Implementation of Low-Temperature Cracking Criteria in Iowa

Final Report
April 2021

ASPHALT MATERIALS &
PAVEMENTS PROGRAM

IOWA STATE UNIVERSITY
Institute for Transportation

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16. Abstract

Iowa is among the northern US states that experience fluctuating low temperatures that cause low-temperature thermal cracking. Thermal stress buildup in pavements due to low temperatures—and often large, sudden drops in temperatures—result in excessive thermal cracking that requires frequent maintenance work. This increases maintenance costs for pavements and reduces pavement service life, adding an extra cost to departments of transportation (DOTs) budgets. To prevent this distress from occurring too soon in new pavements, there are specifications to guide engineers in designing asphalt pavement mixes. Generally, it is expected that field-produced mixes will have higher variance within their results when compared to laboratory-produced mixes. However, when the variance is too high, mix performance becomes compromised, thus leading to more excessive thermal fracture at low temperatures.

This study evaluated the current performance of field-produced mixtures using various low-temperature cracking methods and recommends necessary adjustments to the limiting criteria for laboratory-produced mixes to enable asphalt pavements to perform better and last longer under low-temperature cracking. Ten different field-produced asphalt mixtures were obtained from paving projects paved within the past seven years. These mixtures were reheated and laboratory-compacted using a gyratory compactor to produce 6 in. (150 mm) diameter specimens with a height of approximately 2 in. (50 mm). To determine the fracture energies of the compacted sample, disk-shaped compact tension (DCT) and semi-circular bend (SCB) tests were carried out as specified by ASTM D7313-13 and AASHTO TP 105-13, respectively. Air voids were determined prior to testing to ensure that specimens used met the air void requirement of 7% for testing. Illinois Flexibility Index Test (I-FIT) Procedure 405 was used for testing at intermediate warmer temperatures to get the flexibility index (FI) as well.

The 10 mixtures evaluated had an average fracture energy ranging from 265–470 J/m^2 and 485–905 J/m^2 for DCT and SCB, respectively. The FI obtained for the mixtures ranged from 8.36 to 23.32. The DCT fracture energies did not meet the DCT specifications contained in IM510 for the average minimum fracture energies, and the DCT and SCB fracture energies are lower than those produced for approval to pave. A performance criteria adjustment is recommended to ensure that field-produced mixtures meet design specifications from the laboratory to the field.

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IMPLEMENTATION OF LOW-TEMPERATURE CRACKING CRITERIA IN IOWA

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

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EXECUTIVE SUMMARY

Goals

The goals of this project were to assess the low-temperature cracking resistance of asphalt mixtures used by the Iowa Department of Transportation (DOT), correlate the laboratory results with field performance, and use those correlations to propose additional performance criteria.

Problem Statement

Thermal stress buildup in pavements due to low temperatures—and often large, sudden drops in temperatures—result in excessive thermal cracking that requires frequent maintenance work. This increases maintenance costs for pavements and reduces pavement service life.

Background

Iowa is among the northern US states that experience fluctuating low temperatures that cause low-temperature thermal cracking. To prevent this distress from occurring too soon in new pavements, engineers use specifications to guide them in designing asphalt pavement mixes.

Current Superpave specifications address thermal cracking at low temperatures based on creep and strength testing of asphalt binders and mixtures, but the specifications only have limiting criteria set forth in the asphalt binder specifications. In addition, these low-temperature characterization methods do not take into account the effect from the aggregate part of the mixture.

Mix test specifications consider the effect from both binder and aggregate. However, mix test specifications do not have clearly set national limits in Superpave; they are set by individual state agencies. Researchers and state DOTs within the Midwestern US have used the disk-shaped compact tension (DCT) test, the semi-circular bend (SCB) test, and the Illinois Flexibility Index Test (I-FIT) to assess low-temperature cracking/fracture in mixtures.

To avoid thermal cracking in the field, characterization of mechanical fracture of the asphalt mixture is important in predicting the pavement performance and assists the design engineer in establishing a mix design that can withstand the cold climate for the design period.

Project Description

Ten field-produced asphalt mixtures were obtained from projects that represented typical asphalt mixtures used in Iowa. The mixtures were from Fayette, Hamilton, Harrison, Johnson, Lyon, Marshall, Polk, and Union counties.

Five mixtures were from the old design, and the other five mixtures were from the new design. The mixtures had different binder grades and aggregate gradation, voids in mineral aggregate (VMA), voids filled with asphalt (VFA), binder content, and varying percentage of the recycled material. These mixtures were reheated and laboratory-compacted using a gyratory compactor to produce 6 in. (150 mm) diameter specimens with a height of approximately 2 in. (50 mm).

To determine the fracture energies of the compacted samples, DCT and SCB tests were carried out as specified by ASTM D7313-13 and AASHTO TP 105-13, respectively. Air voids were determined prior to testing to ensure that the specimens used met the air void requirement of 7% for testing. I-FIT Procedure 405 was used for testing at intermediate warmer temperatures to get the flexibility index (FI) as well.

Key Findings

- The 10 mixtures evaluated had an average fracture energy ranging from 265–470 J/m^2 and 485–905 J/m^2 for DCT and SCB, respectively.
- The DCT fracture energies did not meet the DCT specifications contained in Instructional Memorandum 510 for the average minimum fracture energies.
- The DCT and SCB fracture energies are lower than those produced for approval to pave.
- The FI obtained for the mixtures ranged from 8.36 to 23.32.

Implementation Readiness and Benefits

This project assessed 10 field-produced asphalt mixtures used in Iowa to determine their low-temperature cracking resistance and recommends performance criteria adjustments to state specifications based on the results.

These recommended performance criteria adjustments to the state specifications will ultimately reduce maintenance costs and improve the service life of Iowa pavements.

Conclusions and Recommendations

Performance criteria adjustments and a pavement distress survey are recommended to ensure that field-produced mixtures meet design specifications from the laboratory to the field.

- The specification on the need for a DCT test should be revised to state that the test is required when the asphalt binder replacement exceeds 15% for mixtures with recycled asphalt pavement (RAP) and reclaimed asphalt shingles (RAS), rather than the current value of 30% and 25% binder replacement, respectively.
- Since most of the pavements have shown that cracking resistance is low during service life, there is a need for revising the specification or improving the quality-control process, just as the Minnesota DOT (MnDOT) has allowed a 50 J/m^2 range for quality assurance.

- A pavement distress survey is recommended that focuses more on the intensity of thermal- and transverse-cracking distress over the years to assess the field performance of the pavements used in this study in relation to the DCT testing results.

CHAPTER 1. INTRODUCTION

Background Information

In cold regions of North America (northern US and Canada), the main distress observed in asphalt pavements is low-temperature cracking or thermal cracking. At very low temperatures, the top layer of asphalt concrete undergoes shrinking. However, the top layer is constrained because of friction occurring between itself and an underlying layer of asphalt concrete. This is the action by which thermal-induced tensile stresses are produced. As the temperature decreases, the thermal-induced tensile stress increases, and once it exceeds the pavement tensile strength, the asphalt concrete pavement cracks.

Current Superpave specifications address thermal cracking at low temperatures based on creep and strength testing of asphalt binders and mixtures, but it only has limiting criteria set forth in the asphalt binder specifications like the bending beam rheometer (BBR) test. In addition, these low-temperature characterization methods do not take into account the effect from the aggregate phase of the mixture. Mix test specifications consider the effect from both binder and aggregate. However, mix test specifications do not have clearly set national limits in Superpave; they are set by individual state agencies. The aggregate phase makes up 90% to 95% of the total weight of a typical asphalt concrete mixture. To address the impact of the aggregate phase on low-temperature cracking in asphalt mixtures, a fracture mechanics-based approach is necessary. The following low-temperature cracking/fracture mix tests have been used by researchers and state departments of transportation (DOTs) within the Midwestern US:

- Semi-circular bend (SCB)
- Illinois Flexibility Index Test (I-FIT)
- Disk-shaped compact tension (DCT)

The SCB test has become favored by industry due to the ease of fabrication and that it is reproducible. Two specimens can be obtained from one field core, reducing the number of cores to be obtained from the field (Wagoner et al. 2005a). The I-FIT has been found to be more effective at differentiating effects due to design factors and mixture aging than fracture energy (G_f) by itself. The flexibility index (FI) is calculated using G_f and post-peak slope (Rivera-Perez et al. 2018). The DCT test can be used with field cores that have already undergone dynamic modulus and creep compliance testing. Additionally, the geometry maximizes the potential fracture area, which reduces statistical variability of the data obtained (Wagoner et al. 2005a).

Research Objective

Durability and performance of pavements is one of the important aspects of design, and they are achieved by understanding the design product. For low-temperature cracking, characterizing asphalt mixes helps to understand the pavement performance by understanding the fracture strength of different materials. Previously, binder characterization has been used; however, asphalt mixes are composed of approximately 95% other materials than the asphalt binder. To avoid thermal cracking in the field, characterization of mechanical fracture of the asphalt mixture is important in predicting the pavement performance and assists the design engineer in establishing a mix design that can withstand the cold climate for the design period.

The objective of this study was to assess the low-temperature cracking resistance of asphalt mixtures used by the Iowa DOT and correlate the laboratory results with field performance. Based on the developed correlations, performance criteria for the DCT and SCB tests were proposed. The results were compared with what other states in the Midwest are doing.

Overall Report Experimental Plan

A technical advisory committee (TAC) was formed that consisted of representatives from Iowa DOT, local agencies, and industry professionals. A set of projects that represent typical mixtures and materials used by the Iowa DOT was identified for use in this study. DCT and SCB tests were used to evaluate the low-temperature cracking resistance of these mixtures.

Contents of this Report

Chapter 1 introduces background information and the objectives of this study. Chapter 2 contains the literature review on low-temperature cracking, G_f, and the DCT, SCB, and I-FIT tests and their specifications, as well as what other states are doing. It also includes future recommended work. Experimental methods are covered in Chapter 3, while Chapter 4 presents the results and their analysis. Chapter 5 contains conclusions and recommendations on asphalt mix G_f characterization for design.

CHAPTER 2. LITERATURE REVIEW

Low-Temperature Cracking

Low-temperature cracking occurs when stress buildup from thermal contraction surpasses pavement tensile strength due to sudden temperature drop and/or repeated temperature fluctuation. The crack typically forms in a transverse direction on the pavement surface. Low-temperature cracking is affected by material, environment, and pavement-structure geometry (Kliewer et al. 1996). Thermal cracking is a distress that can compromise the structural integrity of the pavement (Behnia et al. 2018), and the primary concern about this distress is the infiltration of water into the pavement structure, which from a durability standpoint increases the rate of moisture and leads to earlier asphalt concrete deterioration. More so, water infiltration promotes pumping of the underlying unbound material, causing depression at the thermal cracks. Ice lenses could also form beneath a thermal crack and in turn would cause tenting of the crack edge (Marasteanu 2007).

Thermal cracks are categorized into two types of events: (1) single-event thermal cracks that occur due to fast cooling, e.g., a drop in temperature from -10°C to -40°C in a span of 24 hours, and (2) thermal-fatigue cracking that can develop due to several cooling cycles and daily temperature fluctuation. There have been great research efforts directed toward characterization and prevention of thermal cracks in pavement, and this has led to the development of mixture-based thermal-cracking performance evaluation tools such as the DCT test, SCB test, and the use of the combination of stiffness and relaxation properties of asphalt mixtures in black space to limit thermal stresses (Oshone et al. 2018).

G_f is an asphalt mixture fracture parameter that recent studies have identified to have a correlation with thermal-cracking resistance. It is defined as the work that is required to cause a unit square (m^2) crack to form in a laboratory test specimen. The G_f is affected by aggregate type, test temperature, the addition of recycled material, and air voids of the mix (Wagoner et al. 2005b, Li et al. 2010). High G_f indicates that the pavement has high tensile strength and thus can dissipate tensile stress buildup more easily in the pavement at low temperatures when the pavement is under loading.

Oshone et al. (2018) reported a positive correlation between G_f and properties that include effective binder content, asphalt film thickness, voids in mineral aggregate (VMA), performance-grade high temperature, and performance-grade spread. A good gradation of material ensures adequate VMA and thus sufficient binder. The voids filled with asphalt (VFA) and VMA are critical in mixture crack resistance and durability. Lowering VMA lowers the binder content for that specific air void content and leads to a more economical mixture but less durability.

Fracture temperature, or the critical cracking temperature, is an important aspect of thermal-crack resistance of a pavement. It is a function of the cooling rate and the temperature at which cooling starts and is affected by asphalt type and degree of aging. Warmer starting temperatures shift the cracking temperature (Mensching et al. 2014). The most frequent actual cooling rate in the field is 1°C to 2°C per hour. An increase in cooling rate results in an increase in the fracture temperature. The cooling rate is the temperature drop per unit of time. Most tests have been conducted at a cooling rate of 10°C per hour by investigators; however, field cooling rates are slower than 10°C (Jung and Vinson 1994). Faster cooling rates cause quicker thermal stress buildup and material cracking at a warmer temperature due to the material lacking time to relax (Mensching et al. 2014).

Hot-mix asphalt (HMA) is designed to resist deterioration due to exposure to traffic and environmental loads. Different HMAs are chosen depending on traffic level and geological location, which influence the variability of mixture components such as binder grade and aggregate. Sustainability is one concern of engineers, and this has led to the use of recycled material as a part of pavement construction, as the milled material is reused as 30% of the asphalt components. This, in turn, has an impact on pavement performance, particularly on distress resistance. An asphalt mixture's fracture and viscoelastic properties play a significant role in controlling the ability of the mixture to limit thermal stress and maintain material integrity as the stress approaches the material stress capacity (Oshone et al. 2018).

Dave et al. (2016) recommended the critical selection of asphalt binder for use and argued that the use of asphalt binder with a low-temperature limit warmer than the required grade can shorten the pavement life significantly. They further strongly recommended the use of performance-based specifications that apply laboratory-mix performance tests. Additionally, the oxidative aging effects of the asphalt binder should be considered while determining asphalt crack resistance.

Hoare and Hesp (2000) state that for a pavement to fail at low temperatures, there has to be either poor material selection or an inadequate testing procedure. An understanding of the fundamental failure mechanisms and other material properties that facilitate crack growth at low temperatures is important.

Behnia et al. (2011) observed that the G_f of an asphalt mixture containing a virgin binder (PG 58-28) was drastically reduced when the recycled asphalt pavement (RAP) amount within the mix gradation exceeded 10%. While the G_f of mixtures containing virgin binder PG 64-22 initially increased with an increase in RAP amount up to 30%, any increase in RAP amount over 30% decreased the G_f. Using a different aging procedure, the study also indicated that the fracture energies of the asphalt mixtures increase with aging levels to a peak level where the fracture energies dropped with further aging. Behnia et al. pointed out that this trend will vary from mixture to mixture, between RAP sources, and from varying binder sources.

Marasteanu (2007) in the first phase of a national pooled fund study recommended the critical need for an asphalt mixture specification. Further, it was pointed out that the G_f of the asphalt mixture is a better parameter to identify an asphalt mixture's low-temperature cracking susceptibility compared to the K_{IC}. The reason for this being that G_f depends less on the conditions of linear elasticity and homogeneity of the tested materials.

In the second phase of the low-temperature cracking national pooled fund study, Mihai et al. (2012) proposed a thermal-cracking specification for asphalt mixtures; based on DCT results, a minimum G_f of 400 J/m^2 was suggested for protection against thermal cracking. Additionally, based on SCB results, a testing value of 400 J/m^2 was suggested too. These suggested values were determined through a correlation of the fracture data and field thermal cracking. The DCT test was recommended to be included as a requirement in the low-temperature thermal-cracking mix performance-based specification.

The outcome of the studies that determined the correlation has been that many agencies have identified 400 J/m^2 as the passing criteria for mixes tested at the low-temperature grade of the asphalt binder for the DCT test (Mihai et al. 2012). In Iowa, the DCT test is the method used for low-temperature cracking performance of asphalt mix. The criteria established by the Iowa DOT is 400 J/m^2, 460 J/m^2, and 690 J/m^2 for traffic levels of standard traffic, heavy traffic, and very heavy traffic, respectively. Dave et al. (2016) concluded that a variation of 25 J/m^2 G_f is enough to show a difference in cracking performance.

In a study by West et al. (2018), Iowa was among the states that use the balanced mix design approach, one which is Volumetric Design with Performance Verification. At the time of study, only Iowa, Minnesota, and Missouri required a thermal-cracking test in their mix design specifications, and they used the DCT. In the study, it was noted that lowering the number of design gyrations (N_{design}) will result in an increase in the optimum asphalt content if aggregate gradation is fixed. Their recommendation was to reduce the N_{design} level by 20% to 25% depending on the design traffic (West et al. 2018).

The Minnesota DOT (MnDOT) has implemented DCT testing as a requirement to ensure the thermal-cracking resistance of asphalt mixtures at design and production. Additionally, a G_f limit has been established in its specification. The minimum G_f during mix design is 450 J/m^2 for traffic levels 1, 2, and 3 and 500 J/m^2 for traffic levels 4 and 5. For quality assurance, the G_f is reduced by 50 J/m^2 to values of 400 J/m^2 for traffic levels 1, 2, and 3 and 450 J/m^2 for traffic levels 4 and 5 (Oshone et al. 2018).

The SCB test has been used to evaluate the factors that affect G_f, and these factors were identified to be aggregate type, air voids content, modifier type, and the binder type (Li et al. 2010). Different aggregate requires different amounts of energy for them to crack, and this compounds the total mixture crack resistance. More energy is needed to break a denser asphalt mixture. Li et al. in their research indicated that asphalt modified with different modifiers had different G_f for the same type of mixture. SCB has also been used to determine the effect of testing configuration on semi-circular bending fracture of asphalt mixture (Nsengiyumva and Kim 2019).

Rivera-Perez et al. (2018) in a study indicated that the FI is an indicator of ductility of the mixture but should be balanced with the stiffness and strength of the mixture. An increase in FI is associated with additional inelastic mechanisms (i.e., plasticity and viscoelasticity) of energy dissipation away from the crack front, which may delay fracture initiation and propagation. The results considered for correlations were those with 8% air void content and below; at 10% air void, the fracture test specimen experiences a high level of non-fracture-related energy dissipation. However, correction factors proposed by Barry (2016) could be used to correct for the air void content variation.

SCB Test and I-FIT

The SCB test is an HMA fracture test used at low temperatures. Recently, the SCB test has become favored among researchers, because specimen fabrication is simple and easily reproducible using both standard laboratory-compacted or field-cored asphalt concrete samples. Within this test, two fracture modes can be studied: Mode I or Mode II. The fracture mode depends on the initial notch orientation. For low-temperature tests, such as the Illinois Test Procedure 405 (I-FIT) developed by researchers from the University of Minnesota–Twin Cities and the University of Illinois–Urbana-Champaign and the SCB test according to AASHTO TP 105-13 (both shown in Figure 1), Mode I fracture is used for specimen preparation, testing, and analysis.

Figure 1. I-FIT SCB test, left, and AASHTO TP 105-13 SCB test, right

G_f, fracture toughness (K_{IC}), and stiffness (S) are the parameters determined using the SCB test results according to AASHTO TP 105-13, while the parameters determined using the I-FIT protocol are G_f and FI (Test- 2007, Li et al. 2010, Marasteanu et al. 2012, Hill et al. 2013, Illinois Test Procedure 405 2016).

The SCB test method for low-temperature cracking was developed due to specifications utilizing only binder tests such as the BBR and direct tension tester (DTT) for characterization of low-temperature performance. These test methods do not include the response from the aggregate phase, even though the aggregate phase makes up 90% to 95% of the total weight of a typical asphalt concrete mixture. To address the impact of the aggregate phase on low-temperature cracking in asphalt mixtures, AASHTO TP 10-13 was developed. Testing takes place at both 10°C above the low-temperature binder grade and 2°C below the low-temperature binder grade. A vertical compressive load is applied at the top of each specimen, so a constant crack mouth opening displacement (CMOD) of 0.00002 in./s (0.0005 mm/s) is achieved. The parameter G_f is determined as the area under load-CMOD curve, while toughness and stiffness are determined using load and load line displacement (LLD) results recorded for each tested specimen.

The I-FIT was developed to screen out potentially poor-performing mixtures with high amounts of RAP and reclaimed asphalt shingles (RAS) and correlates well to field results and other cracking tests, while still being practical and easily repeatable (Ozer et al. 2016, Rivera-Perez et al. 2018). In contrast to other SCB tests done at low temperatures, the I-FIT includes G_f and post-peak behavior in the determination of the FI, which has been found to be more effective at differentiating effects due to design factors and mixture aging than G_f by itself (Barry 2016).

Testing takes place at 25°C with a loading rate of 2 in./min (50 mm/min). Currently, the Illinois DOT has set the minimum criteria for FI at 8, but the I-FIT and FI parameter need to be further calibrated to different traffic levels, climates, mix types, and applications. Further, there are concerns that with the 25°C test temperature for the I-FIT that this does not comply with the principles of fracture mechanics. This is because the test specimens undergo deformation on the millimeter to centimeter scale prior to completion of cracking, and thus the test violates the small-scale yielding condition, so the samples would need to be much larger, e.g., on the scale of meters in diameter.

DCT Test

To examine the fracture mechanics of asphalt concrete at low temperatures, the DCT test is of key interest. The DCT test has received favorable reviews because of its many advantages; the test can be used with field cores that have already undergone dynamic modulus and creep compliance testing, and specimens can be reproduced consistently for use in Mode I fracture testing (Wagoner et al. 2005c, T 322 2007, Test- 2007, Hill et al. 2012, 2013). This test is used to determine the G_f (Wagoner et al. 2005a, Zofka and Braham 2009, Hill et al. 2013).

For the DCT test, a circular specimen with a single edge notch is subjected to tension as shown on the left in Figure 2.

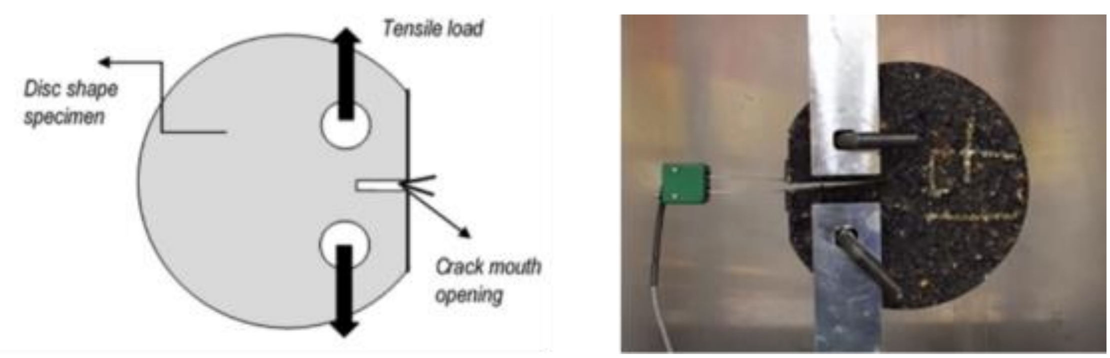
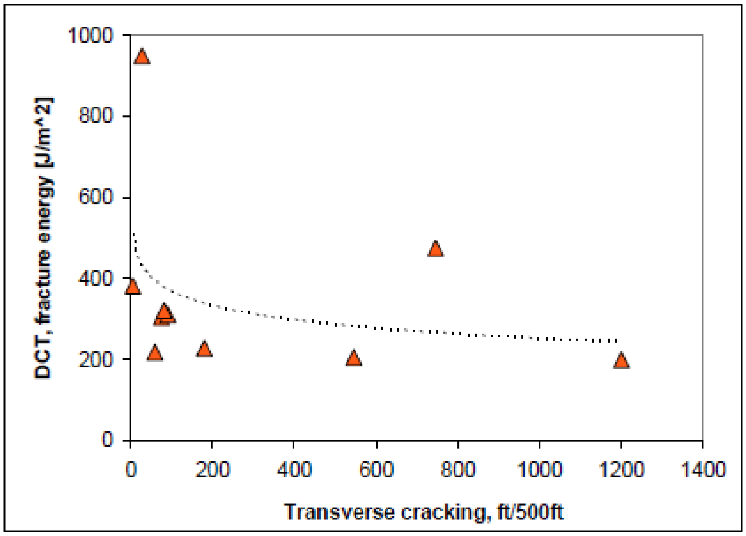


Figure 2. Schematic of DCT test, left, and clip gauge attached to buttons, right

In this setup, a tensile load is applied at the top and bottom of each specimen to produce a constant CMOD with a constant rate of 0.0007 in./s (0.017 mm/s). An epsilon clip gauge as shown on the right in Figure 2 is used to measure the CMOD. The clip gauge is placed between two buttons that are glued to the flat face of the specimen. The G_f is determined through load and fitted CMOD results.

The outcomes of the two-phase national pooled fund study on low-temperature cracking (Mihai et al. 2012) identified the relationship between the amount of transverse cracking of field pavements and the G_f of cores from these pavements (Figure 3).



Marasteanu et al. 2012

Figure 3. Relationship between transverse cracking and DCT G_f

CHAPTER 3. EXPERIMENTAL METHODS AND MATERIALS

Materials

Ten field-produced asphalt mixtures were obtained from projects located in Iowa that represented typical asphalt mixtures used in Iowa. The mixtures were from Fayette, Hamilton, Harrison, Johnson, Lyon, Marshall, Polk, and Union counties. Figure 4 shows the mixture locations, representing five of the six Iowa DOT districts.

Figure 4. Mixture locations and regional recommended Project I type binder grade in Iowa

Note that Project I types are full depth hot-mix asphalt, HMA + cold in-place recycling, HMA + rubblization, HMA + crack and seat HMA overlay >4 in., and HMA + full-depth reclamation (FDR).

Five mixtures were from the old design, and the other five mixtures were from the new design. The mixtures had different binder grades and aggregate gradation, VMA, VFA, binder content, and varying percentage of the recycled material as shown in Table 1.

Table 1. Mixture properties

Mix	Year	Binder type	Binder content	VMA	VFA	AFT	Recycled material % in mix	Traffic level	District
1	2013	PG58-28	5.33	16.7	76.1	10.84	11% RAP, 4% RAS	High	3
2	2014	PG64-22w/hG	5.28	16.8	76.1	10.22	9.5% RAP, 5% RAS	High	1
3	2013	PG58-28	5.33	16.7	76.1	10.84	5% RAP, 4% RAS	High	3
4	2013	PG64-28	4.49	13.2	69.7	8.43	12% slag, 34% RAP	High	6
5	2014	PG58-28	5.48	16.8	76.1	10.22	9.5% RAP, 5% RAS	High	1
6	2018	PG58-28V	4.75	13.9	71.2	9.3	19% RAP	Very high	1
7	2018	PG58-34H	5.34	14.4	72.3	9.85	15% RAP	High	2
8	2018	PG58-28S	5.89	14.7	72.7	8.71	-	Standard	4
9	2018	PG58-28H	5.36	15.3	73.8	14.45	15% RAP	High	4
10	2018	PG58-28S	5.02	14	71.3	8.74	17% RAP	Standard	1

Note: AFT = Asphalt film thickness

Figures 5 and 6 show the gradations of both the old design and the new Ndesign mixtures used in this project.

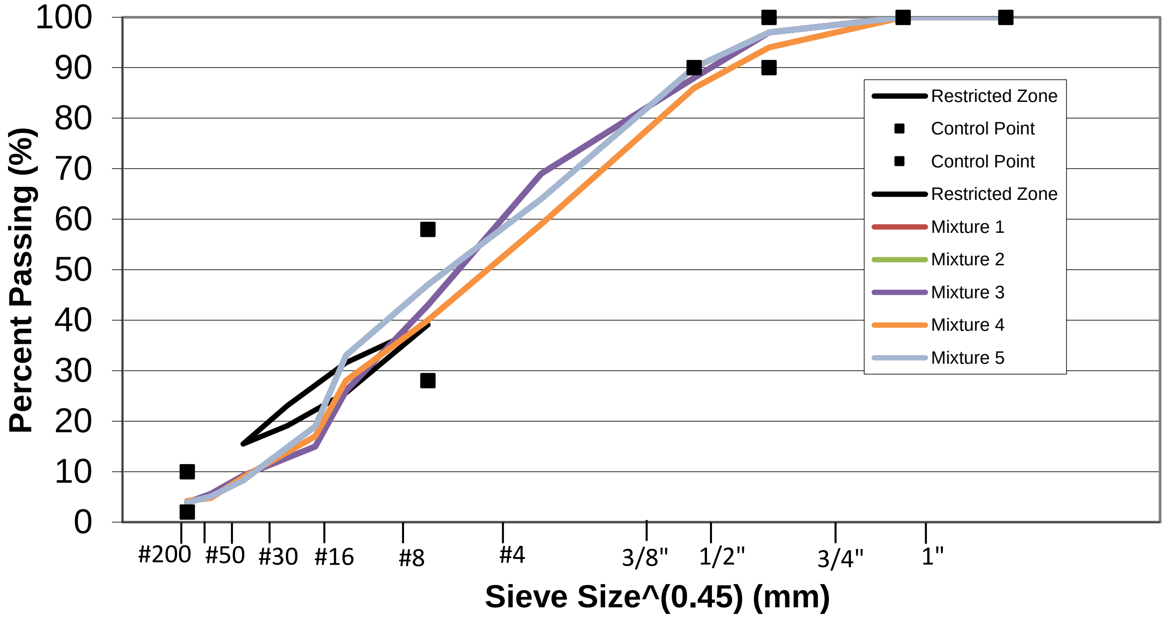


Figure 5. Old Ndesign aggregate mix gradations

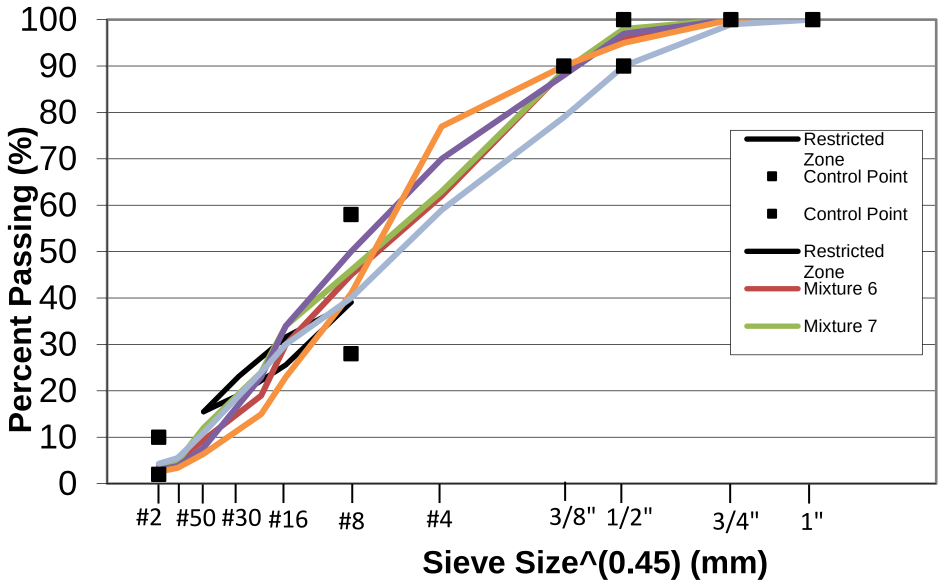


Figure 6. New Ndesign aggregate mix gradations

For the aggregate gradations, most of the aggregate sizes are in the range of 0.04 in. (1 mm) to 0.5 in. (12.5 mm). Although the Ndesign involves lowering the number of design gyrations, this was not evident between the old and new Ndesign gradation as there were not significant differences between asphalt content when lowering gyration levels based on traffic level design.

Methods

The overall test plan is shown in Figure 7.

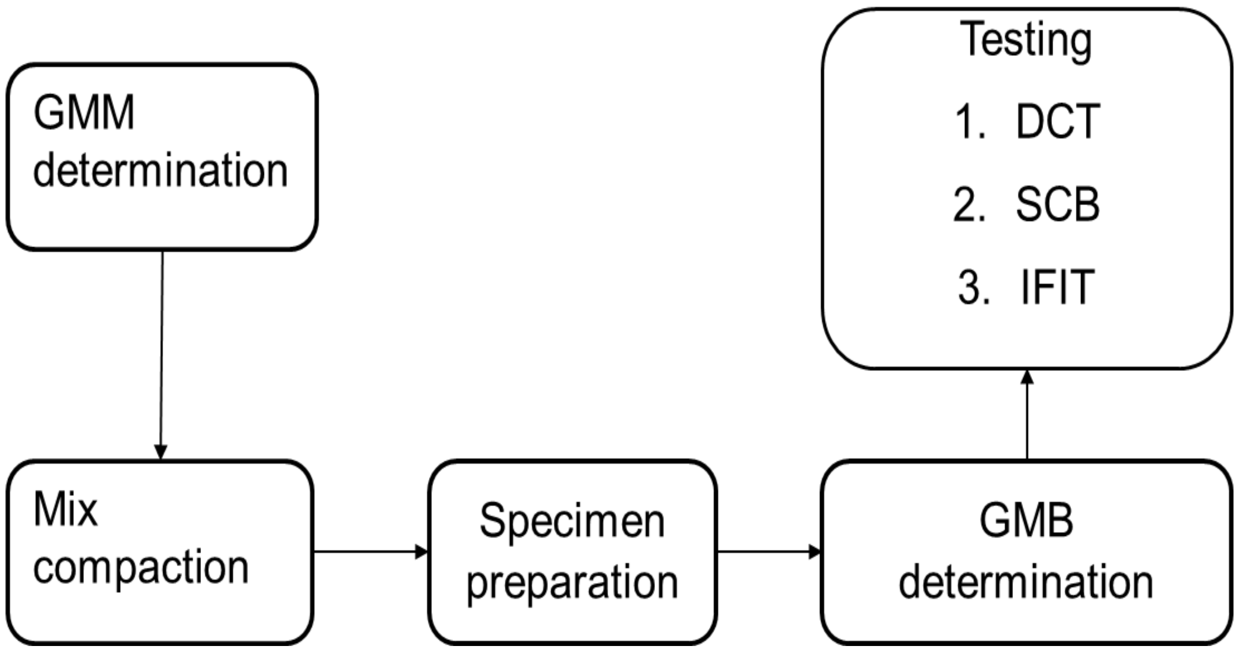


Figure 7. Test plan

Theoretical maximum specific gravity (G_{mm}) was determined using AASHTO T 209-12. The loose mixtures were heated to 90°C, the conglomerates were separated to form fine particles of 0.25 in. (6 mm,) and the process was carefully done to prevent fracture of the aggregate. After cooling, 2,500 grams from the mixtures were measured per mix. Using the G_{mm} test container, the weight of the sample and container were recorded, as well as the weight of the container immersed in a water bath. Water was added to cover the sample in the vacuum equipment; a vacuum between 1 in. (25.5 mm) and 1.2 in. (30 mm) of mercury was applied. During the vacuum period, the container and the contents were agitated using a mechanical vibratory device. After 15 minutes, the sample was immersed in a water bath for 5 minutes, and the weight was recorded; the G_{mm} was then calculated.

The samples were cut to achieve the configuration specified for each test. Water was used while cutting to cool the saw and to wash away small particles to prevent smearing. A bulk specific gravity (G_{mb}) test of the specimen was carried out following ASTM D2726. The samples were left to dry after cutting, and their dry weights were recorded. Each sample was then immersed in water for 5 minutes, and the immersed weight was recorded; the sample was then removed from the water, and the surface wiped with a damp towel to achieve saturated surface dry condition. They were then weighed, and the weight recorded. The G_{mb} was then calculated.

The specimen air voids were calculated using the obtained G_{mm} and G_{mb} to identify the specimen that met the required air void criteria of 7% ± 0.5% to be used for DCT, SCB, and I-FIT tests. To determine the fracture energies of the compacted sample, specimen preparation was done following ASTM and AASHTO specifications for the respective tests. They were a conditioned for minimum of two hours at the test temperature, and then DCT, SCB, and I-FIT were carried out, and four replicates were used per mix per test.

DCT

The DCT tests were carried out in accordance with ASTM D7313-13. The different mixture specimens were tested at 10°C higher than the lower limit temperature of the performance grade, i.e., for PG 64-22, the samples were tested at -12°C, and most of the samples were tested at -18°C. A 0.04 in./min (1.0 mm/min) rate of CMOD was used. Continuous load and CMOD were measured and recorded using the test computer, and a plot of load-CMOD was also obtained. G_f is computed as the area under the load-CMOD curve; the equipment used calculated the G_f value immediately when the specimen fails under loading.

SCB

Following AASHTO TP 105-13 (2015), the SCB tests were carried out with a constant CMOD of 0.00002 in. (0.0005 mm) to ensure the crack growth condition is stable at 10°C higher than the PG lower limit. LLD was measured and recorded using universal testing machine (UTM) equipment. MATLAB was used to plot load and LLD, and G_f was calculated as the area under load-LLD curve.

Table 2 shows a sample of the raw data obtained from an SCB test of one of the mixtures.

Table 2. Sample of SCB raw data of one sample as obtained during the test

Time (seconds)	CMOD (mm)	Load (KN)	Stroke (mm)	LLD (mm)	Ext (mm)	Temp (°C)
0	4.3736	-0.005	-18.419	9.554	0.005	-18
0.1	4.3742	-0.011	-18.424	9.56	0.006	-18
0.2	4.3738	-0.005	-18.417	9.562	0.005	-18
0.3	4.3731	-0.002	-18.409	9.557	0.004	-18
0.4	4.3736	-0.003	-18.412	9.564	0.005	-18
0.5	4.3736	0.001	-18.406	9.566	0.005	-18
0.6	4.374	0.006	-18.398	9.575	0.005	-18
0.7	4.3741	0.013	-18.391	9.585	0.005	-18
0.8	4.3739	0.019	-18.386	9.588	0.005	-18
0.9	4.3738	0.026	-18.383	9.59	0.004	-18
1.0	4.3744	0.039	-18.377	9.598	0.005	-18
1.1	4.3748	0.059	-18.373	9.603	0.006	-18
1.2	4.3743	0.05	-18.369	9.599	0.005	-18
1.3	4.3757	0.061	-18.367	9.609	0.007	-18
1.4	4.3741	0.058	-18.351	9.592	0.004	-18
1.5	4.374	0.044	-18.35	9.592	0.004	-18

I-FIT

The I-FIT was used for the intermediate warmer temperatures and was carried out as per Illinois Test Procedure 405 (2016). The specimens were conditioned at 25°C. A loading rate of 2 in./min (50 mm/min) was applied constantly for the duration of test. Similar to SCB testing, the load and LLD were measured, and the G_f was calculated as the area under load-LLD curve, and this value was further used to calculate the FI.

Table 3 shows a sample of the raw data obtained from an I-FIT of one of the mixtures.

Table 3. Sample of I-FIT raw data of one sample as obtained during the test

Point	Time (s)	Load (KN)	Displacement Channel 1 (mm)	Displacement Channel 2 (mm)
1	0.000	0.08	0.000	0.000
2	0.025	0.11	0.008	0.010
3	0.050	0.27	0.029	0.036
4	0.075	0.47	0.050	0.060
5	0.100	0.68	0.070	0.084
6	0.125	0.89	0.090	0.105
7	0.150	1.11	0.110	0.129
8	0.175	1.33	0.131	0.152
9	0.200	1.55	0.150	0.176
10	0.225	1.78	0.170	0.198
11	0.250	2.02	0.191	0.223
12	0.275	2.25	0.213	0.248
13	0.300	2.46	0.232	0.270
14	0.325	2.67	0.252	0.295

CHAPTER 4. TEST RESULTS

DCT Results

The average G_f value ranged from 265.25 J/m^2 to 470.00 J/m^2 as shown in Figure 8.

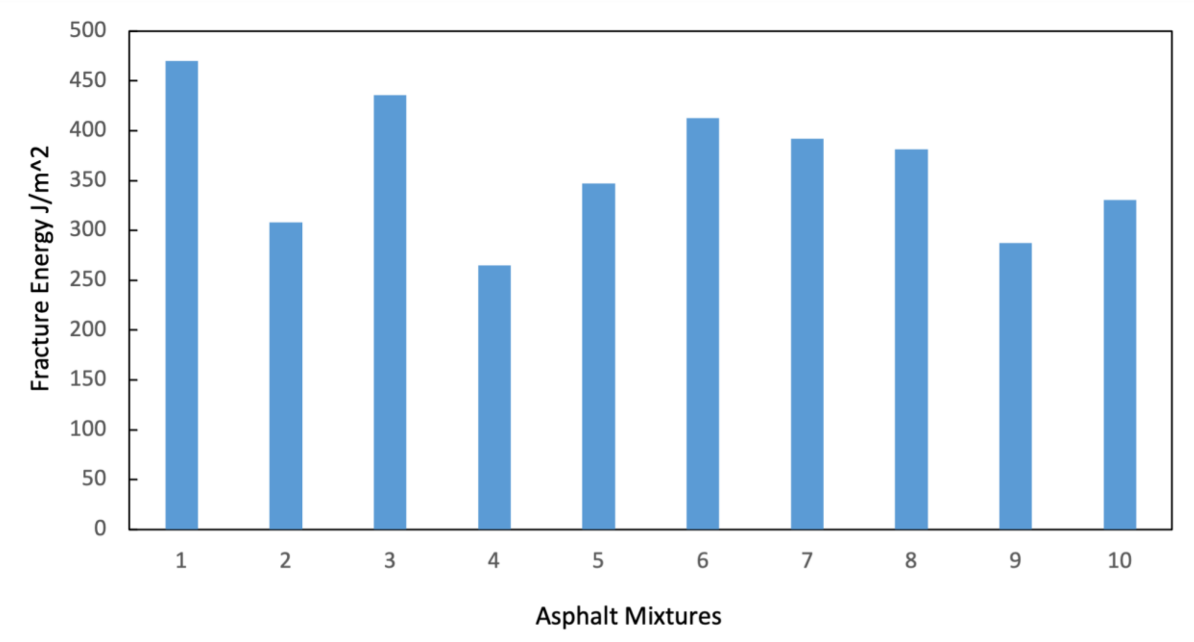


Figure 8. Average DCT fracture energies for the mixtures

Mixture 1 is the only mixture that met the G_f value of the criteria it was designed for, having a G_f value of 470 J/m^2, and it was designed for a minimum value of 460 J/m^2. Mixtures 8 and 10 were designed for standard traffic, and they do not meet the specification of 400 J/m^2, as they have G_f values of 381.25 J/m^2 and 330.50 J/m^2, respectively. Mixtures 3 and 6 have G_f values that meet the criteria for standard traffic; however, they do not satisfy the specification for high traffic value of 460 J/m^2 as shown in Figure 9.

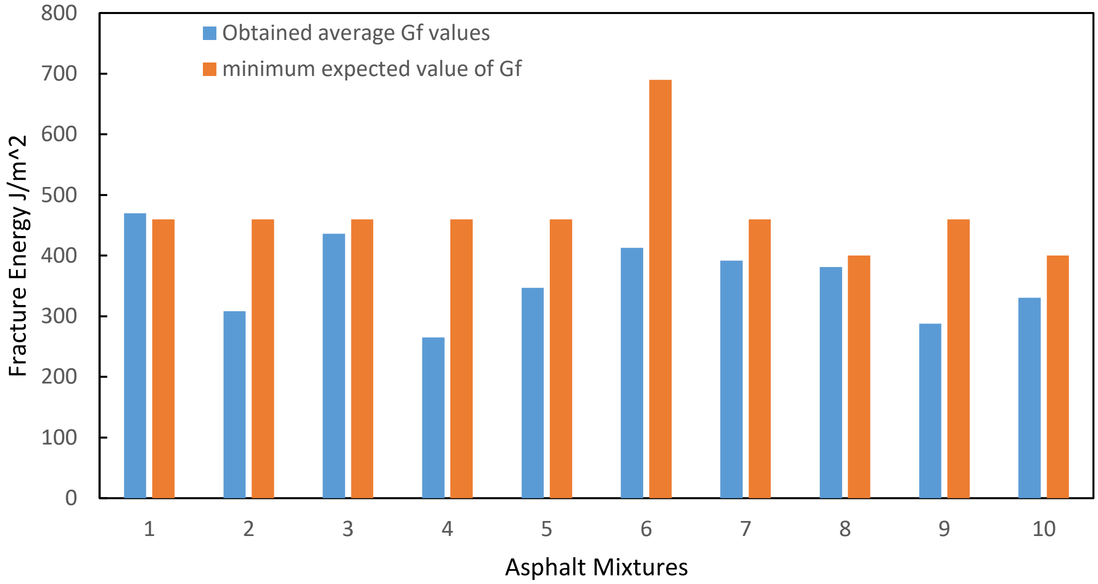


Figure 9. Comparison of DCT G_f obtained to the expected minimum values as per the specification

Mixtures 2, 4, 5, 7, and 9 did not meet their designed traffic specification minimum values nor the standard traffic specification value. Mixture 4 had the lowest fracture resistance, and the highest percentage of recycled material using slag; however, this does not mean the recycled material caused the low G_f, as other mixtures with no or little percentage of recycled material also did not have G_f values for the standard traffic specification. Mixtures 2 and 4 have 64°C as the upper temperature limit, and the G_f values obtained were lower than the other mixtures with a lower value of upper performance-grade temperature limit.

Mixture 3 had the lowest variance in the results followed by Mixture 10 and Mixture 4. Mixtures 2, 6, and 8 had the highest variance followed by Mixture 1, while Mixtures 5, 7, and 9 had variances between Mixture 4 and Mixure 7. The Ndesign for Mixtures 6 to 10 had DCT G_f mean values that were within a small range.

Figure 10 shows a box plot of the DCT test results for all 10 mixtures.

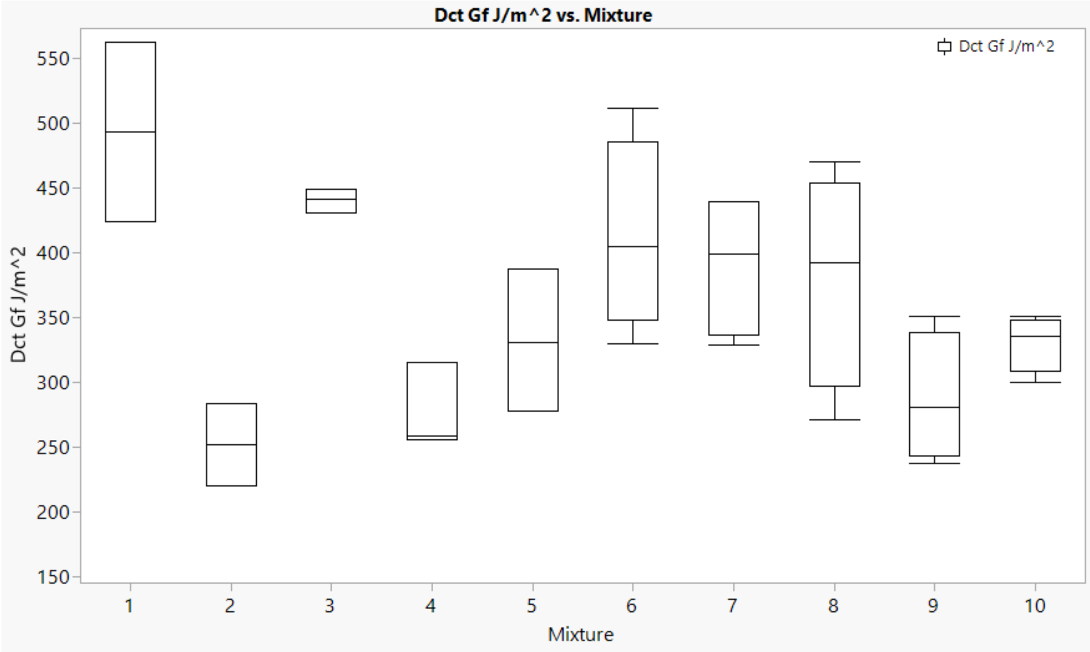


Figure 10. Box plot of DCT results

An increase in RAP caused a reduction in the DCT test fracture energies. This can be attributed to the fact that the RAP had binder that is old, and hence it's stiff and cannot resist fracture. As the binder ages, it exhibits less ductility and thus requires a small amount of energy to fracture.

Figure 11 shows the effect of RAP on the G_f from the DCT results.

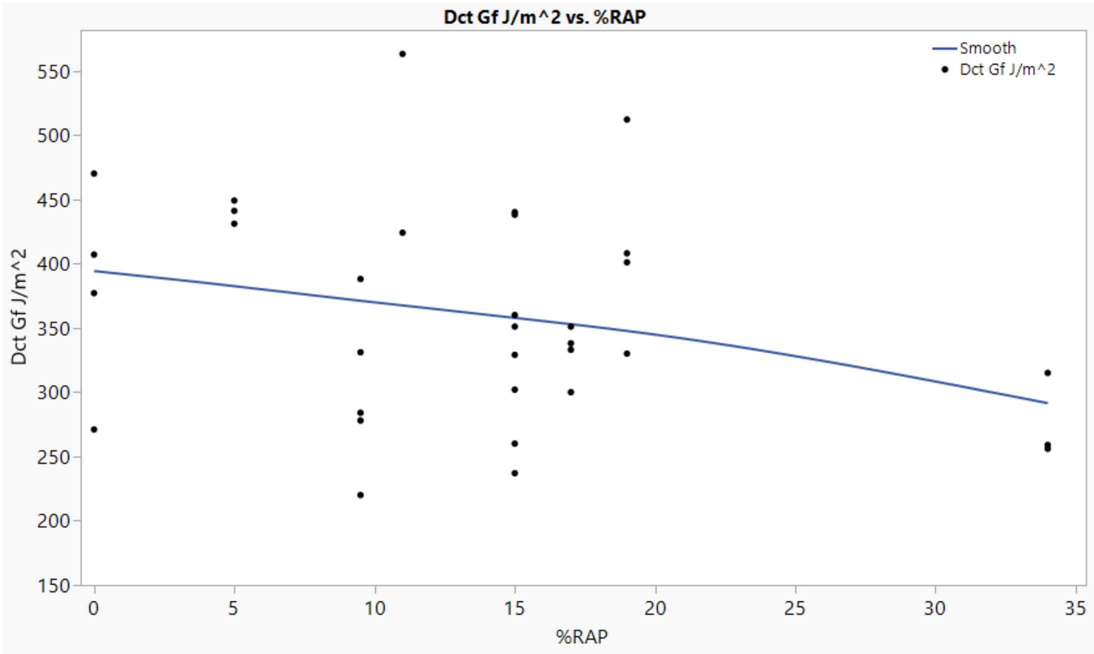


Figure 11. RAP effect on DCT G_f

A high film thickness of the binder causes an increase in DCT fracture resistance up to an optimum value, after which the DCT G_f value decreases with an increase in film thickness. A sufficient asphalt content is required, just enough to coat the aggregates and bond them together. From the trend line shown in Figure 12, it is apparent that as film thickness increases, the G_f will increase, thus improving mix performance against low-temperature fracture.

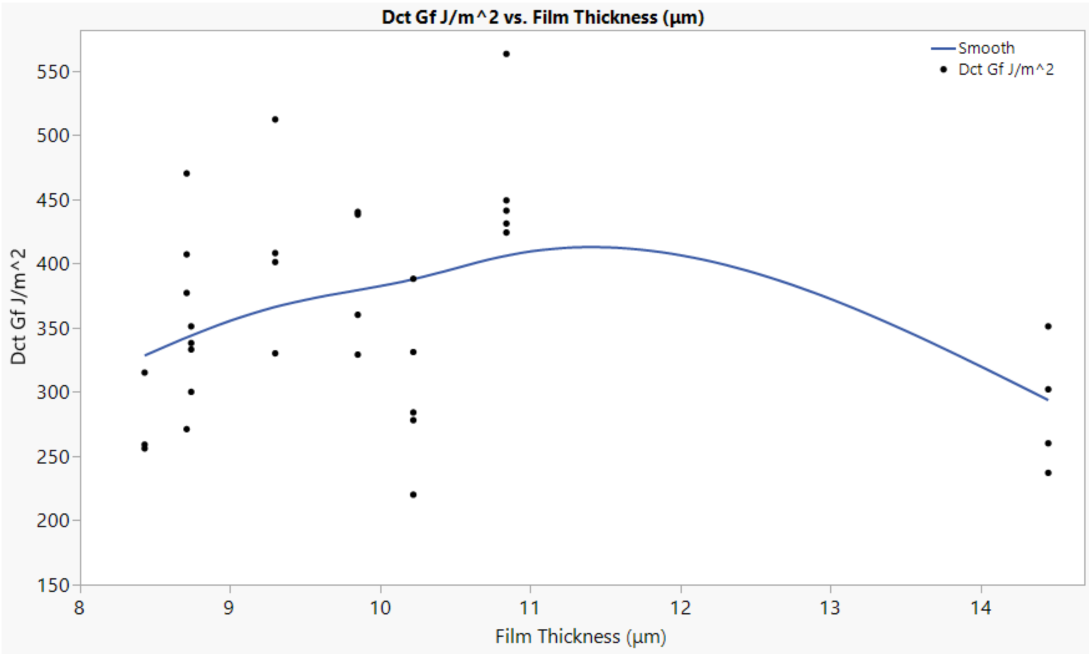


Figure 12. Effect of film thickness on DCT G_f

However, when the film thickness became greater than 12 µm, as shown in the figure, performance decreased.

SCB Results

The average G_f values from the SCB results ranged from 485 J/m^2 to 1,102 J/m^2, as shown in Figure 13.

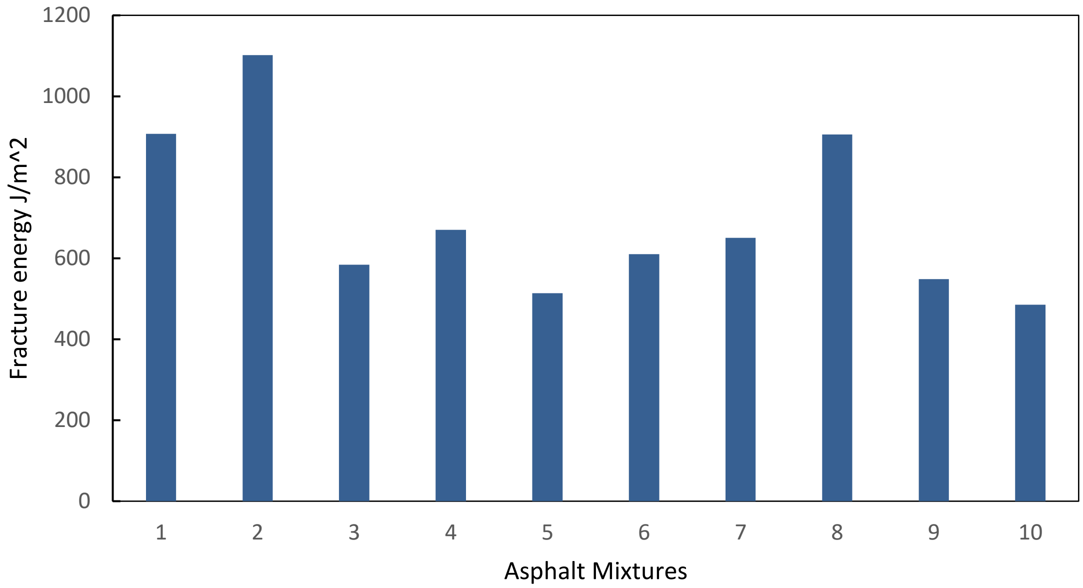


Figure 13. Graph of average SCB G_f of the mixtures

Mixture 2 had the highest SCB G_f, while it was among the low DCT G_f values. Mixture 1 had higher values for both DCT and SCB tests compared to the other mixtures. There was no trend noticed between SCB and DCT G_f values of the mixtures. This could be attributed to the differences in testing configurations of the specimens and the loading rate.

Mixture 10 had the lowest variance for SCB testing, of which this was also observed in the DCT results. Mixture 6 had the second lowest variance while Mixtures 7, 8, and 9 had the highest variance of the five mixtures. Mixtures 7 and 9 had outlier results, which were not used in calculating those mixtures' average mean fracture energies.

Figure 14 shows a box plot of the SCB test results for all 10 mixtures.

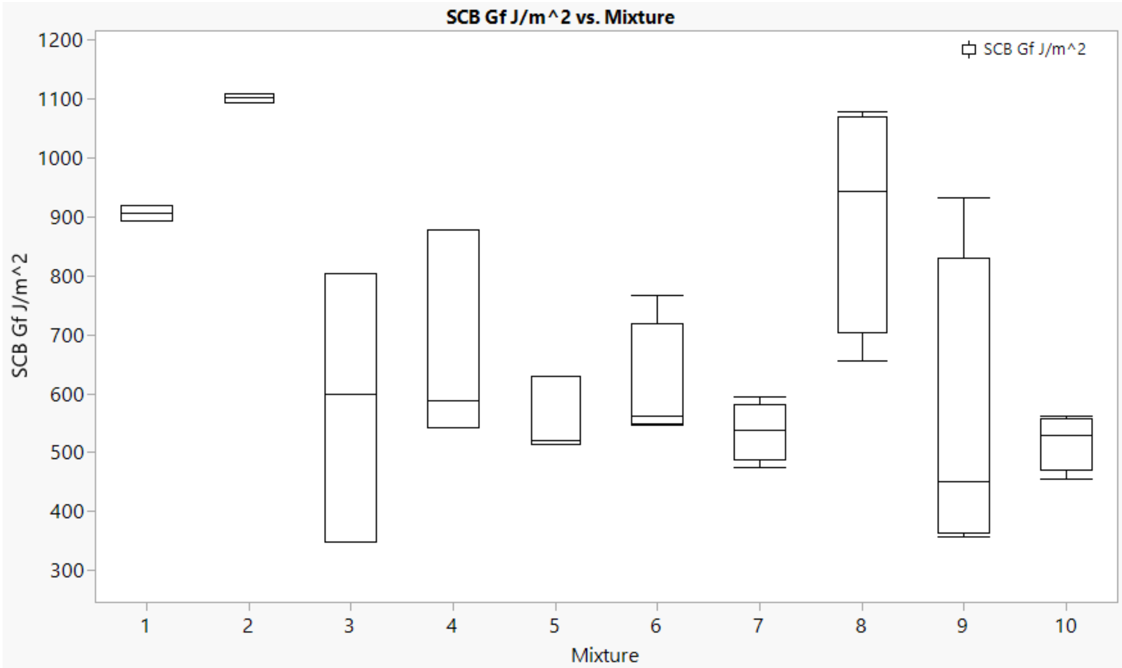


Figure 14. Box plot of SCB G_f

An increase in RAP caused a decrease in the SCB G_f as shown in Figure 15. This was also observed from the fracture energies of the DCT tests.

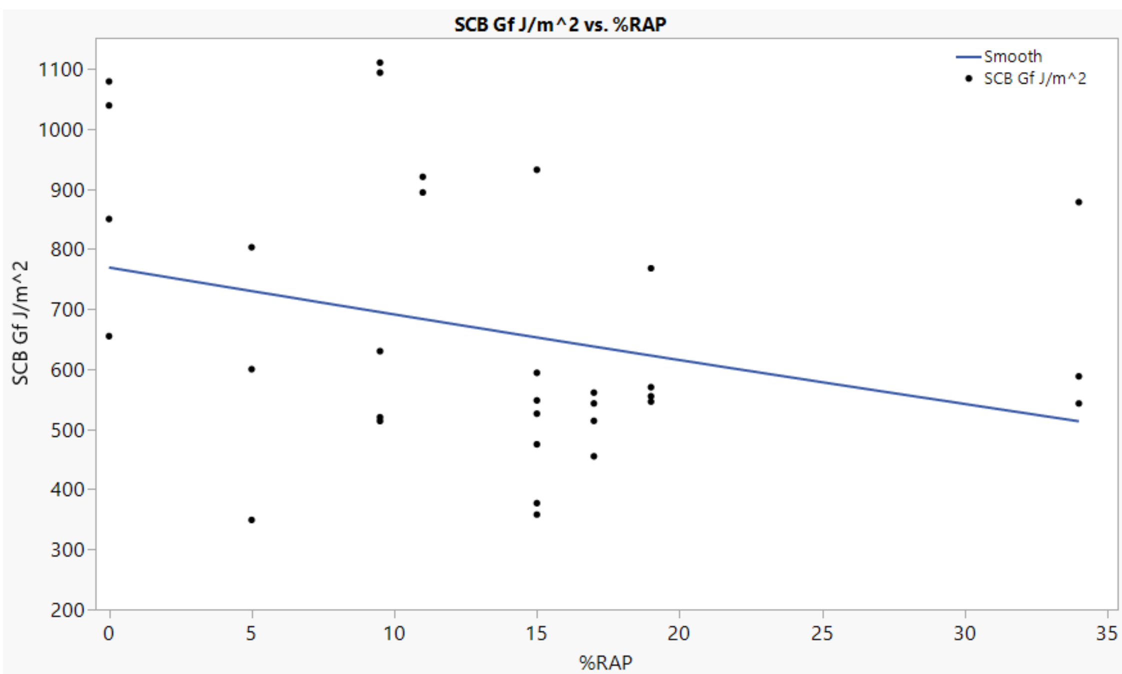


Figure 15. Effect of RAP on SCB G_f

An increase in film thickness caused a decrease in SCB fracture energies (Figure 16).

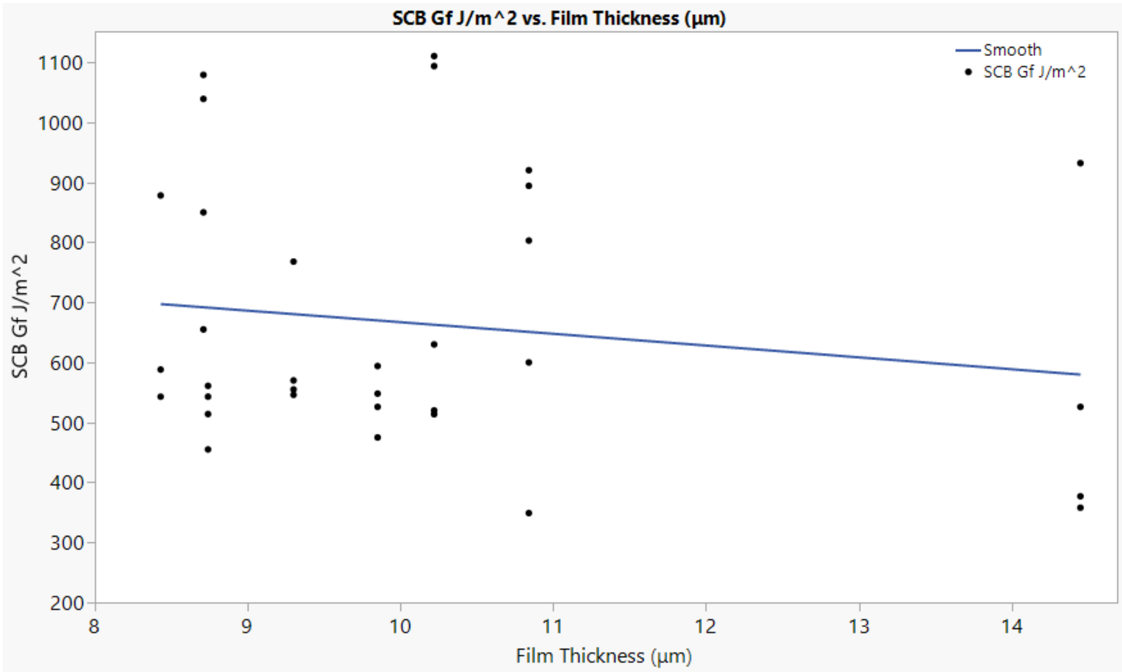


Figure 16. Effect of film thickness on SCB G_f

If asphalt is concentrated in the same point of the mixture, it gives a weak point for fracture and especially in low temperatures, as it becomes plastic; hence, low energy is needed to cause a crack.

I-FIT Results

The FI was calculated from the G_f obtained during I-FIT testing (Illinois Test Procedure 405 2016). All FI values are about 8.0, which is the minimum recommended value for both HMA and stone-matrix asphalt (SMA) asphalt mixtures (Figure 17).

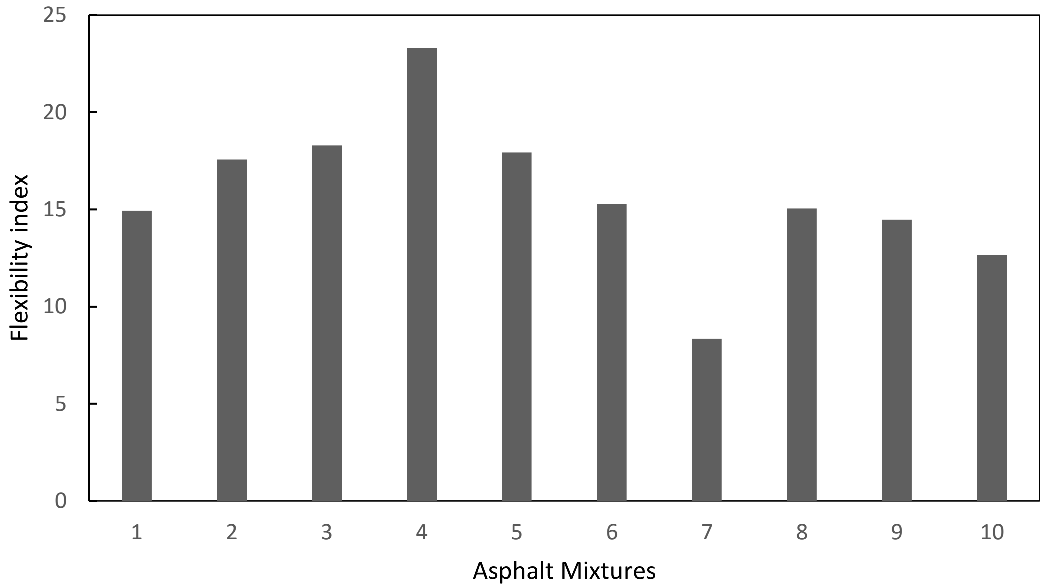


Figure 17. Graph of average FI of the mixtures

Mixture 7 had the lowest value of FI, and this could be related to the performance-grade lower limit temperature, which was lower than the other mixtures' performance-grade lower limit temperatures.

Generally, the mixtures had low variance as shown in the box plot in Figure 18.

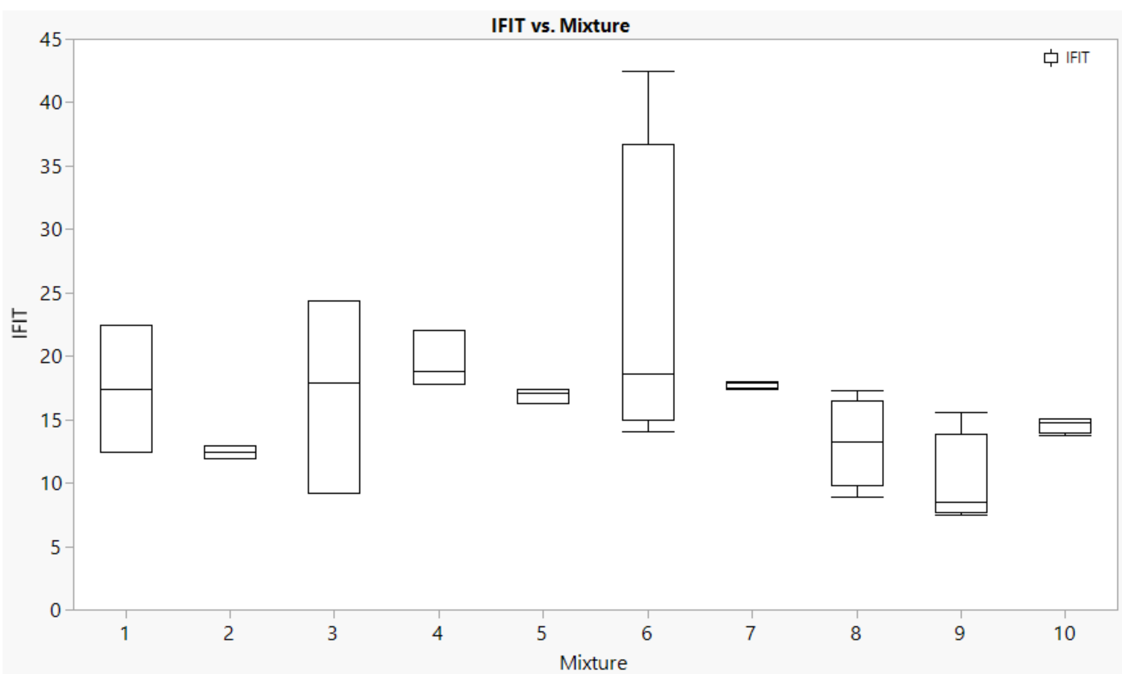


Figure 18. Box plot of FI

Mixture 4 had an outlier, which was not used when calculating the mean FI. Mixtures 1 and 2 had the highest variance as compared to the other mixtures.

Figure 19 shows the effect of RAP on the G_f from the I-FIT results.

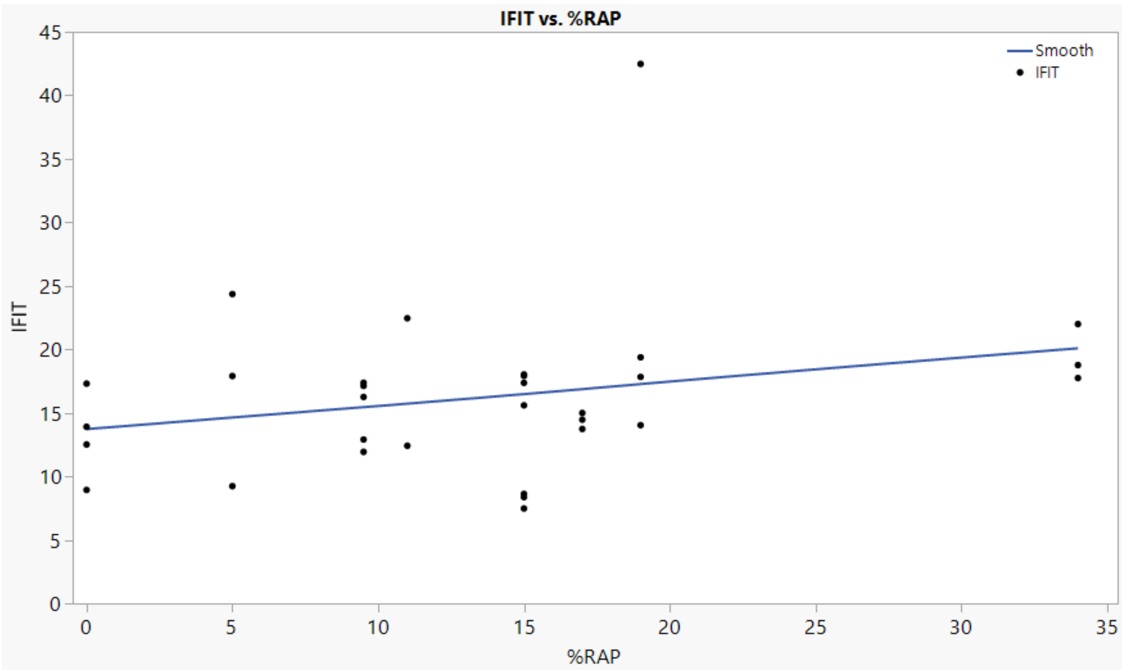


Figure 19. Effect of RAP on G_f

An increase in film thickness caused an increase in FI (Figure 20), of which this trend was also observed in the fracture energies of the SCB tests.

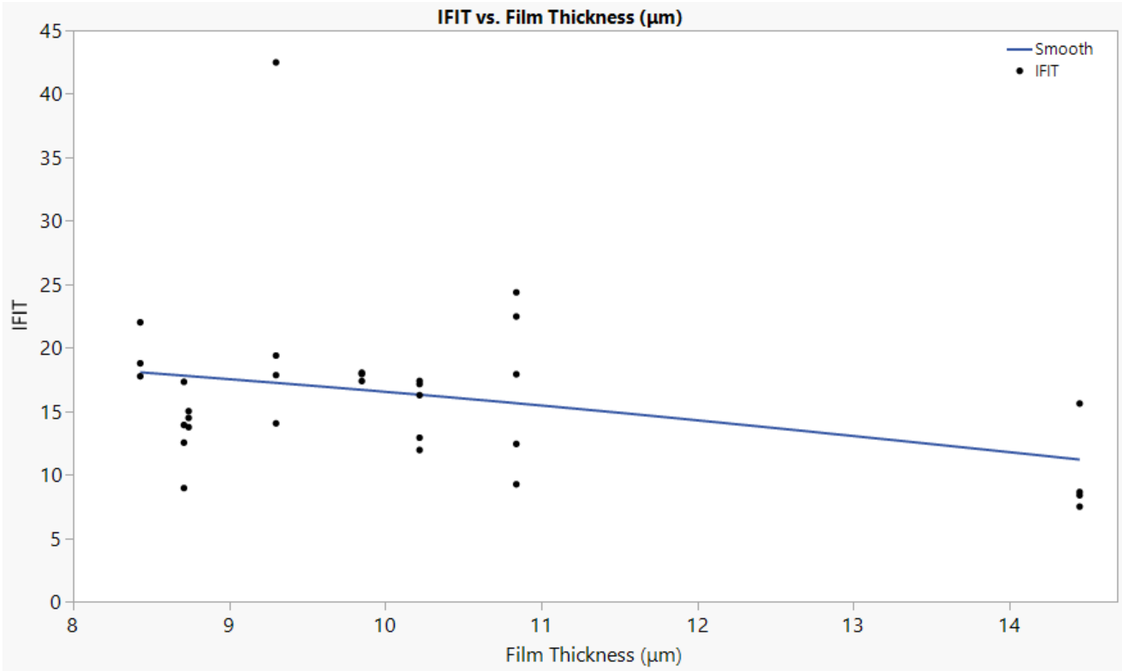


Figure 20. Effect of film thickness on FI

Test Temperatures and Coefficients of Variation

All the mixtures have coefficients of variation (COV) below the recommend 25% for SCB and DCT tests, as shown in Table 4.

Table 4. Test temperatures and COV for SCB and DCT

Mixture	Test temperature (°C)	Reps	DCT		SCB	
			Mean	COV	Mean	COV
1	-18	4	470.00	13.53	907.20	15.23
2	-12	4	308.25	23.23	1102.00	17.52
3	-18	4	436.00	2.61	584.00	20.34
4	-18	4	265.25	13.37	670.00	18.68
5	-18	4	347.00	15.46	514.00	13.56
6	-18	4	412.75	18.16	609.75	17.39
7	-24	4	391.75	14.30	650.80	23.20
8	-18	4	381.25	21.79	905.75	21.49
9	-18	4	287.50	17.45	548.25	23.56
10	-18	4	330.5	6.57	485.17	13.52

Mixture 2 had the highest COV for the DCT test, at 23.23%, and Mixture 9 had the highest COV for SCB, at 23.56%, and the rest of the COV values were in the range of 2.61% to 21.79%.

Mixture 8 had COV values that were similar to one another based on results from both tests. This is an indicator that Mixture 8 met the required COV.

Table 5 shows the test temperatures and COV results from the I-FIT testing.

Table 5. Test temperatures and COV for I-FIT

Mixture	Test temperature (°C)	Reps	I-FIT	
			Mean	COV
1	25	4	14.93	33.71
2	25	4	17.57	35.56
3	25	4	18.29	13.95
4	25	4	23.32	32.21
5	25	4	17.93	0.44
6	25	4	15.28	16.03
7	25	4	8.36	7.52
8	25	4	15.05	7.79
9	25	4	14.47	4.60
10	25	4	12.65	15.09

Overall Analysis

A JMP analysis of the G_f indicated: (1) based on the DCT and SCB results, Mixture 1 was significantly different from Mixtures 2, 4, 5, 9, and 10, while Mixture 2 was significantly different from Mixtures 1, 3, 6, and 7; (2) Mixtures 4, 5, 9, and 10 were not significantly different; and (3) RAP content was observed to be the factor that most affected G_f for the mixtures used in this study.

CHAPTER 5. SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

The mixtures' G_f values of the DCT tests did not meet the design criteria for the traffic level, meaning that the fracture energies of the field-produced mixtures were lower than the value they were designed for demonstrated by the sample mixtures used in this study. It should be noted that the mixtures may have had low fracture energies because they had undergone more aging after mixing; during the laboratory tests, the mixtures were heated before compaction and before the G_{mm} tests.

DCT tests were not required for the laboratory-produced mixtures during construction since the binder replacement was less than 30% for mixtures with RAP and 25% for RAS. Additionally, the majority of mixtures studied in this work did not meet the requirement for DCT testing for their laboratory-designed mixtures and yet did not achieve G_f for their designed traffic volumes. The specification on the need for a DCT test should be revised to state that the test is required when the asphalt binder replacement exceeds 15% for mixtures with RAP and RAS, rather than the current value of 30% and 25% binder replacement, respectively.

The pavements that are still in use and have not had any major rehabilitation or maintenance activities show that these pavements have an adequate amount of cracking resistance as they have been able to carry the loads they were designed for. However, the laboratory tests on the mixtures show low cracking resistance and therefore a need for revising the specification or improving the quality-control process, just as MnDOT has allowed a 50 J/m^2 range for quality assurance.

A pavement distress survey is recommended that focuses more on the intensity of thermal- and transverse-cracking distress over the years to assess the field performance of the pavements used in this study in relation to the DCT testing results.

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APPENDIX. GRADATION AND ADDITIONAL DETAILS ON MIXTURES

Table 6. Mixture aggregate gradation

Gradation (mm)	Mixtures									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
25	100	100	100	100	100	100	100	100	100	100
19	100	100	100	100	100	100	100	100	100	99
12.5	97	97	97	94	97	96	98	97	95	90
9.5	88	90	88	86	90	89	89	88	90	79
4.76	69	64	69	59	64	62	63	70	77	59
2.36	43	47	43	40	47	45	46	50	41	40
1.18	26	33	26	28	33	30	34	34	23	30
0.85	15	19	15	17	19	19	24	23	15	24
0.3	9.2	8.3	9.2	8.9	8.3	9.4	12	7.7	6.4	11
0.15	5.6	5.1	5.6	4.8	5.1	5.2	4.8	3.8	3.4	5.5
0.075	3.9	3.9	3.9	4.2	3.9	3.9	2.9	3	2.6	4.3

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IOWA DOT ASPHALT PAVING DAILY PLANT REPORT

10/6/14 3:59 PM

Date	10/8/2014
Active Project No.:	MP-017-1(705)0--76-77
Contract ID:	77-0171-705
Mix Design No.:	1BD14-065
Contractor:	DMAP
County:	Polk
RAP Stockpile ID	7.8% (ABC9-100) ABC14-0080 (7.4% AC)
Active Placement:	Surface (Travel Lane)
Mix Type:	3M Surface 1/2 L-2 (HMA)
Active Bid Item:	2303-0043502 3M Surf 1/2in L-2 (HMA)
Report No.:	3
Lab Voids Target:	4.0
Design Gyrations:	86

UNCOMPACTED MIXTURE

Hot Box I.D. (Theoretical %AC)	HB-A (5.01%)	HB-P (4.99%)				
Date Sampled	10/8/14	10/8/14				
Time	1:55 PM	2:00 PM				
Station	367+00					
Side	2L-SB\WB					
Sample (Tons)	459.54	523.44				
G_{mb}	2.383	2.384				
Gmb (DOT)						
G_{mm}	2.474	2.475				
Gmm (DOT)						
P_a (%)	3.7	3.7				
P_a (%) (DOT)						
				Avg G_{mb}	Avg G_{mm}	Avg Pa (%)
				2.384	2.475	3.7

GRADATION (%Passing)

Sieve	Specs	CFA 10-08-			Avg	Use DOT District
1 in.	100	100.0			100.0	
3/4 in.	100	100.0			100.0	
1/2 in.	90-100(97)	99.0			99.0	
3/8 in.	83-97(90)	92.0			92.0	
#4	57-71(64)	66.0			66.0	
Dev	± 7.0	**2.0**			**2.0**	
#8	42-52(47)	46.0			46.0	
Dev	± 5.0	**-1.0**			**-1.0**	
#16		31.0			31.0	
#30	15-23(19)	18.0			18.0	
Dev	± 4.0	**-1.0**			**-1.0**	
#50		8.5			8.5	
#100		4.8			4.8	
#200	1.9-5.9(3.9)	3.8			3.8	
Dev	± 2.0	**-0.1**			**-0.1**	
Gradation Compliance?		Yes			Yes	
DBR	0.6 - 1.4	0.78			0.78	
% +4 Type 4	80	#DIV/0!			#DIV/0!	
% +4 Type 3		#DIV/0!			#DIV/0!	
(+4/-4) Type 2	25/0	#DIV/0!			#DIV/0!	
		#DIV/0!				

BINDER

	Target	Actual	Spec	Comply?
% Added Binder	4.20	4.44	N/A	
% Total Binder	5.30	5.28	5.00-5.60	Yes
% RAP	9.50	7.81%	≤100%	Yes
% RAS	5.00	4.11%	≤ 5%	Yes
% Binder Replacement	19.33%	15.91%	≤ 30%	Yes
PG Grade	64-22		58-28	No

Binder replacement exceeded. Binder grade does not comply.AC > 0.2% different tha

Gb:	1.03193	Gsb:	2.652	Pbe (%):	4.87

COMPACTED JOINT

Core #	Station	Joint ID	G_{mb}
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
Average G_{mb}			

USE D.O.T. RESULTS (Enter an 'X')

TEST STRIP (Enter an "X")

FILM THICKNESS (FT) [8.0-15.0]	
FT, µm	**10.9**
Price Adjustment	$0.00

Gyratory VMA [15.8-17.8]	
VMA, %	**15.9**

QUANTITY FOR PAYMENT

Mix Unit Price ($/ton)	$60.00
Binder Unit Price ($/ton)	$550.00
Tons of Mix on Road	385.61
Tons to Other Bid Item(s)	
Tons of Binder	20.37
Tons of Waste	
Tons of Binder to Date	
Tons of Mix to Date	

PLACEMENT RECORD

From Station	To Station	Lane	Width (ft)

Certified Tech: Ryan Horn Cert. No. CI316

Certified Tech: Ben Crawford Cert. No. SW498

Distribution: ___ Dist. Materials ___ Proj. Engineer ___ Contractor

COMPACTED MAT

Cores have been waived

Core	Date of Placement	Station	CL Reference	W1 Dry (g)	W2 in H20 (g)	W3 Wet (g)	G_{mb}	% of Gmm	P_a (%)	Thickness (in.)
1										
2										
3										
4										
5										
6										
7										
8										

Course Placed: Surface (Travel Lane)

Thickness QI:

Intended Lift Thickness: 2.00

Date Placed: 10/08/14

Test Date/By:

Avg. Mat Density:

Avg. % of Gmb:

Avg. % Field Voids:

Q.I. (lower) = = → PWL (lower) =

Q.I. (upper) = = → PWL (upper) =

PWL (total) = + — 100.0 =

Coring may be waived per Engineer approval (2303.03, D, 4, a, 3).

Pay Factor =

Tons of Mix for PWL Field Voids Analysis (00.00 deducted)= 385.61

Field Voids Price Adjustment =

TEMPERATURE, °F

Time	7:00	9:00	11:00	1:00	3:00	5:00	7:00	Spec	Comply?
Air Temp	46	50	61	67	71	71			
Binder Temp			306	308				260-330 °F	Yes
Plant Temp			328	330				225-330 °F	Yes
Mat Temp			305	300	295			225-330 °F	Yes

☐ Break Dow

☐ Rain Out

☐ Re-start after mandatory shutdown

Mix Change Information (when changes are made to start the day, identify them on previous day's report):

Old Target	New Target	Tons	Agg	Initial %	New %	Agg	Initia	New %

Comment

1st sample was a road box at 459.54 tons, 2nd sample was from the plant at 523.44 tons

Form 955 ver. 10.16

Iowa Department of Transportation

Highway Division-Office of Materials

Proportion & Production Limits For Aggregates

ABC 5-2-4 DCT

County: Polk Project No.: MP-017-1(705)0--76-77 Date: 04/01/14

Project Location: From Iowa 141 to NW 158th Avenue Mix Design No.: 1BD14-065

Contract Mix Tonnage: 1,597 Course: Surface Mix Size (in.): 1/2

Contractor: DMAP Mix Type: HMA 3M Design Life ESAL's: 3,000,000

Material	Ident #	% in Mix	Producer & Location	Type (A or B)	Friction Type	Beds	Gsb	%Abs
3/4 Chips	A85006	5.5%	Martin Marietta/Ames Mine	A	5	47	2.655	0.88
1/2 Add Rock-Quartzite	ASD002	9.0%	Lg Everist Inc/Dell Rapids E. Minnehaha C	A	2		2.652	0.42
3/8" Washed Chips L4	A85006	21.5%	Martin Marietta/Ames Mine	A	4	49	2.652	0.78
Manufactured Sand	A85006	32.5%	Martin Marietta/Ames Mine	A	5	47	2.666	0.71
Asphalt Sand	A77504	17.0%	Hallett Materials Co/Denny-Johnston	A	4		2.648	0.69
RAP/RAS	ABC9-100	14.5%	9.5% RAP/5% RAS (7.8% AC)	A	2	BC14-008	2.606	1.80

Type and Source of Asphalt Binder: St. Paul Park Refinery Co. LLC (St. Paul P

Individual Aggregates Sieve Analysis - % Passing (Target)

Material	1"	3/4"	1/2"	3/8"	#4	#8	#16	#30	#50	#100	#200
3/4 Chips	100	100	60	31	5.0	2.5	2.0	1.7	1.5	1.2	1.0
1/2 Add Rock-Quartzite	100	100	99	81	10	1.5	1.0	1.0	1.0	1.0	1.0
3/8" Washed Chips L4	100	100	100	86	18	2.5	2.0	1.8	1.7	1.3	1.0
Manufactured Sand	100	100	100	100	97	68	39	20	8.0	5.0	3.5
Asphalt Sand	100	100	100	100	95	88	76	41	8.0	1.0	0.8
RAP/RAS	100	100	98	93	80	65	50	38	30	23	18

Preliminary Job Mix Formula Target Gradation

Upper Tolerance	100	100	100	97	71	52		23			5.9
Comb Grading	100	100	97	90	64	47	33	19	8.3	5.1	3.9
Lower Tolerance	100	100	90	83	57	42		15			1.9
S.A.sq. m/kg	Total	4.56		+0.41	0.26	0.38	0.54	0.55	0.51	0.63	1.26

Production Limits for Aggregates Approved by the Contractor & Producer.

Sieve Size	5.5% of mix 3/4 Chips		9.0% of mix 1/2 Add Rock-Quartzite		21.5% of mix 3/8" Washed Chips L4		32.5% of mix Manufactured Sand		17.0% of mix Asphalt Sand		14.5% of mix RAP/RAS	
in.	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
1"	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0		
3/4"	98.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0		
1/2"	53.0	67.0	95.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0		
3/8"	24.0	38.0	74.0	88.0	79.0	93.0	100.0	100.0	100.0	100.0		
#4	0.0	12.0	3.0	17.0	11.0	25.0	90.0	100.0	88.0	100.0		
#8	0.0	6.0	0.0	6.0	0.0	6.0	63.0	73.0	83.0	93.0		
#30	0.0	4.0	0.0	4.0	0.0	4.0	16.0	24.0	37.0	45.0		
#200	0.0	1.5	0.0	1.5	0.0	1.5	0.0	5.0	0.0	1.5		

Comments: Signatures on file in District 1 Materials Office

Copies to: DMAP Rex Kinkade Cheryl Barton Rita Eichhorst
Vicky Rink Jefferson RCE Mark Trueblood Central Materials

The above target gradations and production limits have been discussed with and agreed to by an authorized representative of the aggregate producer.

Signed: ______________________ Signed: ______________________

Producer Contractor

Form 956 ver. 10.16

Iowa Department of Transportation

Highway Division - Office of Materials

HMA Gyratory Mix Design

Nmax

				Letting Date :	
County :	Polk		Project : MP-017-1(705)0--76-77	Mix No. :	IBD14-065
Mix Size (in.) :	1/2	Type A	Contractor : DMAP	Contract #:	77-0171-705
Mix Type:	HMA 3M	L - 2	Design Life ESAL's : 3,000,000	Date:	04/01/14
Intended Use :	Surface		Location : MP 0 - 7	From Iowa 141 to NW 158th Avenue	

Aggregate	% in Mix	Source ID	Source Location	Beds	Gsb	%Abs	FAA	Friction
3/4 Chips	5.5%	A85006	Martin Marietta/Ames Mine	47	2.655	0.88	46.0	5
1/2 Add Rock-Quartzite	9.0%	ASD002	Lg Everist Inc/Dell Rapids E. Minneh		2.652	0.42	47.0	2
3/8" Washed Chips L4	21.5%	A85006	Martin Marietta/Ames Mine	49	2.652	0.78	46.0	4
Manufactured Sand	32.5%	A85006	Martin Marietta/Ames Mine	47	2.666	0.71	47.0	5
Asphalt Sand	17.0%	A77504	Hallett Materials Co/Denny-Johnston		2.648	0.69	40.0	4
RAP/RAS	14.5%	ABC9-100	9.5% RAP/5% RAS (7.8% AC)	ABC14-0080	2.606	1.80	43.9	2

Job Mix Formula - Combined Gradation (Sieve Size in.)

	1"	3/4"	1/2"	3/8"	#4	#8	#16	#30	#50	#100	#200
Upper Tolerance	100	100	100	97	71	52		23			5.9
	100	**100**	**97**	**90**	**64**	**47**	**33**	**19**	**8.3**	**5.1**	**3.9**
Lower Tolerance	100	100	90	83	57	42		15			1.9

Asphalt Binder Source and Grade: St. Paul Park Refinery Co. LLC (St. Paul Park, MN

Adjust grade to PG 58-28

Gyratory Data

% Asphalt Binder	4.75	5.25	**5.48**	5.75	
Corrected Gmb @ N-Des.	2.342	2.363	**2.369**	2.376	
Max. Sp.Gr. (Gmm)	2.484	2.472	**2.468**	2.463	
% Gmm @ N- Initial	87.1	88.2	**88.7**	89.2	
%Gmm @ N-Max	94.5	95.9	**96.3**	96.7	
% Air Voids	5.7	4.4	**4.0**	3.5	
% VMA	17.1	16.8	**16.8**	16.8	
% VFA	66.5	73.7	**76.1**	78.9	
Film Thickness	9.01	9.89	**10.22**	10.66	
Filler Bit. Ratio	0.95	0.86	**0.84**	0.80	
Gse	2.693	2.701	**2.707**	2.713	
Pbe	4.11	4.51	**4.66**	4.86	
Pba	0.62	0.73	**0.82**	0.90	
% New Asphalt Binder	77.2	79.5	**80.4**	81.3	
Combined Gb @ 25°C	1.0300	1.0300	**1.0300**	1.0300	

			Combined	Contribution From RAM
Aggregate Type Used	A			
G_{sb}	2.650	% Friction Type 4 (+4)	55.2	2.5
G_{sa}	2.712	Or Better	80.4	4.6
% Water Abs	0.86	% Friction Type 3 (+4)	0.0	0.0
S.A. m^2 / Kg.	4.56	Or Better	25.2	2.1
Angularity-method A	43	% Friction Type 2 (+4)	25.2	2.1
% Flat & Elongated	1.0	% Friction Type 2 (-4)	1.4	0.0
Sand Equivalent	93	Type 2 Fineness Modulus	0.9	0.4
Virgin G_b @ 25°C	1.03	% Crushed	81.0	10.8
Anti-Strip Dose (%)	0.00			
Stripping Inflection Point	14,187			

Number of Gyrations
N-Initial
7
N-Design
86
N-Max
134
Gsb for Angularity
Method A
2.651
Pba / %Abs Ratio
0.52
Slope of Compaction Curve
16.9
Mix Check
Poor
Pb Range Check
1.00
RAM Check
OK
Specification Check
Comply
Moisture Sensitivity Check
SIP (0% AS)=14,187
Please choose AS Dosage if req.

Disposition : An asphalt content of 5.5% is recommended to start this project.

Data shown in 5.48% column is interpolated from test data.

The % ADD AC to start project is 4.4%

Comments : Final approval based upon plant produced mix

Copies to : DMAP, Rex Kinkade, Cheryl Barton, Rita Eichhorst, Vicky Rink, Jefferson RCE, Mark Trueblood, Central Materials

Mix Designer & Cert.# : Thuisman CI-515 Signed : Cheryl L. Barton, District 1 Materials

4/25/13 ver 11.07

IOWA DOT ASPHALT PAVING DAILY PLANT REPORT

Date	10/3/2018
Active Project No	IMX-035-5(108)131--02-40
Contract ID	85-0355-109
Mix Design No	1BD18-011
Contractor	MANATTS INC - AMES
County	HAMILTON
RAP Stockpile ID	1RAP15-021 (4.9 % AC)
Active Placement	Surface (Travel Lane)
Mix Type	Vt Surface L - 2 1/2 (HMA)
Active Bid Item	2303-1053502 VT SURF 1/2IN L-2 (HMA)
Report No	15
Lab Voids Target	4.0
Design Gyrations	95

UNCOMPACTED MIXTURE

Samples from multiple days included for Gmm average.

Hot Box I.D (Theoretical %AC)	D1-006891 (5.02%)	D1-006893 (4.97%)	D1-006894 (4.94%)	D1-006890 (5.02%)		
Date Sampled	10/3/18	10/3/18	10/3/18	10/2/18		
Time	8:30 AM	11:00 AM	1:50 PM	1:20 PM		
Station	382+55	345+00	306+00	410+00		
Bar Code ID	D1-006891	D1-006893	D1-006894	D1-006890		
Sample (Tons)	195.00	661.00	1,250.00	1,250.00		
G_{mb}	2.399	2.400	2.381	2.391		
Gmb (DOT)						
G_{mm}	2.482	2.485	2.487	2.482		
Gmm (DOT)						
P_a (%)	3.3	3.4	4.3	3.7		
P_a (%) (DOT)						
				Avg G_{mb}	Avg G_{mm}	Avg Pa (%)
				2.393	2.484	3.7

GRADATION (%Passing)

☐ Use DOT District

Sieve	Specs	Missing Tons			Avg	District
1 in.	100	100.0			100.0	
3/4 in.	100	100.0			100.0	
1/2 in.	89-100(96)	97.0			97.0	
3/8 in.	82-96(89)	89.0			89.0	
* #4	55-69(62)	60.0			60.0	
* Dev	± 7.0	**-2.0**			**-2.0**	
*#8	40-50(45)	41.0			41.0	
*Dev	± 5.0	**-4.0**			**-4.0**	
#16		28.0			28.0	
*#30	15-23(19)	17.0			17.0	
* Dev	± 4.0	**-2.0**			**-2.0**	
#50		9.2			9.2	
#100		5.6			5.6	
*#200	1.9-5.9(3.9)	4.5			4.5	
*Dev	± 2.0	**0.6**			**0.6**	
Gradation Compliance?		Yes			Yes	
DBR	Sugg. 0.6 - 1.4	1.01			1.01	
% +4 Type 4		89.1			89.1	
% +4 Type 3					0.0	
(+4/-4) Type 2		28.6/27.1			28.6/27.1	

BINDER

	Target	Actual	Spec	Comply?
% Added Binder	4.21	4.12	N/A	
% Total Binder	5.10	4.99	4.80-5.40	Yes
% RAP	19.00	18.61%	≤100%	Yes
% RAS				
% Binder Replacement	17.49%	17.52%	≤ 30%	Yes
PG Grade	58-28V		58-28V	Yes

Gb: 1.03346 Gsb: 2.643 Pbe (%): 4.45

COMPACTED JOINT

Core #	Station	Joint ID	G_{mb}
1			
2			
3			

Average Joint G_{mb}
Average Mat G_{mb}
% Mat Density

For information Only
Joint Length, ft
Unit Price Adjustment ($/ft)

Joint Price Adjustment =

USE D.O.T. RESULTS (Enter an 'X')

TEST STRIP (Enter an "X")

FILM THICKNESS (FT) [8.0-15.0]	
FT, µm	9.5
Price Adjustment	$0.00

Gyratory VMA	
VMA, %	**14.0**

QUANTITY FOR PAYMENT

Mix Unit Price ($/ton)	$45.50
Binder Unit Price ($/ton)	$440.00
Tons of Mix on Road	1,839.00
Tons to Other Bid Item(s)	
Tons of Binder	91.78
Tons of Waste	76.00
Tons of Binder to Date	
Tons of Mix to Date	

PLACEMENT RECORD

From Station	To Station	Lane	Width (ft)

Certified Tech: CINDY DELA ROSA Cert. No CI722
Certified Tech: Cert. No

Distribution ___ Dist. Materials ___ Proj. Engineer ___ Contractor

COMPACTED MAT

Core	Date of Placement	Station	CL Reference	W1 Dry (g)	W2 in H2O (g)	W3 Wet (g)	G_{mb}	% of Gmm	P_a (%)	Thickness (in)
1	10/4/2018	272+33	8.0 S\W Pass							
2	10/4/2018	295+85	0.0 S\W Pass							
3	10/4/2018	317+17	4.0 S\W Pass							
4	10/4/2018	331+62	6.0 S\W Pass							
5	10/4/2018	353+53	3.0 S\W Pass							
6	10/4/2018	377+18	3.0 S\W Pass							
7	10/3/2018	395+62	9.0 S\W Pass							
8	10/3/2018	406+59	7.0 S\W Pass							

Course Placed: Surface (Travel Lane) Thickness QI:
Intended Lift Thickness: 2.00 Avg. Mat Density:
Date Placed: 10/03/18 Avg. % of Gmb:
Test Date/By: 10/04/18 Dennis Ackerman Avg. % Field Voids:

QI (lower) = = → PWL (lower) =
QI (upper) = = → PWL (upper) =
PWL (total) = + − 100.0 =

Pay Factor =

Tons of Mix for PWL Field Voids Analysis (00.00 deducted)= 1,839.00 Field Voids Price Adjustment =

TEMPERATURE, °F

Time	7:00	9:00	11:00	1:00	3:00	5:00	7:00	Spec	Comply?
Air Temp	69	73	77	81					
Binder Temp	315	315	315	315				260-330 °F	Yes
Plant Temp	319	322	321	318				225-330 °F	Yes
Mat Temp								225-330 °F	

☐ Break Down ☐ Rain Out ☐ Re-start after mandatory shutdown

Mix Change Information (when changes are made to start the day, identify them on previous day's report):

	Old Target	New Target	Tons	Agg	Initial %	New %	Agg	Initial	New %
Pb Added	4.21	4.11	1,096						
Pb Total	5.10	5	1,096						

Comments:

Form 956 ver. 11.05

Iowa Department of Transportation

Highway Division - Office of Construction & Materials

HMA Gyratory Mix Design

Ndesign

County :	Story	Project : IMX-035-5(109)112--02-85		Letting Date :	10/17/2017
Mix Size (in.) :	1/2 Type A	Contractor : MANATTS INC - AMES		Mix No. :	IBD18-011
Mix Type:	VT L - 2	Design Traffic :	Very High Traffic	Contract #:	85-0355-109
Intended Use :	Surface	Location : MP 111.78 - 116.74		Date:	05/22/18

I-35 - US 30 INTERCHANGE TO THE CO RD E-29 NB

Aggregate	% in Mix	Source ID	Source Location	Beds	Gsb	%Abs	FAA	Friction
1/2 CRUSHED L-4	21.0%	A85006	Martin Marietta Aggregates/Ames Mi	49-50	2.651	0.81	47.0	4
1/2 QUARTZITE	12.0%	ASD002	L G Everist Inc/Dell Rapids-East		2.641	0.14	47.5	2
3/8 CL CHIP L-4	8.0%	A85006	Martin Marietta Aggregates/Ames Mi	49-50	2.672	0.55	47.0	4
MANF SAND	15.0%	A85006	Martin Marietta Aggregates/Ames Mi	47	2.673	0.60	45.0	5
QUARTZ M SAND	15.0%	ASD002	L G Everist Inc/Dell Rapids-East		2.639	0.25	49.0	2
SAND	10.0%	A85510	Hallett Materials Co/Ames South		2.617	1.03	40.0	4
Classified RAP	19.0%	I-35	19% IRAP15-021 (4.9 % AC)		2.613	1.65	42.9	2

Job Mix Formula - Combined Gradation (Sieve Size in.)

	1"	3/4"	1/2"	3/8"	#4	#8	#16	#30	#50	#100	#200
Upper Tolerance	100	100	100	96	69	50		23			5.9
	100	**100**	**96**	**89**	**62**	**45**	**30**	**19**	**9.4**	**5.2**	**3.9**
Lower Tolerance	100	100	89	82	55	40		15			1.9

Asphalt Binder Source and Grade: BITUMINOUS MATERIALS TAMA, IA PG 58-28V

Gyratory Data

% Asphalt Binder	4.25	**4.70**	4.75	5.25
Gmb @ N-Des.	2.353	**2.388**	2.391	2.401
Max. Sp.Gr. (Gmm)	2.503	**2.487**	2.486	2.466
% Gmm @ N- Initial	86.8	**88.6**	88.8	89.8
%Gmm @ N-Max				
% Air Voids	6.0	**4.0**	3.8	2.6
% VMA	14.7	**13.9**	13.8	13.9
% VFA	59.4	**71.2**	72.4	81.0
Film Thickness	8.36	**9.30**	9.39	10.53
Filler Bit. Ratio	1.02	**0.92**	0.91	0.81
Gse	2.674	**2.676**	2.676	2.675
Pbe	3.81	**4.24**	4.28	4.80
Pba	0.46	**0.49**	0.49	0.48
% New Asphalt Binder	78.8	**81.0**	81.2	83.0
Combined Gb @ 25°C	1.0237	**1.0235**	1.0235	1.0233

Number of Gyrations

N-Initial: 9

N-Design: 95

N-Max

Gsb for Angularity Method A: 2.638

Pba / %Abs Ratio: 0.62

Slope of Compaction Curve

Aggregate Type Used	A
G_{sb}	2.642
G_{sa}	2.697
% Water Abs	0.77
S.A. m^2 / Kg.	4.56
Angularity-method A	45
% Flat & Elongated	2.0
Sand Equivalent	96
Virgin G_b @ 25°C	1.022
Anti-Strip Dose (%)	0.00
Stripping Inflection Point	20,000.0

	Combined	Contribution From RAM
% Friction Type 4 (+4)	64	12
Or Better	94	13
% Friction Type 3 (+4)	0	0
Or Better	30	1
% Friction Type 2 (+4)	30	1
% Friction Type 2 (-4)	26	0
Type 2 Fineness Modulus	1.9	0.7
% Crushed	88.0	16.8

Mix Check: Excellent

Pb Range Check: 1.00

RAM Check: OK

Specification Check: Comply

Hamburg Check

SIP (0% AS)=20,000

Please choose AS Dose/Type if req.

0.00 % of binder

Disposition : An asphalt content of 4.7% is recommended to start this project.

Data shown in 4.70% column is interpolated from test data.

The % ADD AC to start project is 3.8%

Comments : Hamburg results included= PASS

Copies to : MANATTS INC - AMES

Mix Designer & Cert.# : CINDY DELA ROSA CI 722

Signed : Shane Fetters(District 1 Materials)

Form 955 ver. 11.05

Iowa Department of Transportation

Highway Division-Office of Materials

Proportion & Production Limits For Aggregates

County : Story	Project No.: IMX-035-5(109)112--02-85		Date: 05/22/18
Project Location: I-35 - US 30 INTERCHANGE TO THE CO RD E-29 NB			Mix Design No.: 1BD18-011
Contract Mix Tonnage: 18,627	Course: Surface		Mix Size (in.): 1/2
Contractor: MANATTS INC - AMES	Mix Type: VT		Design Traffic: Very High Traffic

Material	Ident #	% in Mix	Producer & Location	Type (A or B)	Friction Type	Beds	Gsb	%Abs
1/2 CRUSHED L-4	A85006	21.0%	Martin Marietta Aggregates/Ames Mine	A	4	49-50	2.651	0.81
1/2 QUARTZITE	ASD002	12.0%	L G Everist Inc/Dell Rapids-East	A	2		2.641	0.14
3/8 CL CHIP L-4	A85006	8.0%	Martin Marietta Aggregates/Ames Mine	A	4	49-50	2.672	0.55
MANF SAND	A85006	15.0%	Martin Marietta Aggregates/Ames Mine	A	5	47	2.673	0.60
QUARTZ M SAND	ASD002	15.0%	L G Everist Inc/Dell Rapids-East	A	2		2.639	0.25
SAND	A85510	10.0%	Hallett Materials Co/Ames South	A	4		2.617	1.03
Classified RAP	I-35	19.0%	19% 1RAP15-021 (4.9 % AC)	A	2		2.613	1.65

Type and Source of Asphalt Binder: PG 58-28V BITUMINOUS MATERIALS TAMA, IA

Individual Aggregates Sieve Analysis - % Passing (Target)

Material	1"	3/4"	1/2"	3/8"	#4	#8	#16	#30	#50	#100	#200
1/2 CRUSHED L-4	100	100	92	77	38	25	17	13	11	8.5	7.0
1/2 QUARTZITE	100	100	99	81	10	1.1	0.6	0.5	0.4	0.3	0.2
3/8 CL CHIP L-4	100	100	100	92	22	3.5	2.5	1.8	1.7	1.6	1.5
MANF SAND	100	100	100	100	96	68	38	20	7.5	3.5	2.5
QUARTZ M SAND	100	100	100	100	99	74	47	30	12	2.8	0.9
SAND	100	100	100	100	98	87	69	40	8.0	0.6	0.2
Classified RAP	100	99	90	82	65	47	36	26	17	12	9.3

Preliminary Job Mix Formula Target Gradation

	1"	3/4"	1/2"	3/8"	#4	#8	#16	#30	#50	#100	#200
Upper Tolerance	100	100	100	96	69	50		23			5.9
Comb Grading	100	100	96	89	62	45	30	19	9.4	5.2	3.9
Lower Tolerance	100	100	89	82	55	40		15			1.9
S.A.sq. m/kg	Total	4.56		+0.41	0.26	0.37	0.50	0.55	0.58	0.64	1.27

Production Limits for Aggregates Approved by the Contractor & Producer.

Sieve Size in.	21.0% of mix 1/2 CRUSHED L-4 Min	Max	12.0% of mix 1/2 QUARTZITE Min	Max	8.0% of mix 3/8 CL CHIP L-4 Min	Max	15.0% of mix MANF SAND Min	Max	15.0% of mix QUARTZ M SAND Min	Max	10.0% of mix SAND Min	Max
1"	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"	98.0	100.0	98.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1/2"	85.0	99.0	92.0	100.0	98.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
3/8"	70.0	84.0	74.0	88.0	85.0	99.0	98.0	100.0	98.0	100.0	98.0	100.0
#4	31.0	45.0	3.0	17.0	15.0	29.0	89.0	100.0	92.0	100.0	91.0	100.0
#8	20.0	30.0	0.0	6.1	0.0	8.5	63.0	73.0	69.0	79.0	82.0	92.0
#30	9.0	17.0	0.0	4.5	0.0	5.8	16.0	24.0	26.0	34.0	36.0	44.0
#200	5.0	9.0	0.0	2.2	0.0	3.5	0.5	4.5	0.0	2.9	0.0	2.2

Comments:

Copies to: MANATTS INC - AMES

The above target gradations and production limits have been discussed with and agreed to by an authorized representative of the aggregate producer.

Signed: ______________________ Producer

Signed: ______________________ Contractor

Form 956 ver. 11.08

Iowa Department of Transportation

Highway Division - Office of Construction & Materials

HMA Gyratory Mix Design

Ndesign

County :	Marshall		Project : FM-CO64(127)--55-64		Letting Date :	4/17/2018
Mix Size (in.) :	3/4	Type A	Contractor : Manatt's Inc.		Mix No. :	1BD16-065
Mix Type:	ST	No Frictn	Design Traffic :	Standard Traffic	Contract #:	64-CO64-127
Intended Use :	Surface		Location :		Date:	08/16/18

Location: E41/235th St, from ECL of State Center E 9 Miles to IA 330.

Aggregate	% in Mix	Source ID	Source Location	Beds	Gsb	%Abs	FAA	Friction
3/4" Clean	34.0%	A64002	Martin Marietta Aggregates/Ferguson	10-17	2.630	1.78	46.0	4
3/8" Chips	5.0%	A64002	Martin Marietta Aggregates/Ferguson	10-17	2.628	1.85	47.0	4
Manufactured Sand	24.0%	A64002	Martin Marietta Aggregates/Ferguson	10-17	2.646	1.75	47.0	4
Screened	20.0%	A64002	Martin Marietta Aggregates/Ferguson		2.630	0.55	39.5	
Classified RAP	17.0%	1RAP18-020	17% ABC18-0068 (5.97 % AC)		2.585	1.63	41.6	4

Job Mix Formula - Combined Gradation (Sieve Size in.)

	1"	3/4"	1/2"	3/8"	#4	#8	#16	#30	#50	#100	#200
Upper Tolerance	100	100	97	85	66	45		28			6.3
	100	**99**	**90**	**78**	**59**	**40**	**30**	**24**	**11**	**5.5**	**4.3**
Lower Tolerance	100	92	83	71	52	35		20			2.3

Asphalt Binder Source and Grade: BITUMINOUS MATERIALS TAMA, IA PG 58-28S

Gyratory Data

% Asphalt Binder	4.60	5.00	**5.02**	5.50	6.00
Gmb @ N-Des.	2.365	2.378	**2.379**	2.402	2.409
Max. Sp.Gr. (Gmm)	2.494	2.479	**2.478**	2.461	2.453
% Gmm @ N- Initial	89.6	90.5	**90.6**	92.1	92.5
%Gmm @ N-Max					
% Air Voids	5.2	4.1	**4.0**	2.4	1.8
% VMA	14.1	14.0	**14.0**	13.6	13.8
% VFA	63.3	70.8	**71.3**	82.3	87.0
Film Thickness	7.87	8.68	**8.74**	9.70	10.37
Filler Bit. Ratio	1.11	1.01	**1.00**	0.90	0.84
Gse	2.679	2.679	**2.678**	2.679	2.692
Pbe	3.87	4.27	**4.30**	4.77	5.10
Pba	0.77	0.77	**0.76**	0.77	0.96
% New Asphalt Binder	78.7	80.5	**80.6**	82.4	83.9
Combined Gb @ 25°C	1.0260	1.0259	**1.0259**	1.0258	1.0257

Number of Gyrations
N-Initial: 7
N-Design: 50
N-Max

Gsb for Angularity
Method A: 2.624

Pba / %Abs Ratio: 0.55

Slope of Compaction Curve

Aggregate Type Used	A
G_{sb}	2.626
G_{sa}	2.734
% Water Abs	1.50
S.A. m^2 / Kg.	4.92
Angularity-method A	42
% Flat & Elongated	0.0
Sand Equivalent	85
Virgin G_b @ 25°C	1.0249
Anti-Strip Dose (%)	0.00
Stripping Inflection Point	

	Combined	Contribution From RAM
% Friction Type 4 (+4)	93	5
Or Better	93	5
% Friction Type 3 (+4)	0	0
Or Better	0	0
% Friction Type 2 (+4)	0	0
% Friction Type 2 (-4)	0	0
Type 2 Fineness Modulus	0.0	0.0
% Crushed	73.0	9.7

Mix Check: Good

Pb Range Check: 1.40

RAM Check: OK

Specification Check: Comply

Hamburg Check: Not Required

Disposition : An asphalt content of 5.0% is recommended to start this project.

Data shown in 5.02% column is interpolated from test data.

The % ADD AC to start project is 4.0%

Comments :

Copies to : Manatt's Inc.

Mix Designer & Cert.# : Brad Karsten CI391 Signed : Shane Fetters(District 1 Materials)

Form 955 ver. 11.08

Iowa Department of Transportation

Highway Division-Office of Materials

Proportion & Production Limits For Aggregates

County : Marshall Project No.: FM-CO64(127)--55-64 Date: 08/16/18

Project Location: E41/235th St, from ECL of State Center E 9 Miles to IA 330. Mix Design No.: 1BD16-065

Contract Mix Tonnage: 15,340 Course: Surface Mix Size (in.): 3/4

Contractor: Manatt's Inc. Mix Type: ST Design Traffic: Standard Traffic

Material	Ident #	% in Mix	Producer & Location	Type (A or B)	Friction Type	Beds	Gsb	%Abs
3/4" Clean	A64002	34.0%	Martin Marietta Aggregates/Ferguson	A	4	10-17	2.630	1.78
3/8" Chips	A64002	5.0%	Martin Marietta Aggregates/Ferguson	A	4	10-17	2.628	1.85
Manufactured Sand	A64002	24.0%	Martin Marietta Aggregates/Ferguson	A	4	10-17	2.646	1.75
Screened	A64002	20.0%	Martin Marietta Aggregates/Ferguson				2.630	0.55
Classified RAP	RAP18-02	17.0%	17% ABC18-0068 (5.97 % AC)	A	4		2.585	1.63

Type and Source of Asphalt Binder: PG 58-28S BITUMINOUS MATERIALS TAMA, IA

Individual Aggregates Sieve Analysis - % Passing (Target)

Material	1"	3/4"	1/2"	3/8"	#4	#8	#16	#30	#50	#100	#200
3/4" Clean	100	98	72	42	8.0	3.5	3.0	2.9	2.8	2.7	2.5
3/8" Chips	100	100	100	94	27	5.0	3.5	3.0	2.8	2.6	2.5
Manufactured Sand	100	100	100	100	97	41	16	9.0	4.0	3.5	2.8
Screened	100	100	100	99	98	95	87	75	33	8.0	5.0
Classified RAP	100	100	97	91	73	57	46	34	17	12	9.8

Preliminary Job Mix Formula Target Gradation

	1"	3/4"	1/2"	3/8"	#4	#8	#16	#30	#50	#100	#200
Upper Tolerance	100	100	97	85	66	45		28			6.3
Comb Grading	100	99	90	78	59	40	30	24	11	5.5	4.3
Lower Tolerance	100	92	83	71	52	35		20			2.3
S.A.sq. m/kg	Total	4.92		+0.41	0.24	0.33	0.49	0.69	0.71	0.67	1.39

Production Limits for Aggregates Approved by the Contractor & Producer.

Sieve Size in.	34.0% of mix 3/4" Clean Min	Max	5.0% of mix 3/8" Chips Min	Max	24.0% of mix Manufactured Sand Min	Max	20.0% of mix Screened Min	Max	17.0% of mix Classified RAP Min	Max
1"	98.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0		
3/4"	91.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0		
1/2"	65.0	79.0	98.0	100.0	100.0	100.0	98.0	100.0		
3/8"	35.0	49.0	87.0	100.0	98.0	100.0	92.0	100.0		
#4	1.0	15.0	20.0	34.0	90.0	100.0	91.0	100.0		
#8	0.0	8.5	0.0	10.0	36.0	46.0	90.0	100.0		
#30	0.0	6.9	0.0	7.0	5.0	13.0	71.0	79.0		
#200	0.5	2.5	0.5	2.5	0.8	2.8	2.0	5.0		

Comments:

Copies to: Manatt's Inc.

The above target gradations and production limits have been discussed with and agreed to by an authorized representative of the aggregate producer.

Signed: ______________________ Producer

Signed: ______________________ Contractor

4/25/13 ver 11.07

IOWA DOT ASPHALT PAVING DAILY PLANT REPORT

10/10/18 7 43 PM

10/10/2018

Active Project No.: FM-CO64(127)--55-64
Contract ID: 64-CO64-127
Mix Design No: 1BD18-065R1

Contractor: Manatt's Inc.
County: Marshall
RAP Stockpile ID: ABC18-0068 (5.97 % AC)

Active Placement: Surface (Travel Lane)
Mix Type: St Surface None 3/4 (HMA)
Active Bid Item: 2303-1033750 ST SURF 3/4IN NO (HMA)

Report No.: 7
Lab Voids Target: 4.0
Design Gyrations: 50

UNCOMPACTED MIXTURE

Hot Box I.D (Theoretical %AC)	SUR-07-A (5.24%)	SUR-07-B (5.14%)	SUR-C (5.07%)	SUR-D (5.24%)		
Date Sampled	10/10/18	10/10/18	10/10/18	10/10/18		
Time	9:00 AM	1:00 PM	4:00 PM	5:30 PM		
Station	84+00	36+00	90+00	64+00		
Bar Code ID						
Sample (Tons)	189.00	956.00	1,592.00	1,963.00		
G_{mb}	2.393	2.374	2.375	2.377		
Gmb (DOT)						
G_{mm}	2.473	2.479	2.483	2.473		
Gmm (DOT)						
P_a (%)	3.2	4.2	4.3	3.9		
P_a (%) (DOT)						
				Avg G_{mb}	Avg G_{mm}	Avg Pa (%)
				2.380	2.477	3.9

GRADATION (%Passing)

☐ Use DOT

Sieve	Specs	CF10-10			Avg	District
1 in.	100	100.0			100.0	
3/4 in.	92-100(99)	100.0			100.0	
1/2 in.	83-97(90)	91.0			91.0	
3/8 in.	71-85(78)	82.0			82.0	
* #4	52-66(59)	64.0			64.0	
* Dev	± 7.0	**5.0**			**5.0**	
*#8	35-45(40)	45.0			45.0	
*Dev	± 5.0	**5.0**			**5.0**	
#16		34.0			34.0	
*#30	20-28(24)	26.0			26.0	
* Dev	± 4.0	**2.0**			**2.0**	
#50		13.0			13.0	
#100		5.3			5.3	
*#200	2.3-6.3(4.3)	3.7			3.7	
*Dev	± 2.0	**-0.6**			**-0.6**	
Gradation Compliance?		Yes			Yes	
DBR	Sugg 0.6 - 1.4	0.84			0.84	
% +4 Type 4		100.0			100.0	
% +4 Type 3					0.0	
(+4/-4) Type 2		00.0/00.0			00.0/00.0	

BINDER

	Target	Actual	Spec	Comply?
% Added Binder	4.15	4.19	N/A	
% Total Binder	5.12	5.17	4.82-5.42	Yes
% RAP	17.00	17.07%	≤100%	Yes
% RAS				
% Binder Replacement	19.00%	18.91%	≤ 30%	Yes
PG Grade	58-28S		58-28S	Yes

Gb: 1.03251 | Gsb: 2.626 | Pbe (%): 4.39

COMPACTED JOINT

Core #	Station	Joint ID	G_{mb}
1	89+00	2L-Centerline	2.18
2	60+00	2L-Centerline	2.26
3			

Average Joint G_{mb}	2.22
Average Mat G_{mb}	2.325
% Mat Density	95.5

For information Only

Joint Length, ft: 4,800
Unit Price Adjustment ($/ft):

Joint Price Adjustment =

USE D.O.T. RESULTS
(Enter an 'X')

TEST STRIP
(Enter an "X")

FILM THICKNESS (FT) [8.0-15.0]	
FT, µm	**8.8**
Price Adjustment	$0.00

Gyratory VMA	
VMA, %	**14.1**

QUANTITY FOR PAYMENT

Mix Unit Price ($/ton)	$22.60
Binder Unit Price ($/ton)	$400.00
Tons of Mix on Road	2,347.19
Tons to Other Bid Item(s)	
Tons of Binder	121.23
Tons of Waste	73.04
Tons of Binder to Date	773.74
Tons of Mix to Date	15,177.45

PLACEMENT RECORD

From Station	To Station	Lane	Width (ft)
0+00	96+00	SB/WB Drive Lr	12
48+00	96+00	NB/EB Drive Ln	12

Certified Tech: Brad Karsten — Cert. No CI391
Certified Tech: Sally Slaven — Cert. No CI489

Distribution ___ Dist. Materials ___ Proj. Engineer ___ Contractor

COMPACTED MAT

Core	Date of Placement	Station	CL Reference	W1 Dry (g)	W2 in H20 (g)	W3 Wet (g)	G_{mb}	% of Gmm	P_a (%)	Thickness (in)
1	10/10/2018	89+00	2.0 S\W Drv	2,015.7	1,151.4	2,017.8	2.327	93.9	6.1	2.00
2	10/10/2018	79+25	6.0 S\W Drv	2,313.0	1,332.5	2,314.5	2.355	95.1	4.9	2.00
3	10/10/2018	60+00	4.0 S\W Drv	2,188.8	1,238.4	2,189.6	2.301	92.9	7.1	2.00
4	10/10/2018	44+50	8.0 S\W Drv	2,256.5	1,294.3	2,257.8	2.342	94.5	5.5	2.25
5	10/10/2018	26+50	2.0 S\W Drv	1,882.4	1,074.3	1,883.3	2.327	93.9	6.1	1.75
6	10/10/2018	10+00	4.0 S\W Drv	2,108.6	1,197.7	2,110.2	2.311	93.3	6.7	2.00
7	10/10/2018	89+00	2.0 N\E Drv	2,093.6	1,195.6	2,094.4	2.329	94.0	6.0	2.00
8	10/10/2018	62+25	4.0 N\E Drv	2,300.9	1,306.2	2,303.5	2.307	93.1	6.9	2.25

Course Placed: Surface (Travel Lane) — Thickness QI: 1.06

Intended Lift Thickness: 2.00 — Avg. Mat Density: 2.325
Date Placed: 10/10/18 — Avg. % of Gmm: 93.838
Test Date/By: 10/11/18 Rich Amendt — Avg. % Field Voids: 6.16

$$Q.I.\ (lower) = \frac{(0.965 \times 2.477) - 2.325}{0.018} = \mathbf{3.63} \rightarrow PWL\ (lower) = 100.0$$

$$Q.I.\ (upper) = \frac{2.325 - (0.915 \times 2.477)}{0.018} = \mathbf{3.25} \rightarrow PWL\ (upper) = 100.0$$

$$PWL\ (total) = 100.0 + 100.0 - 100.0 = \mathbf{100.0}$$

Pay Factor = 1.040

Tons of Mix for PWL Field Voids Analysis (189.33 deducted)= 2,157.86 — Field Voids Incentive = $1,950.71

TEMPERATURE, °F

Time	7:00	9:00	11:00	1:00	3:00	5:00	7:00	Spec	Comply?
Air Temp		58	54	53	50	49			
Binder Temp		305	309	311	312	313		260-330 °F	Yes
Plant Temp		327	321	325	329	323		225-330 °F	Yes
Mat Temp	295	329	315	325	315	305		225-330 °F	Yes

☐ Break Down
☐ Rain Out
☐ Re-start after mandatory shutdown

Mix Change Information (when changes are made to start the day, identify them on previous day's report):

	Old Target	New Target	Tons	Agg	Initial %	New %	Agg	Initia	New %

Comments:

4/25/13 ver 11.07

IOWA DOT ASPHALT PAVING DAILY PLANT REPORT

10/11/18 2:54 PM

Date	10/11/2018
Active Project No.	FM-CO64(127)--55-64
Contract ID	64-CO64-127
Mix Design No.	1BD18-065R1
Contractor	Manatt's Inc.
County	Marshall
RAP Stockpile ID	ABC18-0068 (5.97 % AC)
Active Placement	Surface (Travel Lane)
Mix Type	St Surface None 3/4 (HMA)
Active Bid Item	2303-1033750 ST SURF 3/4IN NO (HMA)
Report No.	8
Lab Voids Target	4.0
Design Gyrations	50

UNCOMPACTED MIXTURE

Hot Box I.D. (Theoretical %AC)	SUR-A (5.08%)	SUR-B (5.30%)				
Date Sampled	10/11/18	10/11/18				
Time	9:20 AM	10:50 AM				
Station	34+00	6+00				
Bar Code ID						
Sample (Tons)	301.00	696.00				
G_{mb}	2.344	2.383				
Gmb (DOT)						
G_{mm}	2.496	2.483				
Gmm (DOT)						
P_a (%)	6.1	4.0				
P_a (%) (DOT)						
				Avg G_{mb}	Avg G_{mm}	Avg Pa (%)
				2.364	2.490	5.1

GRADATION (%Passing)

☐ Use DOT

Sieve	Specs	CF10-11			Avg	District
1 in.	100	100.0			100.0	
3/4 in.	92-100(99)	100.0			100.0	
1/2 in.	83-97(90)	93.0			93.0	
3/8 in.	71-85(78)	83.0			83.0	
* #4	52-66(59)	66.0			66.0	
* Dev	± 7.0	**7.0**			**7.0**	
*#8	35-45(40)	48.0			48.0	
*Dev	± 5.0	**8.0**			**8.0**	
#16		37.0			37.0	
*#30	20-28(24)	26.0			26.0	
* Dev	± 4.0	**2.0**			**2.0**	
#50		13.0			13.0	
#100		5.5			5.5	
*#200	2.3-6.3(4.3)	3.5			3.5	
*Dev	± 2.0	**-0.8**			**-0.8**	
Gradation Compliance?		No			No	
DBR	Sugg. 0.6 - 1.4	0.84			0.84	
% +4 Type 4		100.0			100.0	
% +4 Type 3					0.0	
(+4/-4) Type 2		00.0/00.0			00.0/00.0	

BINDER

	Target	Actual	Spec	Comply?
% Added Binder	4.15	4.20	N/A	
% Total Binder	5.12	5.18	4.82-5.42	Yes
% RAP	17.00	17.14%	≤100%	Yes
% RAS				
% Binder Replacement	19.00%	18.90%	≤ 30%	Yes
PG Grade	58-28S		58-28S	Yes
Gb: 1.03251	Gsb: 2.626		Pbe (%): 4.18	

COMPACTED JOINT

Core #	Station	Joint ID	G_{mb}
1			
2			
3			

Average Joint G_{mb}

Average Mat G_{mb}

% Mat Density

For information Only

Joint Length, ft

Unit Price Adjustment ($/ft)

Joint Price Adjustment =

USE D.O.T. RESULTS
(Enter an 'X')

TEST STRIP
(Enter an "X")

FILM THICKNESS (FT) [8.0-15.0]	
FT, µm	**8.3**
Price Adjustment	$0.00

Gyratory VMA	
VMA, %	**14.6**

QUANTITY FOR PAYMENT

Mix Unit Price ($/ton)	$22.60
Binder Unit Price ($/ton)	$400.00
Tons of Mix on Road	808.16
Tons to Other Bid Item(s)	
Tons of Binder	41.90
Tons of Waste	89.64
Tons of Binder to Date	
Tons of Mix to Date	

PLACEMENT RECORD

From Station	To Station	Lane	Width (ft)
48+00	96+00	NB/EB Drive Ln	12

Certified Tech: Brad Karsten Cert. No. CI391

Certified Tech: Sally Slaven Cert. No. CI489

Distribution: ____ Dist. Materials ____ Proj. Engineer ____ Contractor

COMPACTED MAT

Cores have been waived

Core	Date of Placement	Station	CL Reference	W1 Dry (g)	W2 in H20 (g)	W3 Wet (g)	G_{mb}	% of Gmm	P_a (%)	Thickness (in
1										
2										
3										
4										
5										
6										
7										
8										

Course Placed: Surface (Travel Lane)

Intended Lift Thickness

Date Placed: 10/11/18

Test Date/By: Rich Amendt

Thickness QI:

Avg. Mat Density:

Avg. % of Gmb:

Avg. %-Field Voids:

Q.I. (lower) = = → PWL (lower) =

Q.I. (upper) = = → PWL (upper) =

PWL (total) = + — 100.0 =

Pay Factor =

Tons of Mix for PWL Field Voids Analysis (808.16 deducted)=

Field Voids Price Adjustment =

TEMPERATURE, °F

Time	7:00	9:00	11:00	1:00	3:00	5:00	7:00	Spec	Compl
Air Temp	37	37	39	42					
Binder Temp	311	312	312	311				260-330 °F	Yes
Plant Temp	326	325	321	318				245-330 °F	Yes
Mat Temp								245-330 °F	

☐ Break Down

☐ Rain Out

☐ Re-start after mandatory shutdown

Mix Change Information (when changes are made to start the day, identify them on previous day's report):

	Old Target	New Target	Tons	Agg	Initial %	New %	Agg	Initia	New

Comments

4/25/13 ver.8.10

IOWA DOT ASPHALT PAVING DAILY PLANT REPORT

9/9/13 1:42 PM

9/8/2013
Active Project No.: STP-006-6(74)--2C-52
Contract ID: 52-0015-101
Mix Design No.: ABC13-6043

Contractor: L.L. Pelling
County: Johnson
RAM Lab Number: ABC13-0119 (3.38 % AC)

Active Placement: Surface (Travel Lane)
Mix Type: 10M Surface 1/2 L-3 (HMA)
Active Bid Item: 2303-0053503 10M Surf 1/2in L-3 (HMA)

Report No.: 1
Lab Voids Target: 4.0
Design Gyrations: 96

UNCOMPACTED MIXTURE

Hot Box I.D. (Theoretical %AC)	Su9-8c (4.38%)					
Date Sampled	9/8/13					
Time	10:31 PM					
Station						
Side						
Sample (Tons)	259.00					
G_{mb}	2.549					
Gmb (DOT) (In)	2.551					
G_{mm}	2.609					
Gmm (DOT) (In)	2.614					
P_a (%)	2.3					
P_a (%) (DOT)	2.4					
Article 2303.03,E (Small Quantities) Applies for 300 ton plan quantity				Avg G_{mb}	Avg G_{mm}	Avg Pa (%)
				2.549	2.609	2.3

GRADATION (%Passing)

☐ Use DOT

Sieve	Specs	Su9-8c			Avg	District
1 in.	100	100.0			100.0	100
3/4 in.	100	100.0			100.0	100
1/2 in.	85-99(92)	91.0			91.0	92
3/8 in.	76-90(83)	79.0			79.0	83
* #4	47-61(54)	52.0			52.0	57
* Dev	± 7.0	**-2.0**			**-2.0**	**3**
*#8	32-42(37)	35.0			35.0	39
*Dev	± 5.0	**-2.0**			**-2.0**	**2**
#16		25.0			25.0	28
*#30	13-21(17)	17.0			17.0	21
* Dev	± 4.0	**0**			**0**	**4.0**
#50		9.0			9.0	12.0
#100		5.3			5.3	7.5
*#200	2.4-6.4(4.4)	4.4			4.4	6.0
*Dev	± 2.0	**0**			**0**	**1.6**
Gradation Compliance?		Yes			Yes	Yes
DBR	0.6 - 1.4	1.20			1.20	1.63
% +4 Type 4	80	100.0			100.0	119.8
% +4 Type 3	45				0.0	
(+4/-4) Type 2	(25/0)	32.1/12.6			32.1/12.6	35.9/11.5

BINDER

	Target	Actual	Spec	Comply?
% Added Binder	3.10	3.10	N/A	
% Total Binder	4.30	4.38	4.00-4.60	Yes
% RAP	38.00	39.21%	≤100%	Yes
% RAS				
% Binder Replacement	28.96%	29.29%	≤ 30%	Yes
PG Grade	64-28		64-28	Yes

Gb: 1.01956 Gsb: 2.754 Pbe (%): 3.67

COMPACTED JOINT

Core ID	Lane	G_{mb}	Pa (%) (Gmm=2.609)
1-			
1-			
1-			
1-			
2-			
2-			
2-			
2-			
3-			
3-			
3-			
3-			
Average Pa (%)			

USE D.O.T. RESULTS
(Enter an 'X')

TEST STRIP
(Enter an "X")

FILM THICKNESS (FT) [8.0-15.0]	
FT, µm	**8.2**
Price Adjustment	$0.00

Mix Unapproved (See IM 510A)	
VMA, %	**11.5**

QUANTITY FOR PAYMENT	
Mix Unit Price ($/ton)	$48.55
Binder Unit Price ($/ton)	$686.20
Tons of Mix on Road	317.54
Tons to Other Bid Item(s)	
Tons of Binder	13.92
Tons of Waste	
Tons of Binder to Date	13.92
Tons of Mix to Date	317.54

PLACEMENT RECORD

From Station	To Station	Lane	Width (ft)
235+54	226+27	SB/WB Pass Ln	12
217+60	206+60	SB/WB Pass Ln	12

Certified Tech: Taylor Maxfield Cert. No. EC593
Certified Tech: Dave McDowell Cert. No. EC898
Distribution: ___ Dist. Materials ___ Proj. Engineer ___ Contractor

COMPACTED MAT

Core	Station	CL Reference	W1 Dry (g)	W2 in H20 (g)	W3 Wet (g)	Diff.	G_{mb}	% of Gmm	P_a (%)	Thickness (in.)
1	234+65	3.0 S\W Pass	819.5	479.5	820.0	340.5	2.407	92.3	7.7	1.63
2	229+88	4.6 S\W Pass	867.8	516.5	868.3	351.8	2.467	94.6	5.4	1.75
3	229+33	8.0 S\W Pass	814.9	487.5	815.1	327.6	2.487	95.3	4.7	1.50
4	216+40	7.6 S\W Pass	715.3	422.9	715.9	293.0	2.441	93.6	6.4	1.50
5	213+89	1.0 S\W Pass	701.3	417.2	701.9	284.7	2.463	94.4	5.6	1.25
6	209+39	7.2 S\W Pass	650.4	389.9	650.8	260.9	2.493	95.6	4.4	1.25
7										
8										

Course Placed: Surface (Travel Lane) Thickness QI: 0.96
Intended Lift Thickness: 1.50 Avg. Mat Density: 2.460
Date Placed: 09/08/13 Avg. % of Gmm: 94.300
Test Date/By: 09/08/13 Mike Bloom Avg. % Field Voids: 5.70

$$\text{Q.I. (lower)} = \frac{(0.965 \times 2.609) - 2.460}{0.032} = \mathbf{1.80} \rightarrow \text{PWL (lower)} = 98.0$$

$$\text{Q.I. (upper)} = \frac{2.460 - (0.915 \times 2.609)}{0.032} = \mathbf{2.27} \rightarrow \text{PWL (upper)} = 99.9$$

$$\text{PWL (total)} = 98.0 + 99.9 - 100.0 = \mathbf{97.9}$$

Article 2303.03,E Applies for 300 ton plan quantity.

Field Voids Price Adjustment = $0.00

TEMPERATURE, °F

Time	7:00	9:00	11:00	1:00	3:00	5:00	7:00	Spec	Comply?
Air Temp	83	76	75						
Binder Temp	300	300	300					260-330 °F	Yes
Plant Temp	320	309	322					245-330 °F	Yes
Mat Temp								245-330 °F	

☐ Break Down ☐ Rain Out ☐ Re-start after mandatory shutdown

Mix Change Information (when changes are made to start the day, identify them on previous day's report):

	Old Target	New Target	Tons	Agg	Initial %	New %	Agg	Initia	New %

Comments:
The asphalt mixture contains certified asphalt binder and approved aggregate as specified in the approved mix design and was produced in compliance with the provisions of Article 2303.03, E.

Form 955r ver. 8.10

Iowa Department of Transportation

Highway Division-Office of Materials
Proportion & Production Limits For Aggregates

County :	Johnson	Project No.:	STP-006-6(74)--2C-52	Date:	09/08/13
Project Location:	In Iowa City from 500' N of S Jct IA 1 to Lakeside Dr			Mix Design No.:	ABC13-6043
Contract Mix Tonnage:	300	Course:	Surface (Travel Lane)	Mix Size (in.):	1/2
Contractor:	L.L. Pelling	Mix Type:	HMA (10M ESAL), Surface, 1/2, FRICL-3		

Material	Ident #	% in Mix	Producer & Location	Type (A or B)	Friction Type	Beds	Gsb	%Abs
Sand	A52508	11.0%	Williams/S&G Materials Inc	A	4		2.634	0.47
TAT4 M. Sand	A52006	14.0%	Klein/River Products Co	A	4	2-10	2.649	0.84
3/8"chips	A58002	12.0%	Columbus Junction/River Products Co	A	4	16-19	2.583	3.23
3/4" A	A52006	11.0%	Klein/River Products Co	A	4	2-10	2.652	0.86
3/8" Slag	A70008	14.0%	Montpelier/Blackheart Slag	A	2		3.709	1.20
RAP	Surface mi	38.0%	ABC13-0119 (3.38 % AC)	A	2	0	2.662	1.30

Type and Source of Asphalt Binder: 64-28 Bituminous Matr'l & Supply (Tama, IA)

Individual Aggregates Sieve Analysis - % Passing (Target)

Material	1"	3/4"	1/2"	3/8"	#4	#8	#16	#30	#50	#100	#200
Sand	100	100	100	100	95	90	79	53	16	2	1
TAT4 M. Sand	100	100	100	100	98	76	43	20	8.3	2.8	2.5
3/8"chips	100	100	100	95	50	15	4	2.7	2.6	2.5	2.3
3/4" A	100	100	55	19	4	3	3	2.5	2.5	2	2
3/8" Slag	100	100	100	100	31	1.8	1.6	1.5	1.5	1.4	1
RAP	100	100	93	80	51	36	27	20	14	10	8.8

Preliminary Job Mix Formula Target Gradation

	1"	3/4"	1/2"	3/8"	#4	#8	#16	#30	#50	#100	#200
Upper Tolerance	100	100	99	90	61	42		21			6
Comb Grading	100	100	92	83	54	37	26.0	17.0	8.0	5.1	4.4
Lower Tolerance	100	100	85	76	47	32		13			2.4
S.A.sq. m/kg	Total	4.46		+0.41	0.22	0.30	0.43	0.49	0.55	0.62	1.44

Production Limits for Aggregates Approved by the Contractor & Producer.

Sieve Size in.	11.0% of mix Sand		14.0% of mix TAT4 M. Sand		12.0% of mix 3/8"chips		11.0% of mix 3/4" A		14.0% of mix 3/8" Slag		38.0% of mix RAP	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
1"	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"	100.0	100.0	100.0	100.0	100.0	100.0	98.0	100.0	100.0	100.0	98.0	100.0
1/2"	100.0	100.0	100.0	100.0	98.0	100.0	48.0	62.0	100.0	100.0	86.0	100.0
3/8"	98.0	100.0	98.0	100.0	88.0	100.0	12.0	26.0	98.0	100.0	73.0	87.0
#4	88.0	100.0	91.0	100.0	43.0	57.0	0.0	11.0	24.0	38.0	44.0	58.0
#8	85.0	95.0	71.0	81.0	10.0	20.0	0.0	8.0	0.0	6.8	31.0	41.0
#30	49.0	57.0	16.0	24.0	0.0	6.7	0.0	6.5	0.0	5.5	16.0	24.0
#200	0.0	3.0	0.5	4.5	0.3	4.3	0.0	4.0	0.0	3.0	6.8	10.8

Comments: This is a revised report which includes field changes to the aggregate proportions

Copies to:

The above target gradations and production limits have been discussed with and agreed to by an authorized representative of the aggregate producer.

Signed: ______________________ Signed: ______________________

Producer Contractor

Form 956 ver. 10.10

Iowa Department of Transportation

Highway Division - Office of Materials

HMA Gyratory Mix Design

Letting Date : 4/16/2013

Mix No. : ABD13-3034

Contract #:

Date: 08/22/13

Nmax

County : Lyon

Mix Size (in.) : 1/2 Type A

Mix Type: HMA 3M L - 3

Intended Use : Surface

Project : STPN-182-1(7)--2J-60

Contractor : TriState

Design Life ESAL's : 3,000,000

Location : MP 0 - 9 IA 182 fro US18 in Inwood N. to IA 9

Aggregate	% in Mix	Source ID	Source Location	Beds	Gsb	%Abs	FAA	Friction
3/8 X 8	10.0%	ASD004	Sioux Falls Quartzite/Concrete Matls	1	2.633	0.35	46.0	2
Manf. Sand	5.5%	ASD004	Sioux Falls Quartzite/Concrete Matls	1	2.633	0.35	46.0	2
4 X 20	27.5%	ASD004	Sioux Falls Quartzite/Concrete Matls	1	2.634	0.30	46.0	2
Sand	17.0%	A84510	Hawarden-North/Lg Everist Inc		2.617	0.76	40.0	4
1/2 Cr. Gravel	25.0%	A60548	O'Conner/Hallett Materials Co		2.669	1.10	46.0	3
RAP/RAS	15.0%	ABC13-0094	11% RAP/4% RAS (8.4% AC)		2.633	1.03	42.0	2

Job Mix Formula - Combined Gradation (Sieve Size in.)

	1"	3/4"	1/2"	3/8"	#4	#8	#16	#30	#50	#100	#200
Upper Tolerance	100	100	100	95	76	48		19			5.9
	100	**100**	**97**	**88**	**69**	**43**	**26**	**15**	**9.2**	**5.6**	**3.9**
Lower Tolerance	100	100	90	81	62	38		11			1.9

Asphalt Binder Source and Grade:

Adjust grade to PG 58-28

Gyratory Data

% Asphalt Binder	4.60	5.10	**5.33**	5.60
Corrected Gmb @ N-Des.	2.315	2.317	**2.352**	2.391
Max. Sp.Gr. (Gmm)	2.471	2.460	**2.450**	2.438
% Gmm @ N- Initial	86.2	86.4	**88.2**	90.2
%Gmm @ N-Max	93.7	94.2	**96.0**	98.1
% Air Voids	6.3	5.8	**4.0**	1.9
% VMA	17.4	17.8	**16.7**	15.6
% VFA	63.7	67.3	**76.1**	87.6
Film Thickness	9.35	10.25	**10.84**	11.53
Filler Bit. Ratio	0.94	0.86	**0.81**	0.76
Gse	2.670	2.678	**2.676**	2.673
Pbe	4.14	4.54	**4.80**	5.11
Pba	0.44	0.55	**0.52**	0.48
% New Asphalt Binder	73.5	76.3	**77.3**	78.5
Combined Gb @ 25°C	1.0300	1.0300	**1.0300**	1.0300

Number of Gyrations

N-Initial 7

N-Design 86

N-Max 134

Gsb for Angularity Method A

2.627

Pba / %Abs Ratio

0.29

Slope of Compaction Curve

Mix Check

Good

Pb Range Check

1.00

RAM Check

OK

Aggregate Type Used	A
G_{sb}	2.640
G_{sa}	2.689
% Water Abs	0.69
S.A. m^2 / Kg.	4.43
Angularity-method A	43
% Flat & Elongated	0.6
Sand Equivalent	87
Virgin G_b @ 25°C	1.03

	Combined	From RAM
% Friction Type 4 (+4)	10.3	8.1
Or Better	100.4	8.5
% Friction Type 3 (+4)	69.0	0.0
Or Better	90.1	0.4
% Friction Type 2 (+4)	21.0	0.4
% Friction Type 2 (-4)	54.8	0.0
Type 2 Fineness Modulus	2.3	0.4
% Crushed	75.0	5.3

Anti-Strip Dose (%)	0.00	0.50	0.75
Stripping Inflection Point	11,393	9,382	18,577

Specification Check

Comply

Moisture Sensitivity Check

SIP (0% AS)=11,393

SIP (0.75% AS)=18,577

Disposition : An asphalt content of 5.3% is recommended to start this project.

Data shown in 5.33% column is interpolated from test data.

The % ADD AC to start project is 4.1%

AS Source: LOF6500

Dose Rate= 0.75 % of binder

Comments :

Copies to : TriState

Mix Designer & Cert.# : Thuisman CI-515

Signed :

Form 955 ver. 10.10

Iowa Department of Transportation

Highway Division-Office of Materials
Proportion & Production Limits For Aggregates

County :	Lyon	Project No.:	STPN-182-1(7)--2J-60
Project Location:	IA 182 fro US18 in Inwood N. to IA 9	Date:	08/22/13
Contract Mix Tonnage:	13,571	Mix Design No.:	ABD13-3034
Contractor:	TriState	Mix Size (in.):	1/2
Course:	Surface	Design Life ESAL's:	3,000,000
Mix Type:	HMA 3M		

Material	Ident #	% in Mix	Producer & Location	Type (A or B)	Friction Type	Beds	Gsb	%Abs
3/8 X 8	ASD004	10.0%	Sioux Falls Quartzite/Concrete Matls Co	A	2	1	2.633	0.35
Manf. Sand	ASD004	5.5%	Sioux Falls Quartzite/Concrete Matls Co	A	2	1	2.633	0.35
4 X 20	ASD004	27.5%	Sioux Falls Quartzite/Concrete Matls Co	A	2	1	2.634	0.30
Sand	A84510	17.0%	Hawarden-North/Lg Everist Inc	A	4		2.617	0.76
1/2 Cr. Gravel	A60548	25.0%	O'Conner/Hallett Materials Co	A	3		2.669	1.10
RAP/RAS	ABC13-009	15.0%	11% RAP/4% RAS (8.4% AC)	A	2		2.633	1.03

Type and Source of Asphalt Binder:

Individual Aggregates Sieve Analysis - % Passing (Target)

Material	1"	3/4"	1/2"	3/8"	#4	#8	#16	#30	#50	#100	#200
3/8 X 8	100	100	100	100	40	4.0	2.0	1.0	1.0	1.0	1.0
Manf. Sand	100	100	100	100	100	97	75	57	37	16	5.6
4 X 20	100	100	100	100	99	46	12	5.8	4.5	3.6	2.8
Sand	100	100	100	100	96	78	55	27	7.5	1.2	0.6
1/2 Cr. Gravel	100	100	88	57	16	8.5	6.2	5.1	4.4	3.7	3.0
RAP/RAS	100	100	99	93	80	67	52	35	26	19	15

Preliminary Job Mix Formula Target Gradation

	1"	3/4"	1/2"	3/8"	#4	#8	#16	#30	#50	#100	#200
Upper Tolerance	100	100	100	95	76	48		19			5.9
Comb Grading	100	100	97	88	69	43	26	15	9.2	5.6	3.9
Lower Tolerance	100	100	90	81	62	38		11			1.9
S.A.sq. m/kg	Total	4.43		+0.41	0.28	0.35	0.42	0.44	0.57	0.69	1.29

Production Limits for Aggregates Approved by the Contractor & Producer.

Sieve Size in.	10.0% of mix 3/8 X 8		5.5% of mix Manf. Sand		27.5% of mix 4 X 20		17.0% of mix Sand		25.0% of mix 1/2 Cr. Gravel		15.0% of mix RAP/RAS	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
1"	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0		
3/4"	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0		
1/2"	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	81.0	95.0		
3/8"	95.0	100.0	100.0	100.0	98.0	100.0	100.0	100.0	50.0	64.0		
#4	33.0	47.0	95.0	100.0	92.0	100.0	89.0	100.0	9.0	23.0		
#8	0.0	9.0	0.0	100.0	41.0	51.0	73.0	83.0	0.0	13.0		
#30	0.0	5.0	50.0	65.0	0.0	10.0	23.0	31.0	0.0	8.0		
#200	0.0	3.0	0.0	8.0	0.0	4.5	0.0	1.5	0.0	5.0		

Comments: ______

Copies to: TriState

The above target gradations and production limits have been discussed with and agreed to by an authorized representative of the aggregate producer.

Signed: ______ Producer

Signed: ______ Contractor

Form 956 ver. 10.10

Iowa Department of Transportation

Highway Division - Office of Materials

HMA Gyratory Mix Design

Letting Date : 4/16/2013
Mix No. : ABD13-3034
Contract #:
Date: 08/30/13

Nmax

County : Lyon
Mix Size (in.) : 1/2 Type A
Mix Type: HMA 3M L - 3
Intended Use : Surface

Project : STPN-182-1(7)--2J-60
Contractor : TriState
Design Life ESAL's : 3,000,000
Location : MP 0 - 9 IA 182 fro US18 in Inwood N. to IA 9

Aggregate	% in Mix	Source ID	Source Location	Beds	Gsb	%Abs	FAA	Friction
3/8 X 8	13.0%	ASD004	Sioux Falls Quartzite/Concrete Matls	1	2.633	0.35	46.0	2
Manf. Sand	8.5%	ASD004	Sioux Falls Quartzite/Concrete Matls	1	2.633	0.35	46.0	2
4 X 20	24.5%	ASD004	Sioux Falls Quartzite/Concrete Matls	1	2.634	0.30	46.0	2
Sand	20.0%	A84510	Hawarden-North/Lg Everist Inc		2.617	0.76	40.0	4
1/2 Cr. Gravel	25.0%	A60548	O'Conner/Hallett Materials Co		2.669	1.10	46.0	3
RAP/RAS	9.0%	ABC13-0094	5% RAP/4% RAS (10.6% AC)		2.634	1.16	42.4	2

Job Mix Formula - Combined Gradation (Sieve Size in.)

	1"	3/4"	1/2"	3/8"	#4	#8	#16	#30	#50	#100	#200
Upper Tolerance	100	100	100	96	75	49		20			5.4
	100	**100**	**97**	**89**	**68**	**44**	**27**	**16**	**9.3**	**5.2**	**3.4**
Lower Tolerance	100	100	90	82	61	39		12			1.4

Asphalt Binder Source and Grade:
Adjust grade to PG 58-28

Gyratory Data

% Asphalt Binder	4.60	5.10	**5.33**	5.60
Corrected Gmb @ N-Des.	2.315	2.317	**2.352**	2.391
Max. Sp.Gr. (Gmm)	2.471	2.460	**2.450**	2.438
% Gmm @ N- Initial	86.2	86.4	**88.2**	90.2
%Gmm @ N-Max	93.7	94.2	**96.0**	98.1
% Air Voids	6.3	5.8	**4.0**	1.9
% VMA	17.4	17.8	**16.7**	15.6
% VFA	63.7	67.3	**76.1**	87.6
Film Thickness	9.65	10.54	**11.14**	11.87
Filler Bit. Ratio	0.82	0.75	**0.71**	0.67
Gse	2.670	2.679	**2.677**	2.674
Pbe	4.13	4.51	**4.77**	5.08
Pba	0.45	0.58	**0.55**	0.51
% New Asphalt Binder	80.0	82.0	**82.9**	83.7
Combined Gb @ 25°C	1.0300	1.0300	**1.0300**	1.0300

Number of Gyrations
N-Initial
7
N-Design
86
N-Max
134

Gsb for Angularity Method A
2.627

Pba / %Abs Ratio
0.32

Slope of Compaction Curve

Mix Check
Good

Pb Range Check
1.00

RAM Check
OK

Specification Check
Comply

Moisture Sensitivity Check
SIP (0% AS)=11,393
SIP (0.75% AS)=18,577

Aggregate Type Used	A
G_{sb}	2.639
G_{sa}	2.687
% Water Abs	0.68
S.A. m^2 / Kg.	4.28
Angularity-method A	43
% Flat & Elongated	0.6
Sand Equivalent	87
Virgin G_b @ 25°C	1.03

	Combined	From RAM
% Friction Type 4 (+4)	6.1	3.5
Or Better	100.3	3.7
% Friction Type 3 (+4)	68.0	0.0
Or Better	94.1	0.2
% Friction Type 2 (+4)	26.2	0.2
% Friction Type 2 (-4)	56.7	0.0
Type 2 Fineness Modulus	2.2	0.2
% Crushed	76.0	3.6

Anti-Strip Dose (%)	0.00	0.50	0.75
Stripping Inflection Point	11,393	9,382	18,577

Disposition : An asphalt content of 5.3% is recommended to start this project.

Data shown in 5.33% column is interpolated from test data.

The % ADD AC to start project is 4.4%

AS Source: LOF6500

Dose Rate= 0.75 % of binder

Comments :

Copies to : TriState

Mix Designer & Cert.# : Thuisman CI-515 Signed :

Revised (REV) Version

Form 955 ver. 10.10

Iowa Department of Transportation

Highway Division-Office of Materials
Proportion & Production Limits For Aggregates

County : Lyon | Project No.: STPN-182-1(7)--2J-60 | Date: 08/30/13
Project Location: IA 182 fro US18 in Inwood N. to IA 9 | Mix Design No.: ABD13-3034
Contract Mix Tonnage: 13,571 | Course: Surface | Mix Size (in.): 1/2
Contractor: TriState | Mix Type: HMA 3M | Design Life ESAL's: 3,000,000

Material	Ident #	% in Mix	Producer & Location	Type (A or B)	Friction Type	Beds	Gsb	%Abs
3/8 X 8	ASD004	13.0%	Sioux Falls Quartzite/Concrete Matls Co	A	2	1	2.633	0.35
Manf. Sand	ASD004	8.5%	Sioux Falls Quartzite/Concrete Matls Co	A	2	1	2.633	0.35
4 X 20	ASD004	24.5%	Sioux Falls Quartzite/Concrete Matls Co	A	2	1	2.634	0.30
Sand	A84510	20.0%	Hawarden-North/Lg Everist Inc	A	4		2.617	0.76
1/2 Cr. Gravel	A60548	25.0%	O'Conner/Hallett Materials Co	A	3		2.669	1.10
RAP/RAS	ABC13-009	9.0%	5% RAP/4% RAS (10.6% AC)	A	2		2.634	1.16

Type and Source of Asphalt Binder:

Individual Aggregates Sieve Analysis - % Passing (Target)

Material	1"	3/4"	1/2"	3/8"	#4	#8	#16	#30	#50	#100	#200
3/8 X 8	100	100	100	100	40	4.0	2.0	1.0	1.0	1.0	1.0
Manf. Sand	100	100	100	100	100	97	75	57	37	16	5.6
4 X 20	100	100	100	100	99	46	12	5.8	4.5	3.6	2.8
Sand	100	100	100	100	96	78	55	27	7.5	1.2	0.6
1/2 Cr. Gravel	100	100	88	57	16	8.5	6.2	5.1	4.4	3.7	3.0
RAP/RAS	100	100	99	95	84	71	56	38	31	23	17

Preliminary Job Mix Formula Target Gradation

Upper Tolerance	100	100	100	96	75	49		20			5.4
Comb Grading	100	100	97	89	68	44	27	16	9.3	5.2	3.4
Lower Tolerance	100	100	90	82	61	39		12			1.4
S.A.sq. m/kg	Total	4.28		+0.41	0.28	0.36	0.43	0.46	0.57	0.64	1.11

Production Limits for Aggregates Approved by the Contractor & Producer.

Sieve Size in.	13.0% of mix 3/8 X 8		8.5% of mix Manf. Sand		24.5% of mix 4 X 20		20.0% of mix Sand		25.0% of mix 1/2 Cr. Gravel		9.0% of mix RAP/RAS	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
1"	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0		
3/4"	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0		
1/2"	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	81.0	95.0		
3/8"	95.0	100.0	100.0	100.0	98.0	100.0	100.0	100.0	50.0	64.0		
#4	33.0	47.0	95.0	100.0	92.0	100.0	89.0	100.0	9.0	23.0		
#8	0.0	9.0	0.0	100.0	41.0	51.0	73.0	83.0	0.0	13.0		
#30	0.0	5.0	50.0	65.0	0.0	10.0	23.0	31.0	0.0	8.0		
#200	0.0	3.0	0.0	8.0	0.0	4.5	0.0	1.5	0.0	5.0		

Comments:

Copies to: TriState

The above target gradations and production limits have been discussed with and agreed to by an authorized representative of the aggregate producer.

Signed: ____________________ Producer

Signed: ____________________ Contractor

4/25/13 ver.11.07

IOWA DOT ASPHALT PAVING DAILY PLANT REPORT

9/15/18 10:38 AM

9/14/2018
Active Project No.: NHSX-018-8(45)--3H-33
Contract ID: 33-0188-045
Mix Design No.: ABD18-2027

Contractor: Mathy Construction
County: Fayette
RAP Stockpile ID: ABC14-0116 (5.52 % AC)

Active Placement: Surface (Travel Lane)
Mix Type: Ht Surface L - 4 1/2 (HMA)
Active Bid Item: 2303-1043504 HT SURF 1/2IN L-4 (HMA)

Report No.: 9
Lab Voids Target: 4.0
Design Gyrations: 75

UNCOMPACTED MIXTURE

Hot Box I.D. (Theoretical %AC)	9-14A (5.23%)	9-14B (5.23%)				
Date Sampled	9/14/18	9/14/18				
Time	4:05 PM	5:15 PM				
Station	505+50	529+00				
Bar Code ID	D2-004528	D2-004527				
Sample (Tons)	234.40	419.27				
G_{mb}	2.407	2.402				
Gmb (DOT)						
G_{mm}	2.489	2.489				
Gmm (DOT)						
P_a (%)	3.3	3.5				
P_a (%) (DOT)						
				Avg G_{mb}	Avg G_{mm}	Avg Pa (%)
				2.405	2.489	3.4

GRADATION (%Passing)

☐ Use DOT

Sieve	Specs	CF 9-14 A			Avg	District
1 in.	100	100.0			100.0	
3/4 in.	100	100.0			100.0	
1/2 in.	91-100(98)	98.0			98.0	
3/8 in.	82-96(89)	90.0			90.0	
* #4	56-70(63)	65.0			65.0	
* Dev	± 7.0	**2.0**			**2.0**	
*#8	41-51(46)	48.0			48.0	
*Dev	± 5.0	**2.0**			**2.0**	
#16		36.0			36.0	
*#30	20-28(24)	27.0			27.0	
* Dev	± 4.0	**3.0**			**3.0**	
#50		14.0			14.0	
#100		6.2			6.2	
*#200	0.9-4.9(2.9)	3.9			3.9	
*Dev	± 2.0	**1.0**			**1.0**	
Gradation Compliance?		Yes			Yes	
DBR	Sugg 0.6 - 1.4	0.90			0.90	
% +4 Type 4		92.6			92.6	
% +4 Type 3					0.0	
(+4/-4) Type 2		00.0/00.0			00.0/00.0	

BINDER

	Target	Actual	Spec	Comply?
% Added Binder	4.32	4.44	N/A	
% Total Binder	5.11	5.23	4.81-5.41	Yes
% RAP	15.00	14.99%	≤100%	Yes
% RAS				
% Binder Replacement	15.50%	15.13%	≤ 30%	Yes
PG Grade	58-34H		58-34H	Yes
Gb: 1.02728	Gsb: 2.636		Pbe (%):	4.34

COMPACTED JOINT

Core #	Station	Joint ID	G_{mb}
1	504+78	2L-Centerline	2.285
2	514+18	2L-Centerline	2.297
3	524+25	2L-Centerline	2.239
		Average Joint G_{mb}	2.274
		Average Mat G_{mb}	2.301
		% Mat Density	98.8

For information Only
Joint Length, ft 4,423
Unit Price Adjustment ($/ft) $0.240
Joint Incentive = $1,061.52

USE D.O.T. RESULTS
(Enter an 'X')

TEST STRIP
(Enter an "X")

FILM THICKNESS (FT) [8.0-15.0]	
FT, µm	**8.1**
Price Adjustment	$0.00

Gyratory VMA	
VMA, %	**13.5**

QUANTITY FOR PAYMENT

Mix Unit Price ($/ton)	$25.97
Binder Unit Price ($/ton)	$481.81
Tons of Mix on Road	888.61
Tons to Other Bid Item(s)	
Tons of Binder	46.47
Tons of Waste	4.00
Tons of Binder to Date	844.97
Tons of Mix to Date	15,492.66

PLACEMENT RECORD

From Station	To Station	Lane	Width (ft)
493+32	504+00	SB/WB Pass Lr	10
504+00	526+40	SB/WB Pass Lr	16
526+40	529+98.46	SB/WB Pass Lr	18
524+60.5	534+50	SB/WB Pass Lr	18
534+50	539+09	SB/WB Pass Lr	12.6

Certified Tech: Jay Haas Cert. No. NE208
Certified Tech: Jen Stanley Cert. No. EC223
Distribution: ____ Dist. Materials ____ Proj. Engineer ____ Contractor

COMPACTED MAT

Core	Date of Placement	Station	CL Reference	W1 Dry (g)	W2 in H20 (g)	W3 Wet (g)	G_{mb}	% of Gmm	P_a (%)	Thickness (in.)
1	9/14/2018	504+78	9.0 S\W Pass	654.8	367.6	655.5	2.274	91.4	8.6	1.44
2	9/14/2018	514+18	1.0 S\W Pass	889.0	507.6	889.7	2.327	93.5	6.5	1.88
3	9/14/2018	524+25	4.1 S\W Pass	958.2	542.6	959.0	2.301	92.4	7.6	2.00
4										
5										
6										
7										
8										

Course Placed: Surface (Travel Lane) Thickness QI: 0.49
Intended Lift Thickness: 2.00 Avg. Mat Density: 2.301
Date Placed: 09/14/18 Avg. % of Gmm: 92.433
Test Date/By: 09/15/18 Jimmy Lemke Avg. % Field Voids: 7.57

Q.I. (lower) = $\frac{(0.965 \times 2.489) - 2.301}{0.027}$ = **3.74** → PWL (lower) = 100.0

Q.I. (upper) = $\frac{2.301 - (0.915 \times 2.489)}{0.027}$ = **0.87** → PWL (upper) = 80.3

PWL (total) = 100.0 + 80.3 — 100.0 = **80.3**

Pay Factor = 1.000

Tons of Mix for PWL Field Voids Analysis (304.08 deducted)= 584.53 Field Voids Price Adjustment = $0.00

TEMPERATURE, °F

Time	7:00	9:00	11:00	1:00	3:00	5:00	7:00	Spec	Comply?
Air Temp					85	85			
Binder Temp					320	324		260-330 °F	Yes
Plant Temp					291	284		225-330 °F	Yes
Mat Temp				295	280	290		225-330 °F	Yes

☐ Break Down
☐ Rain Out
☐ Re-start after mandatory shutdown

Mix Change Information (when changes are made to start the day, identify them on previous day's report):

Old Target	New Target	Tons	Agg	Initial %	New %	Agg	Initia	New %

Comments:

4/25/13 ver.11.07

9/15/2018

Active Project No.: NHSX-018-8(45)--3H-33

Contract ID: 33-0188-045

Mix Design No.: ABD18-2027

IOWA DOT ASPHALT PAVING DAILY PLANT REPORT

9/17/18 10:50 AM

Contractor: Mathy Construction

County: Fayette

RAP Stockpile ID: ABC14-0116 (5.52 % AC)

Active Placement: Surface (Travel Lane)

Mix Type: Ht Surface L - 4 1/2 (HMA)

Active Bid Item: 2303-1043504 HT SURF 1/2IN L-4 (HMA)

Report No.: 10

Lab Voids Target: 4.0

Design Gyrations: 75

UNCOMPACTED MIXTURE

Hot Box I.D. (Theoretical %AC)	9-15-A (5.30%)	9-15B (5.30%)	9-15C (5.25%)	9-15D (5.26%)		
Date Sampled	9/15/18	9/15/18	9/15/18	9/15/18		
Time	9:30 AM	11:45 AM	12:55 PM	2:45 PM		
Station	440+00	483+25	499+00	531+50		
Bar Code ID	D2-004526	D2-004525	D2-004524	D2-004468		
Sample (Tons)	357.65	1,188.33	1,550.99	2,113.74		
G_{mb}	2.394	2.408	2.406	2.408		
Gmb (DOT)						
G_{mm}	2.490	2.490	2.493	2.492		
Gmm (DOT)						
P_a (%)	3.9	3.3	3.5	3.4		
P_a (%) (DOT)						
				Avg G_{mb}	Avg G_{mm}	Avg Pa (%)
				2.404	2.491	3.5

GRADATION (%Passing)

☐ Use DOT

Sieve	Specs	CF 9-15 A			Avg	District
1 in.	100	100.0			100.0	
3/4 in.	100	100.0			100.0	
1/2 in.	91-100(98)	98.0			98.0	
3/8 in.	82-96(89)	89.0			89.0	
* #4	56-70(63)	64.0			64.0	
* Dev	± 7.0	**1.0**			**1.0**	
*#8	41-51(46)	49.0			49.0	
*Dev	± 5.0	**3.0**			**3.0**	
#16		38.0			38.0	
*#30	20-28(24)	28.0			28.0	
* Dev	± 4.0	**4.0**			**4.0**	
#50		14.0			14.0	
#100		6.0			6.0	
*#200	0.9-4.9(2.9)	3.6			3.6	
*Dev	± 2.0	**0.7**			**0.7**	
Gradation Compliance?		Yes			Yes	
DBR	Sugg 0.6 - 1.4	0.83			0.83	
% +4 Type 4		89.7			89.7	
% +4 Type 3					0.0	
(+4/-4) Type 2		00.0/00.0			00.0/00.0	

BINDER

	Target	Actual	Spec	Comply?
% Added Binder	4.32	4.47	N/A	
% Total Binder	5.11	5.28	4.81-5.41	Yes
% RAP	15.00	15.33%	≤100%	Yes
% RAS				
% Binder Replacement	15.50%	15.33%	≤ 30%	Yes
PG Grade	58-34H		58-34H	Yes

Gb: 1.02729 Gsb: 2.636 Pbe (%): 4.32

COMPACTED JOINT

Core #	Station	Joint ID	G_{mb}
1	431+05	2L-Centerline	2.301
2	526+75	2L-Centerline	2.275
3	531+41	2L-Centerline	2.329

Average Joint G_{mb}: 2.302

Average Mat G_{mb}: 2.341

% Mat Density: 98.3

For information Only

Joint Length, ft: 13,317

Unit Price Adjustment ($/ft): $0.173

Joint Incentive = $2,303.84

USE D.O.T. RESULTS
(Enter an 'X')

TEST STRIP
(Enter an "X")

FILM THICKNESS (FT) [8.0-15.0]	
FT, µm	**8.2**
Price Adjustment	$0.00

Gyratory VMA	
VMA, %	**13.6**

QUANTITY FOR PAYMENT

Mix Unit Price ($/ton)	$25.97
Binder Unit Price ($/ton)	$481.81
Tons of Mix on Road	2,389.35
Tons to Other Bid Item(s)	
Tons of Binder	126.04
Tons of Waste	6.00
Tons of Binder to Date	971.01
Tons of Mix to Date	17,882.01

PLACEMENT RECORD

From Station	To Station	Lane	Width (ft)
422+45	502+20	NB/EB Drive Ln	16
502+20	529+98.46	NB/EB Drive Ln	12
524+60.5	541+20	NB/EB Drive Ln	12
541+20	546+75	NB/EB Drive Ln	16
546+75	549+46	NB/EB Drive Ln	15

Certified Tech: Jay Haas Cert. No. NE208

Certified Tech: Jen Stanley Cert. No. EC223

Distribution: ____ Dist. Materials ____ Proj. Engineer ____ Contractor

COMPACTED MAT

Core	Date of Placement	Station	CL Reference	W1 Dry (g)	W2 in H20 (g)	W3 Wet (g)	G_{mb}	% of Gmm	P_a (%)	Thickness (in.)
1	9/15/2018	431+05	1.5 N\E Drv	932.5	533.3	932.8	2.334	93.7	6.3	2.00
2	9/15/2018	452+75	2.4 N\E Drv	897.8	519.3	898.5	2.368	95.1	4.9	1.88
3	9/15/2018	472+30	8.2 N\E Drv	939.3	536.7	940.1	2.328	93.5	6.5	2.00
4	9/15/2018	478+10	8.3 N\E Drv	969.5	558.0	970.0	2.353	94.5	5.5	2.00
5	9/15/2018	496+35	1.9 N\E Drv	805.1	457.2	805.7	2.310	92.7	7.3	1.75
6	9/15/2018	526+35	6.9 N\E Drv	1,063.1	607.7	1,064.0	2.330	93.5	6.5	2.18
7	9/15/2018	531+41	1.9 N\E Drv	898.0	518.5	898.3	2.364	94.9	5.1	1.88
8	9/15/2018	539+54	10.4 N\E Drv	879.3	504.8	880.1	2.343	94.1	5.9	1.88

Course Placed: Surface (Travel Lane) Thickness QI: 1.04

Intended Lift Thickness: 2.00 Avg. Mat Density: 2.341

Date Placed: 09/15/18 Avg. % of Gmm: 94.000

Test Date/By: 09/17/18 Jamie Haas Avg. % Field Voids: 6.00

$$\text{Q.I. (lower)} = \frac{(0.965 \times 2.491) - 2.341}{0.020} = 3.14 \rightarrow \text{PWL (lower)} = 100.0$$

$$\text{Q.I. (upper)} = \frac{2.341 - (0.915 \times 2.491)}{0.020} = 3.09 \rightarrow \text{PWL (upper)} = 100.0$$

$$\text{PWL (total)} = 100.0 + 100.0 - 100.0 = \mathbf{100.0}$$

Pay Factor = 1.040

Tons of Mix for PWL Field Voids Analysis (420.15 deducted)= 1,969.20 Field Voids Incentive = $2,045.61

TEMPERATURE, °F

Time	7:00	9:00	11:00	1:00	3:00	5:00	7:00	Spec	Comply?
Air Temp		71	82	87	88				
Binder Temp		324	322	322	320			260-330 °F	Yes
Plant Temp		289	285	286	286			225-330 °F	Yes
Mat Temp		300	285	280	280			225-330 °F	Yes

☐ Break Down

☐ Rain Out

☐ Re-start after mandatory shutdown

Mix Change Information (when changes are made to start the day, identify them on previous day's report):

	Old Target	New Target	Tons	Agg	Initial %	New %	Agg	Initia	New %

Comments:

2395.35 Tons produced

6.0 Tons road waste

2389.35 Tons used for surface on Hwy. 18

Form 955 ver. 11.07

Iowa Department of Transportation

Highway Division-Office of Materials

Proportion & Production Limits For Aggregates

County : Fayette   Project No.: NHSX-018-8(45)--3H-33   Date: 09/14/18

Project Location: On US 18 from Co. Rd. B64 to the Turkey River in Clermont   Mix Design No.: ABD18-2027

Contract Mix Tonnage: 17,481   Course: Surface   Mix Size (in.): 1/2

Contractor: Mathy Construction   Mix Type: HT   Design Traffic: High Traffic

Material	Ident #	% in Mix	Producer & Location	Type (A or B)	Friction Type	Beds	Gsb	%Abs
1/2" AC	A96004	35.0%	Skyline Materials Ltd/Hovey	A	4	1-6	2.570	2.40
Man. Sand	A96011	34.0%	Bruening Rock Products Inc/Gjetley	A	4	1-3	2.731	1.04
Concrete Sand	A33522	16.0%	Bruening Rock Products Inc/Pape	A	5		2.623	0.69
Classified RAP	rings 2RAI	15.0%	15% ABC14-0116 (5.52 % AC)	A			2.599	1.13

Type and Source of Asphalt Binder: PG 58-34H MIDWEST LACROSSE, WI

Individual Aggregates Sieve Analysis - % Passing (Target)

Material	1"	3/4"	1/2"	3/8"	#4	#8	#16	#30	#50	#100	#200
1/2" AC	100	100	95	70	13	5.0	4.5	4.3	4.2	4.1	3.5
Man. Sand	100	100	100	100	95	64	39	24	11	3.3	1.3
Concrete Sand	100	100	100	100	94	84	72	45	10	0.7	0.3
Classified RAP	100	100	99	97	78	63	54	49	34	15	8.4

Preliminary Job Mix Formula Target Gradation

Upper Tolerance	100	100	100	96	70	51		28			4.9
Comb Grading	100	100	98	89	63	46	34	24	12	4.8	2.9
Lower Tolerance	100	100	91	82	56	41		20			0.9
S.A.sq. m/kg	Total	4.57		+0.41	0.26	0.38	0.56	0.69	0.72	0.59	0.96

Production Limits for Aggregates Approved by the Contractor & Producer.

Sieve Size in.	35.0% of mix 1/2" AC Min	Max	34.0% of mix Man. Sand Min	Max	16.0% of mix Concrete Sand Min	Max	15.0% of mix Classified RAP Min	Max		
1"	100.0	100.0	100.0	100.0	100.0	100.0				
3/4"	98.0	100.0	100.0	100.0	100.0	100.0				
1/2"	88.0	100.0	100.0	100.0	100.0	100.0				
3/8"	63.0	77.0	98.0	100.0	98.0	100.0				
#4	6.0	20.0	88.0	100.0	87.0	100.0				
#8	0.0	10.0	59.0	69.0	79.0	89.0				
#30	0.3	8.3	20.0	28.0	41.0	49.0				
#200	1.5	5.5	0.0	3.3	0.0	2.3				

Comments: Item #0140

Copies to: Mathy Construction

The above target gradations and production limits have been discussed with and agreed to by an authorized representative of the aggregate producer.

Signed: ______________________ Producer

Signed: ______________________ Contractor

Form 956 ver. 11.07

Iowa Department of Transportation

Highway Division - Office of Construction & Materials

HMA Gyratory Mix Design

Ndesign

County :	Fayette		Project :	NHSX-018-8(45)--3H-33	Letting Date :	1/17/2018
Mix Size (in.) :	1/2	Type A	Contractor :	Mathy Construction	Mix No. :	ABD18-2027
Mix Type:	HT	L - 4	Design Traffic :	High Traffic	Contract #:	33-0188-045
Intended Use :	Surface		Location :	On US 18 from Co. Rd. B64 to the Turkey River in Clermont	Date:	09/14/18

Aggregate	% in Mix	Source ID	Source Location	Beds	Gsb	%Abs	FAA	Friction
1/2" AC	35.0%	A96004	Skyline Materials Ltd/Hovey	1-6	2.570	2.40	45.0	4
Man. Sand	34.0%	A96011	Bruening Rock Products Inc/Gjetley	1-3	2.731	1.04	45.0	4
Concrete Sand	16.0%	A33522	Bruening Rock Products Inc/Pape		2.623	0.69	38.0	5
Classified RAP	15.0%	prings 2RAP	15% ABC14-0116 (5.52 % AC)		2.599	1.13	39.8	

Job Mix Formula - Combined Gradation (Sieve Size in.)

	1"	3/4"	1/2"	3/8"	#4	#8	#16	#30	#50	#100	#200
Upper Tolerance	100	100	100	96	70	51		28			4.9
	100	**100**	**98**	**89**	**63**	**46**	**34**	**24**	**12**	**4.8**	**2.9**
Lower Tolerance	100	100	91	82	56	41		20			0.9

Asphalt Binder Source and Grade: MIDWEST LACROSSE, WI PG 58-34H

Gyratory Data

% Asphalt Binder	**5.11**	5.34	5.80			Range OUT
Gmb @ N-Des.	**2.377**	2.383	2.395			
Max. Sp.Gr. (Gmm)	**2.476**	2.464	2.440			
% Gmm @ N- Initial	**90.1**	90.6	91.7			
%Gmm @ N-Max						
% Air Voids	**4.0**	3.3	1.8			
% VMA	**14.4**	14.4	14.4			
% VFA	**72.3**	77.2	87.2			
Film Thickness	**9.85**	10.48	11.77			
Filler Bit. Ratio	**0.64**	0.61	0.54			
Gse	**2.681**	2.676	2.667			
Pbe	**4.50**	4.79	5.38			
Pba	**0.65**	0.58	0.45			
% New Asphalt Binder	**84.5**	85.2	86.4			
Combined Gb @ 25°C	**1.0241**	1.0240	1.0239			

Number of Gyrations
N-Initial: 8
N-Design: 75
N-Max

Gsb for Angularity Method A: 2.671

Pba / %Abs Ratio: 0.40

Slope of Compaction Curve

				Combined	Contribution From RAM
Aggregate Type Used	**A**				
G_{sb}	**2.636**		% Friction Type 4 (+4)	88	0
G_{sa}	2.742		Or Better	88	0
% Water Abs	**1.47**		% Friction Type 3 (+4)	0	0
S.A. m^2 / Kg.	**4.57**		Or Better	0	0
Angularity-method A			% Friction Type 2 (+4)	0	0
% Flat & Elongated		OUT	% Friction Type 2 (-4)	0	0
Sand Equivalent		OUT	Type 2 Fineness Modulus	**0.0**	**0.4**
Virgin G_b @ 25°C	1.023		% Crushed	75.0	5.3
Anti-Strip Dose (%)	0.00				
Stripping Inflection Point					

Mix Check: Poor

Pb Range Check: 0.46 < 1.0 Spec.

RAM Check: OK

Specification Check: OUT Does Not Comply

Hamburg Check: Not Required

Disposition : An asphalt content of 5.1% is recommended to start this project.

Data shown in 5.11% column is interpolated from test data.

The % ADD AC to start project is 4.3%

Comments : Item #0140 Surface.
One point Volumetrics Verification for RAM substitution.

Copies to : Mathy Construction
DOC Field Materials Tech.

Mix Designer & Cert.# :

Signed : Jon Kleven

Form 956 ver. 11.05

Iowa Department of Transportation

Highway Division - Office of Construction & Materials

WMA Gyratory Mix Design

Ndesign					Letting Date :	3/20/2018
County :	Harrison		Project :	FM-C043(84)--55-43	Mix No. :	ABD18-4057
Mix Size (in.) :	1/2	Type A	Contractor :	Western Engineering Co., Inc	Contract #:	43-C043-084
Mix Type:	ST	No Frictn	Design Traffic :	Standard Traffic	Date:	10/22/18
Intended Use :	Surface		Location :	On F66 from L-20 E. 4.8 miles to Nixon Ave.		

Aggregate	% in Mix	Source ID	Source Location	Beds	Gsb	%Abs	FAA	Friction
5/8" Type A	10.0%	A78002	Schildberg Construction Co/Crescent	25B-25E	2.599	1.50	45.0	5
1/2" Type A	30.0%	A78002	Schildberg Construction Co/Crescent	25B-25E	2.599	1.50	45.0	5
Limestone Mansand	20.0%	ANE010	Martin Marietta Aggregates/Ft Calhou	25B-25E	2.592	1.52	45.0	5
Oakland Sand	40.0%	A78504	Western Engineering Company/Oaklaı		2.635	0.50	40.0	4

Job Mix Formula - Combined Gradation (Sieve Size in.)

	1"	3/4"	1/2"	3/8"	#4	#8	#16	#30	#50	#100	#200
Upper Tolerance	100	100	100	95	77	55		27			5
	100	**100**	**97**	**88**	**70**	**50**	**34**	**23**	**7.7**	**3.8**	**3.0**
Lower Tolerance	100	100	90	81	63	45		19			1.0

Asphalt Binder Source and Grade: FLINT HILLS OMAHA, NE PG 58-28S (AI = 3.6)

WMA Technology & Rate: [Water Injection System @ 0.5 by % of binder]

Gyratory Data

% Asphalt Binder	5.25	5.50	**5.89**	6.25	6.50
Gmb @ N-Des.	2.296	2.308	**2.321**	2.333	2.345
Max. Sp.Gr. (Gmm)	2.438	2.430	**2.418**	2.407	2.396
% Gmm @ N- Initial	88.8	89.5	**90.4**	91.2	92.0
%Gmm @ N-Max					
% Air Voids	5.8	5.0	**4.0**	3.1	2.1
% VMA	16.7	16.5	**16.4**	16.3	16.1
% VFA	65.1	69.6	**75.6**	81.1	86.7
Film Thickness	11.55	12.14	**13.01**	13.79	14.45
Filler Bit. Ratio	0.61	0.58	**0.54**	0.51	0.49
Gse	2.636	2.636	**2.638**	2.640	2.637
Pbe	4.91	5.16	**5.53**	5.86	6.14
Pba	0.36	0.36	**0.39**	0.42	0.38
% New Asphalt Binder	100.0	100.0	**100.0**	100.0	100.0
Combined Gb @ 25°C	1.0360	1.0360	**1.0360**	1.0360	1.0360

Number of Gyrations

N-Initial: 7

N-Design: 50

N-Max

Gsb for Angularity Method A: 2.624

Pba / %Abs Ratio: 0.35

Slope of Compaction Curve

Aggregate Type Used	A		Combined	Contribution From RAM
G_{sb}	2.612	% Friction Type 4 (+4)	11	0
G_{sa}	2.689	Or Better	11	0
% Water Abs	1.10	% Friction Type 3 (+4)	0	0
S.A. m^2 / Kg.	4.25	Or Better	0	0
Angularity-method A	42	% Friction Type 2 (+4)	0	0
% Flat & Elongated	1.8	% Friction Type 2 (-4)	0	0
Sand Equivalent	92	Type 2 Fineness Modulus	0.0	0.0
Virgin G_b @ 25°C	1.036	% Crushed	60.0	0
Anti-Strip Dose (%)	0.00			
Stripping Inflection Point				

Mix Check: Excellent

Pb Range Check: 1.25

RAM Check: OK

Specification Check: Comply

Hamburg Check: Not Required

Disposition : An asphalt content of 5.9% is recommended to start this project. Target plant temp is 270 °F

Data shown in 5.89% column is interpolated from test data.

Comments :

Copies to : Western Engineering Co., Inc

Mix Designer & Cert.# : Eric Labenz SW585 Signed : Marcia Buthmann District 4 Materials

Form 955 ver. 11.05

Iowa Department of Transportation

Highway Division-Office of Materials

Proportion & Production Limits For Aggregates

County : Harrison Project No.: FM-C043(84)--55-43 Date: 10/22/18

Project Location: On F66 from L-20 E. 4.8 miles to Nixon Ave. Mix Design No.: ABD18-4057

Contract Mix Tonnage: 5,285 Course: Surface Mix Size (in.): 1/2

Contractor: Western Engineering Co., Inc Mix Type: ST Design Traffic: Standard Traffic

Material	Ident #	% in Mix	Producer & Location	Type (A or B)	Friction Type	Beds	Gsb	%Abs
5/8" Type A	A78002	10.0%	Schildberg Construction Co/Crescent	A	5	25B-25E	2.599	1.50
1/2" Type A	A78002	30.0%	Schildberg Construction Co/Crescent	A	5	25B-25E	2.599	1.50
Limestone Mansand	ANE010	20.0%	Martin Marietta Aggregates/Ft Calhoun	A	5	25B-25E	2.592	1.52
Oakland Sand	A78504	40.0%	Western Engineering Company/Oakland	A	4		2.635	0.50

Type and Source of Asphalt Binder: PG 58-28S FLINT HILLS OMAHA, NE

Individual Aggregates Sieve Analysis - % Passing (Target)

Material	1"	3/4"	1/2"	3/8"	#4	#8	#16	#30	#50	#100	#200
5/8" Type A	100	100	80	58	27	11	6.6	5.5	5.0	4.9	4.4
1/2" Type A	100	100	95	73	37	15	11	8.1	7.0	6.3	5.5
Limestone Mansand	100	100	100	100	99	59	22	12	6.4	4.3	2.7
Oakland Sand	100	100	100	100	92	81	65	44	9.5	1.5	1.0

Preliminary Job Mix Formula Target Gradation

Upper Tolerance	100	100	100	95	77	55		27			5.0
Comb Grading	100	100	97	88	70	50	34	23	7.7	3.8	3.0
Lower Tolerance	100	100	90	81	63	45		19			1.0
S.A.sq. m/kg	Total	4.25		+0.41	0.29	0.41	0.56	0.66	0.47	0.47	0.99

Production Limits for Aggregates Approved by the Contractor & Producer.

Sieve Size	10.0% of mix 5/8" Type A		30.0% of mix 1/2" Type A		20.0% of mix Limestone Mansand		40.0% of mix Oakland Sand			
in.	Min	Max	Min	Max	Min	Max	Min	Max		
1"	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0		
3/4"	98.0	100.0	98.0	100.0	100.0	100.0	100.0	100.0		
1/2"	73.0	87.0	88.0	100.0	100.0	100.0	100.0	100.0		
3/8"	51.0	65.0	66.0	80.0	98.0	100.0	98.0	100.0		
#4	20.0	34.0	30.0	44.0	92.0	100.0	85.0	99.0		
#8	6.0	16.0	10.0	20.0	54.0	64.0	76.0	86.0		
#30	1.5	9.5	4.1	12.1	8.0	16.0	40.0	48.0		
#200	2.4	6.4	3.5	7.5	0.7	4.7	0.0	3.0		

Comments:

Copies to: Western Engineering Co., Inc

The above target gradations and production limits have been discussed with and agreed to by an authorized representative of the aggregate producer.

Signed: ______________________ Signed: ______________________

Producer Contractor

4/25/13 ver.11.07

IOWA DOT ASPHALT PAVING DAILY PLANT REPORT

11/20/18 10:42 AM

11/13/2018
Active Project No.: FM-C043(84)--55-43
Contract ID: 43-C043-084
Mix Design No.: ABD18-4057

Contractor: Western Engineering Co,. Inc
County: Harrison
RAP Stockpile ID:

Active Placement: Surface (Travel Lane)
Mix Type: St Surface None 1/2 (HMA)
Active Bid Item: 2303-1033500 ST SURF 1/2IN NO (HMA)

Report No.: 4
Lab Voids Target: 4.0
Design Gyrations: 50

Samples from multiple days included for Gmm average.

UNCOMPACTED MIXTURE						
Hot Box I.D. (Theoretical %AC)	SUR11-13A (5.96%)	SUR11-13B (5.96%)	SUR11-14A (6.19%)	SUR11-14B (6.22%)	SUR11-14C (6.19%)	
Date Sampled	11/13/18	11/13/18	11/14/18	11/14/18	11/14/18	
Time	12:20 PM	4:10 PM	10:25 AM	12:40 PM	3:30 PM	
Station	110+85	36+25	145+50	110+00	15+90	
Bar Code ID	D4-009155	D4-009154	D4-009153	D4-009152	D4-009151	
Sample (Tons)	115.65	502.00	502.00	502.00	502.00	
G_{mb}	2.340	2.325	2.335	2.326	2.324	
Gmb (DOT)						
G_{mm}	2.432	2.432	2.419	2.417	2.419	
Gmm (DOT)						
P_a (%)	3.8	4.4	3.5	3.8	3.9	
P_a (%) (DOT)						
				Avg G_{mb}	Avg G_{mm}	Avg Pa (%)
				2.330	2.424	3.9

GRADATION (%Passing)						☐ Use DOT District
Sieve	Specs	CF11-13A			Avg	District
1 in.	100	100.0			100.0	
3/4 in.	100	100.0			100.0	
1/2 in.	90-100(97)	96.0			96.0	
3/8 in.	81-95(88)	89.0			89.0	
* #4	63-77(70)	71.0			71.0	
* Dev	± 7.0	**1.0**			**1.0**	
*#8	45-55(50)	53.0			53.0	
*Dev	± 5.0	**3.0**			**3.0**	
#16		39.0			39.0	
*#30	19-27(23)	27.0			27.0	
* Dev	± 4.0	**4.0**			**4.0**	
#50		9.8			9.8	
#100		4.1			4.1	
*#200	1.0-5.0(3.0)	3.5			3.5	
*Dev	± 2.0	**0.5**			**0.5**	
Gradation Compliance?		Yes			Yes	
DBR	Sugg 0.6 - 1.4	0.64			0.64	
% +4 Type 4		11.0			11.0	
% +4 Type 3					0.0	
(+4/-4) Type 2		00.0/00.0			00.0/00.0	

BINDER	Target	Actual	Spec	Comply?
% Added Binder	5.89	6.10	N/A	
% Total Binder	5.89	6.10	5.59-6.19	Yes
% RAP				
% RAS				
% Binder Replacement				
PG Grade	58-28S		58-28S	Yes

Gb: 1.03500 | Gsb: 2.612 | Pbe (%): 5.48

COMPACTED JOINT			
Core #	Station	Joint ID	G_{mb}
1			
2			
3			

Average Joint G_{mb}	
Average Mat G_{mb}	2.286
% Mat Density	

For Information Only
Joint Length, ft
Unit Price Adjustment ($/ft)
Joint Price Adjustment =

USE D.O.T. RESULTS
(Enter an 'X')

TEST STRIP
(Enter an "X")

FILM THICKNESS (FT) [8.0-15.0]	
FT, µm	**11.4**
Price Adjustment	$0.00

Gyratory VMA	
VMA, %	**16.2**

QUANTITY FOR PAYMENT	
Mix Unit Price ($/ton)	$36.90
Binder Unit Price ($/ton)	$390.00
Tons of Mix on Road	547.66
Tons to Other Bid Item(s)	
Tons of Binder	33.43
Tons of Waste	2.70
Tons of Binder to Date	258.90
Tons of Mix to Date	4,405.57

PLACEMENT RECORD			
From Station	To Station	Lane	Width (ft)
118+94	92+09	SB/WB Drive Ln	11
43+90	26+52	SB/WB Drive Ln	11
151+40	88+25	NB/EB Drive Ln	11
43+90	10+40	NB/EB Drive Ln	11

Certified Tech: Nathan Underwood Cert. No. SW965
Certified Tech: Kay Petersen Cert. No. 417079
Distribution: ____ Dist. Materials ____ Proj. Engineer ____ Contractor

Cores from multiple days included in this report

COMPACTED MAT										
Core	Date of Placement	Station	CL Reference	W1 Dry (g)	W2 in H20 (g)	W3 Wet (g)	G_{mb}	% of Gmm	P_a (%)	Thickness (in.)
1	11/13/2018	105+72	6.2 S\W Drv	1,396.2	765.7	1,369.3	2.313	95.4	4.6	1.39
2	11/13/2018	96+58	4.0 S\W Drv	1,601.6	894.4	1,601.8	2.264	93.4	6.6	1.63
3	11/13/2018	31+90	1.0 S\W Drv	1,632.9	915.9	1,633.8	2.275	93.9	6.1	1.63
4	11/13/2018	135+69	5.5 S\W Drv	1,678.5	954.0	1,678.9	2.315	95.5	4.5	1.65
5	11/14/2018	122+85	2.5 N\E Drv	1,562.3	870.9	1,562.9	2.258	93.2	6.8	1.68
6	11/14/2018	114+53	6.0 N\E Drv	1,786.8	1,013.1	1,787.1	2.309	95.3	4.7	1.76
7	11/14/2018	94+75	9.2 N\E Drv	1,965.6	1,103.5	1,966.2	2.278	94.0	6.0	1.97
8	11/14/2018	38+68	9.5 N\E Drv	1,670.1	936.4	1,670.6	2.275	93.9	6.1	1.68

Course Placed: Surface (Travel Lane) Thickness QI: 1.17

Intended Lift Thickness: 1.50 Avg. Mat Density: 2.286
Date Placed: Multiple Avg. % of Gmm: 94.325
Test Date/By: 11/20/18 Karley Arman Avg. % Field Voids: 5.68

Q.I. (lower) = [(0.965 x 2.424) — 2.286] / 0.023 = **2.31** → PWL (lower) = 100.0

Q.I. (upper) = [2.286 — (0.915 x 2.424)] / 0.023 = **2.96** → PWL (upper) = 100.0

PWL (total) = 100.0 + 100.0 — 100.0 = **100.0**

Pay Factor = 1.040

Tons of Mix for PWL Field Voids Analysis (00.00 deducted)= 547.66 Field Voids Incentive = $808.35

TEMPERATURE, °F									
Time	7:00	9:00	11:00	1:00	3:00	5:00	7:00	Spec	Comply?
Air Temp	12	21	25	28	34	30	26		
Binder Temp		300	300	300	300			260-330 °F	Yes
Plant Temp		329	330	327	325			245-330 °F	Yes
Mat Temp			295		288			245-330 °F	Yes

☐ Break Down
☐ Rain Out
☐ Re-start after mandatory shutdown

Mix Change Information (when changes are made to start the day, identify them on previous day's report):

	Old Target	New Target	Tons	Agg	Initial %	New %	Agg	Initia	New %

Comments:

Road Waste- 0 Tons

Form 956 ver. 11.08

Iowa Department of Transportation

Highway Division - Office of Construction & Materials

WMA Gyratory Mix Design

Ndesign

County :	Union		Project :	FM-C088(55)--55-88	Letting Date :	1/17/2018
Mix Size (in.) :	1/2	Type A	Contractor :	Henningsen Const. Inc.	Mix No. :	ABD18-4063
Mix Type:	HT	No Frictn	Design Traffic :	High Traffic	Contract #:	88-C088-058
Intended Use :	Surface		Location :	On P-53 from US-34 north 6.4 miles to H-17 REA road	Date:	10/25/18

Aggregate	% in Mix	Source ID	Source Location	Beds	Gsb	%Abs	FAA	Friction
sand	14.0%	A25518	Martin Marietta Aggregates/Raccoon I		2.611	0.61	40.0	5
man sand	16.0%	A61002	Schildberg Construction Co/Early Cha	15A-15C	2.582	1.88	45.0	5
3/4" clean	18.0%	A63002	Martin Marietta Aggregates/Durham M	101	2.519	2.62	45.0	4
3/8" chips	24.0%	A63002	Martin Marietta Aggregates/Durham M	101	2.519	2.62	45.0	4
qtz man sand	13.0%	ASD002	L G Everist Inc/Dell Rapids-East		2.635	0.37	47.0	2
Classified RAP	15.0%	ABC2-208	15% ABC2-208 (4.45 % AC)		2.570	1.85	41.6	

Job Mix Formula - Combined Gradation (Sieve Size in.)

	1"	3/4"	1/2"	3/8"	#4	#8	#16	#30	#50	#100	#200
Upper Tolerance	100	100	100	97	84	46		19			4.6
	100	**100**	**95**	**90**	**77**	**41**	**23**	**15**	**6.4**	**3.4**	**2.6**
Lower Tolerance	100	100	88	83	70	36		11			0.6

Asphalt Binder Source and Grade: BITUMINOUS MATERIALS TAMA, IA PG 58-28H (AI = 2.6)

WMA Technology & Rate: [Water Injection System @ 1.8% added a/c]

Gyratory Data

% Asphalt Binder	5.30	**5.36**	5.80		
Gmb @ N-Des.	2.294	**2.296**	2.307		
Max. Sp.Gr. (Gmm)	2.393	**2.391**	2.380		
% Gmm @ N- Initial	88.1	**88.2**	88.7		
%Gmm @ N-Max		**96.1**			
% Air Voids	4.1	**4.0**	3.1		
% VMA	15.3	**15.3**	15.2		
% VFA	72.9	**73.8**	79.9		
Film Thickness	14.25	**14.45**	15.52		
Filler Bit. Ratio	0.52	**0.51**	0.47		
Gse	2.582	**2.582**	2.586		
Pbe	5.03	**5.10**	5.48		
Pba	0.28	**0.28**	0.34		
% New Asphalt Binder	88.0	**88.1**	89.1		
Combined Gb @ 25°C	1.0379	**1.0379**	1.0380		

Number of Gyrations
N-Initial
8
N-Design
75
N-Max

Gsb for Angularity
Method A
2.599

Pba / %Abs Ratio
0.16

Slope of Compaction Curve

Aggregate Type Used	A		Combined	Contribution From RAM
G_{sb}	2.564	% Friction Type 4 (+4)	71	0
G_{sa}	2.689	Or Better	72	0
% Water Abs	1.81	% Friction Type 3 (+4)	0	0
S.A. m^2 / Kg.	3.53	Or Better	1	0
Angularity-method A	44	% Friction Type 2 (+4)	1	0
% Flat & Elongated	7.5	% Friction Type 2 (-4)	17	0
Sand Equivalent	91	Type 2 Fineness Modulus	0.4	0.5
Virgin G_b @ 25°C	1.039	% Crushed	80.0	8.7
Anti-Strip Dose (%)	0.00			
Stripping Inflection Point				

Mix Check
Good

Pb Range Check
0.50

RAM Check
OK

Specification Check
Comply

Hamburg Check
Not Required

Disposition : An asphalt content of 5.4% is recommended to start this project. Target plant temp is 255 °F

Data shown in 5.36% column is interpolated from test data.

The % ADD AC to start project is 4.7%

Comments : Also for use on FM-C088(58)--55-88

Copies to : Henningsen Const. Inc.

Mix Designer & Cert.# : RW Hansn SW 046 Signed : Marcia Buthmann District 4 Materials

Form 955 ver. 11.08

Iowa Department of Transportation

Highway Division-Office of Materials

Proportion & Production Limits For Aggregates

County : Union Project No.: FM-C088(55)--55-88 Date: 10/25/18

Project Location: On P-53 from US-34 north 6.4 miles to H-17 REA road Mix Design No.: ABD18-4063

Contract Mix Tonnage: 15,525 Course: Surface Mix Size (in.): 1/2

Contractor: Henningsen Const. Inc. Mix Type: HT Design Traffic: High Traffic

Material	Ident #	% in Mix	Producer & Location	Type (A or B)	Friction Type	Beds	Gsb	%Abs
sand	A25518	14.0%	Martin Marietta Aggregates/Raccoon River	A	5		2.611	0.61
man sand	A61002	16.0%	Schildberg Construction Co/Early Chapel-I	A	5	15A-15C	2.582	1.88
3/4" clean	A63002	18.0%	Martin Marietta Aggregates/Durham Mine	A	4	101	2.519	2.62
3/8" chips	A63002	24.0%	Martin Marietta Aggregates/Durham Mine	A	4	101	2.519	2.62
qtz man sand	ASD002	13.0%	L G Everist Inc/Dell Rapids-East	A	2		2.635	0.37
Classified RAP	ABC2-208	15.0%	15% ABC2-208 (4.45 % AC)	A			2.570	1.85

Type and Source of Asphalt Binder: PG 58-28H BITUMINOUS MATERIALS TAMA, IA

Individual Aggregates Sieve Analysis - % Passing (Target)

Material	1"	3/4"	1/2"	3/8"	#4	#8	#16	#30	#50	#100	#200
sand	100	100	100	100	96	83	65	40	7.5	0.8	0.8
man sand	100	100	100	100	87	30	8.3	4.2	3.2	2.7	2.5
3/4" clean	100	99	78	55	12	2.0	1.5	1.4	1.3	1.1	0.9
3/8" chips	100	100	100	100	98	28	3.0	2.0	1.8	1.6	1.2
qtz man sand	100	100	100	100	99	74	47	29	12	2.7	0.7
Classified RAP	100	99	95	89	72	52	38	28	18	13	11

Preliminary Job Mix Formula Target Gradation

Upper Tolerance	100	100	100	97	84	46		19			4.6
Comb Grading	100	100	95	90	77	41	23	15	6.4	3.4	2.6
Lower Tolerance	100	100	88	83	70	36		11			0.6
S.A.sq. m/kg	Total	3.53		+0.41	0.31	0.33	0.38	0.43	0.39	0.41	0.87

Production Limits for Aggregates Approved by the Contractor & Producer.

Sieve Size in.	14.0% of mix sand		16.0% of mix man sand		18.0% of mix 3/4" clean		24.0% of mix 3/8" chips		13.0% of mix qtz man sand		15.0% of mix Classified RAP	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
1"	100.0	100.0	100.0	100.0	98.0	100.0	100.0	100.0	100.0	100.0		
3/4"	100.0	100.0	100.0	100.0	92.0	100.0	100.0	100.0	100.0	100.0		
1/2"	100.0	100.0	100.0	100.0	71.0	85.0	100.0	100.0	100.0	100.0		
3/8"	98.0	100.0	98.0	100.0	48.0	62.0	98.0	100.0	98.0	100.0		
#4	89.0	100.0	80.0	94.0	5.0	19.0	91.0	100.0	92.0	100.0		
#8	78.0	88.0	25.0	35.0	0.0	7.0	23.0	33.0	69.0	79.0		
#30	36.0	44.0	0.2	8.2	0.0	5.4	0.0	6.0	25.0	33.0		
#200	0.0	2.8	0.5	4.5	0.0	2.9	0.0	3.2	0.0	2.7		

Comments:

Copies to: Henningsen Const. Inc.

The above target gradations and production limits have been discussed with and agreed to by an authorized representative of the aggregate producer.

Signed: ____________________ Signed: ____________________

Producer Contractor

4/25/13 ver.11.07

IOWA DOT ASPHALT PAVING DAILY PLANT REPORT

11/15/18 6:48 AM

11/8/2018

Active Project No.: FM-C088(55)--55-88
Contract ID: 88-C088-058
Mix Design No.: ABD18-4063r1

Contractor: Henningsen Const. Inc.
County: Union
RAP Stockpile ID: ABC2-208 (4.45 % AC)

Active Placement: Surface (Travel Lane)
Mix Type: Wma Ht Surface None 1/2 (WMA)
Active Bid Item: 2303-1043500 HT SURF 1/2IN NO (HMA)

Report No.: 3
Lab Voids Target: 4.0
Design Gyrations: 75

UNCOMPACTED MIXTURE

Hot Box I.D. (Theoretical %AC)	SU11-8A (5.63%)	SU11-8B (5.67%)	SU11-8C (5.59%)			
Date Sampled	11/8/18	11/8/18	11/8/18			
Time	9:29 AM	11:40 AM	2:29 PM			
Station	191+00	256+00	327+00			
Bar Code ID	D4-010171	D4-010173	D4-010174			
Sample (Tons)	283.00	919.00	1,683.00			
G_{mb}	2.300	2.304	2.302			
Gmb (DOT)						
G_{mm}	2.394	2.392	2.396			
Gmm (DOT)						
P_a (%)	3.9	3.7	3.9			
P_a (%) (DOT)						
				Avg G_{mb}	Avg G_{mm}	Avg Pa (%)
				2.302	2.394	3.8
	PWL=99.6					

GRADATION (%Passing)

☐ Use DOT District

Sieve	Specs	CF 11-8-18			Avg	District
1 in.	100	100.0			100.0	
3/4 in.	100	100.0			100.0	
1/2 in.	88-100(95)	93.0			93.0	
3/8 in.	82-96(89)	89.0			89.0	
* #4	58-72(65)	61.0			61.0	
* Dev	± 7.0	**-4.0**			**-4.0**	
*#8	33-43(38)	36.0			36.0	
*Dev	± 5.0	**-2.0**			**-2.0**	
#16		23.0			23.0	
*#30	10-18(14)	15.0			15.0	
* Dev	± 4.0	**1.0**			**1.0**	
#50		8.0			8.0	
#100		4.8			4.8	
*#200	1.1-5.1(3.1)	3.8			3.8	
*Dev	± 2.0	**0.7**			**0.7**	
Gradation Compliance?		Yes			Yes	
DBR	Sugg 0.6 - 1.4	0.75			0.75	
% +4 Type 4		44.9			44.9	
% +4 Type 3					0.0	
(+4/-4) Type 2		00.3/19.7			00.3/19.7	

BINDER

	Target	Actual	Spec	Comply?
% Added Binder	4.69	4.83	N/A	
% Total Binder	5.50	5.63	5.20-5.80	Yes
% RAP	19.00	18.79%	≤100%	Yes
% RAS				
% Binder Replacement	14.65%	14.15%	≤ 30%	Yes
PG Grade	58-28H		58-28H	Yes

Gb: 1.03292 Gsb: 2.561 Pbe (%): 5.07

COMPACTED JOINT

Core #	Station	Joint ID	G_{mb}
1			
2			
3			

Average Joint G_{mb}:
Average Mat G_{mb}: 2.213
% Mat Density:

For Information Only
Joint Length, ft
Unit Price Adjustment ($/ft)

Joint Price Adjustment =

USE D.O.T. RESULTS
(Enter an 'X')

TEST STRIP
(Enter an "X")

FILM THICKNESS (FT) [8.0-15.0]	
FT, µm	**12.4**
Price Adjustment	$0.00

Gyratory VMA	
VMA, %	**15.2**

WMA Water Injection System @ 1.8% added a/c

QUANTITY FOR PAYMENT

Mix Unit Price ($/ton)	$41.42
Binder Unit Price ($/ton)	$462.00
Tons of Mix on Road	1,804.89
Tons to Other Bid Item(s)	
Tons of Binder	101.47
Tons of Waste	97.52
Tons of Binder to Date	300.58
Tons of Mix to Date	5,299.33

PLACEMENT RECORD

From Station	To Station	Lane	Width (ft)
166+50	338+00	NB/EB Drive Ln	11

Certified Tech: David Updike Cert. No. 417066
Certified Tech: Dawn Updike Cert. No. SW461

Distribution: ____ Dist. Materials ____ Proj. Engineer ____ Contractor

COMPACTED MAT

Core	Date of Placement	Station	CL Reference	W1 Dry (g)	W2 in H20 (g)	W3 Wet (g)	G_{mb}	% of Gmm	P_a (%)	Thickness (in.)
1	11/8/2018	183+34	3.4 N\E Drv	1,237.1	674.8	1,240.3	2.188	91.4	8.6	1.25
2	11/8/2018	199+96	6.4 N\E Drv	1,562.9	856.8	1,564.7	2.208	92.2	7.8	1.63
3	11/8/2018	213+03	5.6 N\E Drv	1,583.2	862.6	1,588.3	2.182	91.1	8.9	1.63
4	11/8/2018	250+01	10.0 N\E Drv	1,678.2	925.8	1,679.9	2.225	92.9	7.1	1.75
5	11/8/2018	253+74	9.4 N\E Drv	1,597.5	882.7	1,600.1	2.227	93.0	7.0	1.63
6	11/8/2018	283+22	8.0 N\E Drv	1,731.1	950.8	1,735.4	2.206	92.1	7.9	1.75
7	11/8/2018	308+52	1.0 N\E Drv	1,571.5	867.2	1,573.5	2.225	92.9	7.1	1.50
8	11/8/2018	334+64	4.3 N\E Drv	1,509.3	837.4	1,510.8	2.241	93.6	6.4	1.50

Course Placed: Surface (Travel Lane) Thickness QI: 1.16

Intended Lift Thickness: 1.50 Avg. Mat Density: 2.213
Date Placed: 11/08/18 Avg. % of Gmm: 92.400
Test Date/By: 11/15/18 Jeff Eslinger Avg. % Field Voids: 7.60

Q.I. (lower) = $\frac{(0.965 \times 2.394) - 2.213}{0.020}$ = **4.86** → PWL (lower) = 100.0

Q.I. (upper) = $\frac{2.213 - (0.915 \times 2.394)}{0.020}$ = **1.12** → PWL (upper) = 87.0

PWL (total) = 100.0 + 87.0 — 100.0 = **87.0**

Pay Factor = 1.000

Tons of Mix for PWL Field Voids Analysis (00.00 deducted)= 1,804.89 Field Voids Price Adjustment = $0.00

TEMPERATURE, °F

Time	7:00	9:00	11:00	1:00	3:00	5:00	7:00	Spec	Comply?
Air Temp	29	29	31	32	32				
Binder Temp	300	300	300	300	300			260-330 °F	Yes
Plant Temp	328	325	330	325	320			245-330 °F	Yes
Mat Temp		282	299		272			215-330 °F	Yes

☐ Break Down
☐ Rain Out
☐ Re-start after mandatory shutdown

Mix Change Information (when changes are made to start the day, identify them on previous day's report):

	Old Target	New Target	Tons	Agg	Initial %	New %	Agg	Initia	New %

Comments:

4/25/13 ver.11.07

IOWA DOT ASPHALT PAVING DAILY PLANT REPORT

11/8/18 1:27 PM

Date	11/7/2018
Active Project No.:	FM-C088(55)--55-88
Contract ID:	88-C088-058
Mix Design No.:	ABD18-4063r1
Contractor:	Henningsen Const. Inc.
County:	Union
RAP Stockpile ID	ABC2-208 (4.45 % AC)
Active Placement:	Surface (Travel Lane)
Mix Type:	Wma Ht Surface None 1/2 (WMA)
Active Bid Item:	2303-1043500 HT SURF 1/2IN NO (HMA)
Report No.:	2
Lab Voids Target:	4.0
Design Gyrations:	75

UNCOMPACTED MIXTURE

Hot Box I.D. (Theoretical %AC)	SU11-7A (5.75%)	SU11-7B (5.75%)	SU11-7C (5.61%)			
Date Sampled	11/7/18	11/7/18	11/7/18			
Time	10:57 AM	1:04 PM	3:02 PM			
Station	40+45	91+00	142+00			
Bar Code ID	D4-010168	D4-010169	D4-01017C			
Sample (Tons)	442.00	951.00	1,465.00			
G_{mb}	2.297	2.294	2.294			
Gmb (DOT)						
G_{mm}	2.394	2.394	2.402			
Gmm (DOT)						
P_a (%)	4.1	4.2	4.5			
P_a (%) (DOT)						
				Avg G_{mb}	Avg G_{mm}	Avg Pa (%)
				2.295	2.397	4.3
	AAD=0.4					

GRADATION (%Passing) ☐ Use DOT

Sieve	Specs	CF 11-7-18			Avg	District
1 in.	100	100.0			100.0	
3/4 in.	100	100.0			100.0	
1/2 in.	88-100(95)	92.0			92.0	
3/8 in.	82-96(89)	85.0			85.0	
* #4	58-72(65)	62.0			62.0	
* Dev	± 7.0	**-3.0**			**-3.0**	
*#8	33-43(38)	38.0			38.0	
*Dev	± 5.0	**0**			**0**	
#16		24.0			24.0	
*#30	10-18(14)	16.0			16.0	
* Dev	± 4.0	**2.0**			**2.0**	
#50		8.5			8.5	
#100		5.0			5.0	
*#200	1.1-5.1(3.1)	4.0			4.0	
*Dev	± 2.0	**0.9**			**0.9**	
Gradation Compliance?		Yes			Yes	
DBR	Sugg 0.6 - 1.4	0.79			0.79	
% +4 Type 4		45.4			45.4	
% +4 Type 3					0.0	
(+4/-4) Type 2		00.3/19.1			00.3/19.1	

BINDER

	Target	Actual	Spec	Comply?
% Added Binder	4.69	4.85	N/A	
% Total Binder	5.50	5.70	5.20-5.80	Yes
% RAP	19.00	19.99%	≤100%	Yes
% RAS				
% Binder Replacement	14.65%	14.85%	≤ 30%	Yes
PG Grade	58-28H		58-28H	Yes

Gb: 1.03289 Gsb: 2.561 Pbe (%): 5.06

COMPACTED JOINT

Core #	Station	Joint ID	G_{mb}
1	5+85	2L-Centerline	2.256
2	82+15	2L-Centerline	2.223
3	153+43	2L-Centerline	2.19

Average Joint G_{mb}	2.223
Average Mat G_{mb}	2.216
% Mat Density	100.3

For Information Only

Joint Length, ft	6,189
Unit Price Adjustment ($/ft)	$0.400
Joint Incentive =	$2,475.75

USE D.O.T. RESULTS (Enter an 'X')

TEST STRIP (Enter an "X")

FILM THICKNESS (FT) [8.0-15.0]	
FT, µm	**11.9**
Price Adjustment	$0.00

Gyratory VMA	
VMA, %	**15.5**

WMA Water Injection System @ 1.8% added a/c

QUANTITY FOR PAYMENT

Mix Unit Price ($/ton)	$41.42
Binder Unit Price ($/ton)	$462.00
Tons of Mix on Road	1,809.56
Tons to Other Bid Item(s)	
Tons of Binder	103.16
Tons of Waste	19.93
Tons of Binder to Date	199.11
Tons of Mix to Date	3,494.44

PLACEMENT RECORD

From Station	To Station	Lane	Width (ft)
1+45	184+00	SB/WB Drive Ln	11

Certified Tech:	David Updike	Cert. No. 417066
Certified Tech:	Dawn Updike	Cert. No. SW461

Distribution: ____ Dist. Materials ____ Proj. Engineer ____ Contractor

COMPACTED MAT

Core	Date of Placement	Station	CL Reference	W1 Dry (g)	W2 in H20 (g)	W3 Wet (g)	G_{mb}	% of Gmm	P_a (%)	Thickness (in.)
1	11/7/2018	5+85	1.0 S\W Drv	1,264.3	702.2	1,265.8	2.243	93.6	6.4	1.25
2	11/7/2018	34+43	1.2 S\W Drv	1,568.6	864.4	1,570.3	2.222	92.7	7.3	1.50
3	11/7/2018	53+11	5.1 S\W Drv	1,682.8	938.0	1,684.1	2.255	94.1	5.9	1.63
4	11/7/2018	82+15	1.0 S\W Drv	1,442.0	791.3	1,443.9	2.210	92.2	7.8	1.38
5	11/7/2018	103+96	5.2 S\W Drv	1,519.8	831.8	1,521.0	2.205	92.0	8.0	1.50
6	11/7/2018	119+78	1.0 S\W Drv	1,329.1	731.0	1,330.4	2.217	92.5	7.5	1.38
7	11/7/2018	136+78	5.8 S\W Drv	1,527.6	830.5	1,529.3	2.186	91.2	8.8	1.63
8	11/7/2018	153+43	2.6 S\W Drv	1,230.5	670.8	1,232.3	2.191	91.4	8.6	1.25

Course Placed:	Surface (Travel Lane)	Thickness QI:	1.15
Intended Lift Thickness:	1.50	Avg. Mat Density:	2.216
Date Placed:	11/07/18	Avg. % of Gmm:	92.463
Test Date/By:	11/08/18 Jeff Eslinger	Avg. % Field Voids:	7.54

$$\text{Q.I. (lower)} = \frac{(0.965 \times 2.397) - 2.216}{0.024} = 4.05 \rightarrow \text{PWL (lower)} = 100.0$$

$$\text{Q.I. (upper)} = \frac{2.216 - (0.915 \times 2.397)}{0.024} = 0.95 \rightarrow \text{PWL (upper)} = 82.6$$

$$\text{PWL (total)} = 100.0 + 82.6 - 100.0 = 82.6$$

Pay Factor = 1.000

Tons of Mix for PWL Field Voids Analysis (00.00 deducted)= 1,809.56 Field Voids Price Adjustment = $0.00

TEMPERATURE, °F

Time	7:00	9:00	11:00	1:00	3:00	5:00	7:00	Spec	Comply?
Air Temp	26	30	35	37	36				
Binder Temp	300	300	300	300	300			260-330 °F	Yes
Plant Temp	328	326	315	320	315			245-330 °F	Yes
Mat Temp			262	276	268			215-330 °F	Yes

☐ Break Down
☐ Rain Out
☐ Re-start after mandatory shutdown

Mix Change Information (when changes are made to start the day, identify them on previous day's report):

	Old Target	New Target	Tons	Agg	Initial %	New %	Agg	Initia	New %

Comments:

THE INSTITUTE FOR TRANSPORTATION IS THE FOCAL POINT FOR TRANSPORTATION AT IOWA STATE UNIVERSITY.

InTrans centers and programs perform transportation research and provide technology transfer services for government agencies and private companies;

InTrans contributes to Iowa State University and the College of Engineering's educational programs for transportation students and provides K–12 outreach; and

InTrans conducts local, regional, and national transportation services and continuing education programs.