APPENDIX Q
ASPHALT MIXTURE/MATERIAL PRODUCT SHEETS
(MIRAFI, GEOTECHNICAL LINER)

State of New York
Department of Transportation
HUNTERS POINT PLAZA
47-40 21st Street
Long Island City, N.Y. 11101
http://www.dot.state.ny.us

PHILLIP ENG, P. E.
REGIONAL DIRECTOR

JOAN MCDONALD
COMMISSIONER

Date: April 5, 2013

Flushing Asphalt, LLC
120-01 31st Avenue
Flushing, New York 11354

Re: Annual HMA Plant Approval
Facility: H0239

Gentlemen:
On April 4, 2013 personnel from the Regional Materials staff completed the inspection of your bituminous concrete production facility located in Flushing, NY.
As a result of this inspection, it has been determined that the physical plant features, the automation and recordation equipment at this facility are in conformance with the requirements outlined in New York State Department of Transportation's Materials Procedure 401, dated June 2010.
Approval is hereby given to supply bituminous concrete from this facility to department projects during the 2013 construction season.
When producing for Department projects the following limitations shall apply:
1. The batching of mineral filler will not be permitted.
2. The production of recycle mixes will be permitted.
3. The maximum holding time for the hot bituminous holding system is 24 hours.
4.

Switch	Position	Location
Feeders # 1-8	Auto	Manual Panel
A/C Valve	Auto	Manual Panel

Your continued approval will be contingent upon satisfactory and timely completion of the scale checks, adherence to an approved control plan, and all applicable safety requirements.

Yours truly,

Paul Anderle

Paul Anderle,
Regional Materials Engineer, R-11

cc: R. Dhamdhere, Materials & Geotech Supervisor, R-11
file

State of New York
Department of Transportation
HUNTERS POINT PLAZA
47-40 21st Street
Long Island City, N.Y. 11101
http://www.dot.state.ny.us

PHILLIP ENG, P. E.
REGIONAL DIRECTOR

JOAN MCDONALD
COMMISSIONER

Date: April 15, 2013

Willets Point Asphalt Corp.
32-02 College Point Blvd.
Flushing, New York 11354

Re: Annual HMA Plant Approval
Facility: H0354

Gentlemen:

On April 12, 2013 personnel from the Materials Bureau staff completed inspection of your bituminous concrete production facility located in Flushing, New York.
As a result of this inspection, it has been determined that the physical plant features, the automation and recordation equipment at this facility are in conformance with the requirements outlined in New York State Department of Transportation's Materials Procedure 401, dated June 2010.
Approval is hereby given to supply bituminous concrete from this facility to department projects during the 2013 construction season.
When producing for Department projects, the following limitations shall apply:
1. The batching of mineral filler will not be permitted until the mineral filler weigh pot is calibrated.
2. The production of recycle mixes will be permitted.
3. The maximum holding time for the hot bituminous holding system is 12 hours.
3. Operating Modes:

Switch	Position	Location
Spec Mix Mode	On	Computer Setting-Prints on Recordation

Your continued approval will be contingent upon satisfactory and timely completion of the scale checks, adherence to an approved control plan, and all applicable safety requirements.

Yours truly,

Paul Anderle

Paul Anderle,
Regional Materials Engineer, R-11

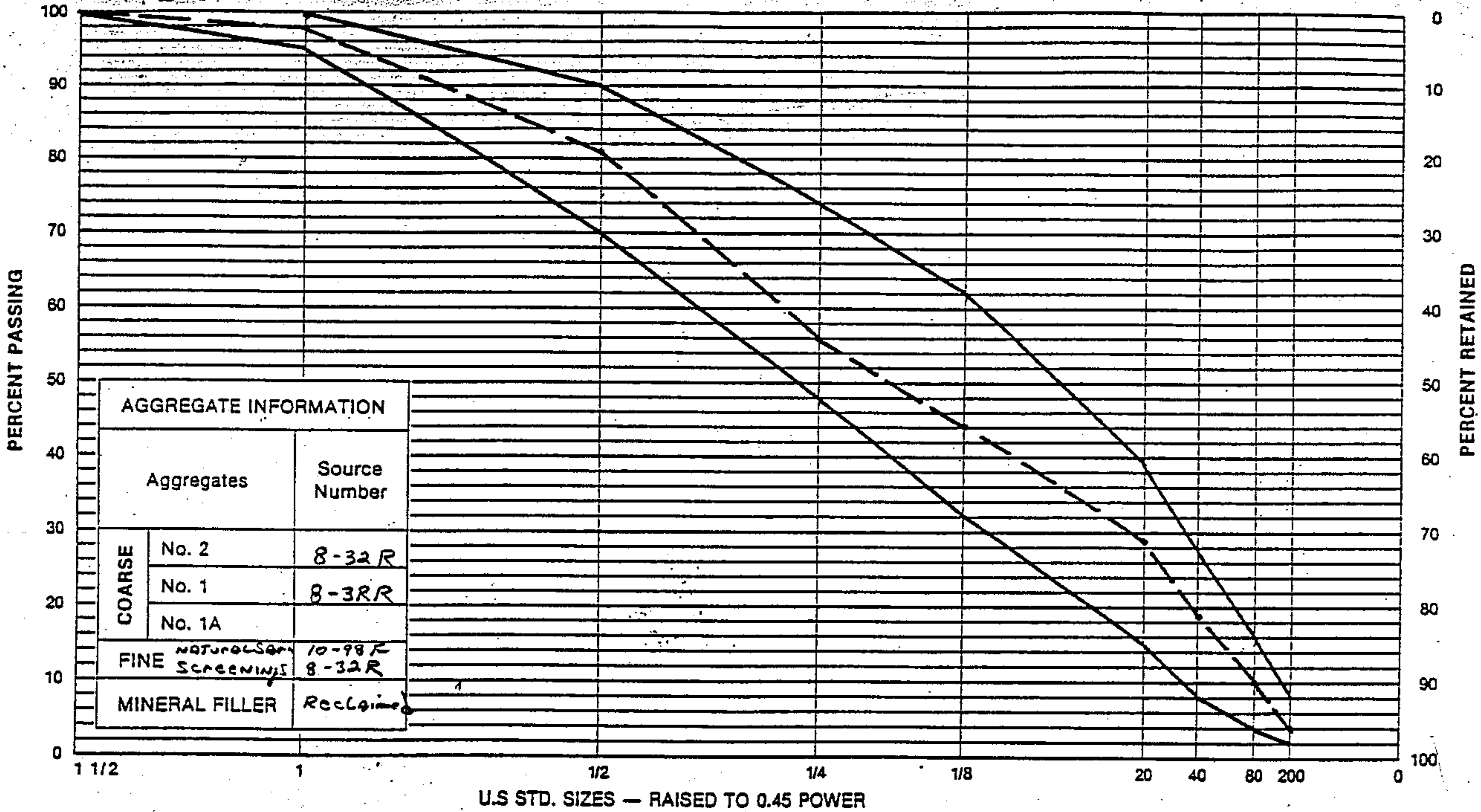
cc: R. Dhamhere, Materials & Geotech Supervisor, R-11
file

BR 298c (2/89)

NEW YORK STATE
DEPARTMENT OF TRANSPORTATION
MATERIALS BUREAU
JOB MIX FORMULA
Type 3 Binder (Dense)

PROD. COPY

Facility No. 10239 Formula No. ______
Plant FLUSHING ASPHALT Region 11
Plant Location college PT
Submitted By R. HoeFFner Date 1-9-13
(SUBMISSION INSTRUCTIONS ON BACK)



AGGREGATE INFORMATION

Aggregates		Source Number
COARSE	No. 2	8-32R
	No. 1	8-3RR
	No. 1A	
FINE	NaturalSand / Screenings	10-98R / 8-32R
MINERAL FILLER		Reclaimed

Sieve Size		2"	1 1/2"	1"	1/2"	1/4"	1/8"	No. 20	No. 40	No. 80	No. 200	Asphalt Content (Percent)
% Passing	1. General Limits		100	95-100	70-90	48-74	32-62	15-39	8-27	4-16	2-8	4.5-6.5
	2. JMF Range		100	95-100	75-87	49-63	37-51	22-36	12-26	6-14	2-6	
	3. Target Value		100	97.5	81	56	44	29	19	10	4	5.0

Asphalt Grade
AC 20

Approved for Regional Director ______ Date 1-9-13

Remarks: ______

BR 77a (2/90)

NEW YORK STATE
DEPARTMENT OF TRANSPORTATION
MATERIALS BUREAU

ITEM 403.13 REGION 11

MIX TYPE DENSE BINDER

PRODUCER Flushing Asphalt

LOCATION COLLEGE POINT

COMPACTION 75 BLOWS PER SIDE

WORKSHEET FOR ANALYSIS OF
COMPACTED PAVING MIXTURE

(Analysis by weight of total mixture)

COMPOSITION OF PAVING MIXTURE

	CONSTITUENT MATERIAL	NYSDOT Source Number	Specific Gravity, G Apparent	Specific Gravity, G Bulk		Region Verification	Mix Composition, % by weight of Total Mix., P — Mix or Trial Number 1	2	3	4	5
Coarse Aggregates	No. 2 Stone	8-32R	2.767	2.740	P_1		31.5	31.4	31.3	31.2	31.1
Coarse Aggregates	No. 1 Stone	8-32R	2.767	2.740	P_2		20.6	20.5	20.4	20.3	20.2
Coarse Aggregates	No. 1 Non-Carbonate Stone	----	----	----	P_3						
Coarse Aggregates	No. 1A Stone	----	----	----	P_4						
Coarse Aggregates	1A Non-Carbonate Stone	----	----	----	P_5						
Fine Aggregates	Manufactured	8-32R	2.767	2.740	P_6		23.3	23.2	23.1	23.0	22.9
Fine Aggregates	Natural	10-98FM	2.646	2.612	P_7		20.2	20.1	20.0	19.9	19.8
MINERAL FILLER					P_8		----	----	----	----	----
TOTAL AGGREGATE					P_S		95.6	95.2	94.8	94.4	94.0
ASPHALT CEMENT @ 77 F (25C)			1.025		P_B		4.4	4.8	5.2	5.6	6.0

			1	2	3	4	5
G_{mm}	Max. Sp. Gr. of Paving Mix (ASTM D2041)		2.551	2.534	2.520	2.501	2.477
G_{mb}	Bulk Sp. Gr. of compacted mix (ASTM D2726)		2.397	2.424	2.440	2.438	2.429
G_{sb}	Bulk Sp. Gr. of total aggregate*		2.711	2.712	2.712	2.712	2.712
G_{se}	Effective Sp. Gr. of total aggregate*		2.738	2.737	2.734	2.733	2.723
G_{sa}	Apparent Sp. Gr. of total aggregate*		2.740	2.740	2.740	2.740	2.741
VMA	$100 - \left(\frac{G_{mb} \times P_S}{G_{sb}}\right)$		15.48	14.91	14.71	15.14	15.81
P_a	Air Voids $= 100 \left(\frac{G_{mm} - G_{mb}}{G_{mm}}\right)$		6.04	4.34	3.17	2.52	1.94
P_{vma}	% VMA filled w/A.C. $= 100 \left(\frac{VMA - P_a}{VMA}\right)$		60.98	70.89	78.45	83.35	87.72
P_{be}	Effective Asphalt Content $= \left(\frac{G_b (VMA - P_a)}{G_{mb}}\right)$		4.03	4.46	4.85	5.30	5.85
	Stability (CORRECTED)		2271	2626	2673	2636	2520
	Flow		6.0	8.7	12.0	14.0	16.3
	Marshall Quotient $= \frac{\text{Stability (corrected)}}{\text{Flow}}$		379	302	228	188	155
	Unit Weight		149.57	151.26	152.26	152.13	151.57

*EQUATIONS FROM CHAPTER V, SECTION E, NY MATERIALS METHOD 5.13

Prepared by R. HOEFFNER on 1-9-13

BR 88b (2/90)

NEW YORK STATE
DEPARTMENT OF TRANSPORTATION
MATERIALS BUREAU
MARSHALL GRADATION ANALYSIS WORKSHEET

REGION 11
ITEM 403.13
MIX TYPE DENSE BINDER
PRODUCER Flushing Asphalt
LOCATION College PT NY

NO. OF ~~HOT BINS~~ COMPOSITE AVERAGED 10+

AGGREGATE INFORMATION

	Aggregates	Source Number	Aggregate Blend %
COARSE	No. 2 Stone	8-32R	
COARSE	No. 1 Stone	8-32R	
COARSE	No. 1 Non-Carbonate Stone		
COARSE	No. 1A Stone		
COARSE	No. 1A Non-Carbonate Stone		
FINE	Manufactured	8-32R	
FINE	Natural	10-98F	
MINERAL FILLER			

# 1 High Friction Blend	
#1A High Friction Blend	
Manufactured /Natural Sand Blend	

AVERAGE BIN BREAKDOWN

Sieve Sizes	BIN NO. % retained	pass	BIN NO. Composite % retained	pass	BIN NO. % retained	pass	BIN NO. % retained	pass	MINERAL FILLER % retained	pass
1 1/2"			0	100						
1"			2.5	97.5						
3/4"			---	---						
1/2"			16.5	81.0						
1/4"			25.0	56.0						
1/8"			12.0	44.0						
20			15.0	29.0						
40			10.0	19.0						
80			9.0	10.0						
200			6.0	4.0						
PAN			4.0	---						
TOTALS										

COMBINED AVERAGE GRADATION

BIN	% BATCH	% Passing Sieve 1 1/2"	1"	3/4"	1/2"	1/4"	1/8"	20	40	80	200
Composite	100.0	100	97.5	--	81.0	56.0	44.0	29.0	19.0	10.0	4.0
Min. Filler											
TOTAL		100	97.5	--	81.0	56.0	44.0	29.0	19.0	10.0	4.0
Spec. LIMITS		100	95/100		75/87	49/63	37/51	22/36	12/26	6/14	2/6

Remarks

TESTED BY R. HOEFFNER ON 1-9-13

BR 88b (2/90)
REVERSE

COMBINED MARSHALL GRADATION
AT THE % ASPHALT CEMENT INDICATED

% A.C.	AGGREGATE COMPONENT (BIN)	% BATCH	GRAMS BATCH	WEIGHT RETAINED (GRAMS) 1"	3/4"	1/2"	1/4"	1/8"	20	40	80	200	PAN	TOTAL Wgt. Ret.
4.4														
	Composite	100.0	1147.2	28.7	--	89.3	286.8	137.6	172.0	114.7	103.2	68.8	46.1	
	Min. Filler													
	TOTAL													

1200.0 gr × 4.4 % A.C. = 52.8 gr. A.C.
1200.0 gr − 52.8 gr. A.C. = 1147.2 gr. Aggregate

% A.C.	AGGREGATE COMPONENT (BIN)	% BATCH	GRAMS BATCH	WEIGHT RETAINED (GRAMS) 1"	3/4"	1/2"	1/4"	1/8"	20	40	80	200	PAN	TOTAL Wgt. Ret.
4.8														
	Composite	100.0	1142.4	28.6	--	88.5	285.6	137.0	171.3	114.2	102.8	68.5	45.9	
	Min. Filler													
	TOTAL													

1200.0 gr × 4.8 % A.C. = 57.6 gr. A.C.
1200.0 gr − 57.6 gr. A.C. = 1142.4 gr. Aggregate

% A.C.	AGGREGATE COMPONENT (BIN)	% BATCH	GRAMS BATCH	WEIGHT RETAINED (GRAMS) 1"	3/4"	1/2"	1/4"	1/8"	20	40	80	200	PAN	TOTAL Wgt. Ret.
5.2														
	Composite	100.0	1137.6	28.4	--	87.7	284.4	136.5	170.6	113.8	102.3	68.2	45.7	
	Min. Filler													
	TOTAL													

1200.0 gr × 5.2 % A.C. = 62.4 gr. A.C.
1200.0 gr − 62.4 gr. A.C. = 1137.6 gr. Aggregate

% A.C.	AGGREGATE COMPONENT (BIN)	% BATCH	GRAMS BATCH	WEIGHT RETAINED (GRAMS) 1"	3/4"	1/2"	1/4"	1/8"	20	40	80	200	PAN	TOTAL Wgt. Ret.
5.6														
	Composite	100.0	1132.8	28.3	--	86.9	283.2	135.9	169.9	113.3	101.9	67.9	45.5	
	Min. Filler													
	TOTAL													

1200.0 gr × 5.6 % A.C. = 67.2 gr. A.C.
1200.0 gr − 67.2 gr. A.C. = 1132.8 gr. Aggregate

% A.C.	AGGREGATE COMPONENT (BIN)	% BATCH	GRAMS BATCH	WEIGHT RETAINED (GRAMS) 1"	3/4"	1/2"	1/4"	1/8"	20	40	80	200	PAN	TOTAL Wgt. Ret.
6.0														
	Composite	100.0	1128.0	28.2	--	86.1	282.0	135.3	169.2	112.8	101.5	67.7	45.2	
	Min. Filler													
	TOTAL													

1200.0 gr × 6.0 % A.C. = 72.0 gr. A.C.
1200.0 gr − 72.0 gr. A.C. = 1128.0 gr. Aggregate

BR 79 (3/81)

COMPUTATION OF MARSHALL MIX PROPERTIES

NEW YORK STATE DEPARTMENT OF TRANSPORTATION MATERIALS BUREAU

ITEM 403.13 REGION 11

MIX TYPE DENSE BINDER

PRODUCER Flushing Asphalt LOCATION COLLEGE POINT, NY

Specimen	Asphalt Content	Weight – Grams: In Air	Weight – Grams: In Water	Weight – Grams: S.S.D.	Volume CC	Specific Gravity: Bulk G_{mb}	Specific Gravity: Theor. G_{mm}	Voids Total Mix	Unit Wt. Lb/Cu Ft	Stability–Lb: Measured	Stability–Lb: Corrected	Flow 0.01 In.
a	b	c	d	e	f	g	h	i	j	k	l	m
					e–d	$\frac{c}{f}$		$100\frac{(h-g)}{h}$	(gX62.4)			
A	4.4	1200.7	702.1	1202.1	500	2.401	2.551			2215	2304	6.0
B	4.4	1205.1	704.6	1206.7	502.1	2.400	2.551			2206	2294	6.0
C	4.4	1199.6	699.3	1201.3	502.0	2.389	2.551			2130	2215	6.0
AVG.	4.4					2.397	2.551	6.04	149.57		2271	6.0
A	4.8	1201.0	706.5	1201.9	495.4	2.424	2.534			2550	2652	10.0
B	4.8	1204.1	709.4	1205.6	496.2	2.427	2.534			2550	2652	8.0
C	4.8	1200	705.6	1201.4	495.8	2.420	2.534			2464	2563	8.0
AVG.	4.8					2.424	2.534	4.34	151.26		2626	8.7
A	5.2	1194.9	706.3	1196.1	489.8	2.439	2.520			2416	2633	12.0
B	5.2	1199.8	708.1	1200.5	492.4	2.436	2.520			2388	2603	12.0
C	5.2	1197.1	708.0	1198.0	490.0	2.443	2.520			2552	2782	12.0
AVG.	5.2					2.439	2.520	3.21	152.2		2673	12.0
A	5.6	1200.7	709.3	1200.9	491.6	2.442	2.501			2469	2692	12.0
B	5.6	1193.0	704.7	1194.1	489.4	2.438	2.501			2425	2643	15.0
C	5.6	1199.5	708.0	1200.8	492.8	2.434	2.501			2361	2573	15.0
AVG.	5.6					2.438	2.501	2.52	152.13		2636	14.0
A	6.0	1206.8	710.7	1207.1	496.4	2.431	2.477			2445	2543	17.0
B	6.0	1203.4	707.5	1203.7	496.2	2.425	2.477			2436	2533	16.0
C	6.0	1204.0	709.3	1204.8	495.5	2.430	2.477			2387	2483	16.0
AVG.	6.0					2.429	2.477	1.94	151.57		2520	16.3

PREPARED BY R. HOEFFNER DATE 1/9/13

BR 76 (3/81)

NEW YORK STATE
DEPARTMENT OF TRANSPORTATION
MATERIALS BUREAU

MIX TYPE DENSE BINDER REGION 11

PRODUCER Flushing Asphalt, LLC

LOCATION COLLEGE POINT

MAXIMUM SPECIFIC GRAVITY OF BITUMINOUS PAVING MIXTURES
ASTM D–2041 (RICE METHOD)

Maximum Specific Gravity of Bituminous Paving Mixture = G_{mm}
A= Weight of dry sample in air (grams)
D= Weight of flask filled with airless water at 77°F (25°C) grams
E= Weight of flask filled with water and sample at 77°F (25°C) grams

$$G_{mm} = \frac{A}{A+D-E}$$

ASPHALT CONTENT	4.4 %		4.8 %		5.2 %		5.6 %		6.0 %	
TEST NO.	1	2	1	2	1	2	1	2	1	2
A	1203.1	1202.4	1204.6	1203.9	1205.9	1206.3	1207.4	1207.4	1208.6	1207.9
D	7391.6	7391.6	7391.6	7391.6	7391.6	7391.6	7391.6	7391.6	7391.6	7391.6
E	8122.5	8123.2	8120.1	8121.1	8118.4	8119.8	8115.3	8118.3	8111.7	8112.4
A + D – E	472.2	470.8	476.1	474.4	479.1	478.1	483.7	482.6	488.5	487.1
G_{mm}	2.548	2.554	2.530	2.538	2.517	2.523	2.496	2.506	2.474	2.480
Average G_{mm}	2.551		2.534		2.520		2.501		2.477	

Test By R. HOEFFNER on 1-9-2013

BR 78a (2/90) 7

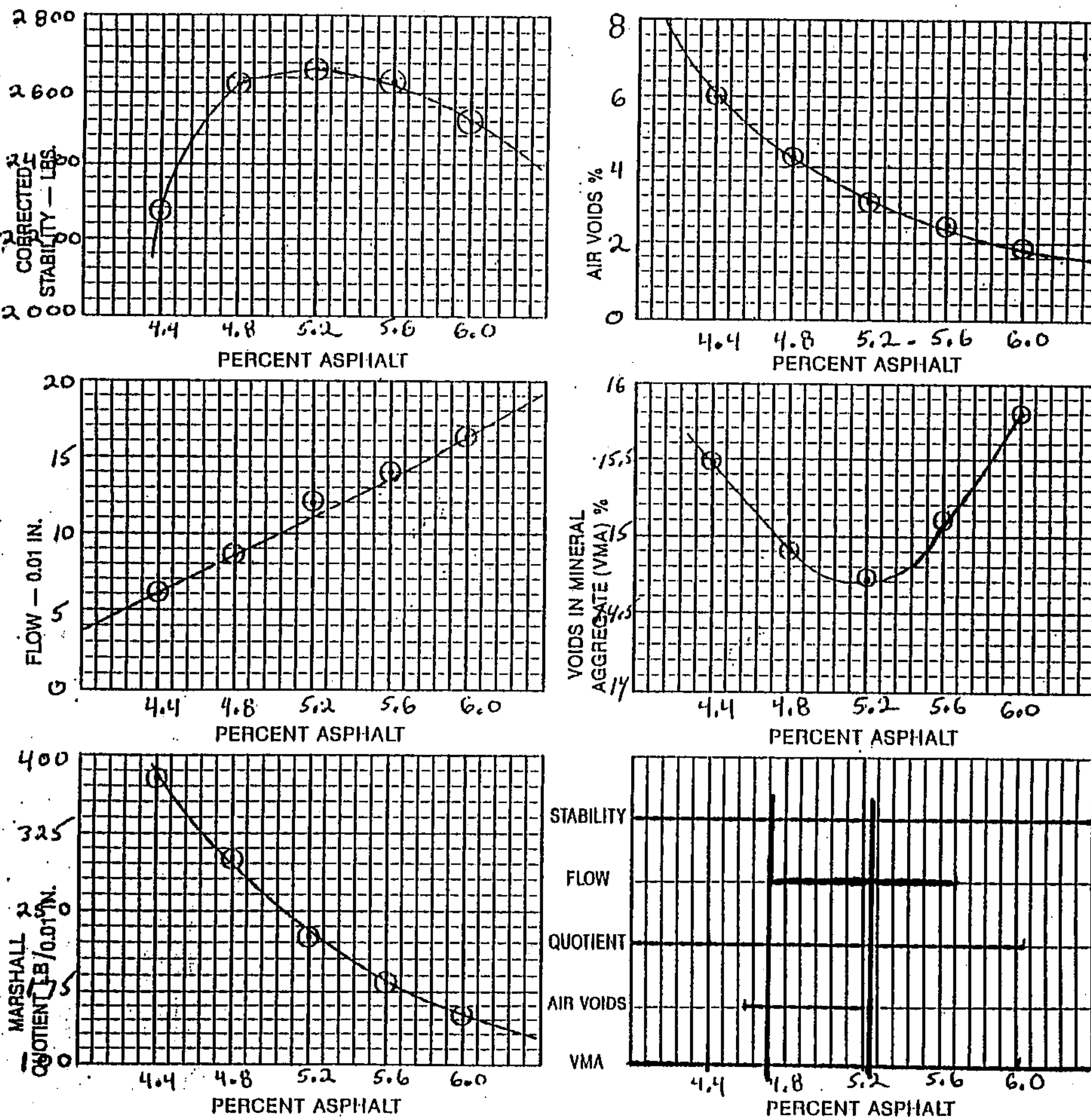
NEW YORK STATE
DEPARTMENT OF TRANSPORTATION
MATERIALS BUREAU

REGION 11

MIX TYPE III

Producer FLUSHING ASPHALT LLC Location College PT

MARSHALL TEST PROPERTY CURVES AND RANGE DATA



COMMON OVERLAP RANGE 4.7 - 5.3

MID POINT 5.0
(OPTIMUM AC CONTENT)

SUBMITTED BY Ralph Hoeffner

DATE 1-9-2013

VALUES AT OPTIMUM AC CONTENT

PROPERTY	STABILITY	FLOW	QUOTIENT	AIR VOIDS	VMA
SPEC.	.1500	8 - 14	150 MIN.	3 - 5	13.5 MIN
ACTUAL	2650	10	260	3.8	14.7

BR 172a (2/89)

NEW YORK STATE
DEPARTMENT OF TRANSPORTATION
MATERIALS BUREAU

JOB MIX FORMULA
MARSHALL MIX DESIGN

Type 6F Top Course (High Friction)

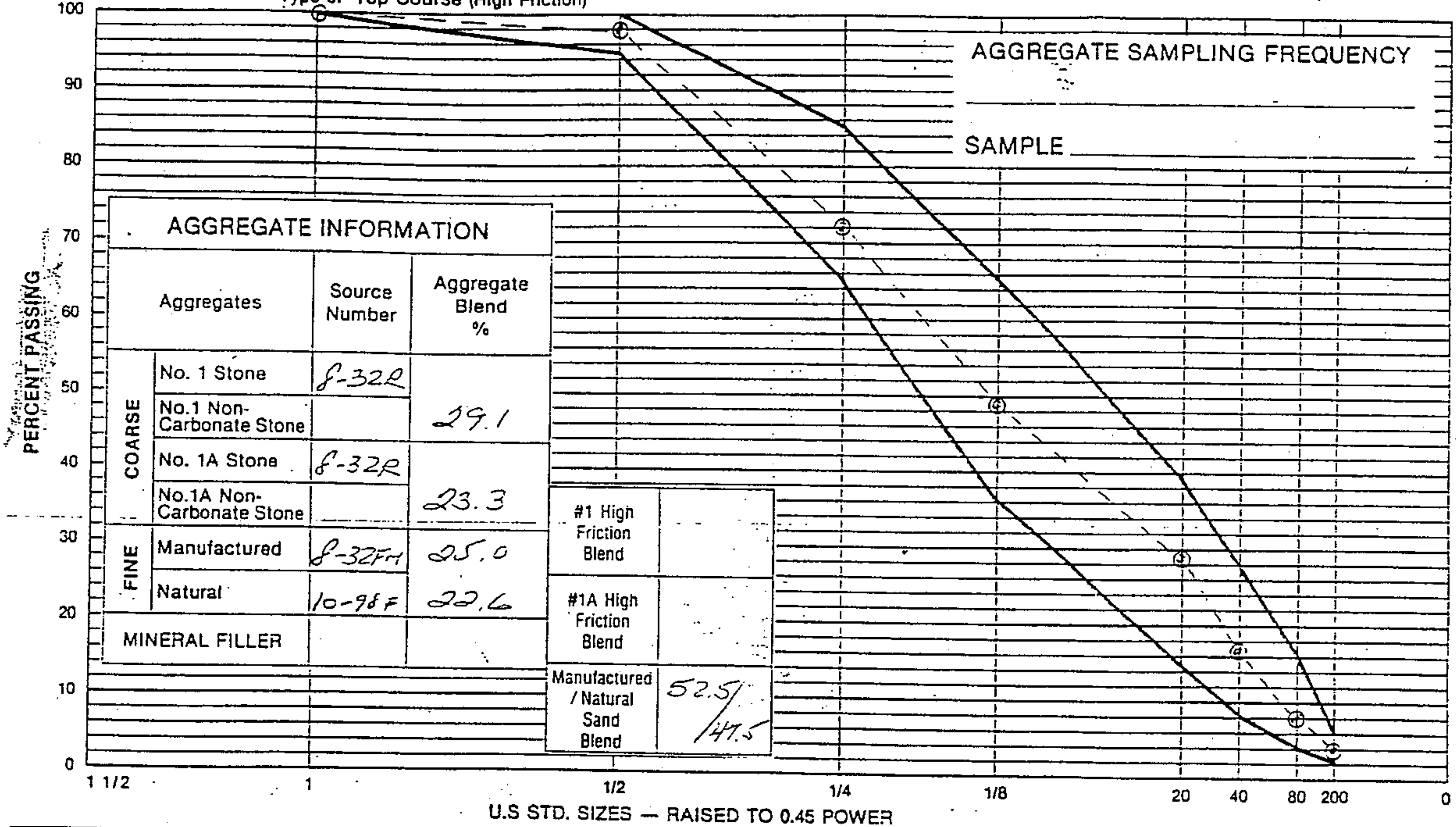
Facility No. ______ Formula No. ______

Plant *FLUSHING ASPHALT, LLC* Region *11*

Plant Location *FLUSHING NY.*

Submitted By *R. Hoeffner Q.C* Date *1-6-2013*

(SUBMISSION INSTRUCTIONS ON BACK)



AGGREGATE INFORMATION

	Aggregates	Source Number	Aggregate Blend %
COARSE	No. 1 Stone	*8-32R*	*29.1*
	No.1 Non-Carbonate Stone		
	No. 1A Stone	*8-32R*	*23.3*
	No.1A Non-Carbonate Stone		
FINE	Manufactured	*8-32FM*	*25.0*
	Natural	*10-98F*	*22.6*
MINERAL FILLER			

#1 High Friction Blend	
#1A High Friction Blend	
Manufactured / Natural Sand Blend	*52.5/47.5*

Sieve Size		2"	1 1/2"	1"	1/2"	1/4"	1/8"	No. 20	No. 40	No. 80	No. 200	Asphalt Content (Percent)
% Passing	1. General Limits			100	95-100	65-85	36-65	15-39	8-27	4-16	2-6	5.8-7.0
	2. JMF Range			100	95-100	*65-79*	*42-56*	*22-36*	*10-24*	*4-12*	*2-6*	*6.-*
	3. Target Value			*100*	*98*	*72*	*49*	*29*	*17*	*8*	*4*	*5.8-6.6*

Asphalt Grade
AC *20*
PG64-22

Recommended for Approval by Regional Director ______ Date ______

Approved by Director, Materials Bureau ______ Date ______

BR 77a (2/90)

NEW YORK STATE DEPARTMENT OF TRANSPORTATION MATERIALS BUREAU

ITEM 1040317 REGION 11

MIX TYPE 6FTOP

PRODUCER FLUSHING ASPHALT, LLC

LOCATION FLUSHING NY

COMPACTION 75 BLOWS PER SIDE

WORKSHEET FOR ANALYSIS OF COMPACTED PAVING MIXTURE

(Analysis by weight of total mixture)

COMPOSITION OF PAVING MIXTURE

			CONSTITUENT MATERIAL	NYSDOT Source Number	Specific Gravity, G Apparent	Specific Gravity, G Bulk		Region Verification	Mix Composition, % by weight of Total Mix., P — Mix or Trial Number 1	2	3	4	5
	Coarse Aggregates	No. 2 Stone					P_1						
	Coarse Aggregates	No. 1 Stone		8-32R	2.767	2.740	P_2		27.6	27.5	27.4	27.2	27.1
	Coarse Aggregates	No. 1 Non-Carbonate Stone					P_3						
	Coarse Aggregates	No. 1A Stone		8-32R	2.767	2.740	P_4		22.1	22.0	21.9	21.8	21.7
	Coarse Aggregates	1A Non-Carbonate Stone					P_5						
	Fine Aggregates	Manufactured		8-32FM	2.758	2.695	P_6		23.7	23.6	23.5	23.4	23.3
	Fine Aggregates	Natural		10-98FM	2.646	2.612	P_7		21.4	21.3	21.2	21.2	21.1
	MINERAL FILLER						P_8						
	TOTAL AGGREGATE						P_S		94.8	94.4	94.0	93.6	93.2
	ASPHALT CEMENT @ 77 F (25C)						P_B		5.2	5.6	6.0	6.4	6.8
G_{mm}	Max. Sp. Gr. of Paving Mix (ASTM D2041)								2.512	2.490	2.471	2.449	2.429
G_{mb}	Bulk Sp. Gr. of compacted mix (ASTM D2726)								2.364	2.369	2.373	2.367	2.359
G_{sb}	Bulk Sp. Gr. of total aggregate*								2.699	2.699	2.699	2.699	2.699
G_{se}	Effective Sp. Gr. of total aggregate*								2.729	2.721	2.716	2.706	2.699
G_{sa}	Apparent Sp. Gr. of total aggregate*								2.736	2.736	2.737	2.737	2.737
VMA	$100 - \left(\frac{G_{mb} \times P_S}{G_{sb}}\right)$								16.97	17.14	17.35	17.91	18.54
P_a	Air Voids $= 100\left(\frac{G_{mm} - G_{mb}}{G_{mm}}\right)$								5.89	4.86	3.97	3.35	2.88
P_{vma}	% VMA filled w/A.C. $= 100\left(\frac{VMA - P_a}{VMA}\right)$								65.29	71.65	77.12	81.30	84.47
P_{be}	Effective Asphalt Content $= \left(\frac{G_b\,(VMA - P_a)}{G_{mb}}\right)$								4.80	5.31	5.78	6.31	6.80
	Stability (CORRECTED)								1873	2009	2212	2043	1783
	Flow								7.2	9.2	11.2	13.7	16.5
	Marshall Quotient $= \frac{\text{Stability (corrected)}}{\text{Flow}}$								260.1	218.4	197.5	149.1	108.1
	Unit Weight								147.51	147.83	148.07	147.70	147.20

*EQUATIONS FROM CHAPTER V, SECTION E, NY MATERIALS METHOD 5.13

Prepared by C. HOEFFNER on 1-6-2013

BR 88b (2/90)
REVERSE

COMBINED MARSHALL GRADATION
AT THE % ASPHALT CEMENT INDICATED

% A.C.	AGGREGATE COMPONENT (BIN)	% BATCH	GRAMS BATCH	WEIGHT RETAINED (GRAMS) 1"	3/4"	1/2"	1/4"	1/8"	20	40	80	200	PAN	TOTAL Wgt. Ret.
5.2														
	Composite	100.0	1137.6				352.4	227.5	227.5	135.4	126.3	33.0	35.3	
	Min. Filler													
	TOTAL													

1200.0 gr × 5.2 % A.C. = 62.4 gr. A.C.
1200.0 gr − 62.4 gr. A.C. = 1137.6 gr. Aggregate

% A.C.	AGGREGATE COMPONENT (BIN)	% BATCH	GRAMS BATCH	WEIGHT RETAINED (GRAMS) 1"	3/4"	1/2"	1/4"	1/8"	20	40	80	200	PAN	TOTAL Wgt. Ret.
5.6														
	Composite	100.0	1132.8				348.5	226.6	226.6	134.8	125.7	32.9	35.1	
	Min. Filler													
	TOTAL													

1200.0 gr × 5.6 % A.C. = 67.2 gr. A.C.
1200.0 gr − 67.2 gr. A.C. = 1132.8 gr. Aggregate

% A.C.	AGGREGATE COMPONENT (BIN)	% BATCH	GRAMS BATCH	WEIGHT RETAINED (GRAMS) 1"	3/4"	1/2"	1/4"	1/8"	20	40	80	200	PAN	TOTAL Wgt. Ret.
6.0														
	Composite	100.0	1128.0				347.4	225.6	225.6	134.2	126.2	32.7	35.0	
	Min. Filler													
	TOTAL													

1200.0 gr × 6.0 % A.C. = 72.0 gr. A.C.
1200.0 gr − 72.0 gr. A.C. = 1128.0 gr. Aggregate

% A.C.	AGGREGATE COMPONENT (BIN)	% BATCH	GRAMS BATCH	WEIGHT RETAINED (GRAMS) 1"	3/4"	1/2"	1/4"	1/8"	20	40	80	200	PAN	TOTAL Wgt. Ret.
6.4														
	Composite	100.0	1123.2				345.9	224.6	224.6	133.7	124.7	32.6	34.8	
	Min. Filler													
	TOTAL													

1200.0 gr × 6.4 % A.C. = 76.8 gr. A.C.
1200.0 gr − 76.8 gr. A.C. = 1123.2 gr. Aggregate

% A.C.	AGGREGATE COMPONENT (BIN)	% BATCH	GRAMS BATCH	WEIGHT RETAINED (GRAMS) 1"	3/4"	1/2"	1/4"	1/8"	20	40	80	200	PAN	TOTAL Wgt. Ret.
6.8														
	Composite	100.0	1118.4				344.5	223.7	223.7	133.1	124.1	32.4	34.7	
	Min. Filler													
	TOTAL													

1200.0 gr × 6.8 % A.C. = 81.6 gr. A.C.
1200.0 gr − 81.6 gr. A.C. = 1118.4 gr. Aggregate

DEPARTMENT OF TRANSPORTATION
MATERIALS BUREAU
MARSHALL GRADATION ANALYSIS WORKSHEET

ITEM 10403117

MIX TYPE 6FTOP.

PRODUCER: FLUSHING ASPHALT, LLC

LOCATION FLUSHING NY

COMPOSITE NO. OF ~~HOT BINS~~ AVERAGED 10T

AGGREGATE INFORMATION

	Aggregates	Source Number	Aggregate Blend %		
COARSE	No. 2 Stone				
	No. 1 Stone	8-32R	29.1	#1 High Friction Blend	
	No. 1 Non-Carbonate Stone				
	No. 1A Stone	8-32R	23.3	#1A High Friction Blend	
	No. 1A Non-Carbonate Stone				
FINE	Manufactured	8-32FM	25.0	Manufactured /Natural Sand Blend	52.5/47.5
	Natural	10-98F	22.6		
	MINERAL FILLER				

AVERAGE BIN BREAKDOWN

Sieve Sizes	BIN NO. % retained	BIN NO. % pass	BIN "COMPOSITE" NO. % retained	BIN "COMPOSITE" NO. % pass	BIN NO. % retained	BIN NO. % pass	BIN NO. % retained	BIN NO. % pass	MINERAL FILLER % retained	MINERAL FILLER % pass
1 1/2"										
1"			0	100						
3/4"										
1/2"			0	100						
1/4"			30.8	69.2						
1/8"			20.0	49.2						
20			20.0	29.2						
40			11.9	17.3						
80			11.1	6.2						
200			2.9	3.3						
PAN			3.3							
TOTALS										

COMBINED AVERAGE GRADATION

BIN	% BATCH	1 1/2"	1"	3/4"	1/2"	1/4"	1/8"	20	40	80	200
Composite	100.0	-	100	—	100	69.2	49.2	29.2	17.3	6.2	3.3
Min. Filler											
TOTAL			100.0	—	100.0	69.2	49.2	29.2	17.3	6.2	3.3
Spec. LIMITS			100	—	95/100	65/85	36/65	15/39	8/27	4/16	2/6

Remarks

TESTED BY R. Heffner ON 1-6-2013

BR 79 (3/81)

COMPUTATION OF MARSHALL
MIX PROPERTIES

NEW YORK STATE
DEPARTMENT OF TRANSPORTATION
MATERIALS BUREAU

ITEM 10403.17 REGION 11

MIX TYPE 6FTOP

PRODUCER Flushing Asphalt LLC LOCATION Flushing NY.

Specimen	Asphalt Content	Weight – Grams: In Air	Weight – Grams: In Water	Weight – Grams: S.S.D.	Volume CC	Specific Gravity: Bulk G_{mb}	Specific Gravity: Theor. G_{mm}	Voids Total Mix	Unit Wt. Lb/Cu Ft	Stability–Lb: Measured	Stability–Lb: Corrected	Flow 0.01 In.
a	b	c	d	e	f	g	h	i	j	k	l	m
					e–d	$\frac{c}{f}$		$100\frac{(h-g)}{h}$	(gX62.4)			
A	5.2	1201.9	695.8	1203.6	507.8	2.367	2.512			1700	1768	6.0
B	"	1210.7	700.2	1211.9	511.7	2.366	"			1900	1900	8.5
C	"	1196.8	690.8	1198.1	507.3	2.359	"			1875	1950	7.0
AVG.	5.2					2.364	2.512	5.89	147.5		1873	7.2
A	5.6	1204.3	695.8	1201.0	505.2	2.365	2.490			2050	2050	9.5
B	"	1200.9	695.4	1202.3	506.9	2.369	"			1900	1976	9.0
C	"	1201.0	696.1	1202.4	506.3	2.372	"			1925	2002	9.0
AVG.	5.6					2.369	2.490	4.86	147.8		2009	9.2
A	6.0	1210.5	701.0	1211.4	510.4	2.371	2.471			2150	2150	11.5
B	"	1208.7	700.0	1210.0	510.0	2.370	"			2225	2225	12.0
C	"	1192.8	691.3	1193.1	501.8	2.377	"			2175	2262	10.0
AVG.	6.0					2.373	2.471	3.97	148.1		2212	11.2
A	6.4	1205.6	697.3	1206.3	509.0	2.368	2.449			2000	2000	14.5
B	"	1207.1	698.9	1208.0	509.1	2.371	"			2100	2100	13.0
C	"	1198.2	691.8	1199.1	507.3	2.362	"			1950	2028	13.5
AVG.	6.4					2.367	2.449	3.35	147.7		2043	13.7
A	6.8	1200.6	692.2	1201.1	508.9	2.359	2.429			1875	1875	15.5
B	"	1200.5	692.1	1201.0	508.9	2.359	"			1700	1700	17.5
C	"	1202.0	692.8	1202.5	509.7	2.358	"			1775	1775	16.5
AVG.	6.8					2.359	2.429	2.88	147.2		1783	16.5

PREPARED BY R Heffner DATE 1-6-2013

BR 76 (3/81)

NEW YORK STATE
DEPARTMENT OF TRANSPORTATION
MATERIALS BUREAU

MIX TYPE [illegible] REGION 11

PRODUCER FLUSHING ASPHAL, LLC

LOCATION FLUSHING NY

MAXIMUM SPECIFIC GRAVITY OF BITUMINOUS PAVING MIXTURES
ASTM D-2041 (RICE METHOD)

Maximum Specific Gravity of Bituminous Paving Mixture = G_{mm}
A= Weight of dry sample in air (grams)
D= Weight of flask filled with airless water at 77°F (25°C) grams
E= Weight of flask filled with water and sample at 77°F (25°C) grams

$$G_{mm} = \frac{A}{A+D-E}$$

ASPHALT CONTENT	5.2 %		5.6 %		6.0 %		6.4 %		6.8 %	
TEST NO.	1	2	1	2	1	2	1	2	1	2
A	1217.6	1229.5	1271.5	1259.2	1222.6	1231.7	1215.7	1214.2	1219.6	1221.6
D	7419.5	7419.5	7419.5	7419.5	7419.5	7419.5	7419.5	7419.5	7419.5	7419.5
E	8152.8	8159.0	8180.6	8172.6	8146.7	8153.1	8139.2	8137.5	8137.4	8137.8
A + D − E	484.3	490.0	510.4	506.1	495.4	498.1	496.0	496.2	501.7	503.3
G_{mm}	2.514	2.509	2.491	2.488	2.468	2.473	2.451	2.447	2.431	2.427
Average G_{mm}	2.512		2.490		2.471		2.449		2.429	

Test By R. Hoeffner on 1-6-2013

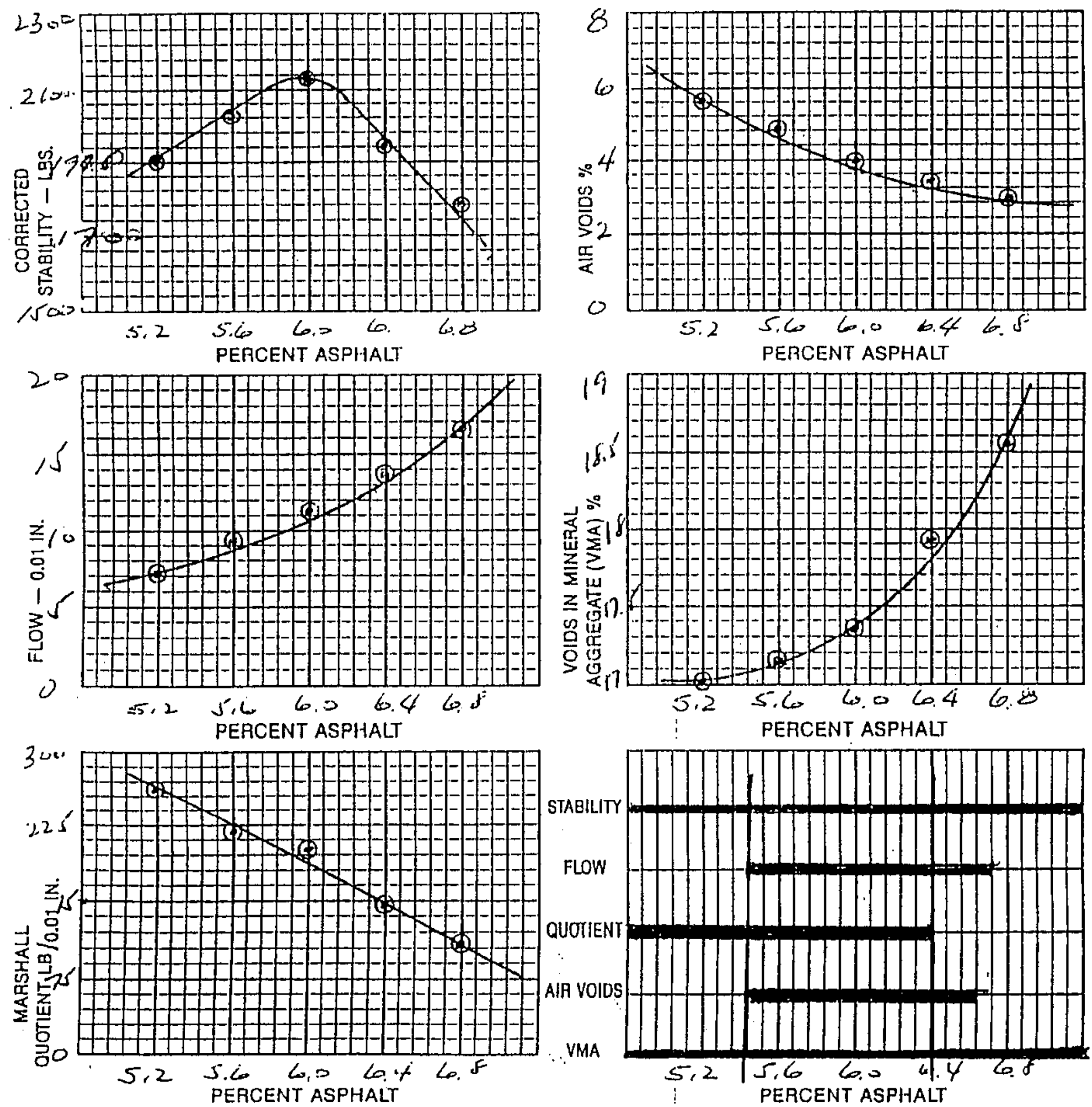
NEW YORK STATE
DEPARTMENT OF TRANSPORTATION
MATERIALS BUREAU

REGION 11

MIX TYPE 6FTOP

Producer FLUSHING ASPHALT, LLC Location FLUSHING NY

MARSHALL TEST PROPERTY CURVES AND RANGE DATA



COMMON OVERLAP RANGE 5.6 – 6.4

MID POINT 6.0
(OPTIMUM AC CONTENT)

SUBMITTED BY R. HOOFFNER

DATE 1-6-2013

VALUES AT OPTIMUM AC CONTENT

PROPERTY	STABILITY	FLOW	QUOTIENT	AIR VOIDS	VMA
SPEC.	1500	8 - 16	150 min	3.0 - 5.0	16
ACTUAL	2212	11.2	197.5	3.97	17.35

Haskell | United States

Submittal Response

Transmittal ID: 0035
Date Sent: 1/4/2013
Submittal ID:

Project: Frito Lay Morgan Avenue
Number: 33110

To:
Richard Angus
Coppola
718-325-8815 (Phone)

From:
Regina Hoyne
Haskell
United States

Subject: Rip Rap - Tensar Fabric
Sent Via: Info Exchange
Return By:
Action: No Exceptions
Remarks:

Response (No Exceptions) from: Andrew Grundy (PAULUS SOKOLOWSKI & SARTOR (PS&S))
Remarks:

No exceptions Rip-Rap Fabric Reviewed by Andrew Grundy

CC:
Delano Palmer
Robert Sweeting (Coppola)

Contents

Quantity: 1 Dated: 12/19/2012 Number:
Description:
Tensar Fabric.pdf
Action:
Remarks:

Quantity: 1 Dated: 1/4/2013 Number:
Description:
No Exceptions Tensar Fabric 12.19.2012.pdf
Action:
Remarks:

DURA♦SKRIM® K30B, K36B & K45B

Scrim Reinforced Polyethylene

ISO 9001:2008 CERTIFIED MANAGEMENT SYSTEM

PRO-FORMA DATA SHEET

PROPERTIES	TEST METHOD	DURA♦SKRIM K30B Minimum Roll Averages	DURA♦SKRIM K30B Typical Roll Averages	DURA♦SKRIM K36B Minimum Roll Averages	DURA♦SKRIM K36B Typical Roll Averages	DURA♦SKRIM K45B Minimum Roll Averages	DURA♦SKRIM K45B Typical Roll Averages
Appearance		Black	Black	Black	Black	Black	Black
Thickness		27 mil	30 mil	32 mil	36 mil	40 mil	45 mil
Weight lbs/MSF, (oz/yd^2)		130 lbs (18.7)	144 lbs (20.7)	156 lbs (22.5)	173 lbs (25)	198 lbs (28.52)	220 lbs (31.70)
Construction		Dense scrim reinforced polyethylene					
*Ply Adhesion lbf/in	ASTM D 6636	19 lbs or FTB	24 lbs or FTB	19 lbs or FTB	24 lbs or FTB	32 lbs or FTB	37 lbs or FTB
Tensile Strength lbf/in	ASTM D 7003	160 lbf MD 150 lbf TD	170 lbf MD 168 lbf TD	178 lbf MD 160 lbf TD	190 lbf MD 172 lbf TD	185 lbf MD 170 lbf TD	198 lbf MD 184 lbf TD
Tensile Elongation at Break % (film break)	ASTM D 7003	500 MD 430 TD	604 MD 508 TD	450 MD 400 TD	542 MD 447 TD	600 MD 420 TD	687 MD 624 TD
Tensile Elongation at Break % (scrim break)	ASTM D 7003	32 MD 30 TD	35 MD 31 TD	32 MD 30 TD	36 MD 32 TD	32 MD 30 TD	35 MD 31 TD
Tongue Tear Strength	ASTM D 5884	160 lbf MD 125 lbf TD	187 lbf MD 168 lbf TD	140 lbf MD 100 lbf TD	174 lbf MD 157 lbf TD	80 lbf MD 115 lbf TD	114 lbf MD 147 lbf TD
Grab Tensile (scrim break)	ASTM D 7004	270 lbf MD 255 lbf TD	293 lbf MD 274 lbf TD	300 lbf MD 285 lbf TD	316 lbf MD 304 lbf TD	335 lbf MD 330 lbf TD	369 lbf MD 363 lbf TD
Grab Tensile Elongation at Break % (scrim break)	ASTM D 7004	25 %	30 %	28 %	32 %	25 %	34 %
HPOIT	ASTM D 5885	800 min	2400 min	800 min	2400 min	800 min	2400 min
Puncture Resistance	ASTM D 4833	90 lbf	105 lbf	100 lbf	129 lbf	100 lbf	150 lbf
Maximum Use Temperature			180° F		180° F		180° F
Minimum Use Temperature			-70° F		-70° F		-70° F

*Raven modified QC procedure

PRO-FORMA Sheet Contents:
The data listed in this Pro-Forma data sheet is representative of initial production runs. These values may be revised at anytime without notice as additional test data becomes available.

DURA♦SKRIM® K30B, K36B and K45B are reinforced laminates manufactured using high strength virgin grade polyethylene resins and stabilizers for excellent UV resistance in exposed applications. DURA♦SKRIM® K30B, K36B and K45B are reinforced with a dense scrim reinforcement to maximize tear and puncture resistance along with providing excellent dimensional stability.

RAVEN INDUSTRIES

Engineered Films Division
P.O. Box 5107
Sioux Falls, SD 57117-5107
Ph: (605) 335-0174 • Fx: (605) 331-0333

Toll Free: 800-635-3456
Email: efdsales@ravenind.com
www.ravenefd.com

Limited Warranty available at www.RavenEFD.com

TENCATE GEOSYNTHETICS
Americas

Mirafi® 160N

Drainage Separation

Mirafi® 160N is a needlepunched nonwoven geotextile composed of polypropylene fibers, which are formed into a stable network such that the fibers retain their relative position. Mirafi® 160N is inert to biological degradation and resists naturally encountered chemicals, alkalis, and acids. Mirafi® 160N meets AASHTO M288-06 Class 2 for Elongation > 50%.

TenCate Geosynthetics Americas Laboratories are accredited by a2La (The American Association for Laboratory Accreditation) and Geosynthetic Accreditation Institute – Laboratory Accreditation Program (GAI-LAP). NTPEP Number: GTX-2012-01-003

Mechanical Properties	Test Method	Unit	Minimum Average Roll Value	
			MD	CD
Grab Tensile Strength	ASTM D4632	lbs (N)	160 (712)	160 (712)
Grab Tensile Elongation	ASTM D4632	%	50	50
Trapezoid Tear Strength	ASTM D4533	lbs (N)	60 (267)	60 (267)
CBR Puncture Strength	ASTM D6241	lbs (N)	410 (1825)	
Apparent Opening Size (AOS)[1]	ASTM D4751	U.S. Sieve (mm)	70 (0.212)	
Permittivity	ASTM D4491	sec^{-1}	1.5	
Flow Rate	ASTM D4491	$gal/min/ft^2$ ($l/min/m^2$)	110 (4481)	
UV Resistance (at 500 hours)	ASTM D4355	% strength retained	70	

[1] ASTM D4751: AOS is a Maximum Opening Diameter Value

Physical Properties	Unit	Typical Value
Roll Dimensions (width x length)	ft (m)	15 x 300 (4.5 x 91)
Roll Area	yd^2 (m^2)	500 (418)
Estimated Roll Weight	lb (kg)	215 (97)

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Made in USA

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FGS000361
ETQR70

GAI-LAP-25-97

Testing Lab 1291.01 & 1291.02

TENCATE
Mirafi®

Mirafi® HP570

Mirafi® HP570 geotextile is composed of high-tenacity polypropylene yarns, which are woven into a network such that the yarns retain their relative position. Mirafi® HP570 geotextile is inert to biological degradation and resistant to naturally encountered chemicals, alkalis, and acids.

Mechanical Properties	Test Method	Unit	Minimum Average Roll Value	
			MD	CD
Tensile Strength (at ultimate)	ASTM D4595	lbs/ft (kN/m)	4800 (70.0)	4800 (70.0)
Tensile Strength (at 2% strain)	ASTM D4595	lbs/ft (kN/m)	960 (14.0)	1320 (19.3)
Tensile Strength (at 5% strain)	ASTM D4595	lbs/ft (kN/m)	2400 (35.0)	2700 (39.4)
Tensile Strength (at 10% strain)	ASTM D4595	lbs/ft (kN/m)	4800 (70.0)	4800 (70.0)
Factory Seam Strength	ASTM D4884	lbs/ft (kN/m)	3000 (43.8)	
Flow Rate	ASTM D4491	gal/min/ft^2 (l/min/m^2)	30 (1222)	
Permeability	ASTM D4491	cm/sec	0.05	
Permittivity	ASTM D4491	sec^{-1}	0.40	
Apparent Opening Size (AOS)[1]	ASTM D4751	U.S. Sieve (mm)	30 (0.60)	
UV Resistance (at 500 hours)	ASTM D4355	% strength retained	80	

[1] ASTM D4751: AOS is a Maximum Opening Diameter Value
NOTE: To obtain Secant Modulus, divide tensile strength by the appropriate strain level
(i.e. Secant Modulus at 5% = 2400/0.05 = 48000 lb/ft)

Filtration Properties	Test Method	Unit	Typical Value
Pore Size Distribution (O_{50})	ASTM D6767	micron	255
Pore Size Distribution (O_{95})	ASTM D6767	micron	385

Physical Properties	Unit	Typical Value
Roll Dimensions (length x width)	ft (m)	15 x 300 (4.5 x 91)
Roll Area	yd^2 (m^2)	500 (418)

TENCATE™
materials that make a difference

SPECTRA®

ROADWAY IMPROVEMENT SYSTEM

INSTALLATION GUIDE

Tensar®
INTERNATIONAL

The Spectra® System incorporates a mechanically stabilized base or subbase layer that offers a predictable, cost-effective solution.

Tensar® Geogrids

The **Spectra System** owes its strength and durability to **TriAx**,® Tensar's patented reinforcement geogrids. With its unique triangular structure, **Tensar® TriAx® Geogrid** represents an advancement in geogrid technology. Its multi-directional properties leverage the triangular geometry to provide in-plane stiffness through 360°.

Introduction

When weak subgrade, heavy loads, thick fill layers, high structural fill costs, contaminated subgrades or shallow utilities disrupt your construction schedule or budget, the Spectra® Roadway Improvement System can provide an optimal solution. The Spectra System includes mechanically stabilized layers (MSL) utilizing one or more layers of Tensar TriAx Geogrid. The purpose of this Installation Guide is to provide guidance for the installation of the MSL incorporating Tensar TriAx Geogrid.

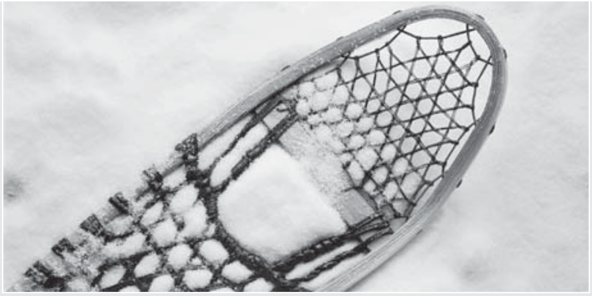
Not only does this system allow access and construction for less than ideal situations, it also offers a predictable engineered solution. This solution relies on Tensar® TriAx® (TX) Geogrids and granular fill acting together to create a stronger composite structure. The mechanically stabilized layer increases the performance of both paved and unpaved road structures.

Tensar TriAx Geogrids have proven their performance and cost-efficiency in thousands of applications. Over soft ground, Tensar TriAx Geogrids improve the soil's effective bearing capacity by distributing applied loads more efficiently, similar to the way a snowshoe supports a man's weight over soft snow. Tensar TriAx Geogrids interlock and stiffen triangular fill materials by confining granular particles within the triangular apertures, thus yielding a stronger component for increased serviceability and durability.

The long-term performance of both paved and unpaved applications are predetermined by ground or foundation support. Proper geogrid installation is also based on subgrade strength. We use California Bearing Ratio (CBR) to quantify this important variable and correlate most measures of soil subgrade support values (such as R-value, SPT data, k-value, M_r, and C_u) to CBR.

Tensar TriAx Geogrids are used to minimize aggregate fill requirements, reduce or eliminate undercut, improve compaction, serve as a construction platform and extend service life. These features depend upon the proper installation procedures presented in this guide.*

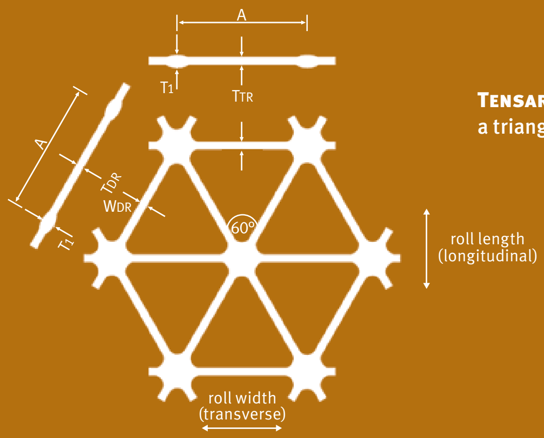
*This guide cannot account for every possible construction scenario, but it does cover most applications of the Spectra System. If you have questions regarding a specific project, call 800-TENSAR-1 or visit www.tensar-international.com.



The Snowshoe Effect – Tensar TriAx Geogrids distribute heavy loads over soft soils just like a snowshoe supports the weight of a man over soft snow.

Spectra® System Components

COMPONENT	FUNCTION
Tensar TriAx Geogrids	Stiff geosynthetic reinforcement
Design	Roadway sections developed using the latest design technology
Site Assistance	Expert Tensar personnel available to visit the project site to ensure an expedited installation



Tensar® TriAx® Geogrids have a triangular aperture structure.

1. Getting Started

- When placing an order, communicate all pertinent project and/or application criteria, including certification requirements, if any, to your Tensar International Corporation (TIC) representative. It is normally advisable to schedule a pre-construction meeting with this representative and any other appropriate parties at this time.
- Upon delivery, check the Tensar® TriAx® Geogrid roll labels to verify that the intended product has been received. For instance, TX5 and TX7 Geogrids have a similar appearance, but different structural characteristics so their distinction is important. Inspect the geogrid to ensure it is free of any flaws or damage that may have occurred during shipping or handling. If variable roll widths are supplied, please confirm that the correct quantities have been delivered. Tensar TriAx Geogrid rolls are assigned distinct nomenclature to distinguish the roll width and length.*
- Store Tensar TriAx Geogrids in a manner that prevents excessive mud, wet concrete, epoxy or other deleterious materials from coming in contact with and affixing to the geogrid. Store geogrids above –20˚F (–29˚C) and avoid handling below 14˚F (–10˚C). Please contact TIC if project conditions require storing and handling beyond these recommended limits. Tensar TriAx Geogrids may be stored uncovered for up to six (6) months in direct exposure to sunlight without any loss of certifiable structural properties (contact TIC if longer exposure is anticipated). The geogrids may be stored vertically (rolls stood on end) or horizontally in stacks not exceeding four rolls high (Image 1).
- Anticipate potential issues and resolve them with TIC prior to construction. To contact the local TIC representative for your area, call 800-TENSAR-1.

Tensar® TriAx® Geogrid		
Product	**Roll Width**	**Roll Length**
Tensar TriAx TX5-475	13.1 ft (4 m)	246 ft (75 m)
Tensar TriAx TX7-450	13.1 ft (4 m)	164 ft (50 m)

*Additional roll characteristics can be found on page 9 of this guide under "Tensar TriAx Roll Characteristics."

Image 1 Storing the Tensar TriAx Geogrid rolls (horizontally).

Image 2 Rolling out Tensar® TriAx® Geogrid.

2. Site Preparation

- Clear, grub and excavate (if necessary) to the design subgrade elevation, stripping topsoil, deleterious debris and unsuitable material from the site. For very soft soils (CBR < 0.5), it may be beneficial to minimize subgrade disturbance and leave root mats in place. Cut stumps and other projecting vegetation as close and even to the ground surface as practical. For moderately competent soils (CBR > 2), it may be prudent to lightly proof roll the subgrade to locate unsuitable materials. When possible, backdrag to smooth out any ruts.
- Smooth grade and compact the soils using appropriate compaction equipment. Swampland, peat, muskeg or marshes may be difficult to smooth grade and/or compact. In these situations, create a surface that is as uniformly smooth as possible. Grade or crown the surface for positive drainage away from the construction zone.

Note: Routine construction procedures are normally recommended for site preparation. Special measures are rarely required to accommodate Tensar TriAx Geogrids.

- Place the rolls of Tensar® TriAx® Geogrid* in position, cut the roll tape and manually unroll the material over the prepared surface (Image 2). In unpaved applications, this surface will always be the subgrade. In paved applications, it may be the subgrade, the granular subbase or an elevation (ex., mid-depth) within the aggregate base course.
- Fine grained, non-cohesive soils such as silts present unique challenges, especially with the presence of excessive moisture. TIC recommends that a Tensar representative be contacted so that site conditions can be analyzed to ensure the geogrid performance is optimized.

*Tensar International Corporation manufactures several different types of geogrid. Selection and optimization depends on structural performance requirements, subgrade and fill parameters, economic considerations and local availability.

Summary of Tensar® TriAx® Geogrid Installation Parameters

Subgrade Strength	Clear All Vegetation?	Geogrid Orientation[3]	Geogrid Overlap[4]	Nylon Zip Ties?[1, 2]	Direct Traffic?[5]	Geotextile?[6]
CBR ≤ 0.5	N	T or L	3 ft	Y	N	Analysis Req'd
0.5 ≤ CBR ≤ 2	Usually	L	2–3 ft	N	N	Analysis Req'd
2 ≤ CBR ≤ 4	Y	L	1–2 ft	N	Limited	Analysis Req'd
4 ≤ CBR	Y	L	1 ft	N	N	N

Notes:
1. Summary is a generalized presentation; see text for specifics.
2. Y = Yes, normally required; N = No, not normally required.
3. Geogrid Orientation (roll axis in relation to traffic): T = Transverse, L = Longitudinal.
4. General Geogrid Overlap Rule: Overlap = 3 ft for CBR ≤ 1; Overlap = 1 ft for CBR ≥ 4; interpolate between.
5. Direct Traffic pertains only to conventional rubber-tired equipment.
6. Analysis Required = Geotextile required only if filtration criteria is not met by aggregate fill.

Table 1

Overlapping Tensar® TriAx® Geogrid in the field is quick and easy.

3. Placing and Overlapping Geogrid

- Unroll the geogrid in the direction of travel so that the long axis of the roll is parallel with channelized traffic patterns. For very soft subgrades (CBR < 0.5), unrolling geogrid transversely or perpendicular to the roadway embankment alignment, may be preferred, particularly if lateral spreading and separation of overlaps is a concern (Table 1).
- Overlap adjacent rolls along their sides and ends in accordance with Table 1.
- Overlap ("shingle") geogrids in the direction that the fill will be spread (Image 3) to avoid "peeling" of geogrid at overlaps by the advancing fill. To expedite the shingling process, consider placing rolls at the far end of the coverage area first, and work toward the near end from where the fill will be advanced. Weaker subgrades that are easily rutted with conventional construction traffic will require an end-dumping operation. Please refer to page 7 "Dumping and Spreading Aggregate Fill" for more information.
- Adjacent geogrid rolls are normally not connected to one another, particularly if fill is placed and spread as described herein (Table 1). A notable exception is over very soft subgrades (CBR < 0.5) where nylon cable ties (or "zip ties") can be effective in helping maintain overlap dimensions. These ties are not considered structural connections, but rather construction aids. In most applications their use is not required.
- Cut and overlap the geogrid to accommodate curves (Image 4). Cutting may be done with sharp shears (Image 5), a knife-like implement or handheld power (i.e., "cutoff") saws. Cut the geogrid to conform to manhole covers and other immovable protrusions such as vertical utilities.
- In some cases, especially on cooler days, Tensar® TriAx® Geogrid will exhibit "roll memory" where a few feet may roll back upon cutting or reaching the end of the roll. It is recommended that the installer take appropriate measures to ensure that the product lies flat during fill placement. This can be easily achieved by using sod staples, zip ties or simply adding a shovelful of fill to weigh down the product.
- **Safety Note**: The use of safety glasses and gloves is highly recommended when installing Tensar TriAx Geogrids.

Image 3 Tensar TriAx Geogrid should overlap in the direction of advancing fill.

Image 4 Placing Tensar TriAx Geogrid to accommodate curves.

Image 5 Cutting Tensar TriAx Geogrid is easily achieved.

4. Tensioning and Anchoring

Tensar® TriAx® Geogrids may be anchored in place to aid in maintaining product overlaps and alignment over the coverage area.

- Before fully unrolling the geogrid, anchor the beginning of the roll, in the center and at the corners, to the underlying surface.
- Anchor the geogrid with small piles of aggregate fill (Image 6), if necessary. Alternatively, sod staples or washers and pins may also be used by driving them into the subsoil through the apertures of the geogrid. This measure is rarely required unless a significant crown or sloping of the subgrade requires some mechanical anchoring to prevent lateral sliding of the product during fill placement.
- Unroll the geogrid. Align and pull it taut to remove wrinkles and laydown slack with hand tension, then secure in place as necessary. Because of the unique manufacturing process and roll sizes of Tensar TriAx Geogrid, maneuvering an unrolled sheet of geogrid is easily achieved. **Gloves should be worn while handling Tensar TriAx Geogrids.**
- Additional shoveled piles of aggregate fill may be required to hold the geogrid in place prior to placement of the aggregate fill along overlaps and the ends of rolls.
- When constructing over very soft soils (CBR < 1.0), it is critically important to maintain overlaps during placement of the fill material. The use of nylon zip ties placed every 5–10 ft is optional to maintain the overlap width recommended in Table 1.

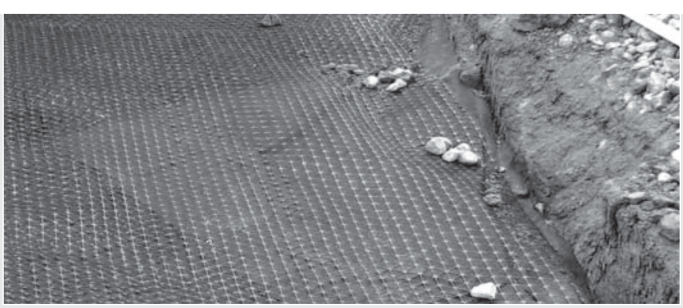


Image 6 Tensar TriAx Geogrid anchored with small piles of aggregate.

5. Dumping and Spreading Aggregate Fill

- Generally, at least 6 in. of compacted aggregate fill is required for the initial lift thickness over a Tensar® TriAx® Geogrid. However, for very soft conditions, a significantly thicker fill layer will be required to prevent excessive rutting and/or bearing capacity failure of the underlying subgrade soils.
- Over relatively competent subgrades (CBR › 4, see Table 1), aggregate fill may be dumped directly onto the geogrid. **Standard, highway-legal, rubber-tired trucks (end dumps and belly dumps) may drive over the geogrid at very slow speeds (less than 5 mph) and dump aggregate fill as they advance, provided this construction traffic will not cause significant rutting upon bare subgrade. Turns and sudden starts and stops should be avoided.**
- Over softer subgrades, back the trucks up and dump fill from the edge of the previously placed material (Image 7). For very soft subgrades (CBR ‹ 0.5), extreme caution should be taken to avoid overstressing the subgrade soil both during and after fill placement. Please contact a Tensar representative at 800-TENSAR-1 for guidance with constructing over very soft subgrade soils (CBR ‹ 0.5).
- Do not drive tracked equipment directly on a Tensar TriAx Geogrid. Ensure at least 6 in. of compacted aggregate fill (or the required minimum design fill thickness) is spread between the geogrid and any tracked equipment (Image 8).
- Over softer subgrades (CBR ‹ 1.5), a lightweight, low ground pressure (LGP) dozer is recommended to evenly push out the initial lift of fill over the exposed geogrid.
- Care should be taken not to catch the dozer blade or other equipment on the geogrid. The dozer blade should be raised gradually as each lift is pushed out over the geogrid. The desired effect is fill that cascades onto the geogrid, rather than being pushed into it.
- When building over a soft subgrade, it is desirable to work from stronger to weaker areas.
- Be aware of geogrid overlaps and advance the aggregate fill with the shingle pattern.

Note: When aggregate fill is spread by pushing it over the geogrid with heavy equipment, such as bulldozers, the shoving action may create a "wave" in the sheet of geogrid ahead of the advancing fill. Shoveled fill can trap this wave and force the geogrid up into the aggregate layer where it can be damaged by the spreading equipment. Pulling the geogrid taut will mitigate laydown slack, thereby removing "waving." If significant waving occurs, the shoveled material should be removed to allow the waves to dissipate at the ends and edges of the roll.

Image 7 End dumping aggregate fill on top of Tensar TriAx Geogrid over soft subgrade.

Image 8 Spreading aggregate fill over Tensar TriAx Geogrid.

Image 10 Compacting the aggregate fill.

6. Compacting

- Standard compaction methods may be used unless the soils are very soft. In these cases, static instead of vibratory compaction is prudent, particularly over fine-grained, non-cohesive soils such as silt. Compaction is then achieved using a light roller. Keeping the moisture content of the fill material near optimum will make compaction more efficient. Water spray is most effective with sand fill (see Image 9). For construction over very soft soils, compaction requirements are normally reduced for the initial lift as the primary intent of the initial lift is to achieve a suitable working surface.
- If rutting or severe pumping occurs under truck or dozer traffic, fill should be added immediately to strengthen the section. Saturated silty subgrades are particularly prone to pumping. In some cases, it may be prudent to cease operations for a period of time, allowing pore pressures to dissipate and the subgrade to stabilize. Otherwise, de-watering measures such as "bleeder ditches" should be considered to reduce the moisture content of the uppermost silty subgrade layer. Please contact a Tensar representative for more information.
- Compact aggregate fill to project specifications, after it has been graded smooth and before it is subject to accumulated traffic (Image 10). Inadequate compaction will result in surface rutting under wheel loads. Rutting reduces the total effective thickness of the fill and increases stress on the subgrade.*
- If the aggregate fill thickness is insufficient to support imposed load(s) when constructing over soft soil, excessive subgrade and surface rutting will result. Measures should be taken to ensure the proper thickness of granular fill is placed atop the geogrid to maximize support and minimize movement at the surface.

*__Note:__ Compaction equipment and methods should be appropriate for the type of fill being used, its thickness and the underlying subgrade conditions.

Image 9 Moistening the fill before compaction.

Tensar® TriAx® Geogrid Roll Characteristics

Product	Roll Width (m)	Roll Width (ft)	Roll Length (m)	Roll Length (ft)	Roll Area (m²)	Roll Area (SY)	Roll Weight (kg)	Roll Weight (lbs)
Tensar TriAx TX5-475	4	13.1	75	246	300	358.5	66.4	143
Tensar TriAx TX7-450	4	13.1	50	164	200	239	58.2	128

7. Special Considerations

Make Repairs

- If Tensar® TriAx® Geogrids become damaged during or after installation, repair them by patching the area with the following measures:
  1. Remove fill from the surface of the damaged geogrid and clear a 3-ft area around the damage.
  2. The geogrid patch should cover the damaged area and extend 3 ft beyond it in all directions.

Surface Rutting

- If deep rutting occurs beneath truck wheels, do not grade out the ruts. Rutting is normally indicative of fill that is too thin, too wet or inadequately compacted. Grading out the rut will reduce aggregate fill thickness between the wheel paths and may lead to geogrid exposure.
- Fill in the ruts with additional specified aggregate fill and compact. This places extra fill where it's needed and may prevent further rutting under channelized traffic.
- Crown the fill during the grading process to ensure rainfall runoff and to prevent fill saturation.

Cold Weather

- At sub-freezing temperatures, the polymer in a Tensar TriAx Geogrid becomes less resistant to impact and can be fractured by applying a dynamic force (i.e., striking with a hammer). Other aspects of dynamic loading associated with very cold temperatures should be avoided. Tensar Geogrids may be installed in extremely cold climates as long as proper storage and placement procedures are employed. For more information regarding the installation of geogrids in cold climates, please consult a Tensar representative at 800-TENSAR-1.

Aggregate Fill Considerations

- The preferred (not required) fill gradation for roadway applications is well-graded crushed aggregate fill with a maximum particle size of 1½ in. and less than 10% fines (passing #200 sieve). The gradation ranges listed below are recommended for the enhanced load distribution and positive drainage of flexible pavement applications where granular base courses are typically utilized. For unpaved applications, most clean granular fills, including sands, are acceptable.

Preferred Fill Gradation

Size	% Passing
1½ in.	100
¾ in.	50–100
#4	25–50
#40	10–20
#100	5–15
#200	less than 10

Image 12 A backhoe excavation through a Tensar TriAx Geogrid.

Excavating Through Tensar® TriAx® Geogrid

When confined beneath and within compacted fill, the geogrid should pose no significant challenges to post-construction activities like utility trenching or driving/auguring supports for rails, signs or standards. Conventional excavation equipment will shear directly through the geogrid leaving a clean cut as shown in Image 12

- Tensar® TriAx® Geogrids will structurally enhance coarser or finer fill gradations, as long as the aggregate fill is compacted and placed at, or just below, optimum moisture content. For coarser fill, a graded filter analysis is recommended to guard against potential contamination from the underlying subgrade (see Table 1 on pg. 4). If the aggregate fill does not meet the requirement(s) of a graded filter over soft and saturated clays and silts it is recommended that a sand filter layer be placed at a minimum depth of 6 in. on top of the geogrid layer. The sand fill thickness may need to be increased in the event the design fill thickness requires a thicker initial lift.
- The use of uniformly sized coarse granular fill is not recommended as it does not compact well and may rut under repeated wheel loading, despite the improved stability brought about by Tensar TriAx Geogrids.
- The moisture content of the fill should not exceed optimum. Wet granular fill is not easy to compact and may perform poorly under construction equipment wheel loading. The use of poor quality and/or overly wet fill material that is difficult to prepare and compact over a firm condition, even with Tensar TriAx Geogrid, is not recommended.

Preferred Equipment

- Soft Ground – the preferred equipment imposes low contact pressure on the ground surface. This may be done with smaller machinery and/or low ground pressure (LGP) vehicle. Equipment that concentrates heavy loads over a relatively small contact area such as front-end loaders, are not recommended. In all soft ground cases, the fill must be sufficiently thick to avoid overstressing the underlying soils and Tensar TriAx Geogrid.
- Firm Ground – the preferred equipment maximizes productivity for specific construction requirements. Over competent ground, geogrids can be trafficked directly by rubber-tired equipment, making hauling equipment (i.e., dump trucks) and spreading equipment (i.e., motor graders) ideal as shown in Image 11. Spreader boxes are not recommended – wrinkling in the geogrid between the screed and wheels of the box and dump trucks can cause slack to become trapped, raising the geogrid up into the aggregate layer.

Image 11 Tensar TriAx Geogrid can be trafficked directly by rubber-tired equipment.

8. SpectraPave4-Pro™ Software for Paved & Unpaved Applications

Tensar International Corporation breaks new ground with the 2010 release of our industry-leading SpectraPave4-Pro™ Software. This design aid allows the user to accurately predict the performance of geogrid reinforced and unreinforced roads with both paved and unpaved surfaces. The software offers application-specific modules for:

- Unpaved roads
- Paved roads
- Cost Analyses – Initial and Life Cycle

Unpaved Applications Module

Based on the Giroud-Han design methodology, the unpaved applications module incorporates an existing design method, which supports the use of certain geosynthetics, to reduce aggregate thickness requirements and improve the subgrade performance. It indicates the required thickness for unreinforced aggregate fill layers and aggregate fill layers reinforced with Tensar® TriAx® Geogrids.

Paved Applications Module

The SpectraPave4-Pro software includes a module for the design of Spectra System Solutions in paved road applications. This module incorporates the design methodology prescribed by AASHTO in their Pavement Design Guide (1993) and also their Interim Standard PP46-01 (2003). Tensar TriAx Geogrids can be used in an AASHTO design to extend the design life of a flexible pavement and/or reduce the thickness of the pavement layers.

Cost Analysis Tools

The cost analysis tools provide total in-place costs (and savings) for each design option. The results can be represented in dollars per unit area or as a lump sum giving you the flexibility to predict performance and economic benefits for a range of design scenarios. Additionally, the SpectraPave4-Pro software offers the flexibility to evaluate the long-term benefits of Tensar TriAx Geogrids for paved applications using the life cycle cost analysis tool.

SpectraPave-Pro software enables engineers to design a Spectra® System Solution for paved and unpaved roads. In early 2010, the software will be available free of charge following the completion of a short training module. To apply for training and your free software, visit us online at www.tensarcorp.com or call 800-TENSAR-1.

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