



**LABORATORIUM JALAN RAYA
UNIVERSITAS NEGERI YOGYAKARTA
FAKULTAS TEKNIK**

Alamat : Kampus Karangmalang, Yogyakarta 5521
Telp. (0274) 586168 psw. 276,289,292 (0274) 586734
Fax. (0274) 586734

Lampiran 1

Judul Pengujian : Pengujian Penetrasi

Tempat : Labortorium Jalan Raya JPTSP, Fakultas Teknik, UNY

Data Pengujian

Waktu Pengujian : Jumat, 25 Januari 2019

Suhu Ruang : 28°C

Cuaca : Cerah Berawan

Tabel 29. Data Hasil Pengujian Penetrasi

Benda Uji		Suhu	Beban	Waktu	Penetrasi	Rerata
Cawan 1	Titik 1	25°C	100 gr	5,30	62	62
	Titik 2	25°C	100 gr	5,18	63	
	Titik 3	25°C	100 gr	5,20	61	
Cawan 2	Titik 1	25°C	100 gr	5,26	64	65
	Titik 2	25°C	100 gr	5,29	64	
	Titik 3	25°C	100 gr	5,38	67	
Cawan 3	Titik 1	25°C	100 gr	5,23	68	65,6
	Titik 2	25°C	100 gr	5,38	67	
	Titik 3	25°C	100 gr	5,47	62	

Mengetahui,
Teknisi Laboratorium

Yogyakarta, 25 Februari 2019
Penguji

Kimin Triono S.Pd, T.

Diffa Nur Ilham



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Lampiran 2

Judul Pengujian : Pengujian Titik Lembek

Tempat : Labortorium Jalan Raya JPTSP, Fakultas Teknik, UNY

Data Pengujian

Waktu Pengujian : Jumat, 1 Februari 2019

Suhu Ruang : 28°C

Cuaca : Cerah Berawan

Tabel 30. Data Hasil Pengujian I Titik Lembek

Suhu	Waktu	Keterangan
5	00° 00' 00"	
10	00° 02' 46.2"	
15	00° 06' 21.8"	
20	00° 07' 22.3'	
25	00° 08' 23.4"	
30	00° 09' 12.4"	
35	00° 10' 02.0"	
40	00° 10' 19.2"	
45	00° 11' 02.3"	
50	00° 11' 45.1"	
55	00° 12' 25.4"	
58	00° 12' 27.5"	Bola Baja 1 Menyentuh Dasar
59	00° 12' 45.1"	Bola Baja 2 Menyentuh Dasar

Titik Lembek Percobaan 1

$$= \frac{58 + 59}{2}$$

$$= 58,5^{\circ}\text{C}$$

Tabel 31. Data Hasil Pengujian II Titik Lembek

Suhu	Waktu	Keterangan
5	00 ⁰ 00' 00"	
10	00 ⁰ 02' 15.3"	
15	00 ⁰ 02' 49.8"	
20	00 ⁰ 03' 49.2"	
25	00 ⁰ 04' 26.2"	
30	00 ⁰ 05' 02.2"	
35	00 ⁰ 05' 46.5"	
40	00 ⁰ 06' 33.4"	
45	00 ⁰ 07' 24.7"	
50	00 ⁰ 08' 08.5"	
55	00 ⁰ 08' 57.1"	
57	00 ⁰ 09' 13.1"	Bola Baja 1 Menyentuh Dasar
57	00 ⁰ 09' 16.9"	Bola Baja 2 Menyentuh Dasar

Titik Lembek Percobaan 2

$$= \frac{57 + 57}{2}$$

$$= 57^{\circ}\text{C}$$

Nilai rata-rata titik lembek

$$= \frac{58,5 + 57}{2}$$

$$= 57,75^{\circ}\text{C}$$

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Lampiran 3

Judul Pengujian : Pengujian Titik Nyala dan Bakar

Tempat : Labortorium Jalan Raya JPTSP, Fakultas Teknik, UNY

Data Pengujian

Waktu Pengujian : Senin, 28 Januari 2019

Suhu Ruang : 28°C

Cuaca : Cerah Berawan

Tabel 32. Data Hasil Pengujian Titik Nyala dan Bakar

Suhu	Waktu	Keterangan
70	00 ⁰ 00' 00"	
75	00 ⁰ 00' 20,06"	
80	00 ⁰ 00' 41,11"	
85	00 ⁰ 01' 46,39"	
90	00 ⁰ 05' 51,53"	
95	00 ⁰ 06' 29,06"	
100	00 ⁰ 06' 26,34"	
105	00 ⁰ 06' 29,70"	
110	00 ⁰ 06' 38,95"	
115	00 ⁰ 06' 47,02"	
120	00 ⁰ 06' 54,03"	
125	00 ⁰ 07' 03,27"	
130	00 ⁰ 07' 10,69"	
135	00 ⁰ 07' 17,64"	
140	00 ⁰ 07' 23,28"	
145	00 ⁰ 07' 31,01"	
150	00 ⁰ 07' 37,41"	
155	00 ⁰ 07' 42,19"	
160	00 ⁰ 07' 47,65"	
165	00 ⁰ 07' 56,76"	
170	00 ⁰ 08' 10,10"	
175	00 ⁰ 08' 20,13"	
180	00 ⁰ 08' 32,24"	
185	00 ⁰ 08' 46,63"	
190	00 ⁰ 09' 07,83"	

Tabel 32. Data Hasil Pengujian Titik Nyala dan Bakar (Lanjutan)

Suhu	Waktu	Keterangan
195	00 ⁰ 09' 25,14"	
200	00 ⁰ 10' 14,26"	
205	00 ⁰ 10' 51,83"	
210	00 ⁰ 11' 17,01"	
215	00 ⁰ 12' 04,63"	
220	00 ⁰ 12' 44,92"	
225	00 ⁰ 13' 20,32"	
230	00 ⁰ 14' 24,90"	
232	00 ⁰ 15' 08,35"	
234	00 ⁰ 15' 28,24"	Titik Nyala
236	00 ⁰ 15' 46,74"	
238	00 ⁰ 15' 58,91"	
240	00 ⁰ 16' 50,06"	
242	00 ⁰ 17' 44,15"	
244	00 ⁰ 18' 36,08"	
246	00 ⁰ 19' 09,07"	
248	00 ⁰ 19' 32,28"	
250	00 ⁰ 19' 50,74"	
252	00 ⁰ 21' 02,66"	
254	00 ⁰ 24' 42,01"	
256	00 ⁰ 24' 55,88"	
258	00 ⁰ 25' 05,11"	
260	00 ⁰ 25' 11,34"	
262	00 ⁰ 25' 21,90"	
264	00 ⁰ 25' 39,24"	
266	00 ⁰ 25' 45,11"	
268	00 ⁰ 25' 48,17"	
270	00 ⁰ 25' 51,27"	
272	00 ⁰ 26' 00,97"	
274	00 ⁰ 26' 14,82"	
276	00 ⁰ 26' 25,43"	
278	00 ⁰ 26' 36,20"	
280	00 ⁰ 26' 46,82"	
282	00 ⁰ 26' 56,13"	
284	00 ⁰ 27' 22,28"	
286	00 ⁰ 27' 29,69"	
288	00 ⁰ 27' 42,13"	
290	00 ⁰ 27' 57,03"	
292	00 ⁰ 28' 05,46"	
294	00 ⁰ 28' 13,07"	
296	00 ⁰ 28' 23,44"	
298	00 ⁰ 28' 46,78"	

Tabel 32. Data Hasil Pengujian Titik Nyala dan Bakar (Lanjutan)

Suhu	Waktu	Keterangan
300	00 ⁰ 29' 03,21"	
302	00 ⁰ 29' 32,62"	
304	00 ⁰ 29' 41,59"	
306	00 ⁰ 30' 12,39"	
308	00 ⁰ 30' 28,41"	
310	00 ⁰ 30' 52,46"	
312	00 ⁰ 31' 15,73"	
314	00 ⁰ 31' 45,41"	
316	00 ⁰ 32' 08,12"	
318	00 ⁰ 32' 26,28"	
320	00 ⁰ 32' 24,70"	Titik Bakar

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Lampiran 4

Judul Pengujian : Pengujian Berat Jenis Agregat Kasar

Tempat : Labortorium Jalan Raya JPTSP, Fakultas Teknik, UNY

Data Pengujian

Waktu Pengujian : Senin, 28 Januari 2019

Suhu Ruang : 28°C

Cuaca : Cerah Berawan

Tabel 33. Data Hasil Pengujian Berat Jenis Agregat Kasar

Notasi	Percobaan 1	Percobaan 2
Berat Kering Oven (A)	1.456 gram	1.462 gram
Berat Jenuh Kering Permukaan (SSD) (B)	1.500 gram	1.500 gram
Berat Dalam Air (C)	922 gram	903gram

Perhitunga percobaan 1 :

$$\begin{aligned} Sd &= \frac{A}{(B - C)} \\ &= \frac{1456}{(1500 - 922)} \\ &= 2.519 \end{aligned}$$

$$\begin{aligned} Ss &= \frac{B}{(B - C)} \\ &= \frac{1500}{(1500 - 922)} \\ &= 2.595 \end{aligned}$$

$$\begin{aligned}
 Sa &= \frac{A}{(A - C)} \\
 &= \frac{1456}{(1456 - 922)} \\
 &= 2.726
 \end{aligned}$$

$$\begin{aligned}
 Sw &= \left(\frac{B - A}{A} \right) \times 100 \% \\
 &= \left(\frac{1500 - 1456}{1456} \right) \times 100 \% \\
 &= 3.0219 \%
 \end{aligned}$$

Perhitungan percobaan 2 :

$$\begin{aligned}
 Sd &= \frac{A}{(B - C)} \\
 &= \frac{1462}{(1500 - 903)} \\
 &= 2.448
 \end{aligned}$$

$$\begin{aligned}
 Ss &= \frac{B}{(B - C)} \\
 &= \frac{1500}{(1500 - 903)} \\
 &= 2.512
 \end{aligned}$$

$$\begin{aligned}
 Sa &= \frac{A}{(A - C)} \\
 &= \frac{1462}{(1462 - 903)} \\
 &= 2.615
 \end{aligned}$$

$$\begin{aligned}
 S_w &= \left(\frac{B - A}{A} \right) \times 100 \% \\
 &= \left(\frac{1500 - 1462}{1462} \right) \times 100 \% \\
 &= 2.599 \%
 \end{aligned}$$

Tabel 34. Hasil Pengujian Berat Jenis Agregat Kasar

Nilai	Percobaan		Rerata
	1	2	
Sd	2.519	2.448	2.483
Ss	2.595	2.512	2.553
Sa	2.726	2.599	2.662
Sw	3.021	2.599	2.810

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Lampiran 5

Judul Pengujian : Pengujian Berat Jenis Agregat Halus

Tempat : Labortorium Jalan Raya JPTSP, Fakultas Teknik, UNY

Data Pengujian

Waktu Pengujian : Senin, 28 Januari 2019

Suhu Ruang : 28°C

Cuaca : Cerah Berawan

Tabel 35. Data Hasil Pengujian Berat Jenis Agregat Halus

Notasi	Percobaan 1	Percobaan 2
Berat Kering Oven (A)	196	195
Berat Picnometer + Air (B)	666	664
Berat Picnometer + Air + Pasir (C)	790	789
Berat Pasir SSD (S)	200	200

Sd = Berat Jenis Curah Kering

Ss = Berat Jenis Curah/Kondisi Jenuh

Sa = Berat Jenis Semu

Sw = Penyerapan air

Perhitungan percobaan 1 :

$$\begin{aligned}sd &= \frac{A}{(B + S - C)} \\&= \frac{196}{(666 + 200 - 790)} \\&= 2.578\end{aligned}$$

$$\begin{aligned}
 ss &= \frac{S}{(B + S - C)} \\
 &= \frac{200}{(666 + 200 - 790)} \\
 &= 2.631
 \end{aligned}$$

$$\begin{aligned}
 sa &= \frac{A}{(B + A - C)} \\
 &= \frac{196}{(666 + 196 - 790)} \\
 &= 2.722
 \end{aligned}$$

$$\begin{aligned}
 Sw &= \left(\frac{S - A}{A} \right) \times 100 \% \\
 &= \left(\frac{200 - 196}{196} \right) \times 100 \% \\
 &= 2.0408 \%
 \end{aligned}$$

Perhitungan percobaan 2 :

$$\begin{aligned}
 sd &= \frac{A}{(B + S - C)} \\
 &= \frac{195}{(664 + 200 - 789)} \\
 &= 2.6
 \end{aligned}$$

$$ss = \frac{S}{(B + S - C)}$$

$$= \frac{200}{(664 + 200 - 789)}$$

$$= 2.631$$

$$sa = \frac{A}{(B + A - C)}$$

$$= \frac{195}{(664 + 195 - 789)}$$

$$= 2.785$$

$$Sw = \left(\frac{S - A}{A} \right) \times 100 \%$$

$$= \left(\frac{200 - 195}{195} \right) \times 100 \%$$

$$= 2.564 \%$$

Tabel 36. Hasil Pengujian Berat Jenis Agregat Halus

Nilai	Percobaan		Rerata
	1	2	
Sd	2.578	2.6	2.589
Ss	2.631	2.666	2.649
Sa	2.722	2.785	2.753
Sw	2.040	2.564	2.302

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Lampiran 6

Judul Pengujian : Pengujian Berat Jenis Aspal

Tempat : Labortorium Jalan Raya JPTSP, Fakultas Teknik, UNY

Data Pengujian

Waktu Pengujian : Senin, 28 Januari 2019

Suhu Ruang : 28°C

Cuaca : Cerah Berawan

Tabel 37. Data Hasil Pengujian Berat Jenis Aspal

Notasi	Percobaan 1	Percobaan 2
Berat Picnometer Kosong (A)	40	32.8
Berat Picnometer + Air (B)	104	125.5
Berat Picnometer + Aspal (C)	53	42.2
Berat Picnometer + Aspal + Air (D)	106	125.8

Berat Jenis :

$$= \frac{(C - A)}{(B - A) \times (D - C)}$$

Percobaan 1

$$= \frac{(53 - 40)}{(104 - 40) \times (106 - 53)}$$

= 1.181

Percobaan 2

$$= \frac{(42 - 32.8)}{(126 - 33) \times (126 - 542)}$$

= 1.032

Tabel 38. Hasil Pengujian Berat Jenis Aspal

Nilai	Percobaan		Rerata
	1	2	
Berat Jenis	1.181	1.032	1.107

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Lampiran 7

Judul Pengujian : Pengujian Keausan Agregat dengan *Los Angeles Machine*

Tempat : Labortorium Bahan Bangunan JPTSP, Fakultas Teknik, UNY

Data Pengujian

Waktu Pengujian : Senin, 28 Januari 2019

Suhu Ruang : 28°C

Cuaca : Cerah Berawan

Tabel 39. Data dan Hasil Pengujian Keausan Agregat

Berat Benda Uji (gram)	Berat Benda Uji Lolos Saringan No.4 (gram)	Berat Benda Uji Tertahan Saringan No.4 (gram)	Nilai Keausan (%)
5.000	2.173	2.663	46,74

$$\text{Keausan} = \frac{\text{Berat Benda Uji} - \text{Berat Tertahan Saringan No. 4}}{\text{Berat Benda Uji}}$$

$$= \frac{5000 - 2663}{5000}$$

$$= 46,67 \%$$

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Lampiran 8

Judul Pengujian : Pengujian Gradasi Agregat Kasar

Tempat : Labortorium Bahan Bangunan JPTSP, Fakultas Teknik, UNY

Data Pengujian

Waktu Pengujian : Senin, 28 Januari 2019

Suhu Ruang : 28°C

Cuaca : Cerah Berawan

Tabel 40. Data Hasil Pengujian Gradasi Agregat Kasar

Saringan	Berat Tertahan		% Tertahan		Berat Lolos		% Lolos	
	Tiap Saringan	Kumulatif	Tiap Saringan	Kumulatif	Tiap Saringan	Kumulatif	Tiap Saringan	Kumulatif
¾"	1155	1155	23.1	23.1	3845	3845	76.9	76.9
½"	1478	2633	29.56	52.66	2367	6212	47.34	124.24
3/8"	1935	4568	38.7	91.36	432	6644	8.64	132.88
#4	280	4848	5.6	96.96	152	6796	3.04	135.92
#8	5.5	4853.5	0.11	97.07	146.5	6942.5	2.93	138.85
#16	4.7	4858.2	0.094	97.164	141.8	7084.3	2.836	141.686
#30	6	4864.2	0.12	97.284	135.8	7220.1	2.716	144.402
#50	13.6	4877.8	0.272	97.556	122.2	7342.3	2.444	146.846
#100	88.3	4966.1	1.766	99.322	33.9	7376.2	0.678	147.524
#200	23.2	4989.3	0.464	99.786	10.7	7386.9	0.214	147.738
PAN	10.7	5000	0.214	100	2.13×10^{-14}	7386.9	4.26×10^{-16}	147.738

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Lampiran 9

Judul Pengujian : Pengujian Gradasi Agregat Halus

Tempat : Labortorium Bahan Bangunan JPTSP, Fakultas Teknik, UNY

Data Pengujian

Waktu Pengujian : Senin, 28 Januari 2019

Suhu Ruang : 28°C

Cuaca : Cerah Berawan

Tabel 41. Data Hasil Pengujian Gradasi Agregat Kasar

Saringan	Berat Tertahan		% Tertahan		Berat Lolos		% Lolos	
	Tiap Saringan	Kumulatif	Tiap Saringan	Kumulatif	Tiap Saringan	Kumulatif	Tiap Saringan	Kumulatif
¾"	0	0	0	0	500	500	100	100
½"	0	0	0	0	500	1.000	100	200
3/8"	0	0	0	0	500	1.500	100	300
#4	0,2	0,2	0,04	0,04	499,8	1999,8	99,96	399,96
#8	15,2	15,4	3,04	3,08	484,6	2484,4	96,92	496,88
#16	57,2	72,6	11,44	14,52	427,4	2911,8	85,48	582,36
#30	139,2	211,8	27,84	42,36	288,2	3200	57,64	640
#50	178	389,8	35,6	77,96	110,2	3310,2	22,04	662,04
#100	95,2	485	19,04	97	15	3325,2	3	665,04
#200	12,3	497,3	2,46	99,46	2,7	3327,9	0,54	665,58
PAN	2,7	500	0,54	100	$4,17 \times 10^{-14}$	3327,9	$8,35 \times 10^{-15}$	665,58

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Lampiran 10

Perhitungan nilai kepadatan

$$\text{Kepadatan} = \frac{W_m}{W_{mssd} - W_{mpv}}$$

W_m = Berat kering benda uji

W_{mssd} = Berat jenuh benda uji

W_m = Berat dalam Air benda uji

$$\text{Kepadatan APS 0. A} = \frac{1.199}{1.241 - 681}$$

$$\text{Kepadatan APS 0. A} = 2,141 \text{ gr/cc}$$

$$\text{Kepadatan APS 0. B} = \frac{1.201}{1.243 - 681}$$

$$\text{Kepadatan APS 0. B} = 2,137 \text{ gr/cc}$$

$$\text{Kepadatan APS 1. A} = \frac{1.150}{1.179 - 649}$$

$$\text{Kepadatan APS 1. A} = 2,169 \text{ gr/cc}$$

$$\text{Kepadatan APS 1. B} = \frac{1.180}{1.203 - 663}$$

$$\text{Kepadatan APS 1. B} = 2,185 \text{ gr/cc}$$

$$\text{Kepadatan APS 2. A} = \frac{1.187}{1.203 - 661}$$

$$\text{Kepadatan APS 2. A} = 2,181 \text{ gr/cc}$$

$$\text{Kepadatan APS 2. B} = \frac{1.217}{1.233 - 678}$$

$$\text{Kepadatan APS 2. B} = 2,177 \text{ gr/cc}$$

$$\text{Kepadatan APS 3. A} = \frac{1.255}{1.289 - 715}$$

$$\text{Kepadatan APS 3. A} = 2,186 \text{ gr/cc}$$

$$\text{Kepadatan APS 3. B} = \frac{1.230}{1.263 - 712}$$

$$\text{Kepadatan APS 3. B} = 2,232 \text{ gr/cc}$$

$$\text{Kepadatan APS 4. A} = \frac{1.267}{1.289 - 726}$$

$$\text{Kepadatan APS 4. A} = 2,250 \frac{\text{gr}}{\text{cc}}$$

$$\text{Kepadatan APS 4. B} = \frac{1.287}{1.302 - 731}$$

$$\text{Kepadatan APS 4. B} = 2,253 \text{ gr/cc}$$

Tabel 42. Data dan Hasil Pengujian Kepadatan

Benda Uji		Wm (gram)	Wmssd (gram)	Wmpv (gram)	Kepadatan (gr/cc)	Rerata (gr/cc)
APS 0	A	1.199	1.241	681	2,141	2,139
	B	1.201	1.243	681	2.137	
APS 1	A	1.150	1.179	649	2.169	2,177
	B	1.180	1.203	663	2,185	
APS 2	A	1.187	1.203	661	2,181	2,191
	B	1.217	1.233	678	2,177	
APS 3	A	1.255	1.289	715	2,186	2,209
	B	1230	1.263	712	2,232	
APS 4	A	1.267	1.289	726	2,250	2,252
	B	1.287	1.302	731	2,253	



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Lampiran 11
Perhitungan Nilai VIM

$$VIM = \frac{Gmm - Gmb}{Gmm} \times 100\%$$

Gmm = Berat jenis maksimum campuran

Gmb = Berat bulk total campuran

$$VIM \text{ APS } 0.A = \frac{2,368 - 1,919}{2,368} \times 100\%$$

$$VIM \text{ APS } 0.A = 18,93\%$$

$$VIM \text{ APS } 0.B = \frac{2,368 - 1,871}{2,368} \times 100\%$$

$$VIM \text{ APS } 0.B = 20,95\%$$

$$VIM \text{ APS } 1.A = \frac{2,368 - 1,867}{2,368} \times 100\%$$

$$VIM \text{ APS } 1.A = 21,13\%$$

$$VIM \text{ APS } 1.B = \frac{2,368 - 1,931}{2,368} \times 100\%$$

$$VIM \text{ APS } 1.B = 18,44\%$$

$$VIM \text{ APS } 2.A = \frac{2,368 - 1,915}{2,368} \times 100\%$$

$$VIM \text{ APS } 2.A = 19,12\%$$

$$VIM\ APS\ 2.B = \frac{2,368 - 1,911}{2,368} \times 100\%$$

$$VIM\ APS\ 2.B = 19,27\%$$

$$VIM\ APS\ 3.A = \frac{2,368 - 1,953}{2,368} \times 100\%$$

$$VIM\ APS\ 3.A = 17,52\%$$

$$VIM\ APS\ 3.B = \frac{2,368 - 1,928}{2,368} \times 100\%$$

$$VIM\ APS\ 3.B = 18,57\%$$

$$VIM\ APS\ 4.A = \frac{2,368 - 2,029}{2,368} \times 100\%$$

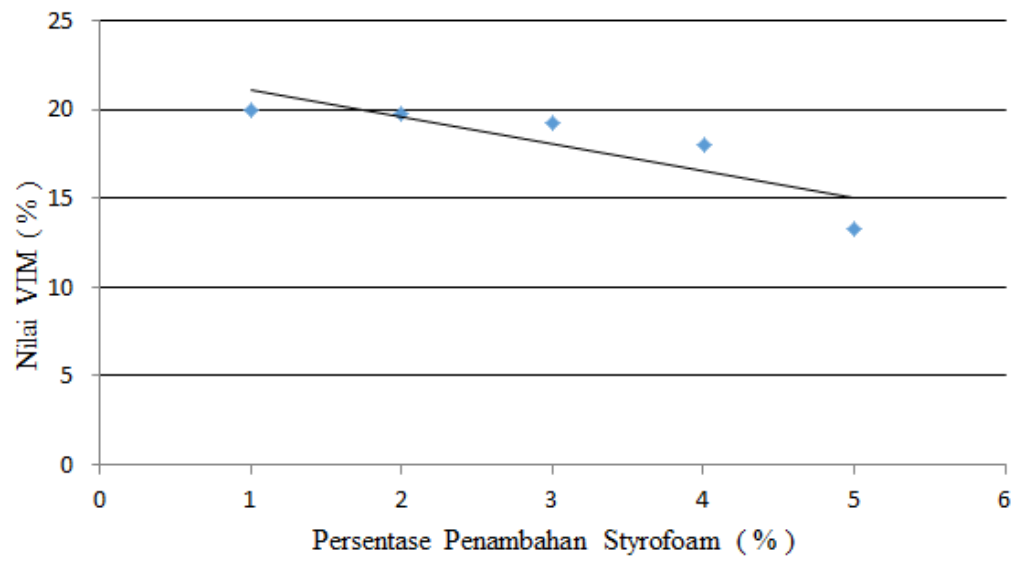
$$VIM\ APS\ 4.A = 14,30\%$$

$$VIM\ APS\ 4.B = \frac{2,368 - 2,079}{2,368} \times 100\%$$

$$VIM\ APS\ 4.B = 12,17\%$$

Tabel 43. Hasil Perhitungan VIM.

Benda Uji		VIM (%)	Rerata (%)
APS 0	A	18,93	19,94
	B	20,95	
APS 1	A	21,13	19,78
	B	18,44	
APS 2	A	19,12	19,19
	B	19,27	
APS 3	A	17,52	18,05
	B	18,57	
APS 4	A	14,30	13,24
	B	12,17	



Gambar 44. Grafik VIM



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Lampiran 12
Perhitungan nilai VMA

$$VMA = \frac{100 \times (Gsb - Gmb) + Gmb \times Pb}{Gsb}$$

Gsb = Berat jenis campuran setelah dipadatkan

Gmb = Berat bulk total campuran

Pb = Persentase kadar aspal dalam campuran

$$VMA_{APS\ 0.A} = \frac{100 \times (2.501 - 1.919) + 1.919 \times 7}{2.501}$$

$$VMA_{APS\ 0.A} = 28,62\%$$

$$VMA_{APS\ 0.B} = \frac{100 \times (2.501 - 1.871) + 1.871 \times 7}{2.501}$$

$$VMA_{APS\ 0.B} = 30,40\%$$

$$VMA_{APS\ 1.A} = \frac{100 \times (2.501 - 1.867) + 1.867 \times 7}{2.501}$$

$$VMA_{APS\ 1.A} = 30,56\%$$

$$VMA_{APS\ 1.B} = \frac{100 \times (2.501 - 1.931) + 1.931 \times 7}{2.501}$$

$$VMA_{APS\ 1.B} = 28,19\%$$

$$VMA\ APS\ 2.\ A = \frac{100 \times (2.501 - 1.915) + 1.915}{2.501}$$

$$VMA\ APS\ 2.\ A = 28,79\%$$

$$VMA\ APS\ 2.\ B = \frac{100 \times (2.501 - 1.911) + 1.911 \times 7}{2.501}$$

$$VMA\ APS\ 2.\ B = 28,92\%$$

$$VMA\ APS\ 3.\ A = \frac{100 \times (2.501 - 1.953) + 1.953}{2.501}$$

$$VMA\ APS\ 3.\ A = 27,39\%$$

$$VMA\ APS\ 3.\ B = \frac{100 \times (2.501 - 1.928) + 1.928 \times 7}{2.501}$$

$$VMA\ APS\ 3.\ B = 28,31\%$$

$$VMA\ APS\ 4.\ A = \frac{100 \times (2.501 - 2.029) + 2.029}{2.501}$$

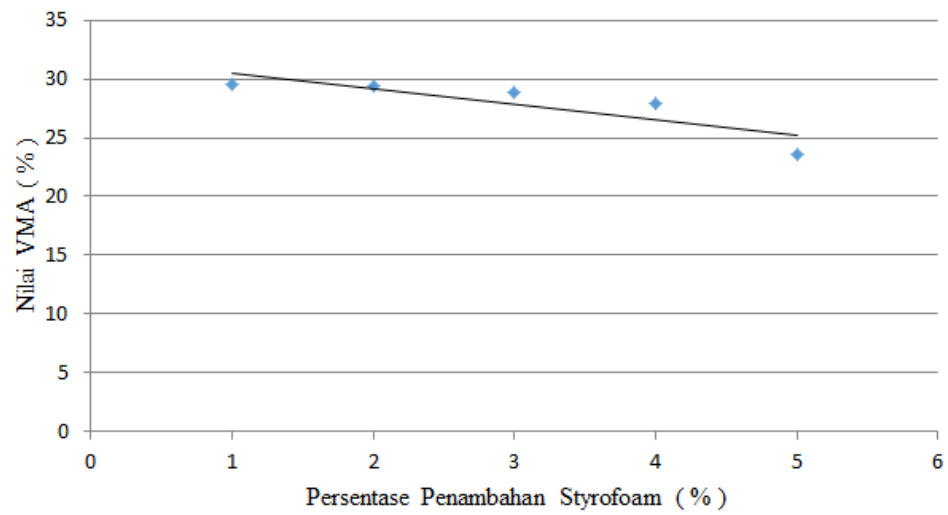
$$VMA\ APS\ 4.\ A = 24,55\%$$

$$VMA\ APS\ 4.\ B = \frac{100 \times (2.501 - 2.079) + 2.079 \times 7}{2.501}$$

$$VMA\ APS\ 4.\ B = 22,68\%$$

Tabel 44. Hasil Perhitungan VMA

Benda Uji		VMA (%)	Rerata (%)
APS 0	A	28,62	29,51
	B	30,40	
APS 1	A	30,56	29,38
	B	28,19	
APS 2	A	28,79	28,86
	B	28,92	
APS 3	A	27,39	27,85
	B	28,31	
APS 4	A	24,55	23,61
	B	22,68	



Gambar 45. Grafik VMA



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Lampiran 13
Perhitungan Nilai VFA

$$VFA = \frac{VMA - VIM}{VMA} \times 100\%$$

VIM = Void In Mix

VMA = Void Material Agregat

VFA = Void Fill with Asphalt

$$VFA_{APS\ 0.A} = \frac{28,62 - 18,93}{28,62} \times 100\%$$

$$VFA_{APS\ 0.A} = 33,83\%$$

$$VFA_{APS\ 0.B} = \frac{30,40 - 20,95}{30,40} \times 100\%$$

$$VFA_{APS\ 0.B} = 33,86\%$$

$$VFA_{APS\ 1.A} = \frac{30,56 - 21,13}{30,56} \times 100\%$$

$$VFA_{APS\ 1.A} = 30,85\%$$

$$VFA_{APS\ 1.B} = \frac{28,19 - 19,12}{28,19} \times 100\%$$

$$VFA_{APS\ 1.B} = 34,58\%$$

$$VFA_{APS\ 2.A} = \frac{28,79 - 21,13}{28,79} \times 100\%$$

$$VFA_{APS\ 2.A} = 33,59\%$$

$$VFA\ APS\ 2.B = \frac{28,92 - 19,27}{28,92} \times 100\%$$

$$VFA\ APS\ 2.B = 33,36\%$$

$$VFA\ APS\ 3.A = \frac{27,39 - 21,13}{27,39} \times 100\%$$

$$VFA\ APS\ 3.A = 36,00\%$$

$$VFA\ APS\ 3.B = \frac{28,31 - 18,57}{28,31} \times 100\%$$

$$VFA\ APS\ 3.B = 34,38\%$$

$$VFA\ APS\ 4.A = \frac{24,55 - 14,30}{24,55} \times 100\%$$

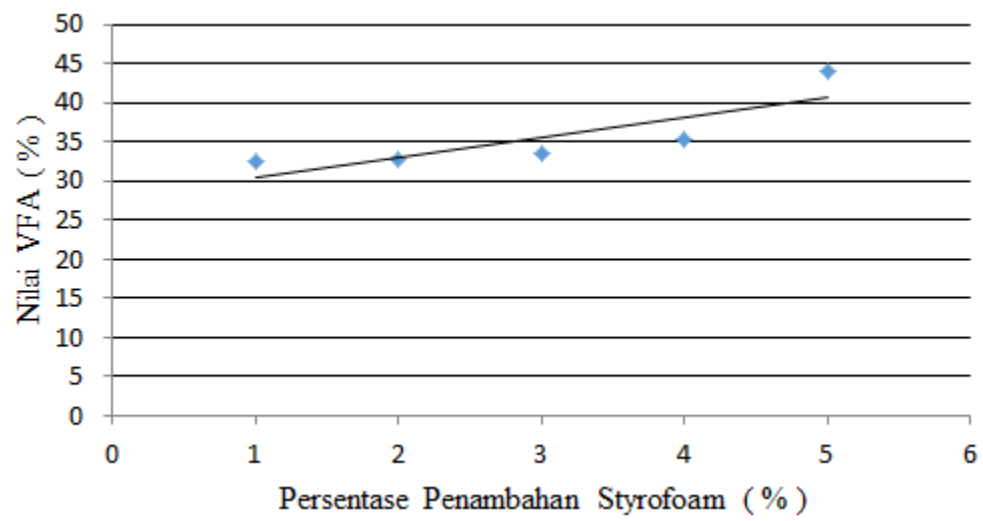
$$VFA\ APS\ 4.A = 41,73\%$$

$$VFA\ APS\ 4.B = \frac{22,68 - 18,57}{22,68} \times 100\%$$

$$VFA\ APS\ 4.B = 46,30\%$$

Tabel 45. Hasil Perhitungan VMA.

Benda Uji		VIM (%)	Rerata (%)
APS 0	A	33,86	32,47
	B	31,08	
APS 1	A	30,85	32,72
	B	34,58	
APS 2	A	33,59	33,47
	B	33,36	
APS 3	A	36,00	35,19
	B	34,38	
APS 4	A	41,73	44,01
	B	46,30	



Gambar 46. Grafik VFA



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Lampiran 14
Perhitungan Nilai *Flow*

Flow = diameter sebelum – diameter sesudah

$$Flow\ APS\ 0.A = 10,03 - 9,63$$

$$Flow\ APS\ 0.A = 0,4\ cm$$

$$Flow\ APS\ 0.A = 4\ mm$$

$$Flow\ APS\ 0.B = 10,17 - 9,44$$

$$Flow\ APS\ 0.B = 0,73\ cm$$

$$Flow\ APS\ 0.B = 7,3\ mm$$

$$Flow\ APS\ 1.A = 10,27 - 9,88$$

$$Flow\ APS\ 1.A = 0,39\ cm$$

$$Flow\ APS\ 1.A = 3,9\ mm$$

$$Flow\ APS\ 1.B = 10,23 - 9,86$$

$$Flow\ APS\ 1.B = 0,37\ cm$$

$$Flow\ APS\ 1.B = 3,7\ mm$$

$$Flow\ APS\ 2.A = 10,34 - 9,98$$

$$Flow\ APS\ 2.A = 0,36\ cm$$

$$Flow\ APS\ 2.A = 3,6\ mm$$

$$\text{Flow APS 2.B} = 10,31 - 9,90$$

$$\text{Flow APS 2.B} = 0,41 \text{ cm}$$

$$\text{Flow APS 2.B} = 4,1 \text{ mm}$$

$$\text{Flow APS 3.A} = 10,22 - 9,92$$

$$\text{Flow APS 3.A} = 0,30 \text{ cm}$$

$$\text{Flow APS 3.A} = 3,0 \text{ mm}$$

$$\text{Flow APS 3.B} = 10,24 - 9,96$$

$$\text{Flow APS 3.B} = 0,28 \text{ cm}$$

$$\text{Flow APS 3.B} = 2,8 \text{ mm}$$

$$\text{Flow APS 4.A} = 10,22 - 9,92$$

$$\text{Flow APS 4.A} = 0,30 \text{ cm}$$

$$\text{Flow APS 4.A} = 3,0 \text{ mm}$$

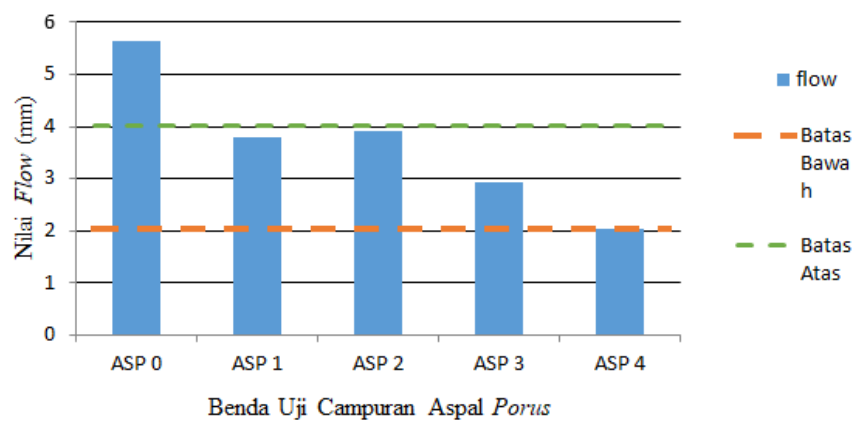
$$\text{Flow APS 4.B} = 10,13 - 9,96$$

$$\text{Flow APS 4.B} = 0,23 \text{ cm}$$

$$\text{Flow APS 4.B} = 2,3 \text{ mm}$$

Tabel 45. Data dan Hasil Perhitungan Nilai *Flow*

Benda Uji		Diameter Sebelum (cm)	Diameter Sesudah (cm)	Nilai <i>Flow</i> (mm)	Rerata (mm)
APS 0	A	10,03	9,63	4	5,6
	B	10,17	9,44	7,3	
APS 1	A	10,27	9,88	3,9	3,8
	B	10,23	9,86	3,7	
APS 2	A	10,34	9,98	3,6	3,9
	B	10,31	9,90	4,1	
APS 3	A	10,22	9,92	3	2,9
	B	10,24	9,96	2,8	
APS 4	A	10,17	9,94	2,3	2,0
	B	10,13	9,96	1,7	



Gambar 47. Grafik *Flow*



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Lampiran 15
Perhitungan Ekstrapolasi

Dikarenakan tabel konfersi *load* hanya tersedia hingga pembacaan arloji 2356, untuk nilai *load* dengan pembacaan diatas nilai tersebut dilakukan ekstrapolasi.

$$\text{Ekstrapolasi nilai Load : } \frac{X1}{X2} = \frac{Y1}{Y2}$$

X1 = Bacaan Arloji Acuan

X2 = Bacaan Arloji Target

Y1 = Nilai Load Acuan

Y2 = Nilai Load Target

$$\begin{aligned} \text{ASP 0. A : } \frac{2356}{2438} &= \frac{50}{Y2} \\ Y2 &= \frac{121.900}{2356} \\ Y2 &= 51,7402 \text{ KN} \\ Y2 &= 5174,02 \text{ kg} \end{aligned}$$

$$\begin{aligned} \text{ASP 1. A : } \frac{2356}{2696} &= \frac{50}{Y2} \\ Y2 &= \frac{134.800}{2356} \\ Y2 &= 57,2156 \text{ KN} \\ Y2 &= 5721,56 \text{ kg} \end{aligned}$$

$$\begin{aligned} \text{ASP 2. A : } \frac{2356}{3562} &= \frac{50}{Y2} \\ Y2 &= \frac{178.100}{2356} \\ Y2 &= 75,5942 \text{ KN} \\ Y2 &= 7559,42 \text{ kg} \end{aligned}$$

$$\begin{aligned}
 ASP\ 2.B : \frac{2356}{3769} &= \frac{50}{Y2} \\
 Y2 &= \frac{188.450}{2356} \\
 Y2 &= 79,9873\ KN \\
 Y2 &= 7998,73\ kg
 \end{aligned}$$



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Lampiran . 16
Perhitungan Nilai Stabilitas

$$\text{Stabilitas} = p \times q$$

p = Bacaan arloji $\times$ Kalibrasi alat (*Load*)

q = Nilai koreksi

$$\text{Stabilitas APS 0.A} = (5.174,02) \times 0,76$$

$$\text{Stabilitas APS 0.A} = 3.932,26 \text{ kg}$$

$$\text{Stabilitas APS 0.B} = (4.910,56) \times 0,76$$

$$\text{Stabilitas APS 0.B} = 3.732,03 \text{ kg}$$

$$\text{Stabilitas APS 1.A} = (5.721,56) \times 0,78$$

$$\text{Stabilitas APS 1.A} = 4.462,82 \text{ kg}$$

$$\text{Stabilitas APS 1.B} = (4.979,67) \times 0,78$$

$$\text{Stabilitas APS 1.B} = 3.884,14 \text{ kg}$$

$$\text{Stabilitas APS 2.A} = (7.559,42) \times 0,81$$

$$\text{Stabilitas APS 2.A} = 6.123,13 \text{ kg}$$

$$\text{Stabilitas APS 2.B} = (7.998,72) \times 0,76$$

$$\text{Stabilitas APS 2.B} = 6.079,03 \text{ kg}$$

Benda uji ASP 3 diuji dengan mesin UTM

Stabilitas APS 3.A = 8992 kg

Stabilitas APS 3.B = 9994 kg

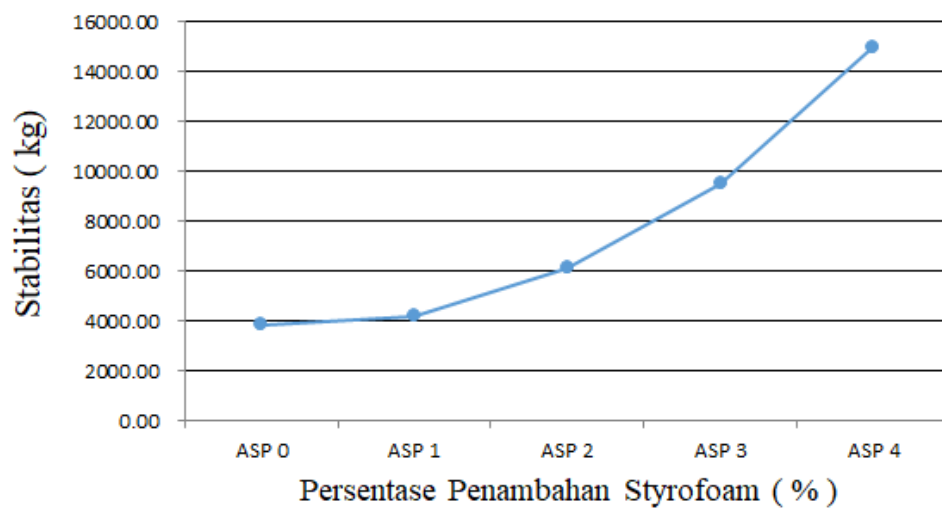
Benda uji ASP 4 diuji dengan mesin uji tekan beton

Stabilitas APS 4.A = 14600 kg

Stabilitas APS 4.B = 15400 kg

Tabel 46. Data dan Hasil Perhitungan Stabilitas

Benda Uji		Bacaan Arloji	Load	Nilai Koreksi	Stabilitas (kg)	Rerata (kg)
APS 0	A	2.438	5.174,02	0,76	3.932,26	3.832,14
	B	2.312	4.910,56	0,76	3.732,03	
APS 1	A	2.696	5.721,56	0,78	4.462,82	4.173,47
	B	2.346	4.979,67	0,78	3.884,14	
APS 2	A	3.562	7.559,42	0,81	6.123,13	6.101,08
	B	3.769	7.998,72	0,76	6.079.03	
APS 3	A	Diuji menggunakan UTM			8.992	9.493
	B				9.994	
APS 4	A	Diuji menggunakan mesin tekan beton			14.600	15.000
	B				15.400	



Gambar 48. Grafik Stabilita



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Lampiran 17
Perhitungan Nilai MQ

$$MQ = \frac{\text{Stabilitas}}{\text{Flow}}$$

$$MQ \text{ APS 0. A} = \frac{3.932,26}{4}$$

$$MQA \text{ PS 0. A} = 370,90 \text{ kg/mm}$$

$$MQ \text{ APS 0. B} = \frac{3.732,03}{7,3}$$

$$MQA \text{ PS 0. B} = 192,973 \text{ kg/mm}$$

$$MQ \text{ APS 1. A} = \frac{4.462,82}{3,9}$$

$$MQA \text{ PS 1. A} = 431,74 \text{ kg/mm}$$

$$MQ \text{ APS 1. B} = \frac{3.884,14}{3,7}$$

$$MQA \text{ PS 1. B} = 396,00 \text{ kg/mm}$$

$$MQ \text{ APS 2. A} = \frac{6.123,13}{3,6}$$

$$MQA \text{ PS 2. A} = 632,93 \text{ kg/mm}$$

$$MQ_{APS\ 2.B} = \frac{6.079,03}{4,1}$$

$$MQA_{PS\ 2.B} = 552,66\ kg/mm$$

$$MQ_{APS\ 3.A} = \frac{8.992,82}{3}$$

$$MQA_{PS\ 3.A} = 2.997,33\ kg/mm$$

$$MQ_{APS\ 3.B} = \frac{9.994,1}{2,8}$$

$$MQA_{PS\ 3.B} = 3.506,67\ kg/mm$$

$$MQ_{APS\ 4.A} = \frac{14.600}{2,3}$$

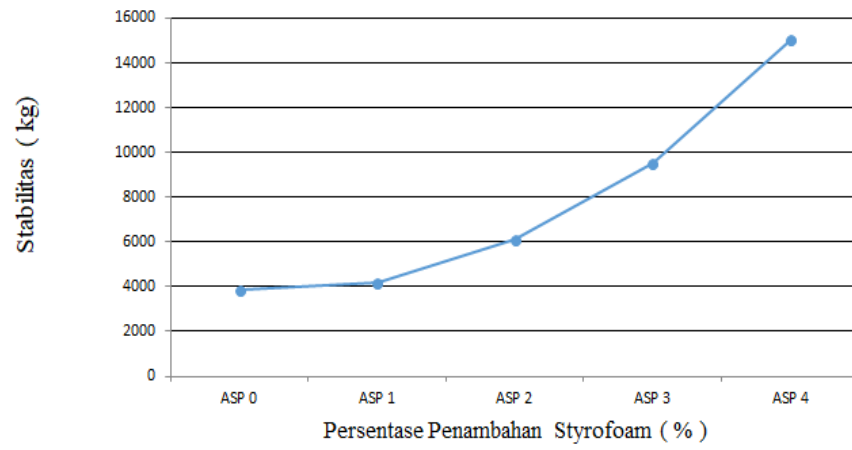
$$MQA_{PS\ 4.A} = 6.212,77\ kg/mm$$

$$MQ_{APS\ 4.B} = \frac{15.400}{1,7}$$

$$MQA_{PS\ 4.B} = 9.058,82\ kg/mm$$

Tabel 47. Data dan Hasil Perhitungan Nilai MQ

Benda Uji		MQ (kg/mm)	Rerata (kg/mm)
APS 0	A	370,90	281,81
	B	192,73	
APS 1	A	431,74	413,87
	B	396,00	
APS 2	A	632,93	592,80
	B	552,66	
APS 3	A	2.997,33	3.252,00
	B	3.506,67	
APS 4	A	6.212,77	7.635,79
	B	9.058,82	



Gambar 49. Grafik MQ

DOKUMENTASI



Gambar 50. Pengujian Titik Bakar



Gambar 51. Pemanasan Agregat



Gambar 52. Aspal dengan Campuran *Styrofoam*



Gambar 53. Penumbukan Benda Uji



Gambar 54. Pengukuran Diameter Benda Uji



Gambar 55. Benda Uji APS 1.A



Gambar 56. Benda Uji APS 4.A



Gambar 57. Perendaman Benda Uji



Gambar 58. Penekanan Benda Uji dengan *Marshall Test Machine*



Gambar 59. Penekanan Benda Uji dengan UTM



Gambar 60. Penekanan Benda Uji dengan Mesin Tekan Beton