

CHAPTER VI

CONCLUSION AND RECOMMENDATION

6.1 Conclusion

Conclusions of this research are:

1. HDPE can be used as additive for Hot Rolled Sheet Wearing Course. Optimum asphalt content is 6.8% with 3% and 5% of HDPE content.
2. The influence of HDPE in the HRS WC mixture are :
 - a. Stability increases as HDPE increase. Stability also increases as percentage of asphalt increase.
 - b. VITM increases as HDPE increase. VITM decrease as percentage of asphalt increase.
 - c. MQ values increases as HDPE increase. MQ also increases as percentage of asphalt increase.
3. Other Marshall parameters decreased as the use of HDPE for additive are :
 - a. Flow decreases when increase HDPE amount in the mixture. Flow decrease as percentage of asphalt increase.
 - b. VFWA decreases as HDPE increase. VFWA increases as percentage of asphalt increase.
 - c. Density decreases as HDPE increase. Density increases as percentage of asphalt increase.

6.2 Recommendation

For better result, there are some recommendations for other researcher that want to continue or do similar research:

1. different asphalt penetration type can be used for similar research.
2. use smaller interval of HDPE amount, so can accurate the asphalt optimum content value.
3. different pavement mix design can be used for similar research
4. the measurement in the laboratory must be done accurately, and carefully because it will influence the result.

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APPENDIX



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ASPHALT PENETRATION TEST

PREPARATION		
Sample heated	Start at 09.15 Finish at 09.30	Temperature : 150 ⁰ C
Sample in the room Temperaturee	Start at 09.30 Finish at 10.00	Room temperature : 27 ⁰ C
Sample in 25 ⁰ C	Start at 10.00 Finish at 11.00	Penetration test Start at : 11.00 Finish at: 11.45

Penetration in 25 ⁰ C With 100 gram weight in 5 second	I	II	III
Observation : 1	58	58	65
2	59.5	65	68
3	64	65	67
4	65	66	78
5	69	61	71
Average	66	64,25	66,67
Total average	65,64		

Asphalt penetration type:

Asphalt type	PEN. 40		PEN. 60		PEN.80	
Requirment	Min.	Max.	Min.	Max.	Min.	Max.
	40	59	60	79	80	99

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ASPHALT PENETRATION AFTER LOSS WEIGHT

PREPARATION	
Sample heated Start at. 12.00 Finish at. 12.30	Temperature asphalt : 150 ° C
Sample in the Start at. 12.30 Room temperature Finish at. 13.00	Room temperature : 27° C
Sample Start at. 15.00 In the 25 ° C Finish at. 16.00	Penetration test Start at. 16.00 Finish at. 16.40

Penetration in 25° C With 100 gram weight in 5 second	I	II	III
Observation: 1	62	56	62
2	64	64	65
3	65	67	67
4	49	69	68
5	66	62	76
Average	61.2	63.6	67.6
Total average	64.1		

Asphalt penetration test:

Asphalt type	PEN. 40		PEN. 60		PEN. 80	
Requirment	Min.	Max.	Min.	Max.	Min.	Max.
	40	59	60	79	80	99

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ASPHALT LOSS WEIGHT TEST

PREPARATION		
Sample heated	Start at 09.15 Finish at 09.30	Temperature : 150 ⁰ C
Sample in the room temperature	Start at 09.30 Finish at 10.00	Room temperature : 27 ⁰ C

TEST				
Loss weight in the oven with temperature 163 ⁰ C		Start at : 11.00 Finish at: 16.00		
Tin box no.		I	II	III
Tin box weight	(A)	7,811	10,354	9,686
Tin box + sample weight	(B)	54,051	57,170	51,45
Sample weight	(C)=(B)-(A)	46,24	46,816	41,76
Tin box + sample weight after heated	(D)	54,010	57,168	51,45
Sample weight after heated	(E)=(D)-(A)	46,229	46,814	41,76
Loss weight	(F)=(C)-(E)	0,011	0,002	0
% loss : $\frac{(F)}{(C)} \times 100\%$		0,0237 9	0,0042 72	0
Average		0,009354		

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SOLUBABILITY OF ASPHALT IN THE CCL₄

PREPARATION		
Sample heated	Start at 09.15 Finish at 09.30	Temperature : 150 ⁰ C
Sample weight measurement	Start at 12.00 Finish at 12.15	Room temperature : 27 ⁰ C
Filtering process	Start at 12.15 Finish at 14.00	Room temperature : 27 ⁰ C
Dry process	Start at 14.00 Finish at 14.15	Temperature : 110 ⁰ C

TEST			
A	Erlenmeyer number	I	
B	Erlenmeyer weight	331,989	gram
C	Erlenmeyer + asphalt weight	333,024	gram
D	Asphalt weight (C – B)	1,035	gram
E	Cone sieve weight	1,022	gram
F	Cone sieve weight after test	1,084	gram
G	Asphalt weight	0,062	gram
H	% weight : $\frac{(G)}{(D)} \times 100\%$	0,3255	%
J	Asphalt solubility = 100 – (I)	99,6745 %	

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DUCTILITY TEST

PREPARATION		
Sample heated	Start at 09.15 Finish at 09.30	Temperature : 150 ⁰ C
In the room temperature	Start at 09.30 Finish at 10.00	Room temperature : 27 ⁰ C
Sample in 25 C	Start at 10.00 Finish at 11.00	Temperature : 25 ⁰ C

TEST		
Test	Start at 11.45 Finish at 11.50	
Ductility at 25 ⁰ C	Tools reading :	
Observation	>100 cm	>100 cm
average	>100 cm	

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FLASHING AND BURNING POINT OF ASPHALT TEST

OBSERVATION		
Sample heated	Start at 09.15 Finish at 09.30	Temperature : 150 ⁰ C
Start observe flashing point -56 ⁰ C	Start at 15.00 Finish at 15.20	Temperature : ⁰ C 15 ⁰ C/ minuets
(between 56 ⁰ C until 26 ⁰ C to the burning point)	Start at 15.20 Finish at 16.00	Temperature : ⁰ C 5 ⁰ C until 6 ⁰ C / minuets

TEST		
⁰ C Before flashing point	Time	Temperature ⁰ C
56	1'6"34	269
51	1'6"35	274
46	59"88	279
41	59"88	284
36	59"88	289
31	1'0"49	294
26	1'0"49	299
21	27"61	304
16	19"87	309
11	23"75	314
6	2'48"39	319
1	50"60	324

OBSERVATION	Temperature ⁰ C
Flashing point	325 ⁰ C
Burning point	331 ⁰ C

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ASPHALT SOFTENING POINT TEST

PREPARATION		
Sample heated	Start at 12.15 Finish at 12.30	Temperature : 150 ⁰ C
Keep in room temperature	Start at 12.30 Finish at 13.00	Temperatureroom : 27 ⁰ C
Sample in 25 ⁰ C	Start at 13.00 Finish at 14.00	Temperature : 25 ⁰ C

OBSERVATION				
No.	Temperature		Time (second)	
	⁰ C	⁰ F	I	II
1.	5	41	0	0
2.	10	50	1'0"89	1'0"89
3.	15	59	1'31"92	1'31"92
4.	20	68	1'11"0	1'11"0
5.	25	77	1'17"0	1'17"0
6.	30	89,6	1'27"0	1'27"0
7.	35	95	1'17"0	1'17"0
8.	40	104	1'05"	1'05"
9.	45	13	1'02"	1'02"
10.	50	122	59"46	59"46
11.	55	131		

Result	Time (sec)	Softening point (⁰ C)
Observation I	21'00"	51 ⁰ C
Observation II	9"22	51,5 ⁰ C
Average	51.25 ⁰ C	

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SPECIFIC WEIGHT OF ASPHALT TEST

PREPARATION		
Sample heated	Start at 09.15 Finish at 09.30	Temperature : 150 ⁰ C
In the room temperature	Start at 09.30 Finish at 10.00	Temperatureroom : 27 ⁰ C
Sample in 25 ⁰ C	Start at 10.00 Finish at 11.00	Temperature : 25 ⁰ C

TEST			
A	No. Picnometer	I	
B	Weight ofPicnometer	31,338	gram
C	Weight ofPicnometer+ asphalt	81,498	gram
D	Weight of water (C – B)	50,16	gram
E	Weight ofPicnometer+ asphalt	32,508	gram
F	Weight of asphalt(E – B)	1,17	gram
G	Weight ofPicnometer + asphalt + water	81,603	gram
H	Water weight (G – E)	49,095	gram
I	Weight of sample (D – H)	1,065	gram
J	Specific weight : $\frac{(F)}{(I)}$	1,0985 9	

Requirement:

Specific weight in the temperature 25⁰C: min = 1

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SOUND EQUIVALENT (SE) TEST

No.	Scale	Sample no.
		I
1.	Mud Scale	4,1
2.	SandScale	4
3.	$SE = \frac{(4)}{(2)} \times 100\%$	97,56%

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AGGREGATESOUNDNESS TEST

	Rough	Fine
Size (mm)		
Weight before test A(gram)	100	200
Weight after test B (gram)	100	200
% loss $C = \frac{A - B}{A} \times 100\%$	0	0
%resstrained = P	100	100
% loss weight $W = \frac{(C - P)}{A}$	0	0

Note	Rough aggregateEx : Fine aggregateEx :.....
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LOS ANGELES AGGREGATE TEST

SIEVE GRADATION		SAMPLE NUMBER
		I
PASS	RESTRAINED	WEIGHT
1/2"	3/8"	2500 gram
3/4"	1/2"	2500 gram

SAMPLE NUMBER	I
Weight before (A)	5000 gram
Weight after test by sieve No. 12 (B)	3868 gram
Weight after (A) – (B)	1132 gram
$LAA = \frac{(A) - (B)}{A} \times 100\%$	22,64 %

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SPECIFIC WEIGHT AND ABSORPTION OF ROUGH AGGREGATE

	TEST NUMBER	I
A	Dry weight	971
B	SSD weight	984
C	Wet weight	598
D	Bulk specific weight = $\frac{(A)}{(B)-(C)}$	2,515544
E	SSD specific weight = $\frac{(B)}{(B)-(C)}$	2,549223
F	Apparent specific weight = $\frac{(A)}{(A)-(C)}$	2,603217
G	Absorption = $\frac{(B)-(A)}{(A)} \times 100\%$	1,338826%
H	Specific weight = $\frac{(D)+(F)}{2}$	2,72945

Requirment :

- Absorption : 5%
- Specific weight : 2,3 – 2,6

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SPECIFIC WEIGHT AND ABSORPTION OF FINE AGGREGATE

	TEST NUMBER	I
A	(SSD) – (500)	500
B	Dry weight	492
C	Weight of Erlenmeyer + water, Temperature 25 ⁰ C	659
D	Weight of Erlenmeyer + sample (SSD) + water, Temperature 25 ⁰ C	960
E	Bulk specific weight = $\frac{(A)}{(C + 500 - D)}$	2,5126
F	(SSD) specific weight = $\frac{(B)}{(C + 500 - D)}$	2,4724
G	(Aparent) apparent specific weight = $\frac{(B)}{(C + B - D)}$	2,5759
H	Absorption = $\frac{(500 - B)}{(B)} \times 100\%$	1,6260

Requirement :

- Absorption : 5%
- Specific weight :

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ASPHALT VISCOSITY TO THE AGGREGATE TEST

Viscosity 100gr, 3hours	% from surface
Observation I	97%
average	97%

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Sieve		% pass		% restrained	amount	
No.	(mm)	range	Ideal Spec		% restrained	Gram
¾"	19	100	100	0	0	0
½"	12,5	90 – 100	95	5	5	60
3/8"	9,5	75 – 85	80	20	15	180
No.8	2,36	50 – 72	61	39	19	228
No.30	0,6	35 – 60	47,5	52,5	13,5	162
No.200	0,075	6 – 10	8	92	39,5	474
Pan (filler)		0	0	100	8	96
Total amount					100	1200

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Calibration Proving Ring Capacity 6000 LBF

1 LBF = 0,453 kg

Ideal	Calibration tools indicator (LBF)	Calibration tools indicator (kg)
0	-	-
100	985,2	446,2956
150	1474,4	668,8092
200	1968,3	891,6399
250	2457,3	1113,1596
300	2928,8	1326,7464
350	3377,7	1530,0981
400	3840,7	1739,8371
450	4312,3	1953,4719
500	4781,9	2166,2007
550	5239,0	2373,6700
600	5691,3	2578,1589
650	6160,5	2790,7065



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Correlation Value

Volume (cm ³)	Sample		Correlation Value
	inch	mm	
200 – 213	1	25,4	5,56
214 – 225	1 1/6	27,0	5,00
226 – 237	1 1/8	28,6	4,55
238 – 250	1 3/16	30,2	4,17
251 – 264	1 ¼	31,8	3,85
265 – 276	1 5/16	33,3	3,57
277 – 289	1 3/8	34,9	3,33
190 – 301	1 7/16	36,5	3,03
302 – 316	1 ½	38,1	2,78
317 – 328	1 9/16	39,7	2,50
329 – 340	1 5/8	41,3	2,27
341 – 353	1 11/16	42,9	2,08
354 – 367	1 ¾	44,4	1,92
368 – 379	1 13/16	46,0	1,79
380 – 392	1 7/8	47,6	1,67
393 – 405	1 15/16	49,2	1,56
406 – 420	2	50,8	1,47
421 – 431	2 1/6	52,4	1,39
432 – 443	2 1/8	54,0	1,32
444 – 456	2 3/16	55,6	1,25
457 – 470	2 ¼	57,2	1,19
471 – 482	2 5/16	58,7	1,14
483 – 495	2 3/8	60,3	1,09
496 – 508	2 7/16	61,9	1,04
509 – 522	2 ½	63,5	1,00
523 – 535	2 9/16	64,0	0,96
536 – 546	2 5/8	65,1	0,93
547 – 559	2 11/16	66,7	0,89
560 – 573	2 ¾	68,3	0,86
574 – 585	2 13/16	71,4	0,83
586 – 598	2 7/8	73,0	0,81
599 – 620	2 15/16	74,6	0,78
611 – 625	3	76,2	0,76



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Date: 12 April 2011

No.	t (mm)	a (%)	b (%)	c (gr)	d (gr)	e (gr)	f (cc)	g ($\frac{g}{cc}$)	h ($\frac{g}{cc}$)	i (%)	j (%)	k (%)	l (%)	m (%)	n (%)	o	p	q (kg)	r (mm)
5A	72,1625	5,0000	4,7619	1227,0000	1229,0000	659,7000	569,3000	2,1553	2,3873	9,3422	80,9403	9,7175	19,0597	49,0154	9,7175	262,0000	1164,4148	1001,3967	340,0000
5B	73,805	5,0000	4,7619	1242,0000	1245,0000	673,0000	572,0000	2,1713	2,3873	9,4118	81,5431	9,0452	18,4569	50,9931	9,0452	230,0000	1024,5501	850,3766	280,0000
								2,1633						50,0042	9,3813			925,8867	340,0000
5,5A	71,8080	5,5000	5,2133	1245,0000	1248,0000	676,0000	572,0000	2,1766	2,3741	10,3288	81,3526	8,3186	18,6474	55,3899	8,3186	273,0000	1211,4081	1041,8110	360,0000
5,5B	71,3700	5,5000	5,2133	1254,0000	1257,0000	688,0000	569,0000	2,2039	2,3741	10,4583	82,3727	7,1690	17,6273	59,3301	7,1690	232,0000	1113,1569	957,3149	330,0000
								2,1902						57,3600	7,7438			1041,8110	345,0000
6,0A	71,3050	6,0000	5,6604	1246,0000	1247,0000	687,0000	560,0000	2,2250	2,3611	11,4641	82,7704	5,7655	17,2296	66,5371	5,7655	232,0000	1033,4108	888,7333	327,5000
6,0B	72,0825	6,0000	5,6604	1256,0000	1257,0000	694,0000	563,0000	2,2309	2,3611	11,4945	82,9901	5,5154	17,0099	67,5754	5,5154	238,0000	1059,9982	911,5985	230,0000
								2,2280						67,0562	5,6405			900,1659	327,5000
6,5A	71,3355	6,5000	6,1033	1264,0000	1266,0000	703,3000	562,7000	2,2463	2,3485	12,4795	83,1709	4,3496	16,8291	74,1544	4,3496	232,0000	1033,4108	888,7333	240,0000
6,5B	71,4950	6,5000	6,1033	1277,0000	1280,0000	712,5000	567,5000	2,2502	2,3485	12,5012	83,3156	4,1832	16,6844	74,9276	4,1832	275,0000	1219,9517	1049,1585	305,0000
								2,2483						74,5410	4,2664			968,9459	305,0000
7,0A	71,1900	7,0000	6,5421	1265,0000	1268,0000	707,0000	561,0000	2,2549	2,3360	13,4278	83,0988	3,4734	16,9012	79,4490	3,4734	261,0000	1160,1466	997,7261	302,5000
7,0B	71,9225	7,0000	6,5421	1278,0000	1281,0000	717,0000	564,0000	2,2660	2,3360	13,4937	83,5062	3,0001	16,4938	81,8106	3,0001	295,0000	1305,3875	1122,6333	220,0000
								2,2604						80,6298	3,2367			1060,1797	302,5000

Note :

a = Asphalt content

b = asphalt to the mixture

c = dry weight

d = SSD weight

e = Wet weight

f = volume of briquette = d - e

g = density = c/f

h =

$$100 \left(\frac{\% \text{aggregate}}{\text{aggregate specific weight}} + \left(\frac{\% \text{asphalt}}{\text{asphalt specific weight}} \right) \right)$$

$$i = \text{vol of asphalt} = \frac{b \times g}{\text{Asphalt specific weight}}$$

$$j = \text{vol of aggregate} = \frac{(100b) \times g}{\text{aggregate specific weight}}$$

$$k = \text{void content in the mix} = 100 - i - j$$

$$l = \text{void content in the aggregate} = 100 - j \text{ (VMA)}$$

$$m = \text{VFWA} = 100 \times (i/l) \text{ (VFWA)}$$

$$n = \text{VITM} = 100 - (100 \text{ g/h})$$

$$o = \text{stability values from tools}$$

$$p = o \times \text{calibration proving ring}$$

$$q = \text{stability} = p \times \text{thickness correction.}$$

$$r = \text{flow}$$

$$s = \text{marshall Quotient (kg/mm)}$$

$$t = \text{briquette thickness}$$

Known by,

Head of transportation laboratory

(Ir. JF. Soandrijanie Linggo, MT.)



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83

Work : Marshall test, HDPE 3%
By : Teofilo Jose Nurratri Soares /08 13 13112
Innocentius Arus Maheri
Viktor Decky Nortantio

Date: 12 April 2011

b (%)	c (gr)	d (gr)	e (gr)	f (cc)	g ($\frac{g}{cc}$)	h ($\frac{g}{cc}$)	i (%)	j (%)	k (%)	l (%)	m (%)	n (%)	o	p	q (kg)	r (mm)
4,7619	1235,0000	1238,0000	665,0000	573,0000	2,1553	2,3873	9,3424	80,9420	9,7156	19,0580	49,0207	9,7156	297,0000	1313,9310	1090,5627	160,0000
4,7619	1240,0000	1243,0000	670,0000	573,0000	2,1640	2,3873	9,3802	81,2697	9,3501	18,7303	50,0803	9,3501	187,0000	833,7039	691,9742	319,0000
					2,1597						49,5505	9,5329	242,0000		1090,5627	319,0000
5,2133	1257,0000	1261,0000	684,0000	577,0000	2,1785	2,3741	10,3379	81,4250	8,2371	18,5750	55,6551	8,2371	230,0000	1024,5500	850,3765	190,0000
5,2133	1253,0000	1256,0000	683,0000	573,0000	2,1867	2,3741	10,3770	81,7325	7,8905	18,2675	56,8057	7,8905	260,0000	1155,8748	936,2586	360,0000
					2,1826						56,2304	8,0638	245,0000		893,3175	360,0000
5,6604	1244,0000	1246,0000	674,0000	572,0000	2,1748	2,3611	11,2056	80,9039	7,8906	19,0961	58,6798	7,8906	310,0000	1367,4200	1134,9586	313,0000
5,6604	1253,0000	1254,0000	682,0000	572,0000	2,1906	2,3611	11,2866	81,4892	7,2242	18,5108	60,9732	7,2242	305,0000	1347,0800	1091,1348	230,0000
					2,1827						59,8265	7,5574			1113,0467	313,0000
6,1033	1296,0000	1299,0000	714,0000	597,0000	2,1709	2,3485	12,0603	80,3770	7,5627	19,6230	61,4601	7,5627	312,0000	1375,5500	1114,1955	295,0000
6,1033	1266,0000	1270,0000	695,5000	574,5000	2,2037	2,3485	12,2425	81,5915	6,1660	18,4085	66,5048	6,1660	322,0000	1416,2210	1147,1390	305,0000
					2,1873						63,9825	6,8643			1130,6673	300,0000
6,5421	1277,0000	1280,0000	706,5000	573,5000	2,2267	2,3360	13,2598	82,0587	4,6816	17,9413	73,9063	4,6816	290,0000	1284,0285	1065,7437	305,0000
6,5421	1281,0000	1284,0000	709,4000	574,6000	2,2294	2,3360	13,2758	82,1581	4,5660	17,8419	74,4083	4,5660	327,0000	1436,5600	1192,3448	70,0000
					2,2280						74,1573	4,6238			1129,0442	305,0000

NOTE :

a = Asphalt content

b = asphalt to the mixture

c = dry weight

d = SSD weight

e = Wet weight

f = volume of briquette = $d - e$

g = density = c/f

h =

$$\left[100 \left(\frac{\% \text{ aggregate}}{\text{aggregate specific weight}} \right) + \left(\frac{\% \text{ asphalt}}{\text{asphalt specific weight}} \right) \right]$$

$$i = \text{vol of asphalt} = \left[\frac{bxg}{\text{Asphalt specific weight}} \right]$$

$$j = \text{vol of aggregate} = \left[\frac{(100b)bxg}{\text{aggregate specific weight}} \right]$$

k = void content in the mix = $100 - i - j$

l = void content in the aggregate = $100 - j$ (VMA)

m = VFWA = $100 \times (i/l)$ (VFWA)

n = VITM = $100 - (100 g/h)$

o = stability values from tools

p = o x calibration proving ring

q = stability = p x thickness correction.

r = flow

s = marshall Quotient (kg/mm)

t = briquette thickness

Known by,

Head of transportation laboratory

(Ir. JF. Soandrijanie Linggo, MT.)



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84

Work : Marshall test, HDPE 5%
By : Teofilo Jose Nurratri Soares /08 13 13112
Innocentius Arus Maheri
Viktor Decky Nortantio

Date: 12 April 2011

No.	t (mm)	a (%)	b (%)	c (gr)	d (gr)	e (gr)	f(cc)	g ($\frac{g}{cc}$)	h ($\frac{g}{cc}$)	i (%)	j (%)	k (%)	l (%)	m (%)	n (%)	o	p	q (kg)	r (mm)
5A	72,24	5,0000	4,7619	1244,0000	1245,0000	664,0000	581,0000	2,1411	2,3873	9,2809	80,4092	10,3099	19,5908	47,3737	10,3099	170,0000	757,9415	629,0914	298,0000
5B	72,808	5,0000	4,7619	1245,0000	1246,0000	676,0000	570,0000	2,1842	2,3873	9,4676	82,0268	8,5056	17,9732	52,6763	8,5056	340,0000	1489,4300	1236,2269	296,0000
								2,1627						50,0250	9,4077			1236,2690	297,0000
5,5A	71,6630	5,5000	5,2133	1246,0000	1248,0000	678,0000	570,0000	2,1860	2,3741	10,3733	81,7037	7,9230	18,2963	56,6961	7,9230	220,0000	980,2470	843,0124	335,0000
5,5B	74,2080	5,5000	5,2133	1248,0000	1250,0000	666,0000	584,0000	2,1370	2,3741	10,1409	79,8730	9,9861	20,1270	50,3846	9,9861	361,0000	1576,2407	1308,2798	327,0000
								2,1615						53,5403	8,9546			1075,6461	331,0000
6,0A	72,7900	6,0000	5,6604	1255,0000	1257,0000	680,0000	577,0000	2,1750	2,3611	11,2067	80,9120	7,8813	19,0880	58,7106	7,8813	320,0000	1408,0900	1210,9574	250,0000
6,0B	72,3350	6,0000	5,6604	1250,0000	1253,0000	678,0000	575,0000	2,1739	2,3611	11,2009	80,8699	7,9292	19,1301	58,5511	7,9292	275,0000	1223,9500	1015,8785	312,0000
								2,1745						58,6309	7,9053			1113,4180	312,0000
6,5A	72,9650	6,5000	6,1033	1263,0000	1264,0000	690,0000	574,0000	2,2003	2,3485	12,2242	81,4690	6,3068	18,5310	65,9662	6,3068	358,0000	1563,6563	1297,8347	110,0000
6,5B	72,9990	6,5000	6,1033	1259,0000	1260,0000	684,0000	576,0000	2,1858	2,3485	12,1431	80,9290	6,9278	19,0710	63,6735	6,9278	245,0000	1091,0100	905,5383	305,0000
								2,1931						64,8199	6,6173			1101,6865	305,0000
7,0A	72,6200	7,0000	6,5421	1272,0000	1273,0000	700,0000	573,0000	2,2199	2,3360	13,2194	81,8087	4,9719	18,1913	72,6687	4,9719	364,0000	1588,8250	1366,3895	299,0000
7,0B	74,0230	7,0000	6,5421	1274,0000	1275,0000	701,0000	574,0000	2,2195	2,3360	13,2171	81,7946	4,9883	18,2054	72,5998	4,9883	294,0000	1301,1157	1079,9260	297,0000
								2,2197						72,6342	4,9801			1223,1578	299,0000

Note :

a = Asphalt content

b = asphalt to the mixture

c = dry weight

d = SSD weight

e = Wet weight

f = volume of briquette = d - e

g = density = c/f

h =

$$100 \left(\frac{\% \text{ aggregate}}{\text{aggregate specific weight}} + \left(\frac{\% \text{ asphalt}}{\text{asphalt specific weight}} \right) \right)$$

$$i = \text{vol of asphalt} = \left[\frac{b \times g}{\text{Asphalt specific weight}} \right]$$

$$j = \text{vol of aggregate} = \left[\frac{(100b) \times g}{\text{aggregate specific weight}} \right]$$

k = void content in the mix = 100 - i - j

l = void content in the aggregate = 100 - j (VMA)

m = VFWA = 100 x (i/l) (VFWA)

n = VITM = 100 - (100 g/h)

o = stability values from tools

p = o x calibration proving ring

q = stability = p x thickness correction.

r = flow

s = marshall Quotient (kg/mm)

t = briquette thickness

Known by,

Head of transportation laboratory

(Ir. JF. Soandrijanie Linggo, MT.)



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85

Work : Marshall test, HDPE 7%
By : Teofilo Jose Nurratri Soares /08 13 13112
Innocentius Arus Maheri
Viktor Decky Nortantio

Date: 12 April 2011

No.	t (mm)	a (%)	b (%)	c (gr)	d (gr)	e (gr)	f (cc)	g ($\frac{g}{cc}$)	h ($\frac{g}{cc}$)	i (%)	j (%)	k (%)	l (%)	m (%)	n (%)	o	p	q (kg)	r (mm)
5A	73,51	5,0000	4,7619	1258,0000	1261,0000	679,5000	581,5000	2,1634	2,3873	9,3773	81,2442	9,3785	18,7558	49,9966	9,3785	340,0000	1489,4278	1280,9079	300,0000
5B	72,7325	5,0000	4,7619	1259,0000	1260,0000	677,0000	583,0000	2,1595	2,3873	9,3606	81,0996	9,5398	18,9004	49,5257	9,5398	337,0000	1477,2267	1196,5536	290,0000
								2,1614						49,7612	9,4592			1238,7308	295,0000
5,5A	73,8625	5,5000	5,2133	1256,0000	1259,0000	680,5000	578,5000	2,1711	2,3741	10,3029	81,1493	8,5478	18,8507	54,6553	8,5478	310,0000	1367,4167	1134,9559	324,0000
5,5B	74,7600	5,5000	5,2133	1264,0000	1268,0000	681,5000	586,5000	2,1552	2,3741	10,2271	80,5522	9,2207	19,4478	52,5875	9,2207	305,0000	1347,0816	1158,4902	322,0000
								2,1631						53,6214	8,8842			1146,7230	323,0000
6,0A	74,4675	6,0000	5,6604	1265,0000	1269,0000	684,0000	585,0000	2,1624	2,3611	11,1415	80,4414	8,4171	19,5586	56,9648	8,4171	315,0000	1387,7519	1151,8341	308,0000
6,0B	75,6075	6,0000	5,6604	1271,0000	1275,0000	689,1500	585,8500	2,1695	2,3611	11,1781	80,7057	8,1162	19,2943	57,9347	8,1162	203,0000	904,9309	778,2406	320,0000
								2,1659						57,4497	8,2667			1151,8341	314,0000
6,5A	75,4600	6,5000	6,1033	1279,0000	1282,0000	695,5000	586,5000	2,1807	2,3485	12,1152	80,7428	7,1420	19,2572	62,9125	7,1420	330,0000	1448,7574	1202,4687	310,0000
6,5B	74,1650	6,5000	6,1033	1268,0000	1272,0000	685,0000	587,0000	2,1601	2,3485	12,0008	79,9802	8,0191	20,0198	59,9444	8,0191	311,0000	1371,4838	1138,3315	278,0000
								2,1704						68,2621	7,5805			1170,4001	294,0000
7,0A	72,4450	7,0000	6,5421	1282,0000	1285,0000	708,1000	576,9000	2,2222	2,3360	13,2332	81,8944	4,8723	18,1056	73,0894	4,8723	190,0000	847,0738	728,4835	300,0000
7,0B	73,2480	7,0000	6,5421	1291,0000	1294,0000	712,0000	582,0000	2,2182	2,3360	13,2094	81,7467	5,0439	18,2533	72,3670	5,0439	343,0000	1501,6289	1246,3520	293,0000
								2,2202						72,7282	4,9581			1246,3520	296,5000

Note :

a = Asphalt content
b = asphalt to the mixture
c = dry weight
d = SSD weight
e = Wet weight
f = volume of briquette = d - e
g = density = c/f
h =

$$100 \left(\frac{\% \text{ aggregate}}{\text{aggregate specific weight}} + \left(\frac{\% \text{ asphalt}}{\text{asphalt specific weight}} \right) \right)$$

$$i = \text{vol of asphalt} = \frac{b \times g}{\text{Asphalt specific weight}}$$

$$j = \text{vol of aggregate} = \frac{(100b) \times g}{\text{aggregate specific weight}}$$

$$k = \text{void content in the mix} = 100 - i - j$$

$$l = \text{void content in the aggregate} = 100 - j \text{ (VMA)}$$

$$m = \text{VFWA} = 100 \times (i/l) \text{ (VFWA)}$$

$$n = \text{VITM} = 100 - (100 \text{ g/h})$$

$$o = \text{stability values from tools}$$

$$p = o \times \text{calibration proving ring}$$

$$q = \text{stability} = p \times \text{thickness correction.}$$

$$r = \text{flow}$$

$$s = \text{marshall Quotient (kg/mm)}$$

$$t = \text{briquette thickness}$$

Known by,

Head of transportation laboratory

(Ir. JF. Soandrijanie Linggo, MT.)



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86

Work : Marshall test, HDPE 9%
By : Teofilo Jose Nurratri Soares /08 13 13112
Innocentius Arus Maheri
Viktor Decky Nortantio

Date: 12April 2011

No.	t (mm)	a (%)	b (%)	c (gr)	d (gr)	e (gr)	f (cc)	g ($\frac{g}{cc}$)	h ($\frac{g}{cc}$)	i (%)	j (%)	k (%)	l (%)	m (%)	n (%)	o	p	q (kg)	r (mm)
5A	73,923	5,0000	4,7619	1255,0000	1258,0000	674,0000	584,0000	2,1490	2,3873	9,3149	80,7035	9,9817	19,2965	48,2722	9,9817	358,0000	1563,6563	1297,8347	296,0000
5B	74,828	5,0000	4,7619	1260,0000	1264,0000	670,0000	594,0000	2,1212	2,3873	9,1945	79,6610	11,1445	20,3390	45,2063	11,1445	368,0000	1605,6041	1300,5393	299,0000
								2,1351						46,7392	10,5631			1299,1870	297,5000
5,5A	76,2150	5,5000	5,2133	1255,0000	1260,0000	675,0000	585,0000	2,1453	2,3741	10,1803	80,1837	9,6359	19,8163	51,3736	9,6359	334,0000	1465,0256	1215,9712	300,0000
5,5B	76,7800	5,5000	5,2133	1262,0000	1266,0000	674,0000	592,0000	2,1318	2,3741	10,1161	79,6775	10,2064	20,3225	49,7778	10,2064	336,0000	1473,1596	1149,0645	290,0000
								2,1385						50,5757	9,9212			1182,5179	300,0000
6,0A	75,6250	6,0000	5,6604	1266,0000	1270,0000	683,0000	587,0000	2,1567	2,3611	11,1123	80,2307	8,6570	19,7693	56,2100	8,6570	345,0000	1509,7629	1222,9080	370,0000
6,0B	75,1700	6,0000	5,6604	1277,0000	1279,0000	689,0000	590,0000	2,1644	2,3611	11,1519	80,5163	8,3318	19,4837	57,2370	8,3318	387,0000	1685,3050	1365,0971	300,0000
								2,1606						56,7235	8,4944			1294,0025	335,0000
6,5A	72,2700	6,5000	6,1033	1267,0000	1273,0000	687,0000	586,0000	2,1621	2,3485	12,0118	80,0535	7,9348	19,9465	60,2199	7,9348	332,0000	1456,8915	1252,9267	275,0000
6,5B	75,2250	6,5000	6,1033	1273,0000	1275,0000	690,0000	585,0000	2,1761	2,3485	12,0893	80,5701	7,3407	19,4299	62,2199	7,3407	370,0000	1613,9937	1339,6148	273,0000
								2,1691						61,2199	7,6377			1296,2707	274,0000
7,0A	75,1575	7,0000	6,5421	1272,0000	1274,0000	701,0000	573,0000	2,2199	2,3360	13,2194	81,8087	4,9719	18,1913	72,6687	4,9719	311,0000	1371,4838	1110,9019	282,0000
7,0B	75,7750	7,0000	6,5421	1274,0000	1275,0000	690,0000	585,0000	2,1778	2,3360	12,9686	80,2566	6,7749	19,7434	65,6855	6,7749	278,0000	1232,7670	998,5413	284,0000
								2,1988						69,1771	5,8734			1054,7216	283,0000

Note :

a = Asphaltcontent
b = asphalttothe mixture
c = dry weight
d = SSD weight
e = Wet weight
f = volume of briquette= d – e
g = density = c/f
h =

$$100 \left(\frac{\% \text{aggregate}}{\text{aggregate weight}} + \left(\frac{\% \text{asphalt}}{\text{asphalt weight}} \right) \right)$$

$$i = \text{vol of asphalt} = \left[\frac{b \times g}{\text{Asphalt weight}} \right]$$

$$j = \text{vol of aggregate.} = \left[\frac{(100b) \times g}{\text{aggregate weight}} \right]$$

k = void content in the mix = 100 – i – j
l = void content inthe aggregate = 100 – j (VMA)

$$m = \text{VFWA} = 100 \times (i/l) \text{ (VFWA)}$$

$$n = \text{VITM} = 100 - (100 \text{ g/h})$$

o = stailityvaluesfromtools

p = o x calibrationproving ring

q = stability = p x thicknesscorrection.

r = flow

s = marshall Quotient (kg/mm)

t = briquette thickness

Known by,

Head of transportation laboratory

(Ir. JF. SoandrijanieLinggo, MT.)



Figure A.1 Samples for asphalt test



Figure A.2 Heat aggregates in the oven before mixing with asphalt and HDPE



Figure A.3 Aggregate preparation



Figure A.4 Filler



Figure A.5 Hot mix process



Figure A.6 Pavement samples



Figure A.7 Weight measurement of sample



Figure A.8 Samples put in the water before measure the wet weight



Figure A.9 Mold, collar, and extruder hydraulic



Figure A.10 HDPE products