

Minnesota Local Road Research Board Investigation 864

Recycled Asphalt Pavement:

MnROAD Study of Fractionated RAP

Task 1 Summary Report: Develop Design Specifications

Submitted to the technical advisory panel: September 12, 2008
Revised September 22, 2008

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Introduction

This report is intended to convey the activity on a MnROAD fractionated recycled asphalt pavement (RAP) research project up to the construction of test sections.

During the past 30 years the use of RAP has become a common practice in the construction of hot mix asphalt pavements. Preliminary results from Minnesota LRRB Investigation 842 show that roughly 50 percent of agencies using RAP restrict the use to non-wear courses [1]. The use of fractionated RAP represents potential for realizing a cost savings on materials, further optimizing the use of available asphalt and aggregate materials, and an environmentally positive method of recycling. Significant experimental work has been performed in the lab to evaluate the asphalt mixtures modified with RAP materials. However, there are few examples of studies focusing on the performance of pavements built with either RAP or incorporating fractionated materials at the mix plant. Many pavements have been built in Minnesota and around the United States using RAP, but very few have been monitored closely to provide useful performance data.

The University of Minnesota recently completed two studies involving RAP that included investigating the effect of various types and percentages of RAP on asphalt binder and asphalt mixture properties and developing a simple test that could obtain asphalt binder properties required in developing blending charts [2, 3]. Since then other research has compared binder properties with properties performed on extracted binders in order to indicate the relative level of binder mixing present in the RAP HMA. The results of these studies also need to be verified with field sections, which is the reason for this project.

The Minnesota Local Road Research Board (LRRB) is supporting the construction, material testing, and long term monitoring of this project for a total of five years at a value of \$200,000.

Study Objectives

RAP is a widely used component in asphalt concrete. Current national trends promote the use of high-RAP asphalt concrete. The incorporation of fractionated RAP at the asphalt mix plant can potentially improve the quality of existing designs and also to enable higher percentages of RAP to be used in mixtures. The Minnesota Department of Transportation specifies the maximum amount of RAP allowed in a mix based on pavement layer, traffic level, and binder grade. Mn/DOT wishes to determine if the present limits on RAP are justified.

MnROAD will conduct a five-year project to specifically study the performance of RAP under controlled testing conditions. This study will include laboratory, construction, and field monitoring components, and it is intended that the RAP research will be performed on newly built test sections at the Minnesota Road Research Facility (MnROAD).

Scope

Three asphalt concrete test sections will be built at the Minnesota Road Research Facility (MnROAD) having similar structural designs. The three sections will contain 30 percent RAP but vary by binder grade and fractionated RAP content. The project will be coordinated with ongoing RAP research efforts at the Western Research Institute (WRI)

in Laramie, Wyoming. The efforts on this project will proceed following input from the Mn/DOT Bituminous Office. The project includes the following nine tasks:

1. Develop Design Specifications
2. Test Section Construction
3. Year 1 Annual Report
4. Lab testing
5. Year 2 Annual Report
6. Year 3 Annual Report
7. Year 4 Annual Report
8. Draft Final Report
9. Final Report

Literature Search

There is not an extensive quantity of standard literature available on the topic of fractionated RAP. The Asphalt Institute (AI), a respected authority on the topic of bituminous pavement construction, has discussed splitting RAP material into two sizes and treating them as separate aggregate sources. This approach provides the advantage of overall consistency with respect to the RAP component of the mix [4]. AI goes on to suggest the RAP material can be fractionated on either the number 4 sieve (4.75 mm) or the 3/8-in sieve (9.5 mm).

A search of state specifications was performed. The following results focus on language used to identify fractionated RAP as well as required methods of handling, screening, crushing, and incorporating the material at the asphalt mix plant.

The State of Florida Specification 320-2.4 requires that the contractor provide separate cold bins for each fine and coarse aggregate component. A use of a grizzly or grid is required to prevent oversized RAP from entering the mixture. According to section 334-2.3.1 Florida permits the amount of RAP to range from 15 to 50 percent depending binder and traffic level. Additionally, the minimum asphalt content of the RAP material must be 4.0 percent. When fractionated RAP is used Florida requires a minimum asphalt content of 2.5 percent on the fraction retained on the number 4 sieve (4.75-mm) [5].

The State of South Carolina Specification 401.03.F requires that all RAP material shall come from South Carolina department projects. All RAP material must pass a 2-in. screen before entering plant and the allowable percentage of RAP ranges between 10 and 30 percent dependent on mix type and location of use within the pavement structure.

South Carolina Specification 401.2.6 describes the permitted percentages of RAP according to whether the material is milled or plant production returns. The permitted amount varies between 10 and 30 percent by mixture type, plant operation methods, and location of use within the pavement. Increased use is allowed if the RAP material is fractionated plant returns. In several cases limits of 10 to 15 percent were established for use of only the fine fractionated RAP material. RAP is required to be separated by size using a high frequency separation device, and stockpiles are controlled by type [6].

Minnesota Specification

The following language was included as a special provision in the proposal and plans for S. P. 8680-157 [9, 10]:

S-57.3 FRACTIONATED RAP

Fractionated RAP shall be used as a component of the asphalt mixture and subject to the attached **Combined 2360/2350 (Gyratory/Marshall Design) Specification** with the following added requirements:

(A) Provide a separate cold bin for each component of the virgin, fractionated RAP, and nonfractionated RAP fine and coarse aggregates required by the design mix.

(B) Equip the cold bins with accurate mechanical means for feeding the aggregates uniformly into the dryer in the proportions required for the material, use a grizzly or grid over the RAP cold bin, in-line roller crusher, screen, or other suitable means to prevent oversized RAP material from showing up in the completed recycled mixture. If oversized RAP material appears in the completed recycled mix, take the appropriate corrective action immediately. If the appropriate corrective actions are not immediately taken, stop plant operations.

(C) Use RAP from Mn/DOT approved stockpiles. **Fractionated and non-fractionated RAP stockpiles shall consist solely of bituminous mixture material removed from the MnROAD test facility.**

(D) The coarse portion of the fractionated RAP shall be the portion of the RAP retained on the No. 4 sieve. The fine portion of the fractionated RAP shall have 100 percent passing the No. 4 sieve. The Engineer may sample the stockpile(s) to verify that this requirement is met.

(E) For MnROAD cell 20 incorporate 30 percent **non-fractionated RAP** by weight of total aggregate into the SPWEB440B wearing course and the SPNWB440B non-wearing course mixtures.

(F) For MnROAD cell 21 incorporate 30 percent **fractionated RAP** by weight of total aggregate into the SPWEB440B Special wearing course and the SPNWB440B Special non-wearing course mixtures. Proportions of coarse and fine RAP fractions shall be determined from mixture design recommendations.

(G) For MnROAD cell 22 incorporate 30 percent **fractionated RAP** by weight of total aggregate into the SPWEB440C Special 1 wearing course and the SPNWB440C Special 1 non-wearing course mixtures. Proportions of coarse and fine RAP fractions shall be determined from mixture design recommendations.

Table 1 Fractionated RAP Bituminous Mixture Requirements [9, Table 58.1A]

CELL NO.	Mixture Designation's	RAP %	Binder Grade	Comments/Remarks
20	SPWEB 440B SPNWB 440B	30 (3)	58-28	
21	SPWEB 440B Special SPNWB 440B Special	30 (3)	58-28	(2)
22	SPWEB 440B Special 1 SPNWB 440B Special 1	30 (3)	58-34	(2)
(2) Fractionated RAP. See Section S-58.3 (HOT MIXED ASPHALT – POROUS PAVEMENT) of these Special Provisions for requirements				
(3) RAP used on Cells 15 thru 23 shall come from the MnROAD Mainline Cell millings.				

Mixture Design

As part of the 2008 MnROAD reconstruction contract the fractionated RAP mixture designs were performed by the bituminous paving subcontractor. The designs were submitted to the Mn/DOT trial mix laboratory for verification and approved by the Mn/DOT Bituminous Office using Specification 2350/2360 criteria [10].

RAP Material

The MnROAD mainline was originally paved in 1993 using dense graded asphalt mixtures having between 4.9 and 6.0 percent asphalt cement (AC). Design details are shown in table 2.

Table 2 MnROAD As-built Gradation, 1997 [7, 8]

Sieve, mm	Component aggregates			Design gradation	As-built ^(a)
	CR Fines 66%	CR Coarse 24%	CA-50 10%		
19 (3/4")	100	100	100	100	100
12.5 (1/2")	100	75	80	92	89
9 (3/8")	99	53	37	82	83
4.75 (#4)	94	19	4	67	65
2 (#10)	82	11		57	57
1 (#18)	63	8		44	43
0.45 (40)	39	6		27	26
0.25 (#60)	10	4			9
0.125 (#120)	8	3			
0.075 (#200)	4.9	2.4		4	4.7
Crush faces %	-	61.2	100		
Percent AC					Average 5.6 Range 4.9 to 6.0

(a) Averages were weighted by lift thickness data.

The paving contractor moved the MnROAD millings to their plant after completing the mainline milling operation. The millings were sized to 100 percent

passing the 5/8-in. sieve for use as the RAP component in Cell 20 as well as general use in several other cells. The fractionated material was obtained using a 1/4-in. slotted screen. Approximately 19 percent of the original material was retained on the 1/4-in. sieve, and will be hereafter referred to as the “coarse” fraction. The remaining 81 percent will be referred to as the “fine” fraction.

The extracted gradation is shown in table 3 along with the percent recovered asphalt binder for each RAP material.

Table 3 MnROAD Millings for 2008 Mixture Design, Mn/DOT and Contractor Results


Sieve, mm	MnROAD Millings		MnROAD Fine ^(a)		MnROAD Coarse ^(b)	
16 (5/8")	100	100 ^(d)	100		100	100 ^(d)
12.5 (1/2")	99	98 ^(d)	100		92	95 ^(d)
9.5 (3/8")	93	94 ^(d)	100	100 ^(d)	78	77 ^(d)
6.3 (1/4")	81 ^(c)					
4.75 (#4)	75	75 ^(d)	88	88 ^(d)	58	58 ^(d)
2.36 (#8)	62	63 ^(d)	72	74 ^(d)	51	50 ^(d)
1.18 (#16)	52	52 ^(d)	59	61 ^(d)	42	42 ^(d)
0.6 (#30)	39	40 ^(d)	45	46 ^(d)	32	33 ^(d)
0.3 (#50)	24	23 ^(d)	27	26 ^(d)	19	19 ^(d)
0.15 (#100)	13	12 ^(d)	15	14 ^(d)	10	10 ^(d)
0.075 (#200)	8.9	7.7 ^(d)	10.6	9.1 ^(d)	7.0	6.4 ^(d)
FAA %	41		41		41	
Crush 1 face %	75.60		69.05		77.85	
Crush 2 face %	75.09		68.30		77.25	
Percent AC	5.86		5.92		5.33	
<p>(a) Material passes the 1/4-in. screen. (b) Material retained on 1/4-in. screen. (c) Interpolated value. (d) Contractor results.</p>						

Final Design for 2008 Fractionated RAP Sections

The final design included a 3-in. wear and 2-in. non-wearing course. The surface design is supported by a structure to be composed of 12 in. of Mn/DOT Class 5 aggregate above 12 in. of MnROAD Class 3 Special, above 7 in. of select granular, all above clay subgrade. The approved mixture designs included the following components:

- 30 percent MnROAD millings
 - Non-fractionated mixture includes approximately 24 percent fine plus 6 percent coarse (Cell 20)
 - Fractionated mixture includes 20 percent fine plus 10 percent coarse (Cells 21 and 22)
- 35 percent washed manufactured sand
- 20 percent 0.5-in. chips
- 15 percent unwashed 0.75-in. rock

The final designs of each cell used identical percentages of RAP and aggregate material for the wear and non-wear mixtures. The asphalt cement content of the non-fractionated mixture increased 0.3 percent between wear and non-wear designs, and the asphalt content increased 0.2 percent between mixtures for the fractionated designs.



MINNESOTA DEPARTMENT OF TRANSPORTATION

BITUMINOUS PLANT MIX DESIGN REPORT
 Minnesota Department of Transportation
 Office of Materials
 1400 Gervais Avenue
 Maplewood, MN 55109
 Phone (651) 386-5459
 FAX: (651) 386-5580

0-2008-193
 Date: 7/30/2008

THIS MIX DESIGN REPORT IS NOT VALID UNTIL PLANT NO. INDICATED BELOW IS CERTIFIED.

TO BE FILLED IN BY CONTRACTOR		SPEC	2360
ENGINEER	FOR	GFCO YEAR	2008
PROJECT NUMBER	8680-157 (MnRD)	MIX TYPE	SPWEB440(R)
		AC GRADE	PG 58-28

THIS MIXTURE HAS BEEN REVIEWED FOR VOLUMETRIC PROPERTIES ONLY, IT DOES NOT ASSURE THAT FIELD PLACEMENT AND COMPACTION REQUIREMENTS HAVE BEEN MET.

PLANT NO. 932051 - JOB MIX FORMULA

Begin With Test Number	Sieve Size (mm) (in.)	Composite Formula	JMF LIMITS	For Information Only Virgin Formula
SP WE 401	37.5 (1 1/2)			P P
-- -- --	25.0 (1)			E A
	19.0 (3/4)	100	100 - 100	R S
	12.5 (1/2)	91	85 - 98	C S
	9.5 (3/8)	85	78 - 90	E I
	4.75 (#4)	64	57 - 71	N N
	2.36 (#8)	48	42 - 54	T G
	0.075 (#200)	3.4	2.0 - 5.4	
	Spec. Voids	4.0	3.0 - 5.0	%AC
	Spec. VMA	14.0	13.7	(NEW)
	% AC	5.2	4.8	
	(TOTAL)			


TM # 2008-130 Indicates a Gyrotory Density of 148.9 (lbs/ft3) at 90 Design Gyration
 Use of anti-strip agent required: N

Proportions	Pit	Source of Material	Sp.G
35 %	73006	MARTIN MARIETTA ST CLOUD WASHED SAND (GRANITE)	2.682
20 %	73006	MARTIN MARIETTA ST. CLOUD 1/2" WASHED CHIPS (GRANITE)	2.731
15 %	05056	LOKEN 3/4 ROCK	2.742
30 %		MnRD CRUSHED MILLINGS	2.630
%			
%			
%			
%			

Mix Aggregate Specific Gravity at the Listed Percentages = 2.685

Remarks MINUS #4 AGGREGATE SPG AT THE LISTED PERCENTAGES = 2.688
 NON - FRACTIONATED RAP DESIGN

Mix Design Reviewed by:



Mix Design Specialist

cc:

Contractor - HARDRIVES, INC

METRO INSPECTION

Figure 1 Cell 20 wear course design.



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0-2008-194

Date: 7/30/2008

THIS MIX DESIGN REPORT IS NOT VALID UNTIL PLANT NO. INDICATED BELOW IS CERTIFIED.

TO BE FILLED IN BY CONTRACTOR	
ENGINEER	FOR
PROJECT NUMBER	8680-157 (MnRD)

SPEC	2360
BIPEG YEAR	2008
MIX TYPE	SPNWB430(R)
AC GRADE	PG 58-28

THIS MIXTURE HAS BEEN REVIEWED FOR VOLUMETRIC PROPERTIES ONLY, IT DOES NOT ASSURE THAT FIELD PLACEMENT AND COMPACTION REQUIREMENTS HAVE BEEN MET.

PLANT NO. 932051 -

JOB MIX FORMULA

Begin With Test Number	Sieve Size (mm) (in.)	Composite Formula	JMF LIMITS	For Information Only Virgin Formula
SP NW 401	37.5 (1 1/2)			P P
-- -- --	25.0 (1)			E A
	19.0 (3/4)	100	100 - 100	R S
	12.5 (1/2)	91	85 - 98	C S
	9.5 (3/8)	85	78 - 90	E I
	4.75 (#4)	64	57 - 71	N N
	2.36 (#8)	49	42 - 54	T G
	0.075 (#200)	3.4	2.0 - 5.4	
	Spec. Voids	3.0	2.0 - 4.0	
	Spec. VMA	14.0	13.7	
	% AC	5.5	5.1	%AC (NEW)
	(TOTAL)			4.0

TM # 2008-130 Indicates a Gyrotory Density of 148.9 (lbs/ft3) at 90 Design Gyration
 Use of anti-strip agent required: N

Proportions	Pit	Source of Material	Sp.G
35 %	73006	MARTIN MARIETTA ST CLOUD WASHED SAND (GRANITE)	2.682
20 %	73006	MARTIN MARIETTA ST. CLOUD 1/2" WASHED CHIPS (GRANITE)	2.731
15 %	05056	LOKEN 3/4 ROCK	2.742
30 %		MnRD CRUSHED MILLINGS	2.630
%			
%			
%			
%			

Mix Aggregate Specific Gravity at the Listed Percentages = 2.685

Remarks MINUS #4 AGGREGATE SPG AT THE LISTED PERCENTAGES = 2.668
 NON - FRACTIONED RAP DESIGN

Mix Design Reviewed by:

 Mix Design Specialist

CC:
 Contractor - HARDRIVES, INC
 METRO INSPECTION

Figure 2 Cell 20 non-wear course design.



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0-2008-197

Date: 8/1/2008

THIS MIX DESIGN REPORT IS NOT VALID UNTIL PLANT NO. INDICATED BELOW IS CERTIFIED.

TO BE FILLED IN BY CONTRACTOR		SPEC	2360
ENGINEER	FOR	SPEC YEAR	2008
PROJECT NUMBER	8680-157 (MnRD)	MIX TYPE	SPWEB440(R)
		AC GRADE	PG 58-28

THIS MIXTURE HAS BEEN REVIEWED FOR VOLUMETRIC PROPERTIES ONLY, IT DOES NOT ASSURE THAT FIELD PLACEMENT AND COMPACTION REQUIREMENTS HAVE BEEN MET.

PLANT NO. 932051 - JOB MIX FORMULA

Begin With Test Number	Sieve Size (mm) (in.)	Composite Formula	JMP LIMITS	For Information Only Virgin Formula
SP WE 401	37.5 (1 1/2)			P P
-- -- --	25.0 (1)			E A
	19.0 (3/4)	100	100 - 100	R S
	12.5 (1/2)	91	85 - 98	C S
	9.5 (3/8)	85	78 - 90	E I
	4.75 (#4)	65	58 - 72	N G
	2.38 (#8)	49	43 - 55	
	0.075 (#200)	3.5	2.0 - 5.5	
	Spec. Voids	4.0	3.0 - 5.0	%AC
	Spec. VMA	14.0	13.7	(NEW)
	% AC	5.2	4.8	
	(TOTAL)			

TM# 2008-121 Indicates a Gyratory Density of 149.7 (lbs/ft3) at 90 Design Gyration

Use of anti-strip agent required: N

Proportions	Pit	Source of Material	Sp.G
35 %	73006	MARTIN MARIETTA ST. CLOUD WASHED SAND (GRANITE)	2.682
20 %	73006	MARTIN MARIETTA ST. CLOUD 1/2" WASHED CHIPS (GRANITE)	2.731
15 %	05056	LOKEN 3/4 ROCK	2.742
20 %		MnRD FRAP FINES	2.595
10 %		MnRD FRAP COARSE	2.632
%			
%			
%			

Mix Aggregate Specific Gravity at the Listed Percentages = 2.677

Remarks: MINUS #4 AGGREGATE SPG AT THE LISTED PERCENTAGES = 2.658
 FRACTIONATED RAP DESIGN

Mix Design Reviewed by

 Mix Design Specialist

cc:
 Contractor - HARDRIVES, INC
 METRO INSPECTION

Figure 3 Cell 21 wear course design.



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0-2008-199

Date: 8/1/2008

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TO BE FILLED IN BY CONTRACTOR		SPEC	2360
ENGINEER	FOR	SPEC YEAR	2008
PROJECT NUMBER	8680-157 (MnRD)	MIX TYPE	SPNWB430(R)
		AC GRADE	PG 58-28

THIS MIXTURE HAS BEEN REVIEWED FOR VOLUMETRIC PROPERTIES ONLY. IT DOES NOT ASSURE THAT FIELD PLACEMENT AND COMPACTION REQUIREMENTS HAVE BEEN MET.

PLANT NO. 932051 - JOB MIX FORMULA

Begin With Test Number	Sieve Size (mm) (in.)	Composite Formula	JMF LIMITS	For Information Only Virgin Formula
SP NW 401	37.5 (1 1/2)			P P
-- -- --	25.0 (1)			R A
	19.0 (3/4)	100	100 - 100	S S
	12.5 (1/2)	91	85 - 98	E I
	9.5 (3/8)	85	78 - 90	N T
	4.75 (#4)	65	58 - 72	G
	2.36 (#8)	49	43 - 55	
	0.075 (#200)	3.5	2.0 - 5.5	
	Spec. Voids	3.0	2.0 - 4.0	
	Spec. VMA	14.0	13.7	
	% AC	5.5	5.1	
	(TOTAL)			

TM # 2008-121 Indicates a Gyrotory Density of 149.7 (lbs/ft³) at 90 Design Gyration
 Use of anti-strip agent required: N

Proportions	Pit	Source of Material	Sp.G
35 %	73006	MARTIN MARIETTA ST CLOUD WASHED SAND (GRANITE)	2.682
20 %	73006	MARTIN MARIETTA ST. CLOUD 1/2" WASHED CHIPS (GRANITE)	2.731
15 %	05056	LOKEN 3/4 ROCK	2.742
20 %		MnRD FRAP FINES	2.595
10 %		MnRD FRAP COARSE	2.632
%			
%			
%			

Mix Aggregate Specific Gravity at the Listed Percentages = 2.677

Remarks MINUS #4 AGGREGATE SPG AT THE LISTED PERCENTAGES = 2.656
 FRACTIONATED RAP DESIGN

Mix Design Reviewed by:

 Mix Design Specialist

cc:
 Contractor - HARDRIVES, INC
 METRO INSPECTION

Figure 4 Cell 21 non-wear course design.

LRRB 864 TASK 1 Summary Report – Development of Design Specification for MnROAD Study of Fractionated RAP



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Date: 8/1/2008

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TO BE FILLED IN BY CONTRACTOR	
ENGINEER	FOR
PROJECT NUMBER	8680-157 (MnRD)

SPEC	2360
SPEC YEAR	2008
MIX TYPE	SPWEB440(R)
AC GRADE	PG 58-34

THIS MIXTURE HAS BEEN REVIEWED FOR VOLUMETRIC PROPERTIES ONLY, IT DOES NOT ASSURE THAT FIELD PLACEMENT AND COMPACTION REQUIREMENTS HAVE BEEN MET.

PLANT NO. 932051 - JOB MIX FORMULA

Begin With Test Number	Sieve Size (mm) (in.)	Composite Formula	JMF LIMITS	For Information Only Virgin Formula
SP WE 401	37.5 (1 1/2)			
-- -- --	25.0 (1)			
	19.0 (3/4)	100	100 - 100	P P A R S 100
	12.5 (1/2)	91	85 - 98	C S 88
	9.5 (3/8)	85	78 - 90	E I 81
	4.75 (#4)	65	58 - 72	N T 59
	2.38 (#8)	49	43 - 55	G 42
	0.075 (#200)	3.5	2.0 - 5.5	1.5
	Spec. Voids	4.0	3.0 - 5.0	%AC (NEW) 3.7
	Spec. VMA	14.0	13.7	
	% AC	5.2	4.8	

(TOTAL)

TM # 2008-121 Indicates a Gyratory Density of 149.7 (lbs/ft³) at 90 Design Gyration
 Use of anti-strip agent required: N

Proportions	Pit	Source of Material	Sp.G
35 %	73006	MARTIN MARIETTA ST. CLOUD WASHED SAND (GRANITE)	2.682
20 %	73006	MARTIN MARIETTA ST. CLOUD 1/2" WASHED CHIPS (GRANITE)	2.731
15 %	05056	LOKEN 3/4 ROCK	2.742
20 %		MnRD FRAP FINES	2.595
10 %		MnRD FRAP COARSE	2.632
%			
%			
%			

Mix Aggregate Specific Gravity at the Listed Percentages = 2.677

Remarks: MINUS #4 AGGREGATE SPG AT THE LISTED PERCENTAGES = 2.658
 FRACTIONATED RAP DESIGN

Mix Design Reviewed by:

 Mix Design Specialist

CC:
 Contractor - HARDRIVES, INC
 METRO INSPECTION

Figure 5 Cell 22 wear course design.



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0-2008-200

Date: 8/1/2008

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TO BE FILLED IN BY CONTRACTOR	
ENGINEER	FOR
PROJECT NUMBER	8680-157 (MnRD)

SPEC	2360
OTCO YEAR	2008
MIX TYPE	SPNWB430(R)
AC GRADE	PG 58-34

THIS MIXTURE HAS BEEN REVIEWED FOR VOLUMETRIC PROPERTIES ONLY, IT DOES NOT ASSURE THAT FIELD PLACEMENT AND COMPACTION REQUIREMENTS HAVE BEEN MET.

PLANT NO. 932051 - JOB MIX FORMULA

Begin With Test Number	Sieve Size (mm) (In.)	Composite Formula	JMF LIMITS	For Information Only Virgin Formula
SP NW 401	37.5 (1 1/2)			P
	25.0 (1)			P
	19.0 (3/4)	100	100 - 100	A
	12.5 (1/2)	91	85 - 98	S
	9.5 (3/8)	85	78 - 90	E
	4.75 (#4)	65	58 - 72	I
	2.36 (#8)	49	43 - 55	N
	0.075 (#200)	3.5	2.0 - 5.5	T
	Spec. Voids	3.0	2.0 - 4.0	G
	Spec. VMA	14.0	13.7	
	% AC	5.5	5.1	
	(TOTAL)			

TM # 2008-121 Indicates a Gyrotory Density of 149.7 (lbs/ft³) at 90 Design Gyration
 Use of anti-strip agent required: N

Proportions	Pit	Source of Material	Sp.G
35 %	73005	MARTIN MARIETTA ST CLOUD WASHED SAND (GRANITE)	2.682
20 %	73005	MARTIN MARIETTA ST. CLOUD 1/2" WASHED CHIPS (GRANITE)	2.731
15 %	05056	LCKEN 3/4 ROCK	2.742
20 %		MnRD FRAP FINES	2.595
10 %		MnRD FRAP COARSE	2.632
%			
%			
%			

Mix Aggregate Specific Gravity at the Listed Percentages = 2.677

Remarks MINUS #4 AGGREGATE SPG AT THE LISTED PERCENTAGES = 2.658
 FRACTIONATED RAP DESIGN

Mix Design Reviewed by:

 Mix Design Specialist

cc:
 Contractor - HARDRIVES, INC
 METRO INSPECTION

Figure 6 Cell 22 non-wear course design.

Task 2 Preview

The topic of the upcoming Task 2 report will be test section construction. The report will convey the activity on this research project for the period of time between development of specifications and through construction of test sections.

Task 2 objectives are:

Monitoring:

- RAP stockpiles
- incorporation of RAP at the plant
- MnROAD paving operations

Material sampling:

- mixture component materials
- RAP mixtures from
 - Plant
 - MnROAD cores

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