO DEPARTMENT OF TRANSPORTATION
HOT MIX ASPHALT DENSITY TEST

Project no. IM 0253-151
Project code (SA#) 11925
Sheet no. 1 of 1

Test number	1	2	3		
Station	255+95	1296+00	1299+60		
Distance rt. or lt. ℄	Rt. 3'	Lt. 4'	Rt. 5'		
Course	bottom	middle	top		
Date placed	5/21/03	5/22/03	5/22/03		
Date retrieved (sampled)	5/21/03	5/22/03	5/22/03		
Dry weight in air (A)	994.6	1149.8	1155.6		
Sat. surf. dry wt. (B)	997.3	1151.6	1159.3		
Weight in H_2O (C)	567.2	663.1	654.8		
Wt. of H_2O displaced	0	0	0		
Bulk Specific Gravity	2.312	2.354	2.291		
Lab Specific Gravity*	2.444	2.444	2.444		
% Relative Compaction	94.6	69.3	93.7		
Test number					
Station					
Distance rt. or lt. ℄					
Course					
Date placed					
Date retrieved (sampled)					
Dry weight in air (A)					
Sat. surf. dry wt. (B)					
Weight in H_2O (C)					
Wt. of H_2O displaced					
Bulk Specific Gravity					
Lab Specific Gravity*					
% Relative Compaction					

* This value must agree with CDOT Form #43 in effect at time of test
Note: Report % Relative Compaction (% Lab Density), etc. on CDOT Form #69

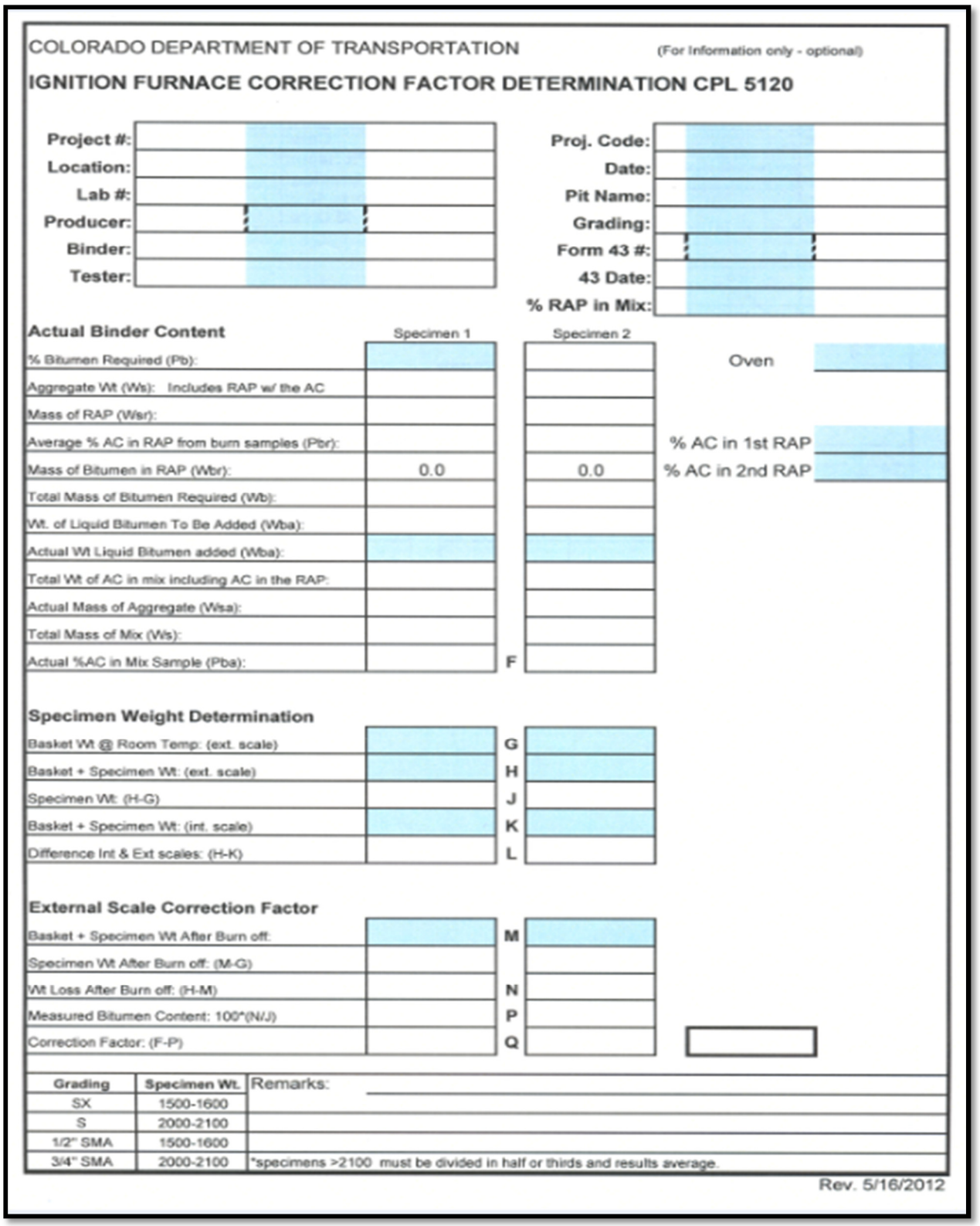
Bulk Specific Gravity = $\frac{A}{B - C}$ = (Wt. of displaced H_2O). See CP 44 in Field Materials Manual.

Remarks

Sampled by D. Elsbernd | Tested by D. Elsbernd | Date 5/23/03

CDOT Form #582 4/05

CDOT Form #582



COLORADO DEPARTMENT OF TRANSPORTATION (For Information only - optional)

IGNITION FURNACE CORRECTION FACTOR DETERMINATION CPL 5120

Project #:		**Proj. Code:**	
Location:		**Date:**	
Lab #:		**Pit Name:**	
Producer:		**Grading:**	
Binder:		**Form 43 #:**	
Tester:		**43 Date:**	
		% RAP in Mix:	

Actual Binder Content	Specimen 1		Specimen 2	
% Bitumen Required (Pb):				Oven
Aggregate Wt (Ws): Includes RAP w/ the AC				
Mass of RAP (Wsr):				
Average % AC in RAP from burn samples (Pbr):				% AC in 1st RAP
Mass of Bitumen in RAP (Wbr):	0.0		0.0	% AC in 2nd RAP
Total Mass of Bitumen Required (Wb):				
Wt. of Liquid Bitumen To Be Added (Wba):				
Actual Wt Liquid Bitumen added (Wba):				
Total Wt of AC in mix including AC in the RAP:				
Actual Mass of Aggregate (Wsa):				
Total Mass of Mix (Ws):				
Actual %AC in Mix Sample (Pba):		F		

Specimen Weight Determination			
Basket Wt @ Room Temp: (ext. scale)		G	
Basket + Specimen Wt: (ext. scale)		H	
Specimen Wt: (H-G)		J	
Basket + Specimen Wt: (int. scale)		K	
Difference Int & Ext scales: (H-K)		L	

External Scale Correction Factor			
Basket + Specimen Wt After Burn off:		M	
Specimen Wt After Burn off: (M-G)			
Wt Loss After Burn off: (H-M)		N	
Measured Bitumen Content: 100*(N/J)		P	
Correction Factor: (F-P)		Q	

Grading	Specimen Wt.
SX	1500-1600
S	2000-2100
1/2" SMA	1500-1600
3/4" SMA	2000-2100

Remarks:

*specimens >2100 must be divided in half or thirds and results average.

Rev. 5/16/2012

Project #:		**Proj. Code:**	
Location:		**Date:**	
Lab #:		**Pit Name:**	
Producer:		**Grading:**	
Binder:		**Form 43 #:**	
Tester:		**43 Date:**	

Agg Weights for

SX	1450
S	1950
3/4" SMA	1950
1/2" SMA	1450

0

Approx Agg Wt. including RAP if Applic.				
Approx Oil Wt.		**Totals for 4 Samples**	**Totals for 6 Samples**	**Totals for 8 Samples**
Approx Total Wt.				

%	Components	Each Agg Wt	Approx Total	Approx Total	Approx Total
1	Lime				
	1st RAP -	0.0			None for Grad
	2nd RAP -	0.0			None for Grad
1	Sum				
	Cellulose Fibers for SMA				

Remarks:

	1st RAP	2nd RAP
	GA of 1st RAP	GA 2nd RAP
	GA = Gradation Analysis from Mix Design	
1 1/2"		
1"		
3/4"		
1/2"		
3/8"		
#4		
#8		
#16		
#30		
#50		
#100		
#200		

Rev. 5/16/2012

COLORADO DEPARTMENT OF TRANSPORTATION
FIELD LABORATORY TEST RESULTS

Project No.	Contract ID
FBR 0404-050	C18180
Project Location: US 40 Over Sand Creek	

Contractor/Supplier:	Item	Class	Lot
Hamon Contractors	403		2
Attention: Larry Jones			

TEST NO.	6-AC	13 Mat D	14 Mat D	7-AC	15 Mat D	Item Description	
DATE	4/22/2015	4/22/2015	4/22/2015	4/22/2015	4/22/2015	S(100) PG64-22	
STATION	135+56	145+66	159+01	178+03	189+15		
LOCATION	NB-PASS	NB-PL 8'LT	NB-PL 3'LT	NB-PASS	NB-PL11'LT	Specs	Failing Test #
QUANTITY	1000	500	500	1000	500		
Sieve 1"	100			100		100	
Sieve 3/4"	99			98		90-100	
Sieve 1/2"	87			85		80-92	
Sieve 3/8"	79			76		71-83	
Sieve #4	62			61		58-68	
Sieve #8	50			50		44-54	
Sieve #16	35			34			
Sieve #30	28			25		22-30	
Sieve #50	21			19			
Sieve #100	9			8			
Sieve #100	7.3			5.3		4.0-8.0	
L.L.							
P.I.							
% Bitumen	5.03			5.12		4.70-5.30	
Max SpG	2.489			2.480			
Voids	3.7			3.1		2.5-4.9	
VMA	14.3			14.5		13.2-15.6	
% Rel. Comp.		94.5	94.1		94.8	92.0-96.0	
% Moisture	3.1			3.5		>2.5%	
Slump							
% Air							
Flex/Cyl PSI							
Other:							

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

Gradation on test # 7-AC is for infomation only.

CDOT (print name)	CDOT (sign name)	Date	Time
Leslie Kochis		04/22/2015	5:15 pm
Contractor's Representative (print name)	**Contractor's Representative (sign name)**	**Date**	**Time**
Larry Jones		4/23/2015	8:10 am

Original - ☑ Contractor
Copy 1 - ☐ Tester
Copy 2 - ☐ Project Engineer

Previous editions are obsolete and may not be used. **CDOT Form #626 5/14**

CDOT Form #634, Sample Label
Revision Date 05/2013
Approximate size 3 ½" (wide) x 3", self-adhesive label

Contract ID # (Proj. Code) 11925

Sample ID # _____ FS # 11902

Material type PG 64-22 Lot # 17

Material Code 702.01.01.03 Can # 1 - 3

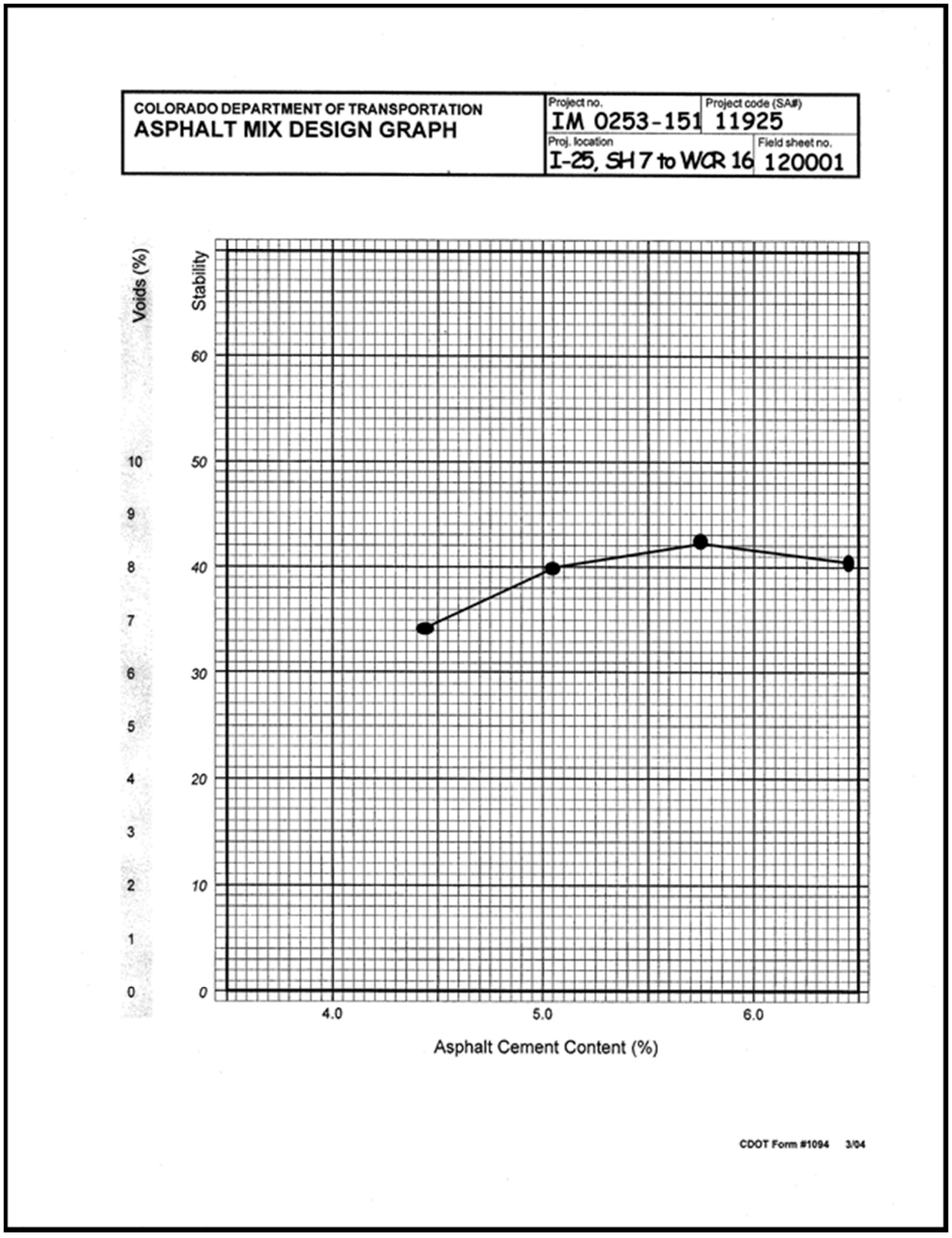
Lab Ref. # _____

COLORADO DEPARTMENT OF TRANSPORTATION
Materials & Geotechnical Branch
4670 N. Holly St. Denver, Unit A
Denver, CO 80216-6408

CDOT Form #634 05/2013

CDOT Form #634

Note: Applicable SDS documents are to be retained in Project Files



CDOT Form #1094

COLORADO DEPARTMENT OF TRANSPORTATION

LONGITUDINAL JOINT DATA

Project Code (SA #)	Project No.	Item	Design (Form 43 No.)
11925	IM-0253-151	403	12554

Date	Paving Contractor	Day or Night Paving	Avg. Lift Thickness
5/29/2010	Kiewit	Day	2.25"

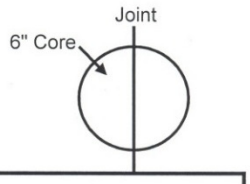
Region	Project Location	HMA Grading	Design Gyrations
4	I-25, SH 7 to WCR 16	S	(100)

Test Number		1	2	3	4	5	6	7
Station / Location		2+00	20+55	10+57				
Distance From Outside Edge of Pavement		15"	15'	15'				
Layer		Bottom	Bottom	Bottom				
Tonnage Core Represents								
Linear Feet Core Represents								
Dates Placed		Left Joint Placed / Right Joint Placed	Left Joint Placed / Right Joint Placed	Left Joint Placed / Right Joint Placed				
Date Cored		5/30/10	5/30/10	6/2/10				
*Dry Weight In Air (A)		3384.5	2301.4	2849.8				
*Sat. Surf. Dry Wt. (B)		3405.3	2412.0	2866.6				
*Weight in H20 (C)		1864.8	1364.3	1603.4				
Sat. Surf. Dry - Weight in H2O (B-C)								
Bulk Specific Gravity A/(B-C)		2.197	2.292	2.256				
Avg. Daily Max. Specific Gravity Value (Rice)	Lt. Of Joint / Rt. Of Joint	2.446 / 2.446						
	Average of Left and Right	2.446	2.446	2.456				
% Relative Compaction At Longitudinal Joint		89.8	93.7	91.0				
Joint Tack Used? (Y/N) (Note If Special Sealant Used)		Yes	See Note	Yes				

* *Follow Procedure Outlined in CP 44*

Comments: (ie. Joint Configuration, Compaction Method, etc.)

For joint core #1, contractor using 1' vertical w/3:1 taper made w/screed shoe. For joint core #2, contractor cut 3' off for vertical face. Tried cafco rubberized sealant before paving hot side joint. Joint #3 is the same as joint #1.



Tester:	Supervisor:
Richard Ramirez	Fidel Gonzales
Title: E/PS Tech II	Project Trailer Phone #: 303-555-1458

CDOT Form #1290 03/13

CDOT Form #1290

COLORADO DEPARTMENT OF TRANSPORTATION

HMA SAMPLE SUBMITTAL

Project No.	Location			Date Submitted	Serial No.
Project Code (SA#)	Function	Region	Participating	Form 43#:	Form 43 date:

Contractor	HMA Supplier	Previously used SA# & FS#:		Special Provisions applicable ☐ No ☐ Yes
Pit name or owner	Contact person	Contact phone #		Contact FAX #
Item # (if not 403)	Field Rice Value	Field Test No.	Quantity represented	Previous quantity	Total quantity to date

Sampled from (CP 41)
☐ Plant ☐ Auger
☐ Windrow ☐ Roadway

Grading
☐ S ☐ SMA
☐ SX ☐ SG
☐ ST ☐ SF
☐ Other: _____

Gyrations
☐ 50 ☐ 100
☐ 75 ☐ 125
☐ Other: _____

Grading
☐ PG58-28 ☐ PG64-28 ☐ Other: _____
☐ PG58-34 ☐ PG70-28
☐ PG64-22 ☐ PG76-28

AC & belt cut submitted
☐ Yes ☐ No

☐ Hamburg Rutter ☐ French Rutter

☐ AMPT

Comments:

Number of Cans Submitted

Central Lab	Region Lab
Flex Lab: _____	_____
Euro Lab: _____	
AMPT Lab: _____	

Date Sampled	Via (state, contractor or courier)	Date shipped	Shipped by

Sampled by	Title	Lab phone #
Supervisor	Title	Lab address

Distribution: White - Staff Materials (if sample is directed to Staff Materials)
Canary - Region Materials Engineer
Pink - Project file

CDOT Form #1304 3/13

CDOT Form #1304

COLORADO DEPARTMENT OF TRANSPORTATION

HMA SEGREGATION DATA

Project Code (SA#)	Mix Design	Region	Date	Ave Lift Thickness
12345	12345SX	4	5/22/06	2.5"

Paving Contractor	HMA Grading (S, SX, SMA)	Gyrations (50, 75, 100)	Binder Grade (58-28, 64-22, etc.)
Kiewit	SX	100	76-28

Truck Type	Delivery System Make and Model	Paver Make and Model
End Dump	IR MC-330 MTV	Blaw Knox AP 51

Look for a temperature difference of 25 degrees or more across the width of the mat within a 3 foot band.
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: X on SB CL
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.

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 Painted an "X" on the pavement at the CL near the green mailbox.
Orange paint, "1"	52" from CL	1021 + 20	245° F	287° F	92. 2%	123 feet from starting "X"
Orange Paint, "2"	31" from CL		253° F	285° F	92.3 %	60 feet from "1"
Orange Paint, "3"	38" from edge of pavement	Near 1024 + 00	241° F	281° F	91.1 %	219 feet from "2"
Orange Paint, "4"	51" from CL		230° F	280° F	90.7 %	630 feet from "3"
Orange Paint, "5"	49" from edge of pavement		249° F	280° F	92.4%	477 feet from "4"
Orange Paint, "6"	44" from edge of pavement		244° F	284° F	91.1%	300 feet from "5"
						1809 feet total
1639 feet (500	tons) occurred	between	"5" and "6". Do	not count reading	#6.	
Just two low	density readings	in 500 tons.	Contractor is	within segregation	spec.	guidelines.

Notes:
About 20 tons per truck. Count no two readings within: 20/ [(20' wide)(2.5" compacted)(.0061)] = 65.6 feet

500 tons is a length of: 500 tons/ (20' wide)(2.5" deep)(.0061) = 1639 feet.
There can be no more than 4 densities below 92.0% in 1639 feet.

Tester/Title	Phone Number	Supervisor
George Forman/ EPST I	303.421.8745	David Bradshaw

CDOT Form #1346 2/06

CDOT Form #1346

Best Practices for Minimizing Segregation

1. Aggregate Stockpiles

A. Build in layers.
B. Avoid any procedure that allows aggregate to be pushed or dumped over the side of a stockpile.
C. Separate to prevent intermingling.
D. Aggregate Handling:
(1) Loader operator works full face of stockpile.
(2) Install dividers on cold feed bins to prevent material from flowing into an adjacent bin.
(3) Do not pile aggregate so high that it flows over the dividers.

2. Loading Surge Silo: (If plant has batcher or gob hopper at top of silo.)

A. Adjust conveying devices to deposit material in center of batcher or gob hopper.
B. Keep gates on batcher or gob hopper closed unless dropping load of mix.
C. Close gates on batcher or gob hopper before it is empty to prevent material from dribbling into silo.

3. Loading Trucks:

A. Keep gates on bottom of silo closed so material does not dribble into trucks.
B. Take care to center trucks (Left to Right) when loading.
C. Consider loading trucks in multiple drops with first drop at rear, second drop at front, and then alternate dumps.
D. If the mix is prone to segregate you should avoid loading trucks by slowly driving forward while dropping mix.

4. Dumping Trucks:

A. To provide a surge of material to the paver, when using end dump trucks, the box should be raised until the mix moves to the rear before opening the tailgate.
B. If any mix is spilled on the roadway in front of the paver while dumping the truck, this mix should be removed from the roadway before the paver starts forward.

5. Laydown Operations:

A. Only dump wings of the hopper at the end of the day and then waste this material. Do not knock cold material off the wings and into the hopper.
B. To provide consistent flow of material to the screed, the operator should avoid gradual deceleration or gradual acceleration.
The paver should be stopped and started quickly at normal operating speed.
C. Keep hopper more than half full at all times.
D. Auger height should be adjusted so bottom of auger is at least two (2) inches above the finished surface of the mat.
E. Adjust feed sensors to keep material near the center of the auger at all times.
F. Correctly adjust the lead and trail crown of the screed so that the surface of the HMA behind the paver is uniform in appearance and texture.
G. Install reverse fins at the center of auger to tuck the proper amount of material under the gear box.
H. Adjust flow gates at rear of the hopper so that:
(1) The slat conveyors run continuously.
(2) The amount of material furnished to the augers allows them to run nearly 100% of the time.
I. The risk of causing thermal segregation is increased when paving in cooler temperatures.

6. Windrow Elevators:

A. When using pick up machines, they should be adjusted such that all the HMA is removed from the surface.

CDOT Form #1346, Page 2 (Information Only)