



UNIVERSITAS BRAWIJAYA

LAMPIRAN

Lampiran 1, Perhitungan P teoritis

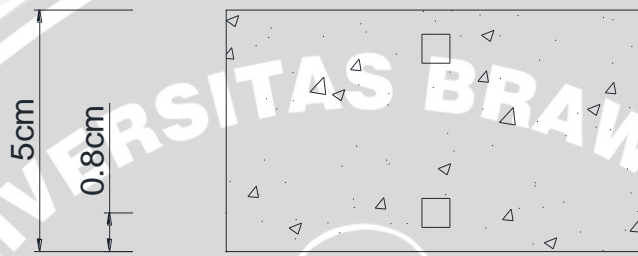
Pada perhitungan dilakukan dengan analisis penampang persegi bertulangan rangkap. Dimana digunakan keseimbangan gaya, yakni gaya tarik = gaya tekan

$$C_c = T$$

$$0,85.f_c'.b.a + A_s'.f_y = A_s.f_y$$

$$a = \frac{(A_s - A_s').f_y}{0,85.f_c'.b}$$

Pada perhitungan diambil perpias 9 cm.



$$A_s = 0,36 \text{ cm}^2$$

$$f_y = 29,4 \text{ MPa}$$

$$f_c' = 23 \text{ MPa}$$

$$C_c = T$$

$$0,85.f_c'.b.a = A_s.f_y$$

$$a = \frac{A_s.f_y}{0,85.f_c'.b} = \frac{0,36.294}{0,85.230.9} = 0,06 \text{ cm}$$

$$c = a/\beta = 0,06/0,85 = 0,07 \text{ cm}$$

$$M_n = A_s.f_y (d - a/2)$$

$$= 0,36.294 (4,2 - 0,06/2)$$

$$= 441,3528 \text{ kg.cm/9 cm}$$

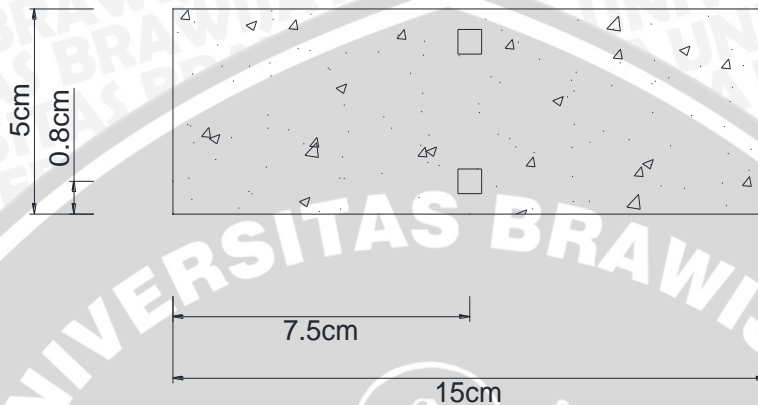
$$M_{n\text{total}} = \left(\frac{441,3528}{9}\right) \times 40$$

$$= 1961,568 \text{ kgcm/cm'}$$

$$A_s = 0,36 \text{ cm}^2$$

$$f_y = 29,4 \text{ MPa}$$

$$f_c' = 23 \text{ MPa}$$



$$C_c = T$$

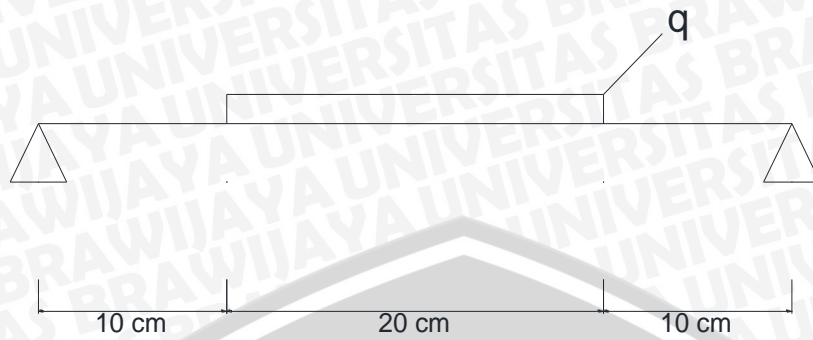
$$0,85 \cdot f_c' \cdot b \cdot a = A_s \cdot f_y$$

$$a = \frac{A_s \cdot f_y}{0,85 \cdot f_c' \cdot b} = \frac{0,36 \cdot 29,4}{0,85 \cdot 23 \cdot 15} = 0,036 \text{ cm}$$

$$c = a / \beta = 0,036 / 0,85 = 0,04$$

$$\begin{aligned} M_n &= A_s \cdot f_y \cdot (d - a/2) \\ &= 0,36 \cdot 29,4 \cdot (4,2 - 0,036/2) \\ &= 442,6229 \text{ kg.cm/15 cm} \end{aligned}$$

$$\begin{aligned} M_{n_{\text{total}}} &= \left(\frac{442,6229}{15} \right) \times 80 \\ &= 2360,6554 \text{ kgcm/cm} \end{aligned}$$



Diperoleh dari perhitungan sebelumnya :

$$M_n = 1961,568 \text{ kgcm/cm}^2$$

$$M_{n_{total}} = \frac{1961,568}{9} \times 80$$

$$= 17436,16 \text{ kgcm/cm}^2$$

Sehingga :

$$M_n = M_{max}$$

$$M_{max} = 20R_a - q \cdot 10.5$$

$$= 20 \cdot 10q - q \cdot 10.5$$

$$M_{max} = 200q - 50q$$

$$= 150q$$

$$q = M_{max} / 150$$

$$= 17436,16 / 150$$

$$= 116,24$$

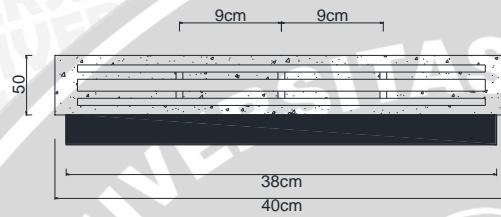
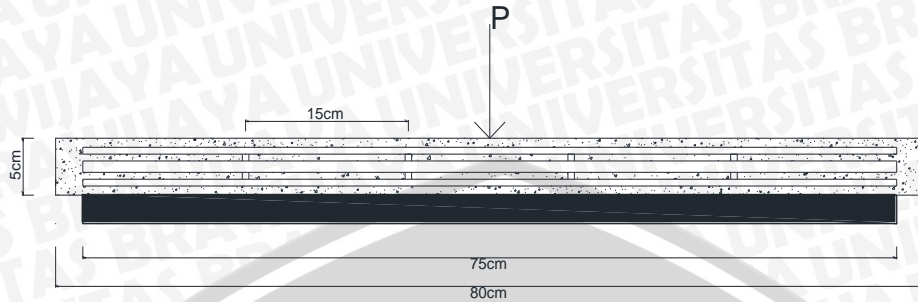
$$P/20 = 116,24$$

$$P = 116,24 \times 20$$

$$= 2324,82 \text{ kg}$$



Perhitungan Shear Connector



$$\begin{aligned} D &= 1/6 \sqrt{f_c'} b w d \\ &= 1/6 \sqrt{23} 400 4,2 \\ &= 13428,3283 \text{ N} \\ &= 1342,833 \text{ kg} \end{aligned}$$

$$D = 1342,833 \text{ kg}$$

$$P \text{ geser} = 2.D = 2.1342,833 = 2685,666 \text{ kg}$$

Terdapat 6 shear connector pada bentang panjang.

$$V_{sc}' = \frac{D}{6} = \frac{1342,833}{6} = 223,806 \text{ kg}$$

Terdapat 5 shear connector pada bentang pendek

$$V_{sc} = \frac{V_{sc}'}{5} = \frac{223,806}{5} = 44,761 \text{ kg}$$

Jarak antar shear connector, $s_v = 15 \text{ cm}$

$$V_s = \frac{V_{sc} \cdot S}{I} \cdot s_v = \frac{44,761 \cdot 120,5}{305.667} \cdot 15 = 264.686 \text{ kg}$$

Diameter minimum shear connector yang dibutuhkan :

$$\tau \cdot A_{\min} > V_s$$

$$13,234 \cdot A_{\min} > 264.686$$

$$A_{\min} > 20 \text{ cm}^2$$

$$\pi \cdot r^2 > 20$$

$$r > 2.523 \text{ cm}$$

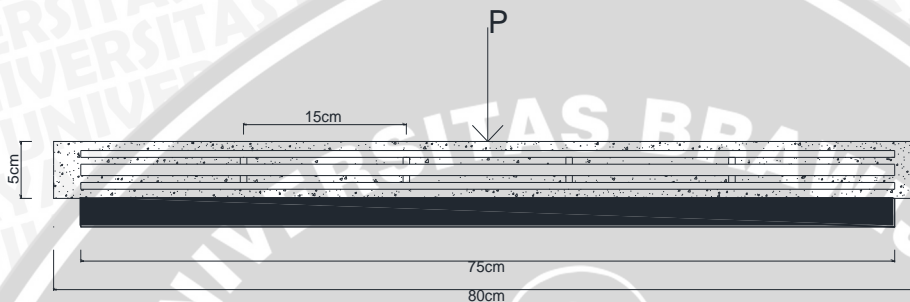
$$D > 5.046 \text{ cm}$$



Perhitungan Momen Retak (M_r)

$$f_r = 0,7\sqrt{f_c'} = 0,7\sqrt{23,4} = 3,39 \text{ MPa} = 33,9 \text{ kg/cm}^2$$

Plat beton lapis *styrofoam*

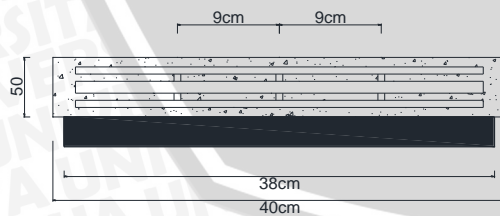


$$\begin{aligned} I &= \Sigma(1/12bh^3 + Ay^2) \\ &= ((1/12 \cdot 36 \cdot 2^3) + (36 \cdot 2 \cdot 1,5^2)) \cdot 2 + ((1/12 \cdot 2 \cdot 5^3) + (2 \cdot 5 \cdot 0)) \cdot 2 - (1/12 \cdot 36 \cdot 1^3) + (36 \cdot 1 \cdot 0) \\ &= 410,6667 \text{ cm}^4 \end{aligned}$$

$$M_r = \frac{f_r \cdot I}{y} = 5568,64$$

$$M_r = \frac{PL}{4}$$

$$P = \frac{4M_r}{L} = 278,432 \text{ kg}$$

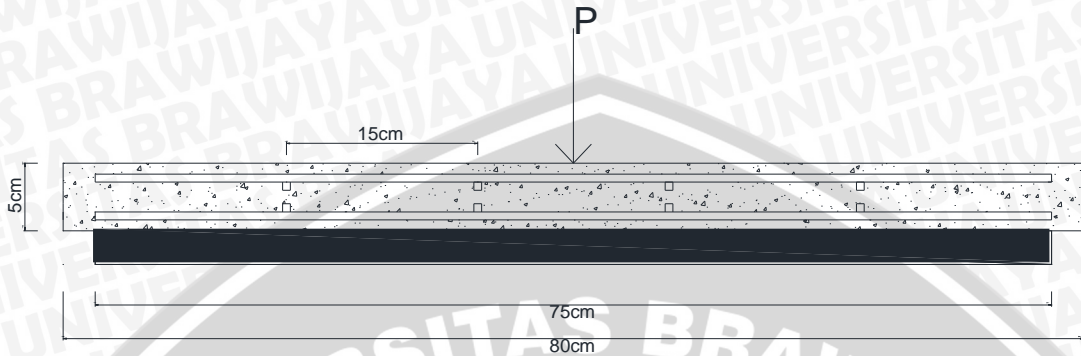


$$\begin{aligned} I &= \Sigma(1/12bh^3 + Ay^2) \\ &= ((1/12 \cdot 75 \cdot 2^3) + (75 \cdot 2 \cdot 1,5^2)) \cdot 2 + ((1/12 \cdot 2 \cdot 5^3) + (2 \cdot 5 \cdot 0)) \cdot 2 - (1/12 \cdot 75 \cdot 1^3) + (36 \cdot 1 \cdot 0) \\ &= 820,83 \text{ cm}^4 \end{aligned}$$

$$Mr = \frac{fr.I}{y} = 11130,4548$$

$$Mr = \frac{PL}{4} \longrightarrow P = \frac{4Mr}{L} = 1113,045 \text{ kg}$$

Plat Beton Tanpa Styrofoam



$$I = \Sigma(1/12bh^3 + Ay^2)$$

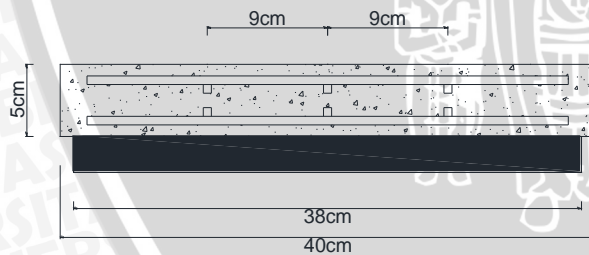
$$= 1/12 \cdot 40 \cdot 5^3 + 40 \cdot 5 \cdot 0^2$$

$$= 416,6667 \text{ cm}^4$$

$$Mr = \frac{fr.I}{y} = 5650$$

$$Mr = \frac{PL}{4}$$

$$P = \frac{4Mr}{L} = 282,5 \text{ kg}$$



$$I = 1/12bh^3 + Ay^2$$

$$= 1/12 \cdot 80 \cdot 5^3 + 80 \cdot 5 \cdot 0^2$$

$$= 833,3333 \text{ cm}^4$$

$$Mr = \frac{fr.I}{y} = 11300$$

$$Mr = \frac{PL}{4} \longrightarrow P = \frac{4Mr}{L} = 1130 \text{ kg}$$

Lampiran 2

Data Hasil Laboratorium

Hasil Kuat Tekan Pengujian Sampel Beton

Benda Uji	Berat (kg)	Pmax (kN)	Pmax (kg)	Kuat Tekan Runtuh (kg/cm ²)	Rata-rata F _{cr} (kg/cm ²)	Rata-rata F _{cr} (MPa)
A	1,70	107	10700	213	234	23,4
B	1,70	136	13600	271		
I	1,72	110	11000	219		

Spesifikasi Dimensi Plat Beton Lapis Styrofoam

Benda Uji	Berat (kg)	Panjang (cm)	Lebar (cm)	Tebal (cm)
S-I1	34,1	80,5	40,1	5,7
S-I2	34,2	81,0	40,0	5,8
S-I3	33,5	80,0	40,0	6,0

Spesifikasi Dimensi Plat Beton Tanpa Styrofoam

Benda Uji	Berat (kg)	Panjang (cm)	Lebar (cm)	Tebal (cm)
TS-A3	39,2	81,0	40,4	6,0
TS-B1	36,7	80,5	40,0	5,4

Data Pengujian Benda Uji S-II

No	Beban (kg)	Δ Tengah (mm)	Δ Tepi (mm)	Keterangan
1	0,00	8,91	9,80	Tanpa Beban
2	29,10	9,11	10,04	
3	79,10	9,22	10,13	
4	129,10	9,31	10,20	
5	179,10	9,43	10,32	
6	229,10	9,52	10,39	
7	279,10	9,65	10,51	
8	329,10	9,75	10,60	
9	379,10	9,89	10,71	
10	429,10	9,96	10,81	
11	479,10	10,10	10,89	
12	529,10	10,18	10,99	
13	579,10	10,25	11,05	
14	629,10	10,42	11,16	
15	679,10	10,50	11,27	
16	729,10	10,60	11,31	
17	779,10	10,68	11,40	
18	829,10	10,88	11,45	
19	879,10	10,88	11,58	
20	929,10	10,98	11,63	
21	979,10	11,08	11,71	
22	1029,10	11,16	11,75	
23	1079,10	11,23	11,84	Retak 1A,2A
24	1129,10	13,49	12,28	
25	1179,10	13,63	12,33	Retak 3A
26	1229,10	13,74	12,40	
27	1279,10	13,95	12,51	
28	1329,10	14,15	12,64	
29	1379,10	14,44	12,77	Retak 4A
30	1429,10	14,59	12,89	
31	1479,10	14,84	12,79	
32	1529,10	15,03	13,08	
33	1579,10	15,13	13,14	Retak 5A
34	1629,10	15,29	13,21	
35	1679,10	15,37	13,26	
36	1729,10	15,59	13,40	Retak 3B,6A,7A,8A
37	1269,10	29,00	23,00	Retak 4B,9A
38	1349,10	30,00	24,00	
39	1357,10	31,00	24,00	
40	1339,10	32,00	25,00	Retak 10A,11A

41	1349,10	33,00	25,00	
42	1369,10	34,00	26,00	
43	1329,10	35,00	26,00	Retak 6B
44	1361,10	36,00	27,00	Retak 6C
45	1349,10	37,00	28,00	Retak 12A,6A,6B,6C,13A,3C
46	1327,10	38,00	29,00	
47	1347,10	39,00	29,00	
48	1361,10	40,00	30,00	
49	1379,10	41,00	30,00	
50	1339,10	42,00	31,00	
51	1373,10	43,00	31,00	Retak 8B,6B,6D
52	1395,10	44,00	32,00	Retak 9B
53	1449,10	45,00	32,00	Retak 9B,3D,13A
54	1285,10	46,00	34,00	Retak 4C,6E,7B,7C,1B



Data Pengujian Benda Uji S-I2

No	Beban (kg)	Δ Tengah (mm)	Δ Tepi (mm)	Keterangan
1	0,00	6,79	7,47	Tanpa Beban
2	29,40	6,85	7,63	
3	79,40	6,94	7,81	
4	129,40	7,06	7,92	
5	179,40	7,18	8,02	
6	229,40	7,34	8,14	
7	279,40	7,43	8,25	
8	329,40	7,54	8,34	
9	379,40	7,60	8,37	
10	429,40	7,72	8,48	
11	479,40	7,85	8,56	
12	529,40	7,93	8,63	
13	579,40	8,05	8,75	
14	629,40	8,14	8,81	
15	679,40	8,27	8,95	Retak 1A
16	729,40	8,98	9,43	
17	779,40	9,07	9,50	
18	829,40	9,20	9,59	Retak 2A
19	879,40	9,35	9,71	
20	929,40	9,47	9,81	
21	979,40	9,57	9,88	
22	1029,40	9,72	9,99	
23	1079,40	9,93	10,14	
24	1129,40	10,08	10,25	
25	1179,40	10,31	10,39	Retak 2B,1B
26	1229,40	11,18	10,83	Retak 3A
27	1279,40	11,86	11,58	Retak 3B,4A
28	1329,40	13,14	12,43	
29	1379,40	13,53	12,64	Retak 2C
30	1429,40	13,76	12,75	
31	1479,40	14,09	12,89	Retak 4B
32	1529,40	14,69	13,21	
33	1579,40	15,09	13,45	Retak 5A
34	1629,40	15,47	13,64	
35	1679,40	15,99	13,95	
36	1729,40	16,43	14,12	Retak 1D,6A,7A,8A
37	1179,40	27,17	20,27	Retak 5B,4C,1E,9A,6B
38	979,40	28,24	22,22	Retak 10A,11A
39	959,40	28,92	22,66	Retak 11B
40	957,40	31,50	24,67	Retak 5C,8B,8C

41	899,40	32,25	25,97	Retak 7B
42	919,40	33,40	26,81	Retak 5D
43	927,40	35,47	28,91	Retak 13A
44	949,40	38,93	31,92	Retak 12B
45	955,40	39,76	33,09	Retak 14A



Data Pengujian Benda Uji S-I3

No	Beban (kg)	Δ Tengah (mm)	Δ Tepi (mm)	Keterangan
1	0	2,87	2,47	Tanpa Beban
2	29,4	3,14	2,74	
3	79,4	3,19	2,77	
4	129,4	3,23	2,81	
5	179,4	3,37	2,96	
6	229,4	3,52	3,07	
7	279,4	3,67	3,18	
8	329,4	3,83	3,29	
9	379,4	3,97	3,38	
10	429,4	4,11	3,47	
11	479,4	4,27	3,58	
12	529,4	4,39	3,65	
13	579,4	4,49	3,71	Retak 1A,2A
14	629,4	8,92	5,76	Retak 3A
15	679,4	9,28	5,87	
16	729,4	9,39	5,98	
17	779,4	9,53	6,09	
18	829,4	9,61	6,15	
19	879,4	9,7	6,2	Retak 4A
20	929,4	9,84	6,33	
21	979,4	9,99	6,47	
22	1029,4	10,1	6,54	
23	1079,4	10,22	6,61	
24	1129,4	10,35	6,72	Retak 5A,6A,7A
25	1179,4	16,37	11,89	
26	1229,4	16,58	11,97	
27	1279,4	16,85	12,14	
28	1329,4	16,99	12,2	
29	1379,4	17,26	12,34	
30	1429,4	17,65	12,56	
31	1479,4	17,97	12,73	
32	1529,4	18,4	12,88	Retak 5B
33	1579,4	18,85	13,15	
34	1629,4	19,29	13,38	
35	1679,4	19,99	13,86	Retak 6B
36	1729,4	24,58	16,17	
37	1779,4	25,78	16,72	Retak 7B
38	1483,4	37	17,25	Retak 8A,9A,8B
39	1479,4	38	18,35	
40	1489,4	40	21	Retak 6C

41	1299,4	41	22,15	
42	1487,4	42	22,78	Retak 9B
43	1621,4	43	23,25	
44	1297,4	44	23,56	Retak 5B,5C
45	1137,4	45	24,22	
46	1129,4	46	24,53	Retak 10A,10B
47	1339,4	47	24,89	Retak 10C
48	1319,4	48	25,2	
49	1379,4	49	25,64	
50	1384,4	50	26	
51	1393,4	51	27	Retak 5D
52	1489,4	52	28	
53	1403,4	53	31	Retak 8C
54	1473,4	54	32	
55	1387,4	55	35	
56	1403,4	55	38	Retak 10D
57	1407,4	55,17	41	Retak 8B,10E
58	1187,4	55,17	44	Retak 9C,9D,10F



Data Pengujian Benda Uji TS-A3

No	Beban (kg)	Δ Tengah (mm)	Δ Tepi (mm)	Keterangan
1	0,00	6,86	9,84	Tanpa Beban
2	29,40	7,07	10,07	
3	79,40	7,13	10,10	
4	129,40	7,19	10,15	
5	179,40	7,31	10,25	
6	229,40	7,40	10,34	
7	279,40	7,55	10,48	
8	329,40	7,66	10,56	
9	379,40	7,76	10,63	
10	429,40	7,88	10,73	
11	479,40	7,99	10,80	
12	529,40	8,08	10,88	
13	579,40	8,20	10,98	
14	629,40	8,30	11,05	
15	679,40	8,39	11,14	
16	729,40	9,33	11,19	
17	779,40	9,42	11,23	
18	829,40	9,56	11,33	Retak 1A,2A
19	879,40	9,66	11,39	
20	929,40	9,79	11,49	
21	979,40	9,85	11,53	
22	1029,40	9,97	11,62	
23	1079,40	10,06	11,66	
24	1129,40	10,18	11,77	
25	1179,40	10,25	11,82	
26	1229,40	10,36	11,89	
27	1279,40	10,44	11,96	
28	1329,40	10,51	12,02	
29	1379,40	10,59	12,10	
30	1429,40	10,71	12,20	
31	1479,40	10,76	12,25	
32	1529,40	10,86	12,33	Retak 3A,4A
33	1579,40	13,21	14,71	
34	1629,40	13,43	14,97	
35	1679,40	13,72	15,11	
36	1729,40	13,88	15,24	
37	1779,40	14,08	15,40	Retak 2B
38	1829,40	14,29	15,56	Retak 4B
39	1879,40	14,63	15,81	Retak 3B
40	1929,40	14,85	15,98	

41	1979,40	15,03	16,10	
42	2029,40	15,19	16,20	
43	2079,40	15,56	16,58	Retak 5A
44	1779,40	20,38	19,37	Retak 6A,7A
45	1819,40	21,46	20,45	Retak 8A
46	1899,40	22,50	21,16	
47	2049,40	27,48	25,69	Retak 6B,9A
48	2079,40	30,56	28,17	Retak 3C
49	2129,40	33,15	30,49	Retak 10A,5B,5C
50	2179,40	37,94	34,64	
51	2229,40	39,53	36,02	Retak 9B,6C
52	2279,40	45,78	41,12	Retak 10B
53	2329,40	50,40	47,26	Retak 11A,3D
54	2379,40	53,11	53,50	Retak 11B,4C
55	2429,40	54,35	55,15	
56	2319,40	55,16	55,14	
57	2429,40	55,17	55,14	Retak 9C,11C,10C
58	2129,40	55,17	55,14	Retak 12A,6D



Data Pengujian Benda Uji TS-B1

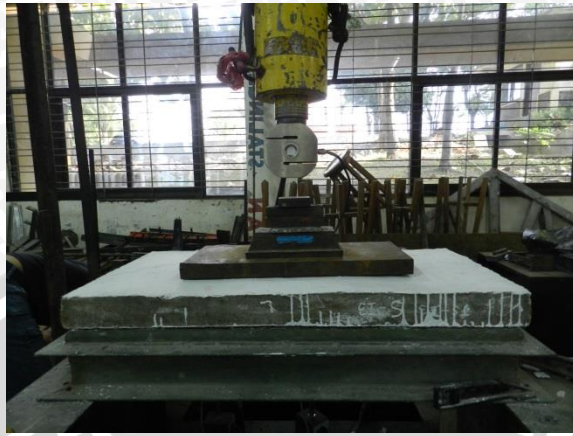
No	Beban (kg)	Δ Tengah (mm)	Δ Tepi (mm)	Keterangan
1	0,00	5,43	5,00	Tanpa Beban
2	29,10	5,48	5,04	
3	79,10	5,63	5,19	
4	129,10	5,70	5,31	
5	179,10	5,82	5,48	
6	229,10	5,97	5,60	
7	279,10	6,07	5,67	
8	329,10	6,21	5,80	
9	379,10	6,35	5,92	
10	429,10	6,47	6,04	
11	479,10	6,57	6,15	
12	529,10	6,72	6,25	
13	579,10	7,64	6,83	
14	629,10	7,75	6,94	
15	679,10	7,89	7,02	
16	729,10	7,97	7,11	
17	779,10	8,09	7,15	
18	829,10	8,24	7,34	Retak 1A
19	879,10	8,39	7,44	
20	929,10	8,53	7,57	
21	979,10	9,21	7,70	
22	1029,10	9,39	7,92	Retak 2A
23	1079,10	9,47	8,01	
24	1129,10	9,55	8,11	
25	1179,10	9,67	8,21	Retak 3A
26	1229,10	9,82	8,35	Retak 4A
27	1279,10	14,98	13,58	
28	1329,10	15,67	13,91	
29	1379,10	15,88	14,00	
30	1429,10	16,10	14,15	
31	1479,10	16,37	14,35	
32	1529,10	16,69	14,62	
33	1579,10	16,99	14,77	
34	1629,10	17,28	14,96	
35	1679,10	17,55	15,12	
36	1729,10	17,84	15,33	
37	1779,10	18,25	15,59	Retak 6A,7A,1B
38	1829,10	28,87	20,81	
39	1879,10	30,45	21,41	Retak 4B,8A,5B
40	1929,10	38,78	25,56	

41	1979,10	40,30	26,62	Retak 2B,3B,7B,8B
42	1529,10	51,00	27,81	
43	1549,10	52,00	29,82	
44	1619,10	53,00	33,41	Retak 2C,6B
45	1629,10	54,00	35,10	Retak 1C
46	1589,10	55,00	35,71	



Lampiran 3

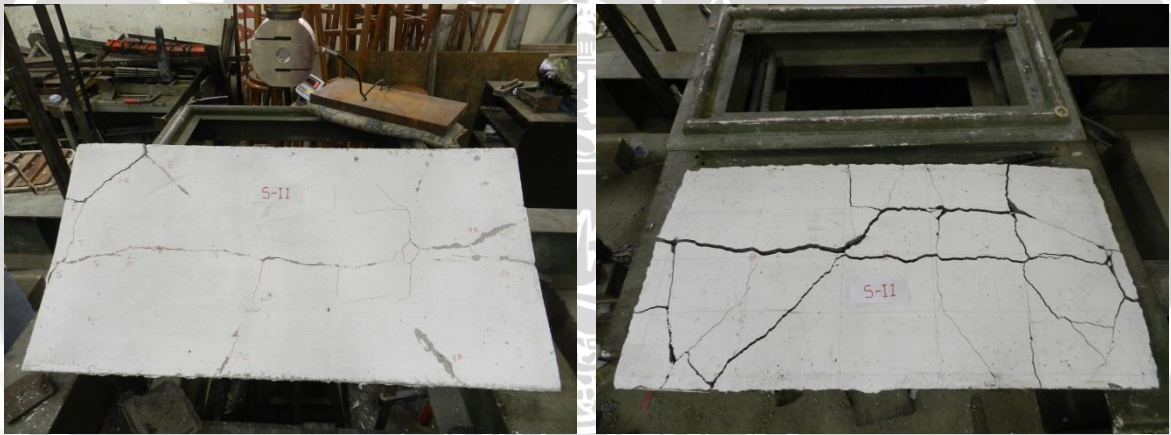
Dokumentasi Penelitian



Setting Alat dan Posisi LVDT



Pengujian Benda Uji S-II



Hasil Akhir Pengujian Benda Uji S-II

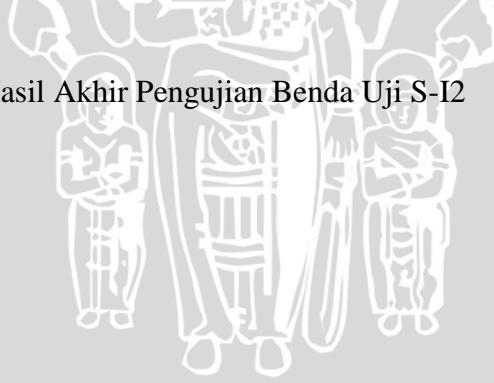


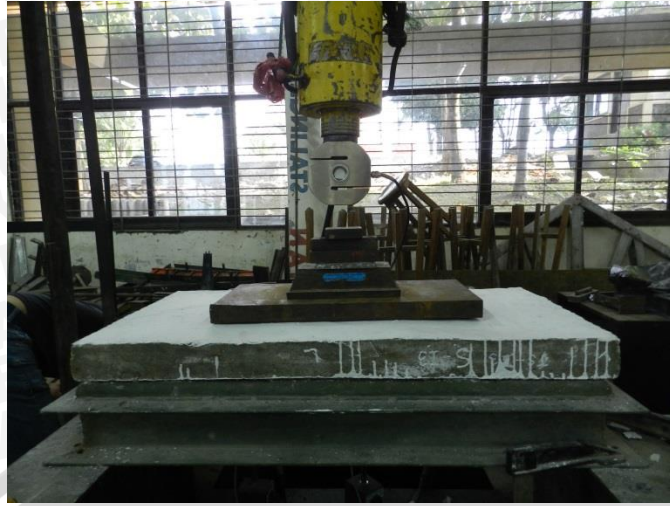


Pengujian Benda Uji S-12



Hasil Akhir Pengujian Benda Uji S-12

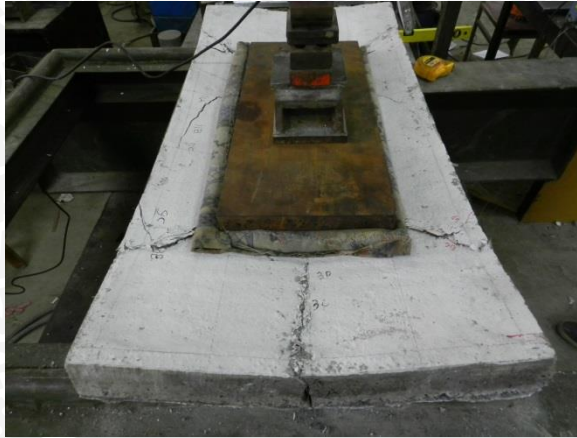




Pengujian Benda Uji S-I3



Hasil Akhir Pengujian Benda Uji S-I3



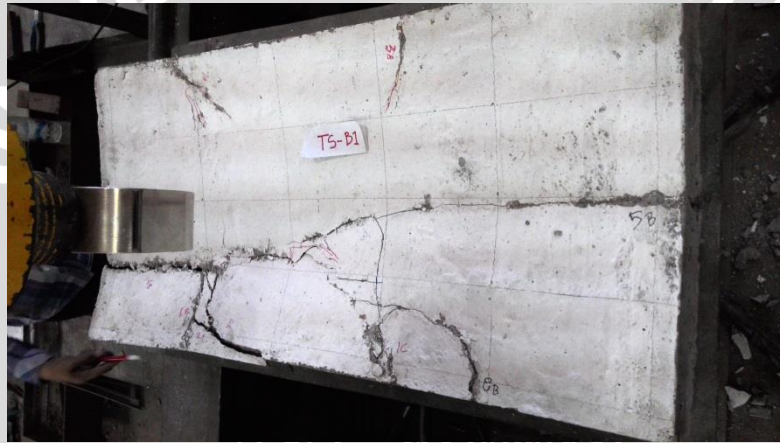
Pengujian Benda Uji TS-A3



Hasil Akhir Pengujian Benda Uji TS-A3



Pengujian Benda Uji TS-B1



Hasil Akhir Pengujian Benda Uji TS-B1

