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Case Studies Using Quality Control for Performance and Pay for Performance Specifications: Field Observations

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16. Abstract

Quality assurance programs for hot-mix asphalt (HMA) have evolved from method to quality assurance specifications that distribute responsibilities and risks between contractors and owners. The Illinois Department of Transportation developed two acceptance specifications, quality control for performance (QCP) and pay for performance (PFP), integrating contractor pay incentives and/or disincentives associated with air voids, voids in mineral aggregate, and in-place density limits. During 2015 to 2016, approximately 55% and 44% of QCP and PFP HMA tonnage production was paid with disincentives. The objective of this project was to understand the potential root causes of pay disincentives and test result variability in QCP and PFP contracts. Eleven contracts were visited during the 2018 construction season, and data of the observation results were analyzed. During the site visits, HMA sampling, coring, and testing procedures were observed and documented by the research team. Later, sublot test results, pay factors, datalogger outputs, and round robin test results were analyzed to identify issues with the mix production and construction. Analyses indicate that mix production, construction, and testing issues were likely to have caused pay disincentives to the contractors. The causes varied per contract. Production issues were related to aggregate consistency, handling, variability, and contamination, as well as to uncontrolled mix switches. Testing issues were related to reheating/absorption, lab gyratory compaction differences, and inconsistencies in the volumetric test weights. Construction included compaction equipment uses and condition of the milled surface. Results of the evaluations are intended to provide contractors and districts with observed best practices to improve pay factors and enhance HMA quality. The observations from this study should serve as guidelines for contractors to improve their pay factor performance and product quality and for IDOT to ensure consistent, timely, and reliable test results are used for determining contractor pay.

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EXECUTIVE SUMMARY

Quality assurance (QA) programs for hot-mix asphalt (HMA) have evolved from method to QA specifications that distribute responsibilities and risks between contractors and owners to ensure that the final product meets acceptable criteria. The Illinois Department of Transportation (IDOT) developed two acceptance specifications, quality control for performance (QCP) and pay for performance (PFP), integrating contractor pay incentives and/or disincentives associated with air void (AV), voids in mineral aggregate (VMA), and in-place density limits. The main difference between QCP and PFP is the calculation approach of pay adjustments; QA oversight, test frequency, and risk level also contribute to the difference. QCP is a stepped payment system in which fixed pay disincentives are assigned to measured-quality ranges. QCP is used for small mainline HMA contracts, in which mixture quantities range between 1,200 and 8,000 tons at the time of bidding. PFP is a percent-within-limits (PWL) specification with incentives/disincentives used for the national highway system, state roadways, and full-depth asphalt pavement contracts with a minimum mix quantity of 8,000 tons.

From 2015 to 2016, approximately 55% and 44% of QCP and PFP HMA production tonnage was paid with disincentives. The disincentives and incentives averaged approximately $20,000 and $30,000 per project, respectively. For a large PFP project, however, disincentives and incentives went up to $100,000. Additionally, 196 PFP mix and density sublots were disputed. As a result, 11 QCP or PFP contracts were visited and evaluated to identify the reasons for pay disincentives, incentives, and disputes.

The site visits to QCP and PFP contracts were conducted during the 2018 construction season. Contract sites were visited by the research team to assess possible causes of pay disincentives. Each jobsite visit consisted of three parts. First, district and contractor personnel were interviewed. The questions focused on the testing procedures followed and data analysis to identify differences between the testing procedures and equipment. Second, the research team visited the district laboratory, contractor plant, and jobsite to monitor production, construction, sampling, blending, and splitting. Third, pay factors, test results, plant datalogger, and other supporting information were collected to evaluate the root causes of pay disincentives.

Interviews were held in the district office or HMA plant, depending on the availability of personnel. During the interviews, contractors’ views and concerns related to QCP and PFP specifications were noted. To identify differences between QCP and PFP contracts, contractors explained their mix design procedures. Questions on mix production were asked to understand the frequency and reasons for mix switches, hot stops (pausing during HMA production), or other deviations. Mix switches indicate a plant changes to different mix designs within the same production day. In addition, the contractor or district engineer presented testing, production, and/or construction techniques used that would help achieve consistent and acceptable test results. Finally, suggestions on improving IDOT’s current QA programs were noted.

After the interview was concluded, district and contractor HMA laboratories were visited. The research team observed stockpile- and tower-control conditions during contractor plant visits.

Stockpile conditions were noted, including base material type, entry/exit points, and barriers. The research team observed production from within the control tower and talked with the plant operator about procedures to control the mix, hot stops, and mix switching. After they visited the plant, the team drove the HMA haul truck route to the jobsite to record the hauling time and observe the type of trucks used to haul the mix. At least one mix sampling and density coring were observed in each visited jobsite.

Once the visits were concluded and pay awarded, QCP and PFP data were analyzed. The following data were requested from the contractor or district for each visit: pay summary report, mix design, mix and density sublot test reports, QC/QA package data, and datalogger output. First, the pay factor that caused a disincentive was identified. The mix sublot results were analyzed to identify significant differences between contractor and district results. The maximum theoretical specific gravity (G_{mm}) and bulk specific gravity (G_{mb}) results were compared with the mix design to identify the possible source of disincentives. Also, the recovered aggregate gradation results and AC content were compared to the design blend. Finally, the datalogger was evaluated to identify variations in production speed, dust control, and AC content. Other operational activities such as mix switches and hot stops were identified from the datalogger.

Issues in mix production, construction, and sample testing could have caused contractor pay disincentives. Mix issues were related to aggregate consistency, variability, and contamination, as well as excessive mix switches. For aggregate consistency, changes in the aggregate gradation and specific gravity may occur between shipments originating from the same quarry. Consequently, targeted volumetric properties of the design could not be met. In plants with limited space, aggregate contamination affected the results when aggregate stockpiles were not separated by barriers. Several mix switches between different designs per day may affect the mix quality.

Testing issues were related to reheating/binder absorption, gyratory compactor offsets between contractors and districts, lack of sample blending prior to splitting, and inconsistencies in volumetric test weights. At some sites, a systematic error was observed in the G_{mm} results, indicating issues with the amount of asphalt binder absorbed due to reheating. Two different gyratory compactors may compact the same mix sample differently. For example, mixes that are the same weight may be compacted to different heights, or vice versa.

Construction issues included compaction equipment and condition of the milled surface. In addition, management issues were observed in the field, including the occasional absence of an experienced IDOT engineer supervisor and/or disabled equipment. The observations are intended to improve HMA production, construction, and/or testing quality, as well as the potential for contractors to receive payment incentives.

IDOT and contractors should consider accreditation or participation in the AASHTO re:source proficiency sample program and continue IDOT round robin data analysis to identify any offsets. At minimum, it would be beneficial for all testing labs to adhere to the "Best Practices for PFP and QCP Implementation" document in IDOT's *Manual of Test Procedures*. Workforce training of the PFP specifications is needed to help contractors optimize pay factors. Only personnel meeting IDOT's Quality Management Training Program requirements should participate in field sampling. In addition, the proper number of certified and trained personnel should be assigned for field sampling and laboratory testing. Improvement of the central database to include all information available is recommended through the new IDOT Construction and Materials Management System (CMMS).

Tracking G_{sb} is recommended as a quality control activity to monitor incoming aggregate and test protocols of AC content, reclaimed asphalt pavement, and production. Plants should use barriers between aggregate stockpiles. To better control cold feeds, the aggregate stockpile should not constitute more than 30% of a single mix; the aggregate stockpile should be split between multiple cold feed bins. Issues with dust control may be reflected in G_{mb}.

Regular equipment calibration and consistency in specimen preparation are important to achieve uniformity. This includes consistency in sample presplitting, blending, splitting, reblending, and reheating, as well as density determination. The more mix switches per day, the greater the challenge in controlling AC content and aggregate gradation. In addition, maintaining production speed and avoiding paver stops are recommended. Finally, a design VMA at least 0.5% above the minimum value is recommended. The availability of district results within the optimum pay window may also minimize variation.

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CHAPTER 1: INTRODUCTION

BACKGROUND

The Illinois Department of Transportation (IDOT) adopted two specifications, quality control for performance (QCP) and pay for performance (PFP), to determine contractor pay incentives and/or disincentives for hot-mix asphalt (HMA). The specifications are intended to meet the Code of Federal Regulations (23 CFR 667) and Federal Highway Administration (FHWA) Technical Advisory recommendations (IDOT, 2010). Additionally, they are intended to achieve better control of the quality of constructed pavements. Pay for QCP and PFP is adjusted based on HMA properties (volumetrics) that are related to performance (FHWA, 2019; NCHRP, 2011). IDOT uses air voids (AV), voids in the mineral aggregate (VMA), and field core density as the parameters to compute pay. HMA contracts are based on pay items. Projects between 1,200 and 8,000 tons per mix are paid using QCP, while projects with more than 8,000 tons are paid using PFP (IDOT, 2018a).

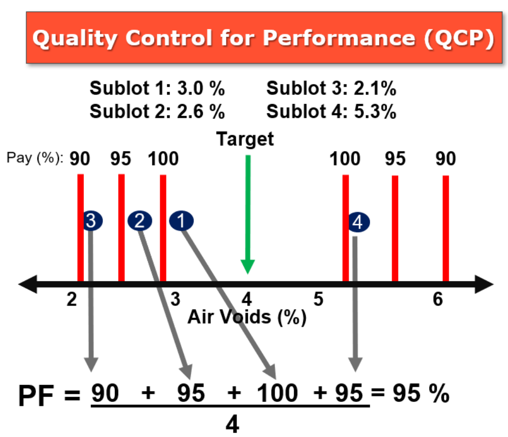
QCP and PFP quality control (QC) is carried out by contractors using field samples tested at the plant laboratory. Quality assurance (QA) is performed by an agency, i.e., IDOT. Illinois is divided into nine districts, with at least one HMA laboratory per district in charge of QA testing. IDOT Central Bureau of Materials (CBM) also has a dispute-resolution HMA laboratory for PFP contracts. QCP does not allow dispute testing by IDOT CBM. However, QCP requires the district to retest samples if the results are not within the precision limits reported by the contractor. In this report,"district" refers to all QA testing conducted by IDOT or the QA consulting laboratory. "Contractor" refers to all QC testing performed by the contractor or QC consulting laboratory.

QCP and PFP sample collection is similar. Samples are collected from the roadway to measure three pay parameters: AV, VMA, and field core density. For AV and VMA, mix samples are typically collected from the mat after the paver places the mix on the roadway. For field density, cores are extracted once the mat has been compacted and cooled down. For PFP, mix samples in Illinois are split between the contractor, district, and IDOT CBM for dispute resolution. The mix samples should provide enough material to allow each lab to produce one asphalt content (AASHTO T 308-18) and aggregate gradation (AASHTO T 30-19), two G_{mb} (AASHTO T 166-16), and two G_{mm} (AASHTO T 209-19) replicates.

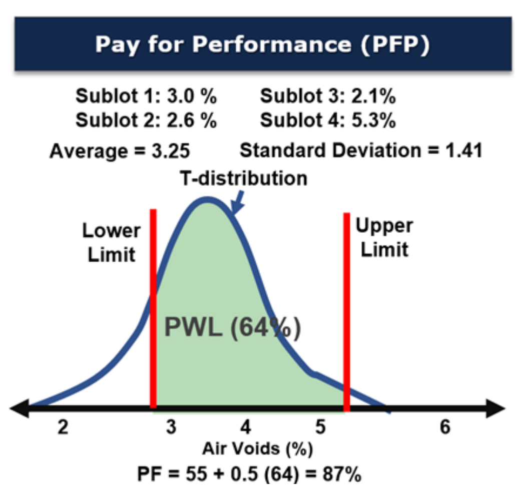
Split samples are collected at a rate of one per sublot. A sublot is typically 1,000 tons of HMA. Typically four sublots constitute one lot in QCP. A total of 10 mix sublots constitute one lot in PFP. In QCP, IDOT randomly tests one sublot per lot. If the district's random sublot results are within the required limits for 100% pay and contractor's results are comparable to IDOT results (based on IDOT limits of precision), the pay factors (PFs) for the entire lot are assigned based on that sublot (IDOT, 2018b). If the results fail to meet either criterion, all QCP sublots are tested by the district to assign pay. For PFP, all IDOT sublots are tested to assign pay (IDOT, 2018c).

The difference between QCP and PFP is based on the method used to compute the PF for each pay parameter (AV, VMA, and field density). QCP is a step system in which a PF is based on how far test results are from a specified target. Figure 1-A shows an AV PF computation for a hypothetical project of 4,000 tons (four sublots). For example, sublot 2 has 2.6% AV, which corresponds to a PF of 95% (IDOT, 2018b). Once all sublots are assigned a PF, the average is the final AV PF for the contract. The same procedure is used to compute PF for VMA and field density.

In PFP, the average and standard deviation of the test results from all sublots are used to compute the three PFs. All sublot results are used to fit a t-distribution that is used to compute the AV, VMA, and field density PF. Figure 1-B shows an AV PF computation for the same sublots used in the QCP example. First, the average and standard deviation of all the sublot results are computed. Then, a normal distribution is fit using the average and standard deviation. A normal distribution is a statistical representation of data that determines the percentage of the whole population (4,000 tons of HMA, in this case) that is within certain limits (specified AV limits, for example). This PWL is used to determine the pay factor as PF = 55 + 0.5*(PWL). The same procedure is used to compute a PF for VMA and field density. Details and restrictions of PF calculation for both specifications can be found in IDOT (2018a).



A. QCP example of an air void computation



B. PFP example of an air void computation

Figure 1. Chart. Computation of an air void pay factor for a hypothetical project of 4,000 tons (four sublots) using (a) QCP and (b) PFP specifications.

Once the three pay factors are computed and averaged for all lots, QCP and PFP combine the PF into one composite pay factor (CPF) (Figure 2):

$$CPF = 0.30(PF_{AV}) + 0.30(PF_{VMA}) + 0.40\ (PF_{Density})$$

Figure 2. Equation. Composite pay factor formula.

where

CPF: composite pay factor

PF_{AV}: AV pay factor

PF_{VMA}: VMA pay factor

$PF_{Density}$: density pay factor

This equation is then used to compute contractor pay by multiplying the CPF, price per ton, and total tonnage used in construction. Please refer to Al-Qadi et al. (2020) for further details.

During 2015 to 2017, approximately 55% and 44% of QCP and PFP HMA production tonnage received disincentives. The disincentives and incentives averaged approximately $20,000 and $30,000 per project, respectively. In a large PFP project, however, the disincentives and incentives were up to $100,000. Additionally, 196 PFP mixes and density sublots were disputed. This has brought attention to PF determination and raised questions about QCP and PFP disincentives, reflecting issues with mix production and construction.

OBJECTIVE AND RESEARCH SCOPE

The objective of this project was to understand the distribution and variability of the test results included in QCP and PFP specifications, the potential causes of variability, and the associated balance of risk between the contractor and district. The study was intended to address practical concerns and questions regarding QCP and PFP specifications and evaluate the trends observed when comparing IDOT contactor and district test results. The study had two major components. First, statistical analyses of QCP and PFP data to understand the reasons driving pay disincentives and disputes. Second, an evaluation of 11 site visits to QCP and PFP projects during the 2018 construction season.

The statistical analyses are covered in Volume 1 of the project's final report (Al-Qadi et al., 2020). The statistical analyses evaluated the data used to determine pay in both programs from 2015–2017 for more than 700 mix contracts (Al-Qadi et al., 2020). Data were collected from four sources: PFs, sublot test results, PFP dispute data, and round robins. The pay factors define pay incentives and disincentives. The sublot test results are the volumetric test results (G_{mm}, G_{mb}, AV, VMA, aggregate gradation) and field density from cores used to compute the pay factors. The PFP dispute data consist of the results of the third-party laboratory used to decide the final pay of sublots that were disputed by the contractor. Round robins are annual tests conducted by IDOT in which different labs are given the same samples for testing G_{mm}, G_{mb}, asphalt binder content, and aggregate gradation. Ideally, they should report the same results.

The statistical analyses detailed in Al-Qadi et al. (2020) intended to identify several causes of pay incentives/disincentives. However, the test results do not document all factors that could influence pay and test variabilities. Material/production, construction, sampling, blending, and testing have the potential to affect the results. Within these categories lie factors that can have an impact on the test results. For example, changes in production speed, hot stops, and mix switches affect production. Reheating time and type of gyratory compactor affect testing. As a result, jobsite visits were conducted that allowed documentation of the factors that may help identify the most probable causes of pay incentives or disincentives (Al-Qadi et al., 2020).

This report focuses on the results of the site visits conducted at 11 construction contracts in which production, construction, sampling, and testing were evaluated to identify possible sources of variability, low-quality production, pay disincentives, and differences between contractor and district test results. Each jobsite visit comprised of three parts. First, interviewing contractor and district personnel on testing procedures and data analysis. The interviews allowed contractors and districts to express their views regarding the specifications. The questions were intended to identify deviations from standard procedures or any other practice that may attribute to the variability and inconsistency or helped to reduce variability in the results. Second, jobsite visits were conducted to monitor sampling, blending, and splitting during mix production and construction at district laboratories, plants, and jobsites. The observations allowed the research team to document specific techniques and conditions in which samples were produced. Third, the PFs, test results, plant datalogger output, and other supporting data from the project were collected to identify possible causes of pay incentives/disincentives and differences between contractor and district test results.

REPORT ORGANIZATION

The report's chapters are organized as follows. Chapter 2 presents the research's methodology used to conduct and evaluate the jobsite visits as well as the data collected and used in the study. Chapter 3 presents observations from construction project visits during the 2018 construction season and summarizes observations from interviews with district personnel and contractors. The chapter also presents the data analysis and results from the jobsite visits. Chapter 4 summarizes the conclusions of this study and lists observations to reduce the sources of test variability, provide consistent results between laboratories, and improve HMA quality.

IMPACT OF THE STUDY

The results of this study identify possible causes of variability from the data collected on projects constructed under IDOT's QCP and PFP specifications. Observations of the site visits are intended to provide guidance to contractors about the likely sources and issues that can occur in their respective construction projects. By addressing these causes, it is expected that higher-quality material would be constructed and fewer disincentives would be received. By addressing testing issues, it is expected that improved representative samples will be obtained and fewer differences will arise when comparing contractor and district test results. This would lead to a reduced potential for disputes between districts and contractors during the acceptance process, overall higher pay for the contractor, and better pavement performance.

CHAPTER 2: METHODOLOGY FOR JOBSITE VISIT ANALYSIS

This chapter presents the methodology used for jobsite visits, interviews, and data evaluation. First, the criteria used to select the studied contracts are introduced. Then, the procedure used to conduct the interviews and site visits is explained. Afterward, the data collected from each contract is described. Finally, the data evaluation procedure, which includes statistical analysis and data visualization, is presented.

SITE-VISIT SELECTION

The contract selection was conducted to obtain a representative sample of the state of Illinois. Eleven contracts were selected, and four criteria were used: (1) geographic location of the project, (2) similar number of QCP and PFP contracts, (3) similar number of contractors that were more likely to achieve full pay or incentives and contractors that were more likely to be assigned disincentives, and (4) contracts represent typical HMA projects built in Illinois during the 2015–2017 construction seasons.

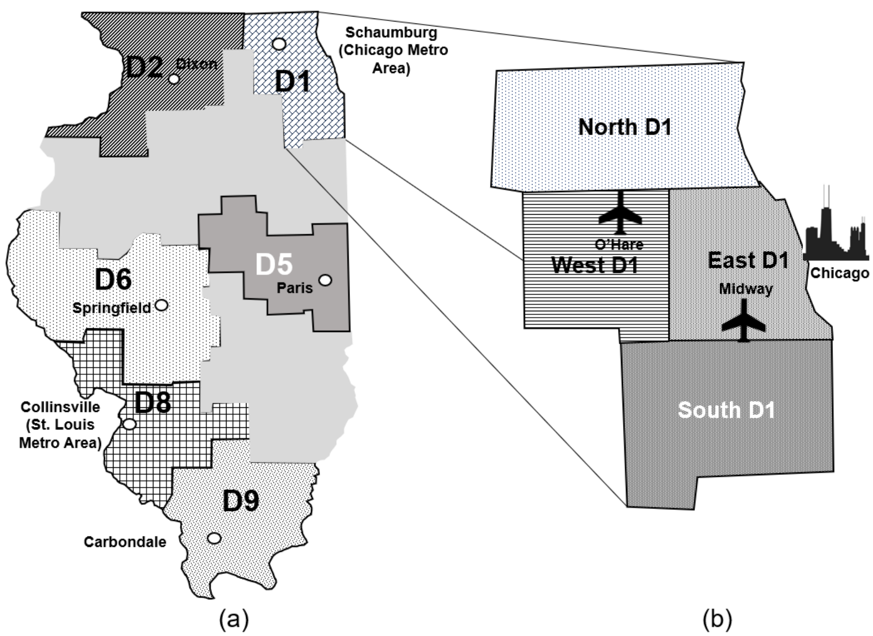
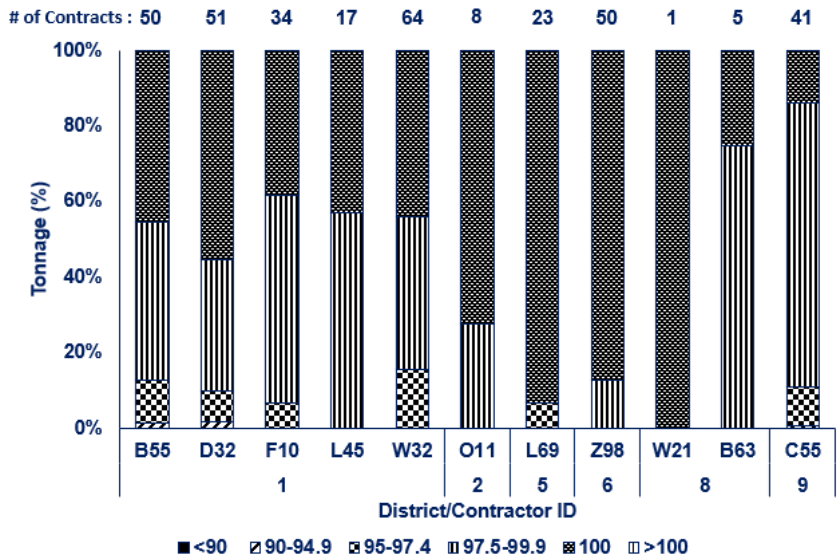


Figure 3. Map. IDOT districts included in the jobsite visits.

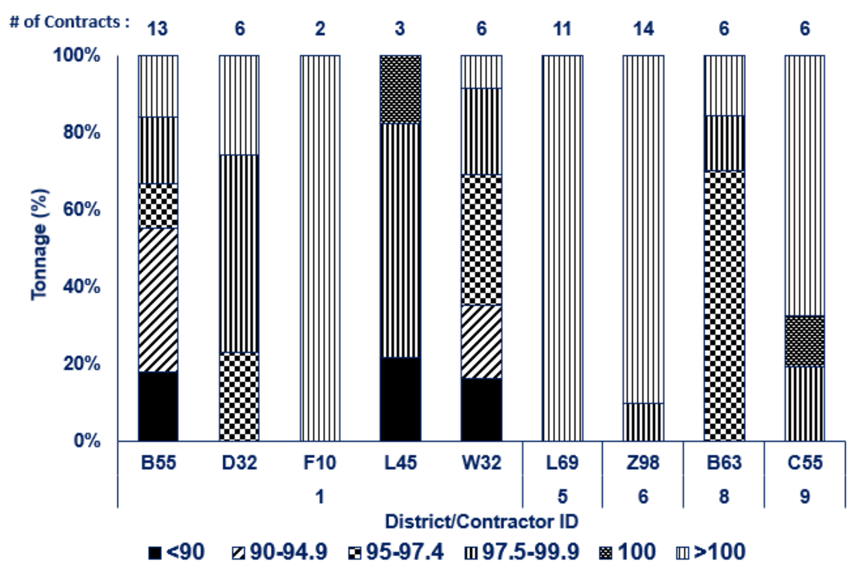
Illinois is divided into nine IDOT districts; sampled districts 1, 2, 5, 6, 8, and 9 are highlighted (Figure 3). The districts operate differently, depending on their needs. For example, District 1 is the largest district in terms of HMA production, resulting in the largest number of samples tested daily. Consequently, District 1 hires consultants or has more than one shift to perform testing, which is not common in other districts. At least one contractor was selected from each of the six districts considered within this research project. Because of the large number of contractors within District 1, five contractors were selected from this district. District 1 contractors were from the north, south, west, and east sections of the district. Two contractors from District 8 and one contractor from each of the remaining districts were chosen.

A similar number of QCP and PFP projects were selected. QCP and PFP project specifications are different, as explained in Chapter 1. Five site visits were to QCP projects and six were to PFP projects. Most PFP site visits occurred in District 1, where larger projects in the 2018 construction season were built. Districts 5, 6, and 9 were mostly executing QCP projects during this period.

The research team selected a similar number of contractors who were more likely to achieve full pay or incentives as well as be assigned disincentives. To achieve this, the CPF of the contractors visited was considered in the site selection. Figure 4 shows the 2015–2017 pay factor distribution for the visited contractors. A similar selection approach was used with QCP and PFP.



A. QCP projects



B. PFP projects

Figure 4. Chart. 2015–2017 pay factors of contractors visited during the 2018 site visits.

Contracts were selected to cover possible combinations of road and mix types. The jobsites visited included three road types: interstates, other principal arterials, and minor arterials. Regarding mix types, Illinois currently uses surface course (SC), binder course (BC), or leveling binder (LB) layers in their projects. Surface course refers to the wearing surface of the pavement (approximately the first 1.5 to 2 in). Binder courses are structural layers of the pavement. (Lift thickness is usually 2 to 4 in.) Leveling binders are the fine-graded mixes used to level the milled surface of a roadway before a surface mix is placed. (Note: leveling binders were removed in 2019 specification updates to maintain a minimum thickness of three times the nominal maximum aggregate size (NMAS) of the mix). Table 1 shows a summary of the studied contract on each site visit. The six mixes from the selected jobsites were one SC, two BC, two LB, and one stone matrix asphalt (SMA).

INTERVIEWS AND SITE-VISIT EVALUATION

The interviews and site visits were conducted during the 2018 construction season (June–October). During the site visits, interviews with IDOT district and contractor personnel were conducted. Next, HMA plant facilities and contractor testing laboratories were observed. Then, the researchers drove to the jobsite using the haul truck route. At the jobsites, paving, HMA sampling, and core extraction (for density) were observed. Finally, the district laboratory was visited. District and contractor interviews were conducted on the same day as the jobsite visit, except for District 1. District interviews were performed at district HMA laboratories.

The interviews with district and contractor personnel identified differences between their procedures that may have caused data variability or testing bias. The following topics were discussed:

- Concerns related to QCP and PFP specifications.
- Procedures for mix design.
- Mix production (mix switches, hot stops).
- Techniques observed or implemented that achieve better pay.

Finally, suggestions on improving the current QA program were collected. Appendix B includes the questions that were asked to contractors during the site visits along with the list of surveyed parts for the plant and jobsite visit.

District and contractor HMA laboratories were visited after the interviews. The team observed cleaning procedures and conditions of the equipment used for reheating, blending, and compaction. The equipment included an ignition oven, gyratory compactor, oven, splitter, pycnometer, and water bath. Four methods to perform aggregate extractions are used in Illinois: reflux, centrifuge, ignition oven, and automated extraction. Only the ignition oven and automated extraction devices were used during the site visits. The procedure to obtain and handle samples from QCP and PFP projects used by the visited contractor was observed, including storage, reheating, and reblending.

Table 1. Summary of Selected Jobsites

Site Visit	Dist.	No. of Lanes	Road Cat.	Spec.	Mix Type	QA	MTD Use	Reblending	Thick. (in)	Contractor Gyratory Compactor	District Gyratory Compactor
1	1	4	Minor Art.	PFP	SC N70 D REC	Dist.	NO	YES	2	Pine GB1 Brovold	Pine AFG2
2	1	4	Other Prncpl. Art.	PFP	SC N70 D 9.5 REC	Dist.	NO	NO	1.5	Troxler 5850	Pine AFG2
3	1	4	Other Prncpl. Art.	PFP	SMA N80 9.5 REC	Dist.	YES, partial	NO	1.75	Pine AFGC125X	Pine AFG2
4	1	2	Other Prncpl. Art.	PFP	SC N70 E	Dist.	NO	YES	1.75	Pine AFG2	Pine AFG2
5	1	2	Minor Art.	QCP	SC N70 D REC	Dist.	NO	YES	1.5	Pine AFG2	Pine AFG2
6	2	4	Inters.	PFP	BC N90 19.0R	Dist.	YES	YES	2.25	Troxler 5850	Troxler 4140
7	5	4	Other Prncpl. Art.	QCP	SC N90 D REC	Dist.	NO	YES	1.5	Pine GB1 Brovold	Troxler 4140
8	6	4	Inters.	PFP	BC N90 19.0R	Dist.	YES	YES	2.25	Troxler 4141	Troxler 5850
9	8	2	Other Prncpl. Art.	QCP	LB N70 REC	Dist.	NO	YES	0.75	Troxler 4141	Pine AFG2
10	8	2	Other Prncpl. Art.	QCP	SC N70 E	Dist.	YES	YES	1.5	Troxler 4140	Pine AFG2
11	9	2	Other Prncpl. Art.	QCP	LB N90 FG REC	Dist.	YES	YES	0.75	Pine G1	Pine AFG2

The jobsite visits started at the asphalt plant. The team observed the plant, stockpiles, and tower control operations. The following details were observed at the plant:

- Manufacturer
- Plant type and condition
- Procedure to waste mix
- Years in operation
- Asphalt cement (AC) pump type
- Dust control
- HMA storage silo
- Operator experience
- Loading of trucks

Base material type, entry/exit points, and barriers in stockpiles were observed. The team visited the control tower to observe the panel and talk with the plant operator. Procedures to control the mix, hot stops (when HMA production is paused), and mix switches were discussed. Finally, the datalogger output was requested to evaluate the final production of the mix.

The team drove the haul truck route to the jobsite to record the haul time and observe the type of trucks used to haul the mix. Pavement construction observations focused on the following:

- Weather condition
- Paver model
- MTD model
- Placing procedure
- Roller equipment

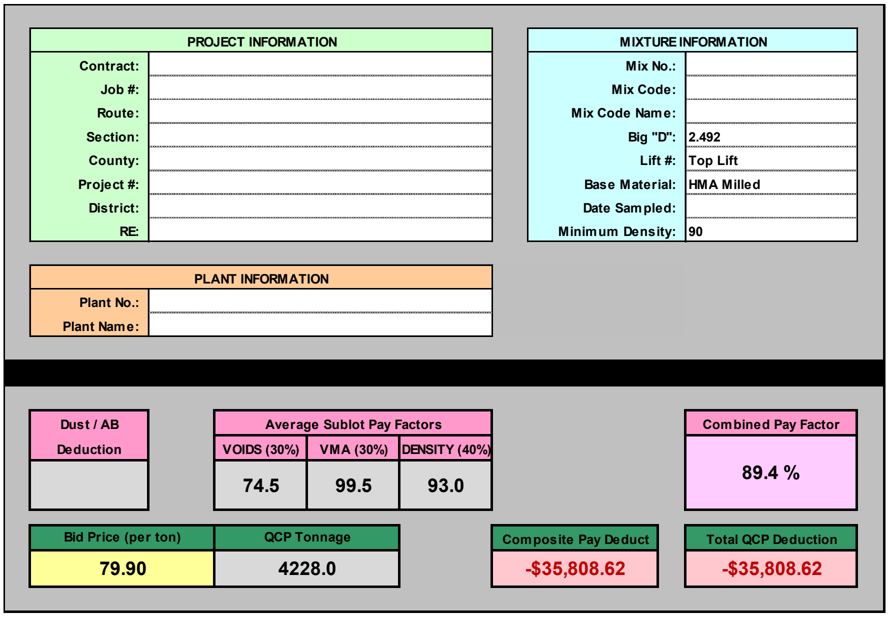
At least one mix sampling and density coring sublot was observed in each visited jobsite. The following were observed during sampling:

- HMA sampling method
- Number of times the sample was split and reblended
- Type of splitter
- Coring equipment
- Storage and sample security

DATA COLLECTION

Quality control and quality assurance data were requested for the 11 sites visited. Data were collected in winter 2018–2019 to allow IDOT to determine pay and resolve any disputes before the sites were evaluated. Six pieces of information were requested from the contractor or district for each visit: pay summary, mix design, mix and density sublot test reports, QC/QA package data, and datalogger output.

The pay summary sheets are the final document produced by IDOT's QC/QA package software that reports the final pay factors. The software stores all sublots results and analyzes them according to either the QCP or PFP specification. Figure 5 shows an example of a pay summary sheet, which provides the contractor's name and contract as well as mix and plant identification information. The three PFs (AV, VMA, field density) and the CPF are reported. Finally, the total produced tonnage as well the price per ton is reported.



PROJECT INFORMATION	
Contract:	
Job #:	
Route:	
Section:	
County:	
Project #:	
District:	
RE:	

MIXTURE INFORMATION	
Mix No.:	
Mix Code:	
Mix Code Name:	
Big "D":	2.492
Lift #:	Top Lift
Base Material:	HMA Milled
Date Sampled:	
Minimum Density:	90

PLANT INFORMATION	
Plant No.:	
Plant Name:	

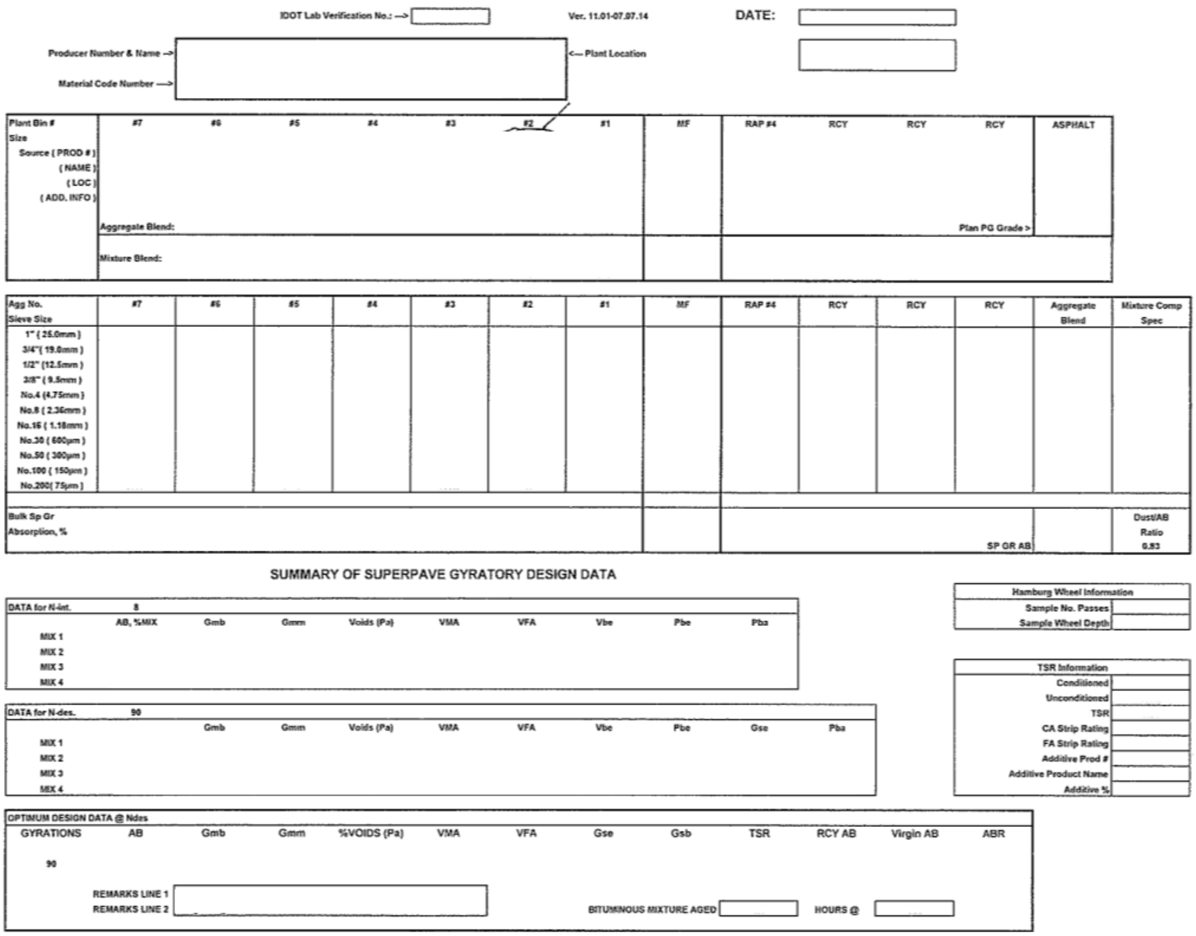
Dust / AB Deduction	Average Sublot Pay Factors			Combined Pay Factor
	VOIDS (30%)	VMA (30%)	DENSITY (40%)	
	74.5	99.5	93.0	89.4 %

Bid Price (per ton)	QCP Tonnage	Composite Pay Deduct	Total QCP Deduction
79.90	4228.0	-$35,808.62	-$35,808.62

Figure 5. Photo. Example of a pay summary sheet for QCP.

IDOT's mix design sheet (Figure 6) provides the aggregate combination and design volumetric results approved by the district. The sheet shows producer information and the plant where the mix was produced. The aggregate stockpile information includes source, name, producer location, gradation, bulk specific gravity, and absorption. The stockpile percentage proportions used for the blend are reported with the corresponding blend gradation in the aggregate rows. The second half of the sheet shows the SuperPave volumetric design data for the blend gradation. It includes G_{mb} and G_{mm} vs AC% curves used to determine the optimum binder content. These curves are reported for the initial number of gyrations (N_{ini}) and the design gyrations (N_{des}). Then, the AV, VMA, VFA, G_{se}, and G_{sb} for the optimum binder content are reported. G_{se} and G_{sb} are aggregate effective and bulk specific gravities, respectively. In the 2015–2017 research period, the sheet reported the performance test results of the Hamburg Wheel Tracking (rutting) and Tensile Stress Ratio (moisture). The current mix design sheet also reports the Illinois Flexibility Index Test (I-FIT) Flexibility Index (cracking potential) parameter results.

The sublot results for PFP dispute resolution were collected as well. PFP projects allow contractors to dispute district (QA) sublot results when the difference between the results exceeds the precision limits shown in Table 2. The contractor must request the sublot to be disputed. Thus, not all sublots that exceed the precision limits are disputed. Currently, two methods are used for dispute resolution (IDOT, 2018a). The first method allows the contractor to dispute the pay parameter result such as AV, VMA, dust/AC ratio, or core density when the results are outside the precision limits (Table 2). IDOT's Central Bureau of Materials (CBM) laboratory then tests the third sample of the disputed sublot and replaces the district test results with IDOT CBM test results. In 2018, IDOT began a second method that allows the contractor to dispute an individual test, such as G_{mm}, G_{mb}, or P_b, that exceeds the precision limits shown in Table 2. This method applies only to contractors who participate and comply with the AASHTO re:source proficiency sample program. In this study, data collection occurred before 2018. Therefore, all disputed sublots were tested using the first method.


IDOT Lab Verification No.: -->
Ver. 11.01-07.07.14
DATE:
Producer Number & Name -->
Material Code Number -->
<-- Plant Location

Plant Bin #	#7	#6	#5	#4	#3	#2	#1	MF	RAP #4	RCY	RCY	RCY	ASPHALT
Size													
Source (PROD #)													
(NAME)													
(LOC)													
(ADD. INFO)													
Aggregate Blend:												Plan PG Grade >	
Mixture Blend:													

Agg No. / Sieve Size	#7	#6	#5	#4	#3	#2	#1	MF	RAP #4	RCY	RCY	RCY	Aggregate Blend	Mixture Comp Spec
1" (25.0mm)														
3/4" (19.0mm)														
1/2" (12.5mm)														
3/8" (9.5mm)														
No.4 (4.75mm)														
No.8 (2.36mm)														
No.16 (1.18mm)														
No.30 (600µm)														
No.50 (300µm)														
No.100 (150µm)														
No.200 (75µm)														
Bulk Sp Gr												SP GR AB		Dust/AB Ratio 0.83
Absorption, %														

SUMMARY OF SUPERPAVE GYRATORY DESIGN DATA

DATA for N-int. 8	AB, %MIX	Gmb	Gmm	Voids (Pa)	VMA	VFA	Vbe	Pbe	Pba
MIX 1									
MIX 2									
MIX 3									
MIX 4									

DATA for N-des. 90	Gmb	Gmm	Voids (Pa)	VMA	VFA	Vbe	Pbe	Gse	Pba
MIX 1									
MIX 2									
MIX 3									
MIX 4									

Hamburg Wheel Information
Sample No. Passes
Sample Wheel Depth

TSR Information
Conditioned
Unconditioned
TSR
CA Strip Rating
FA Strip Rating
Additive Prod #
Additive Product Name
Additive %

OPTIMUM DESIGN DATA @ Ndes

GYRATIONS	AB	Gmb	Gmm	%VOIDS (Pa)	VMA	VFA	Gse	Gsb	TSR	RCY AB	Virgin AB	ABR
90												

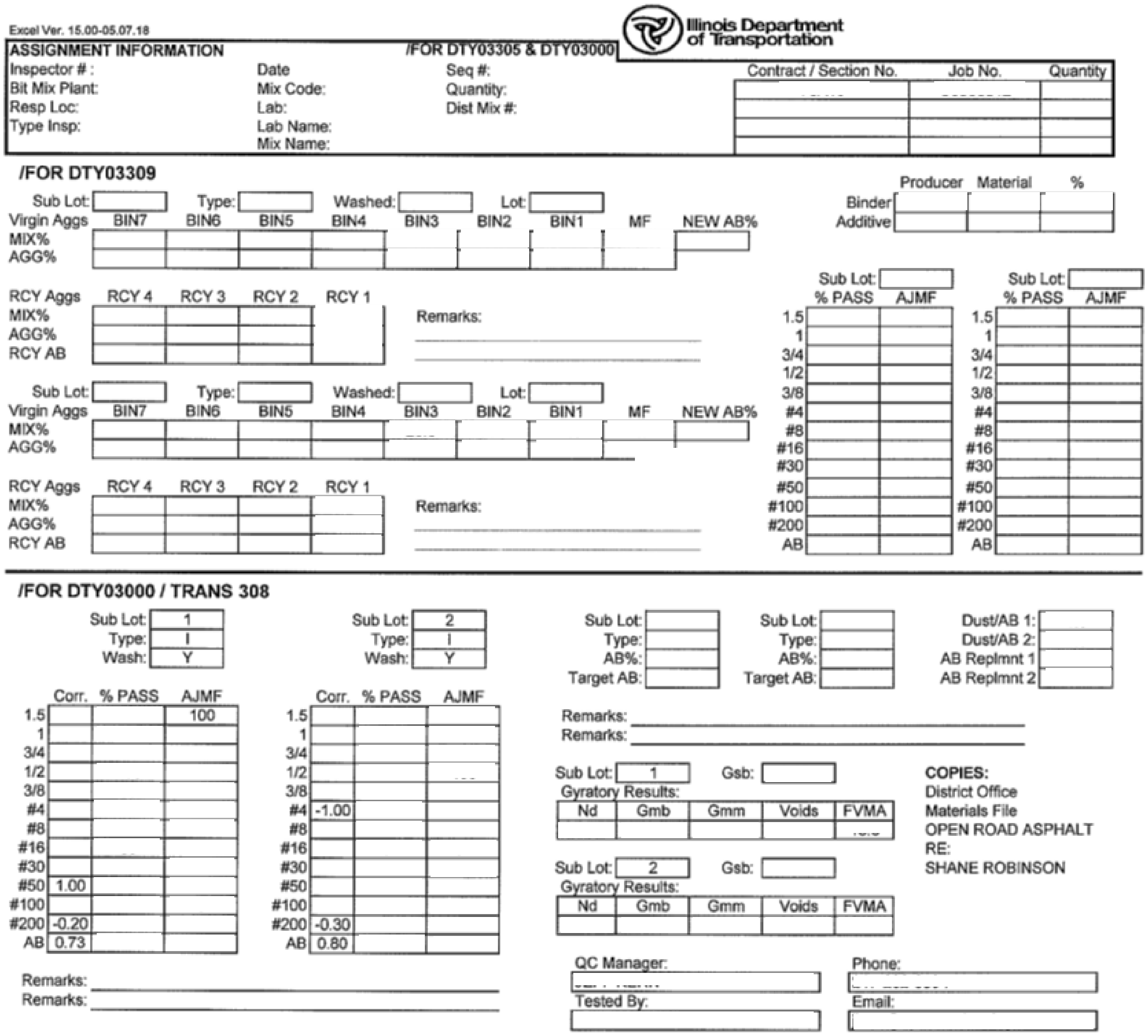
REMARKS LINE 1
REMARKS LINE 2
BITUMINOUS MIXTURE AGED
HOURS @

Figure 6. Photo. Mix design sheet template.

Table 2. Precision Limits for PFP Dispute Resolution Method Nos. 1 and 2

Method No. 1		Method No. 2	
Test Parameter	**Precision Limits**	**Test Parameter**	**Precision Limits**
Air Voids (AV)	1.0%	G_{mm}	0.008
VMA	1.0%	G_{mb}	0.012
Dust/Asphalt Binder	0.2	Asphalt Binder	0.2
Core Density	1.0%		

The mix and density sublot test results are the AV, VMA, and field-density results from both the contractor and district per sublot tested. During sampling, both the IDOT district (QA) and contractor (QC) collected enough mix to produce a replicate per sublot for asphalt binder content and aggregate gradation and two replicates per sublot for G_{mb} and G_{mm} (IDOT, 2018a). The average of both replicates is reported as the final sublot results in IDOT coversheets, as shown in Figure 7. IDOT coversheets do not report the individual replicate results. Therefore, the QC/QA package files were requested if available. The QC/QA package reports the weights recorded while conducting the G_{mb}, G_{mm}, AC%, and aggregate gradation for all the sublot replicates. However, not all QC/QA package reports were available for the 11 site visits.



Excel Ver. 15.00-05.07.18

Illinois Department of Transportation

ASSIGNMENT INFORMATION		/FOR DTY03305 & DTY03000
Inspector # :	Date	Seq #:
Bit Mix Plant:	Mix Code:	Quantity:
Resp Loc:	Lab:	Dist Mix #:
Type Insp:	Lab Name:	
	Mix Name:	

Contract / Section No.	Job No.	Quantity

/FOR DTY03309

Sub Lot: Type: Washed: Lot:

Virgin Aggs	BIN7	BIN6	BIN5	BIN4	BIN3	BIN2	BIN1	MF	NEW AB%
MIX%									
AGG%									

RCY Aggs	RCY 4	RCY 3	RCY 2	RCY 1
MIX%				
AGG%				
RCY AB				

Remarks:

	Producer	Material	%
Binder			
Additive			

Sub Lot: Type: Washed: Lot:

Virgin Aggs	BIN7	BIN6	BIN5	BIN4	BIN3	BIN2	BIN1	MF	NEW AB%
MIX%									
AGG%									

RCY Aggs	RCY 4	RCY 3	RCY 2	RCY 1
MIX%				
AGG%				
RCY AB				

Remarks:

Sub Lot:	% PASS	AJMF	Sub Lot:	% PASS	AJMF
1.5			1.5		
1			1		
3/4			3/4		
1/2			1/2		
3/8			3/8		
#4			#4		
#8			#8		
#16			#16		
#30			#30		
#50			#50		
#100			#100		
#200			#200		
AB			AB		

/FOR DTY03000 / TRANS 308

Sub Lot: 1 Type: I Wash: Y

Sub Lot: 2 Type: I Wash: Y

	Corr.	% PASS	AJMF		Corr.	% PASS	AJMF
1.5			100	1.5			
1				1			
3/4				3/4			
1/2				1/2			
3/8				3/8			
#4				#4	-1.00		
#8				#8			
#16				#16			
#30				#30			
#50	1.00			#50			
#100				#100			
#200	-0.20			#200	-0.30		
AB	0.73			AB	0.80		

Remarks:
Remarks:

Sub Lot: Type: AB%: Target AB:

Sub Lot: Type: AB%: Target AB:

Dust/AB 1: Dust/AB 2: AB Replmnt 1 AB Replmnt 2

Remarks:
Remarks:

Sub Lot: 1 Gsb:

Gyratory Results:

Nd	Gmb	Gmm	Voids	FVMA

Sub Lot: 2 Gsb:

Gyratory Results:

Nd	Gmb	Gmm	Voids	FVMA

COPIES:
District Office
Materials File
OPEN ROAD ASPHALT
RE:
SHANE ROBINSON

QC Manager: Phone:
Tested By: Email:

Figure 7. Photo. Mix sublot result sheet.

The datalogger report of the asphalt plant was collected. The plant’s computerized datalogger records the cumulative amount of material that entered the drum during the entire day for each aggregate bin. These cumulative weights are printed into a datalogger report every 6 minutes (Figure 8). Most dataloggers record the temperature of the drum and the asphalt binder during production. Also, the amount of asphalt binder added to the drum is reported as well as any additives and dust removed. The datalogger report allowed the researchers to evaluate the production process (e.g., production speed, mix switches, hot stops, or changes in temperature).

F B **MIX:** 80 **RATE:** 309tph **TEMP:** 343.9°F **RUN TOTAL:** 895.9Ton **AC CONTENT:** 5.9%MIX

	Material Delta	TPH Rate	%Req	%Act (%Cmd)	Material Totals	%Moisture
Vir Scale	24.1	244.4	82.5	82.5	710	5.4
Rap Scale	4.7	47.2	16	16	138.8	8
+A/C #1	1.486	14.75	5.9	4.9 (39)	43.701	
Virgin Feeder #1	6	59.9	20	19.7 (32.2)	176.3	9
Virgin Feeder #2	3	29.6	10	9.8 (16.9)	85.2	9
Virgin Feeder #3	0	0.0	0	0 (0)	0	9
Virgin Feeder #4	8.3	82.9	26.5	27.3 (37.6)	246.7	3.3
Virgin Feeder #5	0	0.0	0	0 (0)	0	3
Virgin Feeder #6	3.9	39.2	13	12.9 (19.4)	114.5	3.5
Virgin Feeder #7	3.9	39.3	13	12.9 (20.1)	114.7	3.5
Virgin Feeder #8	0	0.0	0	0 (0)	0	3.3
Virgin Feeder #9	0	0.0	0	0 (0)	0	3.3
Recycle Feeder #1	4.8	48.9	16	16.1 (24.5)	141.4	8
Recycle Feeder #2 RAS	0	0.0	0	0 (0)	0	14.4
Recycle Feeder #3	0	0.0	0	0 (0)	0	7.5
Mineral Fill #1	0.4	4.5	1.5	1.5 (19.1)	13.1	0
Mineral Fill #2	0	0.0	0	0 (0)	0	0
AntiStrip	0	0.000	0	0 (0)	0	
UltraFoam GX	0	0	0	0 (0)	0	0
DUST REMOVAL METER:	0.339	3.4		1.4	9.81	

AC STATISTICS: AC Temp: 300°F
RECYCLE AC CONTENTS(%) RCY1: 6.6 % RCY2: 24.5 % RCY3: 3.6 %
%ANTISTRIP IN AC: 0 %

	RCY1:	RCY2:	RCY3:
AC%:	0.982%	0%	0%

AC% VIRGIN TOTAL% 4.87 % State ID: 81BIT336R
ANTISTRIP TOTAL% 0 %
AC TOTAL% (actual) 5.86 %
AC TOTAL% (required) 5.9 % Virgin Rate(Wet):258.38tph Rap Rate(Wet):51.33tph

BH INLET: 261°F
BH OUTLET: 217°F
BH PRESSURE: 3.374"W
BlueSmoke PRESS: 0.146"W

Figure 8. Photo. Example of a 6-min datalogger report.

DATA ANALYSIS PROCEDURE

Pay Factors

Pay factor (PF) is the percentage pay adjustment a contractor would receive based on QA testing results. The performance parameters used in the calculation of PF are AV, VMA, and field density. Composite Pay Factor (CPF) is the weighted mean of the three PFs; AV, VMA, and density PFs have a weight of 0.3, 0.3, and 0.4, respectively. When PF is greater, equal, or less than 1, it reflects an incentive, full pay, or a disincentive, respectively. Pay factor analysis helps identify areas of improvement. For example, if VMA or AV has a penalty, the investigation would focus on potential issues with mix production, sampling, and mix testing. On the other hand, if a disincentive is related to field density, construction (mix placement) and/or compaction effort could be the cause. Even when full payment or an incentive were received, production and construction were evaluated to recognize the best practices that resulted in a full pay or an incentive.

Pay Parameter Analysis

Paired t-test

A paired t-test was used to identify significant differences between IDOT district and contractor results. The paired sample t-test is a statistical procedure used to determine if there is a significant difference between two sets of observations. A significant difference in the paired t-test can indicate differences between the sampling, testing, or equipment used between labs. Differences could also include reheating, gyratory compactor, or lab sample splitting.

The paired-t test was used to check if corresponding values in two observations (i.e., contractor and district results) represent the same population (total asphalt produced). The null and alternative hypotheses, respectively, were:

H_o: average of the differences between the observations (i.e., contractor and district results) is zero
H_a: average of the differences between the observations (i.e., contractor and district results) is significantly different from zero

To conduct the test, the sublot test results of the two observations were paired, and the difference between each paired result was computed. Then, using the differences, the average ($\bar{d}$) and standard deviation of the differences $S(d)$ was calculated.

Afterwards, the standard error $S(\bar{d})$ was calculated by dividing the standard deviation of the differences by the square root of the sample size, as follows in Figure 9.

$$S(\bar{d}) = \frac{S(d)}{\sqrt{n}}$$

Figure 9. Equation. Standard error equation.

where

n: number of observations

$S(d)$: standard deviation of the differences

$S(\bar{d})$: standard error of the average difference

Then, the t-test statistic is calculated, as shown in Figure 10.

$$t = \frac{\bar{d}}{S(\bar{d})}$$

Figure 10. Equation. T-test statistic equation.

Finally, the t-test statistic shown in Figure 10 was used to compute the p-value (which depends on the sample size) using a t-distribution function found in David & Gunnink (1997). If this p-value was less than 0.05, then the null hypothesis could be rejected. (i.e., There is a significant difference between contractor and district results.) For this test, the differences between the corresponding values before and after the action needed to be approximately normally distributed.

F-test of Equal Variances

The F-test determined if the variability of the contractor was different from the district. A significant difference between the variabilities could indicate that testing is less consistent at one laboratory. The null and alternative hypotheses are the following, respectively:

H_o: There is no significant difference between the variances of the two observations.
H_a: There is a significant difference between the variances of the two observations.

To conduct the test, the standard deviation of each observation was calculated as follows in Figure 11:

$$S_X = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n-1}}$$

Figure 11. Equation. Standard deviation equation.

where

S_X: standard deviation of contractor's observations X

x_i: i^{th} test of X in the observations

$\bar{x}$: observations mean

n: sample sizes

After calculating the standard deviation of the district observations (S_Y), the F-statistic for this test was calculated as follows in Figure 12:

$$F = \frac{{S_X}^2}{{S_Y}^2}$$

Figure 12. Equation. F-test statistic equation.

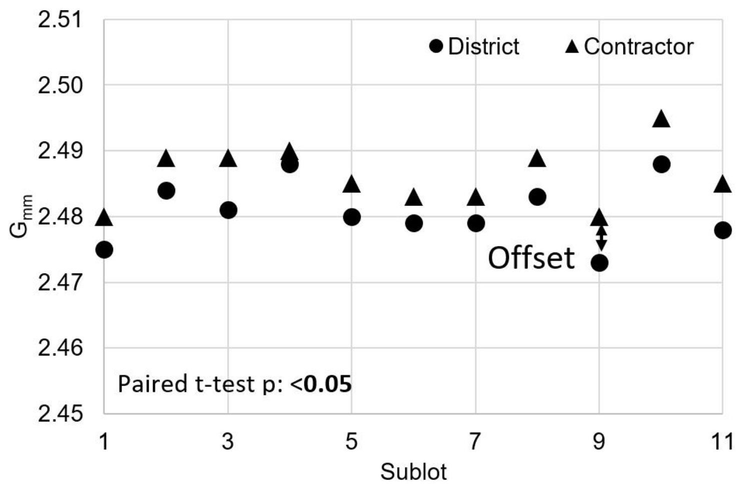
When the F-test statistic gets closer to 1, there is less evidence against the null hypothesis. Then, the two distributions are likely to have similar standard deviations. For each F value, there is a corresponding p-value. The p-value, which depends on the sample sizes, is computed from F-test tables found in Snedecor & Cochran (1989). If the p-value is less than 0.05, the null hypothesis can be rejected and there is enough evidence that the two variances are statistically different.

Statistical Analysis Scenarios

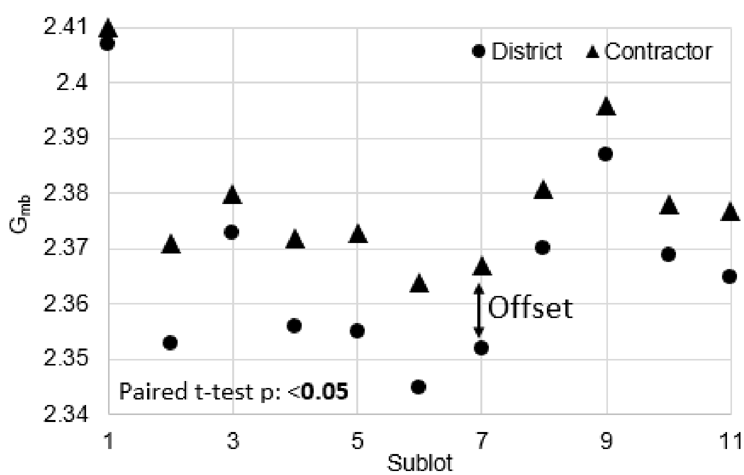
The results of the statistical analysis can identify possible sources of variability. Significant differences in the volumetric test results were evaluated based on four scenarios. The evaluation relied not only on these comparisons but also on other supporting information (e.g., test weight, mix design datalogger report) before drawing a conclusion.

Scenario 1: Reheating/Absorption

The first scenario occurred when the G_{mm} and the G_{mb} tests were significantly different and an offset occurred (either the contractor or the district was consistently higher than the other). Under these conditions, differences in contractor and district reheating procedures could have affected the result. Figure 13 shows a hypothetical example. There is a consistent offset in the G_{mm} (Figure 13-A) and G_{mb} results (Figure 13-B). In general, G_{mm} test results are either affected by lack of blending, splitting, or reheating. However, differences in reheating are more likely to cause an offset in both tests at the same time. To confirm this conclusion, the paired t-test is run with the percent asphalt content (P_{ba}) results.



A. G_{mm} volumetric results for reheating differences



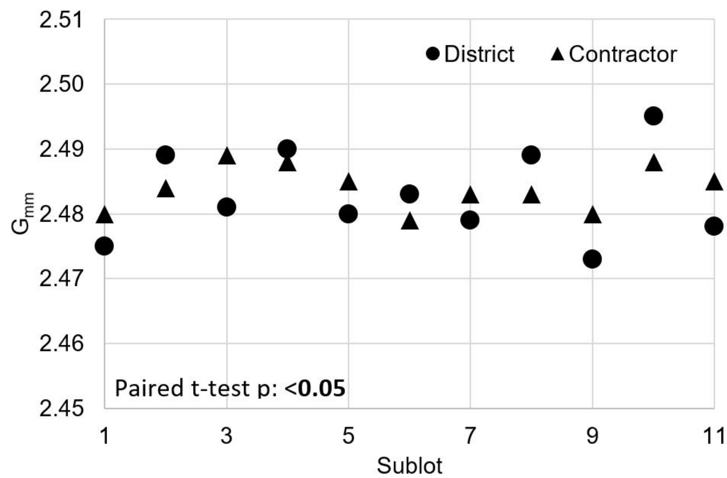
B. G_{mb} volumetric results for reheating differences

Figure 13. Graph. Volumetric results for a hypothetical project with reheating differences.

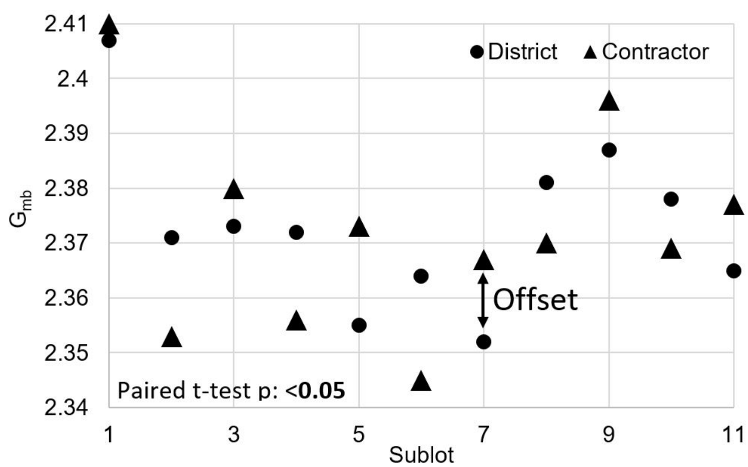
Scenario 2: Sample Blending and Splitting

An issue with sample blending and splitting is indicated when the G_{mm} and G_{mb} tests are significantly different and there is no offset. Figure 14 shows a hypothetical example. The differences between G_{mm} (Figure 14-A) and G_{mb} results (Figure 14-B) are random. Contractor results are higher than the district for part of the sublots, while district results are higher in the rest. In general, G_{mm} is affected by sample splitting and reheating. From these two testing variables, inconsistent splitting is more likely to cause random differences that also are reflected in the G_{mb}. This assumption is made because the segregation due to inconsistent splitting and lack of blending is more likely to generate a random distribution.

When the test results show a pattern with sample splitting issues, the issue is corroborated by also analyzing the extracted aggregate gradation results. The aggregate gradation results should show differences in the percentage passing of the coarse aggregate to confirm a splitting issue, e.g., for 19.0 mixes, it was #4 sieve, and for 12.5 and 9.5 mixes, it was #8 sieve.



A. G_{mm} results volumetric results for lack of blending and splitting issues

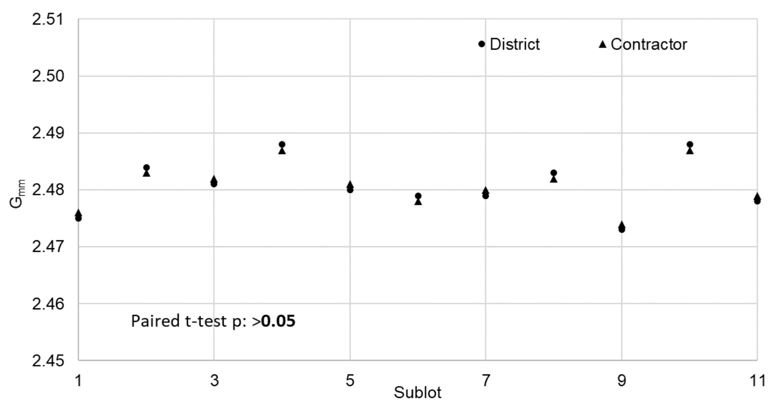


B. G_{mb} results volumetric results for lack of blending and splitting issues

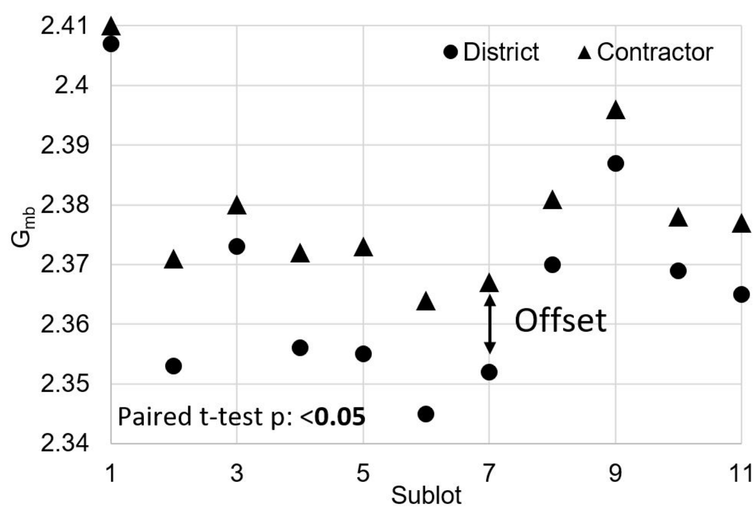
Figure 14. Graph. Volumetric results for a hypothetical project with splitting issues.

Scenario 3: Gyratory Compactor Offset

A gyratory compactor offset is indicated when G_{mm} results are significantly similar, but G_{mb} results are significantly different. Figure 15-A shows an example of similar G_{mm}, and Figure 15-B shows different G_{mb}. The G_{mb} results are generally affected by lack of blending during field splitting, reheating, sample preparation, and G_{mb} operator. When the results of the G_{mm} are similar, field splitting and laboratory reheating are more likely to be comparable. Offsets may occur because of systematic errors. For G_{mb}, the gyratory compactor is the equipment most likely to have caused a systematic error. Operators are more likely to cause random errors, which would not cause a consistent offset in all sublot results. However, to confirm that it is the gyratory procedure, the weights and specimen heights were recorded for further evaluation, as explained in the next section, G_{mb} Testing Procedure.



A. G_{mm} volumetric results for gyratory compactor offset

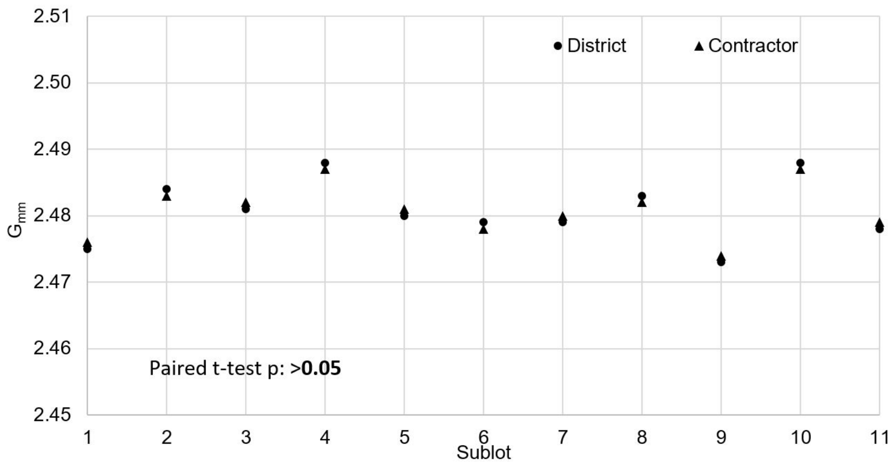


B. G_{mb} volumetric results for gyratory compactor offset

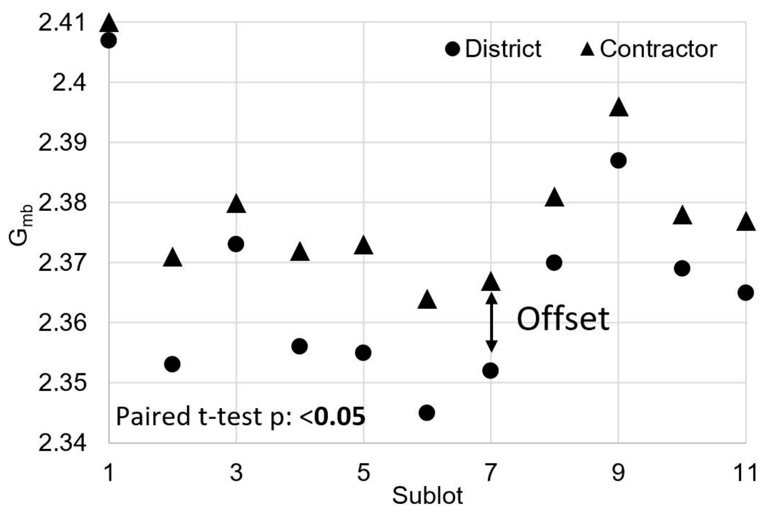
Figure 15. Graph. Volumetric results for a hypothetical project due to gyratory compactor offset.

Scenario 4: G_{mb} Testing Procedure

Inconsistencies while testing the saturated surface dry (SSD) weight and submerged weight could have caused significantly random differences in the G_{mb} test results (Figure 16-B), while not affecting the G_{mm} results (Figure 16-A). Significantly similar G_{mm} results indicate that field splitting and laboratory reheating were comparable. The testing procedure could have caused differences if the results are random. Testing is conducted by an operator, which introduces human error, while offsets are systematic errors caused by the equipment.



A. G_{mm} results

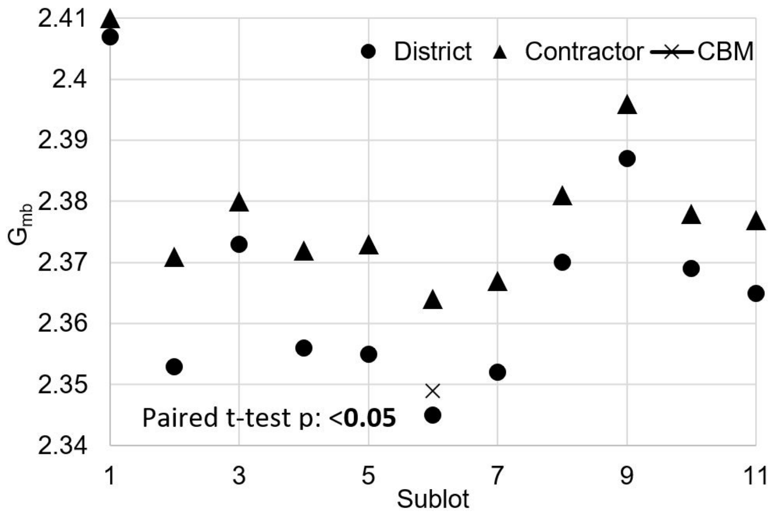


B. G_{mb} results

Figure 16. Graph. Volumetric results for a hypothetical project with G_{mb} testing issues.

Pay for Performance Dispute Results

IDOT CBM dispute results are compared with both datasets (if available) when significant differences between contractor and district results occur. District and contractor results are compared to IDOT CBM results for sublot 6 (Figure 17). In Figure 17-A, IDOT CBM results compared well with district results. In Figure 17-B, IDOT CBM results compared well with those of the contractor. The accepted values are the ones with which the dispute resolution laboratory (CBM) correlated. However, the contractor has a 60% to 70% chance of winning disputes, because they select the sublots for dispute (Al-Qadi et al., 2020).



A. Case where IDOT CBM results are compared with those of the district

B. Case where IDOT CBM results are compared with those of the contractor

Figure 17. Graph. Volumetric results for a hypothetical project with a disputed sublot.

G_{mm} and G_{mb} Data

The G_{mm} and G_{mb} raw data, which include the dry, submerged, and saturated surface dry (SSD) weights, were evaluated to identify any inconsistencies during testing. The evaluation was completed by identifying trends in the results between the contractor and the district or within them.

G_{mm} Raw Data

Two G_{mm} samples are prepared after reheating and splitting to sample size in the laboratory for each sublot. IDOT requires that laboratories split their samples to a weight of approximately 1,500 gm. Additionally, the difference in weight from the two samples should not exceed 10%. Table 3 shows an example where the results from sublot 2 exceed the differences. Hand adjustments were identified (if any) when the difference between the weights was lower than 0.5%. Finally, the spread of G_{mm} dry weights from the contractor and district was compared to see which laboratory is more consistent in splitting their samples to the similar weight.

Table 3. G_{mm} Test Weight Hypothetical Example

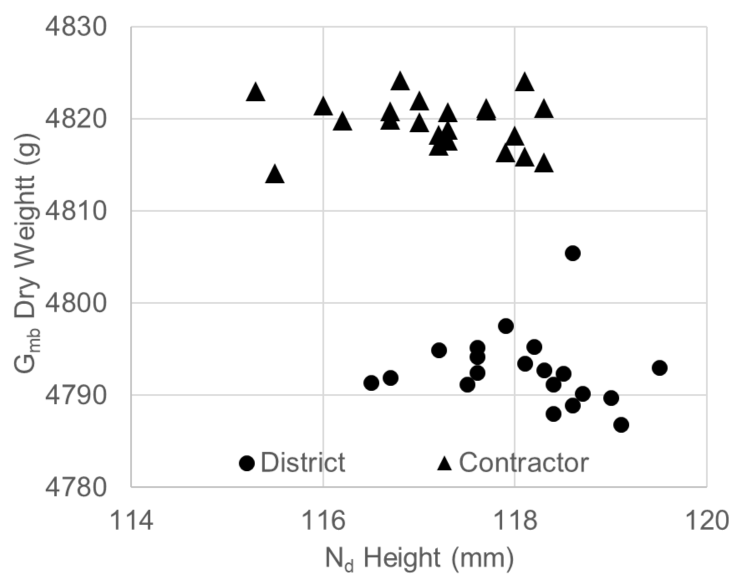
Sublot	Specimen	Dry Weight (g)	Pycnometer and Water (g)	Pycnometer, Water and Sample (G)	G_{mm}	Average	% Difference Weights	Pass/ Fail
1	1	1624	8338	7370	2.475	2.475	5.828	Pass
1	2	1722	8419	7393	2.475			
2	1	1579	8313	7370	2.485	2.478	13.647	Fail
2	2	1811	8470	7393	2.471			

G_{mb} Raw Data

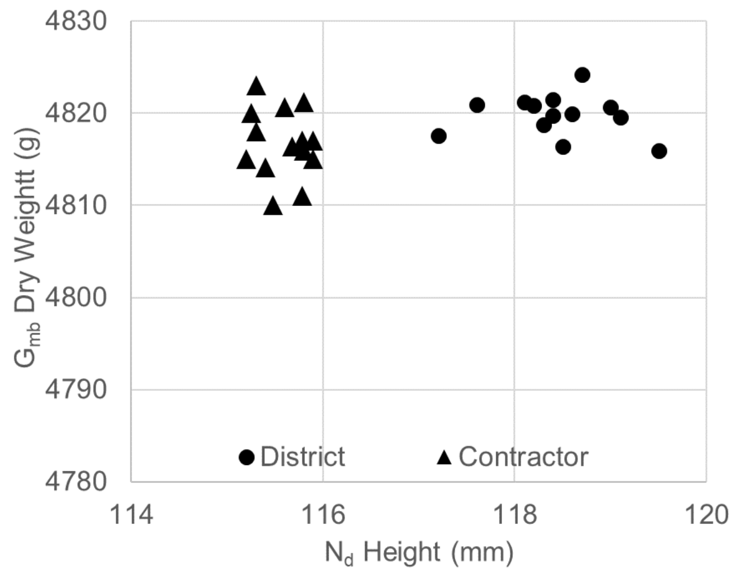
G_{mb} samples are prepared after reheating and splitting to sample size. Contrary to G_{mm}, the sample weights can be hand adjusted to have similar weights. The difference between the weights of the two hand-adjusted samples is typically lower than 0.5%. The specimen's dry weight and height were measured to assess the gyratory compaction operation.

Gyratory Compactor Effort

Differences in gyratory compaction can cause test specimens with similar weights to be compacted to different heights, or vice versa (Figure 18). In Figure 18-A, the contractor's laboratory-produced samples were smaller in weight than the district's, although they were compacted to similar heights. This indicates that the contractor's machine provided less compactive effort than the district's for the same number of gyrations. Conversely, in Figure 18-B, the sample weights are similar, but the height is different.



A. Cases with differences in weight



B. Cases with differences in height

Figure 18. Graph. G_{mb} dry weight vs specimen height for a hypothetical project.

G_{mb} Testing Sample Errors

Samples within the same laboratory with inconsistent weight measurements may indicate a testing error. For example, in Figure 19, the weight of the specimens used for G_{mb} was consistent, but heights of four specimens were significantly different from the rest. This could have been due to several factors, including variation in remixing, segregation, aggregate characteristics, operation, and/or reheating within the same testing laboratory. A similar situation could happen when the heights of the specimens are similar, but their weights are different within the same laboratory.

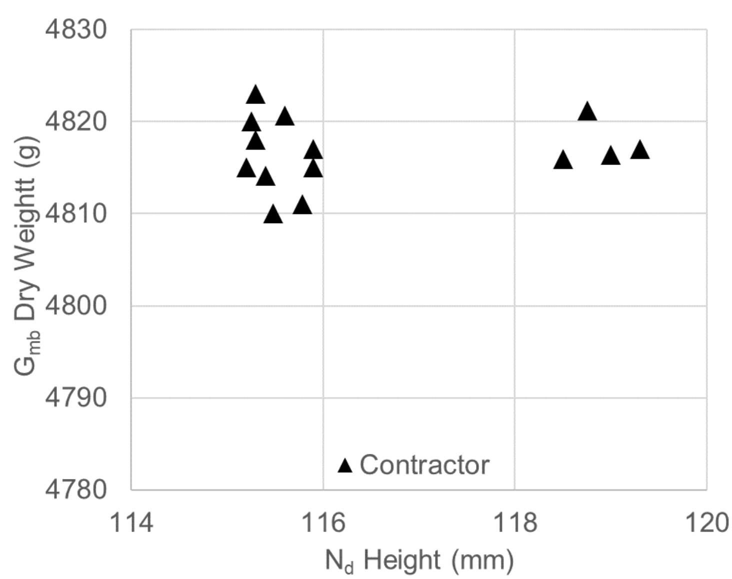


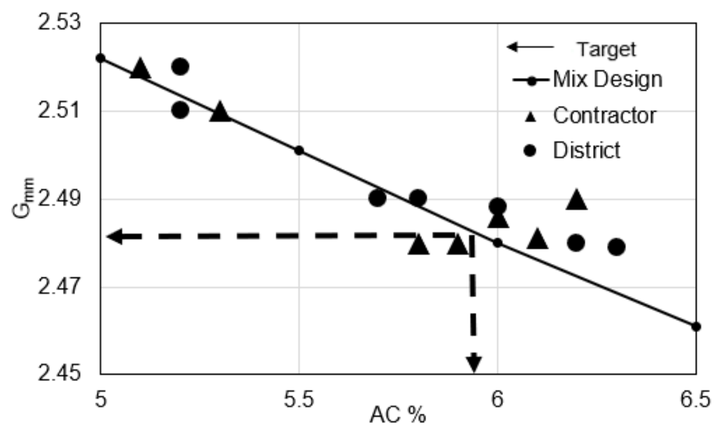
Figure 19. Graph. Volumetric results for a hypothetical project with different specimen heights.

Mix Design Comparison

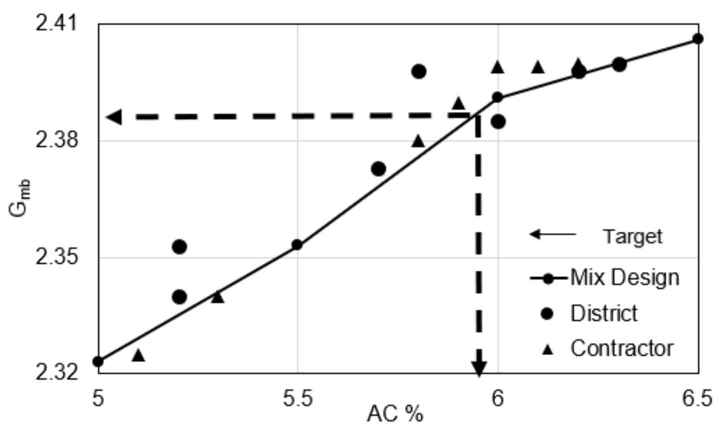
G_{mb} and G_{mm} results were compared to the mix design G_{mb} / G_{mm} vs AC% curves to identify possible production issues. The comparison was completed by identifying the pattern of the results and comparing them with one of the scenarios. This comparison was completed independently for contractor and district results.

AC% Fluctuation

Deviations in the AC% can cause the G_{mb} and G_{mm} results to miss the target. Figure 20 shows a hypothetical example. The AC content for two sublots of the district and the contractor was lower than 5.3%. However, the G_{mb} and G_{mm} results for those cases were close to the design curve. Fluctuations in the AC content caused the results of G_{mm} and G_{mb} to deviate from the target. The aggregate structure of the mix and the dust are not an issue because the G_{mb} and G_{mm} results compared well with the design results. This can be corroborated by comparing the gradation results with the mix design blend. The plant datalogger can be checked to identify inconsistencies in the AC application rates.



A. G_{mm} vs AC%

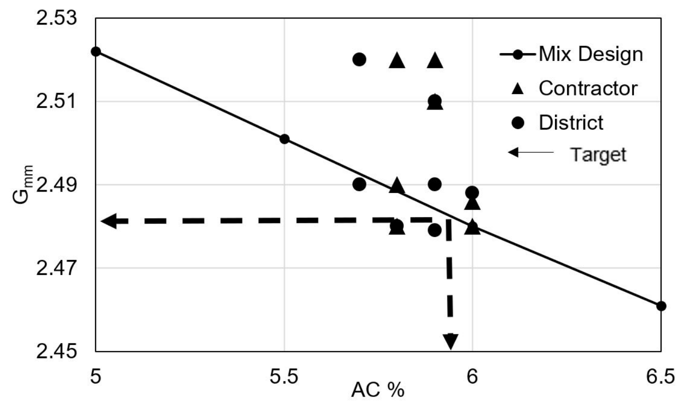


B. G_{mb} vs AC%

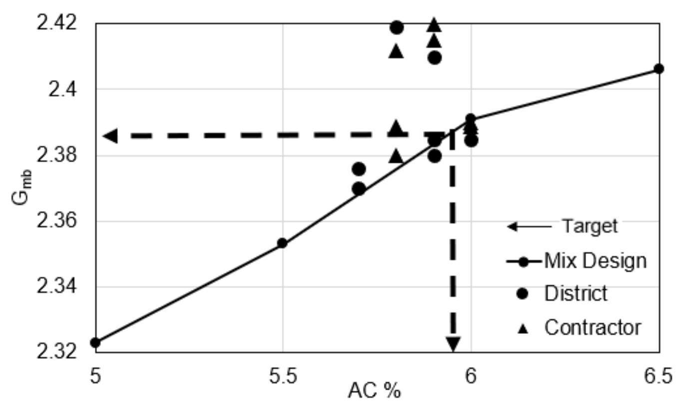
Figure 20. Graph. Hypothetical case where G_{mm} and G_{mb} results varied because of AC%.

Aggregate Gradation Deviation

Mix design, G_{mb}, and G_{mm} could be off target due to aggregate gradation deviation (Figure 21). If AC% is on target, variability in the aggregate gradation could cause G_{mm} and G_{mb} results to deviate from the target. The aggregate structure of the mix is affected because of material variability, segregation, lack of blending, and/or inconsistencies in the production. This results in having an aggregate gradation that does not meet the expected G_{mb} and G_{mm} of the design. Variability in the aggregate structure is checked by comparing the aggregate gradation results with the mix design blend. The datalogger should be reviewed to identify inconsistencies or fluctuations in the mix production. The condition of the stockpiles should be observed to identify a potential source of segregation.



A. G_{mm} vs AC%



B. G_{mb} vs AC%

Figure 21. Graph. Hypothetical case where G_{mm} and G_{mb} results varied because of a deviation in the aggregate gradation.

Dust Issues

Dust (percent passing the #200 sieve) may affect G_{mb} results. When the dust exceeds the target, extra dust may "fill" the AV, increasing the G_{mb}. On the other hand, a low amount of dust may reduce the G_{mb}. When extra dust is added or removed, the G_{mb} results move along the mix design line as if extra binder was added to the mix. Therefore, if dust is the issue, equivalent AC% can be calculated based on the amount of dust added. When the G_{mb} results are plotted against the equivalent AC%, the G_{mb} result should be close to the mix design. The equivalent AC% is computed based on Figure 22.

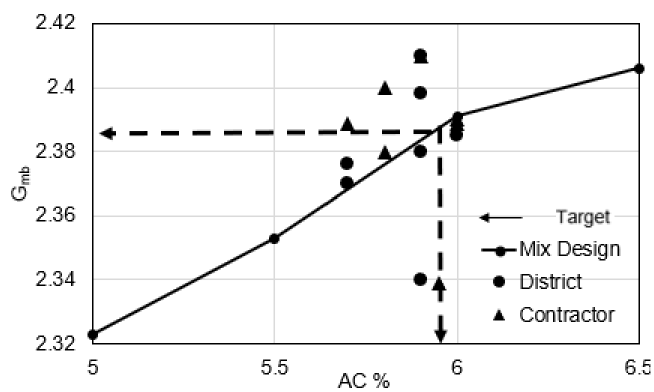
$$AC\%_{Dust\ Equivalent} = AC\% + (\%\ Passing\ \#200_{Actual} - \%\ Passing\ \#200_{Design}) * (\frac{G_b}{Dust\ G_{sb}})$$

Figure 22. Equation. AC% Dust Equivalent.

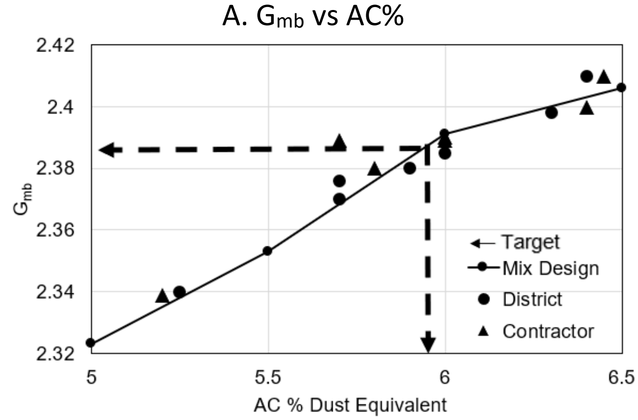
where,

AC% = actual asphalt binder content of the sample (measured from the extraction)
$AC\%_{Dust\ Equivalent}$= AC% equivalent for dust
% Passing $\#200_{Actual}$ = #percent passing #200 in the sample
% Passing $\#200_{Design}$ = #percent passing #200 in the design blend
Dust G_{sb} = Bulk Specific Gravity of Dust
G_b = Binder Specific Gravity

The ratio of the specific gravities of AC and dust typically tends to be 0.3. Figure 23-A shows an example where G_{mb} is neither on target nor on mix design because of dust issues. When the G_{mb} results are plotted against the $AC\%_{Dust\ Equivalent}$, the G_{mb} results fit again to the mix design, indicating G_{mb} deviation was caused by dust. Changes in added dust are due to aggregate cleanliness or lack of dust control during production. The extra dust added or removed from the target dust would affect VMA and, consequently, AV.



A. G_{mb} vs AC%

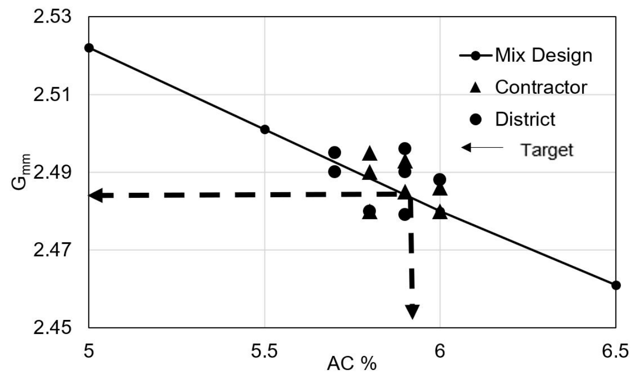


B. G_{mb} vs $AC\%_{Dust\ Equivalent}$

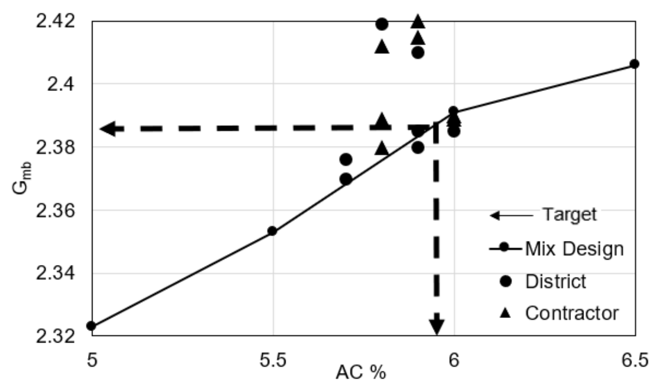
Figure 23. Graph. Hypothetical case where the G_{mm} and G_{mb} result varied because of dust.

Testing Errors

While laboratory testing results meet the requirements, errors were detected on sublots that deviated from the target and design (Figure 24). The results could have been affected by a testing error. However, to arrive at this conclusion, the test weights used as well as reheating and testing procedures were reviewed to corroborate the operation of the gyratory compactor.



A. G_{mm} vs AC%



B. G_{mb} vs AC%

Figure 24. Graph. Hypothetical case where there is a testing issue with the G_{mb} results of the contractor.

Datalogger Result Analysis

The datalogger report was evaluated by computing the average blend percentages of each stockpile used during production for each 6-min interval. Then, the blend results of all stockpiles and 6-min intervals are plotted against the average accumulated tonnage at each interval. These results are then compared to the mix design. For any given stockpile A, the average blend % is computed as shown in Figure 25. In addition, for the stockpile blend, hot stops, mix switches, and fluctuations in the temperature were identified by inspection of the report. Finally, binder content and dust removal were calculated using the equation in Figure 25 and using the respective virgin aggregate and dust-removed weights.

$$B_A\ (\%) = \frac{S_n - \mathrm{S}_{\mathrm{n-1}}}{T_n - T_{n-1}}$$

Figure 25. Equation. Compute blend % of stockpile A.

where

B_A = Blend % of stockpile A

S_n = Accumulated weight of stockpile A in the datalogger report n

S_{n-1} = Accumulated weight of stockpile A in the previous datalogger report

T_n = Accumulated weight of the mix in the datalogger report n

T_{n-1} = Accumulated weight of the mix the previous datalogger report

Density Cores

The density cores were evaluated by visually inspecting the exterior condition of the cores and identifying any deviations in the cores' weight. The visual inspection consisted of identifying the conditions in which the core was extracted, including:

- Aggregate condition: broken, separated, segregated
- Underneath layer Condition: milled surface
- Cut condition: weave, straight
- Surface conditions

The density cores weights were then evaluated in the following manner:

- Dry weights: The relationship between dry weight and thickness was plotted to identify any core that excessively deviated from the rest of the group. Core thickness is not necessarily the thickness of the layer. However, cores thicker than the rest of the group are typically obtained when there is a depression or hole in the milled surface or base, which could cause a density reduction.
- Submerged weight: The relationship between submerged weights and dry weights was reviewed to identify if a core submerged weight excessively deviated from the rest of the cores at similar dry weights.
- SSD weight: The relationship between SSD weights and submerged weights could indicate cores that are excessively dried.

CHAPTER 3: CASE STUDIES

This chapter presents the observations of the jobsite visits and data analysis. Each section focuses on one of the 11 case studies. Each section lists the contract and pay factors and describes the production, construction, sampling, and testing techniques. Finally, this chapter presents the test results and provides a summary of the sources of disincentives.

DISTRICT 1 SITE VISIT 1

The first jobsite visit was to a PFP 2-in pavement-resurfacing job on a four-lane minor arterial. The contract description and pay factors are shown in Table 4. The surface mix received a 2% disincentive in AV. As a result, the analysis focused on mix production and testing.

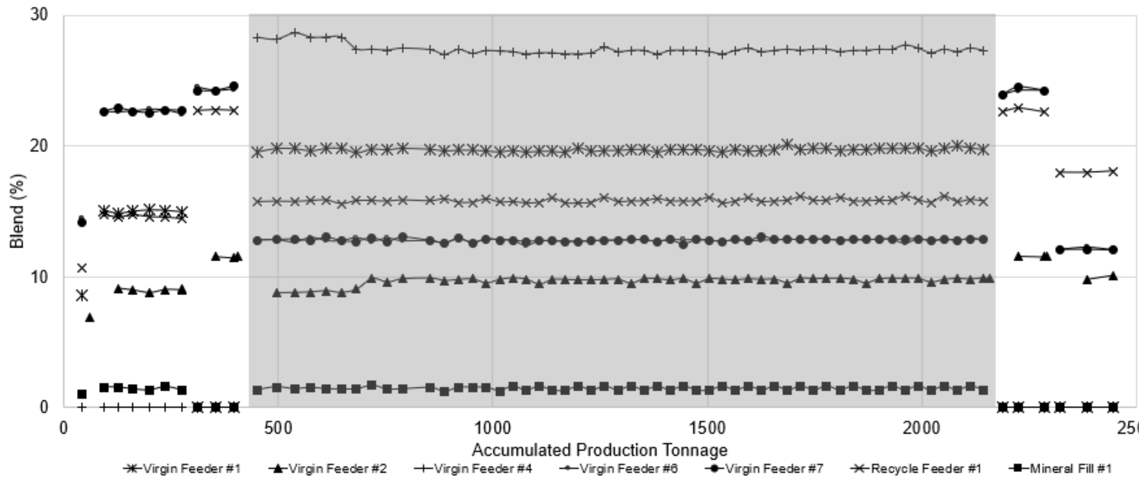
Table 4. District 1 Site Visit 1: Contract Description and Pay Factors (PFP)

Mix		**Project**	
Type	Surface	Project Type	Resurfacing
N Design	N70	Length	4.2 mi
NMAS	9.5 mm	Thickness	2 in
Paving Surface	Leveling Binder	Production	11,549 ton
Requirement		**Pay Factors**	
AV	4.0 ± 1.35%	AV	98%
VMA	15.0 -0.7% +3.0%	VMA	105%
Density	91.5–97.5%	Density	101.10%
Other Pay Adjustments			
Dust/AC	0.6-1.2%	Dust/AC% Penalty	$0
AC (Design)	5.90%	CPF	101.30%

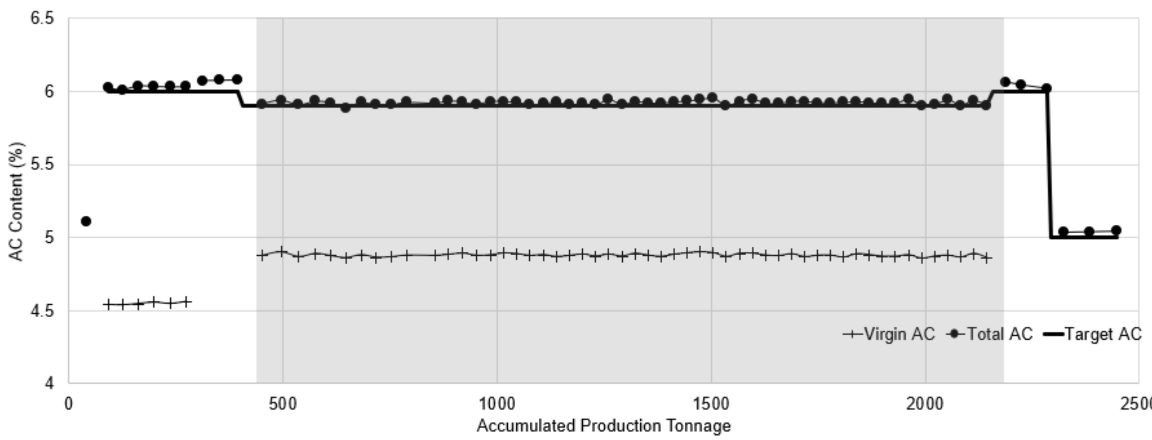
Mix Production

The mix was produced in a single-drum retrofitted Gencor plant. The plant had nine aggregate bins, six silos, and a computerized control system called UltraControl 2018. Weigh pods were used for positive dust control. The asphalt binder was added to the drum using a micromotion asphalt binder pump. The plant had a manual-release agent spray rack for applying a truck-release agent to incoming trucks.

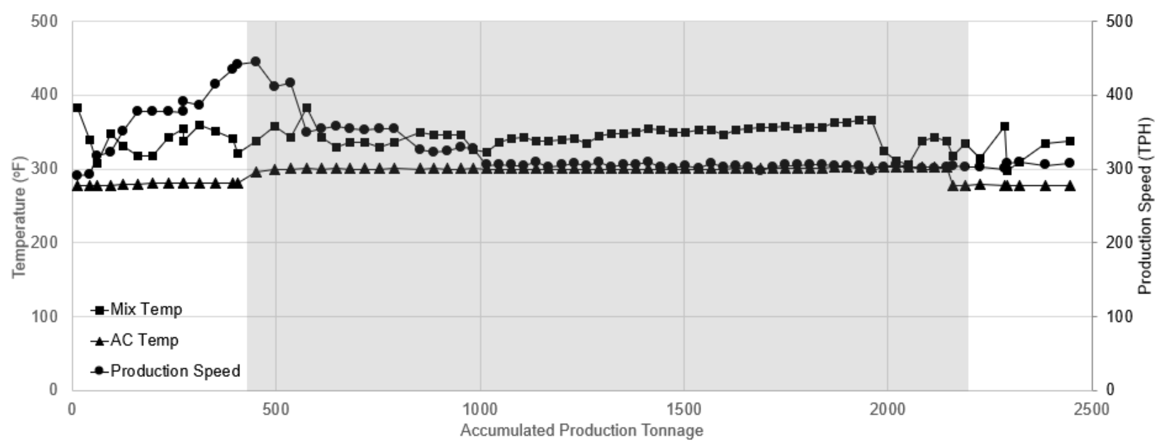
The datalogger report did not show any irregularities in the production (Figure 26). The mix was produced at 300 tons per hour (TPH) with no mix switches or hot stops. Mix switches refer to the transition to different mix designs during the same day of production. A hot stop is a pause in mix production. The maximum percentage of aggregate added from one single feeder was approximately 30%. AC content was fixed at 5.9%. The mixing temperature fluctuated between 322°F to 350°F.



A. Blend



B. AC content (%)



C. Mix temperature and production speed

Figure 26. Graph. Datalogger results for District 1 site visit 1 (grey is the production destined for the project).

Construction and Sampling

The mix was hauled 10 to 15 min to the site and deposited directly in the paver. A material transfer device (MTD) was not used. No precipitation and a minimum temperature of 41°F were reported during the morning. Live bottom trailers were not used in the construction. The personnel had approximately more than 10 years of related experience. Good communication was observed between IDOT and contractor personnel.

Two pavers were used, each located on opposite sides of the paving job. This configuration confused IDOT personnel. It was unclear for random sampling whether to consider the tonnage from pavers independently or combined. This confusion resulted in sampling at 80 tons prior to the proper sampling tonnage mark and in paver-operation delays. Proper guidance should be provided.

The contractor had four QC personnel during the construction project in charge of all QC tasks. Two contractors were sampling in the field, one was responsible for density cores, and the fourth performed laboratory tests in the plant. Eight metal buckets of mix samples were obtained from the mat using an aluminum sampling shovel, as specified in Appendix E.4 of IDOT's *Manual of Test Procedures for Materials* (IDOT, 2018a) and shown in Figure 27. The samples were blended twice using a Gilson SP-55 Quartermaster Asphalt Sample Divider to split the samples into metal buckets on site, which is not an IDOT-approved splitter (Figure 27).

Figure 27. Photo. Aluminum sampling shovel, Gilson SP-55 Quartermaster, and Humboldt Riffle.

The contractor used a Humboldt splitter to reduce the sample size to the G_{mm} and G_{mb} test size. The practice is known as "pre-splitting" in District 1. Samples that were pre-split in the field to the G_{mm} and G_{mb} size took approximately 45 min to obtain, split, and store. However, because of cold weather, IDOT samples were stored in paper buckets after quartermaster splitting because the temperature was too low to complete the pre-split. The paper buckets were placed in canvas bags and secured by the resident engineer.

Testing Procedures

During the contractor testing laboratory visit, the research team observed that the equipment was calibrated and that the lab participated in the AASHTO re:source proficiency sample program. Two technicians were in each plant laboratory. The contractor used a Pine GB1 Brovold gyratory compactor for G_{mb} specimen preparation; the district used a Pine AFG2. A pulley vacuum pump was used with a manometer for the G_{mm}. Humboldt ovens were used for reheating samples. The QC personnel indicated that QCP and PFP projects were treated the same. Contractor QC personnel tended to favor PFP because they preferred to test all IDOT samples, rather than only one. IDOT turnaround time has decreased from two weeks to 48–52 hours since the 2018 construction season.

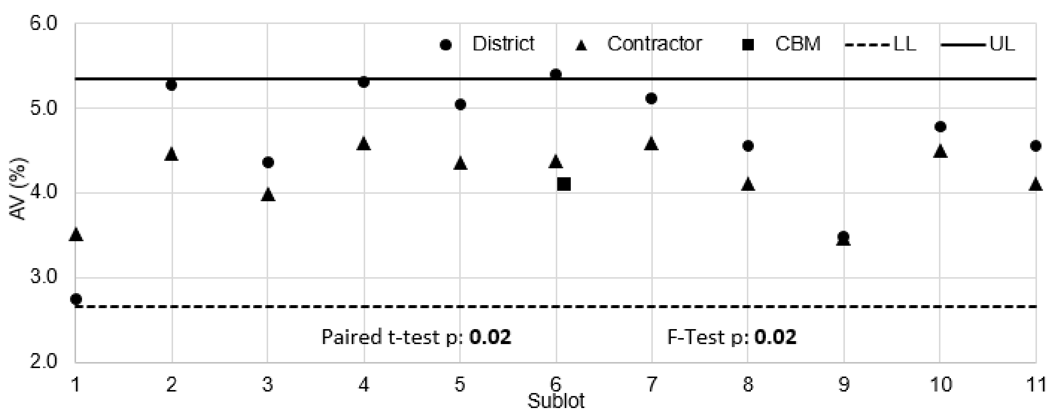
Extractions for aggregate gradation and AC content were completed using an automated extraction device. The contractor shifted from the ignition oven to the automated extraction device to match the District 1 laboratory. The contractor reported problems with AC content comparison between their ignition oven and the district's automated extraction device. The reflux extraction method was used for calibration of the ignition oven or automated extraction device. The contractor also noted experiencing a difference in G_{mm} with the district, which could be related to a difference in reheating procedures.

Pay for Performance Test Results

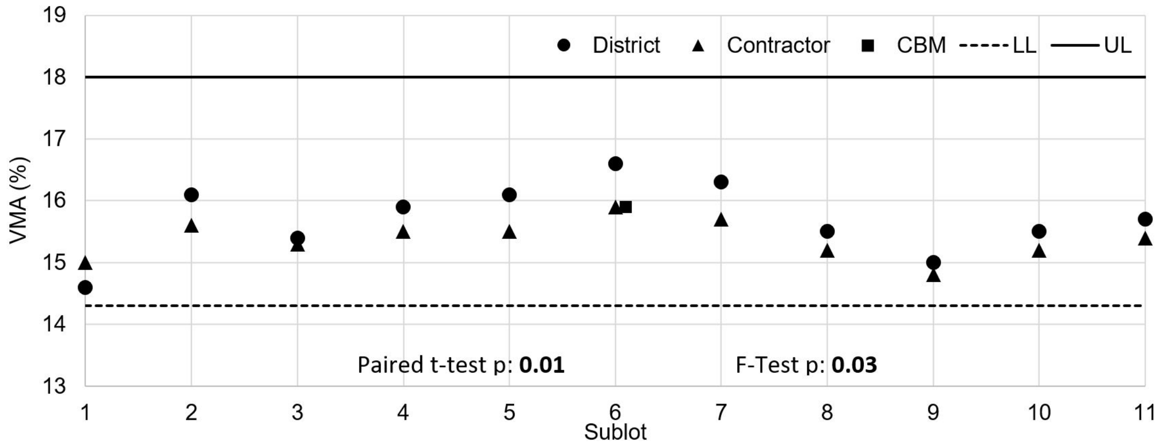
The PF indicated an issue affecting the mix sublot volumetrics. AV had a 96% PF. After the PFP dispute resolution, the AV PF increased to 98% because the district results of one sublot did not compare with IDOT CBM's.

Figure 28-A and Figure 28-B show the results for AV and VMA in 11 sublots, respectively. The paired t-test results indicated a significant difference between contractor and district results for both AV and VMA. Sublot 6 exceeded the PFP upper limit of AV, while sublots 1, 2, and 4 were right at the limit, contributing to a reduced PWL and PF. On average, district VMA results were 0.33% higher than contractor results. However, the average VMA during production was 15.7%, which was high enough to avoid disincentives. (The requirement, in this case, is 15.0%.)

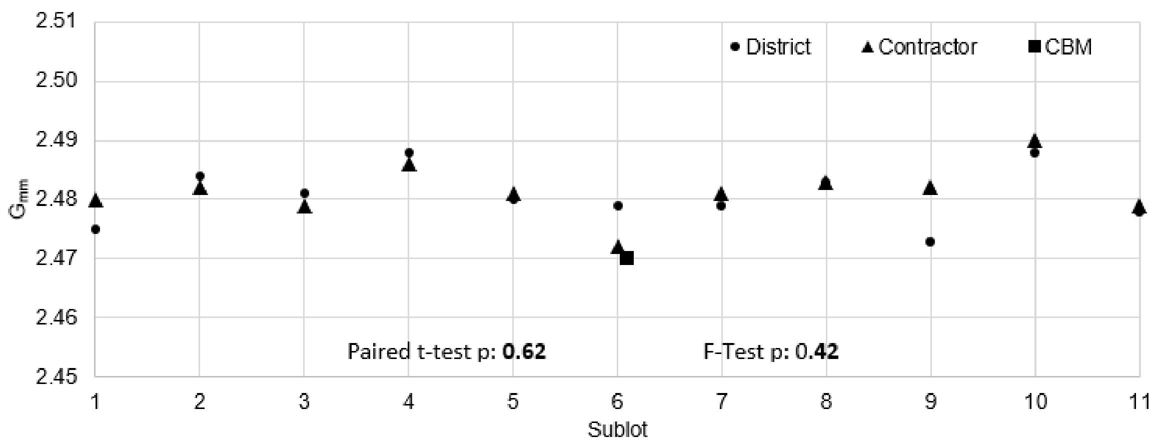
G_{mm} results were similar between the district and contractor (Figure 28-C), but there was a significant difference between G_{mb} test results (Figure 28-D). The average difference between district and contractor G_{mb} results was 0.012, while the difference in G_{mm} results was 0.008. During the mix PFP dispute, the contractor G_{mb} results of sublot 6 compared well with those by IDOT CBM, which increased the pay factor.



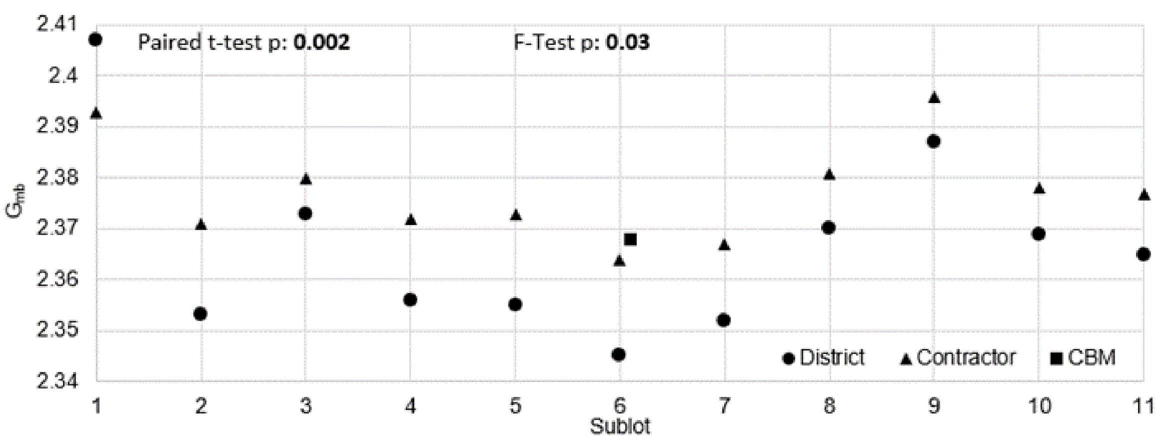
A. AV (%)



B. VMA (%)



C. G_{mm}



D. G_{mb}

Figure 28. Graph. AV, VMA, G_{mm}, and G_{mb} results per sublot for District 1 site visit 1.

Figure 29 shows the G_{mb} specimen dry weight vs specimen height and G_{mb} vs specimen height. For compaction, the district used a Pine G2 gyratory compactor while the contractor used a Brovold gyratory compactor. Both laboratories reported having their respective compactors calibrated. The same weight should be targeted by both the district and the contractor. Their gyratory compactors, however, produced specimens similar in height, but with different weights. For a specimen at the same height, the contractor's specimen was 30 g heavier than the district's. This could be related to specimen preheating temperature and/or a difference in compaction energy if the specimen's height was intended to be the same.

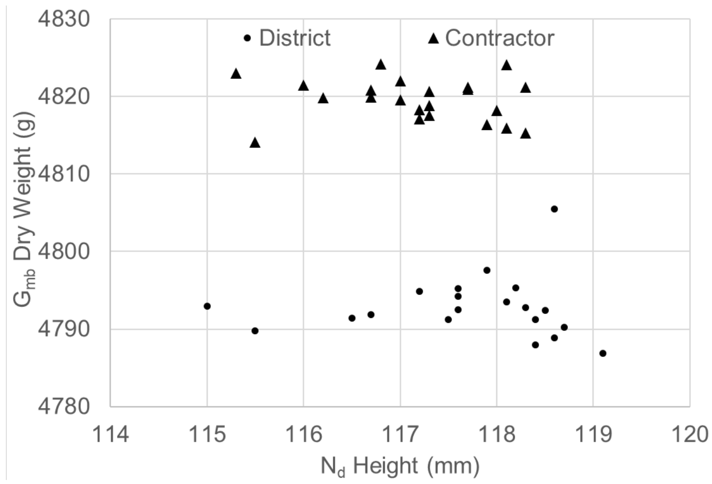
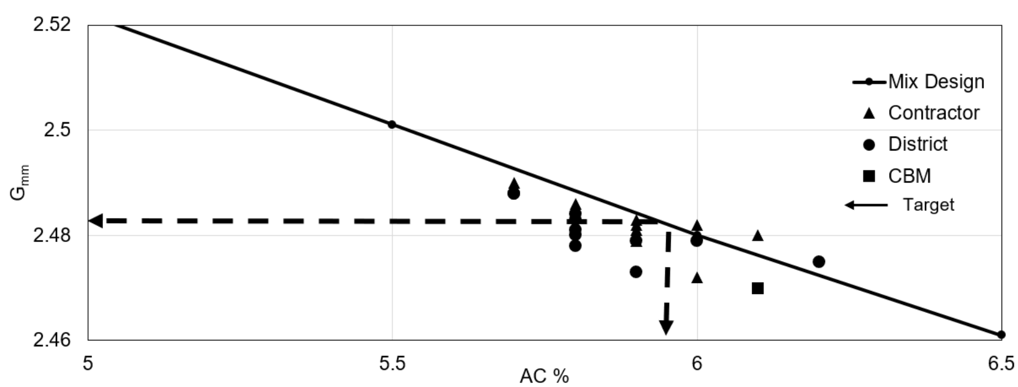


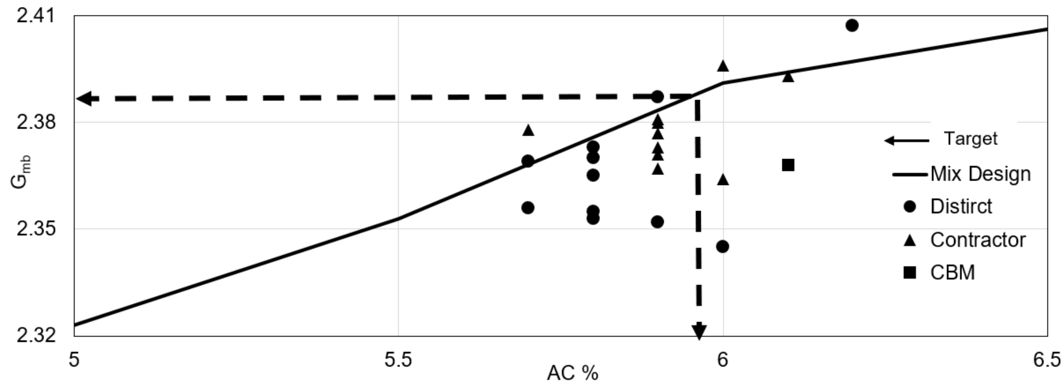
Figure 29. Graph. G_{mb} specimen dry weight vs specimen height and G_{mb} vs specimen height.

Figure 30-A and Figure 30-B compare the G_{mm} and G_{mb} results against the respective mix design target. AC was on target, ranging between 5.7% and 6.2%. G_{mm} results were on the mix design curve for both laboratories. However, district G_{mb} results of sublots 2, 4, and 6 deviated from the mix design and the contractor. The difference between contractor and district G_{mb} results averaged 0.017. This corresponded to a scenario with a possible testing issue in the district compaction.

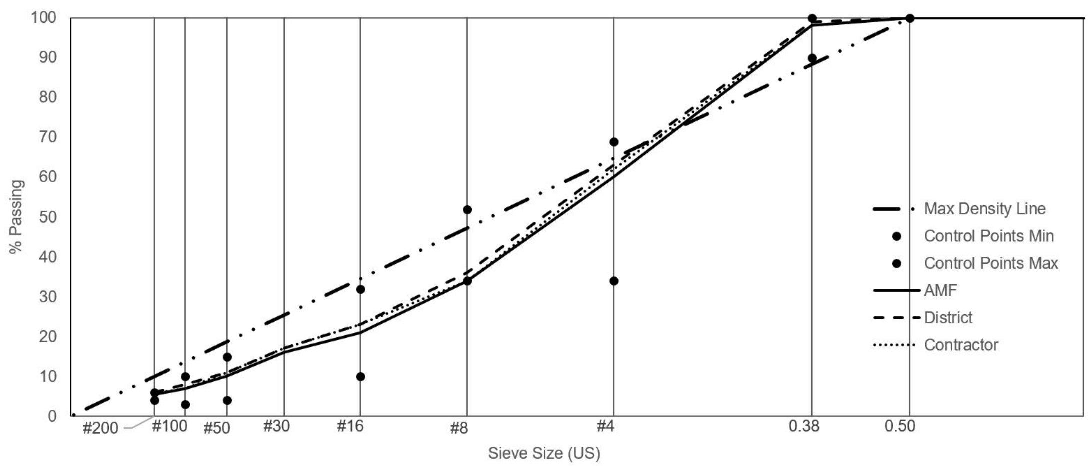
The aggregate gradation results from both laboratories were within IDOT control limits and did not show any issues in mix production. District aggregate gradation had a slightly higher percent passing in sieves #4, #8, and #16, up to a maximum 3% difference. For example, Figure 30-C presents the aggregate gradation results for sublot 1 from the contractor, district, and adjusted mix formulas (AMF).



A. G_{mm} vs. AC%



B. G_{mb} vs. AC%



C. Aggregate gradation

Figure 30. Graph. District 1 site visit 1: (a) G_{mm}, (b) G_{mb}, (c) P_{ba} results per sublot and aggregate gradation results of sublot 1 (d).

The contractor was not able to achieve the full bonus on density (105%) because one core was lower than 90% density and four cores were close to the upper limit (Figure 31). The results of the contractor and district cores were similar for these cases. However, the difference in results was consistent. District density results were higher than those by the contractor. These differences did not cause an issue because the average density was 95.3% and the differences were kept to a maximum of 1%. Finally, the cores close to the pavement edges had lower densities than those in the central portion of the lane (Figure 31).

In summary, the results did not show significant issues with mix production and most were within the limits. However, the difference between district and contractor G_{mb} results most likely caused the AV pay disincentive. The results of the test weight and the dispute resolution suggested an issue with the district's G_{mb} sample. This difference was attributed to similar specimen heights and different weights. It is suggested that both the district and contractor use the same target weight for specimen preparation. In this case, the G_{mb} difference did not impact the VMA because the contractor produced mixes well above the VMA minimum, which avoided possible disincentives.

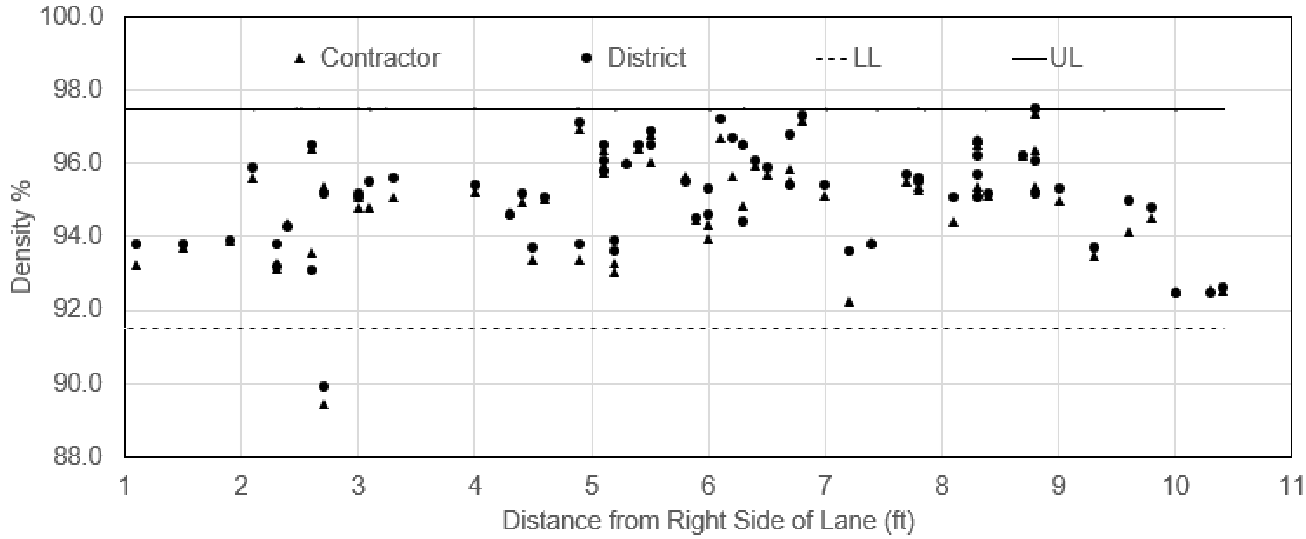


Figure 31. Graph. Density results vs offset of the edge of the pavement.

DISTRICT 1 SITE VISIT 2

The second jobsite visit was to a PFP 1.5-in pavement-resurfacing job on a four-lane other principal arterial. Table 5 shows the contract description and pay performance. The surface mix analyzed received disincentives in AV and VMA. As a result, the analysis focused on mix production and testing.

Table 5. District 1 Site Visit 2: Contract Description and Pay Factors (PFP)

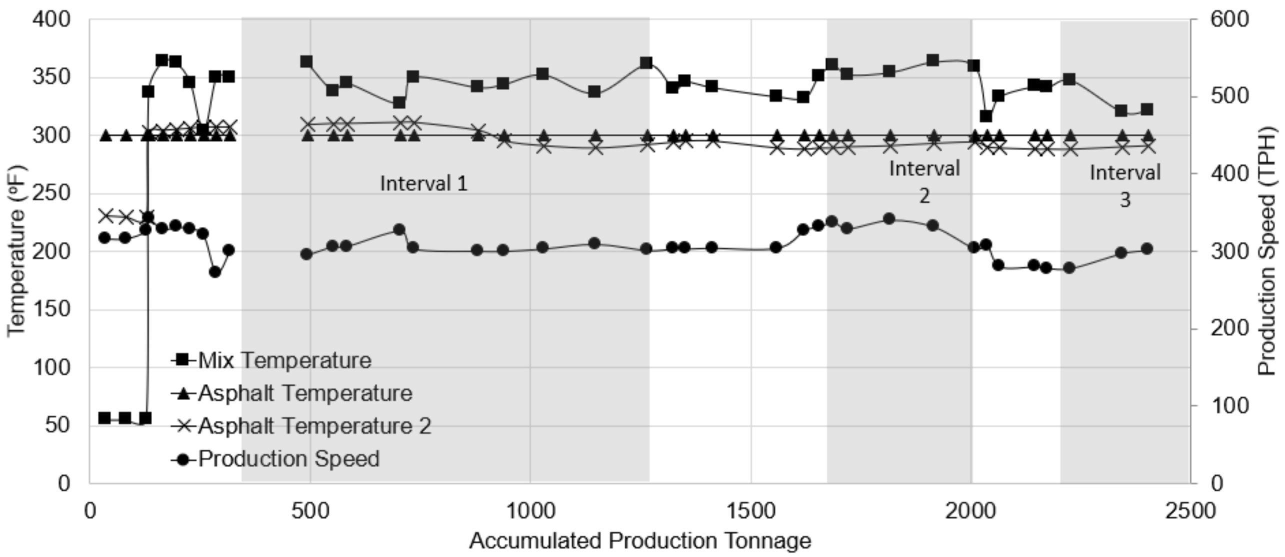
Mix		**Project**	
Type	Surface	Project Type	Resurfacing
N Design	N70	Length	
NMAS	9.5 mm	Thickness	1.5 in
Paving Surface	Leveling Binder	Production	9,462 ton
Requirement		**Pay Factors**	
AV	4.0 ± 1.35%	AV	98%
VMA	15.0 -0.7% +3.0%	VMA	90%
Density	91.5–97.5%	Density	101.7%
Other Pay Adjustments			
Dust/AC%	0.6%-1.2%	Dust/AC% Penalty	$0
AC (Design)	5.8%	CPF	97.1%

Mix Production

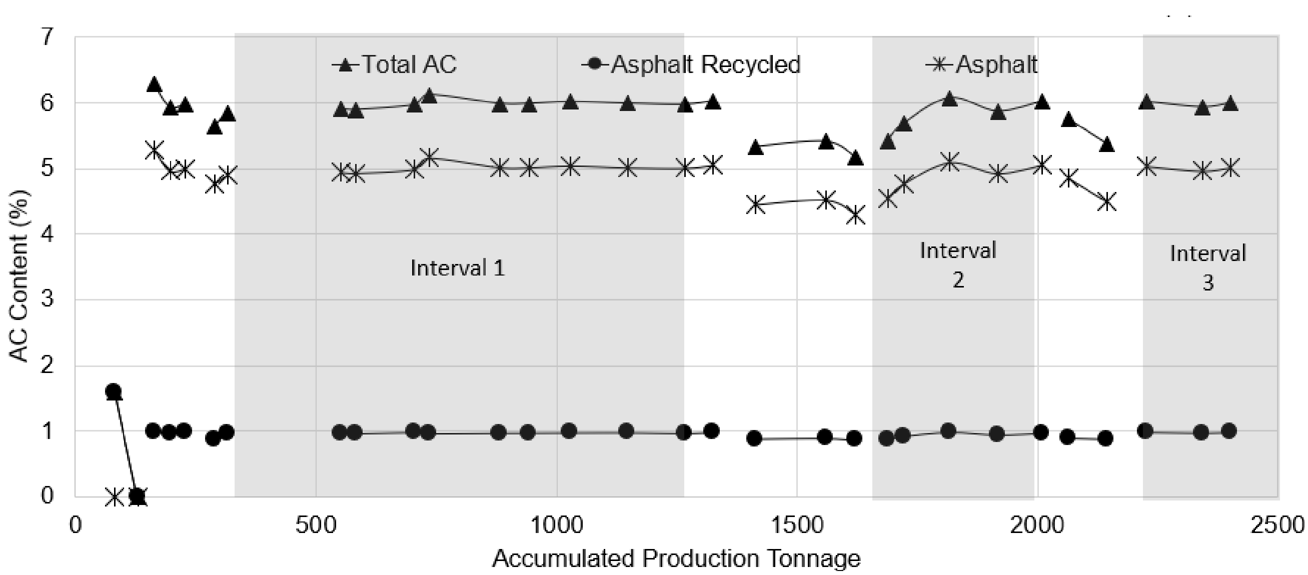
The mix production was performed in a Dillman drum plant with a separate dryer and mixer (known as a baby drum). The plant had five aggregate bins, two recycle bins, two silos, and a 2005 computer panel. The plant ran positive dust control with a weigh pod unit. A micromotion asphalt binder pump was used.

Figure 32 shows the datalogger results. The mixing temperature fluctuated between 330°F to 361°F; the specified maximum temperature was 330°F. There were five mix switches involving the IDOT mixes (highlighted in grey). As a result, the surface mix for IDOT was produced during three continuous intervals (labeled as 1, 2, and 3 in Figure 32). In the first and last intervals, the mix was produced at 300 TPH and in the second at 340 TPH.

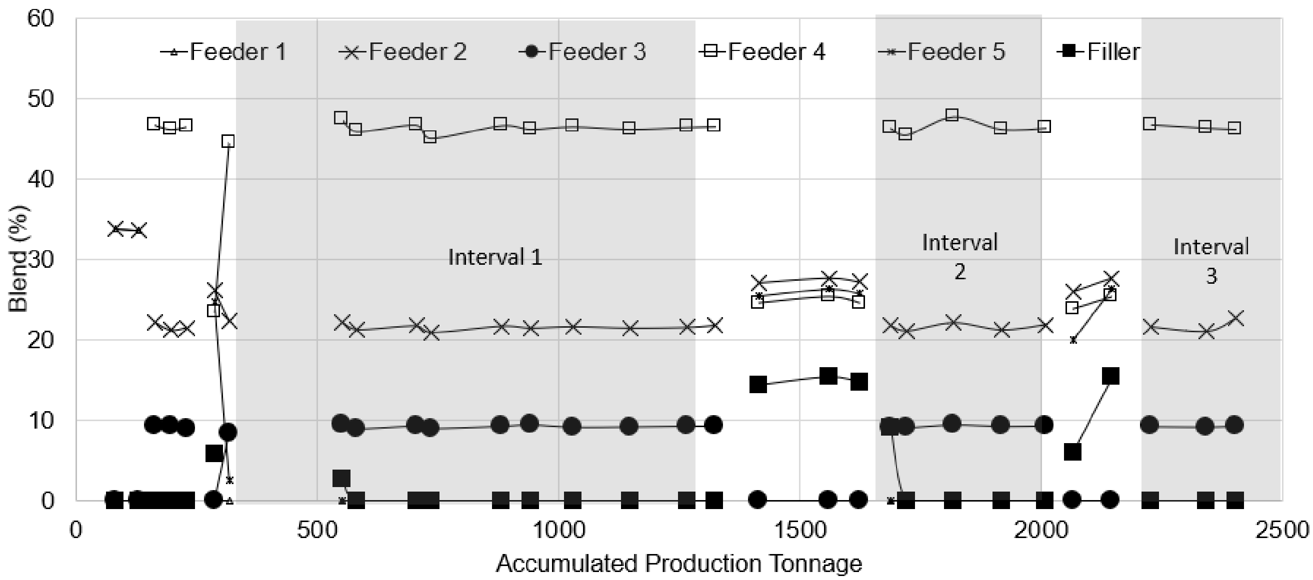
During interval 2, the speed was 40 TPH faster, and the material total and AC content were not constant as in the first production interval. Production speed varied the closest to mix switches. Hence, total AC content fluctuated from 5.4% to 6.12%, when the mix for this project was produced in interval 2 because of transitioning. Drastic changes in the production rate can cause aggregate gradation shifts, affecting the AV (Asphalt Institute, 2007).



A. Mix production temperatures and speed



B. AC content (virgin and recycled)



C. Blend (%)

Figure 32. Graph. Datalogger results for District 1 site visit 2.

Construction and Sampling

The mix was hauled for 10 to 15 min to the site by trucks owned by the same company and deposited directly in one AP 1055F CAT Paver. No MTD was used. No precipitation and a minimum temperature of 37°F, below specification, were reported during the morning, resulting in moisture content below 6%.

Two full-time QC field technicians conducted the QC tasks. One QC personnel had 10 years of experience and the other had four years. Four metal buckets full of mix samples were obtained from the mat (behind the paver) using a regular shovel without built-up sides, which may introduce variability (Mostafa, 2007). Then, the samples were split using an H-3966 Humboldt Riffle Sample Splitter, poured into paper buckets (no blending was performed), and secured by the resident engineer by placing the buckets in canvas bags. There was no formal training for the plant operator position, but they were experienced. According to the contractor QC personnel, better communication has evolved between QC and plant personnel after QCP and PFP implementation.

Testing Procedures

Four technicians were assigned for QA tasks. Two were at the site and were responsible for mix and density core sampling. The other two were at the lab performing tests for this project as well as other projects conducted at the same time. The contractor participated in the AASHTO re:source proficiency sample program.

During the contractor laboratory visit, samples were reheated using Humboldt ovens and were not reblended. Afterwards, G_{mb} specimens were compacted using a Troxler 5850 gyratory compactor; while the district used Pine AFG2. The QC personnel indicated that QCP and PFP projects were treated the same. Mixes were designed close to minimum VMA, regardless of if the mix was for QCP or PFP.

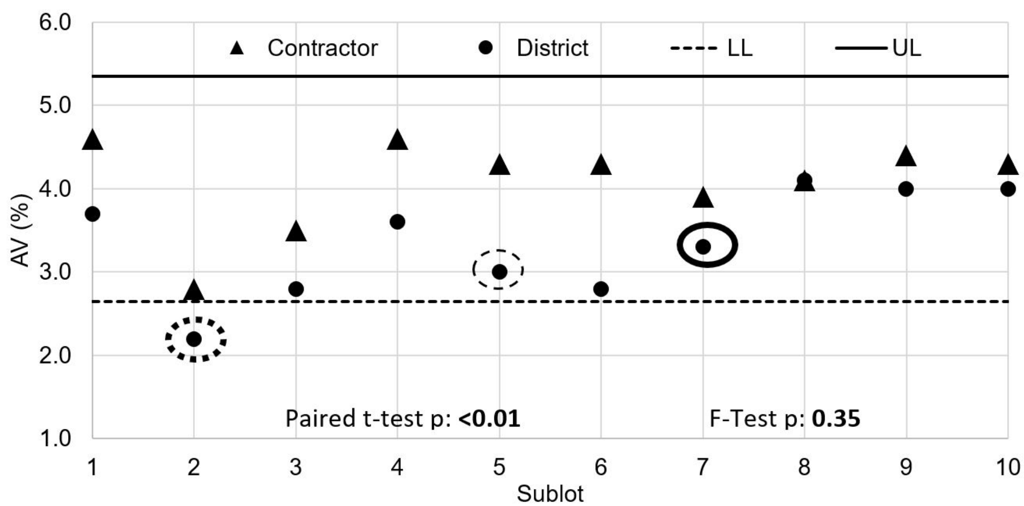
Differences in G_{mb} results between this contractor and district have been reported in the past. The round robin results have reported an average offset of 0.016 between both since 2016, even though the equipment was calibrated.

Pay for Performance Test Results

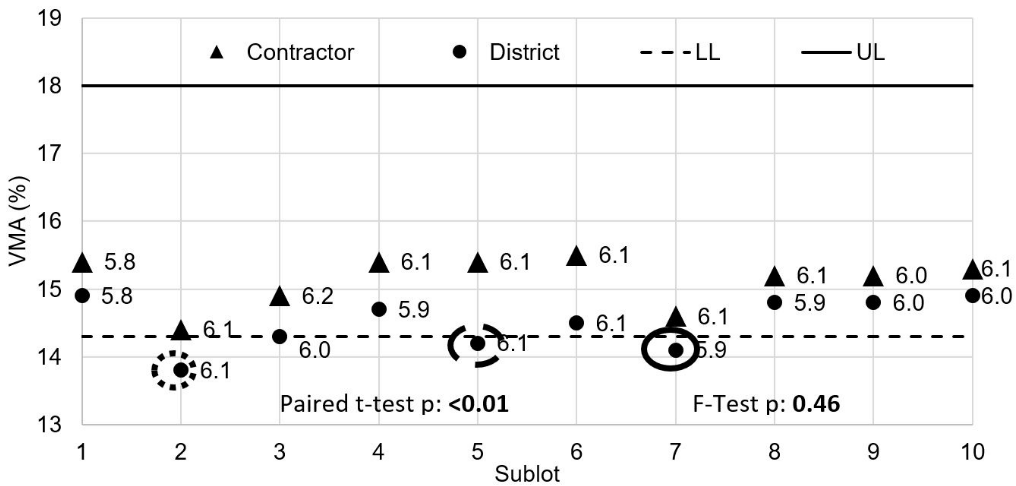
Figure 33-A and Figure 33-B show 10 sublot results for AV and VMA, respectively. A significant difference between contractor and district results for both AV and VMA (t-test p-value < 0.05) was reported. Contractor AV results were on average 0.73% higher than district results. However, only sublot 2 exceeded the PFP lower limit of AV. Sublots 3, 5, and 6 were also close to the limit, reducing the PWL. District VMA results were on average 0.5% lower than contractor results. District results for sublots 2, 5, and 7 (highlighted by the dashed circles in Figure 33) exceeded the PFP lower limit while contractor results did not. In this project, both a drop in VMA during production and a difference in test results affected pay.

This case showed the risk of designing at or close to the minimum VMA, although there was a 0.7% tolerance in VMA (design minimum was 15.0% and lower limit was 14.3%). A good practice documented during the interviews is to design the mix at 0.5% higher than the minimum VMA, allowing a gap of 1.3% in VMA to allow for any drop in VMA or district testing bias. AV has a gap of 1.35% between the target and the lower limit.

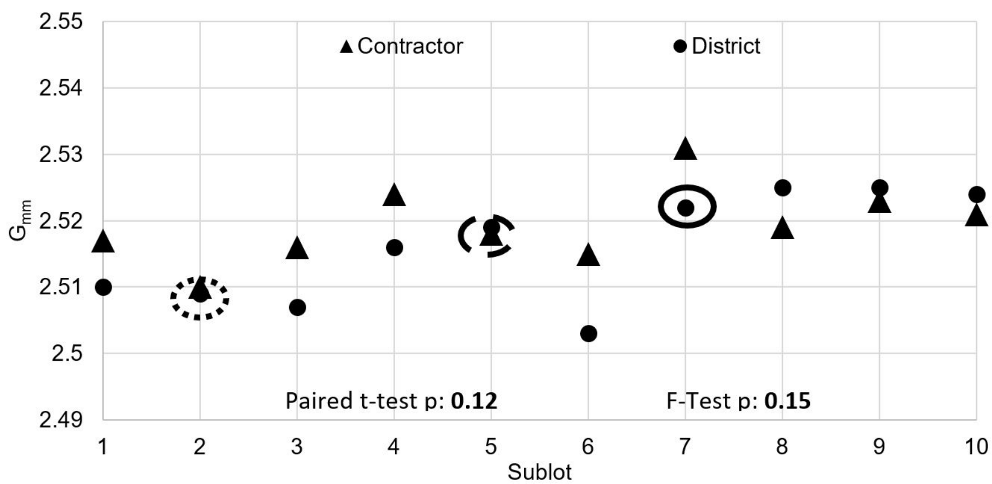
The G_{mm} test results were similar and approximately within the limits of precision (± 0.005), which discards any issue with reheating or splitting (Figure 33-C). There was a significant difference in the G_{mb} test results, however. The G_{mb} results reported by the district were on average higher than the contractor's by 0.016 (Figure 33-D). The difference in G_{mb} exceeded the limits of precision.



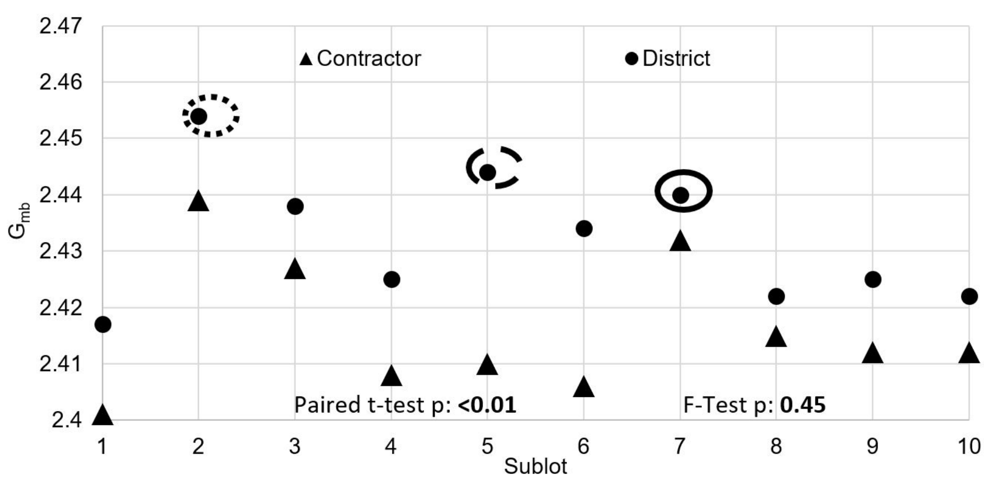
A. AV



B. VMA Data label shows binder content in percent for the sublot.



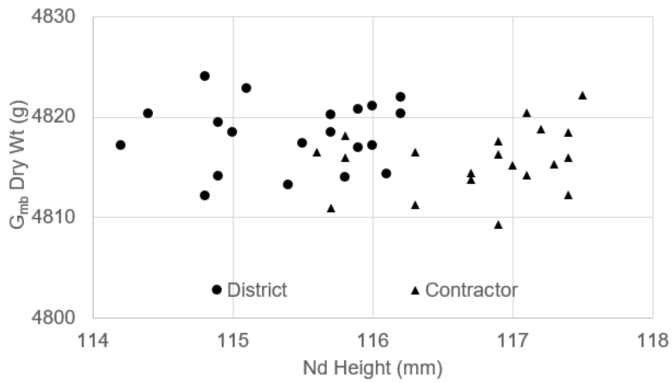
C. G_{mm}



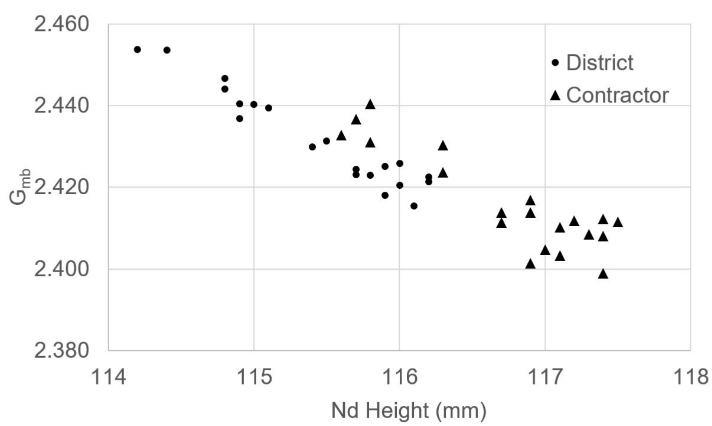
D. G_{mb}

Figure 33. Graph. Volumetric results per sublot for District 1 site visit 2.

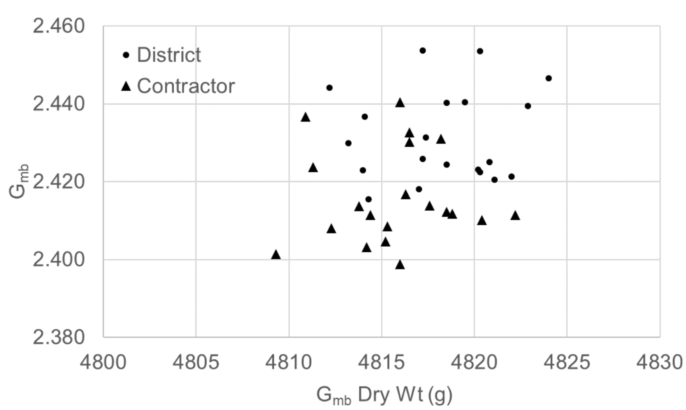
The lack of blending samples prior to splitting and/or compaction could have caused the differences in the G_{mb} results. Figure 34 shows the test weights for all district replicates and the four replicates provided by the contractor. The contractor's gyratory compactor produced approximately 1 to 2 mm thicker specimens than the district, although the weights were similar (4810–4820 g). The Troxler 5850 compacted lower density specimens than the Pine G2 used by the district.



A. G_{mb} specimen dry weight vs specimen height



B. G_{mb} vs specimen height

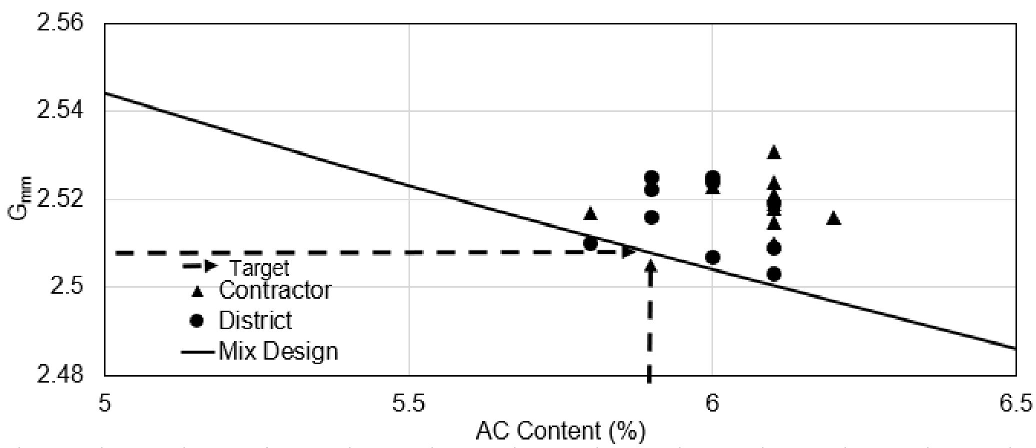


C. G_{mb} vs G_{mb} specimen dry weight

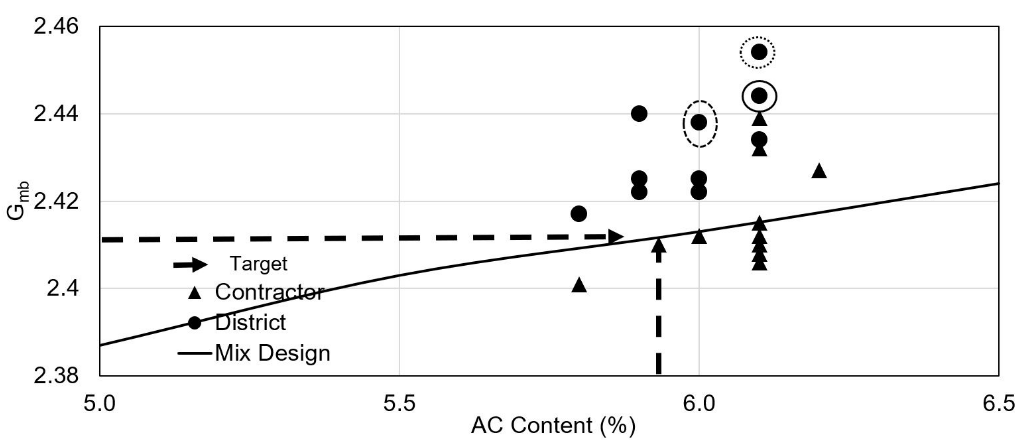
Figure 34. Graph. Test weight results for District 1 site visit 2.

Variability in production and the aggregate affected the results. The standard deviation of all sublots for the district was 0.64 and 0.37 for AV and VMA, respectively. Both were similar to those by the contractor. The AV results ranged from 2.8% to 4.1%, with high standard deviation. The G_{mb} and G_{mm} results were compared against the respective mix design target (Figure 35) (sublot 2, 5, and 6 highlighted by circles). The G_{mm} differed from the mix design line; this could be related to aggregate variability (Figure 35-A). For G_{mm}, the AC content was higher than the design, which led to higher G_{mb}. All district results were off from the design values, suggesting aggregate variability.

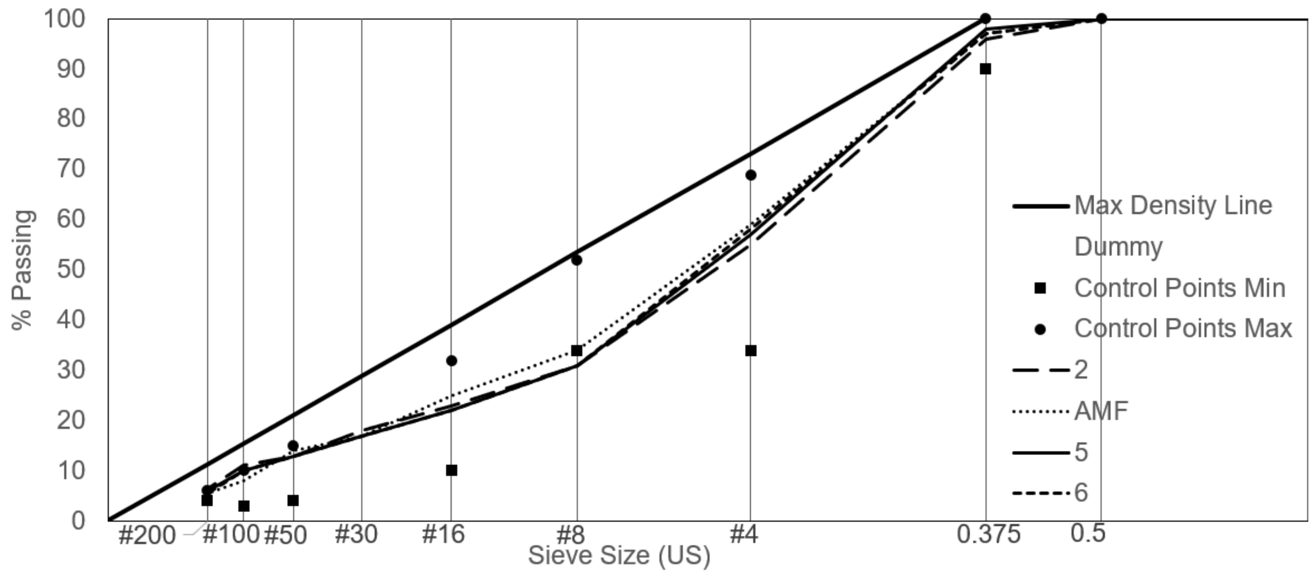
Figure 35-C shows the combined blend aggregate gradations per design and measurement. The mix design blend gradation included 44.7% CM16 from one source. The CM16 was not split into two different feeders during the production. The aggregate gradation results indicated that the material passing sieve #4, #8, and #16, in which stockpile CM16 contributed significantly, were between 3% to 5% lower than the AMF (Figure 35-C). Segregation and material variability originating in the CM16 stockpile could have caused the variations reported with the measured blend aggregate gradations. During the interviews, it was suggested to limit the blend percentage of a single aggregate source to 30% to reduce volumetric variation.



A. G_{mm} vs AC content



B. G_{mb} vs AC content



C. Gradation results for sublots 2, 5, and 6

Figure 35. Graph. Volumetric and gradation results for District 1 site visit 2.

Figure 36 shows the density results. The density PF was 101.7%, and most cores were within the limits. While two cores were outside the lower limit, two cores were close to the upper limit, contributing to PWL reduction. Contractor and district results for these cores were similar.

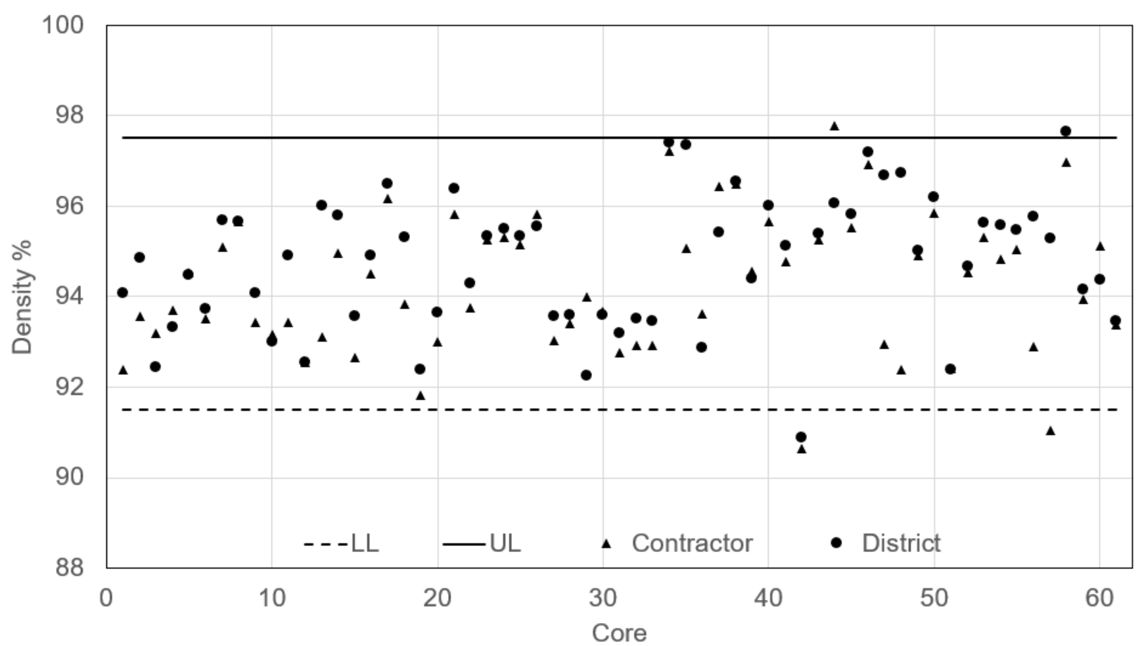


Figure 36. Graph. Density results per core for District 1 site visit 2.

The cause of the disincentive in this project could be attributed to two sources. First, there were consistent differences in AV and VMA results between the district and contractor. These differences were caused by the G_{mb}, some of which exceeded the limits of precision. This suggests the need for better blending of samples as well as gyratory calibration and revisiting the G_{mb} testing procedure. Second, deviation in the blend aggregate gradation from the mix design at middle-sized sieves, which was likely due to lack of sample field blending prior to splitting, resulted in fluctuations in AV and VMA between 2.5% to 4.5% and 14.5% and 15.5%, respectively. In addition, mix switches were observed in the production. Finally, although there was no PFP dispute, the district agreed to retest some of their samples because of the relatively high differences between district and contractor results.

DISTRICT 1 SITE VISIT 3

The third jobsite visit was to a PFP pavement-resurfacing job on a four-lane other principal arterial using a 1.75-in thick stone matrix asphalt (SMA). Table 6 shows the contract description and pay performance. The surface mix analyzed received a disincentive in AV. As a result, the analysis focused on mix production and testing.

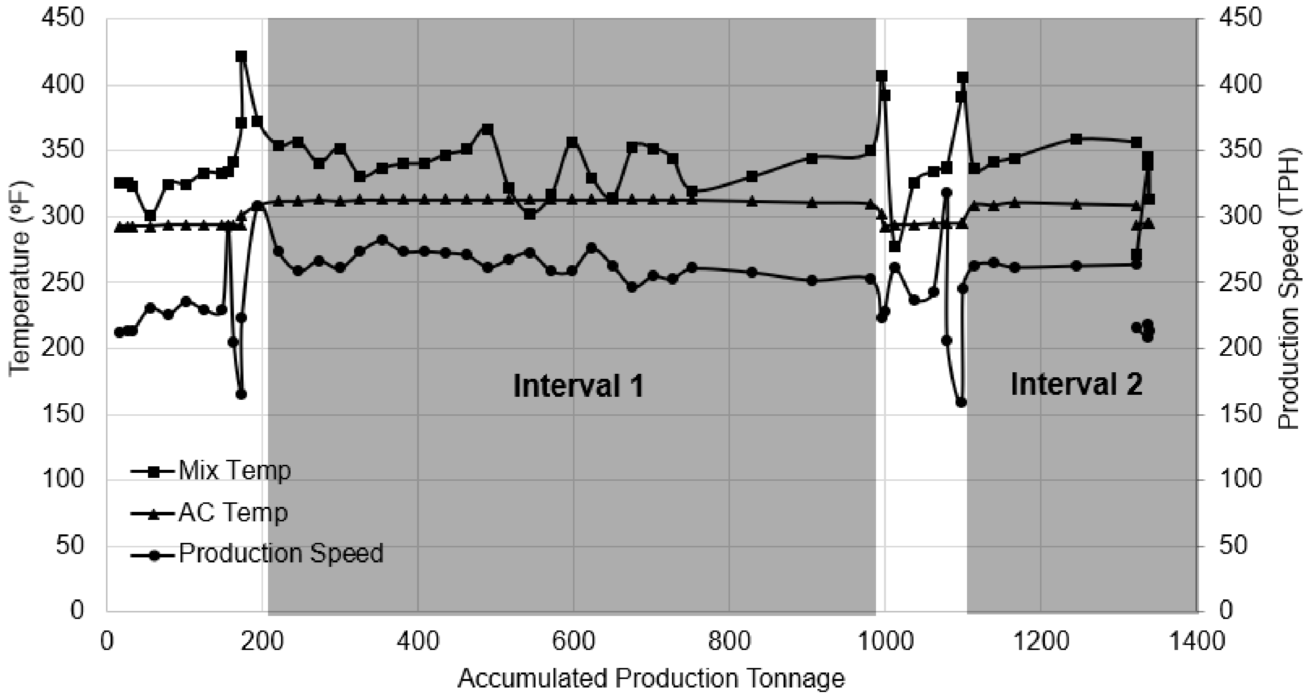
Table 6. District 1 Site Visit 3: Contract Description and Pay Performance (PFP)

Mix		**Project**	
Type	Surface	Project Type	Resurfacing
N Design	SMA N80	Length	
NMAS	9.5 mm	Thickness	1.75 in
Paving Surface	Leveling Binder	Production	12,407 ton
Requirement		**Pay Factors**	
AV	3.5 ± 1.35%	AV	94.5%
VMA	16.0 -0.7% +3.0%	VMA	101%
Density	93–98%	Density	104.4%
Other Pay Adjustments			
Dust/AC%	0.6%-1.2%	Dust/AC% Penalty	$0
AC (Design)	6.5%	CPF	100.4%

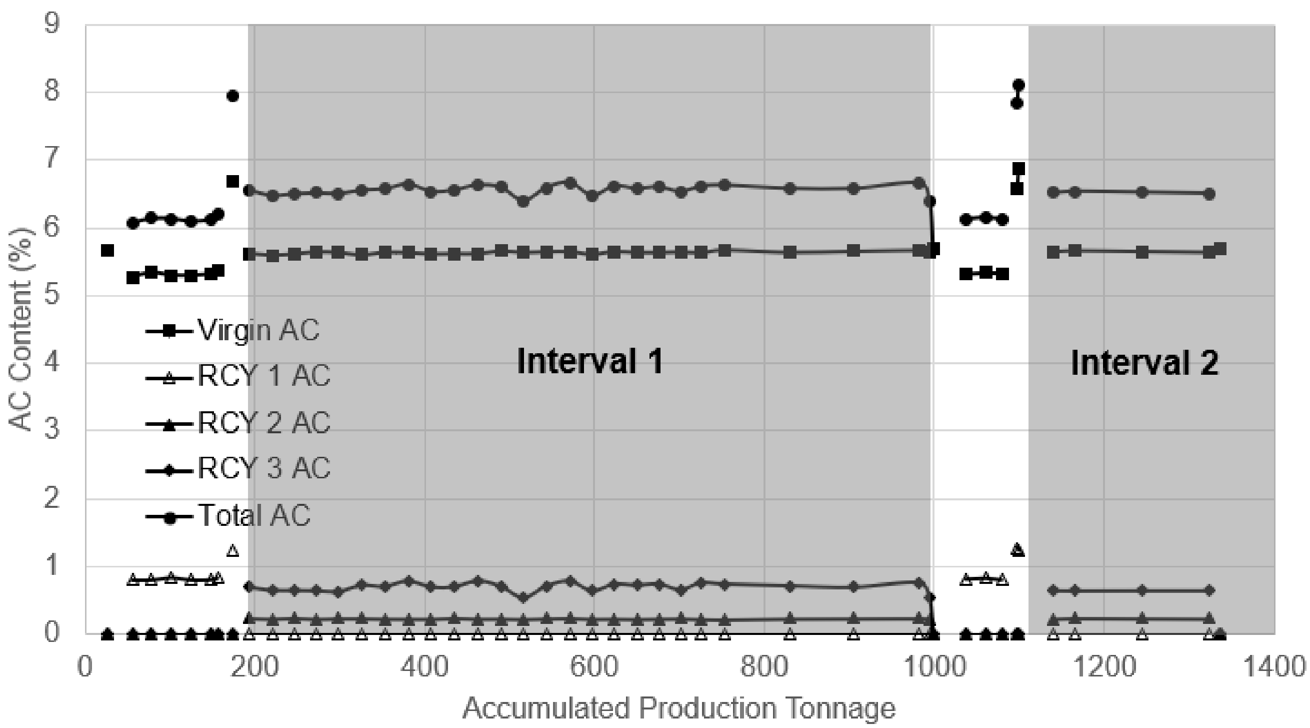
Mix Production

The mix was produced in a Gencor single-drum plant that had positive dust control. No precipitation and a minimum temperature of 49°F were reported. The moisture content in the stockpiles was below 5%. The datalogger indicated that the mix was produced at 260 TPH. There were only two mix switches and no hot stops (Figure 37). The mixing temperature fluctuated between 310°F to 350°F. No irregularities were seen in the aggregate and binder content during production, discarding issues with mix control.

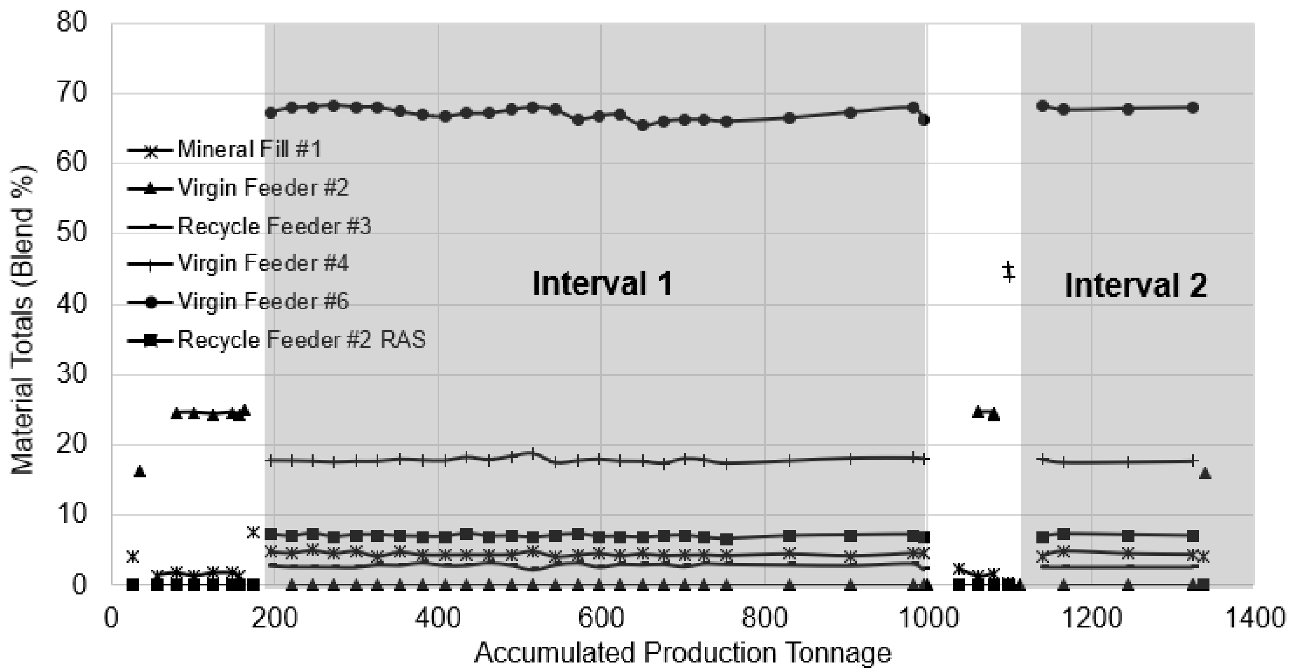
One feeder was used for the aggregate CM16, which is 66% of the mix. As previously mentioned, it is recommended to split large stockpiles of aggregate into two feeders. It is also recommended to get the aggregate from multiple sides of the stockpile to obtain a representative aggregate. From the interviews, it was reported that CM16 has had issues with variability from the supplier.



A. Temperature and production



B. AC content (%)



C. Blend % per stockpile

Figure 37. Graph. Datalogger results for District 1 site visit 3 (grey indicates when contract mix was produced).

The plant had limited stockpile space. Figure 38 shows an image from a non-Illinois plant as an example; contractor identity is protected. The stockpiles had one side for aggregate entry/exit. The material that arrived last was loaded from the stockpiles to the cold feeds. Hence, changes in the quarry are immediately reflected in mix production. The contractor had limited time to check changes in aggregate gradation or G_{sb} values. A good practice is loading the aggregate from multiple sides of the stockpile and keeping the stockpiles separated, if possible, to prevent variability and contamination. In addition, the stockpile height was greater than 20 ft, making it more susceptible to segregation.

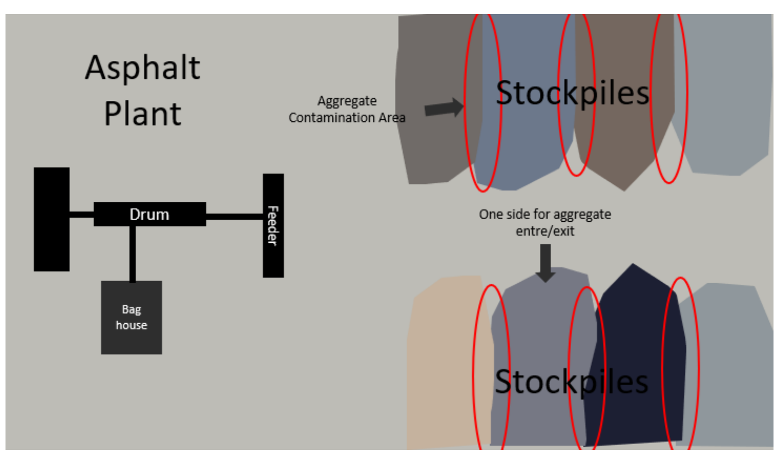


Figure 38. Photo. Stockpile handling in a plant illustrating space constraint.

Construction and Sampling

The mix was hauled for about 15 to 20 min to the site by trucks owned by the same contractor. An MTD was used in the first two days of production until it became disabled. The construction proceeded without an MTD after the second day using only the Blaw Knox Paver. Four metal buckets of mix samples were obtained from the mat using a regular shovel. Then, the samples were split using an H-3966 Humboldt Riffle Sample Splitter, poured into paper buckets without blending, and secured by the resident engineer in canvas bags. Samples should be blended once collected in the field. Four rollers were used, three static and one oscillatory. The oscillatory roller was used for the breakdown. Two static rollers were used for intermediate compaction and one static roller was used for finishing.

There was a delay during the day the MTD broke down. District and contractor personnel were not sure if the specifications allowed the contractor to place the 9.5 NMAS SMA without using an MTD. The confusion caused an hour and a half delay with eight loaded trucks waiting on the lane. The conflict was resolved when both parties agreed that the specifications allowed the mix to be placed without the MTD.

Testing Procedures

During the visit to the contractor testing laboratory, it was observed that the equipment was calibrated and that the lab participated in the AASHTO re:source proficiency sample program. The contractor had a total four full-time HMA level 3 technicians for the entire company. During summer, five HMA level 1 technicians were hired. These technicians were split between jobs, depending on the number of projects. During the visit, one technician was at the testing laboratory and two were on site for mix and density sampling. The contractor used a Pine AFGC125X gyratory compactor for G_{mb} specimen preparation; while the district used Pine AFG2.

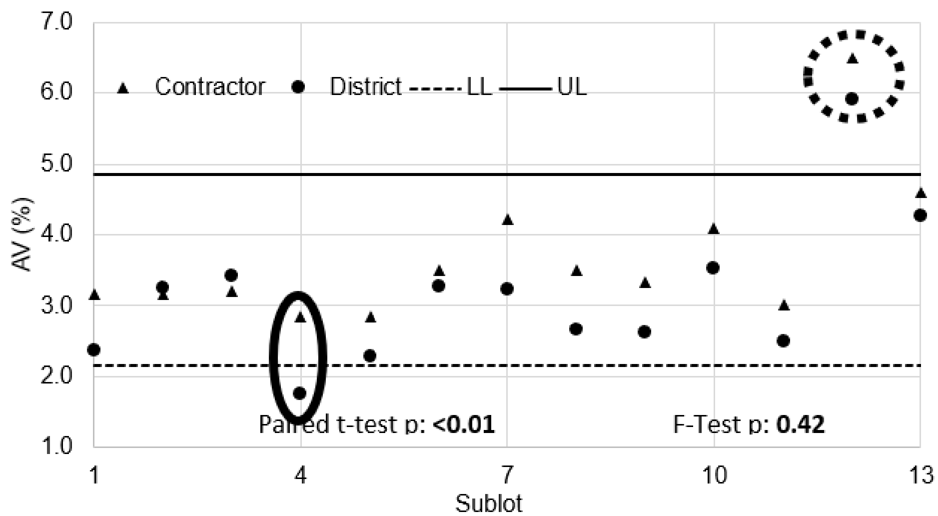
Humboldt ovens were used for reheating samples. The QC personnel indicated that QCP and PFP were treated the same. Extractions for aggregate gradation and AC content were completed using an ignition oven. The contractor reported that one of the main challenges was the amount of dust. The difference between both laboratories could be because the district uses an auto-extractor and the contractor uses an ignition oven. The contractor also had a reflux extractor for calibration of the ignition oven. The contractor reported that volumetric differences between contractor and district were not common.

Pay for Performance Test Results

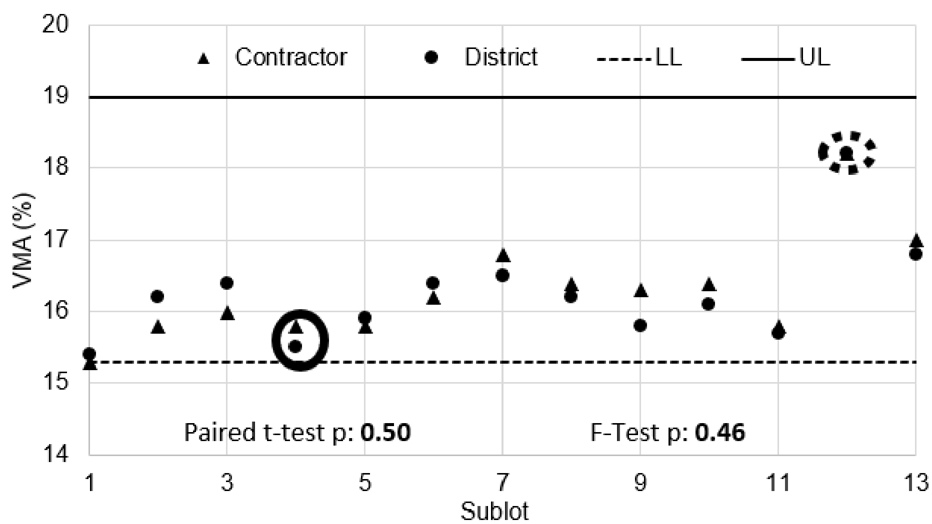
Figure 39-A and Figure 39-B show 13 sublot results for AV and VMA. District and contractor results reflected the same trend in the mix. District sublots 4 and 12 (highlighted by solid and dashed circles) failed the AV in the upper limit and lower limit, respectively. There was a significant difference between the AV results because of both G_{mb} and G_{mm} test results. The average difference for G_{mm} was 0.008 while the difference in G_{mb} was 0.007. The results from the district showed either test results higher or lower than the contractor. The reason for this difference is likely a lack of sample field blending.

In addition, the AV failed because of issues in the aggregate stockpile, affecting the G_{mb} results in Figure 39-D. Figure 40-C shows the aggregate gradation results. The aggregate gradation results for all sublots indicated that the #4 and #8 sieves had high variability. In the first five sublots, the aggregate percent passing for these sieves was up to 6% higher than the target. In the last two sublots, the aggregate percent passing for the #4 sieve was lower than the target by 7%. The mix design indicated that the #4 sieve size originated from the CM16 stockpile, which contributed 71% of the mix blend and was reported to have variability issues. The datalogger indicated that the dust was added according to the design; no disputes were reported.

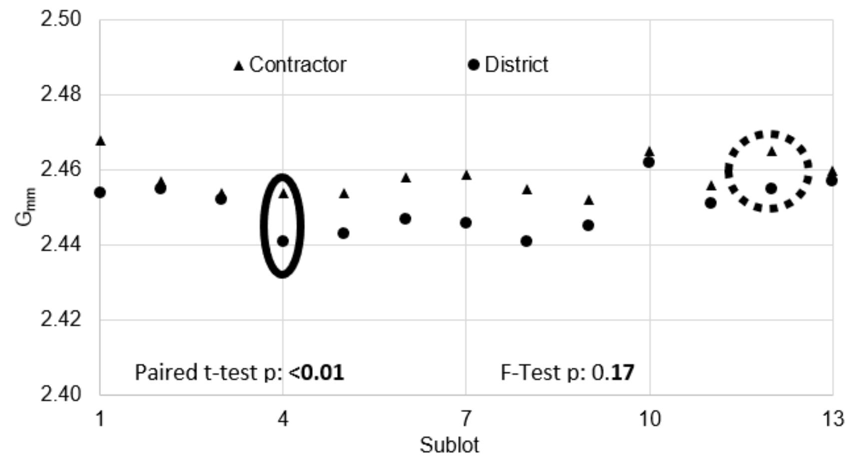
Based on the data analysis and the observations discussed, the cause of the pay disincentive appeared to be related to lack of sample blending prior to splitting, aggregate variability, and handling. The CM16 varied during the production, and there were not enough safeguards in place to prevent this variability from affecting mix composition. Blending the samples prior to splitting should reduce the impact.



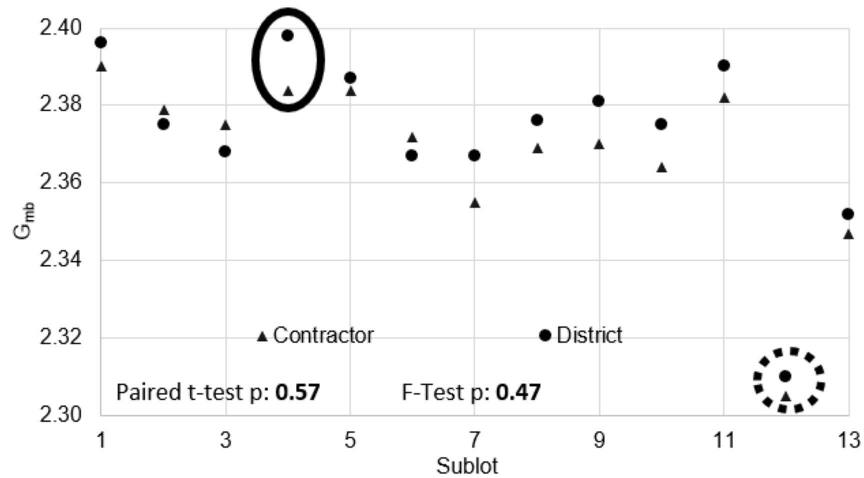
A. AV (%)



B. VMA (%)

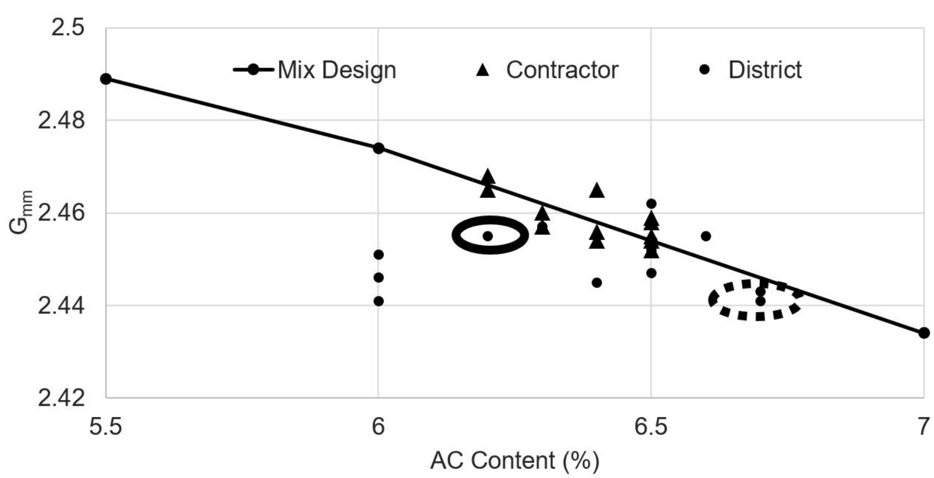


C. G_{mm}

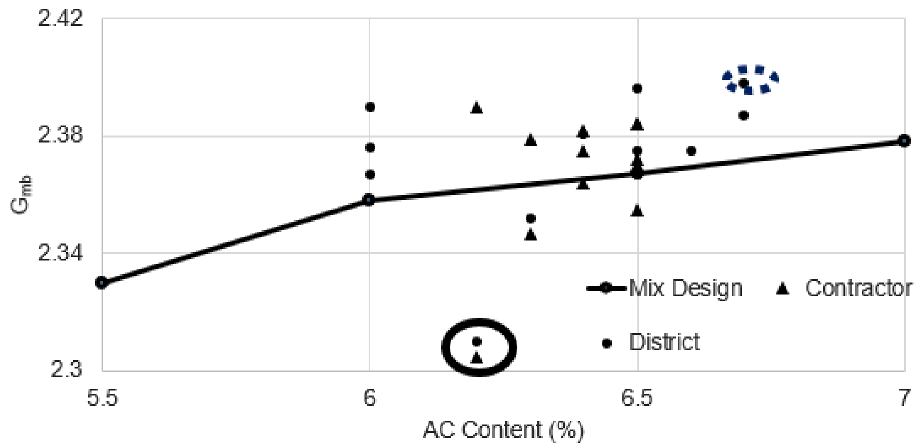


D. G_{mb}

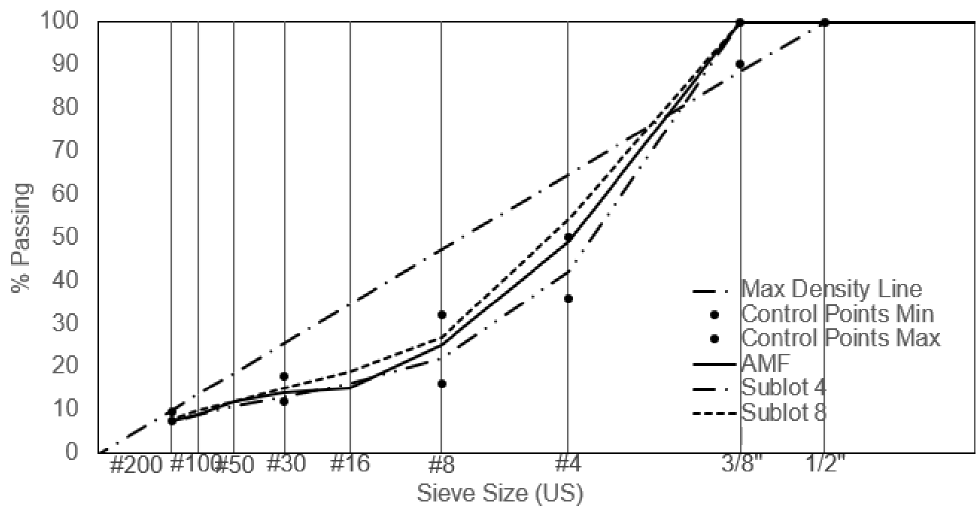
Figure 39. Graph. Volumetric results per sublot for District 1 site visit 3.



A. G_{mm} vs AC content



B. G_{mb} vs AC content



C. Gradation results for sublots 4 and 12

Figure 40. Graph. Volumetric results comparison with mix design and aggregate gradation for District 1 site visit 3.

DISTRICT 1 SITE VISIT 4

The fourth jobsite visit was to a PFP 1.75-in pavement-resurfacing job on a 2.5-mi other principal arterial. The original construction plan called for 8,485 tons of surface mix evaluated using PFP. However, only 4,321.5 tons were placed, lower than the PFP threshold of 8,000 tons, which may affect the outcome due to noncompliant implementation of the specifications. Four sublots were tested. As a result, both parties were at a disadvantage because the PFP specification is not designed for four sublots. The mix pay was 70.5% for AV, 105% for VMA, and 95.5% for density. IDOT CBM received a PFP dispute that the contractor partially won. Table 7 shows the PFs after the dispute. The PFs indicated that there were issues with both mix and density results.

Table 7. District 1 Site Visit 4: Contract Description and Pay Performance (PFP)

Mix		Project	
Type	Surface	Project Type	Resurfacing
N Design	N70	Length	2.5 mi
NMAS	9.5 mm	Thickness	1.75 in
Paving Surface	Leveling Binder	Production	4,321 ton
Requirement		**Pay Factors**	
AV	4 ± 1.35%	AV	84.5%
VMA	15.0 -0.7% +3.0%	VMA	103%
Density	91.5–97.5%	Density	95.5%
Other Pay Adjustments			
Dust/AC	0.6%-1.2%	Dust/AC% Penalty	$0
AC (Design)	6.0%	CPF	94.5%

Mix Production

A Dillman single-drum plant with eight aggregate bins and six silos was used. Manual controls were used for start-up and computerized for blending. Asphalt binder was switched manually during production. The plant used weight pods for positive dust control. Asphalt binder was added using a micromotion pump.

The datalogger indicated irregularities with mix production (Figure 41). The moisture content for the stockpile FM20 was 12%, which is relatively high. Typical moisture content is approximately 5% or lower. Mix production speed was not constant and fluctuated between 350 to 430 TPH. The mixing temperature fluctuated from 300°F to 380°F. There were four different mixes produced on the same day, including the one for the visited jobsite. A total of 17 mix switches were completed during the production day. In some occasions, the plant did not operate for more than 15 min in producing one mix before switching to the next one. Finally, the stockpiles had one side for aggregate entry/exit. As a result, newly arrived material was loaded to feeders. Therefore, any change in the quarry was immediately reflected in the mix.

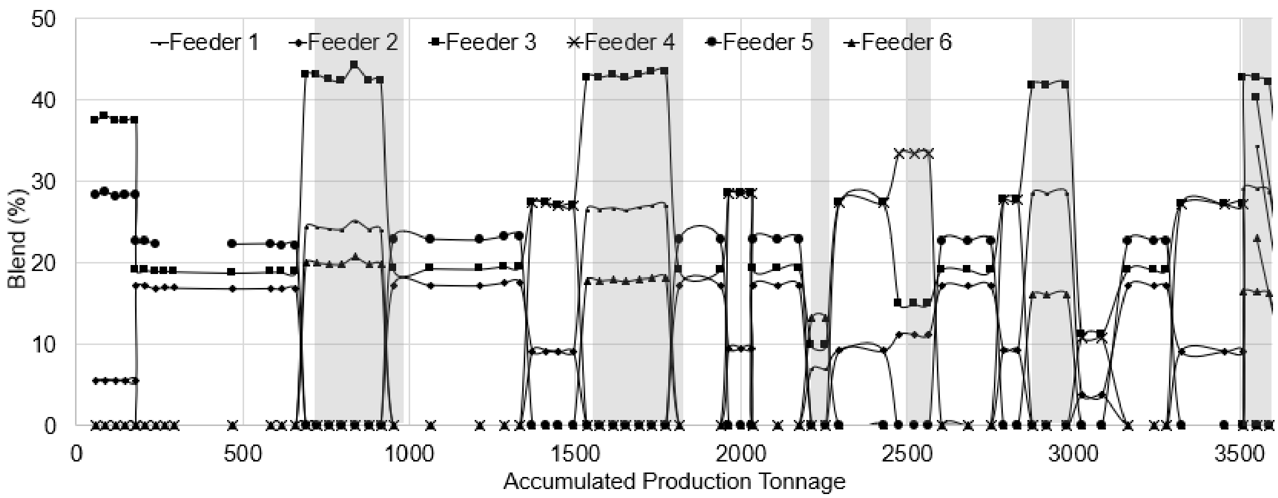
Construction and Sampling

Trucks owned by the same company hauled the mix to the site for 15 to 20 min. No precipitation and a minimum temperature of 42°F were reported. No MTD was used. Mix samples were shoveled from the mat using a commercial asphalt shovel. The samples were blended and then split to the required G_{mb} and G_{mm} test size using an H-3966 Humboldt Riffle Sample Splitter. The samples were then poured into paper buckets and secured by the resident engineer in canvas bags. As a result, there was no need to split the sample in the district's lab and reheating time was shorter.

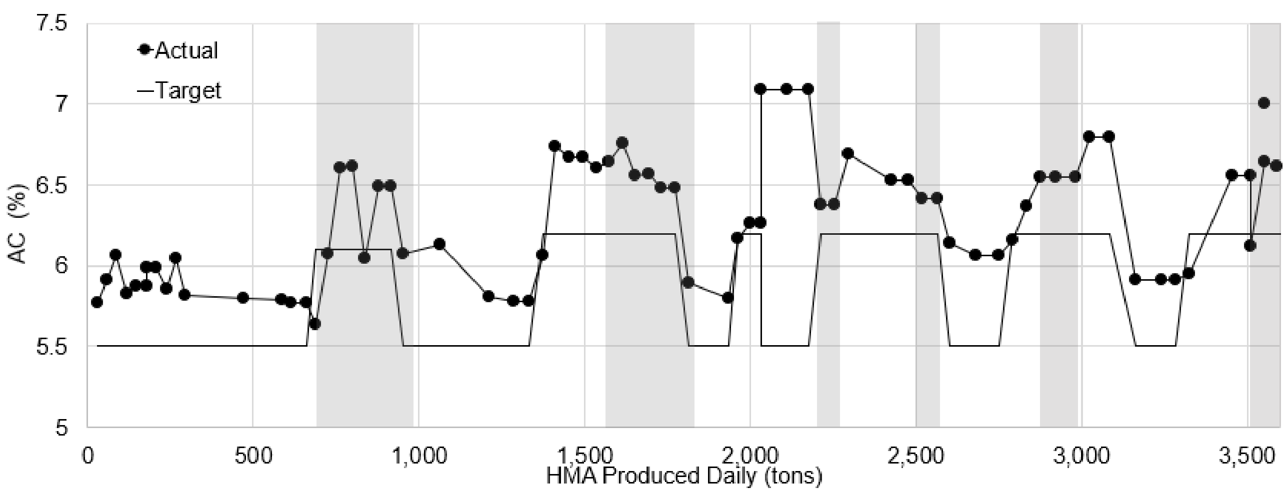
Testing Procedures

During the contractor testing laboratory visit, the equipment was calibrated and the laboratory participated in the AASHTO re:source proficiency sample program. The laboratory had three full-time QC personnel in charge of mix and density sampling who interchanged positions. The contractor and district both used a Pine G2 gyratory compactor for G_{mb} specimen preparation. A pulley vacuum pump was used with a manometer for the G_{mm}. The QC personnel indicated that the same mix designs were used for QCP or PFP. Production checks of samples were done at the fifth load. The company had not conducted an internal check of the results. Extractions for aggregate gradation and AC content were done using an ignition oven. Reflux extraction was used for calibration of the ignition.

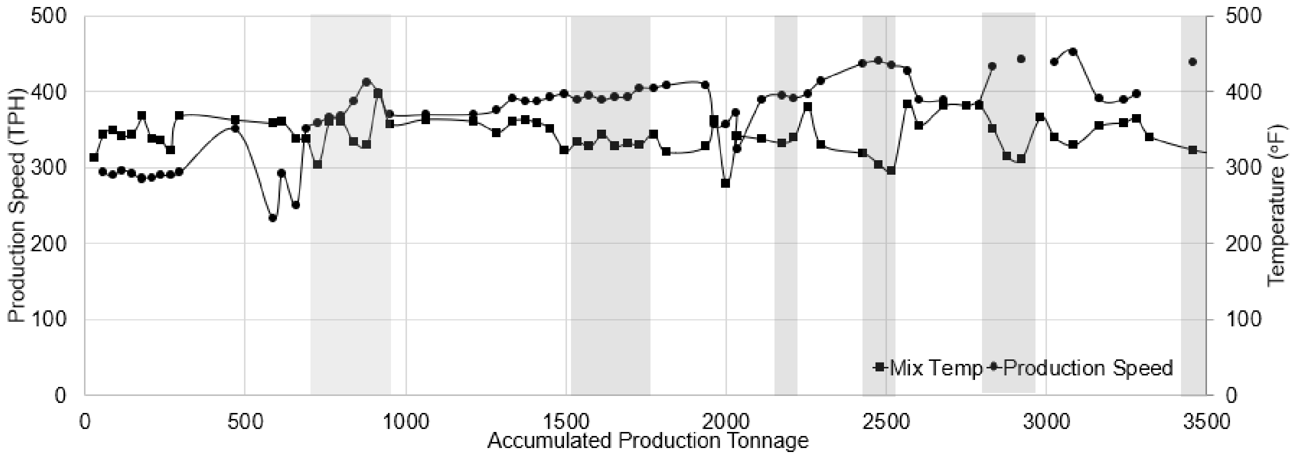
Figure 41-B shows the AC content during the production day, as reported by the plant's datalogger. The different mix designs are shown in the figure. The design used for the visited contract corresponds to the grey background. The plant was not able to keep the AC content close to the target values, possibly because of the many reported mix switches. The AC content fluctuated between 5.7% to 6.6%. Every mix switch between different target AC contents did not occur instantly. For every mix switch, the plant may also need to dispose of material to prevent the mix destined for IDOT projects from being contaminated with other mixes. As a result, the test results could be affected because of the relatively high number of mix switches.



A. Blend



B. AC content

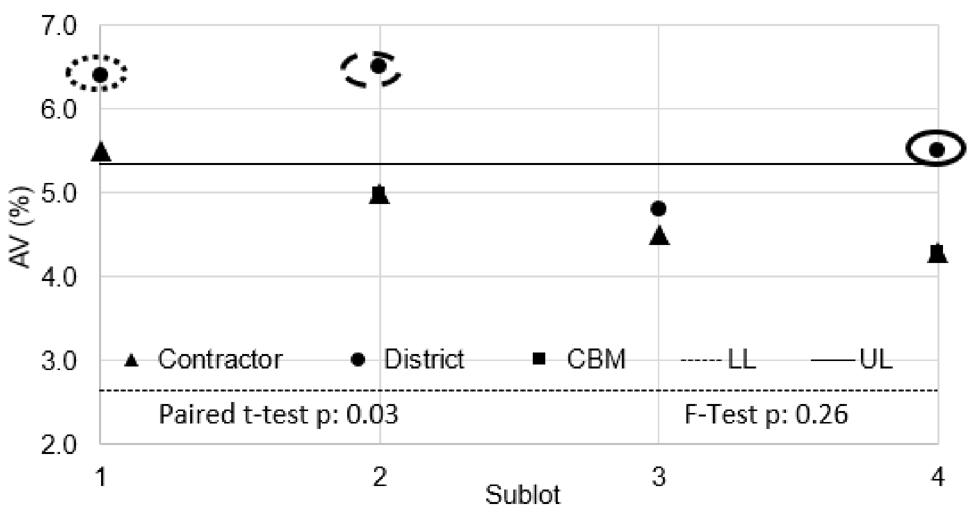


C. Production speed

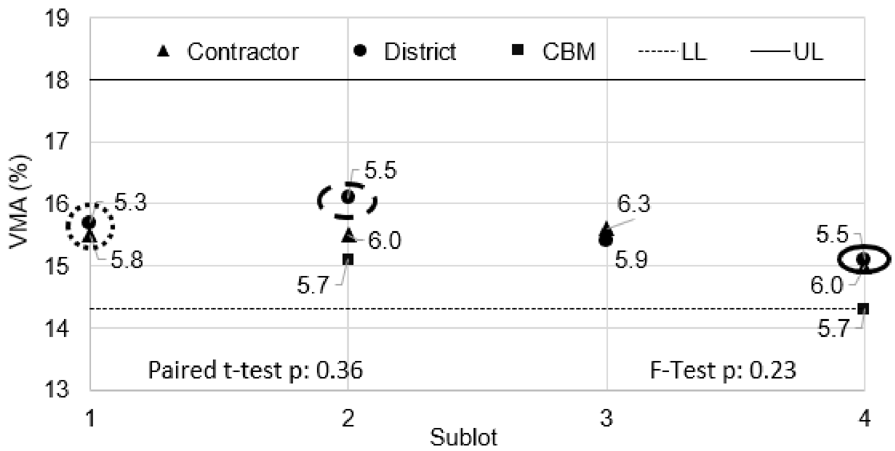
Figure 41. Graph. Datalogger results for District 1 site visit 4 (grey indicates IDOT mix).

Pay for Performance Test Results

The AV and VMA test results are shown in Figure 42-A and Figure 42-B, respectively. The values of VMA reported by the district and contractor were within range and similar. However, there is a significant difference between contractor and district AV results. AV district results were between 0.3% to 1.5% higher than contractor results. Three sublots failed to meet the AV criteria (indicated by the dashed and solid circles in Figure 42 and 44, left to right). The differences in AV were caused by G_{mb}. The average G_{mb} difference was 0.017. G_{mm} was not significantly different. Possible differences rely on G_{mb} specimen preparation. The weight of the district's specimens differed by as much as 80 g per specimen. However, the specimens were still compacted to the same height of 119.1 mm (Figure 43). As a result, the district lab had inconsistent production that significantly ranged in weight while the specimens compacted to the same height. It is suggested that a constant weight should be used by both the district and the contractor for gyratory specimens.

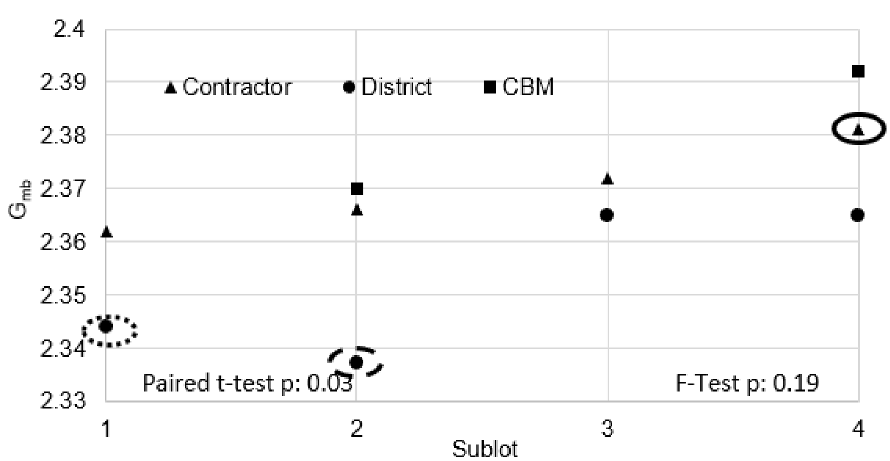


A. AV (%)



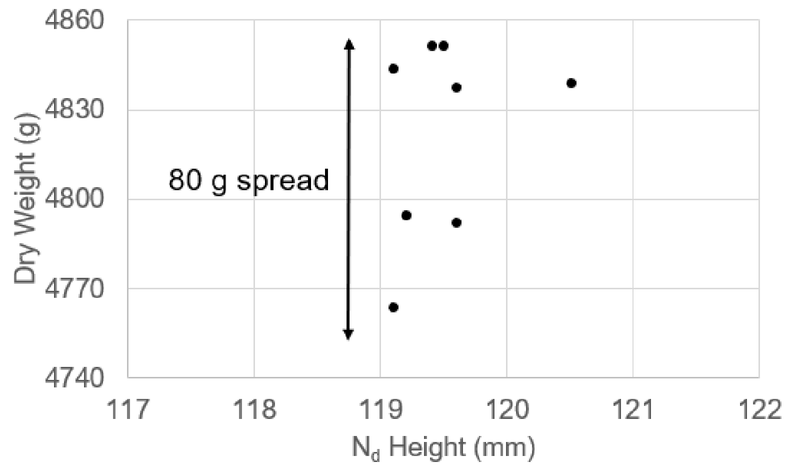
B. VMA (%)

C. G_{mm}

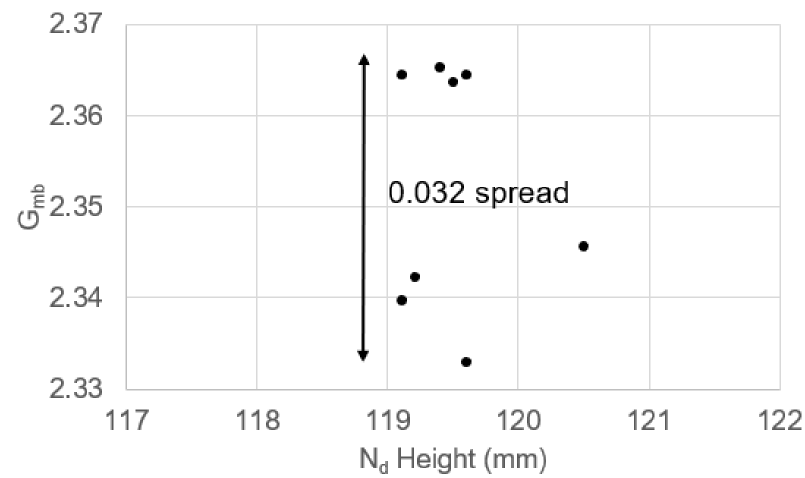


D. G_{mb}

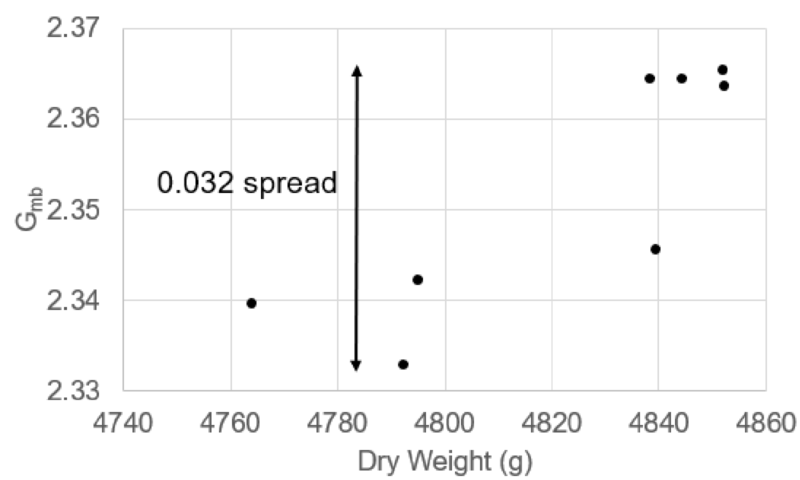
Figure 42. Graph. AV, VMA, G_{mm}, and G_{mb} results per sublot for District 1 site visit 4; asphalt content values are added in plot B for each value.



A. G_{mb} dry weight vs N_d height



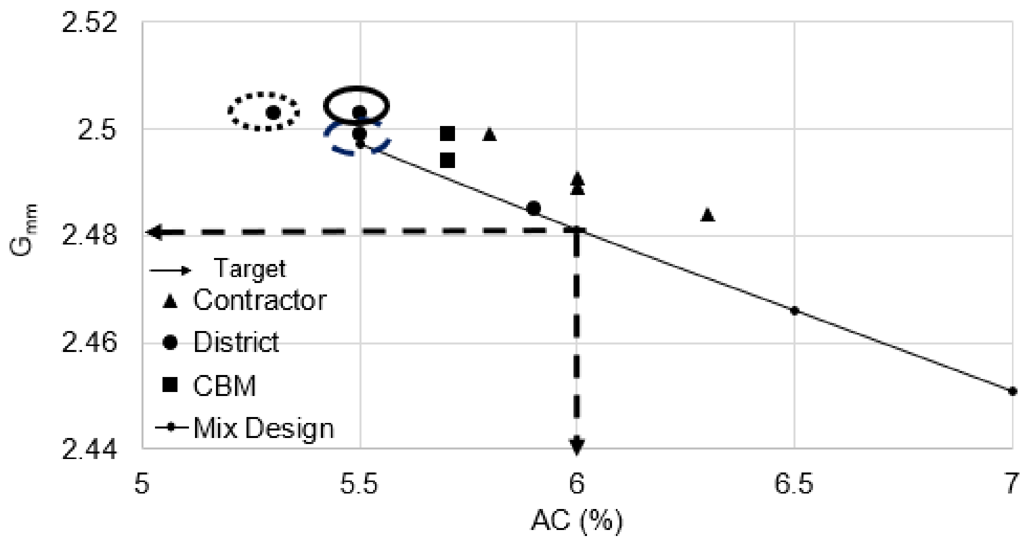
B. G_{mb} vs N_d height



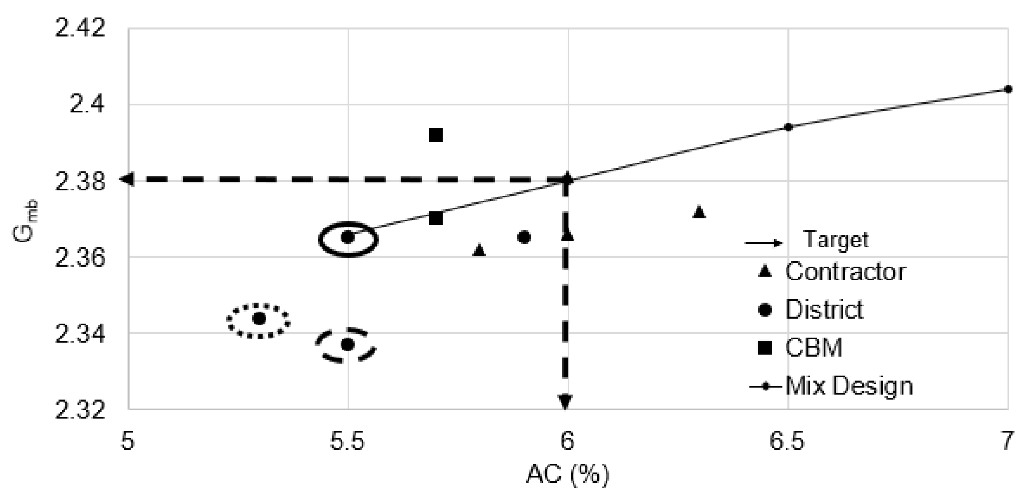
C. G_{mb} vs specimen dry weight

Figure 43. Graph. G_{mb} specimen weight evaluation for District 1 site visit 4.

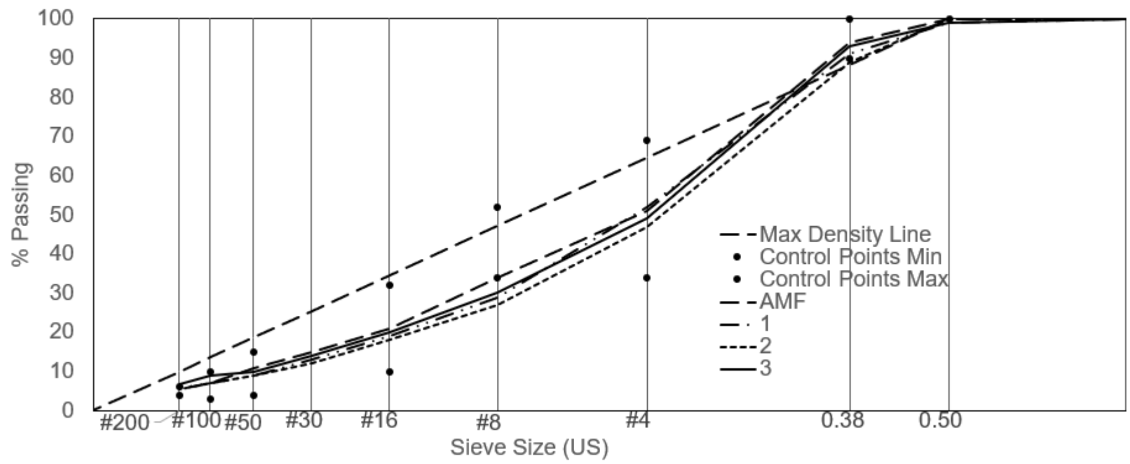
Figure 44 shows the G_{mm} vs AC% and the G_{mb} vs AC% results compared to the mix design. The G_{mm} was lower than the target because of the AC content. AC content also affected G_{mb} results. Nevertheless, G_{mm} results from the contractor and district were close to the mix design. District G_{mb} results differed from the mix design line, which raised questions regarding the difference in G_{mb} sample preparation. Sublots 2 and 4 were disputed and their results were closer to the contractor results. This resulted in a lower disincentive. The aggregate gradation results for all sublots indicated that there were aggregate variability issues with sieves 3/8", #4, and #8. In the four sublots, the aggregate gradation of these sieves was 4% to 7% lower than the target.



A. G_{mm} vs AC content



B. G_{mb} vs AC content



C. Aggregate gradation results for sublots 1, 2, and 3

Figure 44. Graph. Volumetric and gradation results for District 1 site visit 4.

The differences between contractor and district density results were lower than 1% for all results, except for three core pairs, two of which were below the lower limit (Figure 45). The difference in the density between the laboratories was due to differences in the specimens' submerged weight. The disputed district cores differed by 7 g to 10 g of the expected value for the same thickness and weight. IDOT CBM dispute-resolution results increased contractor pay. It was noted that inconsistency in the core measurement in the district contributed to pay deduction. The rest of the contractor and district cores agreed that the density was highly variable from 89% to 97%.

In summary, the main cause of pay disincentives in this case was mix production inconsistency because of the high number of mix switches. In addition, bias in the district G_{mb} values and insufficient sublots to fulfill the PFP PWL normality and sample size assumptions affected contractor pay. In this case, issues related to both mix production and testing caused pay loss.

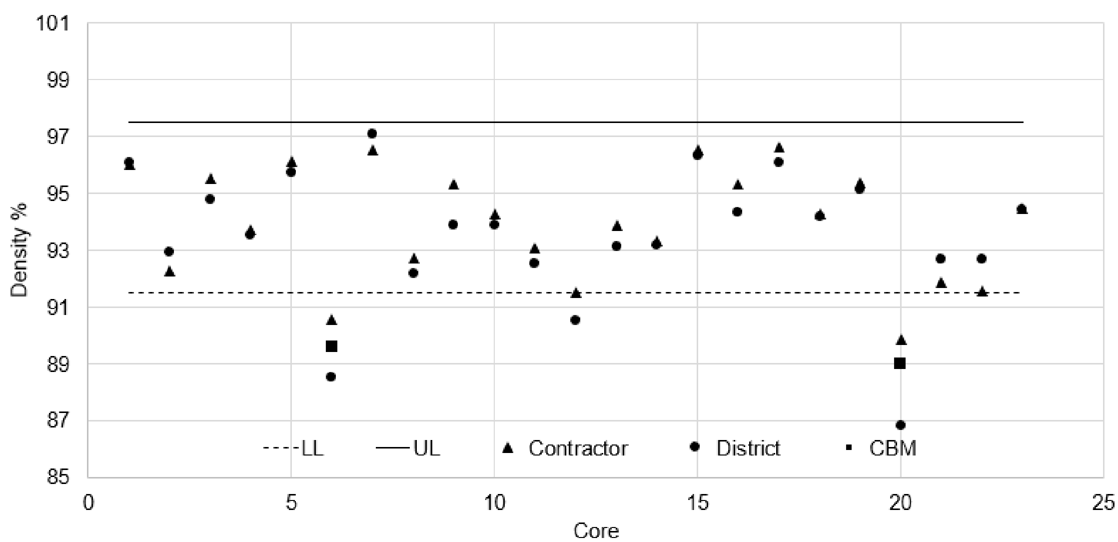


Figure 45. Graph. Density core results for District 1 site visit 4.

DISTRICT 1 SITE VISIT 5

The fifth jobsite visit was to a QCP 1.5-in pavement-milling and -resurfacing on a minor arterial road. Table 8 shows the contract description and pay performance. The surface mix received full pay using the QCP specification. A consultant laboratory conducted QA testing on behalf of the district.

Table 8. District 1 Site Visit 5: Contract Description and Pay Performance (QCP)

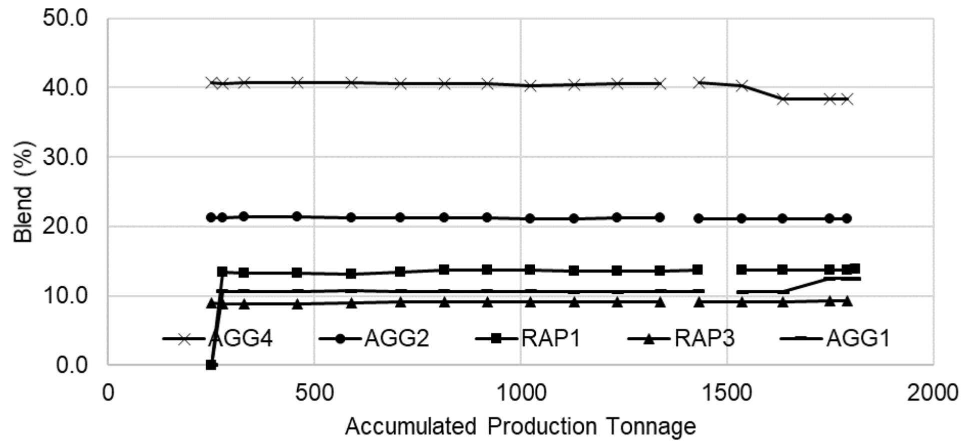
Mix		**Project**	
Type	Surface	Project Type	Resurfacing
N Design	N70	Length	2 mi
NMAS	9.5 mm	Thickness	1.5 in
Paving Surface	Leveling Binder	Production	4,124 ton
Requirement		**Pay Factors**	
AV	4.0 ± 1.2%	AV	100%
VMA	15.0 +2/-0.5%	VMA	100%
Density	92.5–96.5%	Density	100%
Other Pay Adjustments			
Dust/AC	0.6-1.2%	Dust/AC% Penalty	$0
AC (Design)	6%	CPF	100%

Mix Production

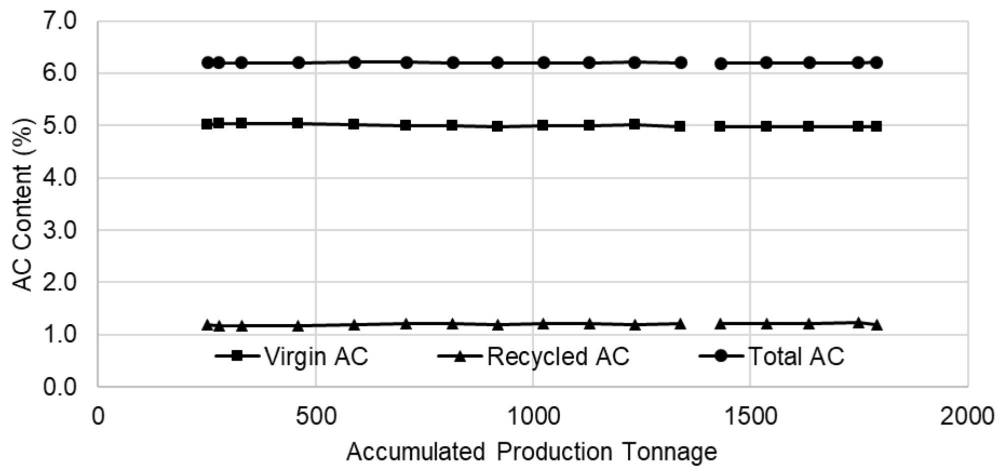
An ASTEC double-barrel drum with seven feeders, two recycle feeders, four silos, and a computerized control panel was used. The plant had positive dust control. The datalogger indicated no issues with mix production (Figure 46). The mix was produced between 210 to 250 TPH with no mix switch or hot stops. The contractor did not allow a single feeder to contribute more than 40% of the mix to control aggregate variability. AC and aggregate content were consistent and on target. No precipitation and a minimum temperature of 60°F were reported during the morning, resulting in moisture content below 5%.

Construction and Sampling

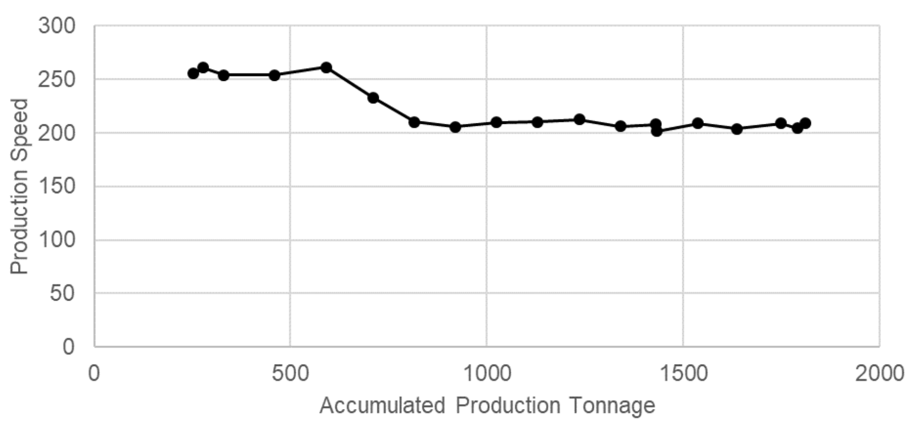
The mix was hauled for 25 to 30 min to the site and deposited directly to the paver. No MTD was used. During the site visit, the resident engineer (RE) was supervising more than one job. When the research team arrived, the RE was not at the visited site and an assistant was supervising the job. The RE assistant was informed of the production tonnage when the loaded truck arrived at the site, which required a decision on where samples would be taken. Although the process should be a standard practice, in this case, it could impact the sampled material quality due to insufficient time to prepare sampling and splitting equipment. During the site visit, the RE assistant was unaware of the detailed sampling practice. He identified the sampling tonnage when the material was already feeding the paver. The lack of time for sampling resulted in stopping paving operation and a discussion between IDOT and contractor personnel. It took approximately 45 min to resolve the situation, collect the samples, and pre-split. Three rollers were used for compaction. The roller pattern consisted of seven vibratory passes and three passes for finishing.



A. Blend (%)



B. AC content



C. Production speed (TPH)

Figure 46. Graph. Datalogger results: (a) blend percentage, (b) AC content, and (c) production speed for District 1 site visit 5.

After the discussion, the contractor collected the samples by shoveling the mat. Then, the samples were blended and split in the field to the G_{mb} and G_{mm} test sizes (pre-splitting). The company (representing the district) set up tables with the scales shown in Figure 47. There was no need to split the sample in the district's lab, which reduced reheating time.

Figure 47. Photo. Pre-splitting set-up.

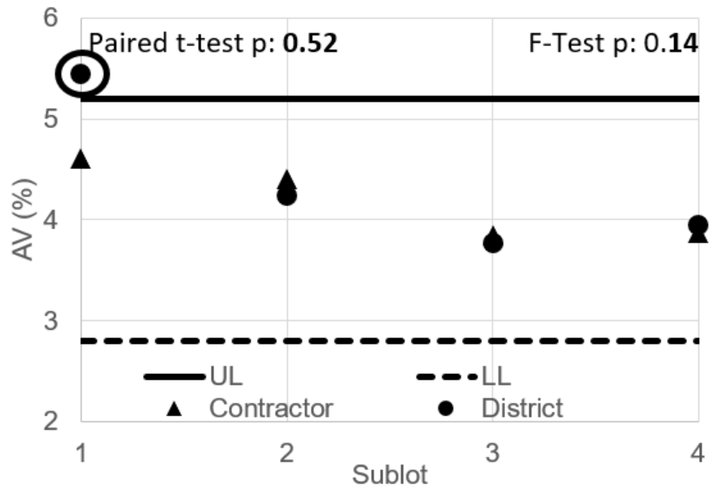
Testing Procedures

During the contractor lab visit, it was observed that the equipment was calibrated and the lab participated in the AASHTO re:source proficiency sample program. The contractor had one full-time technician HMA level 2 at the site for mix and density samples. During mix sampling, another technician helped with blending and splitting. A Pine G2 gyratory compactor was used for G_{mb} specimen preparation. Humboldt ovens were used for reheating samples. Extractions for aggregate gradation and AC content were completed using an ignition oven. The QC personnel indicated that QCP and PFP projects testing were treated similarly.

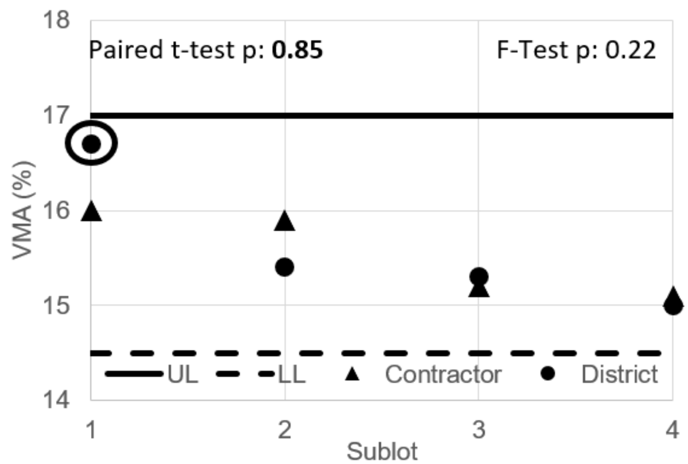
Quality Control Pay Test Results

Figure 48 shows the volumetric test results. The circled datapoint shows the sublot with AV result outside of the limits. District and contractor results were similar. The AV results were within +/- 0.1% of the target. The G_{mm} and G_{mb} results were mostly comparable to the mix design except for one sublot where the district value was different than the design (Figure 48-D). The differences in the G_{mm} results were within 0.001 to 0.005. Finally, the aggregate gradation was within the control limits and +/-4% (except for sublot 1) from the AMF. Sublot 1 was the same sublot where the management issues occurred.

In summary, consistent production of the mix and the use of the pre-splitting method yielded comparable results, resulting in 100% pay. G_{mm} and AC% results were consistent with design because absorption due to reheating was reduced. The results were consistent except for sublot 1, which explains the full payment received in this project. However, logistic challenges delayed sample collection and affected contractors' sample collection. Figure 49-D presents the density results for the district. Except for two cores, the results were within the QCP limits.



A. AV

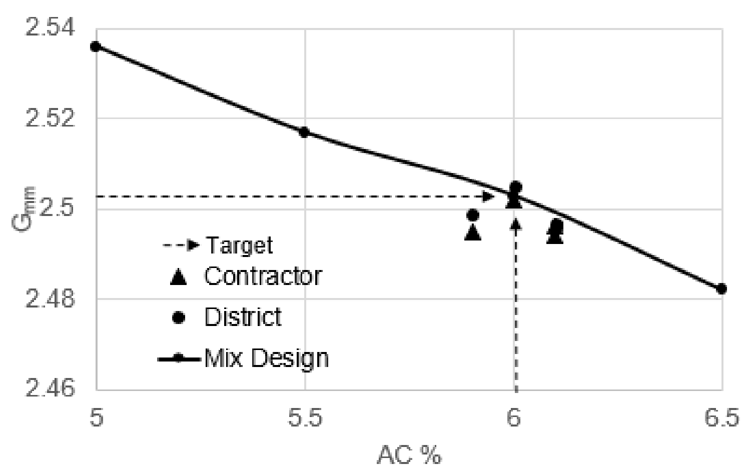


B. VMA

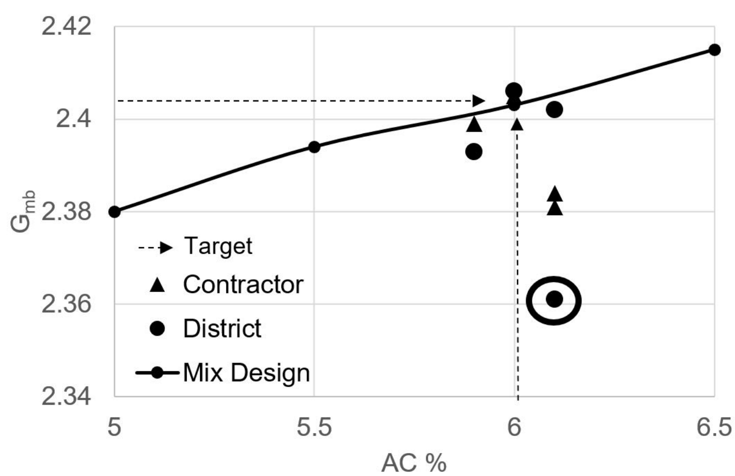
C. G_{mm}

D. G_{mb}

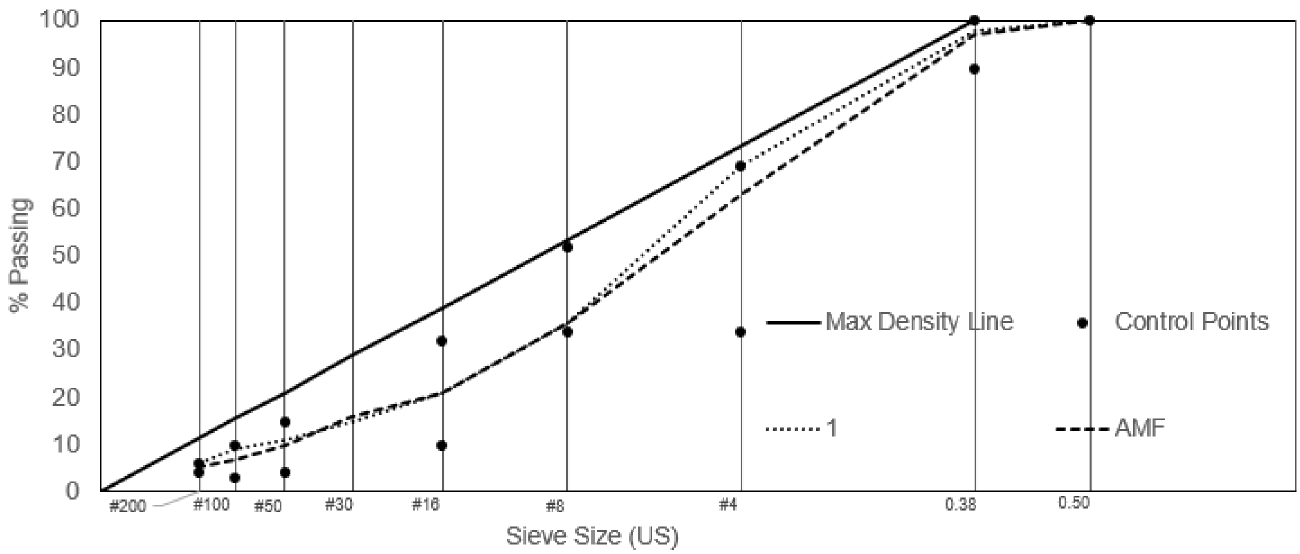
Figure 48. Graph. Volumetric results per sublot for District 1 site visit 5.



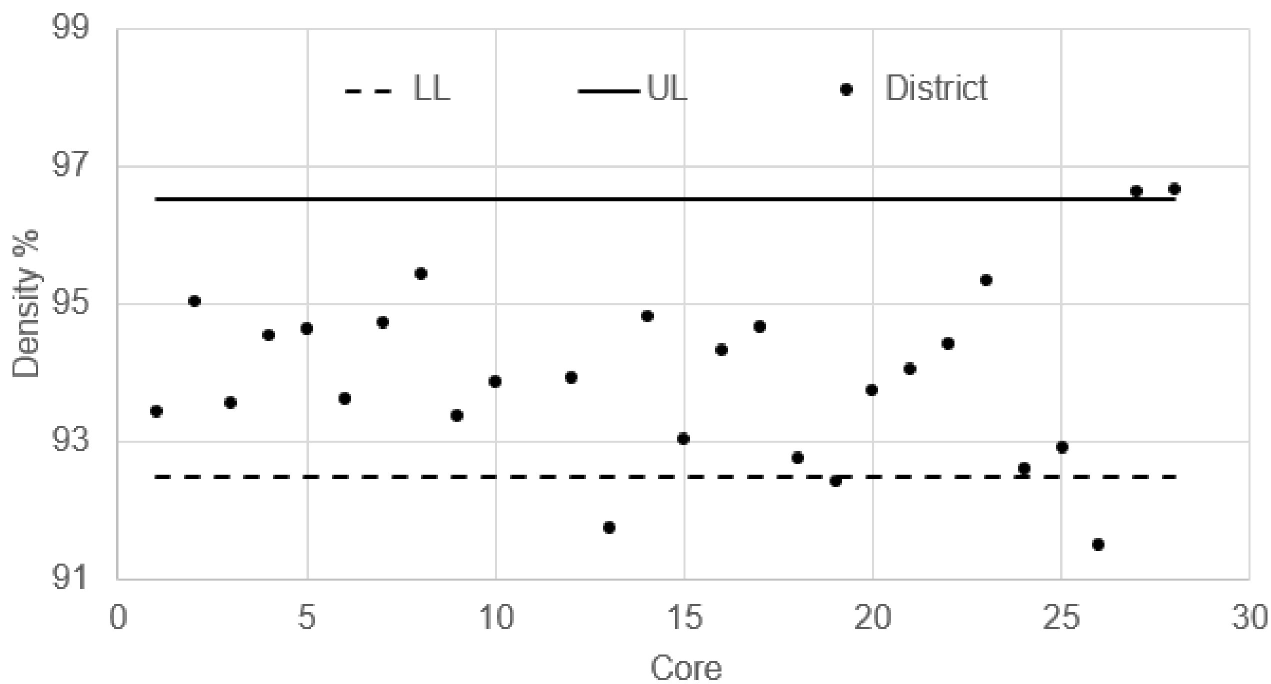
A. G_{mm} vs AC content



B. G_{mb} vs AC content



C. Aggregate gradation results



D. Density results (contractor results were not received)

Figure 49. Graph. QCP project results for District 1 site visit 5.

DISTRICT 2 SITE VISIT

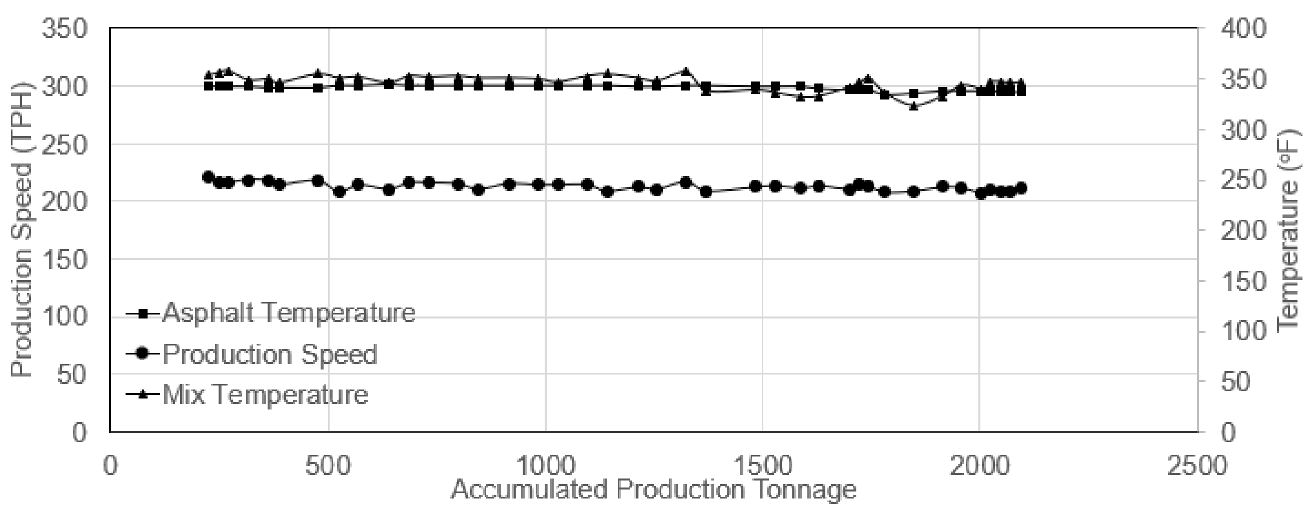
During this PFP interstate jobsite visit, a 2.25-in lift of 19.0 mm binder mix was placed over a continuously reinforced concrete pavement. Table 9 shows the contract description and pay performance. The binder mix received incentives in AV and VMA and a disincentive in density.

Table 9. District 2 Site Visit: Contract Description and Pay Performance (PFP)

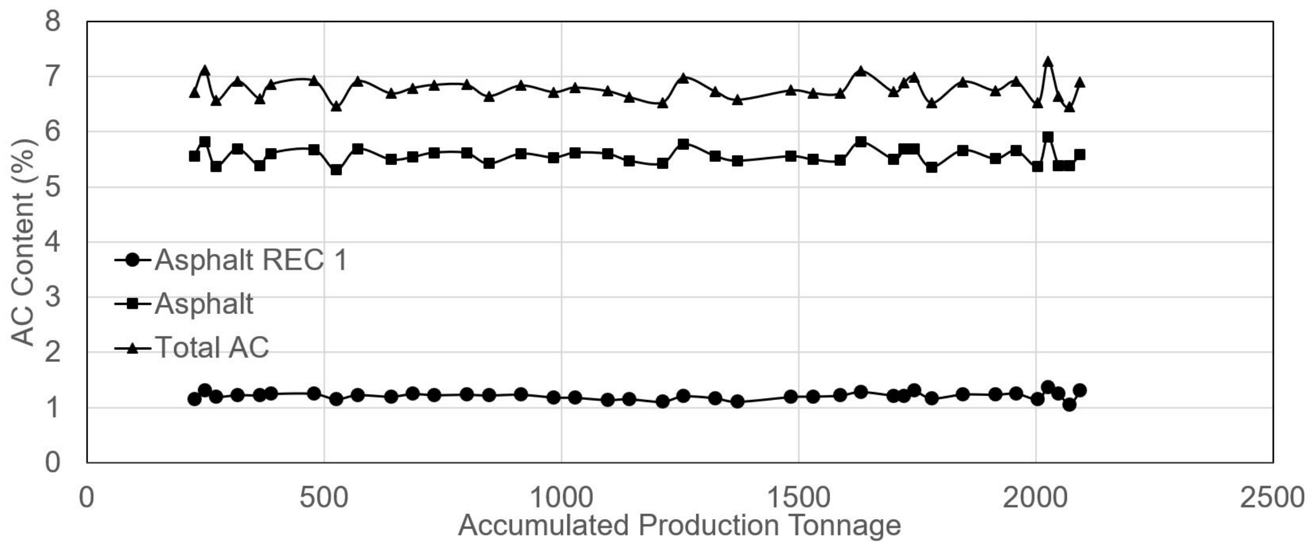
Mix		Project	
Type	Binder	Project Type	Resurfacing
N Design	N90	Length	8.67 mi
NMAS	19.0 mm	Thickness	2.25 in
Paving Surface	CRCP	Production	29,000 ton
Requirement		**Pay Factors**	
AV	4.0 ± 1.35%	AV	101.2%
VMA	13.5 +3/-0.7%	VMA	100.3%
Density	92.5–97.5%	Density	97.7%
Other Pay Adjustments			
Dust/AC	0.6%-1.2%	Dust/AC% Penalty	$0
AC (Design)	5.8%	CPF	99.7%

Mix Production

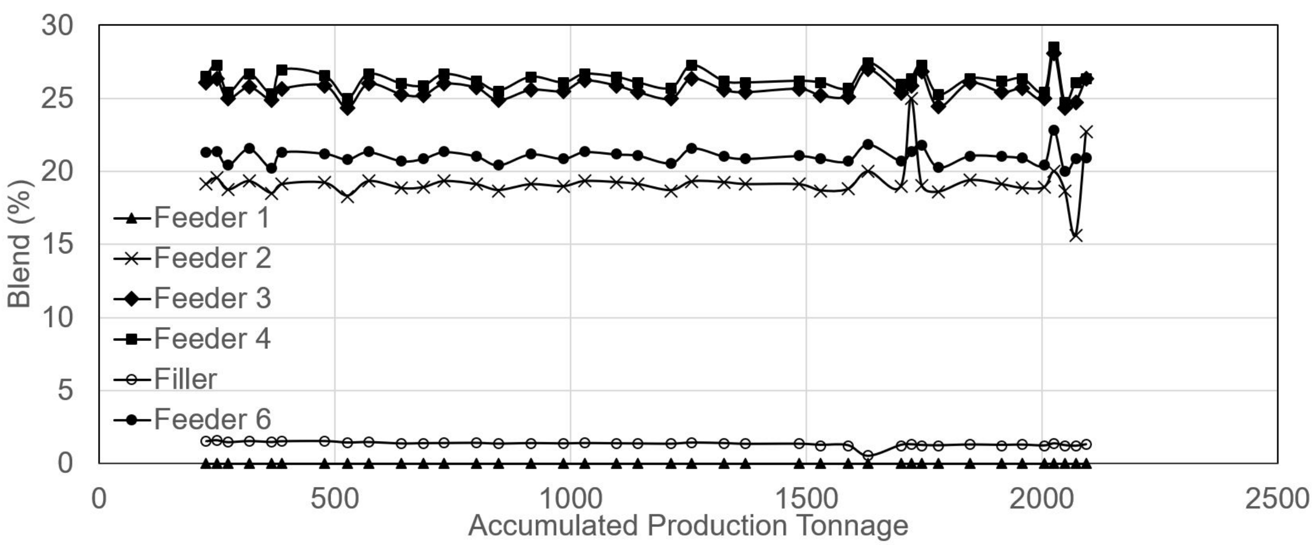
The mix was produced with a Gencor single-drum plant with six aggregate bins and two HMA storage silos. The plant used manual and computer controls. Weigh pods are used for positive dust control. A micromotion asphalt binder pump added the asphalt binder. The datalogger did not indicate irregularities with the mix production (Figure 50). The moisture content was lower than 6%. Mix production speed was fixed at 250 TPH, and no mix switches or hot stops were noted. The mixing temperature was kept around 340°F. Finally, the feeder weights and AC did not show variability with the material that entered the drum.



A. Production speed and temperature (°F)



B. AC content



C. Blend (%)

Figure 50. Graph. Datalogger results for District 2 site visit.

Construction and Sampling

The mix was hauled for 40 to 50 min to the site and deposited to an MTD. During paving, the minimum temperature was 66°F without precipitation. The mix sample was collected from a door below the paver loading conveyor of the MTD (Figure 51). During sampling, the mix was discharged to the ground from the MTD door. Then, from the ground pile, the samples were shoveled. The samples were reblended once and split using an H-3966 Humboldt Sample Splitter. Cubical cardboard boxes secured by the resident engineer stored the samples. Dumping mix from the MTD door can cause the mix to segregate if not reblended properly.

Testing Procedures

During the contractor laboratory visit, the equipment was calibrated and the laboratory participated in the AASHTO re:source proficiency sample program. The contractor had two full-time technicians for sampling in the field (density and mix) and one in the laboratory. The contractor used a Troxler 4141 gyratory compactor for G_{mb} specimen preparation; while the district used Pine AFG2. Despatch ovens were used for reheating samples without temperature alarms. Extractions for aggregate gradation and AC content were completed using an ignition oven.

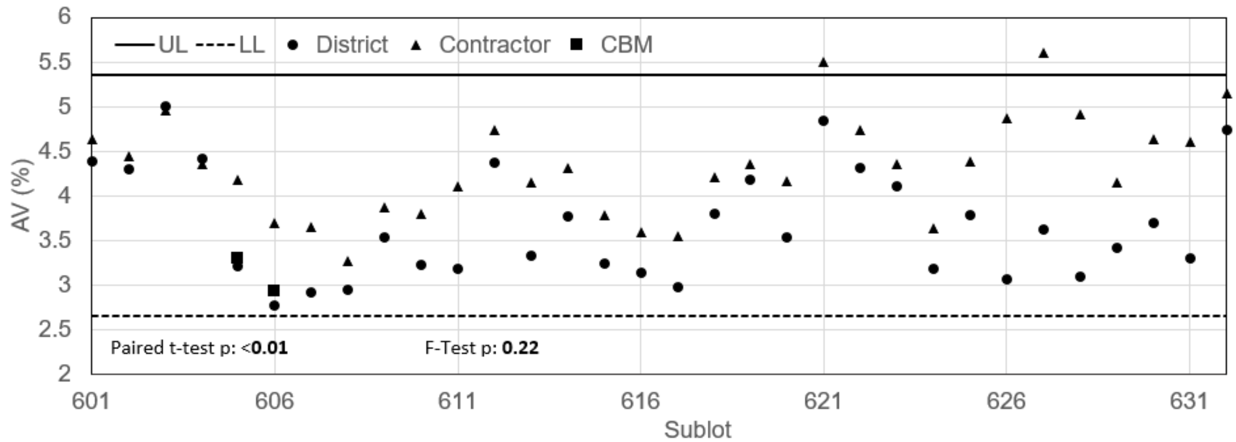
Figure 51. Photo. Field mix sampling from MTD compartment.

Pay for Performance Test Results

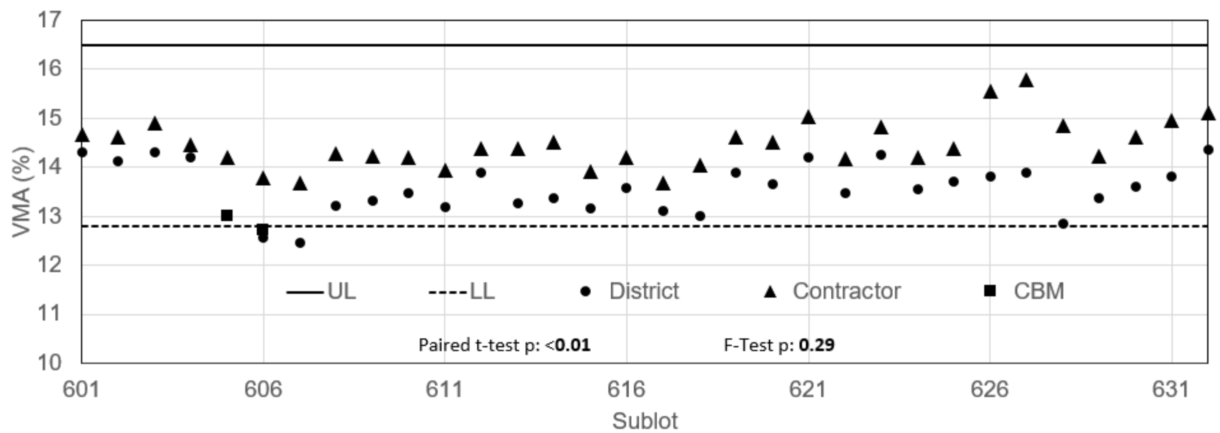
There was a significant difference between contractor and district AV and VMA results (Figure 52-A and Figure 52-B). The district results, on average, were typically 0.7% and 0.9% lower for AV and VMA, respectively. The bias observed in the volumetrics can be attributed to both G_{mm} and G_{mb} test results (Figure 52-C and Figure 52-D). The paired G_{mm} results were significantly different, on average, by 0.009 between the 31 sublots tested. The average difference exceeded the precision limits of 0.008. The G_{mb} results were significantly different by 0.023, on average, which also exceeded the precision limits of 0.017.

Two sources could have caused differences in both tests: sampling and/or reheating. Contractor results were lower for G_{mb} and G_{mm} (one-direction bias). It appears that reheating procedure was the main source. P_{ba} was around 0.2% higher for the district, resulting in higher G_{mb} and G_{mm}. If the contractor did not reheat their samples like the district, this might have caused a reduction in G_{mm} and G_{mb} because of less absorption. The average differences between laboratories were 0.002 for G_{mm} and 0.005 for G_{mb}, respectively. IDOT CBM results were closer to the district for the disputed two sublots (605 and 606). The dispute resolution results are shown as “CBM” in Figure 52.

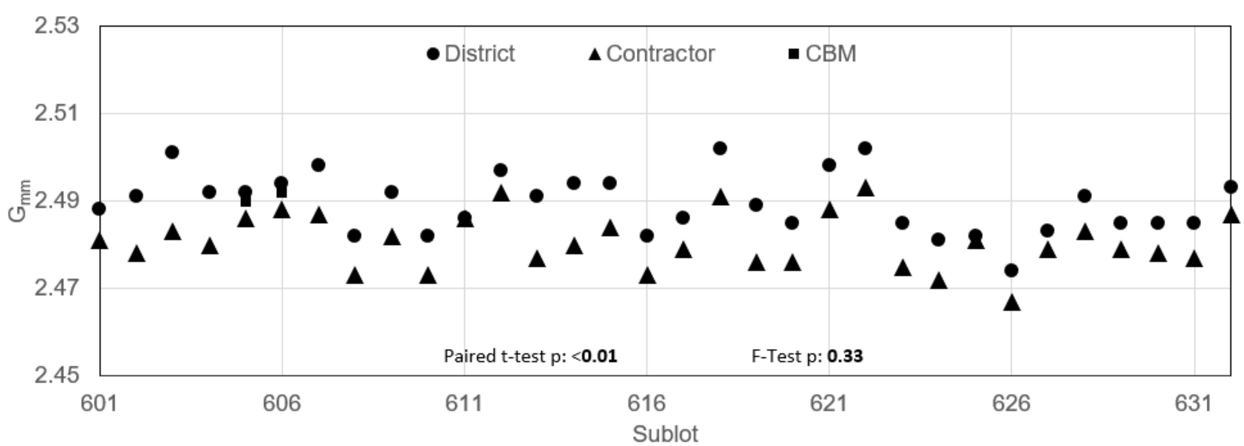
Differences because of reheating could have affected contractor pay. The contractor avoided a high pay disincentive in the VMA by designing 0.5% over the minimum VMA of 13.5%. However, two sublots still failed to meet the VMA lower limit of 12.8%.



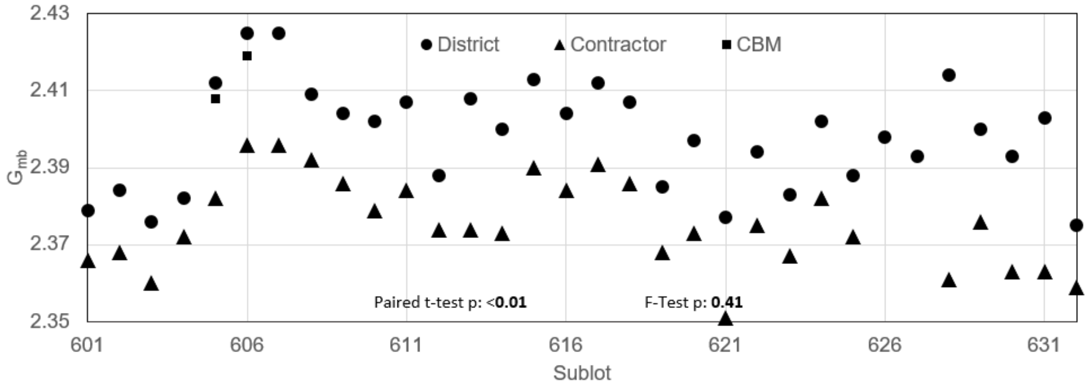
A. AV (%)



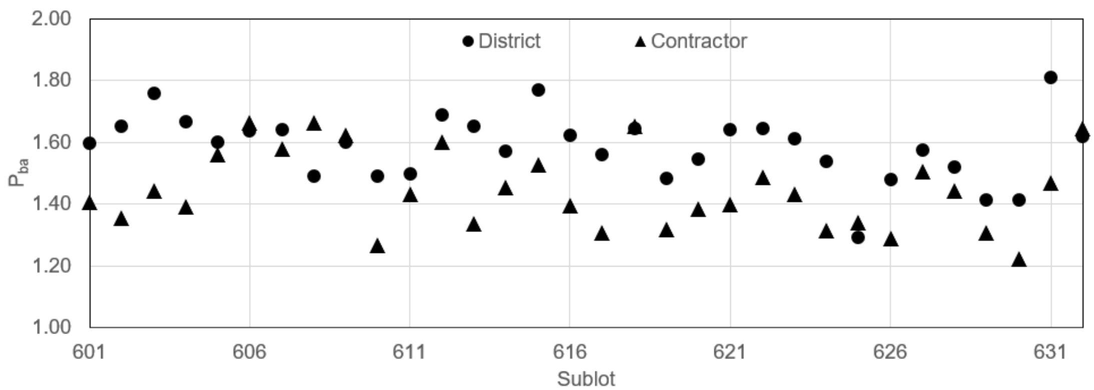
B. VMA (%)



C. G_{mm}



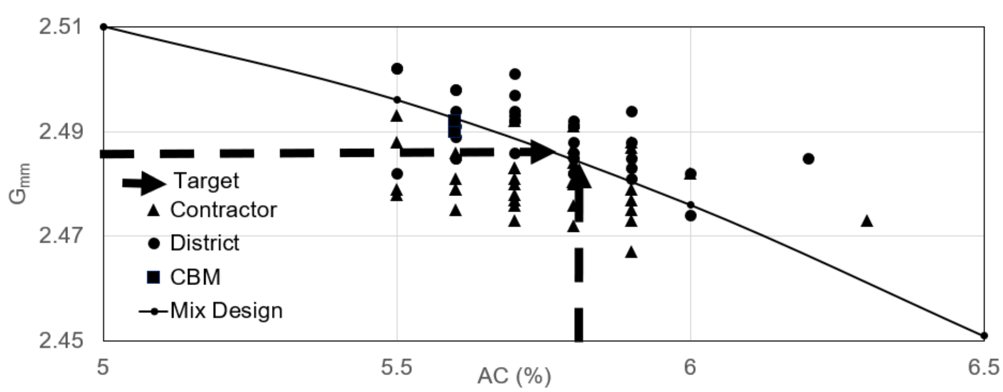
D. G_{mb}



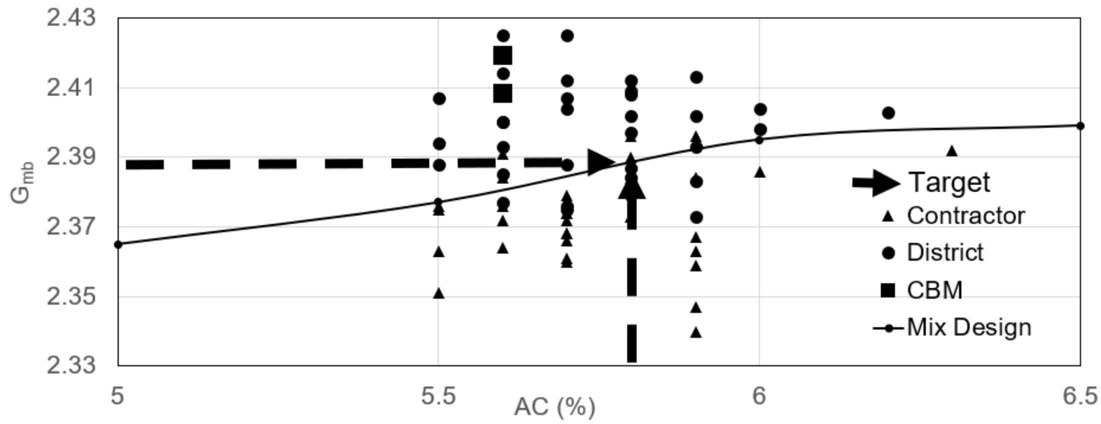
E. P_{ba}

Figure 52. Graph. AV, VMA, G_{mm}, and G_{mb} results per sublot for District 2 site visit.

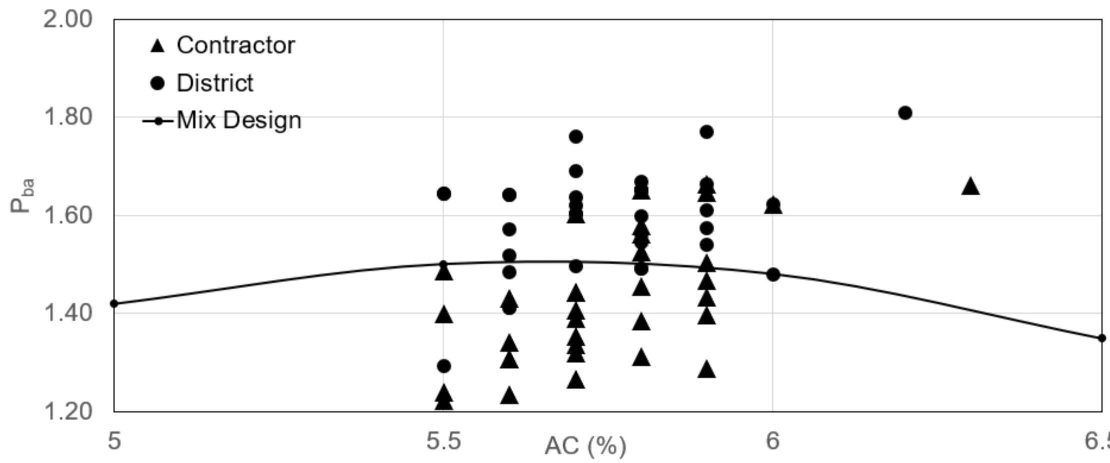
Figure 53-A shows the G_{mm} vs AC% results compared to the mix design. District results were higher than the expected target G_{mm}, while contractors were lower than the design G_{mm}. Some differences were seen in the G_{mb} results (Figure 53-B). However, the G_{mm} results from the contractor and district were close to the mix design. The aggregate gradation results for all sublots suggested minimum variation from the design. In four out of 32 sublots, 1/2-in and 3/8-in sieves differed by 5% or 6% from the design.



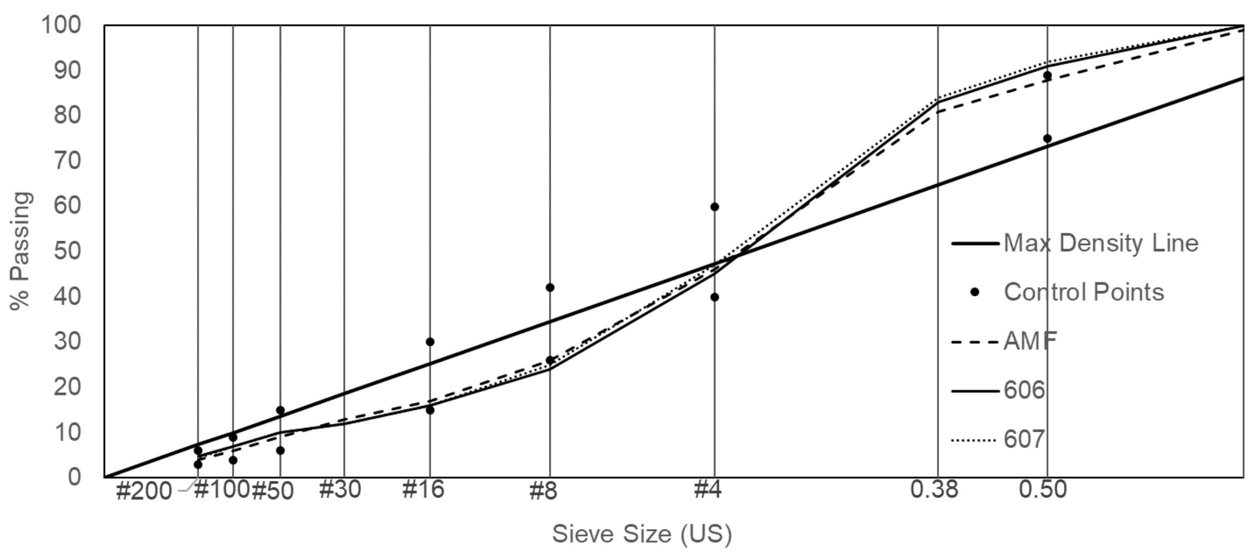
A. G_{mm} vs AC content



B. G_{mb} vs AC content



C. P_{ba} vs AC content



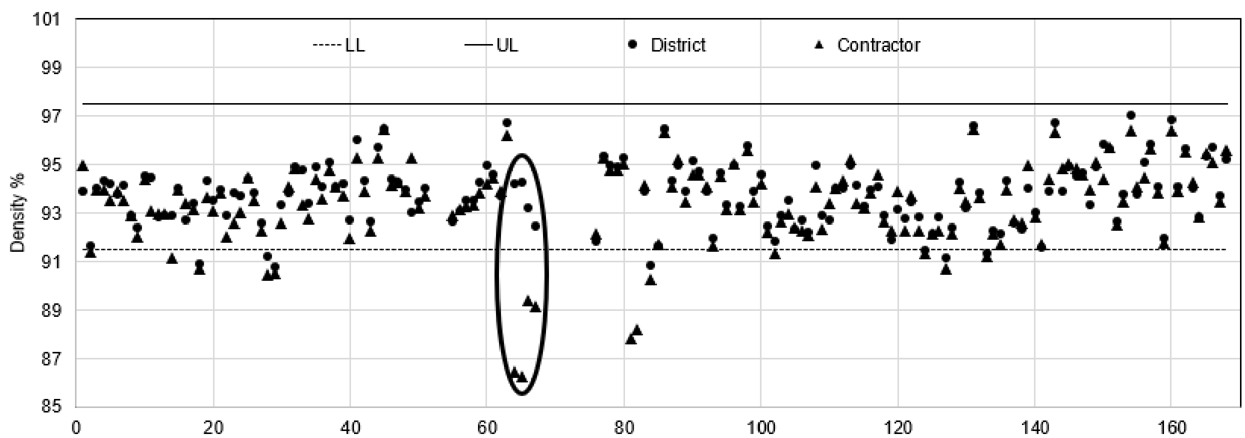
D. Aggregate Gradation results for sublot 606

Figure 53. Graph. Volumetric results and mix design for District 2 site visit.

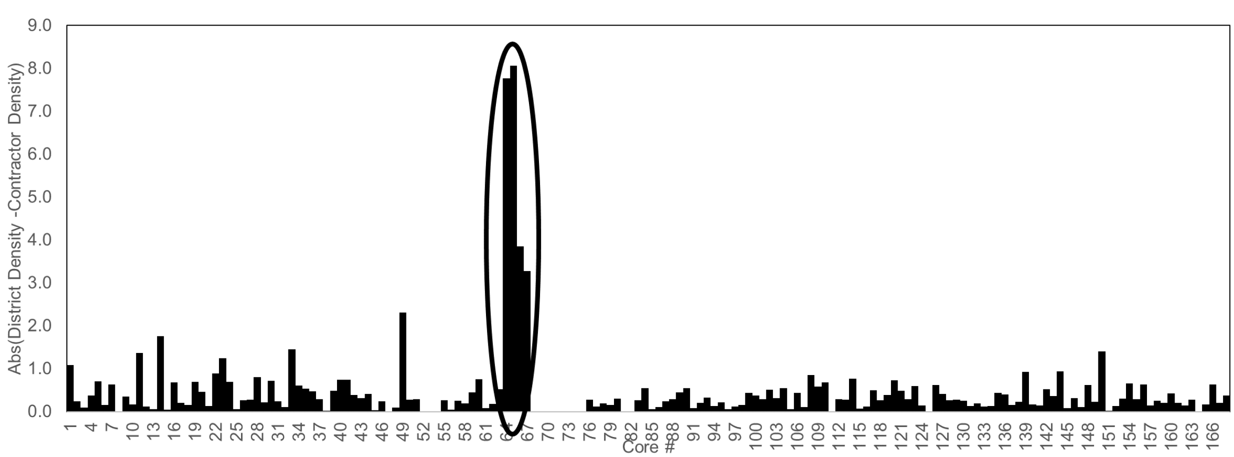
Density was the only factor that received a disincentive. Figure 54-A shows the district and contractor density results. Most density results by the contractor and the district were within acceptable limits. However, 14 out of 168 density cores were either outside the lower limit or close to the limit. Contractor results were close to district results for the 14 district cores that caused disincentives.

District results were within the limits. The difference between the district and contractor is shown in Figure 54-B (circled). These cores were further evaluated. For each core, the measured submerged and SSD weights were plotted against the dry weight of the specimen (Figure 54-C and Figure 54-D). As expected, the SSD or submerged weights showed a strong linear relationship with dry weight. Then, the difference between the submerged or SSD core weight, with respect to the predicted value from the linear relationship, was computed and shown in Figure 54-E as "Difference in Weight Change." Although this is not always the case, the four cores with the largest difference in density were related primarily to a difference in submerged weight.

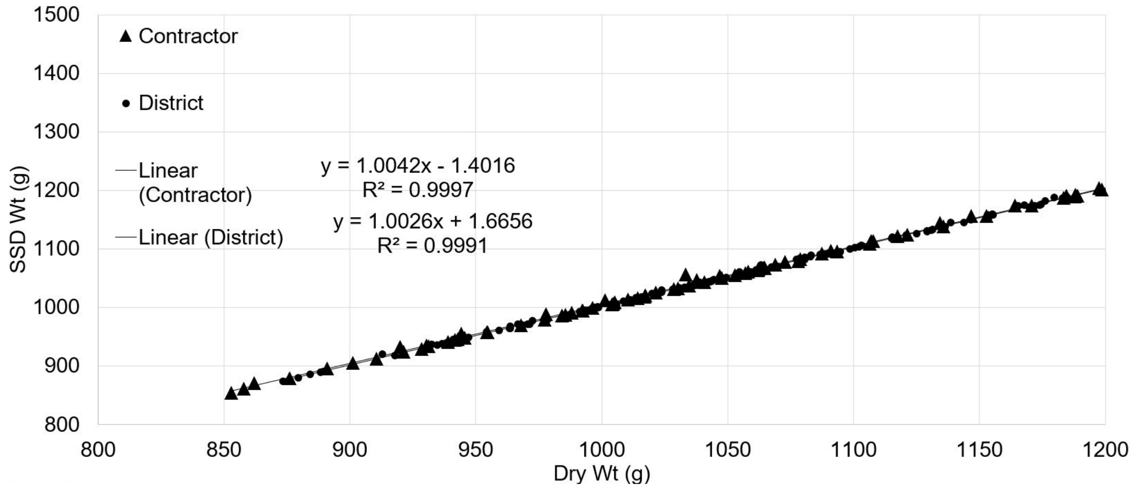
In summary, the root cause of difference in the mix test results is potentially attributed to the difference in the reheating procedure between the district and the contractor. In addition, designing at 0.5% higher than the minimum VMA safeguarded the contractor and helped ensure meeting the specification despite the reheating bias.



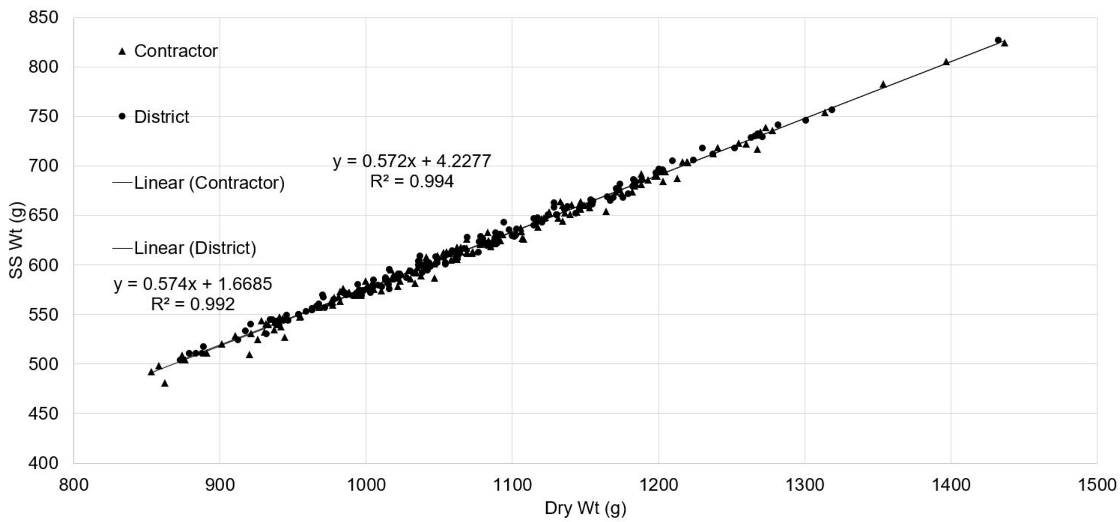
A. Density results



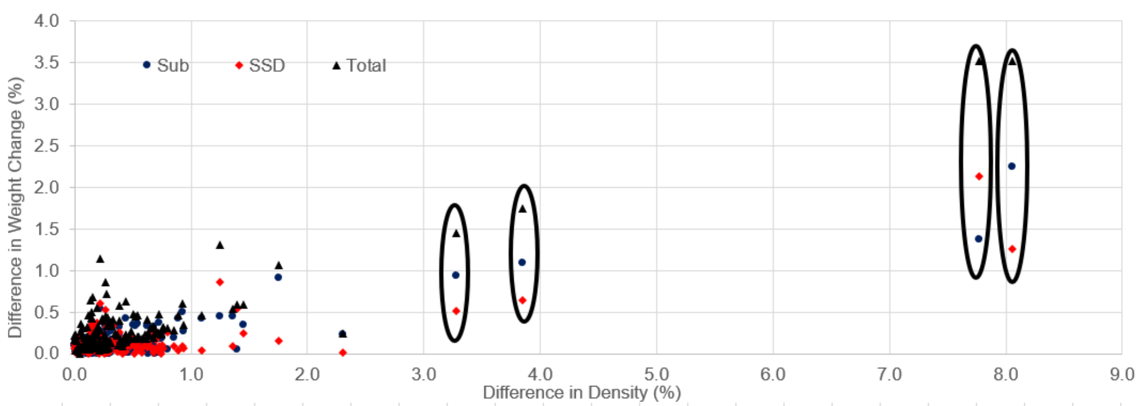
B. Difference in density



C. SSD weight vs dry weight



D. Submerged weight (SS) vs dry weight



E. Test weight analysis

Figure 54. Graph. Density core results for District 2 site visit.

DISTRICT 5 SITE VISIT

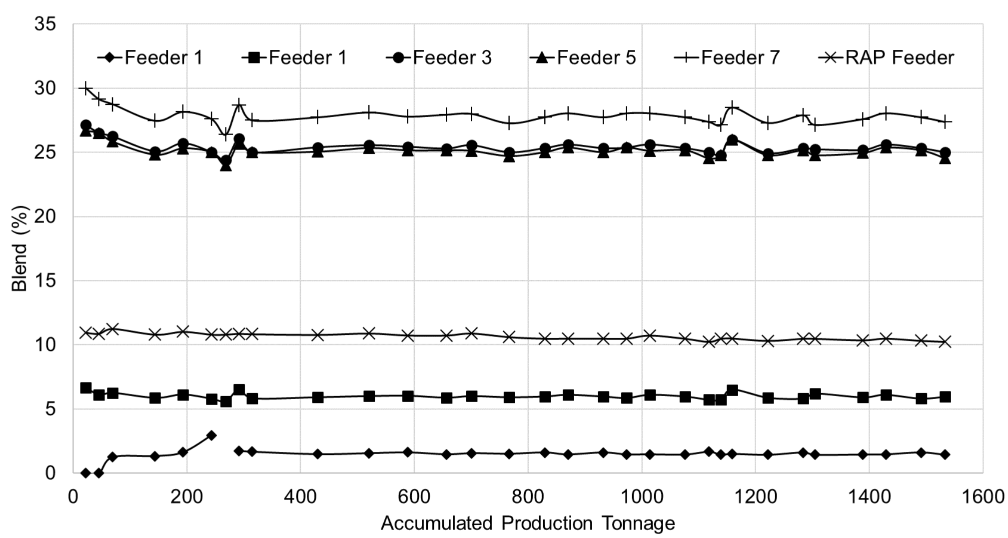
The jobsite visit for District 5 was to a QCP 1.5-in pavement-resurfacing job on another principal arterial. Table 10 shows the contract description and pay performance. The surface mix received full pay.

Table 10. District 5 Site Visit: Contract Description and Pay Performance (QCP)

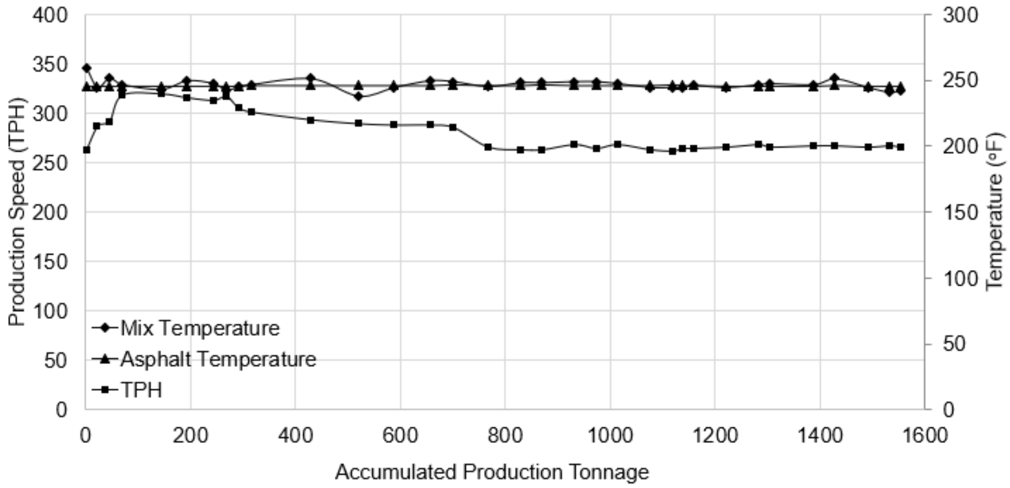
Mix		Pavement	
Type	Surface	Project Type	Resurfacing
N Design	N90	Length	1.8 mi
NMAS	9.5 mm	Thickness	1.5 in
Paving Surface	Leveling Binder	Production	5,000 ton
Requirement		**Pay Factors**	
AV	4.0 ± 1.2%	AV	100%
VMA	15 +2/-0.5%	VMA	100%
Density	92.5–96.5%	Density	100%
Other Pay Adjustments			
Dust/AC	0.6%-1.2%	Dust/AC% Penalty	$0
AC (Design)	6.2%	CPF	100%

Mix Production

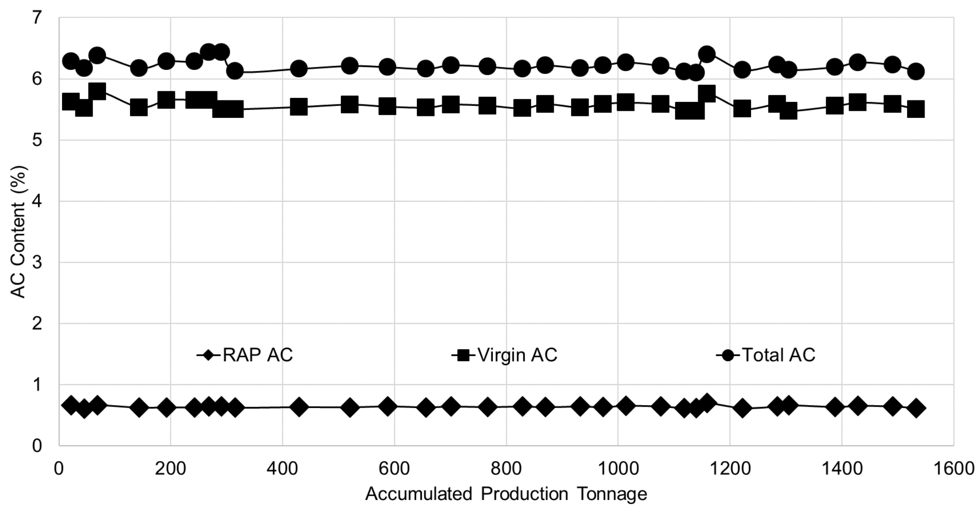
The mix was produced in a Dillman drum plant with separate drying and mixing drums. The plant had eight aggregate bins, three RAP pins, three silos, and a recently installed MINDS computerized control system. Weigh pods were used for positive dust control. Asphalt binder was added using a micromotion Viking pump. The plant had a manual-release agent spray rack for applying a truck-release agent to beds of incoming trucks. The datalogger did not indicate issues with mix production (Figure 55). Production speed was fixed at 200 TPH with no mix switches or hot stops. AC content and aggregates were on target. The partial AC content from the RAP was provided in the datalogger. No fluctuations were observed during production.



A. Blend (%)



B. Production speed and temperature



C. AC content

Figure 55. Graph. Datalogger results for the District 5 site visit.

Construction and Sampling

The mix was hauled for 10 min to the jobsite and delivered directly to the paver. An MTD was not specified for this project. The plate method was used to obtain mix samples in the field following IDOT specification (IDOT, 2018a). The contractor took extra steps to achieve a more consistent sample. First, the plates had four holes at the corners to place a nail. Nails prevent the plate from getting dragged by the paver. The holes were large enough to allow the plate to be lifted off the nails. After the paver laid the mix over the plates, a rectangular box cookie was placed on top of the plates to prevent losing material on the edge of the plates (like a “cookie cutter”). Then, the mix was transferred to level ground and reblended three times. The district samples were secured by the resident engineer and the plant samples were immediately transferred to an insulated box for reheating and testing. Figure 56 shows a set up for the plates.

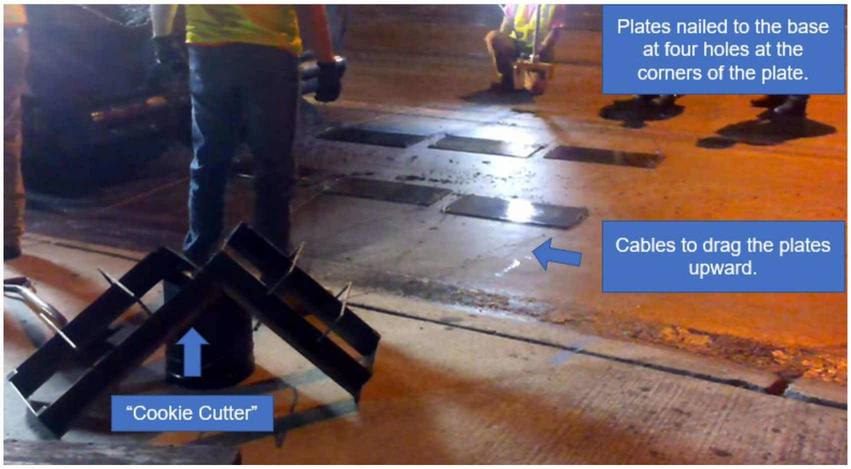


Figure 56. Photo. Plate-sampling set up.

Once the insulated box arrived at the plant with the contractor field samples, the mix was blended again and placed in the oven to bring it to compaction temperature. The time was substantially reduced because the samples were kept insulated. This procedure allows testing in near real-time, which also reduced the potential of additional absorbed AC.

Testing Procedures

During the contractor laboratory visit, it was seen that the equipment was calibrated and the laboratory participated in the AASHTO re:source proficiency sample program. Two technicians were available at each plant laboratory for sample testing. In the field, three technicians were on site for mix sampling and splitting. They were supervised by the QC manager of the plant during the visit. Another technician oversaw density coring. The contractor used a Pine GB1 Brovold gyratory compactor for G_{mb} specimen preparation, while the district used Troxler 4140. A pulley vacuum pump was used with a manometer for G_{mm}. Despatch ovens were used for reheating samples. Extractions for gradation and AC content were completed using an ignition oven.

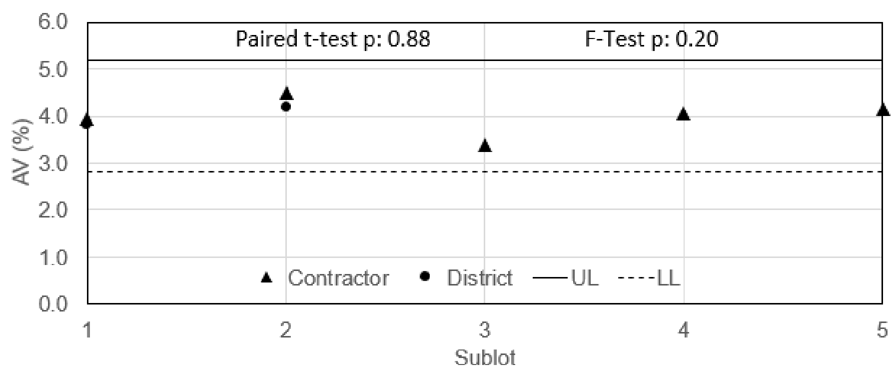
The contractor had a history of achieving full pay or incentives in most of the produced tonnage over the last three years. The contractor shared techniques implemented in the plant to achieve this success record:

- Avoid designing mixes with stockpiles that contribute more than 30% of the aggregate blend. This would reduce the chance of having a high-variable stockpile deviating in the mix.
- Test every received aggregate delivery to determine changes or variability from the aggregate producer.
- Ensure the plant has enough space to have stockpiles with multiple sides exposed to the loader. As a result, the loader would shift sides during production to obtain a more representative sample.

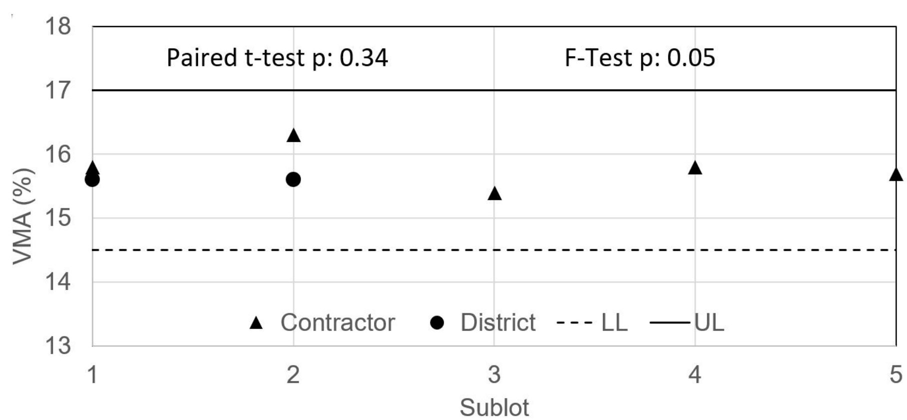
- Obtain plant samples for quality control frequently (about every hour), track mix production before a field sample is obtained, and adjust the plant operation accordingly.
- Obtain real-time results by tracking G_{mb} specimen thickness to estimate AV and VMA.
- Dig into the pile in the truck to obtain samples, rather than from the top of the pile.
- Maintain constant communication with the district laboratory to track changes to the district's gyratory compactor. Keep a record of offset and windage factors between contractor and district equipment for consideration during the production.
- Take field samples at the mat to account for changes in gradation because of paving or MTD.
- Blend and reblend samples thoroughly prior to splitting.

Quality Control Pay Test Results

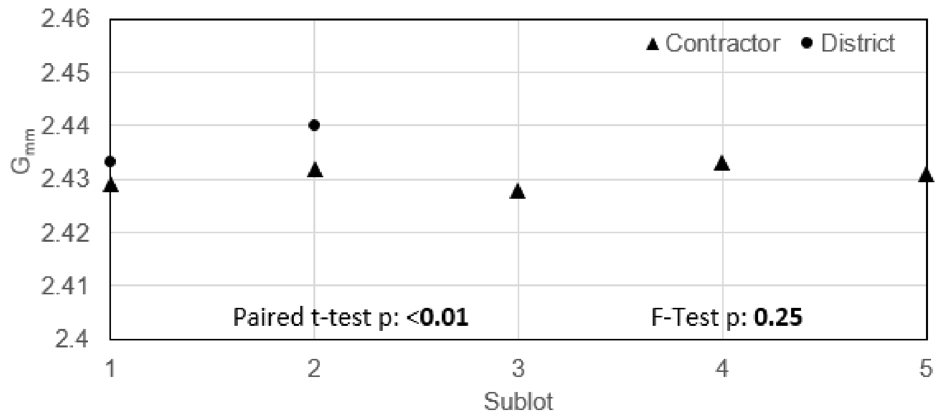
AV and VMA results are shown in Figure 57-A and Figure 57-B, respectively. Both parameters were within the required targets and had significantly similar results between contractor and district labs. Differences between district and contractor G_{mb} and G_{mm} results were lower than the precision limits (0.012 and 0.008, respectively). Differences between the aggregate gradation result and the adjusted mix formulas were within the IDOT control limits. The test results did not present any issues related to testing.



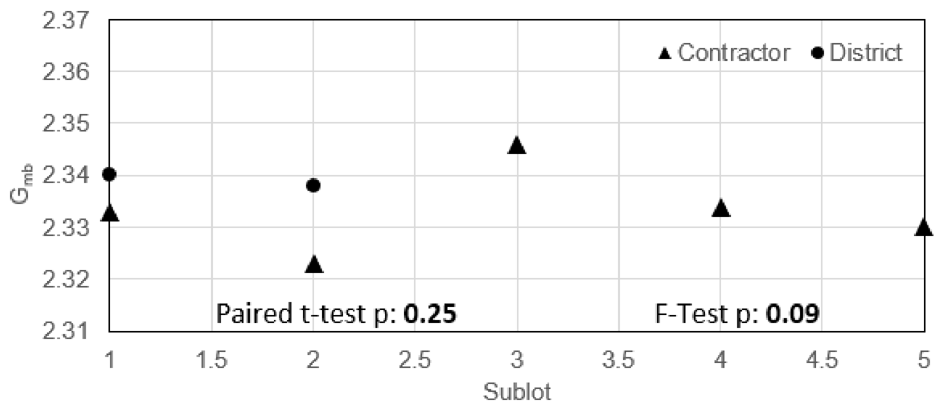
A. AV (%)



B. VMA (%)



C. G_{mm}

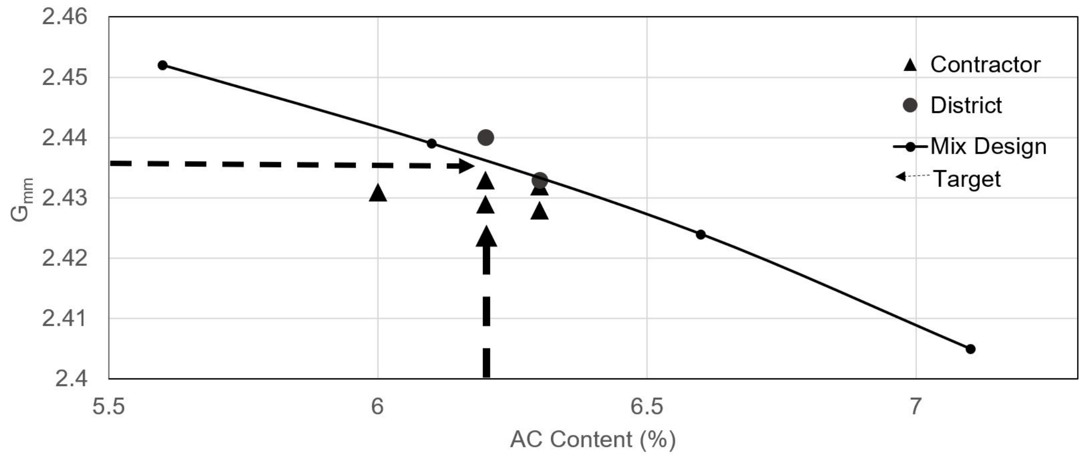


D. G_{mb}

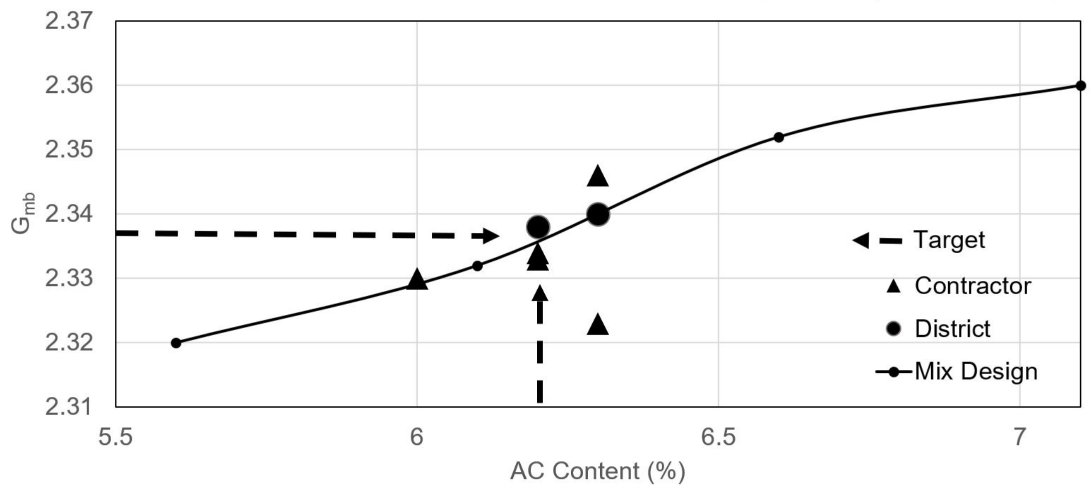
Figure 57. Graph. AV, VMA, G_{mm}, and G_{mb} results per sublot for District 5 site visit.

The G_{mb} and G_{mm} results were compared against the respective mix design target. The correlations between G_{mm} and G_{mb} with AC content results are shown in Figures 58-A and 58-B, respectively. AC content varied between 6% and 6.4%, which did not result in a major deviation from the mix design or target G_{mm} and G_{mb} values. The aggregate gradations were compared against the AMF target. The aggregate gradation was similar to the expected AMF values and within the limits.

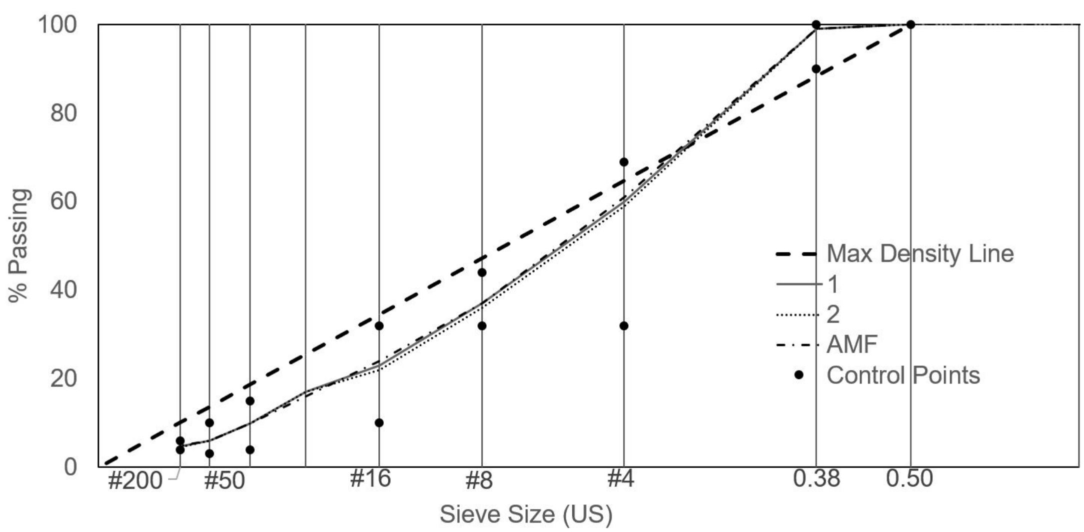
In summary, contractor practices to control aggregate quality and reduce testing variability may explain the success in getting 100% pay for almost 90% of the projects during the last three years. Several quality management techniques were observed in this visit. First, the plant had enough space to build large aggregate stockpiles, which may last for months. As a result, the contractor was not vulnerable to changes in material characteristics at the quarry. In addition, the stockpiles were separated to avoid aggregate contamination and to allow the loader to obtain material from multiple faces of the stockpile during production, resulting in a more representative load. To manage variability, the contractor reported that material was split into two cold feeds if more than 30% of one aggregate source was used in a mix.



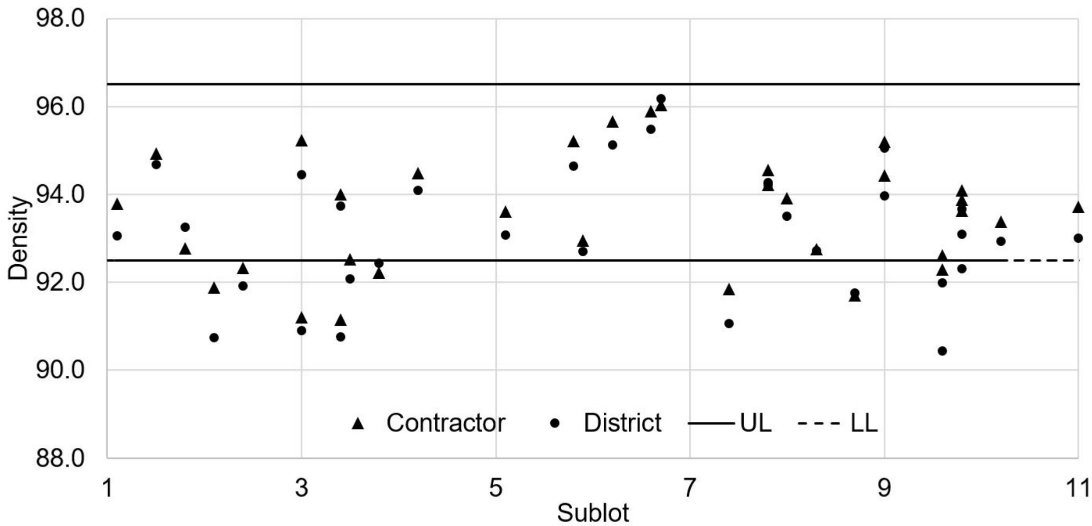
A. G_{mm} vs AC (%)



B. G_{mb} vs AC (%)



C. Aggregate gradation results of sublot 1 and 2



D. Density (%)

Figure 58. Graph. Volumetric results and gradation results of sublot 1 (d) for District 5 site visit.

DISTRICT 6 SITE VISIT

The visit for District 6 was to a PFP 2.25-in pavement-resurfacing project on a four-lane interstate. Table 11 shows the contract description and pay performance. The binder mix received near full-incentive pay.

Table 11. District 6 Site Visit: Contract Description and Pay Performance (PFP)

Mix		Pavement	
Type	Binder	Project Type	Resurfacing
N Design	N90	Length	3.4 mi
NMAS	19 mm	Thickness	2.25 in
Paving Surface	HMA Milled Surface	Production	36,547 ton
Requirement		**Pay Factors**	
AV	4.0 ± 1.35%	AV	104.8%
VMA	13.5 +3/-0.7%	VMA	104.8%
Density	92.2–97.5%	Density	103.5%
Other Pay Adjustments			
Dust/AC	0.6%-1.2%	Dust/AC% Penalty	$0
AC (Design)	5.2%	CPF	104.3%

Mix Production

The mix was produced in a Gencor single-drum plant. No precipitation and a minimum temperature of 66°F were reported. Moisture content was below 6%. The plant did not have positive dust control. The datalogger was not provided. Therefore, the mix production could not be evaluated.

Construction and Sampling

The hauling time was 10 to 15 min. The mix samples were obtained from the MTD at the jobsite. At the time of sampling, the paver loading conveyor was rotated toward the shoulder of the road where there was a pick-up truck with a quartermaster (Figure 59). The paver loading conveyor dropped mix into the quartermaster until it was completely full. Afterwards, the truck returned to the asphalt plant, 15 min away, with the resident engineer witnessing sampling. At the plant, the material was pre-blended once, split using a quartermaster, reblended two more times using a conventional splitter, and then stored in canvas bags. The process took around 30 min after the sample was obtained from the MTD.

Figure 59. Photo. MTD quartermaster.

The district implemented several strategies to achieve similarity between G_{mb} test results. First, the same make of gyratory compactor (Troxler) was used by the district and contractors. Second, the district did an internal round robin with local contractors before the beginning of the season to identify any potential offsets.

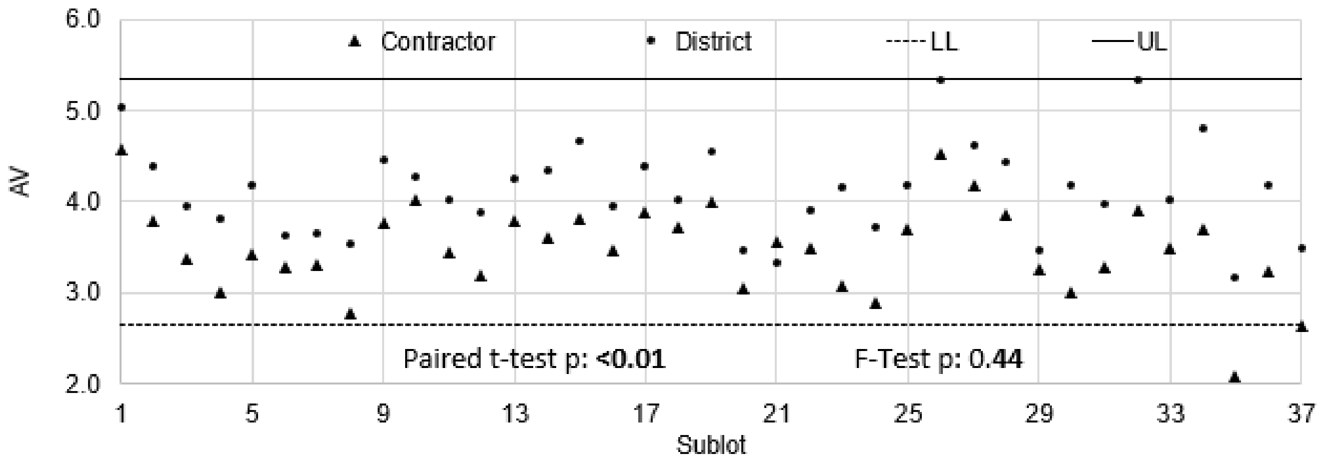
Testing Procedures

The contractor participated in the 2018 AASHTO re:source proficiency sample program; however, the laboratory involved in the program was at a different plant. In the field, one person positioned the quartermaster below the MTD and covered the material before being hauled to the plant. At the plant, two full-time technicians split the samples once the quartermaster arrived at the plant and performed testing after splitting. Another technician obtained the field cores. A Troxler 4141 was used for G_{mb} specimen preparation. Despatch ovens were used for reheating samples with timers. Extractions for aggregate gradation and AC content were completed using an ignition oven.

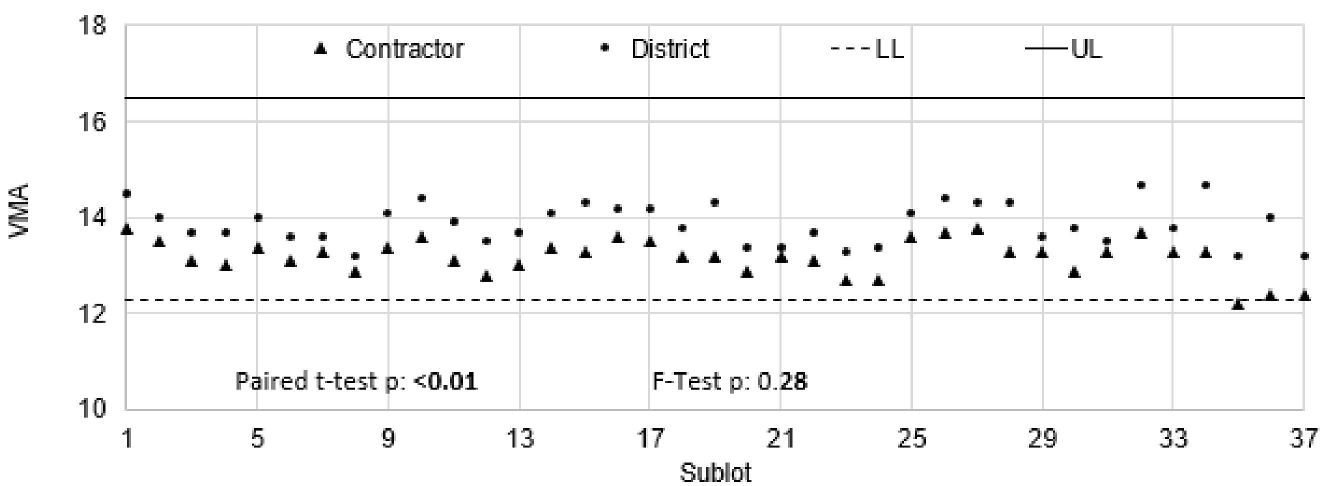
Pay for Performance Test Results

The AV and VMA test results are shown in Figure 60-A and 60-B, respectively. District results for AV and VMA were higher than those obtained by the contractor. Although there was a bias in VMA results obtained by the contractor with respect to those by the district, the VMA values by the contractor were higher than the lower limit. Hence, this led to a pay incentive. In the case of AV, district results of sublots 26 and 32 were near the upper limit of 5.3%. These results did not cause a pay disincentive but lowered the pay incentive for the contractor. As a result, the contractor disputed sublot 32 because it was outside the limits of precision. The contractor won the dispute. IDOT CBM results for both AV and VMA were closer to the contractor by 0.3 and 0.2%, respectively.

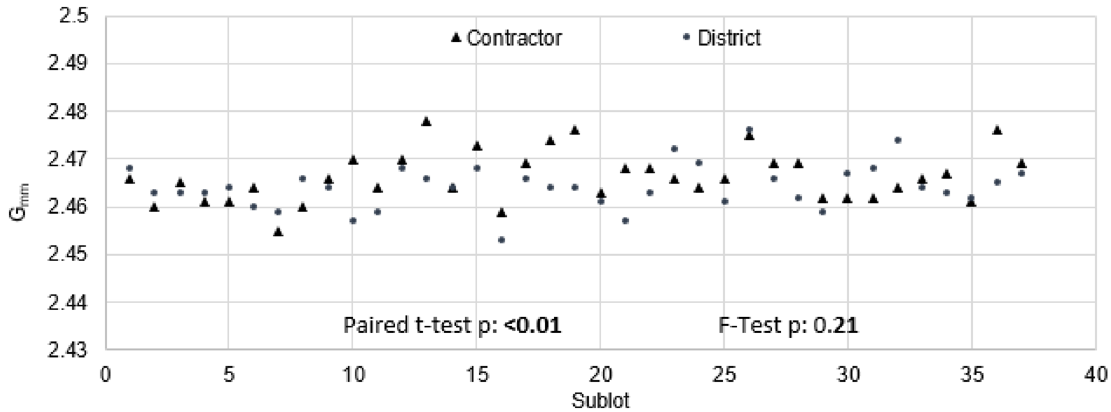
The volumetric test results are shown in Figures 60-C and Figure 60-D. The differences between the contractor and district G_{mm} results were comparable (lower than 0.008). The bias in AV and VMA was attributed to the G_{mb} test results. The differences between G_{mb} test results exceeded the precision limits of 0.012 for 32 out of the 37 tested. The largest offset was 0.026. Because these offset values were largely in favor of contractor results, the contractor did not dispute the results, except for the case previously mentioned.



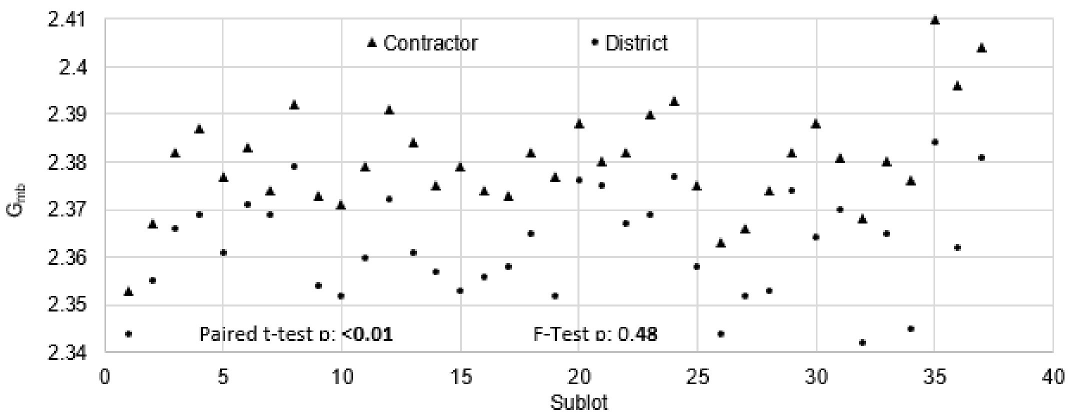
A. AV (%)



B. VMA (%)



C. G_{mm}

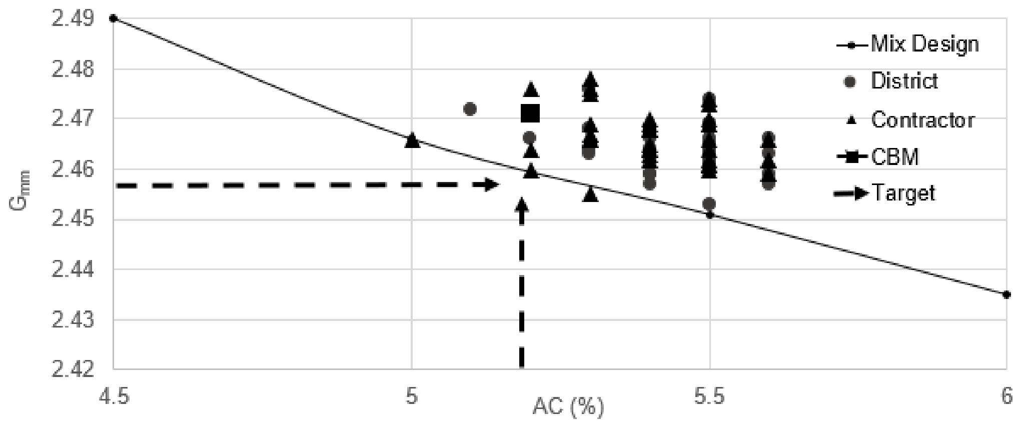


D. G_{mb}

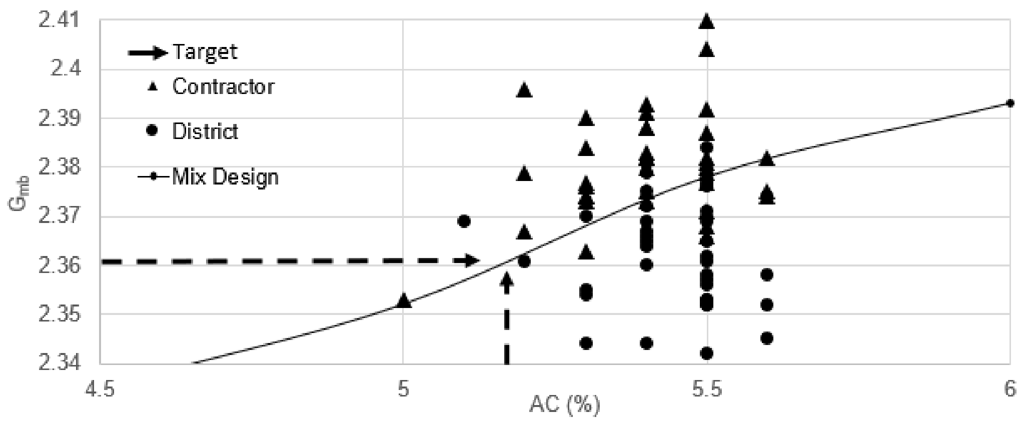
Figure 60. Graph. AV, VMA, G_{mm}, and G_{mb} results per sublot for District 6 site visit.

Figure 61-A and Figure 61-B compares the G_{mm} and G_{mb} results with the mix design, respectively; Figure 61-C shows the density results. G_{mm} results for both the contractor and district were close to the mix design and target. However, G_{mb} district results primarily differed from the target and the mix design expected values. This suggested a questionable compacting effort, combined with the fact that the district lost the dispute for those sublots. The difference in the gyratory compactors in the district compared to those used by the contractor and IDOT CMB might have explained the outcome of the dispute. Finally, the aggregate gradation results indicated that there was not a major deviation from the mix design target in the sublots that had AV and VMA results close to the PFP lower and upper limits. A full evaluation of the production was incomplete because the datalogger was not provided.

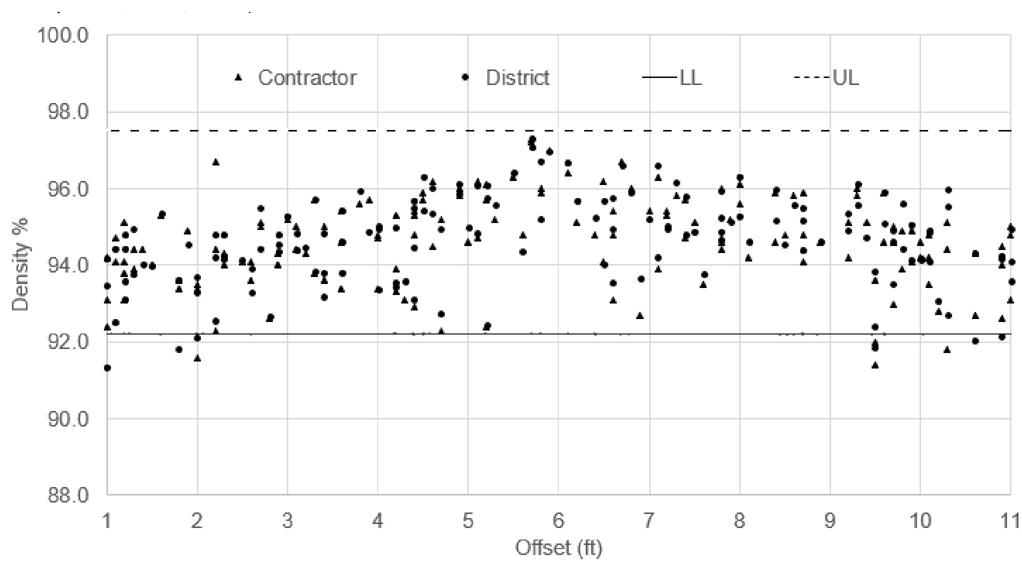
In summary, the differences in the test results were in favor of the contractor to receive a higher pay incentive. The AV, VMA, and density results were within the required limits. There was a consistent bias between the district and contractor in all test parameters, including AV, VMA, G_{mm}, and G_{mb}. The measurements reported by the district were closer to design values. The consistent difference in the G_{mm} and G_{mb} tests could be attributed to mix reheating procedures and variation in compaction characteristics.



A. G_{mm} vs AC (%)



B. G_{mb} vs AC (%)



C. Density data

Figure 61. Graph. Volumetric test results compared with the design for the District 6 site visit.

DISTRICT 8 SITE VISIT 1

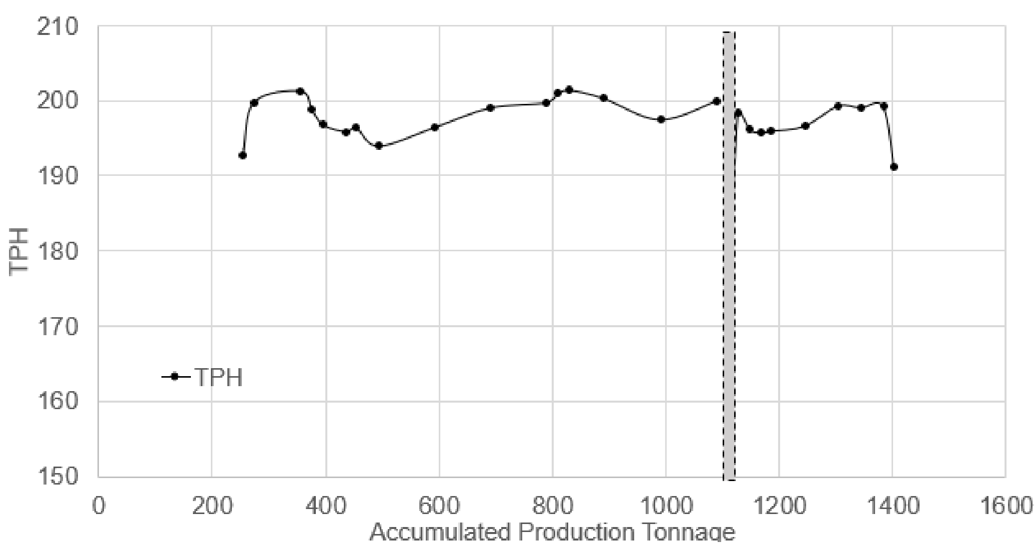
The first jobsite visit in District 8 was for a QCP 0.75-in pavement-resurfacing project on a two-lane other principal arterial. Table 15 shows the contract description and pay performance. A leveling binder mix, N70, 9.5 mm was placed over a milled surface. A surface mix followed afterwards.

Table 12. District 8 Site Visit 1: Contract Description and Pay Performance (QCP)

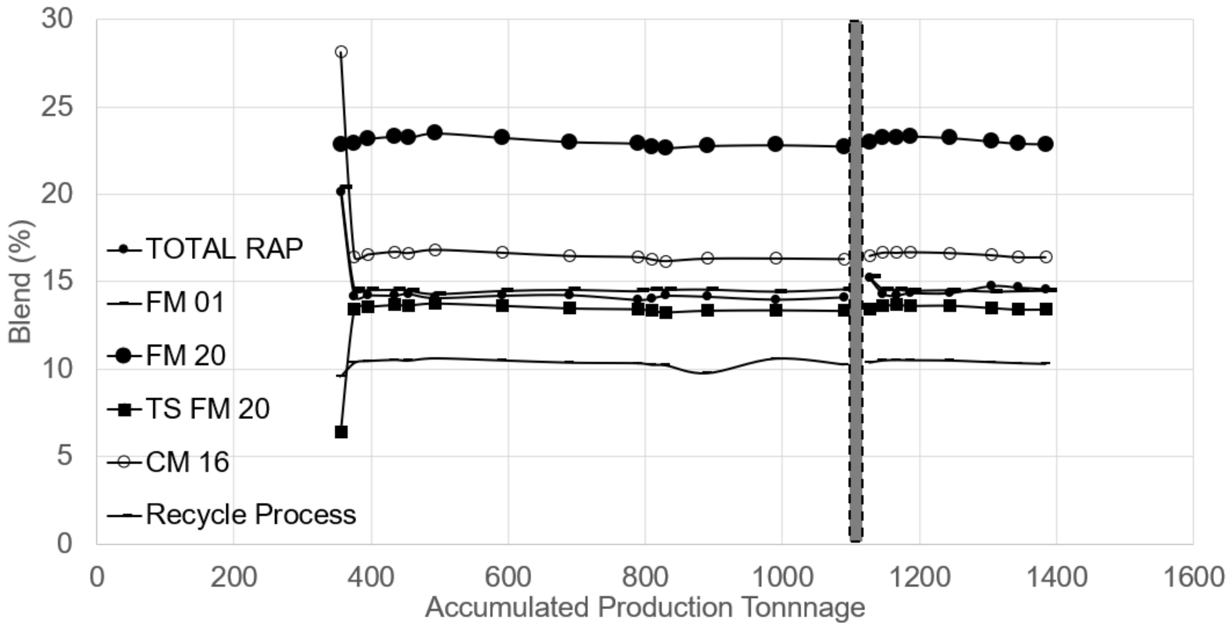
Mix		**Project**	
Type	Leveling Binder	Project Type	Resurfacing
N Design	N70	Length	1.8 mi
NMAS	9.5 mm	Thickness	1.5 in
Paving Surface	Milled Surface	Production	3,000 ton
Requirement		**Pay Factors**	
AV	4.0 ± 1.2%	AV	96.7%
VMA	15 +2/-0.5%	VMA	96.7%
Density	92.5–96.5%	Density	100%
Other Pay Adjustments			
Dust/AC	0.6-1.2%	Dust/AC% Penalty	$0
AC (Design)	5.9%	CPF	97.1%

Mix Production

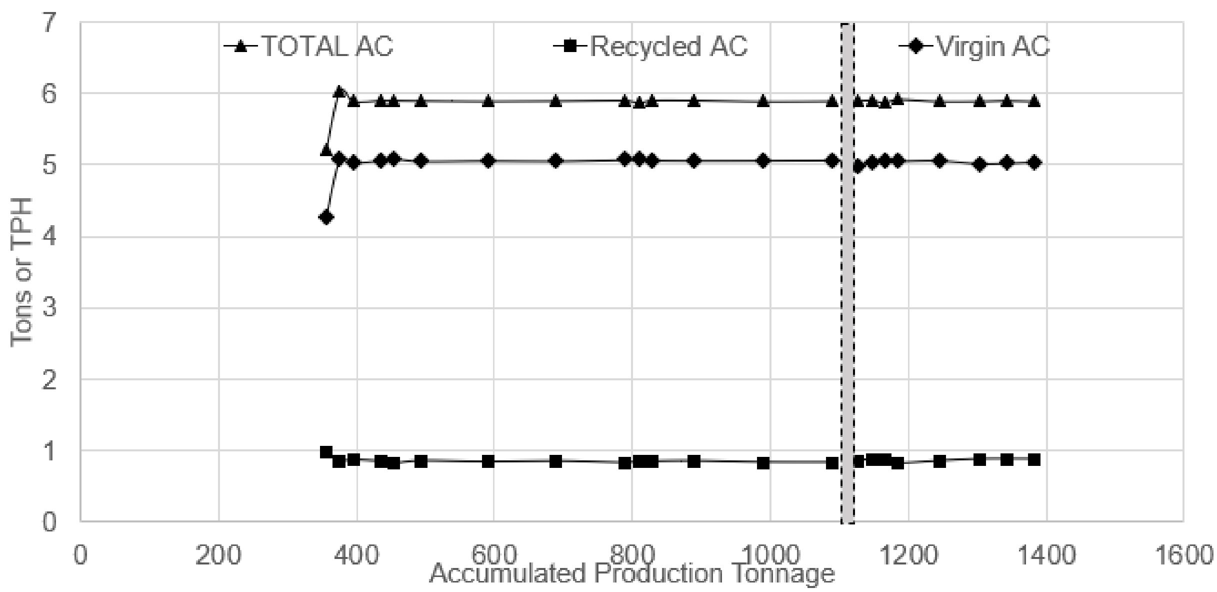
The mix was produced in an ASTEC double-barrel drum plant with six aggregate feeders, one recycle feeder, and three silos. The plant had a computerized control system. No precipitation and a minimum temperature of 70°F were reported. Moisture content was below 6%. The datalogger shown in Figure 62 did not report irregularities with the mix production. First, the moisture content was lower than 4%. Second, mix production speed was constant between 195 to 200 TPH. No mix switches or hot stops were reported. The AC content and aggregate percentages did not vary during the production day. Hence, the mix production seemed acceptable.



A. Production speed (TPH)



B. Blend (%)



C. AC content (%)

Figure 62. Graph. Datalogger results for District 8 site visit 1.

Construction and Sampling

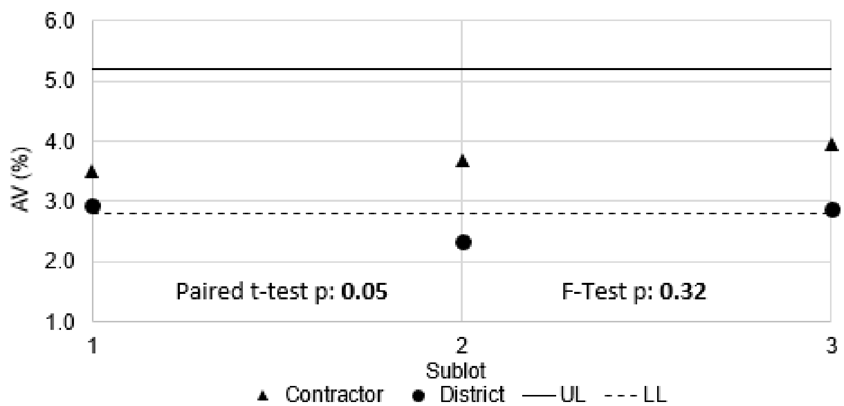
The mix was hauled for 30 to 40 min to the site and placed in the paver. No MTD was used in this project. The samples were collected from the paver auger because the leveling binder thickness was too thin to use the plate method. This practice is common for all districts in Illinois using leveling binder mixes. The sampling was observed by the RE, reblended, and placed in canvas bags and secured by the RE.

Testing Procedures

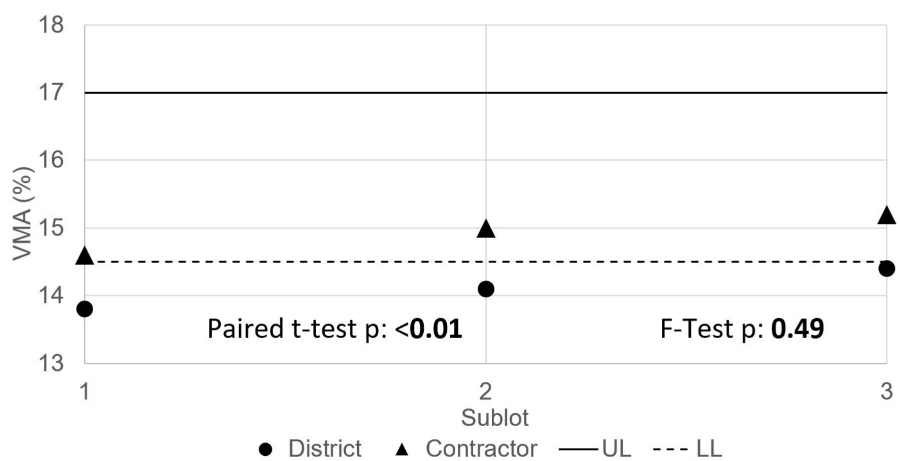
During the contractor laboratory visit, the lab participated in the 2019 AASHTO re:source proficiency program, but not the 2018 program. One technician was in the plant laboratory, and the QC manager was in the field obtaining mix samples. The contractor hired a consultant to obtain density cores. The contractor used a Troxler 4140 gyratory compactor for G_{mb} specimen preparation, while the district used Pine AFG2. The ignition oven was used to determine asphalt binder content. In 2018, the district invited its contractor to the lab to observe testing to ensure procedure harmonization between the district and contractors.

Quality Control Pay Test Results

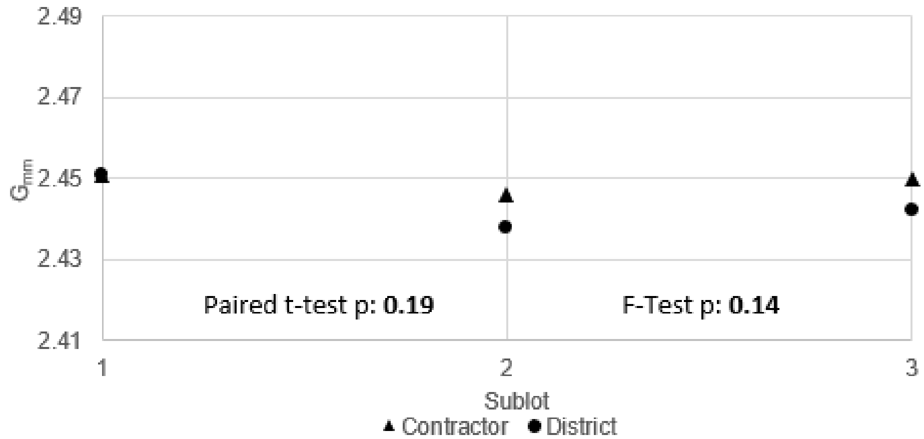
The AV and VMA test results are shown in Figure 63-A and Figure 63-B, respectively. Contractor and district results showed that AV and VMA were close to the lower limit of 2.8%. The difference in VMA results between the contractor and district was significant. The AV and VMA district results were 0.8% to 1.3% lower than contractor results. One sublot failed the AV and two failed the VMA criteria. The G_{mm} results between the contractor and district were comparable (differences were less than 0.008 for G_{mm}) (Figure 63-C). As shown in Figure 63-D, the G_{mb} results indicated an average bias of 0.020 between the contractor, and district results exceeded the QCP limit of precision (0.012).



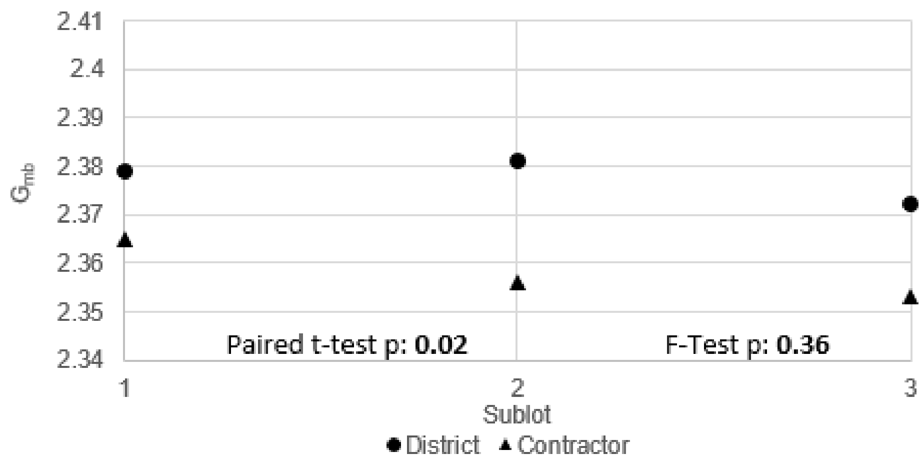
A. AV (%)



B. VMA (%)



C. G_{mm}

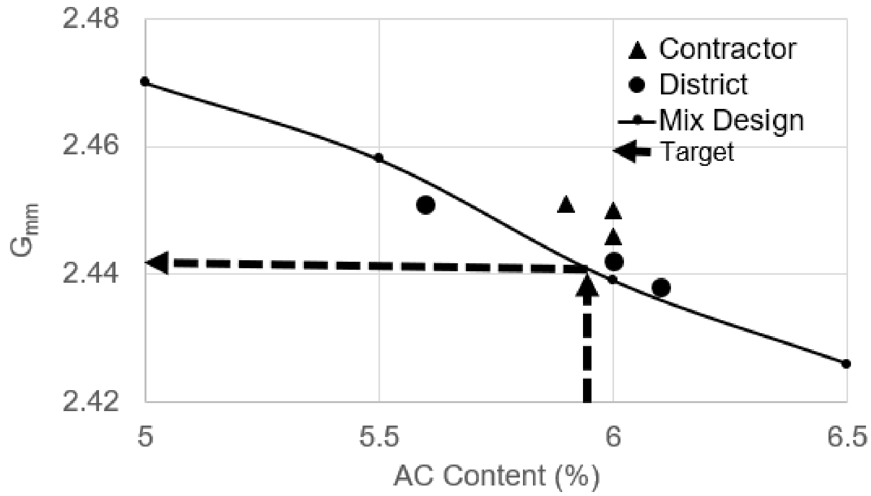


D. G_{mb}

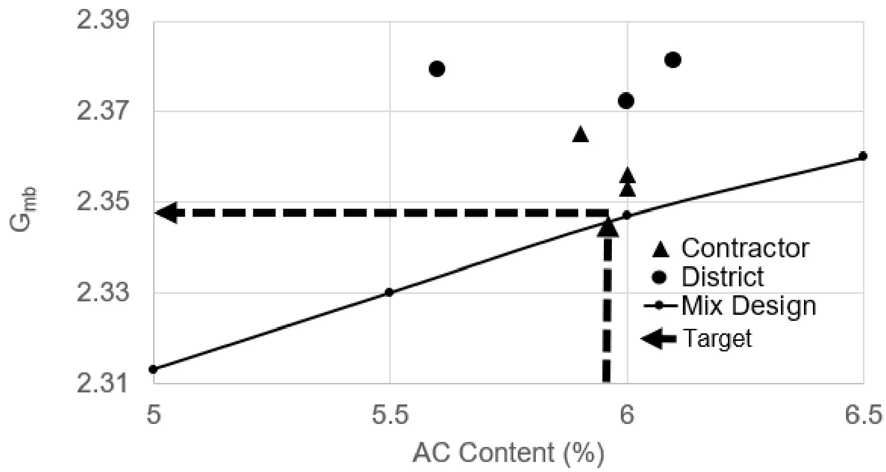
Figure 63. Graph. AV, VMA, G_{mm}, and G_{mb} results per sublot for District 8 site visit 1.

Figure 64-A shows the AC content (except one sublot) and G_{mm} were on target. However, the G_{mb} (Figure 64-B) results from the contractor were slightly higher than the mix design. Figure 64-C shows aggregate percent passing in sieves #4, #8, and #16 were, on average, 3.5%, 4.5%, and 2.5% lower than the target values, respectively. The coarse-aggregate CM16 and fine-aggregate FM20 were the materials that contributed to these variations. The differences were consistent between the district and contractor and were not outside the control limits for aggregate gradation. This suggested a deviation from the target aggregate gradation, which led to the drop in VMA. The consistency in mix production, per the datalogger, suggested that the change is due to aggregate variability.

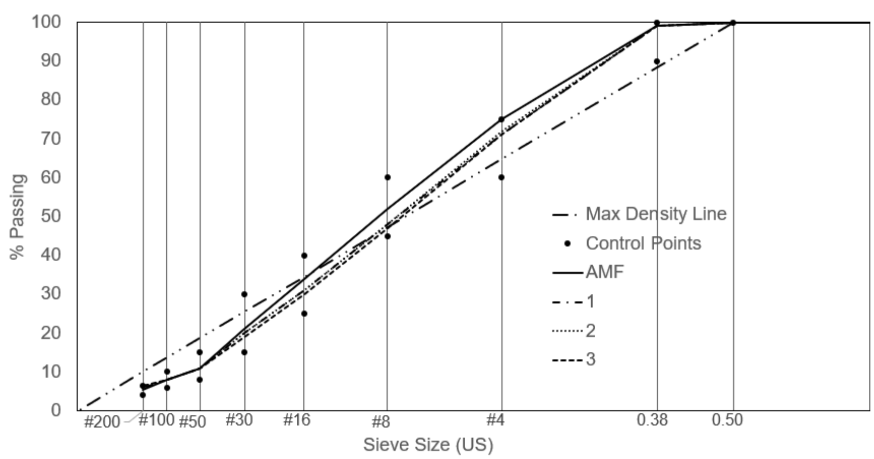
In summary, the main cause of pay disincentive in this contract could be related to aggregate variability and testing bias that resulted in a difference between the district and contractor G_{mb} values. Hence, the VMA and AV values were slightly lower than their respective design targets of 15.4% and 4.0 %, respectively.



A. G_{mm} vs AC (%)



B. G_{mb} vs AC (%)



C. Gradation results

Figure 64. Graph. District 8 site visit 1 volumetric results compared with the mix design.

DISTRICT 8 SITE VISIT 2

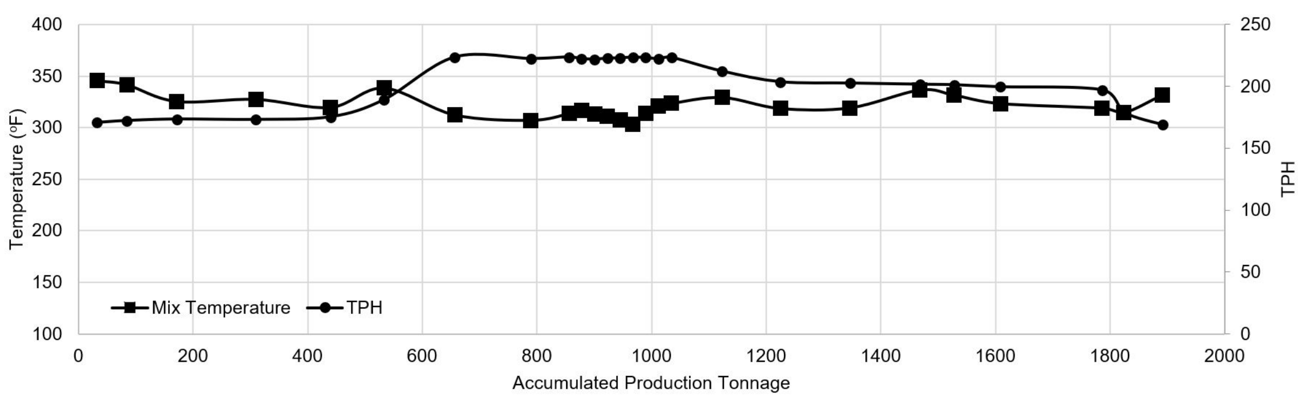
The second jobsite visit in District 8 was to a QCP 1.5-in pavement-resurfacing project on another principal arterial. Table 13 shows the contract description and pay performance. The contractor received full pay. However, there were issues with dust control.

Table 13. District 8 Site Visit 2: Contract Description and Pay Performance (QCP)

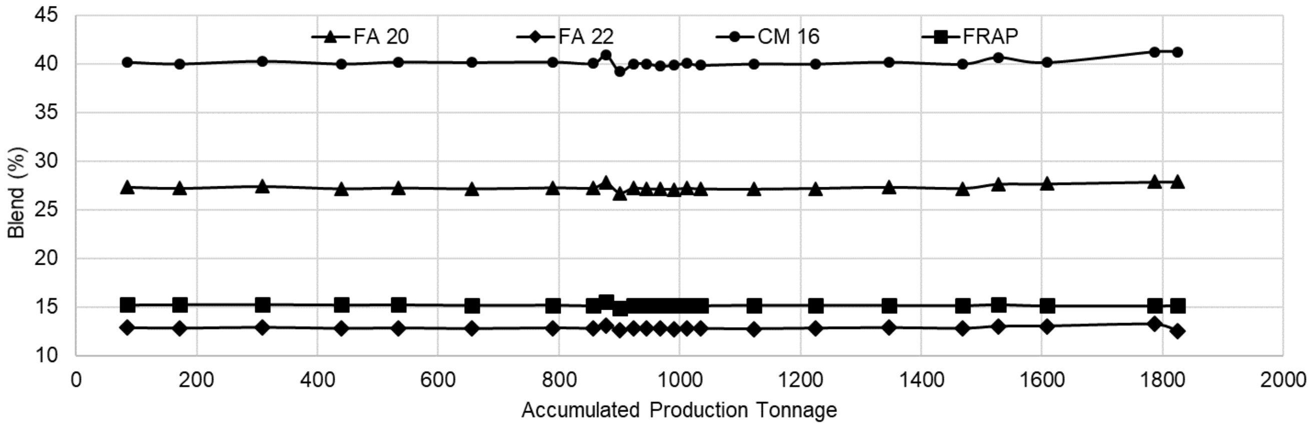
Mix		**Project**	
Type	Surface	Project Type	Resurfacing
N Design	N70	Length	1.8 mi
NMAS	9.5 mm	Thickness	1.5 in
Paving Surface	Leveling Binder	Production	5,000 ton
Requirement		**Pay Factors**	
AV	4.0 ± 1.2%	AV	100%
VMA	15 +2/-0.5%	VMA	100%
Density	92.5–96.5%	Density	100%
Other Pay Adjustments			
Dust/AC	0.6%-1.2%	Dust/AC% Penalty	$3,000
AC (Design)	5.9%	CPF	100%

Mix Production

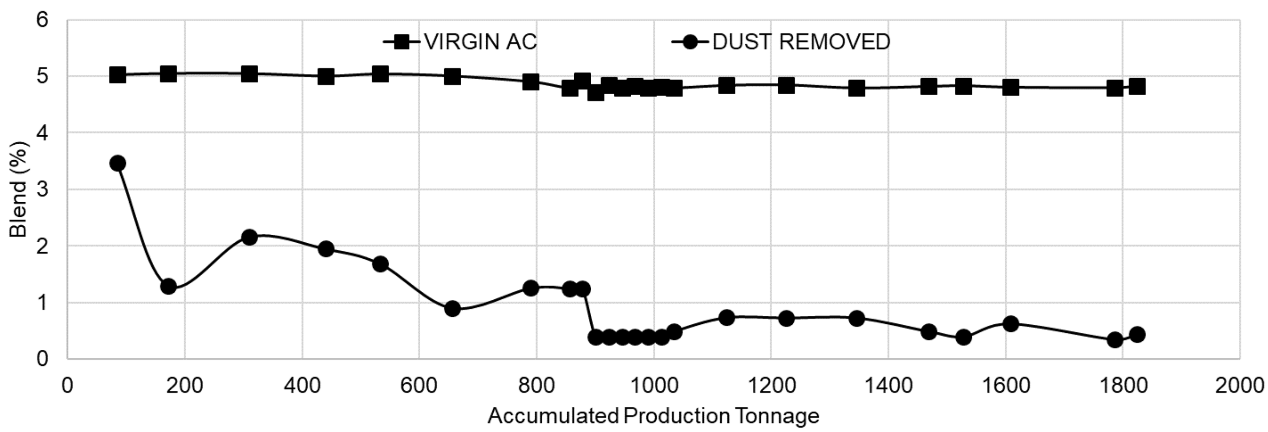
The mix production was completed in an ASTEC baby drum plant with a computerized control panel, six feeders, and two recycle feeders. No precipitation and a minimum temperature of 71°F were reported. Moisture content was below 6%. The datalogger indicated a fluctuation in the dust removal rate: 0.5% to 3% for both days of production. This would impact the VMA (Figure 65-D). The moisture content was lower than 6% for the aggregates, but 19% for the recycled asphalt shingles (RAS). Mix production speed was constant at 195 to 200 TPH. No mix switches or hot stops were reported.



A. Production speed (TPH)



B. Blend (%)



C. AC content and dust removed (%)

Figure 65. Graph. Datalogger results for District 8 site visit 2.

Construction and Sampling

The mix was hauled for 40 min to the jobsite and delivered to an MTD. The plate method was used to obtain mix samples in the field following IDOT specifications (IDOT, 2018a). Two personnel oversaw sampling, one of whom had 25 years of experience. The mix was transferred to a pick-up truck and prepared with an extended table and conventional splitter. The sample was blended and split in accordance with the requirements. Finally, district and contractor samples were stored in cardboard boxes and secured by district personnel (Figure 66). The contractor had been able to achieve comparable results with the district. Samples were stored overnight and reheated the next day using a Despatch oven.

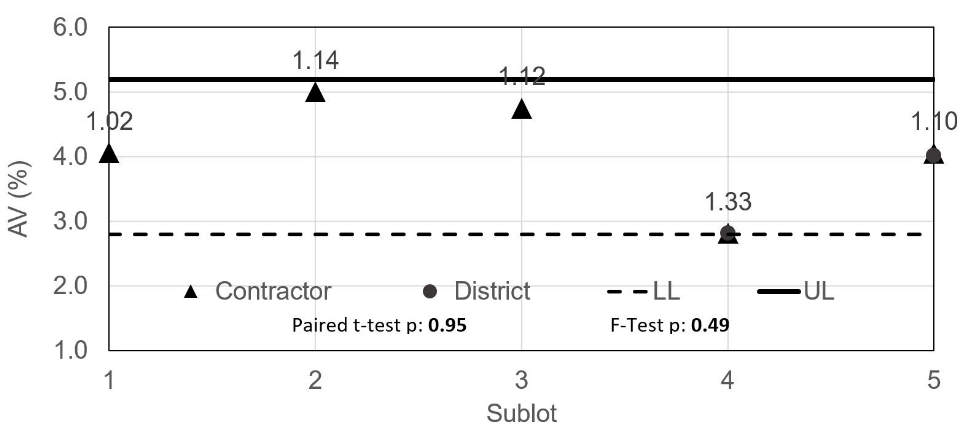
Figure 66. Photo. Rectangular boxes used to store and secure district and contractor samples.

Testing Procedures

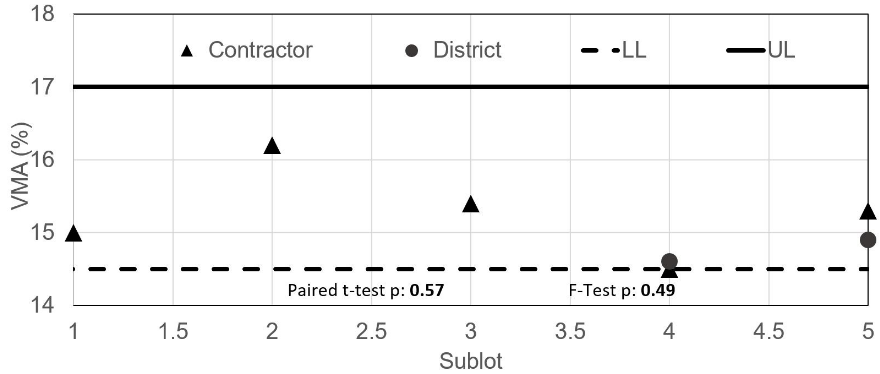
The contractor laboratory participated in the 2018 AASHTO re:source proficiency sample program. In the field, two personnel collected and split mix samples to the box size. At the plant, one full-time technician performed the testing. The contractor used a Pine G2 gyratory compactor for G_{mb} specimen preparation, while the district used Pine AFG2. The contractor shifted to this compactor after having an AV offset of 1.5% with a Troxler gyratory compactor. Despatch ovens were used for reheating samples with timers (no temperature alarm was used). Extractions for aggregate gradation and AC content were completed using an ignition oven.

Quality Control Pay Test Results

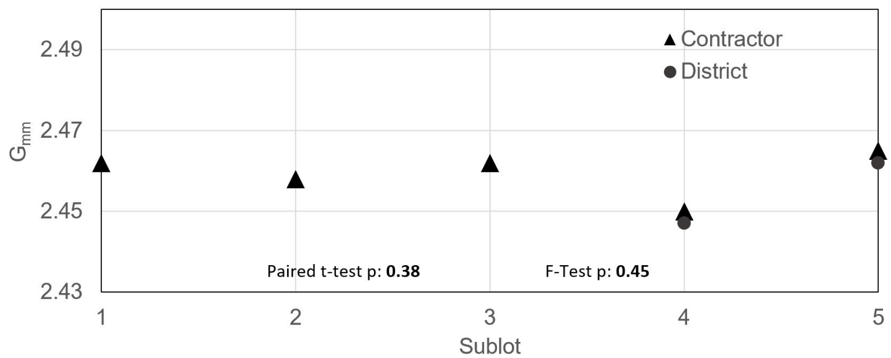
Figure 67-A and Figure 67-B show the AV and VMA test results, respectively. Contractor and district results were significantly similar and neither met the AV and VMA design values of 4% and 15.4%, respectively. The results were within the upper and lower limits, resulting in a 100% PF. Figure 68-B shows the dust/AC ratios; the sublots were high on dust. The AV was closer to the upper and lower limits.



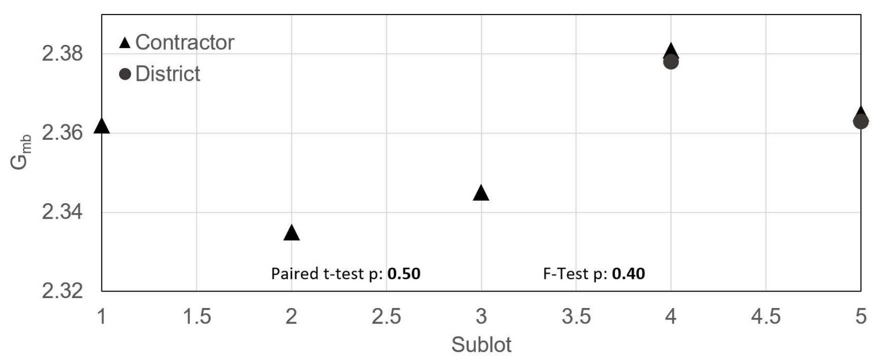
A. AV (%), Dust/AC ratios are listed for each contractor's result



B. VMA (%)



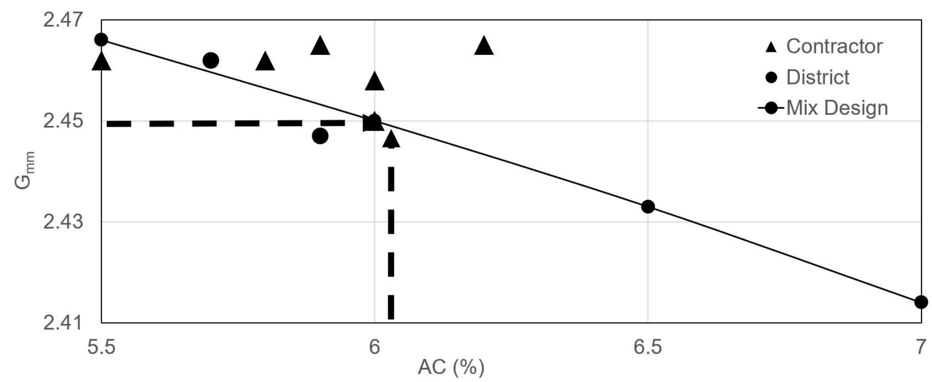
C. G_{mm}



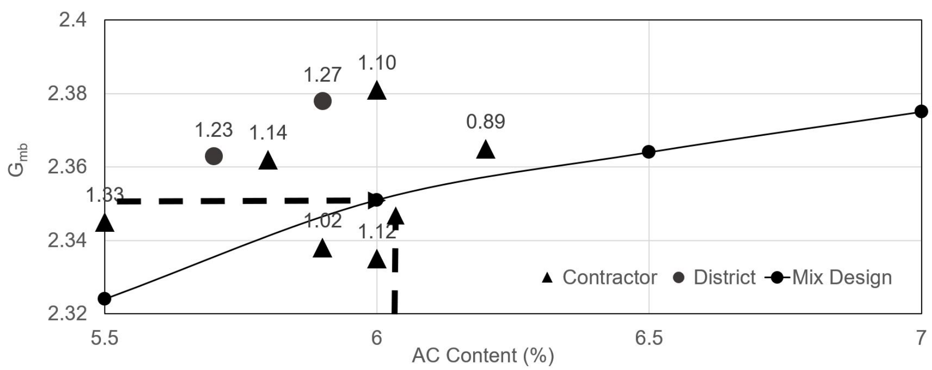
D. G_{mb}

Figure 67. Graph. Volumetric results for District 8 site visit 2.

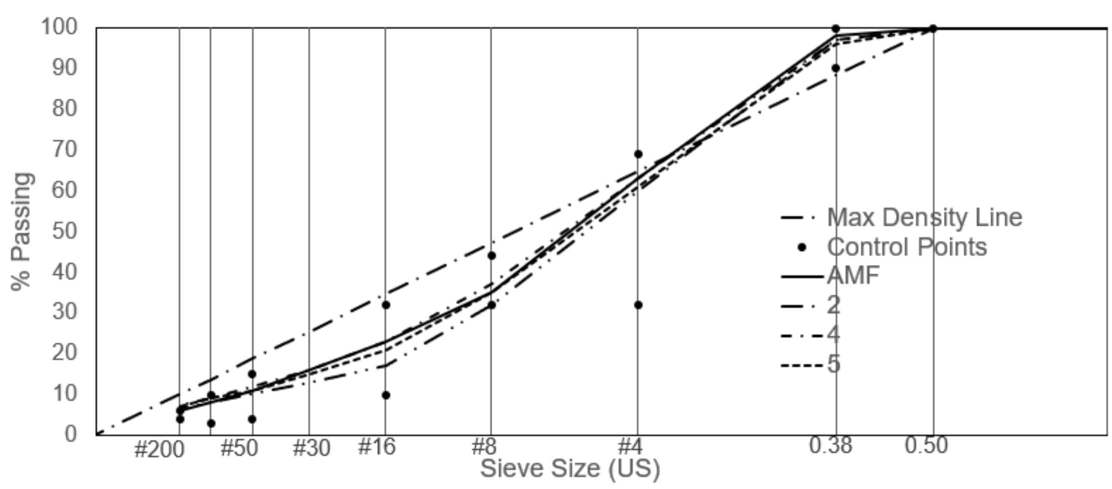
Figure 68-A and Figure 68-B show the G_{mm} and G_{mb} results, respectively. First, the results of both the contractor and district were similar, with a difference of 0.003 or less. Both G_{mb} and G_{mm} results were generally higher than the design values. Figure 68-C shows the aggregate gradation for sublots 2, 4, and 5. The dust content did not meet the design and fluctuated between 6% to 7.5%. In addition, the aggregate gradation from the contractor results in sublots 1, 2, 3, and 5 reported that material in #16, which comes from the FM20, was up to 6% off from the design. This could be related to dust-control and aggregate variability.



A. G_{mm} vs AC



B. G_{mb} vs AC, Dust/AC ratios are listed for each contractor's result



C. Gradation

Figure 68. Graph. Mix sublot results for District 8 site visit 2.

Although no AV, VMA, and density disincentives were applied, dust control was an issue and resulted in pay disincentives. The plant could not keep a consistent dust-removal rate and did not have positive dust control. Aggregate gradation was off target and affected VMA and AV results.

DISTRICT 9 SITE VISIT

The jobsite visit in District 9 was to a QCP pavement-resurfacing project on a two-lane other principal arterial. A 0.75-in-thick N90 FG leveling binder was placed over a milled surface. Table 14 shows the contract description and pay performance. The pay factors indicated a disincentive in VMA and density.

Table 14. District 9 Site Visit: Contract Description and Pay Performance (QCP)

Mix		Project	
Type	Leveling Binder	Project Type	Resurfacing
N Design	N90	Length	1.8 mi
NMAS	9.5 mm FG	Thickness	0.75 in
Paving Surface	Leveling Binder	Production	2,000 ton
Requirement		**Pay Factors**	
AV	4.0 ± 1.2%	AV	101.5%
VMA	15 +2/-0.5%	VMA	95%
Density	92.5–96.5%	Density	97.5%
Other Pay Adjustments			
Dust/AC	0.6% -1.2%	Dust/AC% Penalty	$0
AC (Design)	6.2%	CPF	98.0%

Mix Production

Mix was produced in an ASTEC baby drum plant. No precipitation and a minimum temperature of 72°F were reported. Moisture content was below 6%. The mix production report was not available due to lack of datalogger. The contractor indicated that the VMA drop was a result of the aggregate source. The quarry that supplied the aggregate shifted into a new ledge and the G_{sb} values were not updated; this affected all mix designs. The contractor noticed those changes too late for this project but was able to adjust for the remainder of the season. The contractor attributed the pay disincentive to the change in aggregate source.

Construction and Sampling

The mix was hauled 10 to 15 min to the site and MTD was used; the paver was a Caterpillar AP1000D. The personnel had more than 10 years of varied experience. Good communication was observed between IDOT and contractor personnel. The contractor indicated that three rail crossings from three railroad companies created back-ups and operation was a challenge.

The contractor indicated that maintaining a minimal effect on cross traffic resulted in a delay in paving operation. Rapid compaction was required occasionally to allow the road to open on time. The contractor was granted a relief from obtaining cores at the intersections so it would not affect the pay. Similarly, the contractor indicated issues with compacting around utility manholes, where “hand work” was used. According to the contractor, the hand work decreased the asphalt laydown to 200 tons a day.

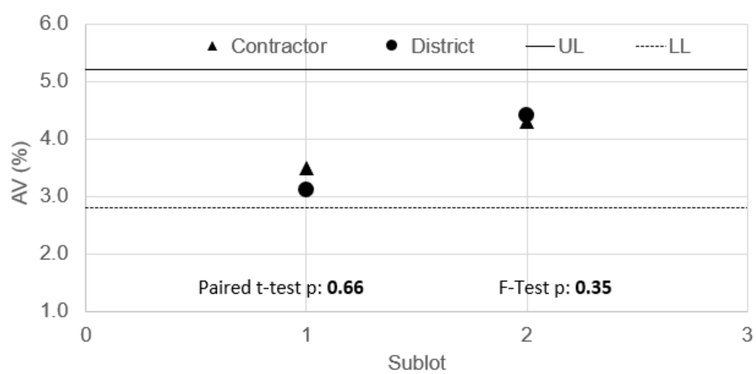
The contractor had two QC personnel during the project construction for sampling and field splitting. The leveling binder mix was sampled using plates. The samples were blended twice using a conventional splitter that resembles the Humboldt Riffle. Four metal rectangular containers of mix samples were obtained. Finally, the samples were stored in canvas bags and secured by the RE. Sampling a leveling binder using plates caused consistency concerns.

Testing Procedures

During the contractor laboratory visit, it was observed that the equipment was calibrated and the lab participated in the AASHTO re:source proficiency sample program. One technician was at the plant laboratory. The contractor used a Pine G2 gyratory compactor for G_{mb} specimen preparation, while the district used Pine AFG2. Despatch ovens were used for reheating samples; no timer or temperature alarm was used. Extractions for aggregate gradation and AC content were completed using an ignition oven.

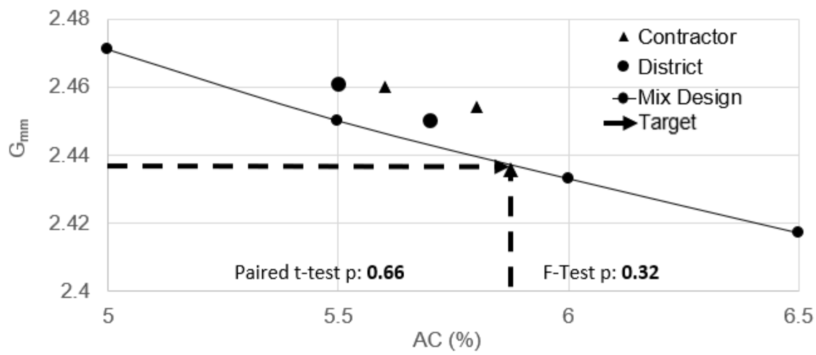
Quality Control Pay Test Results

Figure 69-A and Figure 69-B show the AV and VMA test results, respectively. District and contractor results were similar and reflected the same mix trend. There was a drop in VMA to 14.6%, which is lower than the design value of 15.7%. The contractor attributed this drop to the change in the supplied aggregate characteristics. The contractor mentioned that the aggregate G_{sb} values had changed from the values used in the design; this affected the computed VMA. Similarly, AV fluctuated between 3.5% to 4.4%. The contractor did not provide the datalogger of the plant production. G_{mm} and G_{mb} were off from the design value, which would be expected if G_{sb} for production was different from the one used in design. Figure 69-C and Figure 69-D show G_{mm} and G_{mb} vs AC content, respectively.

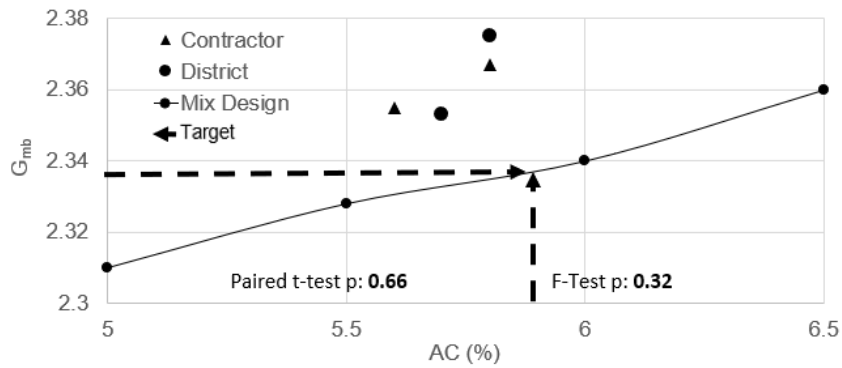


A. AV (%)

B. VMA (%)



C. G_{mm}



D. G_{mb}

Figure 69. Graph. Volumetric results per sublot for District 9 site visit.

Figure 70-A shows the aggregate gradation for sublots 1 and 2. The change in aggregate gradation from the mix design was reflected in the results of the percent passing 4.75 mm, 2.36 mm, and 1.18 mm sieves. The percent passing was higher than the mix design by 2% to 3%, as reported by the district and contractor. The difference was not as high as other projects; therefore, the impact was expected to be minimum. However, the change in aggregate specific gravity when supplied aggregate source was changed could cause the drop in VMA.

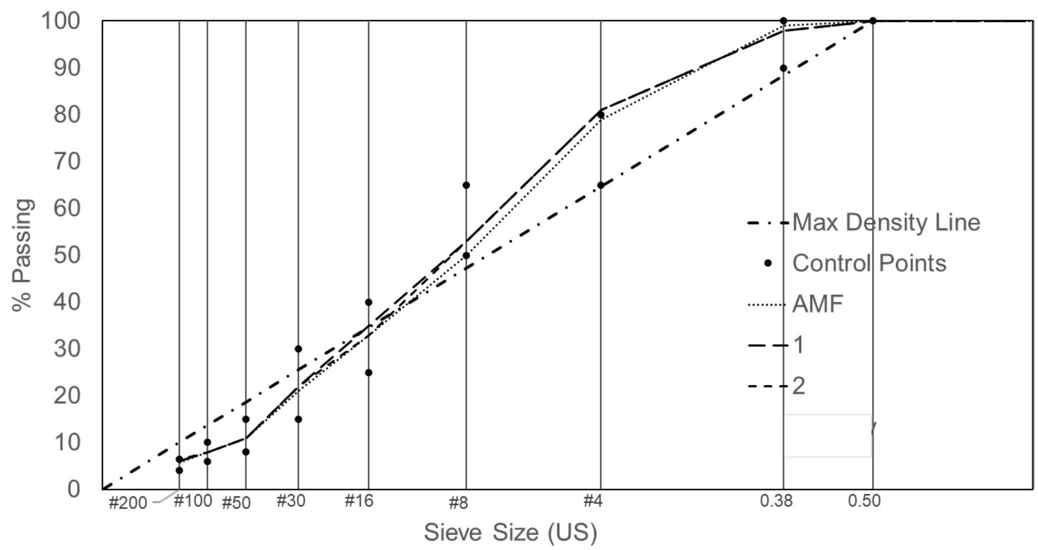
Figure 70-B presents the density results from the contractor and district cores. The results were similar; sublots 403 and 404 did not meet the requirements. The contractor used three oscillating rollers and one static roller per the district's request in leu of vibratory rollers that the contractor was planning to use.

The contractor reported additional challenges that affected the compaction effort. There were sections of heavily patched concrete, while other sections were milled HMA of varying quality (e.g., clean grooved surface, scabbed areas, and some exposed brick base areas). The primary lanes of the roadway through town were in "good condition," although some areas varied in thickness. Turn and parking lanes were in poor condition with pop-outs and exposed brick base. According to the contractor, cores from the turn and parking lanes were eliminated and were not considered. No information was provided on core elimination procedure.

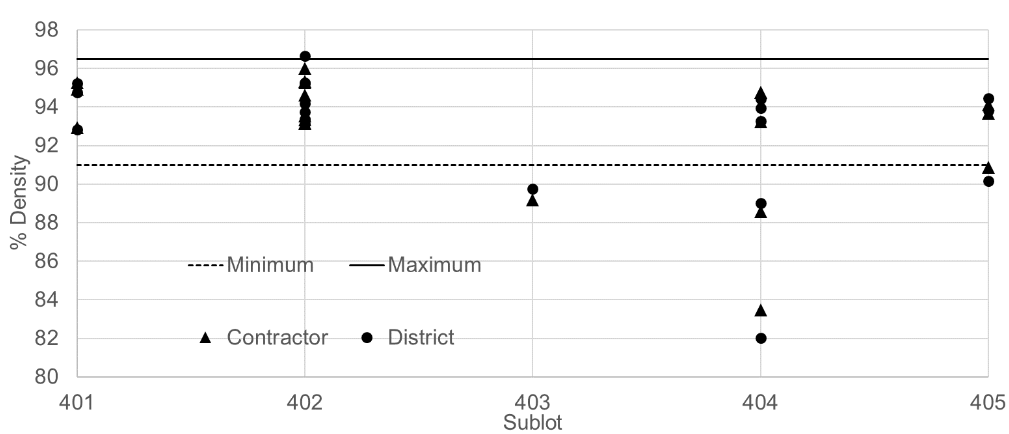
Subgrade varied throughout the project. The contractor suggested that density requirements should be relaxed because of varied subgrade throughout the project while “good rolling practices and best efforts” were maintained.

The contractor obtained a total of 20 cores. Not all cores met the thickness requirement; nine cores were used for the pay calculation. Cores that met the density limit but were not 3/4-in-thick were discarded. Irregularly paved surfaces resulted in layer thickness variation. The contractor claimed that those results significantly affected pay; if all the cores were used, the density pay factor would have been 99.5% instead of 97.5%. The industry has requested eliminating thin level binder cores from pay adjustment.

In summary, the project had a pay disincentive for density that could be attributed to aggregate-source change and field compaction.



A. Aggregate gradation for district sublots 1 and 2



B. Density cores results

Figure 70. Graph. Aggregate gradation and density results for District 9 site visit.

CHAPTER 4: CONCLUSIONS AND OBSERVATIONS

This study evaluated variability in production, sampling, and testing that could cause disincentives in QCP and PFP HMA contracts. QCP and PFP contracts were observed, and test results were analyzed. The evaluation consisted of jobsite visits conducted during the 2018 construction season and analysis of the test results after payment. The outcome of the analysis and sources of disincentives are described in this report to help contractors and districts identify and address practices that may affect the mix production, sampling, and testing for QCP and PFP contracts.

Jobsite visits were conducted at five QCP and six PFP contracts. The research team observed and documented production, construction, and sampling. In general, plants, labs, and jobsites were visited to observe sampling, blending, splitting, and testing. Testing procedures of contractor and district laboratories were documented. During the site visits, district and contractor personnel were interviewed and concerns were noted.

Data from the visited contract projects and laboratories were analyzed to identify differences between contractor and district test results and possible causes of pay disincentives. Volumetric and aggregate gradation test results were reviewed to allow researchers to identify differences in contractor and district testing as well as mix issues. The datalogger was used to identify inconsistencies with mix production. Density core data were used to evaluate the construction. Data used to calculate G_{mb} and G_{mm}, including test weights, were utilized to identify testing issues.

IDOT and the asphalt industry should consider the identified risks and make changes to improve mix consistency and quality. The following observations and suggestions are related to mix production and construction, sampling, testing, and sources of PF incentives/disincentives. Note that PFP uses a normal distribution and relatively larger number of samples; hence, the approach balances the risk between IDOT and contractors. On the other hand, QCP is used on relatively smaller projects and utilizes a relatively lower number of samples; hence, the specifications are relaxed to reduce contractor risk.

General Observations and Recommendations

- Contracts with less than 8,000 tons per mix and paid using the PFP specification should adjust the number of sublots for testing.
- Designing close to the minimum VMA increases the chances of receiving disincentives. In general, plant-produced VMA was observed to be lower than the design value. A design VMA at least 0.5% above the minimum VMA value is recommended.
- Contractor knowledge of the PFP specification should be enhanced through workforce training to help them optimize pay factors. Training courses and developing guide documents may include basic statistics concepts to help estimate populations, determine pass/fail, and identify production issues based on the procedures used herein to evaluate site visits.
- IDOT collects mix production and construction data. Currently, only final sublot average volumetric results and aggregate gradation are stored at the central database. The remaining

data, e.g., individual replicate results and raw test weights, are stored separately by the district in QC individual packages. Improvement of the central database to include all information available is recommended through the new IDOT Construction and Materials Management system (CMMS).

- Only personnel meeting IDOT's Quality Management Training Program requirements should participate in field sampling, as stipulated by FHWA requirements. Acceptance testing should be completed by the same experienced and approved technician for each project to improve consistency. In addition to certification, newly recruited personnel should always be under the supervision of experienced personnel to avoid QCP and PFP sampling issues, including sampling location and time.
- It is essential for good comparisons with district laboratories to thoroughly blend samples prior to splitting. Each split should contain an equal amount of each spot across the mat or each sample container utilizing a riffle splitter.
- At minimum, it would be beneficial for all testing labs to adhere to the "Best Practices for PFP and QCP Implementation" document in IDOT's *Manual of Test Procedures* (2018a).

Observations and Recommendations Related to Testing

- Gradation of some aggregate sources was highly variable and affected contractor pay. Changing aggregate suppliers impacted the mix quality. Also, the VMA calculation should be completed with the yearly updated G_{sb} of the aggregates used for production in accordance with the IDOT *Manual of Test Procedures* Appendix B.9 (2018a) and when the aggregate source is changed. Tracking G_{sb} is recommended as a QC activity to monitor incoming aggregate and test protocols of AC content, RAP, and production.
- A proper number of certified and trained personnel should be assigned for field sampling and laboratory testing.
- Gyratory compactors can cause differences between laboratories. Consistency in specimen preparation is also important. The height of the G_{mb} specimen vs dry weights must be maintained constant. Contractors should keep track of the G_{mb} specimen height to estimate the expected G_{mb} value of the plant sample once the specimen is compacted. This would eliminate waiting time for the G_{mb} specimen to cool prior to testing. Both parties should consider accreditation or participation in the AASHTO re:source proficiency sample program and continue IDOT round robin data analysis to identify any offsets.
- To limit segregation potential, the IDOT sampling procedure should be followed (i.e., plate samples behind a paver for most mixes). In addition, consistency in splitting, blending, and reblending should be maintained.
- Sample reheating may change the amount of binder absorbed. This would impact both G_{mb} and G_{mm} values. Hence, using consistent reheating practices for both parties would improve uniformity and avoid altering in situ values.
- Inconsistencies in G_{mb} and G_{mm} sample weights were observed. For a single project, variation in G_{mb} weight could range up to 80 g, indicating differences in splitting. Pre-splitting is

expected to help contractors achieve comparable results. This is time-intensive and requires careful preparation, coordination, and trained personnel to maintain sample temperature. Following HMA Level I practice for sampling, blending, and splitting should help achieve uniformity. In addition, both parties should use the same target weight.

- Differences in core densities can be caused by inconsistencies in both submerged and SSD weight measurements. Both parties should follow the same procedure.
- Testing bias does not necessary imply a pay penalty. It should be used, however, to better control the mix and optimize pay. The availability of district results within an optimum pay window may minimize variation.

Observations and Recommendations Related to Construction

- The more mix switches per day, the greater the material variability and the more challenging it is to control AC content and aggregate gradation.
- Large and sudden changes in production speed can cause a mix to have issues with the aggregate blend.
- Issues with dust control in a plant were reflected in G_{mb} test results.
- Stockpiles with one side of aggregate entry and exit may cause aggregate variability if contractors cannot keep track of newly arriving material. In addition, plants should use barriers between aggregate stockpiles per IDOT's Standard Specifications Section 1102.01(2).
- To better control cold feeds, mixtures that require more than 30% of a single aggregate stockpile should be fed into the plant using multiple cold feed bins.
- Paver stops should be avoided during construction.

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APPENDIX A: OBSERVATIONS FROM THE 2019 CONSTRUCTION SEASON IN DISTRICT 1

During the 2019 construction season, a member of the research team inspected an additional contract (apart from the 11 cases visited).

District 1 Case 2019 A

The case was to a PFP 2-in pavement-resurfacing project on a four-lane minor arterial. A 9.5 mm SMA was placed over a leveling binder. The mixture was placed during the night in August 2019. No precipitation was reported, and the minimum reported temperature was 74°F. The mix was sampled per PFP requirements at the jobsite, and the samples were obtained using regular commercial shovels and split using a quartermaster. The contractor results showed AV of 10.4%. Quality assurance was performed by an independent contractor and showed AV of 10.2%, which resulted in an investigation of the sublot. The sublot results in question are shown in Table 15.

Table 15. District 1 Case 2019 A

District	1	Site Visit		2019 A
Material Code	19665R	SMA SC 9.5 F REC		
		Lot 1-07 Sublot 1		
	Design	AMF	QC	QA
1" (25.0 mm)	100.0	100.0	100.0	100.0
3/4" (19.0 mm)	100.0	100.0	100.0	100.0
1/2" (12.5 mm)	100.0	100.0	100.0	98.0
3/8" (9.5 mm)	92.0	92.0	85.0	84.0
No. 4 (4.75 mm)	42.0	42.0	33.0	33.0
No. 8 (2.36 mm)	28.0	28.0	16.0	17.0
No. 16 (1.18 mm)	19.0	19.0	12.0	12.0
No. 30 (600 µm)	16.0	16.0	10.0	10.0
No. 50 (300 µm)	12.0	12.0	8.0	9.0
No. 100 (150 µm)	9.0	9.0	7.0	8.0
No. 200 (75 µm)	8.0	8.0	5.3	6.5
AC Content	6.4	6.4	5.9	5.7
Gmb			2.204	2.207
Gmm			2.459	2.459
Gsb		2.632		
Gse			2.693	2.721
VMA			21.2	20.9
AV			10.4	10.2

The investigation indicated that QC and QA results were comparable within IDOT PFP precision limits. Contractor personnel, and RE in charge of sampling were interviewed. The contractor personnel were questioned about the HMA field sampling, field splitting, and testing procedures. No unusual issues were noted. Following the interviews, the night datalogger was reviewed. The datalogger for the entire production night was requested. Approximately 1,419 tons of the mix were produced at a fixed production speed of 285 TPH. The datalogger showed that the SMA production started at 7:56 p.m.

and a hot stop was applied at the plant at 11:00 p.m., when a total of 917 tons of SMA were produced. The production restarted at 1:19 a.m. and ended at 2:58 a.m. Because the PFP sample was obtained at 926 tons, the interval of time in the datalogger when the sample was produced was reviewed and shown in Table 16.

The failing test results appeared to be related to the at hot stop at 917 tons, which was close to the sampling time. The datalogger showed that at the time of restart, the MF addition and dust removal were not on target when SMA transferred to the storage silos. This operation resulted in a shortage of dust in the SMA.

Subsequent review of the datalogger and quality control test results suggested that production prior to and after that event had no issues in AC, MF, or dust. The 80 tons before and after the production hot stop were removed and remaining production was acceptable.

Table 16. Datalogger for SMA Mix from 11:00 p.m. to 1:35 a.m.

Date	8/X/2019				
Formula ID Formula Name	N80 SMA F				
	Time (hours)				
	22:50:58	23:00:35		1:19:06	1:35:07
Legend	Datalogger Tonnage Reported (Tons)				
AGG Belt	604.02	621.32		655.44	675.27
RAP Belt	183.59	192.49		199.51	205.67
Virgin Asphalt	39.65	41.42		42.68	43.98
ADD2	0.59	0.62		0.64	0.65
Total	877.96	917.44		946.35	975.45
F1 951	79.61	81.6		85.86	88.41
F5K13	331.89	340.02		358.31	368.94
F6K16	271.69	278.3		293.32	302.01
1/4GATE12"	87.48	91.34		94.75	97.62
RAS/GATE5	38.15	39.83		41.31	42.57
1/2HOLE6	68.68	71.69		74.6	76.84
Mineral	44.29	46.44		47.43	48.74
Dust Removal	20.46	20.81		20.81	21.27
	Target (%)	Actual (%)	**HOT STOP**	Target (%)	Actual (%)
AGG Belt	72.5	43.8		72.5	68.1
RAP Belt	22	22.5		22	21.2
Virgin Asphalt	4.48	4.5		4.48	4.5
ADD2	1.5	0.1		1.5	0.0
PRODUCTION SPEED		246.3			109.1
F1 951	8	5.0		8	8.8
F5K13	35.5	20.6		35.5	36.5
F6K16	29	16.7		29	29.9
1/4GATE12"	10	9.8		10	9.9
RAS/GATE5	4	4.3		4	4.3
1/2HOLE6	8	7.6		8	7.7
Mineral	5.5	5.4		5.5	4.5
Dust Removal	0.01	0.9		0.01	1.6

APPENDIX B: ICT PROJECT R27-189 SURVEY SHEET

Project Shadowing Visits Survey Sheet (Part of R27-189):

Document Objective

This project is conducting an assessment of the data obtained from the projects included in the Quality Control for Performance (QCP) and Pay for Performance (PFP) programs. The objective is to gain a better understanding of the distribution and variability of the test results included in the QCP and PFP programs with respect to specific categories that will be defined as part of this study.

To understand the root causes of data distribution and variability, interviews will be conducted. These interviews will include questions about the procedures followed during testing and data analysis. The collected information enables researchers to identify the deviations from standard procedures and/or practice that may attribute to variability and inconsistency.

This document (Project Shadowing Visits Survey Sheet) will be used to guide the R27-189 project personnel during the site visits. However, personnel can add questions to this document based on their engineering judgment and field conditions.

Part A: HMA Contractor General Information

Contact Information

Name of the Respondent: ____________________

Title: ____________________

Company Name: ____________________

Address: ____________________

City: ____________________

State/Province: ____________________

IDOT Contractor ID: ____________________

Phone Number: ____________________

Years in the Company: ____________________

Part B: Project Site General Information

Address (Location) of the project: ____________________

Contract Number: ____________________

Project Description (Pavement section, mix design,): ____________________

Project Miles: ____________________

HMA Production amount (sh.tons): ____________________

HMA Placement times: ____________________

# of Personnel involved with the project: ____________________

Nominal Maximum Aggregate Size (NMAS): ____________________

Binder Grade: ____________________

No. of Gyrations: ____________________

IDOT District: ____________________

Part C: Survey Follow Up

Question from Online Survey (numbers correspond to those on the survey)	**Follow Up Approach (guide for shadowing visits)**
1. Please provide the following information about your QC personnel: ☐ Full Time at Jobsite ______ ☐ Floating between Jobsites ______ ☐ Full Time QC Laboratory ______ •	Interview the QC personnel to confirm: • What is the amount of time spent in the field or at the lab? • Which test does each QC personnel regularly perform in the lab or field (to observe if same person serves on each test)
5. What is your average QC Cost (staff, equipment, and supplies) per ton of mix?	For this online survey question, we may not get an accurate answer because the QC manager is not in charge of the payroll. As a result, the interviewers should extract information indirectly to obtain a better estimate of the amount of resources spent on QC. Questions may include: • How many personnel are performing QC tasks? • How much time is deployed in field? • What is the QC salary? • Do you supplement with Consultants? •
15. What is the minimum additional QC tests that you usually perform? This is beyond what is required (not including your random sample for pay):	If additional tests are needed, are results reported in the server? Investigate if plant QC laboratory performs preliminary tests before mixture production (for calibration purposes). •
16. If, in question 13, you selected the sampling location "plant," please explain your company's process for such sampling.	During the visit, observe or ask for details such as: • Who are the personnel performing the sampling,

	• Observe the process and focus on sampling location, handling, and segregation mitigation.
18. What practices do you follow to minimize segregation?	Observe how the aggregate stockpiles are handled. • Are the aggregates taken in a manner that will minimize segregation? • Do you see fines (powder) in the stockpile base? (hinting degradation) • What are the procedures after new aggregate is received? • Check labelling of stockpiles • How is stockpile built? • Estimate stockpile heights
21. Do you rely on splits or hand adjust the sample weight for Maximum Specific Gravity (G_{mm})?	• Most of the technicians probably rely on hand adjustments. Hence, please investigate further by evaluating the "VOIDS" tab of the QC/QA Package and look at the difference between individual G_{mm} replicate sample weights. If the weights are too close, there was hand adjustments.
23. For each gyratory equipment used, please provide the following information:	• Check if there are any existing records on internal angle and applied pressure.
28 How often is the oven temperature checked?	How is the thermometer calibrated? • Is the calibration performed in the oven or in a liquid bath? • How is the reference temperature measured? • Thermometer placed in sample? Temp alarms used? If not how do they ensure samples aren't overheated?
32: If multiple ignition ovens are used in your lab,	Evaluate the calibration constants for ignition ovens. • If multiple, check if the make and model are the same

Part D: General Plant Conditions

1. Number of years in operation:
2. Type of plant batch: (single, double, or baby drum)
3. Stockpiles evaluation:
    a) Type of base:
    b) Do you run moisture and specific gravity tests; how often?
    c) Who does check the 6-min counts and how often are they performed?
    d) Review weight of bridges vs feeders
4. Type of plant controls:
    a) Name:
    b) Manufacture:
    c) Year/version:
    d) Panel or Computerized:

5. Dust Control:
    a) Do you run positive dust control?
    b) Type of weighing unit: (weigh pods, weigh auger, impact meter, other)
    c) Review dust removal (for drum plants if using recycle)
6. Asphalt Cement (AC) pump:
    a) Name:
    b) Manufacture:
    c) Year/version:
    d) Meter, micro-motion, weight, meter over meter, other
    e) Calibration:
7. AC calibration tank:
    a) Manufacturer:
    b) Fixed or portable:
    c) When was the last time the AC was calibrated? (Obtain a copy of the calibration if possible). Range of calibration.
8. Describe the production procedure for:
    a) Switch AC liquids during production:
    b) Switch mix designs or make other mixes:
    c) Mix wasting:
    d) Do you waste material at the start-up?
    e) How about during hot stops or switches?
    f) How often has the plant experienced hot stops or mix switches?
    g) Do you change production rates during the day?
    h) Evaluate the production speeds for anomalies:
    i) Reclaimed Asphalt Pavement (RAP) Management: (How long RAP is kept, is it fractionated, how many sizes)
    j) How multiple silos are filled?
    k) What procedure does the plant follow to keep records?
9. Trucks:
    a) Does the plant has an automated or manual spray rack for the incoming trucks?
    b) Live-bottom trucks or baffles to minimize segregation
10. Feeders:
    a) Number of feeders:
    b) If there is a production problem, are the feeders recalibrated?
    c) Obtain the calibration rates:
    d) Do the feeders match with the designs?
    e) How much is the offset between the mix design and the produced mix?
11. Silos:
    a) Number of silos:
    b) Capacity (size):
    c) Does the plant record indicate which silo is being filled and when it goes empty?
    d) Does your plant have 20 hrs of storage approval from IDOT?
12. Weather:
    a) Explain actions taken (or protocols followed) when there is a change of weather:

i. Rain:
ii. Cold Weather:
iii. Snow (in case its needed):

13. How much experience does the plant personnel have? How much experience with the current contractor?
14. New Technologies:
    a) Are you using warm mix technology? Why?
    b) Other technology (rejuvenators)?
15. Review virgin AC numbers:
16. Review mineral filler (MF) numbers:
17. Data logger:
    a) Does the plant have an active data logger?
    b) Is the data logger working during the whole production day?
    c) Review the data logger to check required information:
    d) Obtain a copy of the data logger:
    e) Is there an automated printout of the documents?
18. Temperature Charts:
    a) How often are the charts reviewed by QC and QA?

Part E: Quality Control Laboratory (for visits to AC plants Laboratories)

1) Daily Routine
    a) Please explain the daily routine for QCQA, PFP, and QCP:
    b) Are there any different tasks done for PFP or QCP projects?
    c) Is a new design created for a PFP or a QCP project?
    d) If extra preparation is needed for a PFP or a QCP project, what is usually done?
2) Calibration (to see records):
    a) How often is the laboratory equipment calibrated?
    b) How often the equipment is within calibration range?
    c) Are the calibration records available for the team to review?
3) HMA sample preparation:
    a) What equipment is used to determine AC content?
    b) What is the make and model of your gyratory?
    c) Type of vacuum pump: (direct drive, pulley, oil less)
    d) Is a manometer used?
    e) Type of oven, number size and does it hold temperature?
    f) What are the calibration factors for the ignition ovens?
    g) Is there a correction factor for the dust (#200)?
4) Aggregate testing:
    a) Type of mechanical shaker:
    b) Type of washing aggregate:
    c) Review stockpile gradations:
    d) Check aggregate moisture numbers:
5) Quality Assurance Laboratory Comparisons:
    a) What could be the cause for the differences between the QA and QC?

6) Sample Handling and Analysis:
    a) How are samples “IDed” or organized? How are they stored?
    b) Is a customized spreadsheet or worksheet used or data are directly input into the QCQA package?
    c) Does a review process exists for checking test results before submittal? Please explain.
    d) If a review system is used, why it used?
    e) What is the logic used when results are challenged?
7) Plant Production:
    a) How the communication between the Quality Control and the Plant Production personnel defined? (Discuss details)
    b) How influential is the QC laboratory in modifying the plant production rates?
    c) Does the Quality Control Lab have any say during the calibration of the plant? (setting of gate openings, speed of production)
    d) Is QC’s opinion valued? (Rate on scale of 1–10)
    e) Do sampling of mixtures, belt samples, and hot bins be performed during the production?
    f) Does the plant operator have any plant operation training? How about the laydown personnel?
8) Laboratory Care (to be assessed by the team):
    a) How often does lab equipment get cleaned? (Ignition ovens, splitter, water bath)
    b) When the lab was last inspected? By whom? Can the tram see the document
    c) Does your lab participate in AASHTO Resource (formerly known as AMRL)? Is your lab participating in the proficiency testing?
9) Review of the condition of the field sampling equipment:
    a) Shovels
    b) Plates (metal, wood, plastic, etc.)
    c) Putty knives, scrapers
    d) Splitter condition, opening size, pans conditions, size of unit, etc.
    e) Scale
    f) Lubricant
    g) Sampling container (metal bucket, plastic, etc.)
    h) Storage or secured sample container (Chicken bucket, boxes, bags)
    i) Security tags
    j) Sampling Plates
        i. Size
        ii. Number
        iii. Materials
        iv. Smoothness of Plate:
    a) Does the company use a material transfer device (MTD)?
        i. Type:
        ii. Model:
10) Pre-pave Meeting:
    a) Is a pre-pave meeting usually held? Who attends?

11) Coring Equipment:
   a) What are the sizes and conditions of the core barrel(s) and when are they replaced? Are they used for concrete?
   b) Water tank size:
   c) Who cuts cores?
   d) Review how the cores are labeled:
   e) Review the storage and security of the cores:
   f) Observe layout, cutting and securing of the cores.
   g) Observe running test on cores.
   h) Check core preparation and cleaning.
   i) Check calculations (which G_{mm} is used)
   j) Observe the processing of the cores (trimming, cleaning, water temperature) and which G_{mm} is used: Get a copy of the worksheet:
12) Field Measurements:
   a) Who does the sample location lay-out?
   b) Are plates being used over granular or milled surfaces?
   c) Who does the sampling and splitting observation?
   d) How long does it take to obtain a sample; then split and secure the sample? Does the paver stop?
   e) Observe sampling of mixture. Do they get even amounts from all sample areas?
   f) Is the mix cooling and clumping while splitting?
   g) Is there a separate split for G_{mm}, AC tests?
   h) How is the correct split size ensured? How about for split G_{mm} and AC?
   i) Are split G_{mm} or AC cooled before securing it?
   j) When samples are rub? (complete cool down, when it's still warm, other)
   k) Observe sizing of samples…how many times is it remixed:
   l) Observe G_{mm}, G_{mb} and AC content. Review gyratory heights (N initial vs N design)
   m) Is QC being performed onsite or lab at another plant or both? (some downstate contractors use a single "central" lab for split sample testing)
13) Compaction and Placement:
   a) Is intelligent compaction used? What brand? What version?
   b) For QC, is there a choice of rollers to be used? Number to be used?
   c) How experienced is the paving crew? Paver operator, 1st Roller, finish roller, dump person, lute person, foreman
   d) Paver Model: Type of screed (flexible/rigid)
   e) Type of grade control: (sonic, contact, wired-string line, GPS)
   f) Distance between paver and rollers: (too much, too close, adequate, not catching up)
   g) Paver speed: (too fast, too slow, okay, set by QC)
   h) Auger speed: (fast, slow, inconsistent)
   i) Angle of attack of screed with respect to grade: (ok, too steep, too flat)
   j) Are the screeds heated before use?
   k) Is the vibrator being used on the screed?

l) When mat is segregated, is it centerline, auger extensions, random, end of truckload)
m) Temperature of mat: Climatic conditions:
n) Type of roller(s):
   i. Model:
   ii. Condition of the rollers: (Do they work? Are they in sync?):
o) Did QC set the roller passes? Did they use a tachometer?
p) Number of rollers:
q) Rollers pattern:

Part F: Quality Assurance (for visits to IDOT Districts Laboratories)

1) Daily Routine
   a) Please explain the daily routine for QC/QA, PFP, and QCP:
   b) Any difference in handling a PFP or a QCP project?
   c) Is a new design created for a PFP or a QCP project?
   d) Is extra preparation done if needed for a PFP or a QCP project?
2) Calibration (ask for records):
   a) How often is the laboratory equipment calibrated?
   b) How often are the values checked within calibration range?
   c) Can the calibration records be available to the research team?
3) AC Sample Preparation:
   a) What equipment is used to determine AC content?
   b) What is the make and model of your gyratory?
   c) Type of vacuum pump: (direct drive, pulley, oil less)
   d) Is a manometer used?
   e) Type of oven, number, and size; do they hold temperature?
   f) If multiple ignition ovens are used in the QA lab, please provide their calibration constants.
4) Aggregate testing:
   a) Type of mechanical shaker:
   b) Type of washing aggregate:
5) Sample Handling and Analysis:
   a) How you are samples "IDed" or organized? Are they tested blind? How are they stored
   b) Is a custom spreadsheet or worksheet used, or data are directly input into the QC/QA package? Are worksheets/reports initialed by tech?
   c) Does a review process exist for checking test results before submittal?
   d) If a review system exits, what does it check?
6) Plant Production:
   a) How the communication is defined between the QA and QC personnel?
7) Laboratory Care:
   a) How often does the lab equipment get cleaned? (Ignition ovens, splitter, water bath); John to assess
   b) When the lab was last inspected? By whom?

c) Does the lab participate in AASHTO Resource (formerly known as AMRL)? Does the lab participate in the proficiency testing?

8) Ask about how to separate layers:

a) Review how the cores are labeled:
b) Review storage and security of cores:
c) Observe layout, cutting and securing of cores:
d) Observe running test on cores: Check core preparation and cleaning: Check calculations: (which G_{mm} is used)
e) Observe the processing of the cores (trimming, cleaning, water temperature) and which G_{mm} is used: Get copy of worksheet:

APPENDIX C: 2018 SURVEY RESULTS

Contractor Survey

During spring 2018, a survey was sent to IDOT contractors to gather their opinions about QCP and PFP. Twenty-four responses were received. The responders typically conducted business with more than one of the IDOT districts. Figure 71 shows the districts with which the contractors did business.

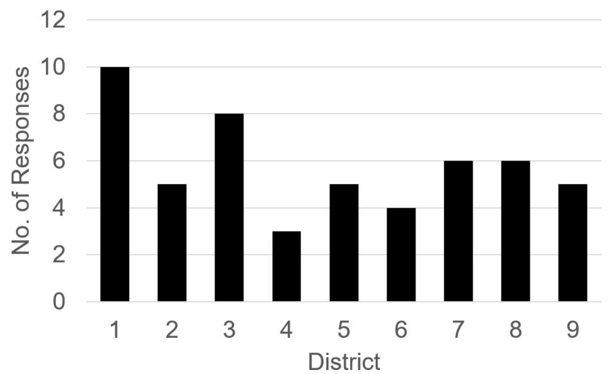


Figure 71. Chart. Districts that had business with the contractors that were surveyed.

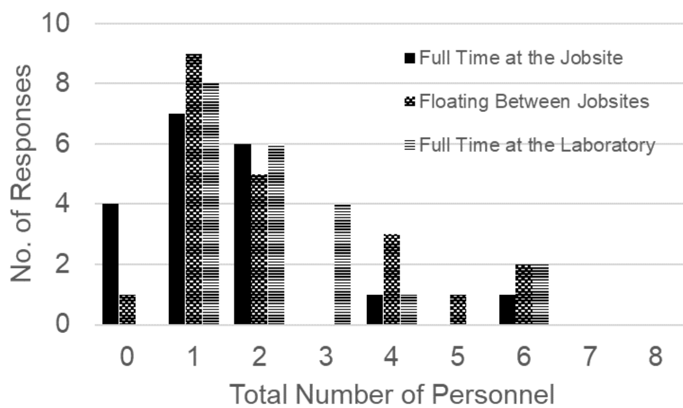


Figure 72. Chart. Number of personnel assigned exclusively for quality control tasks.

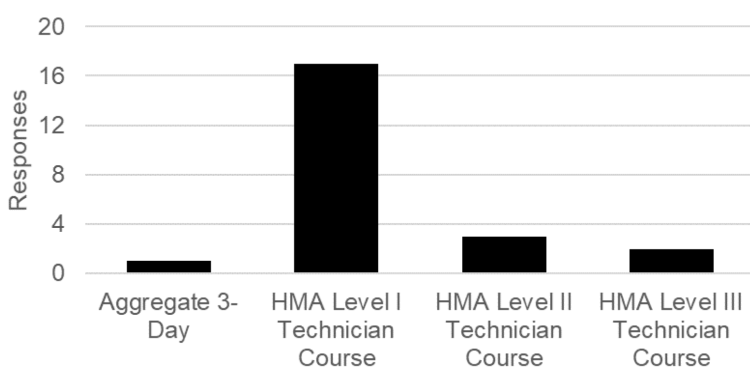


Figure 73. Chart. Minimum level of training required for technicians.

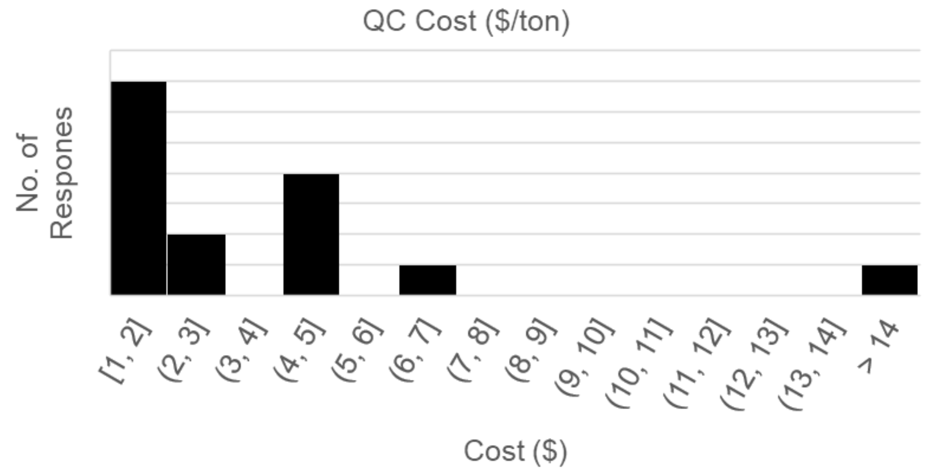


Figure 74. Histogram. Quality control cost per mix ton.

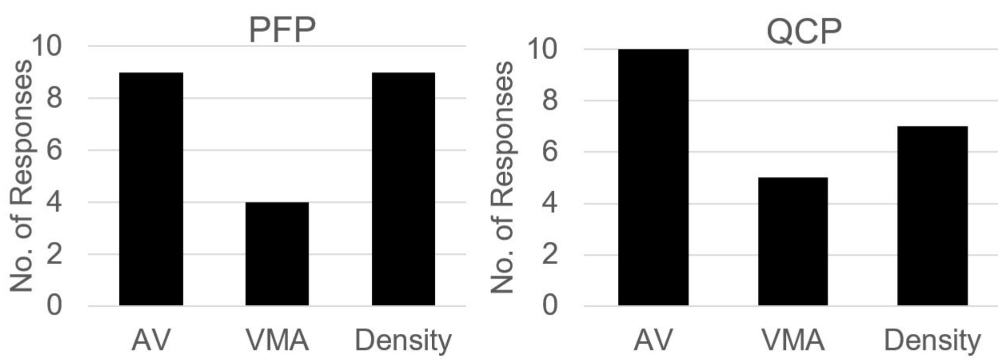


Figure 75. Chart. Parameter driving pay loss.

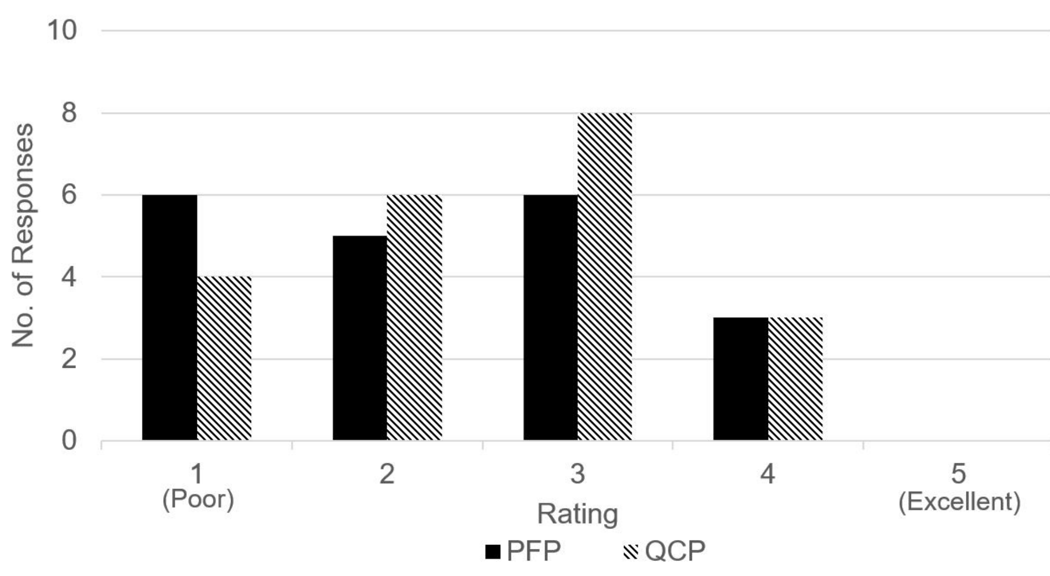


Figure 76. Chart. Rate the QC programs.

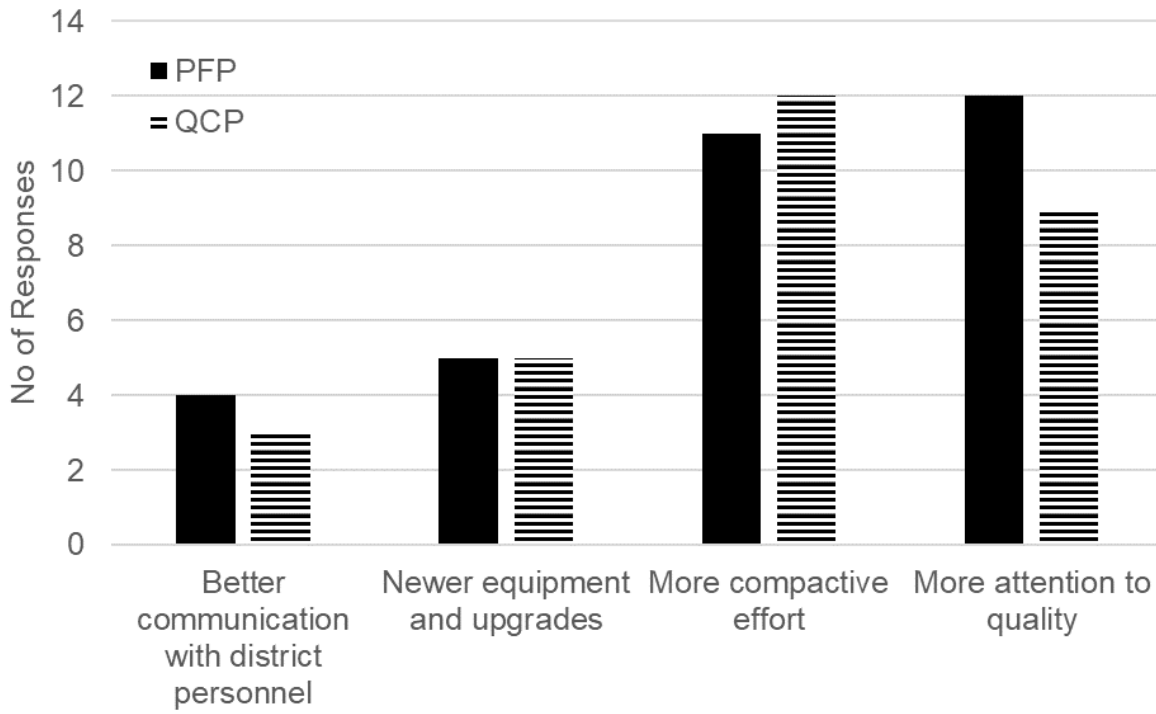


Figure 77. Chart. QC programs benefits.

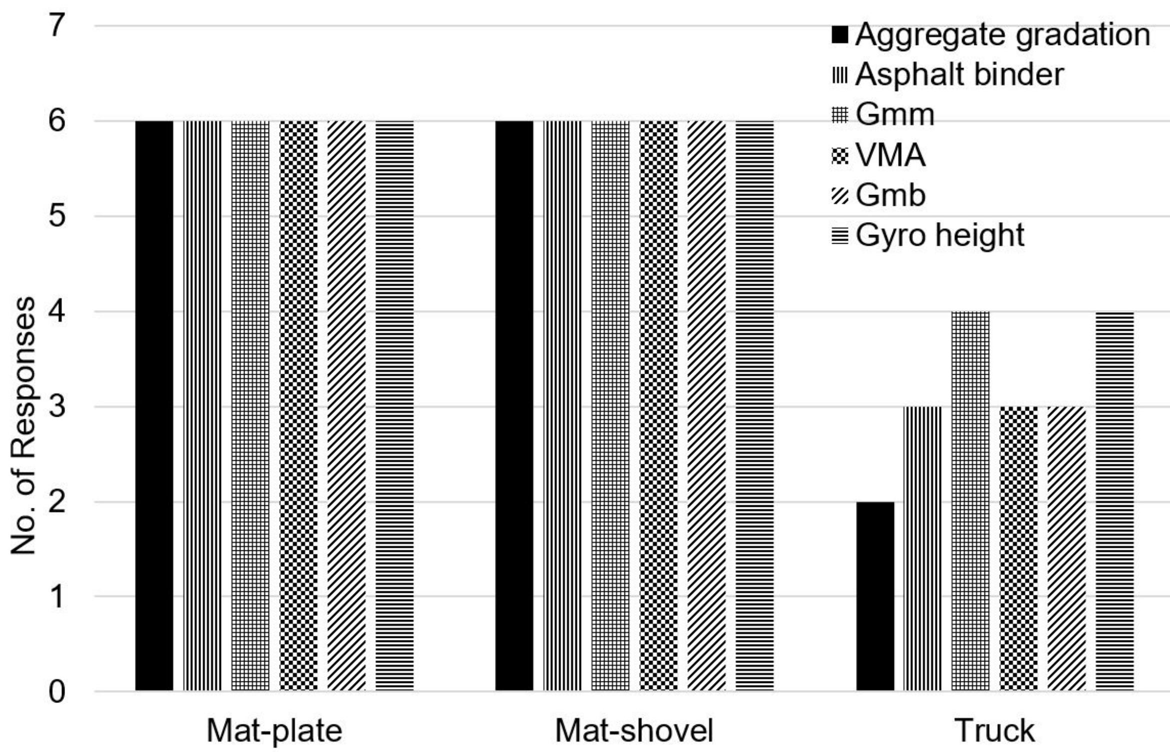


Figure 78. Chart. QC sampling location.

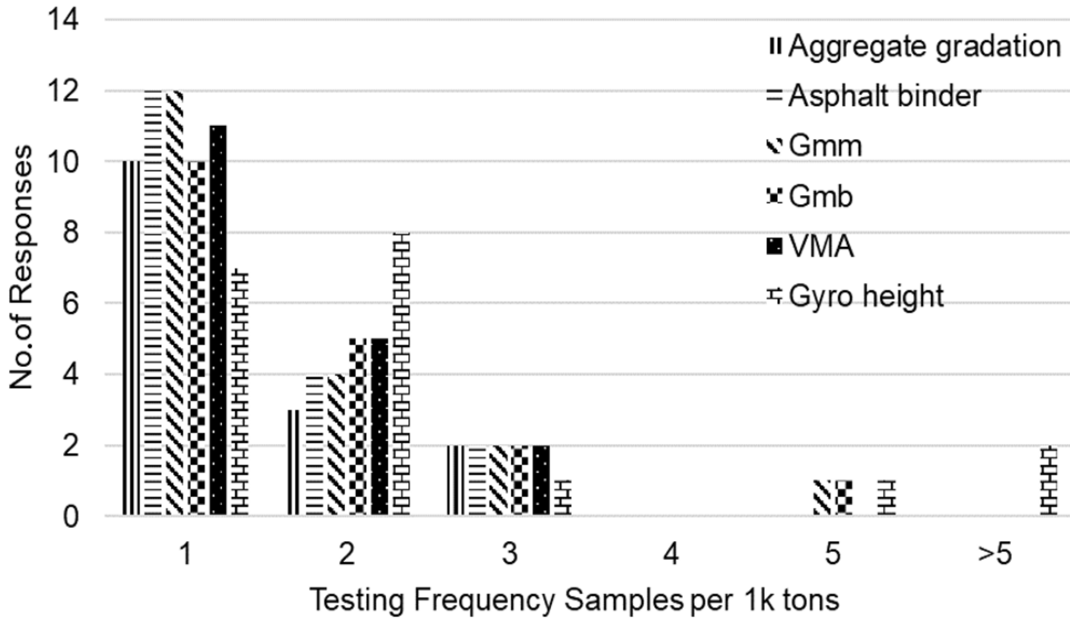


Figure 79. Chart. Testing frequency samples per 1k tons.

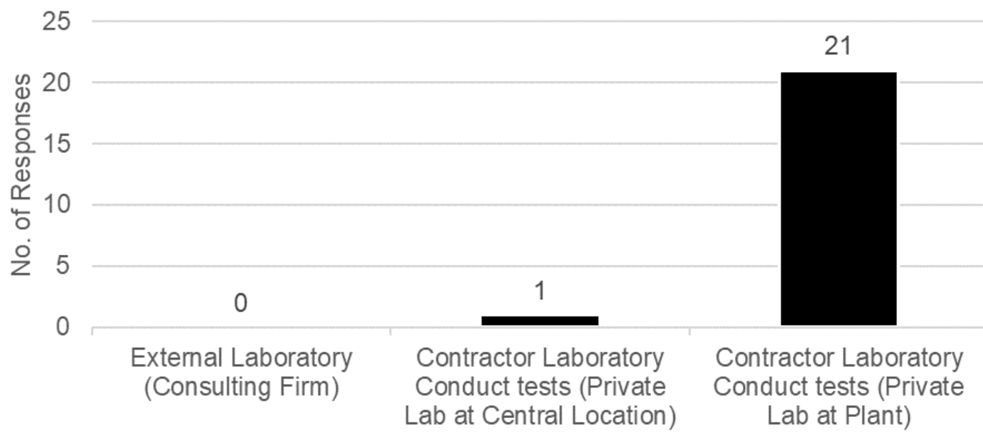


Figure 80. Chart. QC testing location.

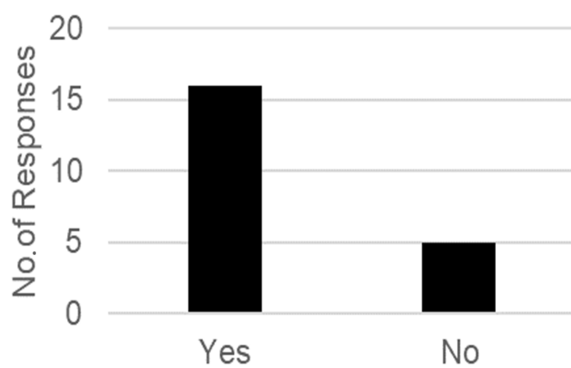


Figure 81. Chart. Does the company have the same person running all samples on a project?

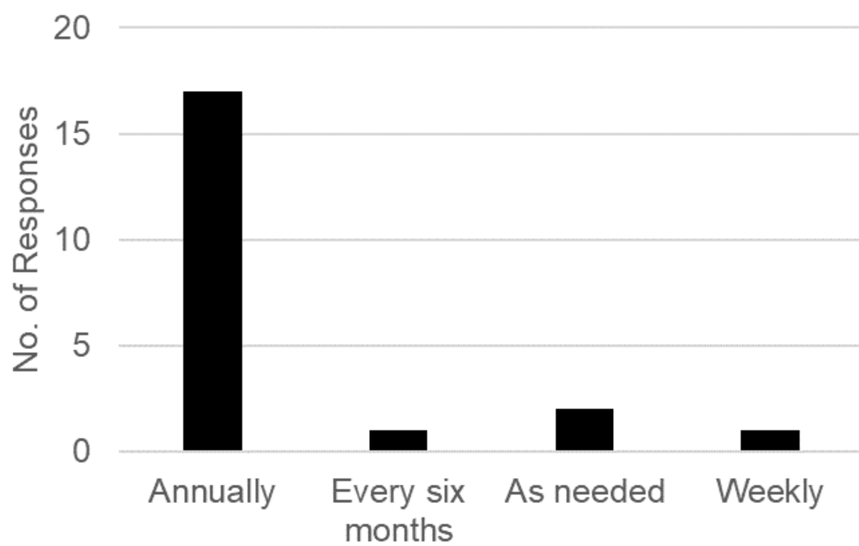


Figure 82. Chart. How often are the molds inspected with a bore gauge?

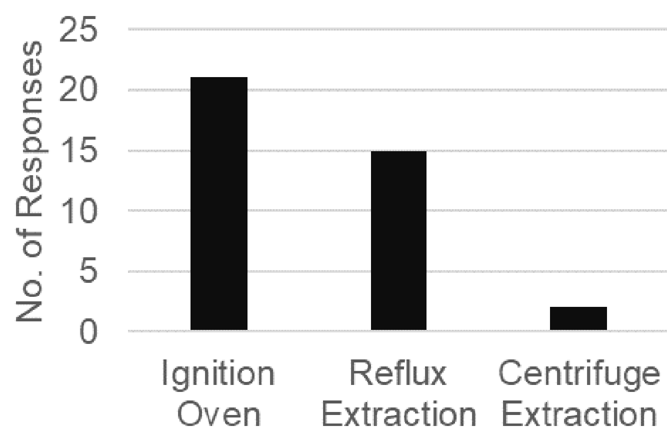


Figure 83. Chart. What equipment is used to determine AC content?

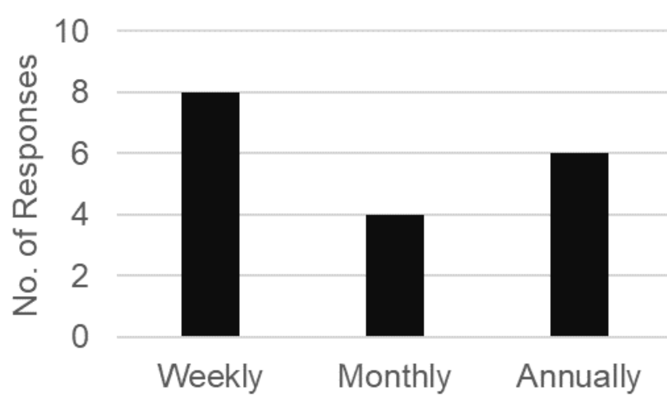
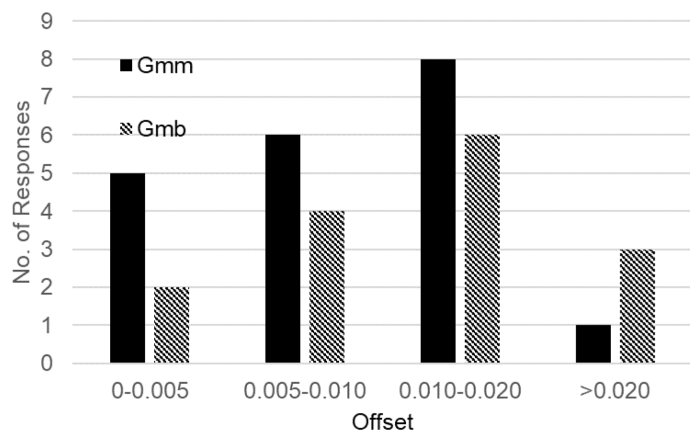
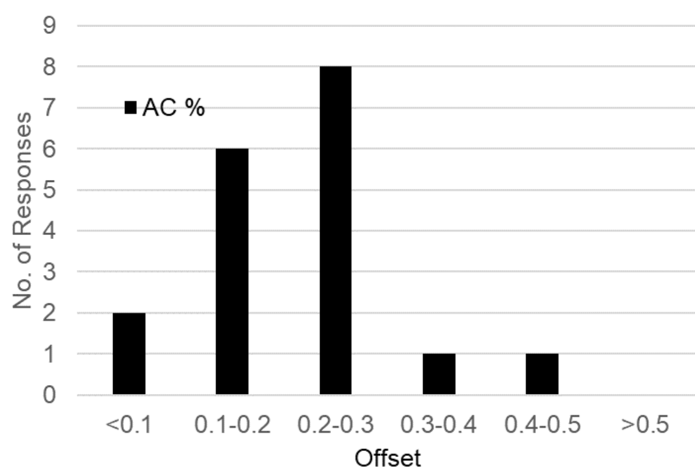


Figure 84. Chart. How often is the lift test performed on the ignition oven?



A. G_{mm} and G_{mb}



B. AC%

Figure 85. Chart. What is your typical offset between your lab and the district lab for?

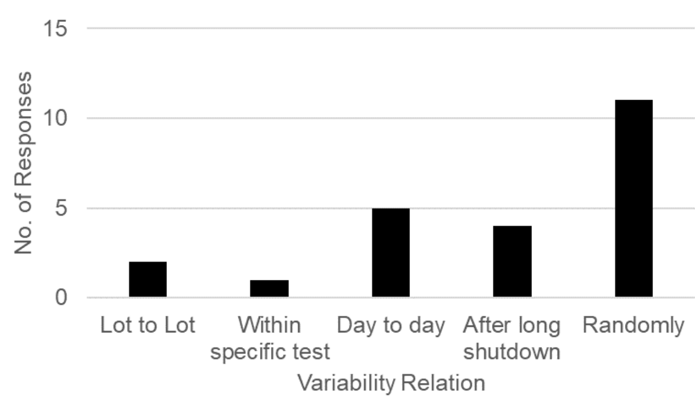


Figure 86. Chart. For those mixes that seem to have more variability, is the variability related to one or more of the following?

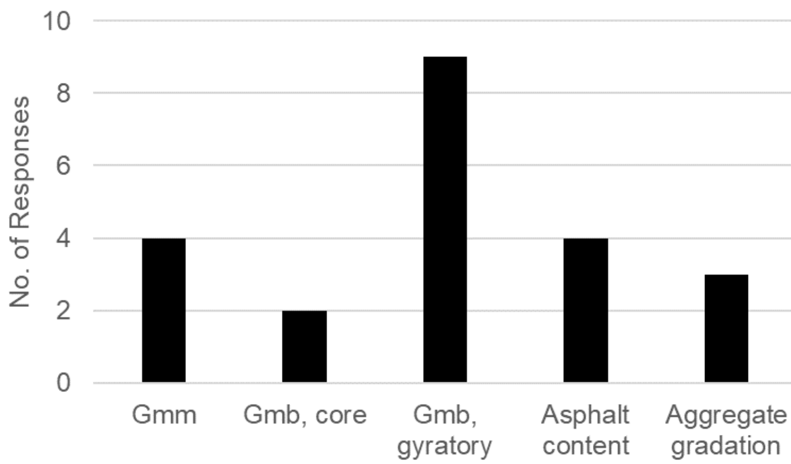


Figure 87. Chart. For contractors working with multiple department district labs, do you notice a difference in the following tests results between labs for pay samples?

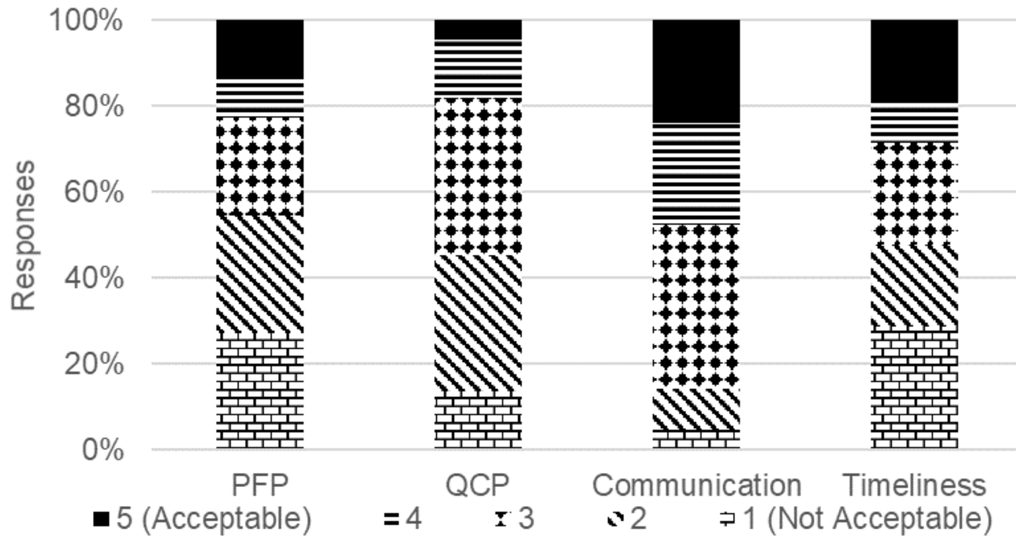


Figure 88. Chart. Please rate the following items.

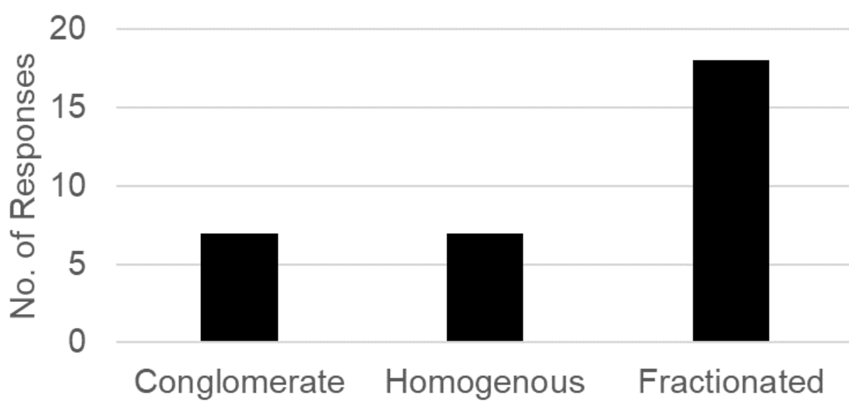


Figure 89. Chart. What type of RAP stockpiles do you have? (Check all that apply.)

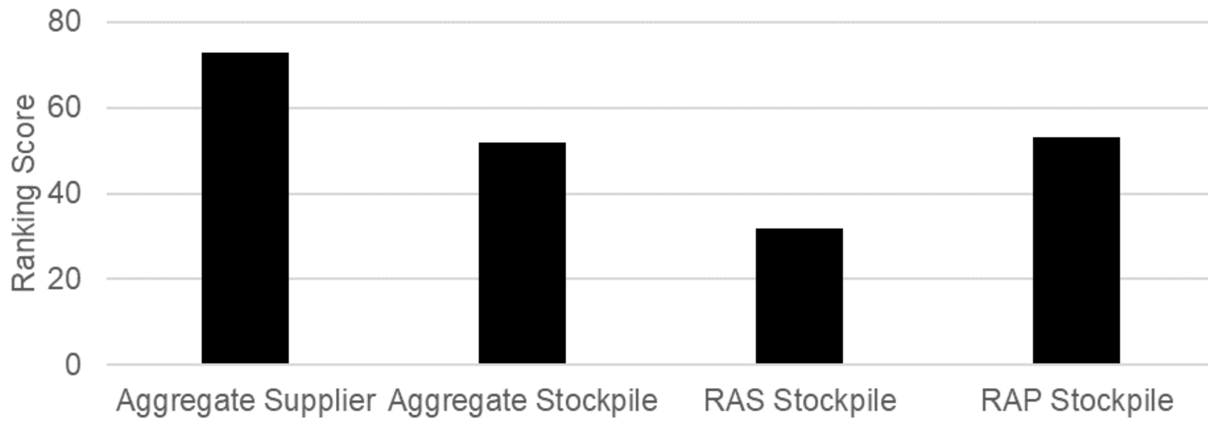


Figure 90. Chart. Rank the source of variability at the plant (1 is least and 5 is greatest).

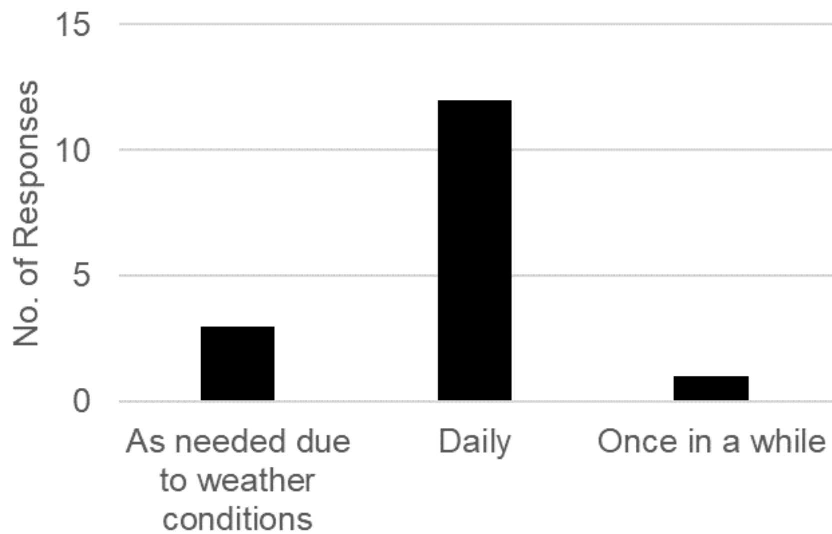


Figure 91. Chart. How often is the aggregate stockpile moisture test conducted?

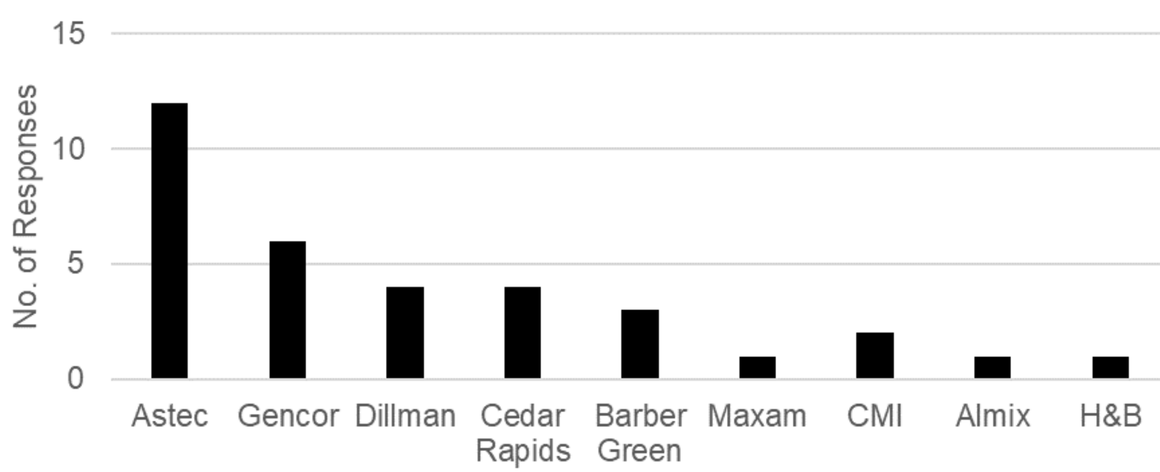


Figure 92. Chart. Plant manufacturer.

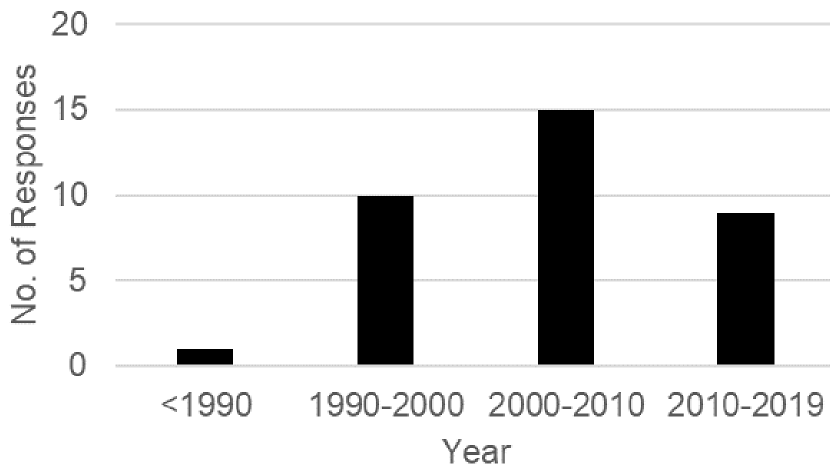


Figure 93. Chart. Plant year.

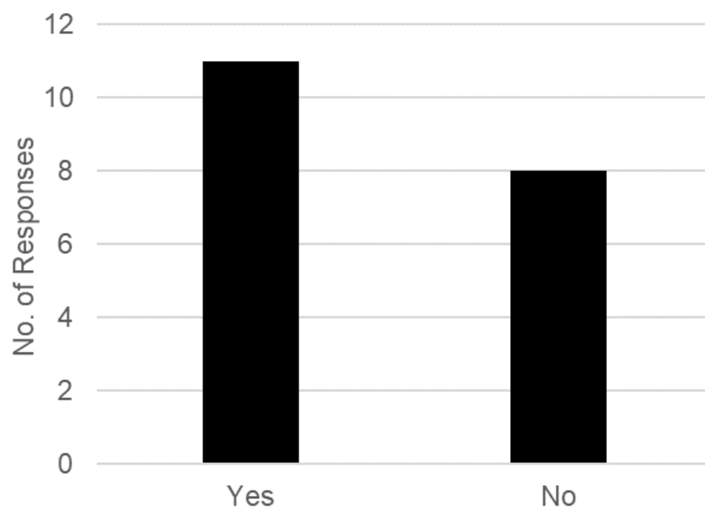


Figure 94. Chart. Do you switch mixes while producing for PFP/QCP projects?

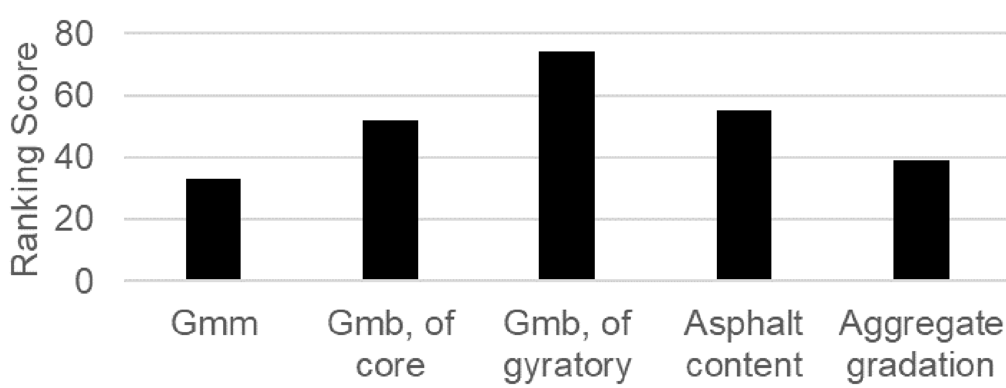


Figure 95. Chart. Rank the following criteria for cause of error (or pay disincentive).

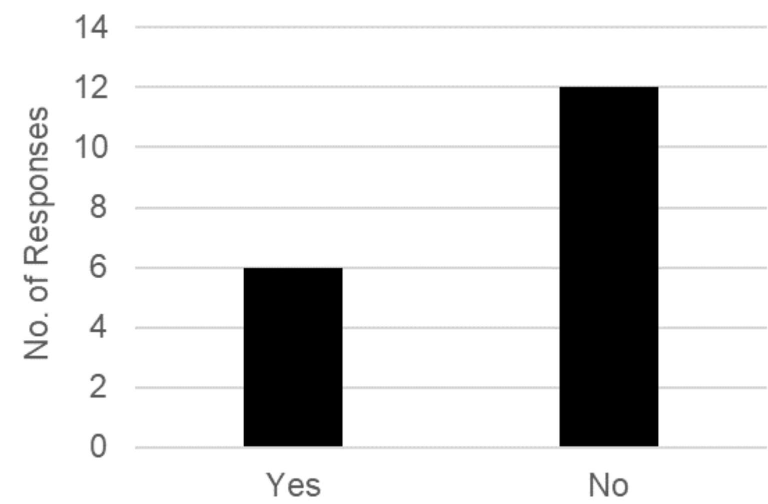


Figure 96. Chart. Are the QC managers directives ever overruled by others (project superintendent, chief estimator, etc.)?

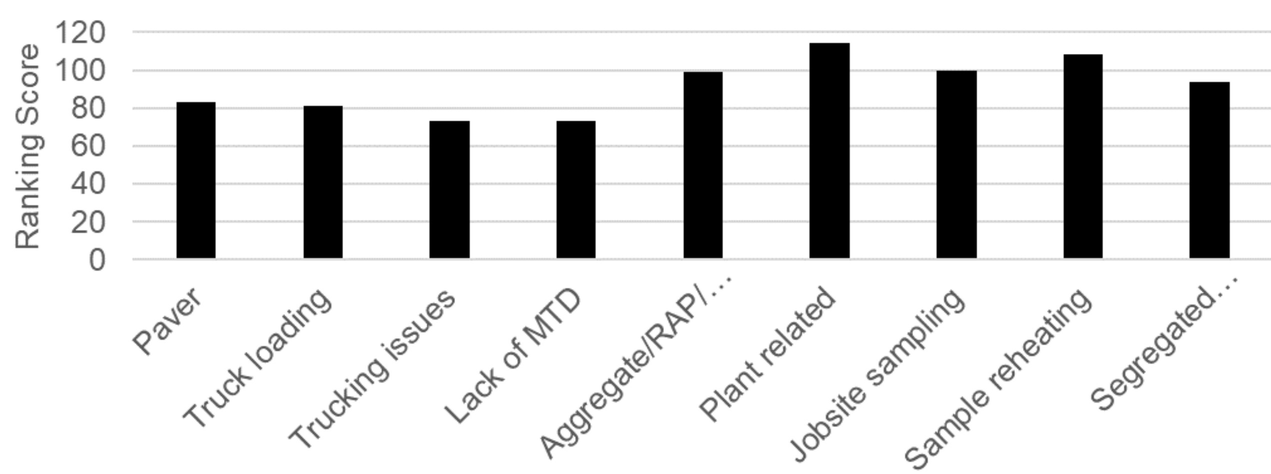


Figure 97. Chart. Rank the following nine sources of error that typically lead to failure to meet PFP/QCP volumetric requirements (1 is least and 9 is greatest) (Please refer to Survey Monkey, 2020 for ranking score definition).

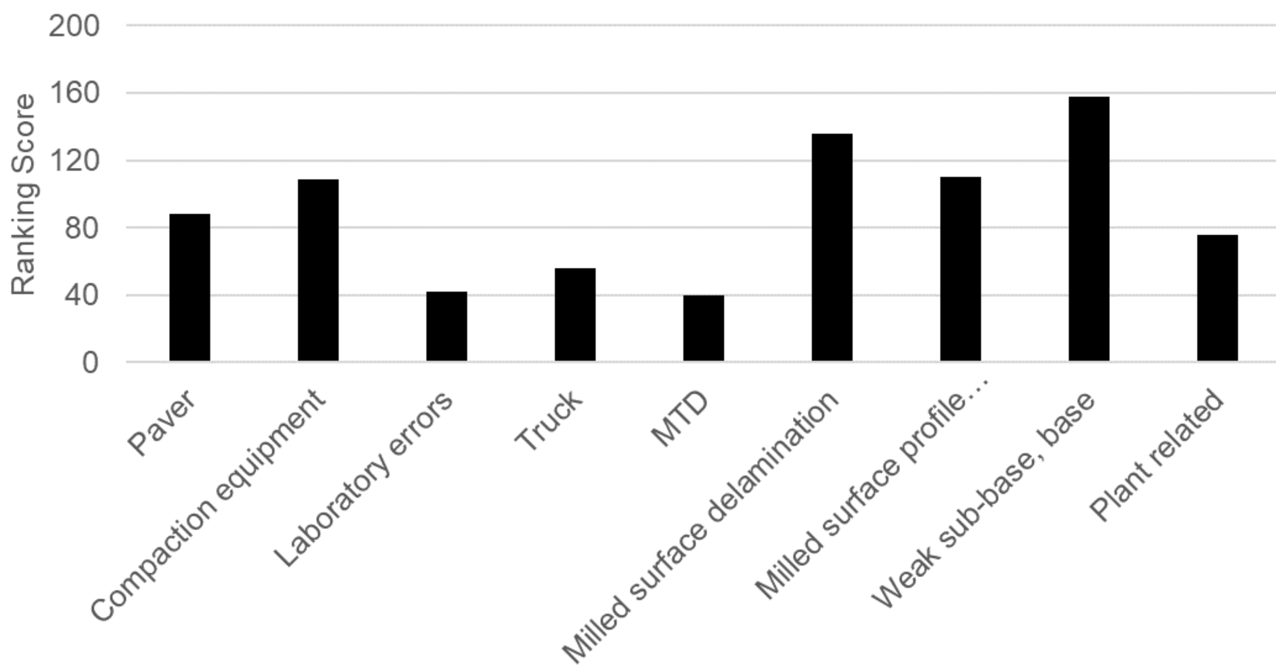


Figure 98. Chart. Rank the following ten sources of error to meet PFP/QCP in-place density requirements (1 is least and 10 is greatest) (Please refer to Survey Monkey, 2020 for ranking score definition).

Table 17. Main Reason for Success in PFP

Responses
We treat PFP/QCP testing the same as every other mix that we run. With focus on having accurate and consistent results that we can make good decisions on to control the mix. But there is also a lot of luck involved with IDOT getting good test results also.
Extra testing on all factors, continual testing above and beyond required frequency. We receive test results from IDOT next day. This is extremely important!
Team Work & Communication.
Because it was a PFP project there was an opportunity for a bonus. Timely adjustments to mix and density. Was proactive instead of reactive.
Communication between everyone involved. Including but not limited to, aggregate suppliers, loader operators, plant crew, paving crew, QC staff and management.
Good QC in the lab and the field
Consistency of mix.
Was able to play the correct windage with IDOT samples and had no flyer that time.
24 hour turn around time on results

Table 18. Benefits from QC Programs

Responses:
Is all I have is frustration!
I think everyone in our company makes sure that they are doing whatever it takes to ensure we are placing the best product we can on the roads.
None. More compactive effort is applied but many times it is too much and we are reducing the life of the mat. It has cost all contractors monetarily. It is tough in a competitive market to receive .90/.97% on the $1.00 bid.
PFP has made quicker responses to mix issues a necessity.
More testing takes place only to find out I can't apply any windage to D1 because they are all over the place with their numbers.
None. IDOT is not receiving any better of a product than the QC program gave them
More compactive effort detrimental to pavement. More attention to quality more attention to detail.

Table 19. Comments to Improve QCP

Responses:
Let's us do our job. We can test and adjust in a timely manner, as opposed to the waiting and uncertain results generated by IDOT.
Yes- Remove density from the level binder pay factor calculation- Currently the pay factor for full depth pavement is calculated by equally weighting each HMA course type. Instead the pay factor should be calculated by prorating the tonnage. - Current treatment of thin level binder cores need to be re-examined.
Same as the comments for the PFP.
Set a higher minimum ton before it is used.
No Bonus only penalty. Thin lift binder an issue (hard to get a good road sample, Plant or Cores)
Under 8000 tons just let us pave (QCQA)
More education for everyone involved. We (IDOT and Industry) need to work together to make sure everyone is doing things accurately.
why not let me get a bonus. why not average a 103% rating on my VMA test to raise my payfactor above 100%?
Too much compactive effort Size of sublots on lower tonnage jobs
Lack of ability to challenge
Allow truck sampling as an official sample method. This will allow the department and contractor to maintain a more uniform process. This will also allow contractors to make small adjustments within their process and will create a more real time QC process.
Use contractor results.
Not good for small production days. Although intended for smaller tonnage jobs there are realistic limits and conditions that should not be lump summed.
More use of engineering judgement
Marry up QCP with PFP and have only one testing format regardless of tonnage. Take the pros from each and retire the cons from each. (i.e., edge density vs. +2% for edge cores)

Table 20. How Is the Decision Made on What Gyratory Compactor to Use for What Materials/Projects?

Responses
We only have one in each lab.
Randomly to serve as a check and balance
Based on which District we are running the mix for. All the labs are different on their bulks.
Same one is always used. The extra is a backup.
Match IDOT
Location (gyratory at each plant site)

Table 21. Information for Your HMA Ovens

Please identify the manufacturer, model, and size of the oven used to heat HMA samples.	Does your lab use temperature alarms for ovens?	How often is the oven temperature checked?
Thermolyne NCAT	Yes	Weekly
DesPatch, LAC2-18-6, 18CF	Yes	Every three months
Despatch LBB1-69A 6.9cuft	No	As needed
Humboldt; H-30160.2F; 7.2 cu. ft. / Humboldt; H-30145; 7.8 cu. ft.	No	Daily
Blue M	Yes	Annually
Blue M SPX	Yes	Daily
Despatch LAC Series 6.6 cubic feet	Yes	As needed
Despatch	Yes	Annually
Despatch, LAC1-67 (6.7 cubic feet)	Yes	Daily
1680 VWR its big.	No	Annually
Despatch LBB2-12-1 12 Cubic Ft	Yes	Daily
Blue M/DC-246-F-PM Blue M/DC-246-F-HP Hot Pack/TruTemp 212061	Yes	As needed
blue m 336 size 336	Yes	Daily
Grieve Ovens	Yes	Daily
Despatch LBB2-18-2 Same as D1 Lab	No	Annually
Despatch forced Air LC18	Yes	Daily
2 each Deptach LAC, 3 cu ft	Yes	Every month
Despatch, Protocol Plus, 22CF	Yes	Daily
Blue M DC-246-F-ST350	Yes	Every three months
Quincy Labs 31-350 10.6 cuft.	No	Every three months

Table 22. Are There Specific Mixes (Mix Type, Nominal Maximum Aggregate Size (NMAS), Binder Grade, Recycle Content, etc.) That Tend to Show More Variability in Test Results Than Others?

Responses
D mixes.
IL 4.75 mm mix have more variability
To a minor extent mixes utilizing recycled materials present an issue
Any mix with steel slag
We tend to have more variability in mixes that use Dolomite (CM16 and FM20).
N70 Surface for me, Voids = IDOT came in 2% higher on test strip (mine was actually below spec), 1% on Lot 1, 0% on lot 2.......

Responses
IL19.0, IL9.5 D Mix aggregate segregation/ high absorptions
19.0 mm mixes have been the hardest to get a good comparison
Depends on the day. Sometimes 4.75mm, 9.5mm, or 19.0mm
Binder mixes
9.5 surface

Table 23. In the Order of Importance (First Is the Most Important), What Are the Top Three Improvements You Suggest to the Department Specifications to Enhance Payout and Reduce Penalties?

Responses:		
1 (most important)	2	3
Timely turnaround of results so I can adjust in a timely manner		
Use consultant labs	Quick turn around on sample results	delete unconfined joint spec
Use contractor lab results for pay calculations	For QCP, allow 105% pay factor for each component to carry through to final pay calculation	Remove level binder density from the QCP program
Testing: use common sense, if something looks wrong it generaly is. Then they should rerun tests.	Test in our labs. Contractor provided gyratory.	Controll reheating the material which effects our G_{mm}.
PFP should be pass/fail not statistical analysis	Better IDOT turn around time on samples	IDOT districts should determine any credits not Central Bureau
No thin lift cores	Edge cores on two lanes	loosen up spec for pay for projects which have low tonnage days.
Eliminate QCP	Dist 2 need to follow 8000 ton spec for PFP	Correct 1 flyer in a sublot, maybe average the other 9
Do not use QCP / PFP where it is not appropriate	Verify that everyone is doing things the same	Provide some best practices seminars for PFP / QCP
Adjusting sublot tonnage on lower tonnage QCP	Less reliance on density	Less coring
Loosen tolerances	Guarantee 100% Payment	
Use contractor Results	check data	
loosen statistical limits		
Use of supporting information	Dispute samples (QCP)	Proper assignment of QCP/PFP
24 hour turnaround	increase QCP tonnage <20,000, PFP >20,000	3rd party dispute sampling
Marry QCP/PFP, alter penalties to only affect tonnages pay factors on the specific paving days/tonnages for which penalties occurred	Rewrite edge density spec, 6" from edge +2% added to final density must be >90%	

Table 24. What Test(s) Do You Perform Quality Control Testing on Aggregate Stockpiles and How Do You Use That Information?

Responses
Gradation results to adjust blend, control mix.
Bulk gravity and Moistures
Follow the AGCS program, grad checks to ensure that we are within our targets of the mix design parameters
Bailey Method to understand how stockpile variability impacts VMA and Voids.
Incoming aggregates are tested as well as stockpile samples. Let's us know if we're getting good materials in from the quarries which is not always the case.
Occasionally specific gravity

Table 25. Please Explain If You Requite Aggregate Suppliers to Comply with Tighter Aggregate Specifications than the Department?

Responses
We ask suppliers to try and supply material within half of the tolerance then normal spec. Most of the time we do get materials with in those ranges
At our request in order to better control the quality of the mix during production
We try too. But most will only do what IDOT requires them to do.
If they only meet AGCS standards our PFP/QCP pay will suffer. We give them tighter master bands especially on dust.
In receiving aggregates from a supplier, we request that they are within tolerance of what gradation percent's we design with.
We look at the average and standard deviations that suppliers have shown us in the past and expect them to remain consistent. This is done with communication. Unfortunately, IDOT specifications are not tight enough to produce HMA consistent enough for PFP and QCP.
we require it, but they don't always.
We try to keep targets within 4% and have very good communications with most of our suppliers
We crush our own material, so we know what tighter standards we need to meet

Table 26. If Multiple Ignition Ovens Are Used in Your Lab, How Do You Decide Which Ignition Oven to Use?

Responses:
We calibrate each mix to both ovens.
For PFP / QCP, we often use two ovens and use the average results.
Calibrate per mix
Only one machine at each site.

Table 27. Do You Switch Mixes While Producing for PFP/QCP Projects?

Responses:
if absolutely have to. Lots of waste before we send it to the silo.
As little as possible
"No" is our preference, but with completion dates and multiple crews it is not always practical.
Too often. Depends on work load. Try to keep to a minimum.
We try to dedicate to a PFP / QCP job but when that is not possible, we do switch. It depends on the job, if we can make enough for the other job and hold it in 1 silo, we make that first and then go to the PFP / QCP. If not, we may have to switch back and forth multiple times.
1-2
try not to but it does happen
Depends on daily tonnage. Tonnage <1000, 1-2 times day, >1000 tons very seldom

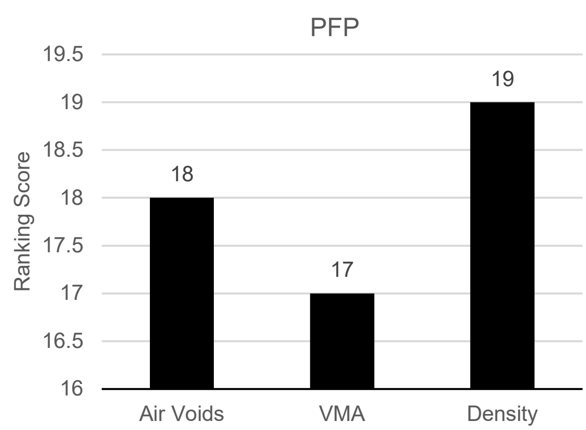
Table 28. Please Answer the Following Question Regarding Shutdowns

How often do you need to shut down during daily production?	What are the top three causes for the shutdowns?	How much material do you waste on each start-up? (tons)
2-4 times	Waiting on trucks	6-8
once or twice a day	plants running faster than paving, reduce over curing on mix	20-30
not often	Full silo, breakdown, weather	15
Only when the silo's are full or the when the required amount of mix is made.	Silo full; Plant problems; Weather	3
Depends on production schedule	Job production, end of day, weather	5
Varies	Too far ahead of paving crew; weather	10-15
2	End of day, trucking isssues, production issues (plant equipment)	5-10
minimal	crew moving/full silo/no trucks	20-30
2	Issues with the paving crew, making sure RAP chutes are not plugging up	25
1-2	mix changes	3
hopefully not ever, but occasionally	field breakdowns of equipment	20
2	Plant issues/road issues/material issues	10
Depends on TPH paving and traffic	1. Maintain a constant inventory 2. Haul time and jobsite issues/trucking 3. Weather	30
not much	break down	5

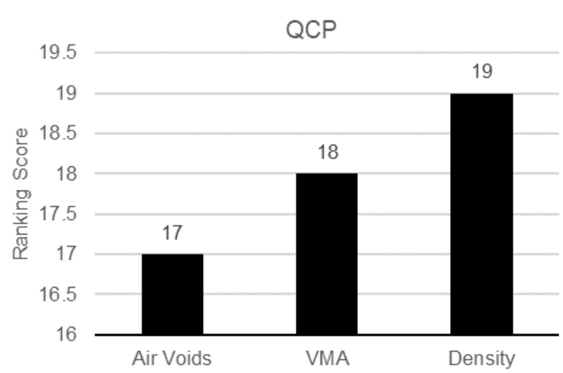
How often do you need to shut down during daily production?	What are the top three causes for the shutdowns?	How much material do you waste on each start-up? (tons)
occasionally	out of trucks, holding,	1
0 to 1	mix balance, breakdown, weather	3
1-3 at most	inaccuracy on tonnage orderd by crew, aggregate change, weather concerns	20
Aim to not shut down	field breakdown, bad estimate of material, plant too far ahead of field	15

District Survey

During spring 2018, a survey was sent to IDOT districts to gather opinions about QCP and PFP quality control programs. One response per district was received.



(a)



(b)

Figure 99. Chart. Parameter driving pay loss.

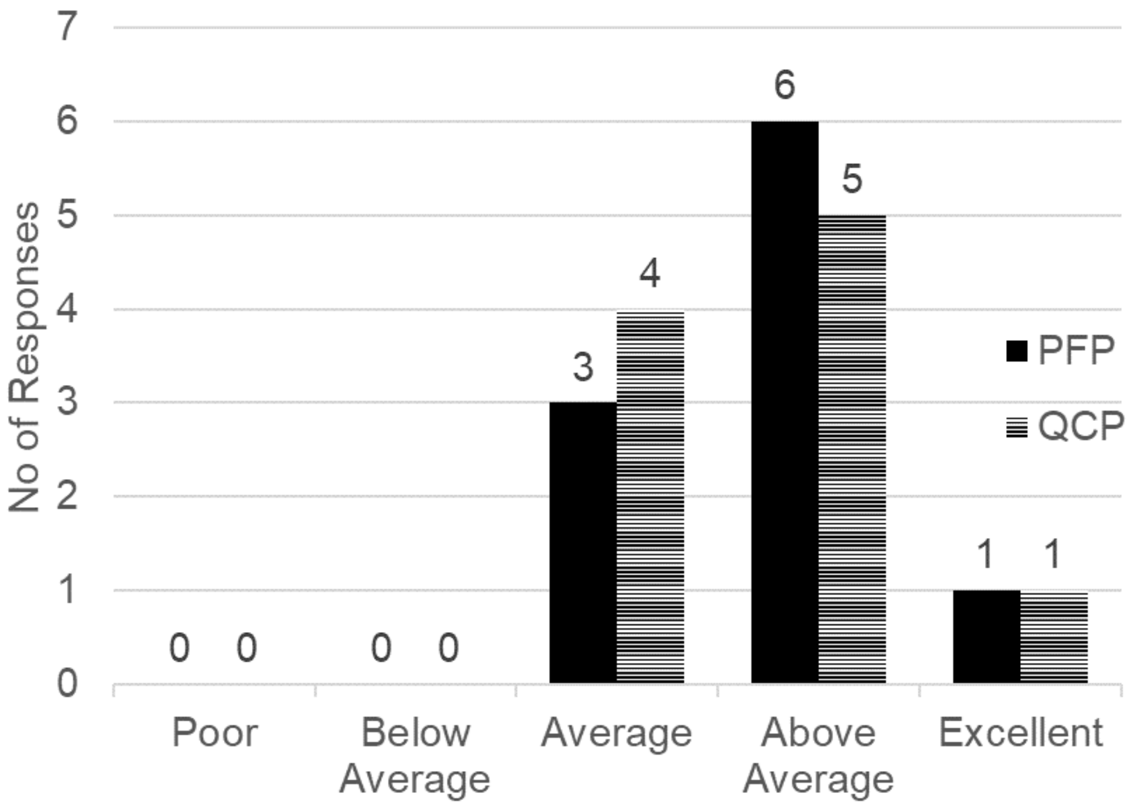


Figure 100. Chart. Rate the QC programs.

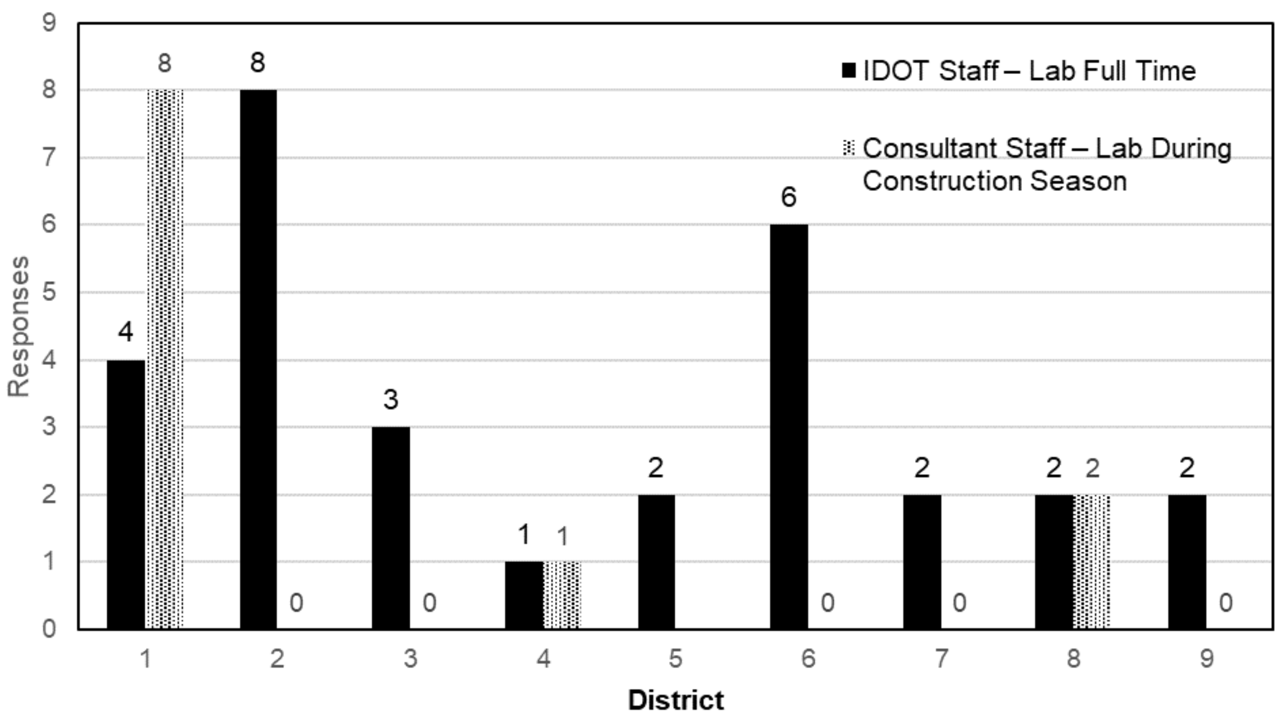


Figure 101. Chart. Total number of personnel assigned to QC testing.

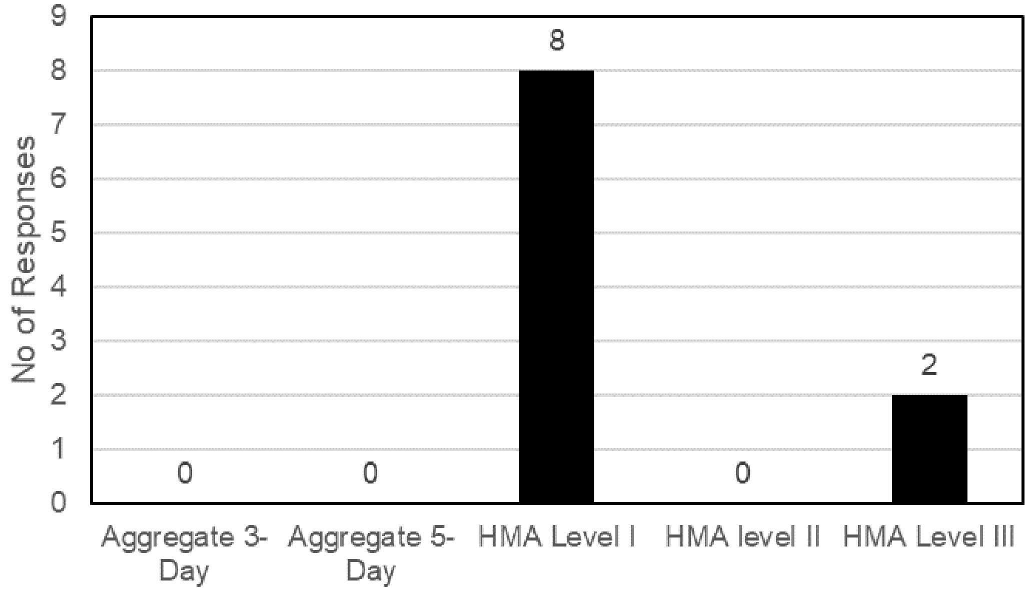


Figure 102. Chart. What is the minimum level of training required for a technician performing volumetric testing?

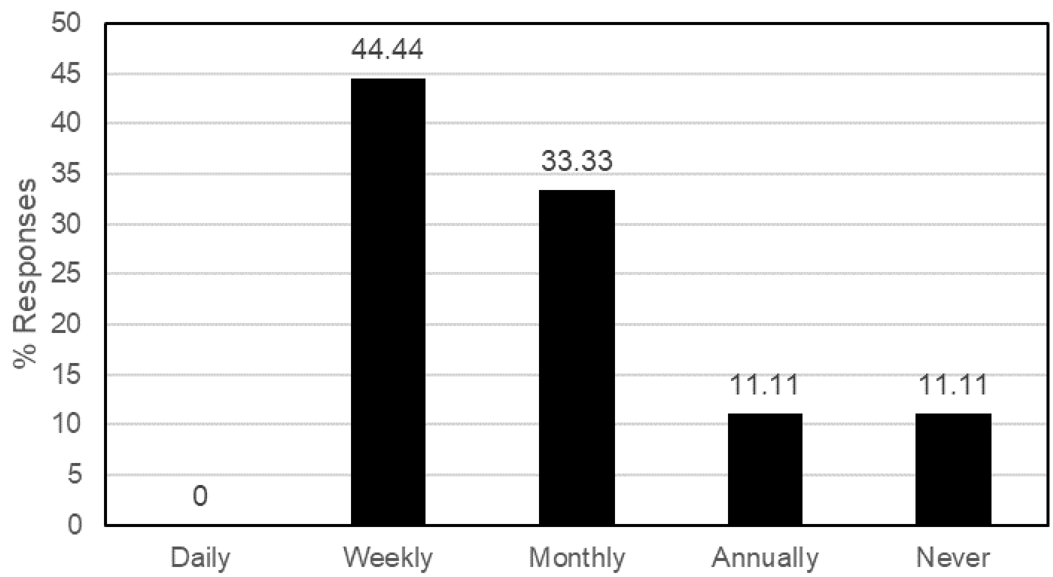


Figure 103. Chart. How often is the lift test performed on the ignition oven?

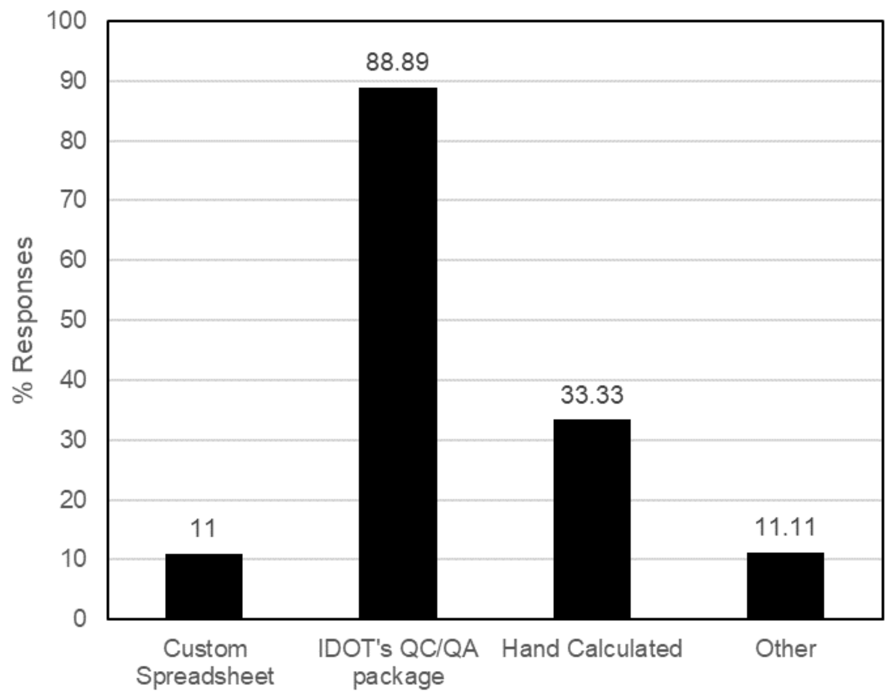


Figure 104. Chart. How are volumetric parameters (G_{mm}, G_{mb}, VMA, etc.) calculated?

Table 29. Provide the Following Information for Gyratory Compactors

District	Make & Model	Location	Measured Internal Angle	Frequency of internal angle correction (months)	Measured Pressure	Frequency of pressure correction (months)
1	Pine AFG2 (8005)	District central laboratory	1.17	> Every year	600	> Every year
	Pine AFG2 (8118)	District central laboratory	1.16	> Every year	600	> Every year
	Pine AFG2 (8687)	District central laboratory	1.16	> Every year	600	> Every year
2	Dixon = Troxler - 5850	District central laboratory	1.14	> Every year	605	> Every year
	Rockford = Troxler - 5850	Satellite laboratory	1.15	> Every year	600	> Every year
	Quad Cities = Troxler - 4140	Satellite laboratory	1.16	> Every year	600	> Every year
3	Troxler 4140	District central laboratory	1.15	> Every year	600	> Every year
	Troxler 4140	District central laboratory	1.15	> Every year	600	> Every year
4	Troxler 4140	District central laboratory	1.17	> Every year	600	> Every year
	Pine AFGC125XA	District central laboratory	1.15	> Every year	600	> Every year

District	Make & Model	Location	Measured Internal Angle	Frequency of internal angle correction (months)	Measured Pressure	Frequency of pressure correction (months)
5	Troxler 4140	District central laboratory	1.15	> Every year	600	> Every year
	Pine AFG2 (backup - do not use for testing)	District central laboratory	1.16	> Every year	600	> Every year
6	Troxler 4140	District central laboratory	1.18	> Every year	605	> Every year
	Troxler 5850	District central laboratory	1.17	> Every year	600	> Every year
	Troxler 5850	Satellite laboratory	1.16	> Every year	600	> Every year
7	Troxler 5850	District central laboratory	1.14	> Every year	595	> Every year
	Troxler 4140	District central laboratory	1.16	> Every year	600	> Every year
8	Pine AFG2AS	District central laboratory	1.16	> Every year	600	> Every year
	Pine AFG2A	District central laboratory	1.16	> Every year	600	> Every year
9	Pine G2	District central laboratory	1.16	> Every year	600	> Every year
	Pine G2	District central laboratory	1.16	> Every year	600	> Every year

Tables A.14 and A.15 are the districts' responses. There are ten responses because two responses were received from the same district. CBM responses are not included; questionnaires were addressed only to district personnel.

Table 30. If Multiple Gyratory Compactors Are Used, How Is the Decision Made on What Gyratory Compactor to Use for What Materials/Projects?

If multiple gyratory compactors are used, how is the decision made on what gyratory compactor to use for what materials/projects?
8005 is the only one used for PFP projects. 8118 is the only one used for QCP projects. 8687 is used for other samples.
Location of the project
Unit 1 is used for all contracts unless we foresee a larger number of upcoming contracts, in which case unit 2 would also be utilized. At no time are the two gyratory compactors used interchangeably between contracts.
Pine solely used due to better consistency. Troxler only if Pine will be down for long period of time, haven't used it in over 5 years for any work.
D5 uses the Troxler 4140 for all HMA testing. The Pine AFG2 is used as a backup machine.
Troxler 5850 is the Primary, the 4140 is the backup
4140 is just a backup
Material Code/Job Specific
We use the same compactor to run all tests. the second machine is a backup

Table 31. Is a Review Process Used for Checking Test Results before Determining Pay?

Answer	Explanation
Yes	Technician performs the test and calculation. The Senior lab tech for HMA checks all numbers and calculations. The District Lab Supervisor will review a portion of the test samples (paying particular attention to out of tolerance results). These results are sent to the Field Inspector and Mixtures Area Supervisor for the Asphalt plant. They review all results before submitting to the Contractor and a Phase III consultant. The Phase III consultant performs all pay calculations to ensure uniformity throughout the District.
Yes	The lab technician will review their notes for a "double check." No other review of the material test results is done. The Mixtures Control Engineer then reviews final test results put into the QC/QA Package that are outside the acceptable limits of the PFP/QCP provision used. Those results are submitted to CBC for review and recommended additional credits. If allowed to remain in-place, those sublots are placed into a separate sheet and the additional credit from CBC is calculated. The sublot is then at "final pay" status.
No	
Yes	The bituminous mixtures unit collaborates with the area laboratory personnel to confirm final pay factors prior to sending them to the contract resident engineer
Yes	Results are hand calculated in the lab. Reviewed by different personnel while being entered into the QCQA Package. Double checked by another staff member after placing in PWL.
Yes	Both the Mixtures Control Engineer and Construction R.E. compile data and enter into the QC/QA package. A pay factor is calculated by both and compared.
Yes	Lab Supervisor reviews results before submitting to HMA Supervisor, who checks all data before giving to Mixtures Control Engineer. Mixtures Control Engineer reviews all test results before sending out memo for pay / disincentive.
Yes	tech's check each other's math
No	
Yes	The lab supervisor checks all of the work before entering in QC/QA program. The Mixtures Control Engineer reviews the results and compares with contractor results. If there is a discrepancy, we will check our equipment and possibly retest the result in question depending on what we find.

Table 32. Information for Your HMA Ovens

Oven	Does your lab use temperature alarms for ovens?	Response
Despatch LAC2-18 18cf	Yes	Annually
5 Despatch / LAC2-18-6 / 18 cu.ft.	Yes	Annually
Despatch LAC-18	Yes	Annually
Grieve; Model SA-550; 70.9 cuft	Yes (NIST Digital Thermometers equipped with set-point alarms)	Annually
Despatch LAD2-24-3 Grieve model 333	No	Annually
Grieve Model SA-550 ~30 Cu. Ft. - Central District Lab Shellab Model HF 25-2 ~27 Cu. Ft. - Satellite Lab	Yes	Annually
Gilson 270A 27 cu ft	Yes	Annually
Blue M Electric DC-206F (for compaction) Despatch LBB2-27-2 (for samples before splitting)	Yes	As needed
Blue M - model 326 Batch Oven 51"x50"x24" Dispatch - model LBB1-69A-1 30"x22"x18" Horizontal - model 1685 32'x67"x26" Blue M - model DC series oven 25'x22"x20"	Yes	Annually

APPENDIX D: RAW DATA

District 1 Site Visit 1

Table 33. District 1 Site Visit 1 Volumetric Results

District	1	Site Visit			1	Material Code			19525R		HMA SC N70 E REC 9.5 mm						
		Sublot 1			Sublot 2			Sublot 3			Sublot 4			Sublot 5			
	Design	AMF	QC	QA	AMF	QC	QA	AMF	QC	QA	AMF	QC	QA	AMF	QC	QA	
1" (25.0 mm)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	1" (25.0 mm)
3/4" (19.0 mm)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	3/4" (19.0 mm)
1/2" (12.5 mm)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	1/2" (12.5 mm)
3/8" (9.5 mm)	98.0	98.0	98.0	99.0	98.0	99.0	99.0	98.0	99.0	99.0	98.0	99.0	99.0	98.0	99.0	99.0	3/8" (9.5 mm)
No. 4 (4.75 mm)	60.0	60.0	62.0	63.0	60.0	61.0	59.0	60.0	61.0	59.0	60.0	61.0	63.0	60.0	61.0	60.0	No. 4 (4.75 mm)
No. 8 (2.36 mm)	34.0	34.0	34.0	36.0	34.0	32.0	32.0	34.0	34.0	33.0	34.0	33.0	34.0	34.0	34.0	33.0	No. 8 (2.36 mm)
No. 16 (1.18 mm)	21.0	21.0	23.0	23.0	21.0	21.0	21.0	21.0	21.0	22.0	21.0	21.0	21.0	21.0	21.0	22.0	No. 16 (1.18 mm)
No. 30 (600 µm)	16.0	16.0	17.0	17.0	16.0	15.0	15.0	16.0	16.0	16.0	16.0	15.0	15.0	16.0	16.0	16.0	No. 30 (600 µm)
No. 50 (300 µm)	10.0	10.0	11.0	11.0	10.0	9.0	9.0	10.0	10.0	10.0	10.0	9.0	9.0	10.0	10.0	10.0	No. 50 (300 µm)
No. 100 (150 µm)	7.0	7.0	7.0	8.0	7.0	6.0	7.0	7.0	7.0	7.0	7.0	6.0	7.0	7.0	7.0	7.0	No. 100 (150 µm)
No. 200 (75 µm)	5.5	5.5	5.8	5.9	5.5	5.0	4.9	5.5	5.5	5.6	5.5	5.0	5.4	5.5	5.3	5.4	No. 200 (75 µm)
AC Content	5.9	5.9	6.1	6.2	5.9	5.9	5.8	5.9	5.9	5.8	5.9	5.8	5.7	5.9	5.9	5.8	AC Content
Gmb	2.39		2.393	2.41		2.37	2.353		2.38	2.37		2.37	2.36		2.37	2.36	Gmb
Gmm	2.48		2.480	2.48		2.48	2.48		2.48	2.48		2.49	2.49		2.48	2.48	Gmm
Gsb	2.64	2.643			2.643			2.643			2.643			2.643			Gsb
Gse	2.72		2.730	2.728		2.723	2.720		2.719	2.717		2.723	2.721		2.721	2.715	Gse
VMA	15.1		15.0	14.6		15.6	16.1		15.3	15.4		15.5	15.9		15.5	16.1	VMA
AV	4.0		3.5	2.7		4.5	5.3		4.0	4.4		4.6	5.3		4.4	5.0	AV

		District	1	Site Visit			1	Material Code			19525R		HMA SC N70 E REC 9.5 mm						
		Sublot 6			Sublot 7			Sublot 8			Sublot 9			Sublot 10			Sublot 11		
	Design	AMF	QC	QA	AMF	QC	QA	AMF	QC	QA	AMF	QC	QA	AMF	QC	QA	AMF	QC	QA
1" (25.0 mm)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
3/4" (19.0 mm)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1/2" (12.5 mm)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
3/8" (9.5 mm)	98.0	98.0	99.0	99.0	98.0	99.0	99.0	98.0	98.0	98.0	98.0	98.0	99.0	98.0	99.0	99.0	98.0	99.0	99.0
No. 4 (4.75 mm)	60.0	60.0	62.0	62.0	60.0	61.0	59.0	60.0	62.0	61.0	60.0	62.0	61.0	60.0	60.0	62.0	60.0	62.0	61.0
No. 8 (2.36 mm)	34.0	34.0	33.0	33.0	34.0	33.0	32.0	34.0	34.0	34.0	34.0	35.0	35.0	34.0	34.0	34.0	34.0	35.0	34.0
No. 16 (1.18 mm)	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	22.0	22.0	21.0	22.0	23.0	21.0	22.0	22.0	21.0	22.0	23.0
No. 30 (600 µm)	16.0	16.0	15.0	15.0	16.0	15.0	15.0	16.0	16.0	16.0	16.0	17.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0
No. 50 (300 µm)	10.0	10.0	9.0	9.0	10.0	10.0	9.0	10.0	10.0	10.0	10.0	11.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
No. 100 (150 µm)	7.0	7.0	6.0	7.0	7.0	6.0	6.0	7.0	7.0	6.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
No. 200 (75 µm)	5.5	5.5	5.0	4.9	5.5	5.0	5.0	5.5	5.3	5.1	5.5	5.7	5.4	5.5	5.4	5.3	5.5	5.5	5.6
AC Content	5.9	5.9	6.0	6.0	5.9	5.9	5.9	5.9	5.9	5.8	5.9	6.0	5.9	5.9	5.7	5.7	5.9	5.9	5.8
Gmb	2.385		2.36	2.345		2.367	2.352		2.381	2.37		2.396	2.39		2.38	2.369		2.377	2.365
Gmm	2.484		2.47	2.479		2.481	2.479		2.483	2.48		2.482	2.47		2.49	2.488		2.479	2.478
Gsb	2.643	2.643			2.643			2.643			2.643			2.643			2.643		
Gse	2.721		2.715	2.724		2.721	2.719		2.724	2.719		2.727	2.711		2.723	2.721		2.719	2.713
VMA	15.1		15.9	16.6		15.7	16.3		15.2	15.5		14.8	15.0		15.2	15.5		15.4	15.7
AV	4.0		4.4	5.4		4.6	5.1		4.1	4.6		3.5	3.5		4.5	4.8		4.1	4.6

Table 34. District 1 Site Visit 1 Density Results

Density Core																			
District			1		Material Code			19525R		Site Visit			1		HMA SC N70 E REC 9.5 mm				
	QC		QA			QC		QA			QC		QA			QC		QA	
Core/Sublot	Gmb	% Density	Gmb	% Density	Core/Sublot	Gmb	% Density	Gmb	% Density	Core/Sublot	Gmb	% Density	Gmb	% Density	Core/Sublot	Gmb	% Density	Gmb	% Density
11	2.393	96.4	2.394	96.5	41	2.317	93.4	2.327	93.8	2	2.311	93.1	2.314	93.2	60	2.365	95.4	2.361	95.2
12	2.374	95.7	2.400	96.7	42	2.329	93.8	2.328	93.8	3	2.219	89.4	2.231	89.9	31	2.392	96.4	2.395	96.5
13	2.371	95.5	2.375	95.7	45	2.343	94.4	2.340	94.3	4	2.357	95.0	2.365	95.3	32	2.405	96.9	2.408	97.1
16	2.373	95.6	2.381	95.9	50	2.353	94.8	2.360	95.1	5	2.345	94.5	2.353	94.8	33	2.335	94.1	2.356	95
17	2.367	95.4	2.374	95.7	51	2.326	93.7	2.329	93.8	6	2.412	97.2	2.416	97.3	34	2.330	93.9	2.347	94.6
18	2.389	96.2	2.387	96.2	65	2.367	95.4	2.371	95.5	7	2.343	94.4	2.361	95.1	35	2.359	95.1	2.362	95.2
19	2.391	96.3	2.386	96.1	66	2.297	92.6	2.296	92.5	8	2.356	94.9	2.362	95.2	36	2.415	97.3	2.418	97.5
20	2.330	93.9	2.332	93.9	22	2.375	95.6	2.371	95.5	9	2.359	95.0	2.360	95.1	37	2.314	93.3	2.327	93.8
21	2.399	96.7	2.399	96.6	23	2.351	94.7	2.348	94.6	10	2.363	95.2	2.360	95.1	38	2.391	96.4	2.394	96.5
14	2.403	96.8	2.406	96.9	24	2.368	95.4	2.365	95.2	52	2.363	95.3	2.372	95.6	39	2.380	95.9	2.385	96.1
15	2.370	95.5	2.367	95.4	25	2.401	96.7	2.414	97.2	53	2.295	92.5	2.293	92.5	40	2.309	93.1	2.321	93.6
43	2.360	95.1	2.373	95.6	26	2.362	95.1	2.369	95.4	54	2.359	95.1	2.362	95.2	61	2.377	95.8	2.401	96.8
44	2.296	92.5	2.299	92.6	27	2.377	95.7	2.380	95.8	55	2.318	93.5	2.324	93.7	64	2.289	92.3	2.322	93.6
46	2.314	93.2	2.327	93.8	28	2.384	96.0	2.383	96	56	2.382	96.0	2.394	96.5	62	2.395	96.5	2.388	96.2
47	2.317	93.4	2.326	93.7	29	2.316	93.3	2.331	93.9	57	2.395	96.6	2.393	96.5	63	2.374	95.7	2.381	95.9
48	2.364	95.2	2.368	95.4	30	2.353	94.8	2.371	95.5	58	2.379	95.9	2.383	96.1	67	2.344	94.5	2.345	94.5
49	2.342	94.3	2.365	95.3	1	2.355	94.9	2.343	94.4	59	2.321	93.6	2.310	93.1					

District 1 Site Visit 2

Table 35. District 1 Site Visit 2 Volumetric Results

District	1	Site Visit			2	Material Code			19524R		HMA SC N70 D REC 9.5 mm					
		Sublot 1			Sublot 2			Sublot 3			Sublot 4			Sublot 5		
	Design	AMF	QC	QA	AMF	QC	QA	AMF	QC	QA	AMF	QC	QA	AMF	QC	QA
1" (25.0 mm)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
3/4" (19.0 mm)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1/2" (12.5 mm)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
3/8" (9.5 mm)	97.0	97.0	97.0	96.0	97.0	96.0	96.0	97.0	97.0	96.0	97.0	97.0	97.0	97.0	96.0	98.0
No. 4 (4.75 mm)	59.0	59.0	57.0	54.0	59.0	57.0	55.0	59.0	56.0	54.0	59.0	55.0	55.0	59.0	59.0	57.0
No. 8 (2.36 mm)	34.0	34.0	31.0	29.0	34.0	32.0	31.0	34.0	29.0	29.0	34.0	30.0	29.0	34.0	31.0	31.0
No. 16 (1.18 mm)	25.0	25.0	23.0	22.0	25.0	23.0	23.0	25.0	21.0	21.0	25.0	21.0	20.0	25.0	22.0	22.0
No. 30 (600 µm)	17.0	17.0	18.0	17.0	17.0	19.0	18.0	17.0	16.0	16.0	17.0	17.0	16.0	17.0	17.0	17.0
No. 50 (300 µm)	14.0	14.0	14.0	13.0	14.0	15.0	13.0	14.0	12.0	13.0	14.0	13.0	12.0	14.0	14.0	13.0
No. 100 (150 µm)	8.0	8.0	10.0	10.0	8.0	11.0	11.0	8.0	9.0	9.0	8.0	9.0	9.0	8.0	10.0	10.0
No. 200 (75 µm)	5.5	5.5	4.9	6.0	5.5	5.2	6.5	5.5	5.7	6.0	5.5	4.5	5.8	5.5	4.7	6.1
AC Content	5.8	5.8	5.8	5.8	5.8	6.1	6.1	5.8	6.2	6.0	5.8	6.1	5.9	5.8	6.1	6.1
Gmb	2.41		2.401	2.417		2.439	2.454		2.427	2.438		2.408	2.425		2.41	2.444
Gmm	2.51		2.517	2.51		2.51	2.509		2.516	2.507		2.524	2.516		2.518	2.519
Gsb	2.674	2.674			2.674			2.674			2.674			2.674		
Gse	2.751		2.763	2.754		2.768	2.767		2.781	2.760		2.787	2.766		2.779	2.780
VMA	15.1		15.4	14.9		14.4	13.8		14.9	14.3		15.4	14.7		15.4	14.2
AV	4.0		4.6	3.7		2.8	2.2		3.5	2.8		4.6	3.6		4.3	3.0
District	1	Site Visit			2	Material Code			19524R		HMA SC N70 D REC 9.5 mm					
		Sublot 6			Sublot 7			Sublot 8			Sublot 9			Sublot 10		
	Design	AMF	QC	QA	AMF	QC	QA	AMF	QC	QA	AMF	QC	QA	AMF	QC	QA
1" (25.0 mm)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
3/4" (19.0 mm)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1/2" (12.5 mm)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
3/8" (9.5 mm)	97.0	97.0	97.0	97.0	97.0	97.0	97.0	97.0	98.0	95.0	97.0	97.0	98.0	97.0	97.0	98.0
No. 4 (4.75 mm)	59.0	59.0	59.0	58.0	59.0	57.0	60.0	59.0	55.0	55.0	59.0	53.0	58.0	59.0	59.0	58.0
No. 8 (2.36 mm)	34.0	34.0	32.0	31.0	34.0	31.0	31.0	34.0	31.0	30.0	34.0	29.0	31.0	34.0	31.0	31.0
No. 16 (1.18 mm)	25.0	25.0	23.0	22.0	25.0	23.0	23.0	25.0	23.0	21.0	25.0	21.0	21.0	25.0	23.0	22.0
No. 30 (600 µm)	17.0	17.0	18.0	17.0	17.0	18.0	18.0	17.0	18.0	17.0	17.0	17.0	16.0	17.0	18.0	17.0
No. 50 (300 µm)	14.0	14.0	14.0	13.0	14.0	14.0	14.0	14.0	14.0	13.0	14.0	13.0	12.0	14.0	13.0	13.0
No. 100 (150 µm)	8.0	8.0	9.0	10.0	8.0	10.0	10.0	8.0	9.0	9.0	8.0	9.0	10.0	8.0	9.0	10.0
No. 200 (75 µm)	5.5	5.5	4.6	5.6	5.5	4.8	6.1	5.5	4.2	5.9	5.5	4.0	6.0	5.5	4.2	6.1
AC Content	5.8	5.8	6.1	6.1	5.8	6.1	5.9	5.8	6.1	5.9	5.8	6.0	6.0	5.8	6.1	6.0
Gmb	2.41		2.406	2.434		2.432	2.44		2.415	2.422		2.412	2.425		2.412	2.422
Gmm	2.51		2.515	2.503		2.531	2.522		2.519	2.525		2.523	2.525		2.521	2.524
Gsb	2.674	2.674			2.674			2.674			2.674			2.674		
Gse	2.751		2.775	2.759		2.796	2.774		2.780	2.778		2.780	2.783		2.783	2.782
VMA	15.1		15.5	14.5		14.6	14.1		15.2	14.8		15.2	14.8		15.3	14.9
AV	4.0		4.3	2.8		3.9	3.3		4.1	4.1		4.4	4.0		4.3	4.0

Table 36. District 1 Site Visit 2 Density Results

Density Core									
District		1		Material Code			19525R		
Site Visit		1		HMA SC N70 E REC 9.5 mm					
	QC		QA			QC		QA	
SEQ number	Gmb	% Density	Gmb	% Density	Core/Sublot	Gmb	% Density	Gmb	% Density
1	2.320	92.4	2.362	94.1	32	2.333	92.9	2.348	93.5
2	2.350	93.6	2.382	94.9	33	2.333	92.9	2.347	93.5
3	2.340	93.2	2.321	92.4	34	2.441	97.2	2.446	97.4
4	2.353	93.7	2.344	93.3	35	2.387	95.1	2.444	97.3
5	2.373	94.5	2.372	94.5	36	2.351	93.6	2.332	92.9
6	2.348	93.5	2.354	93.7	37	2.426	96.4	2.400	95.4
7	2.388	95.1	2.402	95.7	38	2.427	96.5	2.428	96.6
8	2.402	95.7	2.402	95.7	39	2.378	94.6	2.374	94.4
9	2.346	93.4	2.362	94.1	40	2.406	95.7	2.415	96.0
10	2.339	93.2	2.335	93.0	41	2.384	94.8	2.392	95.1
11	2.346	93.4	2.383	94.9	42	2.280	90.6	2.286	90.9
12	2.324	92.5	2.324	92.5	43	2.396	95.3	2.399	95.4
13	2.338	93.1	2.411	96.0	44	2.459	97.8	2.416	96.1
14	2.385	95.0	2.405	95.8	45	2.406	95.5	2.414	95.8
15	2.327	92.7	2.350	93.6	46	2.442	96.9	2.448	97.2
16	2.373	94.5	2.383	94.9	47	2.341	92.9	2.435	96.7
17	2.415	96.2	2.423	96.5	48	2.327	92.4	2.436	96.7
18	2.356	93.8	2.393	95.3	49	2.391	94.9	2.394	95.0
19	2.306	91.8	2.320	92.4	50	2.414	95.8	2.423	96.2
20	2.336	93.0	2.351	93.6	51	2.328	92.4	2.327	92.4
21	2.406	95.8	2.421	96.4	52	2.381	94.5	2.385	94.7
22	2.354	93.8	2.368	94.3	53	2.401	95.3	2.409	95.6
23	2.392	95.2	2.394	95.3	54	2.389	94.8	2.407	95.6
24	2.393	95.3	2.398	95.5	55	2.394	95.0	2.405	95.5
25	2.389	95.2	2.394	95.3	56	2.340	92.9	2.412	95.8
26	2.406	95.8	2.399	95.5	57	2.293	91.0	2.400	95.3
27	2.336	93.0	2.349	93.6	58	2.443	97.0	2.465	97.7
28	2.345	93.4	2.350	93.6	59	2.367	94.0	2.376	94.2
29	2.360	94.0	2.316	92.2	60	2.396	95.1	2.382	94.4
30	2.352	93.7	2.350	93.6	61	2.352	93.4	2.359	93.5
31	2.330	92.8	2.340	93.2					

District 1 Site Visit 3

Table 37. District 1 Site Visit 3 Volumetric Results

Mix Information

District	1	Site Visit			3	Material Code			19665R		SMA Surface 9.5 REC					
		Sublot 1			Sublot 2			Sublot 3			Sublot 4			Sublot 5		
	Design	AMF	QC	QA	AMF	QC	QA	AMF	QC	QA	AMF	QC	QA	AMF	QC	QA
1" (25.0 mm)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
3/4" (19.0 mm)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1/2" (12.5 mm)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
3/8" (9.5 mm)	100.0	100.0	99.0	100.0	100.0	99.0	100.0	100.0	100.0	100.0	100.0	99.0	100.0	100.0	99.0	100.0
No. 4 (4.75 mm)	49.0	49.0	52.0	54.0	49.0	51.0	52.0	49.0	52.0	53.0	49.0	52.0	54.0	49.0	52.0	55.0
No. 8 (2.36 mm)	25.0	25.0	26.0	27.0	25.0	25.0	26.0	25.0	26.0	27.0	25.0	27.0	27.0	25.0	27.0	28.0
No. 16 (1.18 mm)	18.0	15.0	18.0	20.0	15.0	17.0	18.0	15.0	18.0	19.0	15.0	19.0	19.0	15.0	19.0	19.0
No. 30 (600 μm)	14.0	14.0	14.0	15.0	14.0	13.0	14.0	14.0	14.0	14.0	14.0	14.0	15.0	14.0	14.0	15.0
No. 50 (300 μm)	12.0	12.0	12.0	13.0	12.0	11.0	11.0	12.0	11.0	11.0	12.0	12.0	12.0	12.0	12.0	12.0
No. 100 (150 μm)	9.0	9.0	10.0	11.0	9.0	9.0	10.0	9.0	9.0	9.0	9.0	10.0	10.0	9.0	10.0	10.0
No. 200 (75 μm)	7.6	7.6	8.1	8.4	7.6	6.6	7.1	7.6	7.2	7.1	7.6	7.5	7.7	7.6	7.6	7.5
AC Content	6.5	6.5	6.2	6.5	6.5	6.3	6.6	6.5	6.4	6.5	6.5	6.5	6.7	6.5	6.5	6.7
Gmb	2.367		2.390	2.396		2.38	2.375		2.38	2.37		2.38	2.4		2.38	2.39
Gmm	2.453		2.468	2.454		2.46	2.46		2.45	2.45		2.45	2.44		2.45	2.44
Gsb	2.648	2.648			2.648			2.648			2.648			2.648		
Gse	2.714		2.719	2.810		2.709	2.721		2.710	2.712		2.715	2.707		2.715	2.710
VMA	16.4		15.3	15.4		15.8	16.2		16.0	16.4		15.8	15.5		15.8	15.9
AV	3.5		3.2	2.4		3.2	3.3		3.2	3.4		2.9	1.8		2.9	2.3

District	1		Site Visit			3	Material Code			19665R	SMA Surface 9.5 REC		
		Sublot 6			Sublot 7			Sublot 8			Sublot 9		
	Design	AMF	QC	QA	AMF	QC	QA	AMF	QC	QA	AMF	QC	QA
1" (25.0 mm)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
3/4" (19.0 mm)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1/2" (12.5 mm)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
3/8" (9.5 mm)	100.0	100.0	100.0	100.0	100.0	99.0	100.0	100.0	100.0	99.0	100.0	100.0	100.0
No. 4 (4.75 mm)	49.0	49.0	51.0	51.0	49.0	53.0	53.0	49.0	51.0	52.0	49.0	49.0	50.0
No. 8 (2.36 mm)	25.0	25.0	26.0	26.0	25.0	25.0	26.0	25.0	26.0	26.0	25.0	26.0	25.0
No. 16 (1.18 mm)	18.0	15.0	19.0	19.0	15.0	18.0	18.0	15.0	19.0	19.0	15.0	19.0	18.0

District	1		Site Visit		3		Material Code		19665R	SMA Surface 9.5 REC		
		Sublot 6			Sublot 7			Sublot 8			Sublot 9	
	Design	AMF	QC	QA	AMF	QC	QA	AMF	QC	QA	AMF	QC	QA
No. 30 (600 µm)	14.0	14.0	14.0	14.0	14.0	13.0	14.0	14.0	14.0	14.0	14.0	15.0	14.0
No. 50 (300 µm)	12.0	12.0	12.0	12.0	12.0	11.0	11.0	12.0	12.0	12.0	12.0	12.0	11.0
No. 100 (150 µm)	9.0	9.0	10.0	10.0	9.0	9.0	9.0	9.0	10.0	10.0	9.0	10.0	10.0
No. 200 (75 µm)	7.6	7.6	7.5	7.3	7.6	6.7	7.0	7.6	7.6	7.5	7.6	7.9	7.0
AC Content	6.5	6.5	6.5	6.5	6.5	6.5	6.6	6.5	6.5	6.6	6.5	6.5	6.4
Gmb	2.367		2.372	2.367		2.355	2.367		2.369	2.376		2.37	2.381
Gmm	2.453		2.458	2.447		2.459	2.446		2.455	2.441		2.452	2.445
Gsb	2.648	2.648			2.648			2.648			2.648		
Gse	2.714		2.720	2.706		2.721	2.709		2.716	2.703		2.712	2.698
VMA	16.4		16.2	16.4		16.8	16.5		16.4	16.2		16.3	15.8
AV	3.5		3.5	3.3		4.2	3.2		3.5	2.7		3.3	2.6

District	1		Site Visit		3		Material Code		19665R	SMA Surface 9.5 REC		
		Sublot 10			Sublot 11			Sublot 12			Sublot 13	
	Design	AMF	QC	QA	AMF	QC	QA	AMF	QC	QA	AMF	QC	QA
1" (25.0 mm)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
3/4" (19.0 mm)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1/2" (12.5 mm)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
3/8" (9.5 mm)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
No. 4 (4.75 mm)	49.0	49.0	49.0	49.0	49.0	47.0	50.0	49.0	42.0	42.0	49.0	47.0	46.0
No. 8 (2.36 mm)	25.0	25.0	24.0	26.0	25.0	24.0	25.0	25.0	23.0	22.0	25.0	24.0	24.0
No. 16 (1.18 mm)	18.0	15.0	17.0	19.0	15.0	18.0	19.0	15.0	16.0	16.0	15.0	18.0	18.0
No. 30 (600 µm)	14.0	14.0	13.0	15.0	14.0	14.0	15.0	14.0	13.0	13.0	14.0	14.0	15.0
No. 50 (300 µm)	12.0	12.0	10.0	12.0	12.0	11.0	12.0	12.0	10.0	11.0	12.0	11.0	12.0
No. 100 (150 µm)	9.0	9.0	8.0	10.0	9.0	9.0	11.0	9.0	8.0	9.0	9.0	9.0	10.0
No. 200 (75 µm)	7.6	7.6	6.5	7.5	7.6	7.3	7.8	7.6	6.6	7.2	7.6	7.3	7.6
AC Content	6.5	6.5	6.4	6.5	6.5	6.4	6.6	6.5	6.2	6.2	6.5	6.3	6.3
Gmb	2.367		2.364	2.375		2.382	2.39		2.305	2.31		2.347	2.352
Gmm	2.453		2.465	2.462		2.456	2.451		2.465	2.455		2.46	2.457
Gsb	2.648	2.648			2.648			2.648			2.648		
Gse	2.714		2.725	2.725		2.713	2.716		2.715	2.702		2.713	2.709
VMA	16.4		16.4	16.1		15.8	15.7		18.4	18.2		17.0	16.8
AV	3.5		4.1	3.5		3.0	2.5		6.5	5.9		4.6	4.3

Table 38. District 1 Site Visit 3 Density Results

Density Core									
District			1		Material Code			19665R	
Site Visit			3		SMA Surface 9.5 REC				
	QC		QA			QC		QA	
SEQ number	Gmb	% Density	Gmb	% Density	SEQ number	Gmb	% Density	Gmb	% Density
1	2.365	95.0	2.338	93.9	79	2.357	94.6	2.359	94.7
2	2.277	91.4	2.282	91.7	80	2.345	94.1	2.340	93.9
3	2.339	93.9	2.341	94.0	81	2.283	91.7	2.291	92.0
4	2.340	94.0	2.349	94.3	82	2.355	94.5	2.358	94.7
5	2.329	93.5	2.347	94.3	83	2.320	93.1	2.325	93.3
6	2.339	93.9	2.335	93.8	84	2.367	95.0	2.366	95.0
7	2.332	93.5	2.348	94.2	85	2.321	93.2	2.324	93.3
8	2.316	92.9	2.317	92.9	86	2.381	95.6	2.385	95.8
9	2.295	92.0	2.303	92.4	87	2.329	93.5	2.340	93.9
10	2.353	94.4	2.357	94.6	88	2.348	94.2	2.357	94.6
11	2.321	93.1	2.355	94.5	89	2.297	92.2	2.304	92.5
12	2.318	93.0	2.315	92.9	90	2.276	91.4	2.289	91.9
13	2.318	93.0	2.316	92.9	91	2.307	92.6	2.315	92.9
14	2.273	91.2	2.316	92.9	92	2.316	93.0	2.329	93.5
15	2.340	94.0	2.344	94.0	93	2.302	92.4	2.300	92.4
16	2.326	93.4	2.312	92.7	94	2.299	92.3	2.310	92.7
17	2.320	93.2	2.328	93.4	95	2.294	92.1	2.297	92.2
18	2.259	90.7	2.263	90.9	96	2.344	94.1	2.365	95.0
19	2.335	93.7	2.352	94.4	97	2.301	92.4	2.315	92.9
20	2.320	93.1	2.332	93.5	98	2.329	93.4	2.312	92.7
21	2.339	93.8	2.342	94.0	99	2.345	94.0	2.345	94.0
22	2.295	92.0	2.317	92.9	100	2.353	94.3	2.346	94.1
23	2.308	92.6	2.339	93.8	101	2.375	95.2	2.368	95.0
24	2.319	93.0	2.336	93.7	102	2.330	93.4	2.349	94.2
25	2.356	94.5	2.354	94.4	103	2.324	93.2	2.326	93.3
26	2.333	93.6	2.340	93.8	104	2.341	93.9	2.344	94.0
27	2.302	92.3	2.309	92.6	105	2.360	94.6	2.347	94.1
28	2.256	90.4	2.276	91.2	106	2.310	92.6	2.317	92.9
29	2.258	90.6	2.264	90.8	107	2.301	92.3	2.292	91.9
30	2.310	92.6	2.328	93.3	108	2.342	93.9	2.324	93.2
31	2.346	94.1	2.340	93.8	109	2.300	92.3	2.312	92.8
32	2.365	94.8	2.368	94.9	110	2.336	93.7	2.329	93.4
33	2.328	93.4	2.364	94.8	111	2.300	92.3	2.314	92.9
34	2.314	92.8	2.329	93.4	112	2.277	91.4	2.280	91.5
35	2.354	94.4	2.368	94.9	113	2.296	92.1	2.296	92.1
36	2.335	93.6	2.346	94.1	114	2.299	92.3	2.314	92.9
37	2.365	94.8	2.372	95.1	115	2.261	90.7	2.271	91.1
38	2.347	94.1	2.346	94.1	116	2.296	92.1	2.303	92.4
39	2.337	93.7	2.349	94.2	117	2.343	94.0	2.349	94.3

Density Core									
District			1		Material Code			19665R	
Site Visit			3		SMA Surface 9.5 REC				
	QC		QA			QC		QA	
SEQ number	Gmb	% Density	Gmb	% Density	SEQ number	Gmb	% Density	Gmb	% Density
40	2.292	92.0	2.312	92.7	118	2.330	93.5	2.323	93.2
41	2.374	95.3	2.393	96.0	119	2.402	96.5	2.405	96.6
42	2.341	93.9	2.351	94.3	120	2.333	93.7	2.337	93.9
43	2.300	92.3	2.308	92.6	121	2.271	91.2	2.274	91.3
44	2.375	95.3	2.385	95.7	122	2.295	92.2	2.298	92.3
45	2.404	96.5	2.404	96.5	123	2.284	91.7	2.295	92.1
46	2.347	94.2	2.353	94.4	124	2.340	94.0	2.350	94.4
47	2.350	94.3	2.350	94.3	125	2.309	92.7	2.305	92.6
48	2.339	93.9	2.342	94.0	126	2.299	92.6	2.293	92.4
49	2.375	95.3	2.318	93.0	127	2.359	95.0	2.335	94.1
50	2.323	93.2	2.329	93.5	128	2.306	92.9	2.310	93.0
51	2.336	93.7	2.343	94.0	129	2.278	91.7	2.274	91.6
52	2.313	92.9	2.306	92.7	130	2.344	94.4	2.331	93.9
53	2.319	93.2	2.318	93.1	131	2.392	96.4	2.401	96.7
54	2.322	93.3	2.328	93.5	132	2.354	94.8	2.331	93.9
55	2.324	93.4	2.329	93.6	133	2.359	95.0	2.357	94.9
56	2.336	93.8	2.347	94.3	134	2.357	94.9	2.350	94.6
57	2.346	94.2	2.364	95.0	135	2.350	94.6	2.353	94.7
58	2.352	94.5	2.354	94.6	136	2.335	94.0	2.319	93.3
59	2.337	93.9	2.332	93.7	137	2.364	95.1	2.358	94.9
60	2.395	96.2	2.408	96.7	138	2.347	94.4	2.381	95.8
61	2.383	95.6			139	2.378	95.7	2.378	95.7
62	2.284	91.6			140	2.300	92.5	2.303	92.7
63	2.390	95.8			141	2.323	93.5	2.330	93.8
64	2.301	92.3			142	2.396	96.4	2.412	97.1
65	2.292	91.9			143	2.338	94.1	2.331	93.8
66	2.298	92.1	2.291	91.9	144	2.347	94.4	2.363	95.1
67	2.376	95.3	2.379	95.4	145	2.380	95.7	2.383	95.8
68	2.364	94.8	2.369	95.0	146	2.334	93.9	2.341	94.1
69	2.364	94.8	2.368	94.9	147	2.283	91.8	2.288	92.0
70	2.370	95.0	2.377	95.3	148	2.398	96.4	2.408	96.8
71	2.349	94.2	2.342	93.9	149	2.335	93.9	2.340	94.1
72	2.251	90.3	2.265	90.8	150	2.376	95.5	2.379	95.7
73	2.287	91.7	2.285	91.6	151	2.345	94.3	2.338	94.0
74	2.400	96.4	2.403	96.5	152	2.309	92.8	2.309	92.8
75	2.344	94.1	2.350	94.3	153	2.375	95.5	2.371	95.3
76	2.372	95.2	2.365	95.0	154	2.365	95.1	2.381	95.7
77	2.328	93.5	2.339	93.9	155	2.325	93.5	2.330	93.7
78	2.357	94.6	2.370	95.1	156	2.379	95.6	2.369	95.2

District 1 Site Visit 4

Table 39. District 1 Site Visit 4 Volumetric Results

Mix Information

District	1	Site Visit			4	Material Code				19525R		HMA SC N70 E REC 9.5 mm			
		Sublot 1			Sublot 2				Sublot 3			Sublot 4			
	Design	AMF	QC	QA	AMF	QC	QA	CBM	AMF	QC	QA	AMF	QC	QA	CBM
1" (25.0 mm)	100.0	100.0		100.0	100.0	100.0	100.0	100.0	100.0		100.0	100.0	100.0	100.0	100.0
3/4" (19.0 mm)	100.0	100.0		100.0	100.0	100.0	100.0	100.0	100.0		100.0	100.0	100.0	100.0	100.0
1/2" (12.5 mm)	100.0	100.0		99.0	100.0	100.0	100.0	100.0	100.0		100.0	100.0	100.0	99.0	99.0
3/8" (9.5 mm)	94.0	94.0		91.0	94.0	94.0	89.0	94.0	94.0		95.0	94.0	93.0	93.0	94.0
No. 4 (4.75 mm)	51.0	51.0		52.0	51.0	52.0	47.0	52.0	51.0		55.0	51.0	50.0	49.0	53.0
No. 8 (2.36 mm)	34.0	34.0		29.0	34.0	30.0	27.0	28.0	34.0		30.0	34.0	30.0	30.0	31.0
No. 16 (1.18 mm)	21.0	21.0		19.0	21.0	18.0	18.0	18.0	21.0		20.0	21.0	20.0	20.0	20.0
No. 30 (600 μm)	15.0	15.0		13.0	15.0	13.0	12.0	13.0	15.0		14.0	15.0	14.0	14.0	14.0
No. 50 (300 μm)	11.0	11.0		9.0	11.0	9.0	9.0	9.0	11.0		10.0	11.0	10.0	10.0	10.0
No. 100 (150 μm)	7.0	7.0		7.0	7.0	7.0	7.0	7.0	7.0		9.0	7.0	8.0	9.0	8.0
No. 200 (75 μm)	5.6	5.6		5.7	5.6	4.9	5.5	5.5	5.6		6.9	5.6	5.7	6.7	6.3
AC Content	6.0	6.0	5.8	5.3	6.0	6.0	5.5	5.7	6.0	6.3	5.9	6.0	6.0	5.5	5.7
Gmb	2.381		2.362	2.344		2.37	2.337	2.370		2.37	2.37		2.38	2.365	2.39
Gmm	2.48		2.499	2.503		2.49	2.5	2.49		2.48	2.49		2.49	2.503	2.5
Gsb	2.632	2.632			2.632				2.632			2.632			
Gse	2.725		2.740	2.740		2.739	2.725	2.728		2.744	2.726		2.736	2.730	2.735
VMA	15.0		15.5	15.7		15.5	16.1	15.1		15.6	15.4		15.0	15.1	14.3
AV	4.0		5.5	6.4		5.0	6.5	5.0		4.5	4.8		4.3	5.5	4.3

Table 40. District 1 Site Visit 4 Density Results

Density Core									
District		1		Material Code			19525R		
Site Visit		4		HMA SC N70 E REC 9.5 mm					
	QC		QA			QC		QA	
SEQ number	Gmb	% Density	Gmb	% Density	SEQ number	Gmb	% Density	Gmb	% Density
1	2.399	96.0	2.400	96.1					
2	2.305	92.3	2.321	92.9					
3	2.387	95.5	2.368	94.8					
4	2.341	93.7	2.336	93.5					
5	2.401	96.1	2.391	95.7					
6	2.262	90.6	2.211	88.5					
7	2.412	96.5	2.424	97.1					
8	2.316	92.7	2.303	92.2					
9	2.381	95.3	2.345	93.9					
10	2.355	94.3	2.345	93.9					
11	2.324	93.1	2.311	92.5					
12	2.286	91.5	2.261	90.5					
13	2.345	93.9	2.326	93.1					
14	2.331	93.3	2.328	93.2					
15	2.411	96.5	2.407	96.3					
16	2.382	95.3	2.356	94.3					
17	2.413	96.6	2.400	96.1					
18	2.355	94.3	2.352	94.1					
19	2.382	95.4	2.377	95.1					
20	2.245	89.9	2.168	86.8					
21	2.295	91.9	2.315	92.7					
22	2.287	91.6	2.315	92.7					
23	2.360	94.5	2.358	94.4					

District 1 Site Visit 5

Table 41. District 1 Site Visit 5 Volumetric Results

Mix Information

District	1	Site Visit			5	Material Code			19524R		HMA SC N70 D REC		
		Sublot 1			Sublot 2			Sublot 3			Sublot 4		
	Design	AMF	QC	QA	AMF	QC	QA	AMF	QC	QA	AMF	QC	QA
1" (25.0 mm)	100.0	100.0	100.0	100.0	100.0		100.0	100.0		100.0	100.0		100.0
3/4" (19.0 mm)	100.0	100.0	100.0	100.0	100.0		100.0	100.0		100.0	100.0		100.0
1/2" (12.5 mm)	100.0	100.0	100.0	100.0	100.0		100.0	100.0		100.0	100.0		100.0
3/8" (9.5 mm)	97.0	97.0	97.0	98.0	97.0		97.0	97.0		97.0	97.0		98.0
No. 4 (4.75 mm)	63.0	63.0	67.0	69.0	63.0		62.0	63.0		67.0	63.0		66.0
No. 8 (2.36 mm)	36.0	36.0	35.0	36.0	36.0		34.0	36.0		36.0	36.0		37.0
No. 16 (1.18 mm)	21.0	21.0	21.0	21.0	21.0		21.0	21.0		22.0	21.0		23.0
No. 30 (600 μm)	16.0	16.0	15.0	15.0	16.0		16.0	16.0		16.0	16.0		16.0
No. 50 (300 μm)	10.0	10.0	11.0	11.0	10.0		12.0	10.0		12.0	10.0		12.0
No. 100 (150 μm)	7.0	7.0	8.0	9.0	7.0		9.0	7.0		10.0	7.0		10.0
No. 200 (75 μm)	5.2	5.2	4.3	6.2	5.2		6.6	5.2		6.5	5.2		6.7
AC Content	6.0	6.2	6.1	6.1	6.2	6.1	5.9	6.2	5.9	6.1	6.2	6.0	6.0
Gmb	2.403		2.381	2.361		2.384	2.393		2.399	2.402		2.405	2.406
Gmm	2.503		2.496	2.497		2.494	2.499		2.495	2.496		2.502	2.505
Gsb	2.662	2.662			2.662			2.662			2.662		
Gse	2.754		2.750	2.757		2.748	2.744		2.739	2.750		2.753	2.757
VMA	15.1		16.0	16.7		15.9	15.4		15.2	15.3		15.1	15.0
AV	4.0		4.6	5.4		4.4	4.2		3.8	3.8		3.9	4.0

Table 42. District 1 Site Visit 5 Density Results

Density Core				
District			1	
Site Visit			5	
Material Code			19524R	
HMA SC N70 D REC				
	QC		QA	
SEQ number	Gmb	% Density	Gmb	% Density
1			2.334	93.4
2			2.374	95.0
3			2.338	93.6
4			2.361	94.5
5			2.364	94.6
6			2.339	93.6
7			2.367	94.7
8			2.384	95.4
9			2.333	93.4
10			2.345	93.9
11				
12			2.346	93.9
13			2.292	91.7
14			2.369	94.8
15			2.324	93.0
16			2.357	94.3
17			2.365	94.7
18			2.317	92.8
19			2.309	92.4
20			2.342	93.7
21			2.349	94.1
22			2.358	94.4
23			2.382	95.4
24			2.313	92.6
25			2.321	92.9
26			2.286	91.5
27			2.414	96.6
28			2.415	96.7

District 2 Site Visit

Table 43. District 2 Site Visit Volumetric Results

Mix Information

District	2	Site Visit			Material Code				19532R		HMA BC N90 19.0R		
		Sublot 1			Sublot 2			Sublot 3			Sublot 4		
	Design	AMF	QC	QA	AMF	QC	QA	AMF	QC	QA	AMF	QC	QA
1" (25.0 mm)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
3/4" (19.0 mm)	99.0	99.0	98.0	100.0	99.0	100.0	99.0	99.0	99.0	99.0	99.0	99.0	100.0
1/2" (12.5 mm)	88.0	88.0	92.0	87.0	88.0	89.0	91.0	88.0	89.0	91.0	88.0	90.0	93.0
3/8" (9.5 mm)	81.0	81.0	83.0	80.0	81.0	84.0	82.0	81.0	83.0	83.0	81.0	83.0	88.0
No. 4 (4.75 mm)	46.0	46.0	46.0	44.0	46.0	44.0	45.0	46.0	45.0	46.0	46.0	45.0	50.0
No. 8 (2.36 mm)	26.0	26.0	23.0	23.0	26.0	23.0	23.0	26.0	23.0	23.0	26.0	23.0	25.0
No. 16 (1.18 mm)	17.0	17.0	14.0	14.0	17.0	14.0	14.0	17.0	14.0	14.0	17.0	14.0	15.0
No. 30 (600 µm)	13.0	13.0	10.0	10.0	13.0	11.0	11.0	13.0	10.0	11.0	13.0	10.0	11.0
No. 50 (300 µm)	9.0	9.0	7.0	8.0	9.0	7.0	8.0	9.0	7.0	8.0	9.0	7.0	9.0
No. 100 (150 µm)	6.0	6.0	4.0	6.0	6.0	5.0	6.0	6.0	4.0	6.0	6.0	4.0	6.0
No. 200 (75 µm)	4.1	4.1	3.0	3.3	4.1	3.1	3.4	4.1	2.8	3.4	4.1	2.9	4.0
AC Content	5.8	5.7	5.7	5.8	5.7	5.7	5.8	5.7	5.7	5.7	5.7	5.7	5.8
Gmb	2.387		2.366	2.379		2.368	2.384		2.360	2.376		2.372	2.382
Gmm	2.486		2.481	2.488		2.478	2.491		2.483	2.501		2.48	2.492
Gsb	2.615	2.615			2.615			2.615			2.615		
Gse	2.723		2.712	2.614		2.708	2.729		2.714	2.737		2.711	2.731
VMA	14.0		14.7	14.3		14.6	14.1		14.9	14.3		14.5	14.2
AV	4.0		4.6	4.4		4.4	4.3		5.0	5.0		4.4	4.4

District	2	Site Visit			Material Code			19532R		HMA BC N90 19.0R			
		Sublot 5			Sublot 6			Sublot 7			Sublot 8		
	Design	AMF	QC	QA	AMF	QC	QA	AMF	QC	QA	AMF	QC	QA
1" (25.0 mm)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
3/4" (19.0 mm)	99.0	99.0	99.0	99.0	99.0	100.0	100.0	99.0	100.0	100.0	99.0	100.0	100.0
1/2" (12.5 mm)	88.0	88.0	89.0	89.0	88.0	92.0	91.0	88.0	92.0	92.0	88.0	93.0	93.0
3/8" (9.5 mm)	81.0	81.0	80.0	80.0	81.0	84.0	83.0	81.0	84.0	84.0	81.0	86.0	85.0
No. 4 (4.75 mm)	46.0	46.0	42.0	42.0	46.0	44.0	45.0	46.0	46.0	47.0	46.0	47.0	48.0
No. 8 (2.36 mm)	26.0	26.0	22.0	22.0	26.0	23.0	24.0	26.0	25.0	25.0	26.0	24.0	25.0
No. 16 (1.18 mm)	17.0	17.0	15.0	14.0	17.0	15.0	16.0	17.0	16.0	16.0	17.0	16.0	16.0
No. 30 (600 µm)	13.0	13.0	11.0	11.0	13.0	11.0	12.0	13.0	12.0	12.0	13.0	12.0	12.0
No. 50 (300 µm)	9.0	9.0	9.0	9.0	9.0	8.0	10.0	9.0	9.0	10.0	9.0	8.0	9.0
No. 100 (150 µm)	6.0	6.0	6.0	6.0	6.0	5.0	7.0	6.0	6.0	7.0	6.0	5.0	7.0
No. 200 (75 µm)	4.1	4.1	3.9	4.1	4.1	4.1	4.8	4.1	4.3	4.4	4.1	3.9	4.4
AC Content	5.8	5.7	5.8	5.7	5.7	5.9	5.7	5.7	5.8	5.6	5.7	6.3	5.8
Gmb	2.387		2.382	2.412		2.396	2.425		2.396	2.425		2.392	2.409
Gmm	2.486		2.486	2.492		2.488	2.494		2.487	2.498		2.473	2.482
Gsb	2.615	2.615			2.615			2.615			2.615		
Gse	2.723		2.723	2.726		2.730	2.728		2.724	2.729		2.730	2.718
VMA	14.0		14.2	13.0		13.8	12.6		13.7	12.5		14.3	13.2
AV	4.0		4.2	3.2		3.7	2.8		3.7	2.9		3.3	2.9

District			2	Site Visit		Material Code			19532R		HMA BC N90 19.0R		
		Sublot 9			Sublot 10			Sublot 11			Sublot 12		
	Design	AMF	QC	QA	AMF	QC	QA	AMF	QC	QA	AMF	QC	QA
1" (25.0 mm)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
3/4" (19.0 mm)	99.0	99.0	99.0	100.0	99.0	100.0	99.0	99.0	100.0	100.0	99.0	98.0	99.0
1/2" (12.5 mm)	88.0	88.0	91.0	93.0	88.0	93.0	93.0	88.0	91.0	94.0	88.0	89.0	90.0
3/8" (9.5 mm)	81.0	81.0	84.0	86.0	81.0	86.0	86.0	81.0	85.0	87.0	81.0	80.0	82.0
No. 4 (4.75 mm)	46.0	46.0	46.0	48.0	46.0	46.0	47.0	46.0	48.0	49.0	46.0	44.0	47.0
No. 8 (2.36 mm)	26.0	26.0	24.0	25.0	26.0	24.0	24.0	26.0	25.0	25.0	26.0	23.0	24.0
No. 16 (1.18 mm)	17.0	17.0	16.0	15.0	17.0	15.0	15.0	17.0	16.0	15.0	17.0	15.0	15.0
No. 30 (600 µm)	13.0	13.0	12.0	12.0	13.0	11.0	11.0	13.0	12.0	12.0	13.0	11.0	11.0
No. 50 (300 µm)	9.0	9.0	8.0	9.0	9.0	7.0	9.0	9.0	8.0	9.0	9.0	7.0	9.0
No. 100 (150 µm)	6.0	6.0	6.0	7.0	6.0	5.0	6.0	6.0	5.0	6.0	6.0	5.0	6.0
No. 200 (75 µm)	4.1	4.1	4.2	4.3	4.1	3.8	3.8	4.1	4.0	4.0	4.1	3.7	4.1
AC Content	5.8	5.7	6.0	5.7	5.7	5.7	5.8	5.7	5.6	5.7	5.7	5.7	5.7
Gmb	2.387		2.386	2.404		2.379	2.402		2.384	2.407		2.374	2.388
Gmm	2.486		2.482	2.492		2.473	2.482		2.486	2.486		2.492	2.497
Gsb	2.615	2.615			2.615			2.615			2.615		
Gse	2.723		2.727	2.726		2.702	2.718		2.714	2.718		2.726	2.732
VMA	14.0		14.2	13.3		14.2	13.5		13.9	13.2		14.4	13.9
AV	4.0		3.9	3.5		3.8	3.2		4.1	3.2		4.7	4.4

Mix Information

District	2	Site Visit			Material Code				19532R		HMA BC N90 19.0R		
		Sublot 13			Sublot 14			Sublot 15			Sublot 16		
	Design	AMF	QC	QA	AMF	QC	QA	AMF	QC	QA	AMF	QC	QA
1" (25.0 mm)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
3/4" (19.0 mm)	99.0	99.0	99.0	100.0	99.0	100.0	100.0	99.0	99.0	100.0	99.0	99.0	100.0
1/2" (12.5 mm)	88.0	88.0	93.0	94.0	88.0	94.0	92.0	88.0	91.0	92.0	88.0	91.0	92.0
3/8" (9.5 mm)	81.0	81.0	86.0	87.0	81.0	86.0	85.0	81.0	86.0	83.0	81.0	85.0	85.0
No. 4 (4.75 mm)	46.0	46.0	46.0	47.0	46.0	48.0	48.0	46.0	48.0	48.0	46.0	47.0	47.0
No. 8 (2.36 mm)	26.0	26.0	24.0	25.0	26.0	25.0	24.0	26.0	25.0	25.0	26.0	24.0	24.0
No. 16 (1.18 mm)	17.0	17.0	15.0	15.0	17.0	16.0	15.0	17.0	16.0	16.0	17.0	15.0	15.0
No. 30 (600 µm)	13.0	13.0	11.0	12.0	13.0	12.0	11.0	13.0	12.0	12.0	13.0	11.0	11.0
No. 50 (300 µm)	9.0	9.0	7.0	9.0	9.0	8.0	9.0	9.0	8.0	9.0	9.0	7.0	9.0
No. 100 (150 µm)	6.0	6.0	5.0	6.0	6.0	5.0	6.0	6.0	5.0	7.0	6.0	5.0	6.0
No. 200 (75 µm)	4.1	4.1	3.7	4.3	4.1	4.0	4.1	4.1	4.0	4.3	4.1	3.9	4.1
AC Content	5.8	5.7	5.7	5.8	5.7	5.8	5.6	5.7	5.8	5.9	5.7	5.9	6.0
Gmb	2.387		2.374	2.408		2.373	2.4		2.39	2.413		2.384	2.404
Gmm	2.486		2.477	2.491		2.48	2.494		2.484	2.494		2.473	2.482
Gsb	2.615	2.615			2.615			2.615			2.615		
Gse	2.723		2.707	2.729		2.715	2.655		2.720	2.738		2.711	2.727
VMA	14.0		14.4	13.3		14.5	13.4		13.9	13.2		14.2	13.6
AV	4.0		4.2	3.3		4.3	3.8		3.8	3.2		3.6	3.1

Mix Information

District	2	Site Visit			Material Code			19532R		HMA BC N90 19.0R		
		Sublot 17			Sublot 18			Sublot 19			Sublot 20	
	Design	AMF	QC	QA	AMF	QC	QA	AMF	QC	QA	AMF	QC	QA
1" (25.0 mm)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
3/4" (19.0 mm)	99.0	99.0	98.0	100.0	99.0	100.0	100.0	99.0	100.0	100.0	99.0	100.0	99.0
1/2" (12.5 mm)	88.0	88.0	90.0	92.0	88.0	92.0	92.0	88.0	93.0	93.0	88.0	93.0	89.0
3/8" (9.5 mm)	81.0	81.0	84.0	85.0	81.0	84.0	83.0	81.0	87.0	86.0	81.0	85.0	82.0
No. 4 (4.75 mm)	46.0	46.0	45.0	47.0	46.0	44.0	45.0	46.0	47.0	47.0	46.0	49.0	48.0
No. 8 (2.36 mm)	26.0	26.0	24.0	25.0	26.0	23.0	24.0	26.0	24.0	25.0	26.0	25.0	25.0
No. 16 (1.18 mm)	17.0	17.0	15.0	16.0	17.0	15.0	16.0	17.0	15.0	16.0	17.0	15.0	16.0
No. 30 (600 µm)	13.0	13.0	11.0	12.0	13.0	11.0	12.0	13.0	11.0	12.0	13.0	11.0	12.0
No. 50 (300 µm)	9.0	9.0	8.0	9.0	9.0	8.0	10.0	9.0	7.0	10.0	9.0	7.0	9.0
No. 100 (150 µm)	6.0	6.0	5.0	7.0	6.0	5.0	7.0	6.0	5.0	7.0	6.0	5.0	7.0
No. 200 (75 µm)	4.1	4.1	3.8	4.3	4.1	3.7	4.7	4.1	3.5	4.2	4.1	3.2	4.1
AC Content	5.8	5.7	5.6	5.8	5.7	5.8	5.5	5.5	5.7	5.6	5.5	5.8	5.8
Gmb	2.387		2.391	2.412		2.386	2.407		2.368	2.385		2.373	2.397
Gmm	2.486		2.479	2.486		2.491	2.502		2.476	2.489		2.476	2.485
Gsb	2.615	2.615			2.615			2.615			2.615		
Gse	2.723		2.705	2.723		2.729	2.729		2.706	2.717		2.710	2.722
VMA	14.0		13.7	13.1		14.0	13.0		14.6	13.9		14.5	13.7
AV	4.0		3.5	3.0		4.2	3.8		4.4	4.2		4.2	3.5

Mix Information

District	2	Site Visit			Material Code				19532R		HMA BC N90 19.0R	
		Sublot 21			Sublot 22			Sublot 23			Sublot 24	
	Design	AMF	QC	QA	AMF	QC	QA	AMF	QC	QA	AMF	QC	QA
1" (25.0 mm)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
3/4" (19.0 mm)	99.0	99.0	99.0	100.0	99.0	99.0	99.0	99.0	100.0	99.0	99.0	99.0	100.0
1/2" (12.5 mm)	88.0	88.0	88.0	92.0	88.0	88.0	89.0	88.0	93.0	91.0	88.0	89.0	92.0
3/8" (9.5 mm)	81.0	81.0	83.0	86.0	81.0	82.0	80.0	81.0	85.0	86.0	81.0	82.0	85.0
No. 4 (4.75 mm)	46.0	46.0	48.0	50.0	46.0	44.0	45.0	46.0	48.0	49.0	46.0	47.0	51.0
No. 8 (2.36 mm)	26.0	26.0	25.0	25.0	26.0	23.0	24.0	26.0	24.0	25.0	26.0	25.0	25.0
No. 16 (1.18 mm)	17.0	17.0	15.0	15.0	17.0	14.0	15.0	17.0	15.0	15.0	17.0	16.0	16.0
No. 30 (600 µm)	13.0	13.0	11.0	11.0	13.0	11.0	11.0	13.0	11.0	11.0	13.0	12.0	12.0
No. 50 (300 µm)	9.0	9.0	7.0	9.0	9.0	7.0	9.0	9.0	7.0	8.0	9.0	8.0	9.0
No. 100 (150 µm)	6.0	6.0	5.0	6.0	6.0	5.0	6.0	6.0	4.0	6.0	6.0	5.0	6.0
No. 200 (75 µm)	4.1	4.1	3.8	3.7	4.1	3.4	3.9	4.1	3.4	4.0	4.1	4.0	4.3
AC Content	5.8	5.5	5.5	5.6	5.6	5.5	5.5	5.6	5.9	5.9	5.6	5.8	5.9
Gmb	2.387		2.351	2.377		2.375	2.394		2.367	2.383		2.382	2.402
Gmm	2.486		2.488	2.498		2.493	2.502		2.475	2.485		2.472	2.481
Gsb	2.615	2.615			2.615			2.615			2.615		
Gse	2.723		2.711	2.729		2.718	2.729		2.714	2.726		2.705	2.721
VMA	14.0		15.0	14.2		14.2	13.5		14.8	14.2		14.2	13.6
AV	4.0		5.5	4.8		4.7	4.3		4.4	4.1		3.6	3.2

Mix Information

District	2	Site Visit			Material Code				19532R		HMA BC N90 19.0R		
		Sublot 25			Sublot 26			Sublot 27			Sublot 28		
	Design	AMF	QC	QA	AMF	QC	QA	AMF	QC	QA	AMF	QC	QA
1" (25.0 mm)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
3/4" (19.0 mm)	99.0	99.0	100.0	99.0	99.0	100.0	100.0	99.0	100.0	99.0	99.0	98.0	100.0
1/2" (12.5 mm)	88.0	88.0	89.0	88.0	88.0	92.0	94.0	88.0	89.0	92.0	88.0	86.0	90.0
3/8" (9.5 mm)	81.0	81.0	81.0	81.0	81.0	85.0	88.0	81.0	82.0	84.0	81.0	79.0	82.0
No. 4 (4.75 mm)	46.0	46.0	45.0	45.0	46.0	46.0	49.0	46.0	46.0	48.0	46.0	43.0	45.0
No. 8 (2.36 mm)	26.0	26.0	23.0	24.0	26.0	23.0	24.0	26.0	24.0	24.0	26.0	23.0	23.0
No. 16 (1.18 mm)	17.0	17.0	14.0	15.0	17.0	15.0	15.0	17.0	15.0	15.0	17.0	15.0	15.0
No. 30 (600 µm)	13.0	13.0	11.0	12.0	13.0	11.0	11.0	13.0	11.0	11.0	13.0	11.0	12.0
No. 50 (300 µm)	9.0	9.0	7.0	10.0	9.0	7.0	9.0	9.0	7.0	9.0	9.0	8.0	9.0
No. 100 (150 µm)	6.0	6.0	4.0	7.0	6.0	4.0	6.0	6.0	4.0	6.0	6.0	5.0	7.0
No. 200 (75 µm)	4.1	4.1	3.4	4.4	4.1	3.4	3.8	4.1	3.4	3.9	4.1	4.1	4.4
AC Content	5.8	5.6	5.6	5.5	5.7	5.9	6.0	5.7	5.9	5.9	5.7	5.7	5.6
Gmb	2.387		2.372	2.388		2.347	2.398		2.340	2.393		2.361	2.414
Gmm	2.486		2.481	2.482		2.467	2.474		2.479	2.483		2.483	2.491
Gsb	2.615	2.615			2.615			2.615			2.615		
Gse	2.723		2.707	2.704		2.703	2.717		2.719	2.634		2.714	2.720
VMA	14.0		14.4	13.7		15.5	13.8		15.8	13.9		14.9	12.9
AV	4.0		4.4	3.8		4.9	3.1		5.6	3.6		4.9	3.1

Mix Information

District	2	Site Visit		Material Code					19532R		HMA BC N90 19.0R		
		Sublot 29			Sublot 30			Sublot 31			Sublot 32		
	Design	AMF	QC	QA	AMF	QC	QA	AMF	QC	QA	AMF	QC	QA
1" (25.0 mm)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
3/4" (19.0 mm)	99.0	99.0	99.0	99.0	99.0	98.0	100.0	99.0	100.0	100.0	99.0	100.0	100.0
1/2" (12.5 mm)	88.0	88.0	88.0	89.0	88.0	88.0	89.0	88.0	94.0	92.0	88.0	91.0	93.0
3/8" (9.5 mm)	81.0	81.0	83.0	82.0	81.0	81.0	82.0	81.0	89.0	86.0	81.0	85.0	86.0
No. 4 (4.75 mm)	46.0	46.0	44.0	45.0	46.0	45.0	46.0	46.0	48.0	49.0	46.0	48.0	50.0
No. 8 (2.36 mm)	26.0	26.0	23.0	24.0	26.0	23.0	24.0	26.0	24.0	25.0	26.0	25.0	25.0
No. 16 (1.18 mm)	17.0	17.0	15.0	15.0	17.0	14.0	15.0	17.0	15.0	15.0	17.0	15.0	15.0
No. 30 (600 µm)	13.0	13.0	11.0	11.0	13.0	11.0	11.0	13.0	11.0	11.0	13.0	11.0	11.0
No. 50 (300 µm)	9.0	9.0	7.0	8.0	9.0	7.0	8.0	9.0	7.0	9.0	9.0	7.0	8.0
No. 100 (150 µm)	6.0	6.0	5.0	6.0	6.0	5.0	6.0	6.0	5.0	6.0	6.0	4.0	6.0
No. 200 (75 µm)	4.1	4.1	3.8	4.0	4.1	3.7	4.0	4.1	3.6	3.9	4.1	3.2	3.6
AC Content	5.8	5.6	5.6	5.6	5.5	5.5	5.6	5.7	5.9	6.2	5.7	5.9	5.7
Gmb	2.387		2.376	2.4		2.363	2.393		2.363	2.403		2.359	2.375
Gmm	2.486		2.479	2.485		2.478	2.485		2.477	2.485		2.487	2.493
Gsb	2.615	2.615			2.615			2.615			2.615		
Gse	2.723		2.705	2.712		2.699	2.712		2.716	2.741		2.729	2.727
VMA	14.0		14.2	13.4		14.6	13.6		15.0	13.8		15.1	14.4
AV	4.0		4.2	3.4		4.6	3.7		4.6	3.3		5.1	4.7

Table 44. District 2 Site Visit Density Results

Density Core									
District Site Visit			2		Material Code HMA BC N90 19.0R			19532R	
	QC		QA			QC		QA	
SEQ number	Gmb	% Density	Gmb	% Density	SEQ number	Gmb	% Density	Gmb	% Density
1	2.365	95.0	2.338	93.9	90	2.357	94.6	2.370	95.1
2	2.277	91.4	2.282	91.7	91	2.357	94.6	2.359	94.7
3	2.339	93.9	2.341	94.0	92	2.345	94.1	2.340	93.9
4	2.340	94.0	2.349	94.3	93	2.283	91.7	2.291	92.0
5	2.329	93.5	2.347	94.3	94	2.355	94.5	2.358	94.7
6	2.339	93.9	2.335	93.8	95	2.320	93.1	2.325	93.3
7	2.332	93.5	2.348	94.2	96	2.367	95.0	2.366	95.0
8	2.316	92.9	2.317	92.9	97	2.321	93.2	2.324	93.3
9	2.295	92.0	2.303	92.4	98	2.381	95.6	2.385	95.8
10	2.353	94.4	2.357	94.6	99	2.329	93.5	2.340	93.9
11	2.321	93.1	2.355	94.5	100	2.348	94.2	2.357	94.6
12	2.318	93.0	2.315	92.9	101	2.297	92.2	2.304	92.5
13	2.318	93.0	2.316	92.9	102	2.276	91.4	2.289	91.9
14	2.273	91.2	2.316	92.9	103	2.307	92.6	2.315	92.9
15	2.340	94.0	2.344	94.0	104	2.316	93.0	2.329	93.5
16	2.326	93.4	2.312	92.7	105	2.302	92.4	2.300	92.4
17	2.320	93.2	2.328	93.4	106	2.299	92.3	2.310	92.7
18	2.259	90.7	2.263	90.9	107	2.294	92.1	2.297	92.2
19	2.335	93.7	2.352	94.4	108	2.344	94.1	2.365	95.0
20	2.320	93.1	2.332	93.5	109	2.301	92.4	2.315	92.9
21	2.339	93.8	2.342	94.0	110	2.329	93.4	2.312	92.7
22	2.295	92.0	2.317	92.9	111	2.345	94.0	2.345	94.0
23	2.308	92.6	2.339	93.8	112	2.353	94.3	2.346	94.1
24	2.319	93.0	2.336	93.7	113	2.375	95.2	2.368	95.0
25	2.356	94.5	2.354	94.4	114	2.330	93.4	2.349	94.2
26	2.333	93.6	2.340	93.8	115	2.324	93.2	2.326	93.3
27	2.302	92.3	2.309	92.6	116	2.341	93.9	2.344	94.0
28	2.256	90.4	2.276	91.2	117	2.360	94.6	2.347	94.1
29	2.258	90.6	2.264	90.8	118	2.310	92.6	2.317	92.9
30	2.310	92.6	2.328	93.3	119	2.301	92.3	2.292	91.9
31	2.346	94.1	2.340	93.8	120	2.342	93.9	2.324	93.2
32	2.365	94.8	2.368	94.9	121	2.300	92.3	2.312	92.8
33	2.328	93.4	2.364	94.8	122	2.336	93.7	2.329	93.4
34	2.314	92.8	2.329	93.4	123	2.300	92.3	2.314	92.9
35	2.354	94.4	2.368	94.9	124	2.277	91.4	2.280	91.5
36	2.335	93.6	2.346	94.1	125	2.296	92.1	2.296	92.1

Density Core									
District Site Visit			2		Material Code HMA BC N90 19.0R			19532R	
	QC		QA			QC		QA	
SEQ number	Gmb	% Density	Gmb	% Density	SEQ number	Gmb	% Density	Gmb	% Density
37	2.365	94.8	2.372	95.1	126	2.299	92.3	2.314	92.9
38	2.347	94.1	2.346	94.1	127	2.261	90.7	2.271	91.1
39	2.337	93.7	2.349	94.2	128	2.296	92.1	2.303	92.4
40	2.292	92.0	2.311	92.7	129	2.343	94.0	2.349	94.3
41	2.374	95.3	2.393	96.0	130	2.330	93.5	2.323	93.2
42	2.341	93.9	2.351	94.3	131	2.402	96.5	2.405	96.6
43	2.300	92.3	2.308	92.6	132	2.333	93.7	2.337	93.9
44	2.375	95.3	2.385	95.7	133	2.271	91.2	2.274	91.3
45	2.404	96.5	2.404	96.5	134	2.295	92.2	2.298	92.3
46	2.347	94.2	2.353	94.4	135	2.284	91.7	2.295	92.1
47	2.350	94.3	2.350	94.3	136	2.340	94.0	2.350	94.4
48	2.339	93.9	2.342	94.0	137	2.309	92.7	2.305	92.6
49	2.375	95.3	2.318	93.0	138	2.299	92.6	2.293	92.4
50	2.323	93.2	2.329	93.5	139	2.359	95.0	2.335	94.1
51	2.336	93.7	2.343	94.0	140	2.306	92.9	2.310	93.0
55	2.313	92.9	2.306	92.7	141	2.278	91.7	2.274	91.6
56	2.319	93.2	2.318	93.1	142	2.344	94.4	2.331	93.9
57	2.322	93.3	2.328	93.5	143	2.392	96.4	2.401	96.7
58	2.324	93.4	2.329	93.6	144	2.354	94.8	2.331	93.9
59	2.336	93.8	2.347	94.3	145	2.359	95.0	2.357	94.9
60	2.346	94.2	2.364	95.0	146	2.357	94.9	2.350	94.6
61	2.352	94.5	2.354	94.6	147	2.350	94.6	2.353	94.7
62	2.337	93.9	2.332	93.7	148	2.335	94.0	2.319	93.3
63	2.395	96.2	2.408	96.7	149	2.364	95.1	2.358	94.9
64	2.152	86.4	2.345	94.2	150	2.347	94.4	2.381	95.8
65	2.147	86.3	2.347	94.3	151	2.378	95.7	2.378	95.7
66	2.229	89.4	2.320	93.2	152	2.300	92.5	2.303	92.7
67	2.224	89.2	2.301	92.4	153	2.323	93.5	2.330	93.8
76	2.298	92.1	2.291	91.9	154	2.396	96.4	2.412	97.1
77	2.376	95.3	2.379	95.4	155	2.338	94.1	2.331	93.8
78	2.364	94.8	2.369	95.0	156	2.347	94.4	2.363	95.1
79	2.364	94.8	2.368	94.9	157	2.380	95.7	2.383	95.8
80	2.370	95.0	2.377	95.3	158	2.334	93.9	2.341	94.1
81	2.191	87.8			159	2.283	91.8	2.288	92.0
82	2.200	88.2			160	2.398	96.4	2.408	96.8
83	2.349	94.2	2.342	93.9	161	2.335	93.9	2.340	94.1
84	2.251	90.3	2.265	90.8	162	2.376	95.5	2.379	95.7
85	2.287	91.7	2.285	91.6	163	2.345	94.3	2.338	94.0

Density Core									
District Site Visit			2		Material Code			19532R	
					HMA BC N90 19.0R				
	QC		QA			QC		QA	
SEQ number	Gmb	% Density	Gmb	% Density	SEQ number	Gmb	% Density	Gmb	% Density
86	2.400	96.4	2.403	96.5	164	2.309	92.8	2.309	92.8
87	2.344	94.1	2.350	94.3	165	2.375	95.5	2.371	95.3
88	2.372	95.2	2.365	95.0	166	2.365	95.1	2.381	95.7
89	2.328	93.5	2.339	93.9	167	2.325	93.5	2.330	93.7
					168	2.379	95.6	2.369	95.2

District 5 Site Visit

Table 45. District 5 Site Visit Volumetric Results

Mix Information

District	5	Site Visit				Material Code			19534R		HMA SC N90 D REC 9.5					
		Sublot 1			Sublot 2			Sublot 3			Sublot 4			Sublot 5		
	Design	AMF	QC	QA	AMF	QC	QA	AMF	QC	QA	AMF	QC	QA	AMF	QC	QA
1" (25.0 mm)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0		100.0	100.0		100.0	100.0	
3/4" (19.0 mm)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0		100.0	100.0		100.0	100.0	
1/2" (12.5 mm)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0		100.0	100.0		100.0	100.0	
3/8" (9.5 mm)	99.0	99.0	98.0	99.0	99.0	99.0	99.0	99.0	98.0		99.0	98.0		99.0	97.0	
No. 4 (4.75 mm)	61.0	61.0	59.0	60.0	61.0	60.0	59.0	61.0	60.0		61.0	59.0		61.0	57.0	
No. 8 (2.36 mm)	37.0	37.0	35.0	37.0	37.0	35.0	36.0	37.0	36.0		37.0	35.0		37.0	34.0	
No. 16 (1.18 mm)	24.0	24.0	23.0	23.0	24.0	23.0	22.0	24.0	24.0		24.0	23.0		24.0	23.0	
No. 30 (600 µm)	16.0	16.0	14.0	17.0	16.0	14.0	17.0	16.0	15.0		16.0	15.0		16.0	14.0	
No. 50 (300 µm)	10.0	10.0	9.0	10.0	10.0	8.0	10.0	10.0	9.0		10.0	9.0		10.0	9.0	
No. 100 (150 µm)	6.0	6.0	5.0	6.0	6.0	5.0	6.0	6.0	6.0		6.0	6.0		6.0	6.0	
No. 200 (75 µm)	4.8	4.8	4.3	4.7	4.8	4.1	4.6	4.8	4.7		4.8	4.6		4.8	4.4	
AC Content	6.24	6.2	6.2	6.3	6.2	6.3	6.2	6.2	6.3		6.2	6.2		6.2	6	
Gmb	2.338		2.333	2.340		2.323	2.338		2.346			2.334			2.330	
Gmm	2.435		2.429	2.433		2.432	2.440		2.428			2.433			2.431	
Gsb	2.599	2.599			2.599			2.599			2.599			2.599		
Gse	2.678		2.669	2.608		2.677	2.683		2.672			2.674			2.662	
VMA	15.7		15.8	15.6		16.3	15.6		15.4			15.8			15.7	
AV	4.0		4.0	3.8		4.5	4.2		3.4			4.1			4.2	

Table 46. District 5 Site Visit Density Results

Density Core				
District			5	
Site Visit				
Material Code			19534R	
HMA SC N90 D REC 9.5				
	QC		QA	
SEQ number	Gmb	% Density	Gmb	% Density
1	2.313	94.9	2.306	94.7
2	2.260	92.8	2.271	93.2
3	2.300	94.4	2.289	94.0
4	2.254	92.5	2.243	92.1
5	2.295	94.2	2.295	94.2
6	2.284	93.8	2.267	93.0
7	2.237	91.8	2.218	91.1
8	2.275	93.4	2.264	92.9
9	2.287	93.9	2.278	93.5
10	2.256	92.6	2.203	90.4
11	2.264	93.0	2.258	92.7
12	2.320	95.2	2.301	94.4
13	2.319	95.2	2.306	94.6
14	2.247	92.2	2.252	92.4
15	2.280	93.6	2.267	93.1
16	2.336	95.9	2.326	95.5
17	2.234	91.7	2.235	91.8
18	2.287	93.9	2.268	93.1
19	2.330	95.7	2.317	95.1
20	2.220	91.1	2.211	90.8
21	2.259	92.7	2.259	92.7
22	2.292	94.1	2.282	93.7
23	2.303	94.5	2.296	94.3
24	2.283	93.7	2.266	93.0
25	2.238	91.9	2.211	90.7
26	2.222	91.2	2.214	90.9
27	2.249	92.3	2.239	91.9

Density Core				
District			5	
Site Visit				
Material Code			19534R	
HMA SC N90 D REC 9.5				
	QC		QA	
SEQ number	Gmb	% Density	Gmb	% Density
28	2.290	94.0	2.283	93.7
29	2.319	95.2	2.315	95.1
30	2.281	93.6	2.249	92.3
31	2.301	94.5	2.292	94.1
32	2.248	92.3	2.241	92.0
33	2.339	96.0	2.343	96.2
34	2.260	92.8	2.259	92.7

District 6 Site Visit

Table 47. District 6 Site Visit Volumetrics Results

Mix Information

District	6	Site Visit			Material Code				19532R		HMA BC N90 19.0R					
		Sublot 1			Sublot 2			Sublot 3			Sublot 4			Sublot 5		
	Design	AMF	QC	QA	AMF	QC	QA	AMF	QC	QA	AMF	QC	QA	AMF	QC	QA
1" (25.0 mm)	100.0	100.0	100.0		100.0	100.0		100.0	100.0		100.0	100.0	100.0	100.0	100.0	100.0
3/4" (19.0 mm)	100.0	100.0	98.0		100.0	100.0	98.0	100.0	99.0		100.0	99.0	100.0	100.0	100.0	99.0
1/2" (12.5 mm)	89.0	89.0	85.0		89.0	88.0	87.0	89.0	87.0		89.0	88.0	89.0	89.0	91.0	87.0
3/8" (9.5 mm)	82.0	82.0	75.0		82.0	80.0	79.0	82.0	80.0		82.0	83.0	81.0	82.0	84.0	81.0
No. 4 (4.75 mm)	57.0	57.0	52.0		57.0	56.0	56.0	57.0	57.0		57.0	59.0	57.0	57.0	60.0	57.0
No. 8 (2.36 mm)	32.0	32.0	29.0		32.0	31.0	31.0	32.0	31.0		32.0	33.0	32.0	32.0	33.0	32.0
No. 16 (1.18 mm)	21.0	21.0	19.0		21.0	20.0	20.0	21.0	21.0		21.0	22.0	21.0	21.0	22.0	21.0
No. 30 (600 µm)	14.0	14.0	12.0		14.0	13.0	13.0	14.0	14.0		14.0	14.0	14.0	14.0	14.0	13.0
No. 50 (300 µm)	8.0	8.0	7.0		8.0	8.0	7.0	8.0	8.0		8.0	9.0	8.0	8.0	8.0	7.0
No. 100 (150 µm)	6.0	6.0	5.0		6.0	6.0	6.0	6.0	6.0		6.0	6.0	6.0	6.0	6.0	6.0
No. 200 (75 µm)	4.6	4.6	4.4		4.6	4.7	4.6	4.6	5.1		4.6	5.4	5.2	4.6	5.2	4.5
AC Content	5.2	5.2	5.0		5.3	5.3	5.3	5.3	5.4		5.3	5.5	5.4	5.3	5.5	5.5
Gmb	2.362		2.353	2.344		2.367	2.355		2.382	2.366		2.387	2.369		2.377	2.361
Gmm	2.46		2.466	2.468		2.46	2.463		2.465	2.463		2.461	2.463		2.461	2.464
Gsb	2.594	2.594			2.594			2.594			2.594			2.594		
Gse	2.662		2.661	2.468		2.667	2.671		2.678	2.463		2.678	2.675		2.678	2.681
VMA	13.7		13.8	9.6		13.6	14.0		13.1	8.8		13.0	13.6		13.4	14.0
AV	4.0		4.6	5.0		3.8	4.4		3.4	3.9		3.0	3.8		3.4	4.2

District	6	Site Visit		Material Code				19532R			HMA BC N90 19.0R		
		Sublot 6			Sublot 7			Sublot 8			Sublot 9		
	Design	AMF	QC	QA	AMF	QC	QA	AMF	QC	QA	AMF	QC	QA
1" (25.0 mm)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
3/4" (19.0 mm)	100.0	100.0	100.0	99.0	100.0	98.0	99.0	100.0	98.0	100.0	100.0	97.0	99.0
1/2" (12.5 mm)	89.0	89.0	91.0	90.0	89.0	88.0	87.0	89.0	89.0	88.0	89.0	84.0	87.0
3/8" (9.5 mm)	82.0	82.0	83.0	82.0	82.0	80.0	81.0	82.0	81.0	80.0	82.0	77.0	76.0
No. 4 (4.75 mm)	57.0	57.0	56.0	58.0	57.0	55.0	57.0	57.0	54.0	58.0	57.0	57.0	53.0
No. 8 (2.36 mm)	32.0	32.0	31.0	32.0	32.0	31.0	33.0	32.0	31.0	33.0	32.0	31.0	30.0
No. 16 (1.18 mm)	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	22.0	21.0	20.0	20.0
No. 30 (600 µm)	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	15.0	14.0	13.0	13.0
No. 50 (300 µm)	8.0	8.0	8.0	7.0	8.0	8.0	7.0	8.0	8.0	7.0	8.0	7.0	7.0
No. 100 (150 µm)	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	5.0	6.0
No. 200 (75 µm)	4.6	4.6	5.0	4.6	4.6	4.9	4.5	4.6	4.7	4.7	4.6	4.4	4.5
AC Content	5.2	5.3	5.4	5.5	5.3	5.5	5.4	5.3	5.3	5.4	5.3	5.3	5.3
Gmb	2.362		2.383	2.371		2.374	2.369		2.392	2.379		2.373	2.354
Gmm	2.46		2.464	2.46		2.455	2.459		2.46	2.466		2.466	2.464
Gsb	2.594	2.594			2.594			2.594			2.594		
Gse	2.662		2.677	2.676		2.670	2.670		2.667	2.679		2.675	2.672
VMA	13.7		13.1	13.6		13.5	13.6		12.7	13.2		13.4	14.1
AV	4.0		3.3	3.6		3.3	3.7		2.8	3.5		3.8	4.5

District	6	Site Visit		Material Code				19532R			HMA BC N90 19.0R		
		Sublot 10			Sublot 11			Sublot 12			Sublot 13		
	Design	AMF	QC	QA	AMF	QC	QA	AMF	QC	QA	AMF	QC	QA
1" (25.0 mm)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0		100.0	100.0	100.0
3/4" (19.0 mm)	100.0	100.0	100.0	98.0	100.0	99.0	100.0	100.0	99.0		100.0	99.0	100.0
1/2" (12.5 mm)	89.0	89.0	89.0	88.0	89.0	85.0	88.0	89.0	84.0		89.0	85.0	85.0
3/8" (9.5 mm)	82.0	82.0	81.0	80.0	82.0	77.0	79.0	82.0	78.0		82.0	78.0	78.0
No. 4 (4.75 mm)	57.0	57.0	54.0	58.0	57.0	52.0	56.0	57.0	55.0		57.0	53.0	55.0
No. 8 (2.36 mm)	32.0	32.0	30.0	32.0	32.0	29.0	31.0	32.0	30.0		32.0	29.0	29.0
No. 16 (1.18 mm)	21.0	21.0	20.0	20.0	21.0	20.0	20.0	21.0	20.0		21.0	19.0	19.0
No. 30 (600 µm)	14.0	14.0	13.0	13.0	14.0	13.0	14.0	14.0	14.0		14.0	13.0	13.0
No. 50 (300 µm)	8.0	8.0	7.0	7.0	8.0	7.0	7.0	8.0	8.0		8.0	8.0	7.0
No. 100 (150 µm)	6.0	6.0	5.0	6.0	6.0	5.0	6.0	6.0	6.0		6.0	5.0	6.0
No. 200 (75 µm)	4.6	4.6	4.4	4.4	4.6	4.1	4.5	4.6	4.7		4.6	4.5	4.3
AC Content	5.2	5.3	5.5	5.6	5.3	5.2	5.4	5.3	5.4		5.3	5.3	5.2
Gmb	2.362		2.371	2.352		2.379	2.36		2.391	2.372		2.384	2.361
Gmm	2.46		2.47	2.457		2.464	2.459		2.47	2.468		2.478	2.466
Gsb	2.594	2.594			2.594			2.594			2.594		
Gse	2.662		2.689	2.677		2.668	2.670		2.684	2.468		2.690	2.670
VMA	13.7		13.6	14.4		13.1	13.9		12.8	8.6		13.0	13.7
AV	4.0		4.0	4.3		3.4	4.0		3.2	3.9		3.8	4.3

		Sublot 14			Sublot 15			Sublot 16			Sublot 17			Sublot 18		
	Design	AMF	QC	QA	AMF	QC	QA	AMF	QC	QA	AMF	QC	QA	AMF	QC	QA
1" (25.0 mm)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
3/4" (19.0 mm)	100.0	100.0	99.0	99.0	100.0	99.0	100.0	100.0	99.0	100.0	100.0	98.0	99.0	100.0	100.0	99.0
1/2" (12.5 mm)	89.0	89.0	87.0	90.0	89.0	90.0	88.0	89.0	89.0	91.0	89.0	87.0	89.0	89.0	89.0	84.0
3/8" (9.5 mm)	82.0	82.0	81.0	82.0	82.0	82.0	79.0	82.0	81.0	83.0	82.0	80.0	83.0	82.0	82.0	78.0
No. 4 (4.75 mm)	57.0	57.0	56.0	58.0	57.0	55.0	56.0	57.0	58.0	57.0	57.0	55.0	58.0	57.0	61.0	57.0
No. 8 (2.36 mm)	32.0	32.0	30.0	31.0	32.0	30.0	30.0	32.0	31.0	31.0	32.0	30.0	32.0	32.0	33.0	32.0
No. 16 (1.18 mm)	21.0	21.0	20.0	20.0	21.0	20.0	20.0	21.0	20.0	20.0	21.0	20.0	21.0	21.0	22.0	21.0
No. 30 (600 µm)	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	15.0	15.0
No. 50 (300 µm)	8.0	8.0	8.0	7.0	8.0	8.0	7.0	8.0	8.0	7.0	8.0	8.0	7.0	8.0	8.0	7.0
No. 100 (150 µm)	6.0	6.0	5.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
No. 200 (75 µm)	4.6	4.6	4.6	4.5	4.6	4.7	4.9	4.6	4.6	4.5	4.6	4.6	4.8	4.6	4.6	4.7
AC Content	5.2	5.3	5.4	5.5	5.3	5.5	5.5	5.3	5.6	5.6	5.3	5.4	5.5	5.3	5.5	5.4
Gmb	2.362		2.375	2.357		2.379	2.353		2.374	2.356		2.373	2.358		2.382	2.365
Gmm	2.46		2.464	2.464		2.473	2.468		2.459	2.453		2.469	2.466		2.474	2.464
Gsb	2.594	2.594			2.594			2.594			2.594			2.594		
Gse	2.662		2.677	2.637		2.693	2.686		2.680	2.672		2.683	2.684		2.694	2.677
VMA	13.7		13.4	14.1		13.3	14.3		13.6	14.3		13.5	14.1		13.2	13.8
AV	4.0		3.6	4.3		3.8	4.7		3.5	4.0		3.9	4.4		3.7	4.0

District	6	Site Visit		Material Code				19532R			HMA BC N90 19.0R		
		Sublot 19			Sublot 20			Sublot 21			Sublot 22		
	Design	AMF	QC	QA	AMF	QC	QA	AMF	QC	QA	AMF	QC	QA
1" (25.0 mm)	100.0	100.0		100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
3/4" (19.0 mm)	100.0	100.0		100.0	100.0	100.0	100.0	100.0	99.0	100.0	100.0	100.0	99.0
1/2" (12.5 mm)	89.0	89.0		89.0	89.0	89.0	87.0	89.0	89.0	88.0	89.0	89.0	89.0
3/8" (9.5 mm)	82.0	82.0		81.0	82.0	82.0	82.0	82.0	82.0	80.0	82.0	81.0	80.0
No. 4 (4.75 mm)	57.0	57.0		57.0	57.0	61.0	60.0	57.0	54.0	56.0	57.0	54.0	56.0
No. 8 (2.36 mm)	32.0	32.0		31.0	32.0	33.0	33.0	32.0	30.0	31.0	32.0	30.0	30.0
No. 16 (1.18 mm)	21.0	21.0		20.0	21.0	22.0	22.0	21.0	21.0	21.0	21.0	21.0	20.0
No. 30 (600 µm)	14.0	14.0		14.0	14.0	15.0	15.0	14.0	15.0	15.0	14.0	14.0	14.0
No. 50 (300 µm)	8.0	8.0		7.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	7.0
No. 100 (150 µm)	6.0	6.0		6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
No. 200 (75 µm)	4.6	4.6		4.7	4.6	4.6	4.9	4.6	4.8	4.9	4.6	4.6	4.3
AC Content	5.2	5.3		5.5	5.3	5.5	5.5	5.3	5.4	5.4	5.3	5.4	5.4
Gmb	2.362		2.377	2.352		2.388	2.376		2.38	2.375		2.382	2.367
Gmm	2.46		2.476	2.464		2.463	2.461		2.468	2.457		2.468	2.463
Gsb	2.594	2.594			2.594			2.594			2.594		
Gse	2.662		2.476	2.681		2.680	2.678		2.682	2.668		2.682	2.675
VMA	13.7		8.4	14.3		13.0	13.4		13.2	13.4		13.1	13.7
AV	4.0		4.0	4.5		3.0	3.5		3.6	3.3		3.5	3.9

District	6	Site Visit		Material Code			19532R			HMA BC N90 19.0R		
		Sublot 23			Sublot 24			Sublot 25			Sublot 26	
	Design	AMF	QC	QA	AMF	QC	QA	AMF	QC	QA	AMF	QC	QA
1" (25.0 mm)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
3/4" (19.0 mm)	100.0	100.0	98.0	99.0	100.0	99.0	98.0	100.0	100.0	100.0	100.0	99.0	99.0
1/2" (12.5 mm)	89.0	89.0	84.0	83.0	89.0	87.0	88.0	89.0	90.0	89.0	89.0	88.0	88.0
3/8" (9.5 mm)	82.0	82.0	77.0	74.0	82.0	80.0	80.0	82.0	84.0	83.0	82.0	78.0	81.0
No. 4 (4.75 mm)	57.0	57.0	55.0	52.0	57.0	56.0	58.0	57.0	60.0	56.0	57.0	52.0	56.0
No. 8 (2.36 mm)	32.0	32.0	30.0	30.0	32.0	31.0	32.0	32.0	32.0	31.0	32.0	28.0	30.0
No. 16 (1.18 mm)	21.0	21.0	20.0	20.0	21.0	21.0	22.0	21.0	21.0	20.0	21.0	19.0	19.0
No. 30 (600 µm)	14.0	14.0	14.0	14.0	14.0	15.0	15.0	14.0	14.0	14.0	14.0	13.0	13.0
No. 50 (300 µm)	8.0	8.0	8.0	7.0	8.0	8.0	7.0	8.0	8.0	7.0	8.0	8.0	7.0
No. 100 (150 µm)	6.0	6.0	5.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
No. 200 (75 µm)	4.6	4.6	4.3	4.3	4.6	4.8	4.6	4.6	4.8	4.6	4.6	4.8	4.7
AC Content	5.2	5.3	5.3	5.1	5.3	5.4	5.5	5.3	5.6	5.5	5.3	5.3	5.3
Gmb	2.362		2.39	2.369		2.393	2.377		2.375	2.358		2.363	2.344
Gmm	2.46		2.466	2.472		2.464	2.469		2.466	2.461		2.475	2.476
Gsb	2.594	2.594			2.594			2.594			2.594		
Gse	2.662		2.675	2.673		2.677	2.688		2.688	2.678		2.686	2.687
VMA	13.7		12.7	13.3		12.7	13.4		13.6	14.1		13.7	14.4
AV	4.0		3.1	4.2		2.9	3.7		3.7	4.2		4.5	5.3

District	6	Site Visit			Material Code				19532R		HMA BC N90 19.0R					
		Sublot 1			Sublot 2			Sublot 3			Sublot 4			Sublot 5		
	Design	AMF	QC	QA	AMF	QC	QA	AMF	QC	QA	AMF	QC	QA	AMF	QC	QA
1" (25.0 mm)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
3/4" (19.0 mm)	100.0	100.0	99.0	100.0	100.0	99.0	100.0	100.0	98.0	99.0	100.0	100.0	97.0	100.0	98.0	98.0
1/2" (12.5 mm)	89.0	89.0	90.0	90.0	89.0	89.0	91.0	89.0	88.0	88.0	89.0	89.0	85.0	89.0	87.0	86.0
3/8" (9.5 mm)	82.0	82.0	82.0	81.0	82.0	80.0	83.0	82.0	81.0	81.0	82.0	81.0	78.0	82.0	80.0	77.0
No. 4 (4.75 mm)	57.0	57.0	55.0	57.0	57.0	54.0	56.0	57.0	56.0	58.0	57.0	56.0	53.0	57.0	56.0	53.0
No. 8 (2.36 mm)	32.0	32.0	30.0	30.0	32.0	29.0	31.0	32.0	31.0	32.0	32.0	30.0	30.0	32.0	31.0	30.0
No. 16 (1.18 mm)	21.0	21.0	20.0	20.0	21.0	20.0	21.0	21.0	21.0	21.0	21.0	21.0	20.0	21.0	21.0	20.0
No. 30 (600 µm)	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0
No. 50 (300 µm)	8.0	8.0	8.0	7.0	8.0	8.0	7.0	8.0	8.0	7.0	8.0	8.0	7.0	8.0	8.0	7.0
No. 100 (150 µm)	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	5.0	6.0	6.0	6.0	5.0	6.0	6.0	6.0
No. 200 (75 µm)	4.6	4.6	5.0	4.9	4.6	4.8	4.7	4.6	4.4	4.4	4.6	4.8	4.2	4.6	4.6	4.3
AC Content	5.2	5.3	5.5	5.5	5.3	5.3	5.5	5.3	5.6	5.6	5.3	5.5	5.4	5.3	5.5	5.3
Gmb	2.362		2.366	2.352		2.374	2.353		2.382	2.374		2.388	2.364		2.381	2.37
Gmm	2.46		2.469	2.466		2.469	2.462		2.462	2.459		2.462	2.467		2.462	2.468
Gsb	2.594	2.594			2.594			2.594			2.594			2.594		
Gse	2.723		2.688	2.657		2.678	2.679		2.683	2.680		2.679	2.680		2.679	2.677
VMA	14.0		13.8	14.3		13.3	14.3		13.3	13.6		13.0	13.8		13.3	13.5
AV	4.0		4.2	4.6		3.8	4.4		3.2	3.5		3.0	4.2		3.3	4.0

District	6	Site Visit		Material Code				19532R	HMA BC N90 19.0R	
		Sublot 32			Sublot 33			Sublot 34		
	Design	AMF	QC	QA	AMF	QC	QA	AMF	QC	QA
1" (25.0 mm)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
3/4" (19.0 mm)	100.0	100.0	99.0	99.0	100.0	100.0	99.0	100.0	98.0	99.0
1/2" (12.5 mm)	89.0	89.0	90.0	89.0	89.0	93.0	88.0	89.0	86.0	89.0
3/8" (9.5 mm)	82.0	82.0	83.0	80.0	82.0	85.0	81.0	82.0	80.0	82.0
No. 4 (4.75 mm)	57.0	57.0	56.0	56.0	57.0	55.0	56.0	57.0	56.0	59.0
No. 8 (2.36 mm)	32.0	32.0	30.0	31.0	32.0	31.0	32.0	32.0	30.0	32.0
No. 16 (1.18 mm)	21.0	21.0	19.0	20.0	21.0	22.0	21.0	21.0	20.0	21.0
No. 30 (600 µm)	14.0	14.0	14.0	13.0	14.0	15.0	14.0	14.0	14.0	14.0
No. 50 (300 µm)	8.0	8.0	8.0	7.0	8.0	8.0	7.0	8.0	8.0	8.0
No. 100 (150 µm)	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
No. 200 (75 µm)	4.6	4.6	4.8	4.7	4.6	4.9	4.7	4.6	4.7	4.9
AC Content	5.2	5.3	5.5	5.5	5.3	5.5	5.4	5.3	5.3	5.6
Gmb	2.362		2.368	2.342		2.38	2.365		2.376	2.345
Gmm	2.46		2.464	2.474		2.466	2.464		2.467	2.463
Gsb	2.594	2.594			2.594			2.594		
Gse	2.723		2.681	2.694		2.684	2.677		2.676	2.685
VMA	14.0		13.7	14.7		13.3	13.8		13.3	14.7
AV	4.0		3.9	5.3		3.5	4.0		3.7	4.8

District	6	Site Visit		Material Code				19532R	HMA BC N90 19.0R	
		Sublot 35			Sublot 36			Sublot 37		
	Design	AMF	QC	QA	AMF	QC	QA	AMF	QC	QA
1" (25.0 mm)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
3/4" (19.0 mm)	100.0	100.0	100.0	100.0	100.0	100.0	99.0	100.0	99.0	100.0
1/2" (12.5 mm)	89.0	89.0	92.0	88.0	89.0	87.0	90.0	89.0	91.0	87.0
3/8" (9.5 mm)	82.0	82.0	83.0	83.0	82.0	80.0	82.0	82.0	82.0	79.0
No. 4 (4.75 mm)	57.0	57.0	57.0	58.0	57.0	55.0	57.0	57.0	54.0	54.0
No. 8 (2.36 mm)	32.0	32.0	33.0	33.0	32.0	32.0	32.0	32.0	31.0	32.0
No. 16 (1.18 mm)	21.0	21.0	22.0	22.0	21.0	21.0	21.0	21.0	22.0	21.0
No. 30 (600 µm)	14.0	14.0	16.0	15.0	14.0	15.0	15.0	14.0	15.0	15.0
No. 50 (300 µm)	8.0	8.0	9.0	7.0	8.0	8.0	7.0	8.0	8.0	7.0
No. 100 (150 µm)	6.0	6.0	7.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
No. 200 (75 µm)	4.6	4.6	5.5	4.7	4.6	4.9	4.7	4.6	4.9	4.8
AC Content	5.2	5.3	5.5	5.5	5.3	5.2	5.5	5.3	5.5	5.4
Gmb	2.362		2.41	2.384		2.396	2.362		2.404	2.381
Gmm	2.46		2.461	2.462		2.476	2.465		2.469	2.467
Gsb	2.594	2.594			2.594			2.594		
Gse	2.723		2.678	2.679		2.683	2.683		2.688	2.680
VMA	14.0		12.2	13.2		12.4	14.0		12.4	13.2
AV	4.0		2.1	3.2		3.2	4.2		2.6	3.5

Table 48. District 6 Site Visit Density Results

Density Core									
District			6		Material Code			19532R	
Site Visit					HMA BC N90 19.0R				
	QC		QA			QC		QA	
SEQ number	Gmb	% Density	Gmb	% Density	SEQ number	Gmb	% Density	Gmb	% Density
1			2.283	92.6	95			2.372	96.3
2			2.368	96.1	96			2.339	95.0
3			2.309	93.7	97			2.337	94.8
4			2.360	95.8	98			2.356	95.6
5			2.334	94.7	99			2.338	94.9
6			2.364	96.0	100			2.342	95.1
7			2.331	94.6	101			2.350	95.4
8			2.314	93.9	102			2.308	93.7
9			2.251	91.4	103			2.319	94.1
10			2.307	93.6	104			2.278	92.5
11			2.360	95.8	105			2.355	95.6
12			2.380	96.6	106			2.312	93.8
13			2.354	95.5	107			2.324	94.5
14			2.317	94.1	108			2.337	94.9
15			2.364	96.0	109			2.300	93.5
16			2.337	94.8	110			2.365	96.1
17			2.330	94.5	111			2.316	94.1
18			2.336	94.8	112			2.323	94.4
19			2.341	95.0	113			2.352	95.6
20			2.280	92.6	114			2.333	94.8
21			2.322	94.3	115			2.337	94.9
22			2.356	95.7	116			2.360	95.7
23			2.303	93.5	117			2.356	95.6
24			2.315	94.0	118			2.350	95.3
25			2.324	94.4	119			2.381	96.6
26			2.344	95.2	120			2.329	94.5
27			2.343	95.2	121			2.358	95.7
28			2.339	95.0	122			2.366	96.0
29			2.268	92.1	123			2.330	94.5
30			2.348	95.4	124			2.328	94.4
31			2.318	94.2	125			2.349	95.2
32			2.304	93.6	126			2.343	94.9
33			2.352	95.5	127			2.339	94.8
34			2.320	94.2	128			2.367	95.9
35			2.319	94.2	129			2.275	92.2
36			2.366	96.1	130			2.320	94.0
37			2.341	95.1	131			2.300	93.2
38			2.338	95.0	132			2.303	93.3
39			2.338	95.0	133			2.287	92.7

Density Core									
District			6		Material Code			19532R	
Site Visit					HMA BC N90 19.0R				
	QC		QA			QC		QA	
SEQ number	Gmb	% Density	Gmb	% Density	SEQ number	Gmb	% Density	Gmb	% Density
40			2.261	91.8	134			2.345	95.0
41			2.363	96.0	135			2.300	93.2
42			2.342	95.1	136			2.322	94.2
43			2.278	92.5	137			2.324	94.3
44			2.360	95.9	138			2.296	93.1
45			2.296	93.3	139			2.306	93.5
46			2.395	97.3	140			2.391	97.0
47			2.344	95.3	141			2.308	93.6
48			2.282	92.7	142			2.281	92.5
49			2.322	94.4	143			2.338	94.8
50			2.350	95.5	144			2.338	94.8
51			2.358	95.8	145			2.313	93.9
55			2.389	97.1	146			2.319	94.1
56			2.303	93.6	147			2.341	95.0
57			2.326	94.4	148			2.326	94.4
58			2.356	95.7	149			2.329	94.5
59			2.345	95.2	150			2.330	94.6
60			2.350	95.4	151			2.356	95.5
61			2.327	94.5	152			2.320	94.0
62			2.372	96.3	153			2.354	95.4
63			2.369	96.2	154			2.342	94.9
64			2.310	93.8	155			2.322	94.1
65			2.319	94.2	156			2.350	95.3
66			2.337	94.9	157			2.303	93.4
67			2.346	95.3	158			2.371	96.1
76			2.311	93.8	159			2.340	94.9
77			2.375	96.4	160			2.334	94.6
78			2.369	96.0	161			2.324	94.2
79			2.366	95.9	162			2.309	93.6
80			2.323	94.2	163			2.345	95.0
81			2.283	92.6	164			2.288	92.7
82			2.315	93.8	165			2.330	94.4
83			2.316	93.9	166			2.271	92.0
84			2.296	93.1	167			2.342	94.9
85			2.313	93.8	168			2.342	94.9
86			2.386	96.7	169			2.301	93.2
87			2.335	94.7	170			2.351	95.3
88			2.267	91.9	171			2.325	94.3
89			2.381	96.7	172			2.335	94.6
90			2.330	94.6	173			2.339	94.8
91			2.284	92.7	174			2.328	94.4

Density Core									
District			6		Material Code			19532R	
Site Visit					HMA BC N90 19.0R				
	QC		QA			QC		QA	
SEQ number	Gmb	% Density	Gmb	% Density	SEQ number	Gmb	% Density	Gmb	% Density
92			2.338	94.9	175			2.326	94.4
93			2.276	92.4	176			2.294	93.1
94			2.302	93.4	177			2.339	94.9

District 8 Site Visit 1

Table 49. District 8 Site Visit 1 Volumetrics Results

Mix Information

District	8	Site Visit			1	Material Code			19605FR	
		Sublot 1			Sublot 2			Sublot 3		
	Design	AMF	QC	QA	AMF	QC	QA	AMF	QC	QA
1" (25.0 mm)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
3/4" (19.0 mm)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1/2" (12.5 mm)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
3/8" (9.5 mm)	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	98.0	99.0
No. 4 (4.75 mm)	75.0	75.0	72.0	71.0	75.0	71.0	72.0	75.0	72.0	71.0
No. 8 (2.36 mm)	52.0	52.0	48.0	48.0	52.0	47.0	48.0	52.0	48.0	47.0
No. 16 (1.18 mm)	34.0	34.0	33.0	31.0	34.0	32.0	31.0	34.0	32.0	30.0
No. 30 (600 µm)	21.0	21.0	22.0	20.0	21.0	21.0	20.0	21.0	20.0	19.0
No. 50 (300 µm)	11.0	11.0	12.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0
No. 100 (150 µm)	8.0	8.0	7.0	8.0	8.0	6.0	8.0	8.0	7.0	8.0
No. 200 (75 µm)	5.5	5.5	5.3	6.0	5.5	4.7	6.0	5.5	5.6	6.4
AC Content	5.9	5.9	5.9	5.6	5.9	6.0	6.0	5.9	6.1	6.0
Gmb	2.344		2.365	2.379		2.356	2.381		2.353	2.372
Gmm	2.442		2.451	2.451		2.446	2.438		2.450	2.442
Gsb	2.605	2.605			2.605			2.605		
Gse	2.686		2.683	2.688		2.681	2.671		2.691	2.676
VMA	15.4		14.6	13.8		15.0	14.1		15.2	14.4
AV	4.0		3.5	2.9		3.7	2.3		4.0	2.9

Table 50. District 8 Site Visit 1 Density Results

Density Core				
District			8	
Site Visit			1	
Material Code			19605FR	
HMA LB N70 FG REC				
	QC		QA	
SEQ number	Gmb	% Density	Gmb	% Density
1				
2	2.226	90.8	2.225	91.1
3				
4				
5				
6				
7	2.293	93.6	2.293	93.8
8	2.254	92.0	2.301	94.2
9	2.201	89.8	2.207	90.3
10				
11				
12	2.221	90.6	2.228	91.2
13	2.273	92.7	2.281	93.3
14	2.317	94.5	2.324	95.1
15	2.293	93.5	2.248	92.0
16	2.236	91.2	2.240	91.6
17	2.223	90.7	2.219	90.8
18	2.216	90.4	2.208	90.3
19	2.254	92.0	2.263	92.6
20	2.268	92.5	2.283	93.4
21	2.303	94.0	2.282	93.4
22	2.265	92.4	2.293	93.8
23	2.226	90.8	2.273	93.0
24	2.266	92.5	2.262	92.5
25	2.230	91.0	2.279	93.3
26	2.183	89.1	2.218	90.7
27	2.264	92.4	2.290	93.7
28	2.262	92.3	2.264	92.6
29	2.226	90.8	2.238	91.6
30	2.298	93.8	2.304	94.3
31	2.201	89.8	2.202	90.1
32	2.214	90.3	2.153	88.1
33	2.295	93.6	2.305	94.3

Density Core				
District			8	
Site Visit			1	
Material Code			19605FR	
HMA LB N70 FG REC				
	QC		QA	
SEQ number	Gmb	% Density	Gmb	% Density
34	2.200	89.8	2.211	90.4
35				
36				
37				
38				
39	2.2438	91.5	2.240	91.6
40				
41	2.2813	93.1	2.294	93.8
42				
43				
44	2.2441	91.6	2.268	92.8
45				
46				
47				
48				
49	2.26077	92.2	2.270	92.9

District 8 Site Visit 2

Table 51. District 8 Site Visit 2 Volumetrics Results

District	8	Site Visit		2	Material Code	19523R		HMA SC N70 C REC 9.5		
		Sublot 0			Sublot 1			Sublot 2		
	Design	AMF	QC	QA	AMF	QC	QA	AMF	QC	QA
1" (25.0 mm)	100.0	100.0	100.0	100.0	100.0	100.0		100.0	100.0	
3/4" (19.0 mm)	100.0	100.0	100.0	100.0	100.0	100.0		100.0	100.0	
1/2" (12.5 mm)	100.0	100.0	100.0	100.0	100.0	100.0		100.0	100.0	
3/8" (9.5 mm)	98.0	98.0	97.0	98.0	98.0	96.0		98.0	97.0	
No. 4 (4.75 mm)	63.0	63.0	63.0	62.0	63.0	59.0		63.0	60.0	
No. 8 (2.36 mm)	35.0	35.0	33.0	34.0	35.0	32.0		35.0	32.0	
No. 16 (1.18 mm)	23.0	23.0	20.0	21.0	23.0	18.0		23.0	17.0	
No. 30 (600 µm)	16.0	16.0	13.0	14.0	16.0	14.0		16.0	13.0	
No. 50 (300 µm)	11.0	11.0	10.0	11.0	11.0	11.0		11.0	10.0	
No. 100 (150 µm)	8.0	8.0	8.0	9.0	8.0	9.0		8.0	8.0	
No. 200 (75 µm)	6.0	6.0	6.0	6.8	6.0	6.6		6.0	6.7	
AC Content	6.0	6.0	5.9	5.9	6.0	5.8		6.0	6.0	
Gmb	2.351		2.338	2.339		2.362			2.335	
Gmm	2.449		2.465	2.467		2.462			2.458	
Gsb	2.619	2.619			2.619			2.619		
Gse	2.686		2.701	2.747		2.692			2.697	
VMA	15.6		16.0	16.0		15.0			16.2	
AV	4.0		5.2	5.2		4.1			5.0	

District	8	Site Visit		2	Material Code	19523R		HMA SC N70 C REC 9.5		
		Sublot 3			Sublot 4			Sublot 5		
	Design	AMF	QC	QA	AMF	QC	QA	AMF	QC	QA
1" (25.0 mm)	100.0	100.0	100.0		100.0	100.0	100.0	100.0	100.0	100.0
3/4" (19.0 mm)	100.0	100.0	100.0		100.0	100.0	100.0	100.0	100.0	100.0
1/2" (12.5 mm)	100.0	100.0	100.0		100.0	100.0	100.0	100.0	100.0	100.0
3/8" (9.5 mm)	98.0	98.0	96.0		98.0	97.0	97.0	98.0	97.0	96.0
No. 4 (4.75 mm)	63.0	63.0	60.0		63.0	63.0	63.0	63.0	64.0	61.0
No. 8 (2.36 mm)	35.0	35.0	33.0		35.0	36.0	37.0	35.0	34.0	35.0
No. 16 (1.18 mm)	23.0	23.0	18.0		23.0	20.0	23.0	23.0	17.0	21.0
No. 30 (600 µm)	16.0	16.0	14.0		16.0	15.0	16.0	16.0	13.0	15.0
No. 50 (300 µm)	11.0	11.0	11.0		11.0	11.0	12.0	11.0	10.0	11.0
No. 100 (150 µm)	8.0	8.0	9.0		8.0	9.0	9.0	8.0	7.0	9.0
No. 200 (75 µm)	6.0	6.0	7.3		6.0	6.6	7.5	6.0	5.5	7.0
AC Content	6.0	6.0	5.5		6.0	6.0	5.9	6.0	6.2	5.7
Gmb	2.351		2.345			2.381	2.378		2.365	2.363
Gmm	2.449		2.462			2.450	2.447		2.465	2.462
Gsb	2.619	2.619			2.619			2.619		
Gse	2.686		2.679			2.686	2.678		2.715	2.688
VMA	15.6		15.4			14.5	14.6		15.3	14.9
AV	4.0		4.8			2.8	2.8		4.1	4.0

Table 52. District 8 Site Visit 2 Density Results

Density Core				
District			8	
Site Visit			2	
Material Code			19523R	
HMA SC N70 C REC 9.5				
	QC		QA	
SEQ number	Gmb	% Density	Gmb	% Density
1			2.297	93.5
2			2.280	92.9
3			2.320	94.5
4			2.304	93.8
5			2.266	92.3
6			2.297	93.6
7			2.354	95.9
8			2.380	97.0
9			2.250	91.7
10			2.342	95.4
11			2.284	93.0
12			2.262	92.1
13			2.313	94.2
14			2.327	94.8
15			2.324	94.6
16			2.338	95.2
17			2.291	93.3
18			2.267	92.3
19			2.311	94.1
20			2.264	92.2
21			2.374	96.7
22			2.329	94.9
23			2.310	94.1
24			2.279	92.9
25			2.282	92.9
26			2.209	90.0
27			2.365	96.3
28			2.276	92.7
29			2.264	92.2
30			2.299	93.7
31			2.293	93.4
32			2.255	91.9
33			2.262	92.1
34			2.282	93.0

Density Core				
District			8	
Site Visit			2	
Material Code			19523R	
HMA SC N70 C REC 9.5				
	QC		QA	
SEQ number	Gmb	% Density	Gmb	% Density
35			2.336	95.2
36			2.353	95.8
37			2.382	97
38			2.352	95.8
39			2.286	93.1
40			2.37	96.5
41			2.33	94.9
42			2.346	95.6
43			2.281	92.9
44			2.305	93.9

District 9 Site Visit

Table 53. District 9 Site Visit Volumetrics Results

Mix Information

District	9	Site Visit			Material Code		19606FR
HMA LB N90 FG REC		Sublot 1			Sublot 2		
	Design	AMF	QC	QA	AMF	QC	QA
1" (25.0 mm)	100.0	100.0	100.0	100.0	100.0	100.0	100.0
3/4" (19.0 mm)	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1/2" (12.5 mm)	100.0	100.0	100.0	100.0	100.0	100.0	100.0
3/8" (9.5 mm)	99.0	99.0	99.0	98.0	99.0	99.0	98.0
No. 4 (4.75 mm)	79.0	79.0	80.0	81.0	79.0	80.0	81.0
No. 8 (2.36 mm)	50.0	50.0	53.0	53.0	50.0	52.0	53.0
No. 16 (1.18 mm)	33.0	33.0	33.0	35.0	33.0	32.0	33.0
No. 30 (600 µm)	21.0	21.0	22.0	22.0	21.0	21.0	22.0
No. 50 (300 µm)	11.0	11.0	11.0	11.0	11.0	11.0	11.0
No. 100 (150 µm)	8.0	8.0	8.0	8.0	8.0	8.0	8.0
No. 200 (75 µm)	5.7	5.7	5.9	6.0	5.7	5.9	6.3
AC Content	5.9	5.9	5.8	5.7	5.9	5.6	5.5
Gmb	2.339		2.367	2.375		2.355	2.353

Mix Information

District	9	Site Visit			Material Code		19606FR
HMA LB N90 FG REC		Sublot 1			Sublot 2		
	Design	AMF	QC	QA	AMF	QC	QA
Gmm	2.436		2.454	2.450		2.460	2.461
Gsb	2.609	2.609			2.609		
Gse	2.665		2.682	2.686		2.681	2.678
VMA	15.7		14.5	14.2		14.8	14.8
AV	4.0		3.5	3.1		4.3	4.4

Table 54. District 9 Site Visit Density Results

Density Core				
District			9	
Site Visit				
Material Code			19606FR	
HMA LB N90 FG REC				
	QC		QA	
SEQ number	Gmb	% Density	Gmb	% Density
1	2.282	92.9	2.280	92.8
2	2.331	94.9	2.327	94.7
3	2.340	95.3	2.339	95.2
4	2.324	94.6	2.313	94.2
5	2.341	95.3	2.339	95.2
6	2.287	93.1	2.293	93.4
7	2.358	96.0	2.374	96.7
8	2.340	95.3	2.340	95.3
9	2.297	93.5	2.287	93.1
10	2.288	93.2	2.292	93.3
11	2.292	93.3	2.302	93.7
12	2.190	89.2	2.204	89.7
13	2.175	88.6	2.186	89.0
14	2.050	83.5	2.014	82.0
15	2.327	94.7	2.319	94.4
16	2.327	94.7	2.307	93.9
17	2.290	93.2	2.291	93.3
18	2.301	93.7	2.304	93.8
19	2.232	90.9	2.214	90.1
20	2.311	94.1	2.320	94.5

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