

BAB VI

KESIMPULAN DAN SARAN

6.1. Kesimpulan

Dari hasil pengujian yang telah dilakukan yang kemudian dibahas pada bab lima, diperoleh kesimpulan sebagai berikut.

1. Beban maksimum hasil perhitungan dan hasil pengujian memiliki persentase selisih paling besar 27,7883% yaitu pada kolom E70FG2. Hal ini dikarenakan, pada perhitungan teoritis untuk kolom yang diberi perkuatan *fiber glass* rumus yang digunakan masih merupakan rumus pendekatan dengan mengambil f'_c sebesar 1,5 kali f'_c kolom normal. Selain itu besarnya selisih antara perhitungan teoritis dan hasil pengujian pada kolom E70FG2 juga disebabkan oleh kerusakan pada kaki kolom, sehingga kolom E70FG2 belum mencapai beban maksimumnya. Sedangkan untuk kolom normal, selisih antara hasil perhitungan teoritis dengan hasil pengujian paling besar adalah kolom E70N2 dengan selisih sebesar 9,1937%.
2. Terdapat kenaikan beban maksimum pada kolom yang diberi perkuatan dengan *fiber glass* sebesar 35,8599% dan 57,5365%. Kenaikan sebesar 35,8599% terjadi pada kolom yang diberi perkuatan *fiber glass* dengan eksentrisitas sebesar 70 mm (E70FG3). Sedangkan kenaikan sebesar 57,5365% terjadi pada kolom yang diberi perkuatan *fiber glass* dengan eksentrisitas sebesar 90 mm (E90FG1). Kolom E90FG1 mengalami kenaikan persentase yang lebih besar karena pada eksentrisitas yang lebih

besar, momen lentur yang terjadi juga lebih besar, dengan demikian pengaruh perkuatan *fiber glass* yang berupa pengekanan akan lebih terlihat.

3. Perkuatan kolom dengan *fiber glass* juga berpengaruh terhadap besarnya defleksi yang terjadi pada kolom. Dari grafik yang diperoleh, terlihat bahwa grafik untuk kolom yang diberi perkuatan *fiber glass* selalu berada di atas grafik kolom normal. Hal tersebut menunjukkan bahwa *fiber glass* memberi pengekanan yang berpengaruh terhadap kekakuan kolom.
4. Dari pola retak yang terjadi pada kolom, terlihat bahwa kerusakan kolom diawali dengan munculnya retak-retak halus pada bagian sisi samping kolom yang kemudian memanjang dan menjadi satu pada bagian sisi atas kolom seiring dengan penambahan beban yang diberikan. Hal tersebut menandakan bahwa keruntuhan yang terjadi adalah keruntuhan tarik.

6.2. Saran

Berikut adalah beberapa saran dari penulis untuk penelitian selanjutnya.

1. Untuk penelitian selanjutnya dapat dilakukan pengujian kolom di daerah keruntuhan tekan.
2. Kaki kolom diperkuat dengan menambah jumlah sengkang atau menambah jumlah tulangan memanjang (tulangan utama).
3. Dapat juga dilakukan penelitian baru dengan mengambil benda uji yang telah mengalami retak untuk kemudian diberi perkuatan dengan *fiber glass*.

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PEMERIKSAAN GRADASI BESAR BUTIRAN *SPLIT*

Bahan : *Split*
Asal : Clereng
Diperiksa : 25 September 2013

DAFTAR AYAKAN

No. Saringan	Berat Saringan (gram)	Berat Saringan + Tertahan (gram)	Berat Tertahan (gram)	Σ Berat Tertahan (gram)	Persentase Σ Berat Tertahan (%)	Persentase Lolos (%)
¾"	559	559	0	0	0	100
½"	462	508	46	46	0,46	95,4
3/8"	547	955	408	454	45,4	54,6
No. 4	416	935	519	973	97,3	2,7
No. 8	329	342	13	986	98,6	1,4
No. 30	295	297	2	988	98,8	1,2
No. 50	294	295	1	989	98,9	1,1
No. 100	286	289	3	992	99,2	0,8
No. 200	339	342	3	995	99,5	0,5
Pan	378	383	5	1000	100	0
Total	-	-	1000	-	642,3	-

$$\text{Modulus Halus Butir} = \frac{642,3}{100} = 6,423$$

Kesimpulan: MHB *split* $6 \leq 6,423 \leq 7,1$ Syarat terpenuhi (OK)

Yogyakarta, 16 Desember 2013

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PEMERIKSAAN BERAT JENIS DAN PENYERAPAN *SPLIT*

Bahan : *Split*
Asal : Clereng
Diperiksa : 25 September 2013

	Nomor Pemeriksaan	I
A	Berat Contoh Kering	984 gram
B	Berat Contoh Jenuh Kering Permukaan (SSD)	999 gram
C	Berat Contoh Dalam Air	631 gram
D	Berat Jenis $Bulk = \frac{(A)}{(B) - (C)}$	2,6739
E	Berat Jenis Jenuh Kering Permukaan (SSD) $= \frac{(B)}{(B) - (C)}$	2,7147
F	Berat Jenis Semu (<i>Apparent</i>) $= \frac{(A)}{(A) - (C)}$	2,7875
G	Penyerapan (<i>Absorption</i>) $= \frac{(B) - (A)}{(A)} \times 100 \%$	1,5244%
H	Berat Jenis Rerata	2,7307

Kesimpulan: Berat jenis *split* $2,4 < 2,7307 < 3$, Syarat terpenuhi (OK)

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PEMERIKSAAN KANDUNGAN LUMPUR DALAM *SPLIT*

- I. Waktu Pemeriksaan: 25 September 2013
- II. Bahan
- a. *Split* kering tungku asal : Clereng, Berat: 100 gram
 - b. Air jernih asal : LSBB Prodi TS FT-UAJY
- III. Alat
- a. Pan
 - b. Timbangan
 - c. Tungku (*oven*), suhu dibuat antara 105-110°C
 - d. Air tetap jernih setelah 2 kali pencucian dalam air
 - e. *Split*+pan masuk tungku tanggal 25 September 2013 jam 12.00 WIB
- IV. Hasil
- Setelah pasir keluar tungku tanggal 26 September jam 12.00 WIB
- a. Berat pan+*split* = 227 gram
 - b. Berat piring kosong = 128 gram
 - c. Berat *split* = 99 gram

$$\text{Kandungan Lumpur} = \frac{100 - 99}{100} \times 100\% = 1\%$$

Kesimpulan: Kandungan lumpur $1\% \leq 1\%$, Syarat terpenuhi (OK)

Pemeriksa

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PEMERIKSAAN LOS ANGELES ABRASION TEST

Bahan : *Split*
Asal : Clereng
Diperiksa : 25 September 2013

Gradasi Saringan		Nomor Contoh
		I
<i>Lolos</i>	<i>Tertahan</i>	<i>Berat Masing-Masing Agregat</i>
$\frac{3}{4}"$	$\frac{1}{2}"$	2500 gram
$\frac{1}{2}"$	$\frac{3}{8}"$	2500 gram

Nomor Contoh	I
Berat sebelumnya (A)	5000 gram
Berat sesudah diayak saringan No. 12 (B)	3752 gram
Berat sesudah (A)-(B)	1248 gram
$\text{Keausan} = \frac{(A)-(B)}{(A)} \times 100\%$	24,96%
Keausan Rata-rata	24,96%

Kesimpulan: Keausan agregat kasar 24,96% < 40%, Syarat terpenuhi (OK)

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PEMERIKSAAN GRADASI BESAR BUTIRAN PASIR

Bahan : Pasir
Asal : Sungai Progo
Diperiksa : 25 September 2013

DAFTAR AYAKAN

No. Saringan	Berat Saringan (gram)	Berat Saringan + Tertahan (gram)	Berat Tertahan (gram)	Σ Berat Tertahan (gram)	Persentase Σ Berat Tertahan (%)	Persentase Lolos (%)
3/4"	558	558	0	0	0	100
1/2"	462	466	4	4	0,4	99,6
3/8"	547	553	6	10	1	99
No. 4	416	429	13	23	2,3	97,7
No. 8	329	357	28	51	5,1	94,9
No. 30	295	630	335	386	38,6	61,4
No. 50	294	660	366	752	75,2	24,8
No. 100	286	520	234	986	98,6	1,4
No. 200	339	351	12	998	99,8	0,2
Pan	377	379	2	1000	100	0
Total	-	-	1000	-	321	-

$$\text{Modulus Halus Butir} = \frac{321}{100} = 3,21$$

Kesimpulan: MHB pasir $1,5 \leq 3,21 \leq 3,8$ Syarat terpenuhi (OK)

Yogyakarta, 16 Desember 2013

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PEMERIKSAAN BERAT JENIS DAN PENYERAPAN PASIR

Bahan : Pasir
Asal : Sungai Progo
Diperiksa : 25 September 2013

	Nomor Pemeriksaan	I
A	Berat Contoh Jenuh Kering Permukaan (SSD) – (500)	500 gram
B	Berat Contoh Kering	491 gram
C	Berat Labu+Air, Temperatur 25°C	709 gram
D	Berat Labu+Contoh (SSD) + Air, Temperatur 25°C	1023 gram
E	Berat Jenis <i>Bulk</i> = $\frac{(A)}{(C + 500 - D)}$	2,6882
F	Berat Jenis Jenuh Kering Permukaan (SSD) = $\frac{(B)}{(C + 500 - D)}$	2,6398
G	Berat Jenis Semu (<i>Apparent</i>) = $\frac{(B)}{(C + B - D)}$	2,7740
H	Penyerapan (<i>Absorption</i>) = $\frac{(500 - B)}{(B)} \times 100 \%$	1,833%
I	Berat Jenis Rerata	2,7311

Kesimpulan: Berat jenis pasir $2,4 < 2,7311 < 2,9$, Syarat terpenuhi (OK)

Pemeriksa

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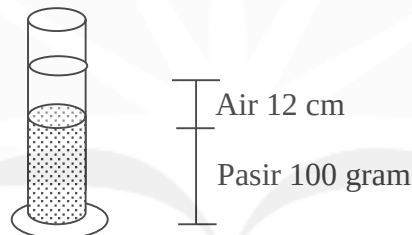


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PEMERIKSAAN KANDUNGAN LUMPUR DALAM PASIR

- I. Waktu Pemeriksaan:
- II. Bahan
- a. Pasir kering tungku, Asal : Sungai Progo, Berat: 100 gram
 - b. Air jernih asal : LSBB Prodi TS FT-UAJY
- III. Alat
- a. Gelas ukur, ukuran: 250 cc
 - b. Timbangan
 - c. Tungku (*oven*), suhu dibuat antara 105-110°C
 - d. Air tetap jernih setelah 5 kali pengocokan
 - e. Pasir+piring masuk tungku tanggal 25 September 2013 jam 13.00 WIB
- IV. Sketsa



- V. Hasil
- Setelah pasir keluar tungku tanggal 26 September 2013 jam 13.00 WIB
- a. Berat piring+pasir = 215,75 gram
 - b. Berat piring kosong = 115,75 gram
 - c. Berat pasir = 99,7 gram

$$\text{Kadar Lumpur} = \frac{100 - 99,7}{100} \times 100\% = 0,3\%$$

Kesimpulan: Kandungan lumpur $0,3\% \leq 5\%$, Syarat terpenuhi (OK)

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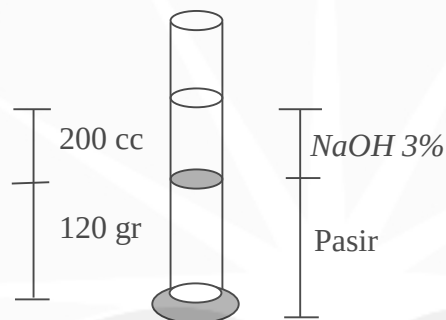


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PEMERIKSAAN KANDUNGAN ZAT ORGANIK DALAM PASIR

- I. Waktu Pemeriksaan: 25 September 2013
- II. Bahan
- a. Pasir kering tungku, Asal: Sungai Progo, Volume: 120 gram
 - b. Larutan NaOH 3%
- III. Alat
- Gelas ukur, ukuran: 250cc
- IV. Sketsa



- V. Hasil
- Setelah didiamkan selama 24 jam, warna larutan di atas pasir sesuai dengan warna *Gardner Standard Color* No. 8.

Yogyakarta, 16 Desember 2013

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PENGUJIAN KUAT TARIK BAJA BETON

Diameter = 7,58 mm

$$A_o = \frac{1}{4} \times \pi \times d^2 = \frac{1}{4} \times \pi \times 7,58^2 = 45,1262 \text{ mm}^2$$

Po = 108,1 – 5,9 = 102,2 mm

x koreksi = 0,8011

1 kgf = 9,80671 N

Beban		Pembacaan pada <i>extensometer</i>	f (MPa)	ϵ (10^{-4})	ϵ koreksi (10^{-4})
kgf	N				
0	0,0000	0	0,0000	0,8011	0,0000
50	490,3355	1	10,8659	1,3611	0,5600
100	980,6710	2	21,7317	1,9211	1,1200
150	1471,0065	2,5	32,5976	2,4811	1,6800
200	1961,3420	3	43,4635	2,9902	2,1891
250	2451,6775	4	54,3294	3,5502	2,7491
300	2942,0130	5	65,1952	4,1102	3,3091
350	3432,3485	5	76,0611	4,6702	3,8691
400	3922,6840	5,5	86,9270	5,2302	4,4291
450	4413,0195	6	97,7928	5,7902	4,9891
500	4903,3550	6,5	108,6587	6,3502	5,5491
550	5393,6905	7	119,5246	6,9101	6,109
600	5884,0260	7,5	130,3905	7,4192	6,6181
650	6374,3615	8	141,2563	7,9792	7,1781
700	6864,6970	9	152,1222	8,5392	7,7381
750	7355,0325	9,5	162,9881	9,0992	8,2981
800	7845,3680	10	173,8539	9,6592	8,8581
850	8335,7035	10,5	184,7198	10,2192	9,4181
900	8826,0390	11	195,5857	10,7792	9,9781
950	9316,3745	11,5	206,4516	11,2883	10,4872
1000	9806,7100	12	217,3174	11,8483	11,0472
1050	10297,0455	12,5	228,1833	12,4083	11,6072
1100	10787,3810	13,5	239,0492	12,9683	12,1672
1150	11277,7165	14	249,9150	13,5283	12,7272
1200	11768,0520	14,5	260,7809	14,0883	13,2872
1250	12258,3875	15	271,6468	14,6483	13,8472
1300	12748,7230	15	282,5127	15,2083	14,4072
1350	13239,0585	16	293,3785	15,7174	14,9163
1400	13729,3940	16,5	304,2444	16,2774	15,4763
1450	14219,7295	17	315,1103	16,8373	16,0362
1460	14317,7966	17	317,2835	16,9392	16,1381
1470	14415,8637	30	319,4566	17,0410	16,2399
1480	14513,9308	35	321,6298	17,1937	16,3926



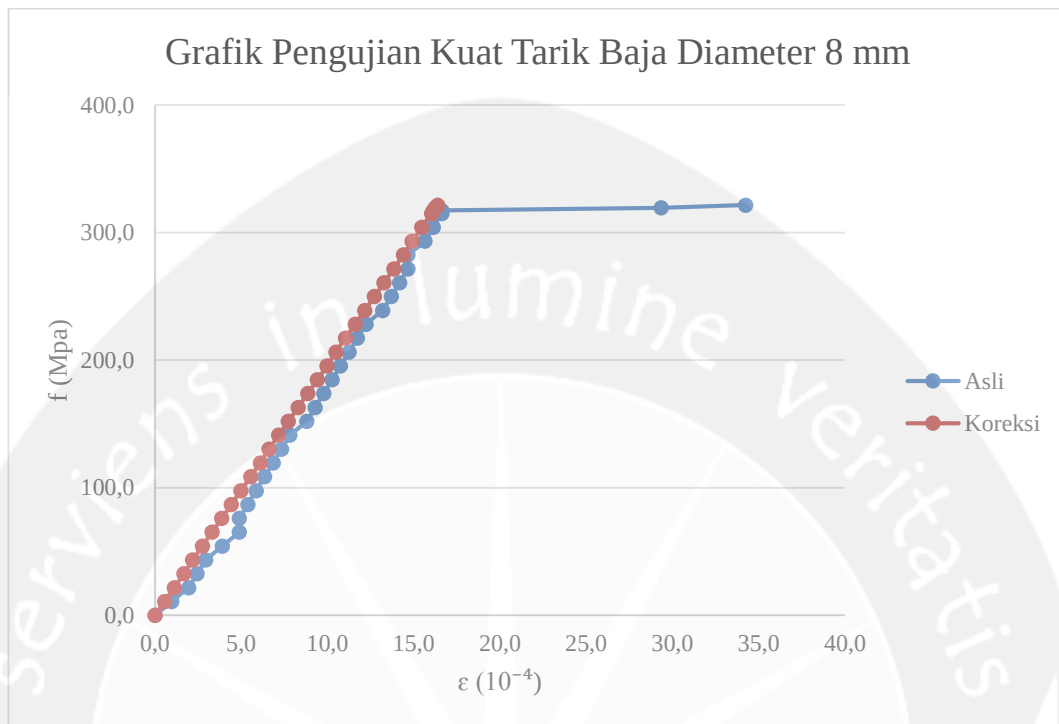
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$$f_p = f_y = 315,1103 \text{ MPa}$$

$$\epsilon_p = 16,0362 \times 10^{-4}$$

$$E = \frac{315,1103}{16,0362 \times 10^{-4}} = 196498,7817 \text{ MPa}$$

$$f_u = \frac{2140 \times 9,80671}{45,1262} = 465,0593 \text{ MPa}$$

Yogyakarta, 16 Desember 2013

Pemeriksa

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Lampiran B	74
Perencanaan Adukan Beton Normal	

TATA CARA PEMBUATAN RENCANA CAMPURAN BETON NORMAL
(SNI 03-2834-1993)

No	Uraian	Tabel /Grafik/ Perhitungan	Nilai
1	Kuat tekan yang disyaratkan	Ditetapkan	20 MPa
2	Tingkat pengendalian mutu	Ditetapkan	Memuaskan
3	Deviasi standar	Tabel 1	2,8 MPa
4	Nilai tambah	$1,64 \times 2,8 \text{ MPa}$	4,592 MPa
5	Kekuatan rata-rata yang ditargetkan	No. 1 + No. 4	$20 \text{ Mpa} + 4,592 \text{ Mpa} = 24,592 \text{ MPa}$
6	Jenis semen	Ditetapkan	Tipe I
7	Jenis agregat kasar	Ditetapkan	Batu pecah
8	Jenis agregat halus	Ditetapkan	Pasir alam
9	Faktor air semen bebas	Tabel 2	0,6
10	Faktor air semen bebas	Grafik 1	0,5764
11	Faktor air semen maksimum	No. 9 dan No. 10 diambil yang terkecil	0,5764
12	<i>Slump</i>	Tabel 3	75 mm -150 mm
13	Ukuran agregat maksimum	Ditetapkan	10 mm
14	Kadar air bebas	Tabel 4, $\frac{2}{3}W_h + \frac{1}{3}W_k$	$\frac{2}{3} \times 225 + \frac{1}{3} \times 250 = 233,3333$ kg/m ³
15	Jumlah semen maksimum	No. 14 : No. 11	$233,3333 : 0,5764 = 404,8114$ kg/m ³
16	Jumlah semen minimum	Tabel 2	275 kg/m ³
17	Jumlah semen	No. 15 atau No. 16 diambil yang terbesar	404,8114 kg/m ³
18	Faktor air semen yang disesuaikan	No. 14 : No. 17	0,5764
19	Susunan besar butir agregat halus	Diketahui	Daerah 3
20	Persen agregat halus	Grafik 2	43,3333%
21	Berat jenis relatif, agregat	Diketahui	2,7311 kg/m ³

Lampiran B	75
Perencanaan Adukan Beton Normal	

22	Berat isi beton	Grafik 3	2387,5 kg/m ³
23	Kadar agregat gabungan	No.22 – (No. 17 + No. 14)	2387,5 - (404,8114 + 233,333) = 1749,3553 kg/m ³
24	Kadar agregat halus	No. 20 x No. 23	43,3333% x 1749,3553 = 758,0534 kg/m ³
25	Kadar agregat kasar	No. 23 – No. 24	1749,3553 – 758,0534 = 991,3019 kg/m ³
26	Proporsi campuran	Semen	404,8114 kg/m ³
		Air	233,3333 kg/m ³
		Agregat halus	758,0534 kg/m ³
		Agregat Kasar	991,3019 kg/m ³

Tabel 1. Nilai Deviasi Standar Berdasarkan Tingkat Pengendalian Mutu Pelaksanaan

Tingkat pengendalian mutu pekerjaan	Sd (MPa)
Memuaskan	2,8
Sangat baik	3,5
Baik	4,2
Cukup	5,6
Jelek	7,0
Tanpa kendali	8,4

Tabel 2. Persyaratan Jumlah Semen Minimum Dan Faktor Air Semen Untuk Berbagai Macam Pembetonan Dalam Lingkungan Khusus

Lokasi	Jumlah semen minimum per m ³ beton (kg)	Nilai faktor air semen
Beton di dalam ruang bangunan :		
a. Keadaan keliling non-korosif	275	0,60
b. Keadaan keliling korosif disebabkan oleh kondensasi uap atau uap korosif	325	0,52
Beton di luar ruangan bangunan :		
a. Tidak terlindung dari hujan dan terik matahari langsung	325	0,60
b. Terlindung dari hujan dan terik matahari langsung	275	0,60

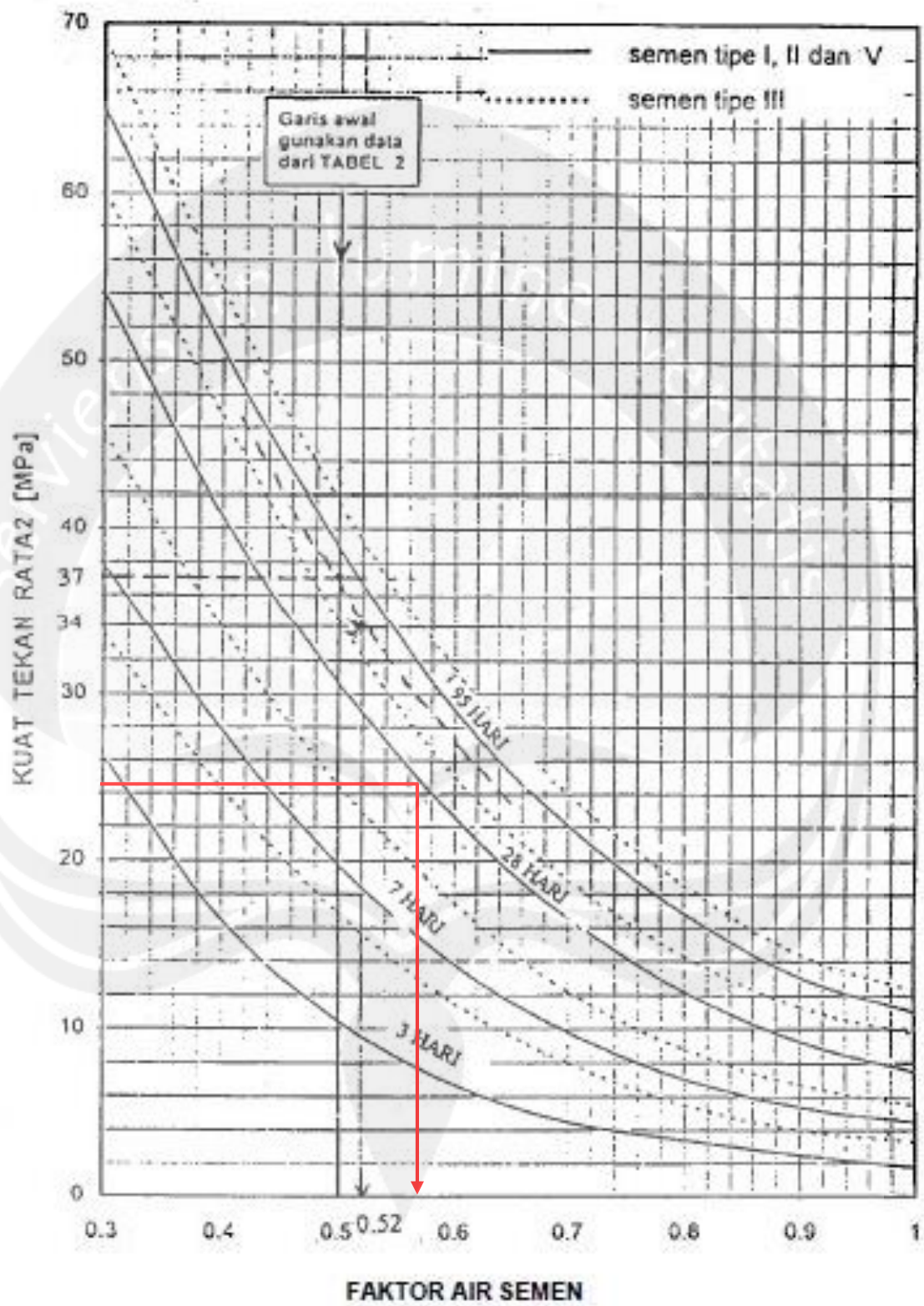
Lampiran B	76
Perencanaan Adukan Beton Normal	

Tabel 3. Nilai *Slump* (cm)

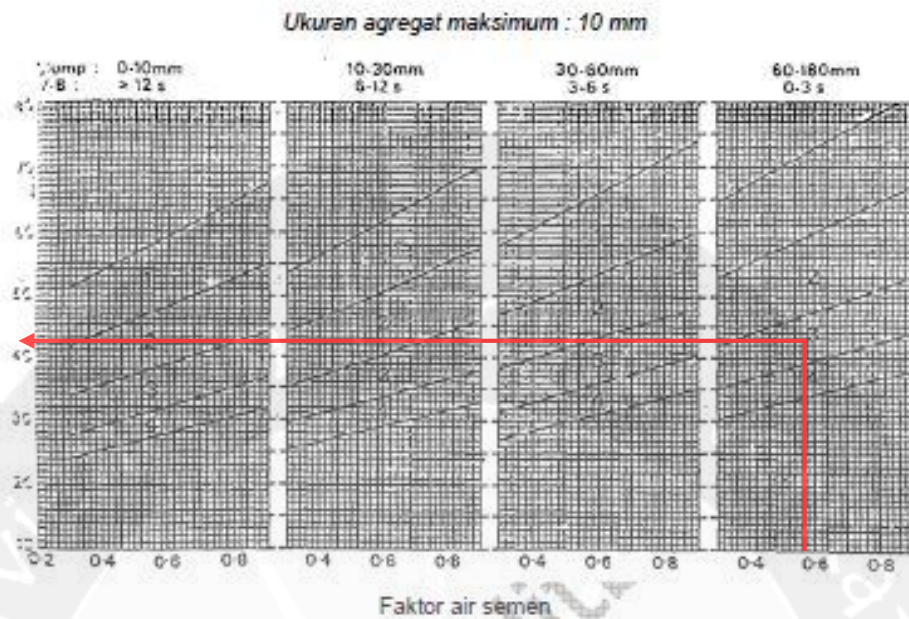
Pemakaian beton	Maksimum	Minimum
Dinding, plat fondasi, dan fondasi telapak bertulang	12,5	5,0
Fondasi telapak tidak bertulang, kaison, dan struktur di bawah tanah	9,0	2,5
Plat, balok, kolom, dan dinding	15,0	7,5
Pengerasan jalan	7,5	5,0
Pembetonan massa	7,5	2,5

Tabel 4. Perkiraan Kadar Air Bebas (kg/m^3) Yang Dibutuhkan Untuk Beberapa Tingkat Kemudahan Pengerjaan Adukan Beton

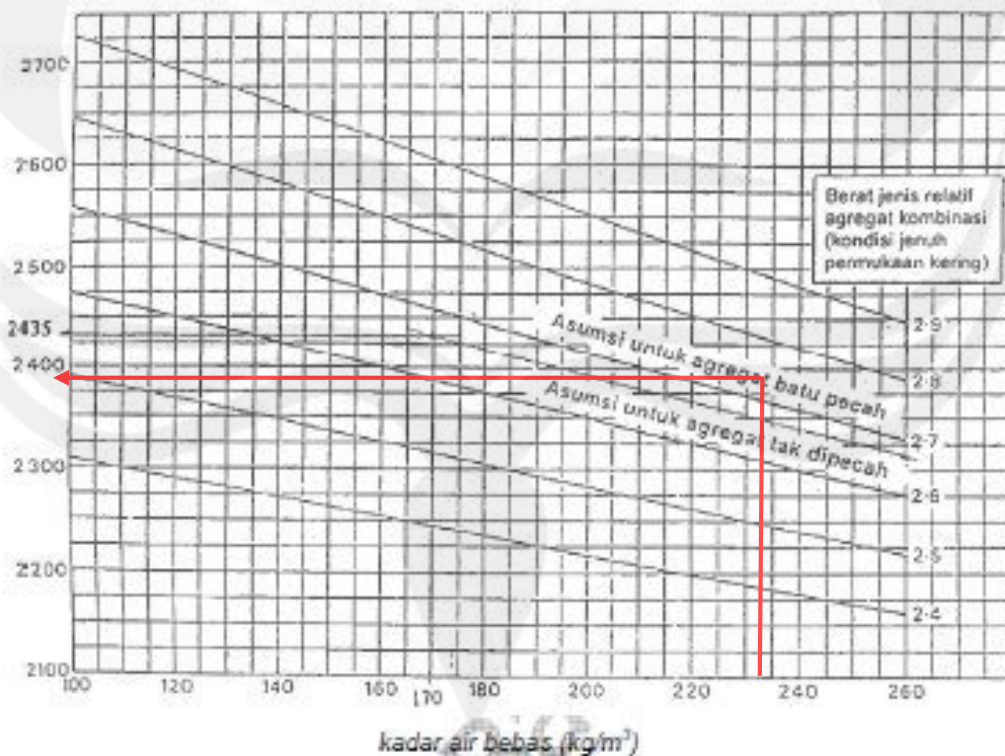
<i>Slump</i> (mm)		0-10	10-30	30-60	60-180
Ukuran besar butir agregat maksimum (mm)	Jenis agregat	-	-	-	-
10	Batu tak dipecahkan	150	180	205	225
	Batu pecah	180	205	230	250
20	Batu tak dipecahkan	135	160	180	195
	Batu pecah	170	190	210	225
40	Batu tak dipecahkan	115	140	160	175
	Batu pecah	155	175	190	205



Grafik 1. Hubungan Antara Kuat Tekan Dan Faktor Air Semen



Grafik 2. Persen Pasir Terhadap Kadar Total Agregat Yang Dianjurkan Untuk Ukuran Butir Maksimum 10 mm



Grafik 3. Perkiraan Berat Isi Beton Basah Yang Telah Selesai Dipadatkan

PERHITUNGAN KELANGSINGAN KOLOM

Untuk kolom yang tidak dapat bergoyang

Tumpuan sendi-sendi ($k = 1$)

$$l_u = 750 \text{ mm}$$

$$M_1 = M_2 = M$$

$$b = h = 120 \text{ mm}$$

$$r = \sqrt{\frac{I}{A}} = \sqrt{\frac{\frac{1}{12} \times 120 \times 120^3}{120 \times 120}} = 20\sqrt{3} \text{ mm}$$

$$\frac{kl_u}{r} \leq 34 - 12 \left(\frac{M_1}{M_2} \right) = \frac{1 \times 750}{20\sqrt{3}} \leq 34 - 12 \left(\frac{M}{M} \right) = \frac{1 \times 750}{20\sqrt{3}} \leq 34 - 12(1) = 21,6506 \leq 22$$

Dengan demikian, kolom termasuk dalam klasifikasi kolom pendek.

PERHITUNGAN BEBAN MAKSIMUM SECARA TEORITIS

1. Kolom normal dengan eksentrisitas di keruntuhan *balanced*

$$\begin{aligned}
 d &= 8 \text{ mm} \\
 b = h &= 120 \text{ mm} \\
 f'_c &= 30,5397 \text{ MPa} \\
 f_y &= 315,1103 \text{ MPa} \\
 E_s &= 196498,7817 \\
 \text{Selimut beton} &= 15 \text{ mm} \\
 \text{Sengkang} &= 6 \text{ mm} \\
 d'_s &= 25 \text{ mm} \\
 d &= 95 \text{ mm}
 \end{aligned}$$

$$\begin{aligned}
 A_s = A'_s &= 2 \times \frac{1}{4} \pi \times d^2 = 2 \times \frac{1}{4} \pi \times 8^2 \\
 &= 100,531 \text{ mm}^2
 \end{aligned}$$

$$\begin{aligned}
 c_b &= \frac{0,003}{0,003 + \frac{f_y}{E_s}} \times d = \frac{0,003}{0,003 + \frac{315,1103}{196498,7817}} \times 95 \\
 &= 61,9077 \text{ mm}
 \end{aligned}$$

$$\begin{aligned}
 \beta_1 &= 0,85 - \frac{0,05 \times (f'_c - 30)}{7} = 0,85 - \frac{0,05 \times (30,5397 - 30)}{7} \\
 &= 0,8461
 \end{aligned}$$

$$\begin{aligned}
 a_b &= \beta_1 c_b = 0,8461 \times 61,9077 \\
 &= 52,3801 \text{ mm}
 \end{aligned}$$

$$\begin{aligned}
 f'_s &= 0,003 E_s \frac{c_b - d'}{c_b} = 0,003 \times 196498,7817 \frac{61,9077 - 25}{61,9077} \\
 &= 351,4418 \text{ MPa} > f_y, \text{ maka } f'_s = f_y = 315,1103 \text{ MPa}
 \end{aligned}$$

$$\begin{aligned}
 f_s &= 0,003 E_s \frac{d - c_b}{c_b} = 0,003 \times 196498,7817 \frac{95 - 61,9077}{61,9077} \\
 &= 315,1109 \text{ MPa} > f_y, \text{ maka } f'_s = f_y = 315,1103 \text{ MPa}
 \end{aligned}$$

$$\begin{aligned}
 C_c &= 0,85 f'_c b a_b = 0,85 \times 30,5397 \times 120 \times 52,3801 \\
 &= 163166,5991 \text{ N}
 \end{aligned}$$

$$\begin{aligned}
 C_s &= A'_s (f'_s - 0,85 f'_c) = 100,531 (315,1103 - 0,85 \times 30,5397) \\
 &= 29068,695 \text{ N}
 \end{aligned}$$

$$T_s = A_s f_s = 100,531 \times 315,1103 = 31678,3536 \text{ N}$$

$$P_{nb} = C_c + C_s - T_s = 163166,5991 + 29068,695 - 31678,3536 = 160556,9405 \text{ N}$$

$$M_{nb} = C_c \times \left(\bar{y} - \frac{a_b}{2} \right) + C_s \times (\bar{y} - d') + T_s \times (d - \bar{y})$$

$$= 163166,5991 \times \left(60 - \frac{52,3801}{2} \right) + 29068,695 \times (60 - 25) + 31678,3536 \times (95 - 60)$$

$$= 7642801,258 \text{ Nmm}$$

$$e_b = \frac{M_{nb}}{P_{nb}} = \frac{7642801,258}{160556,9405} = 47,5988 \text{ mm}$$

2. Kolom normal dengan eksentrisitas 70 mm (keruntuhan tarik) $\Leftrightarrow$ E70N1

$$\begin{aligned} d &= 8 \text{ mm} \\ b = h &= 120 \text{ mm} \\ f'_c &= 21,6572 \text{ MPa} \\ \beta_1 &= 0,85 \\ f_y &= 315,1103 \text{ MPa} \\ E_s &= 196498,7817 \\ \text{Selimut beton} &= 15 \text{ mm} \\ \text{Sengkang} &= 6 \text{ mm} \\ d'_s &= 25 \text{ mm} \\ d &= 95 \text{ mm} \end{aligned}$$

Asumsi tulangan tekan sudah luluh ($f'_s = f_y$)

$$m = \frac{f_y}{0,85 f'_c} = \frac{315,1103}{0,85 \times 21,6572} = 17,1175$$

$$\rho = \frac{A_s}{bd} = \frac{100,531}{120 \times 95} = 8,8185 \cdot 10^{-3}$$

$$\begin{aligned}
 Pn &= 0,85 f'_c b d \left[\frac{h-2e}{2d} + \sqrt{\left(\frac{h-2e}{2d} \right)^2 + 2m\rho \left(1 - \frac{d'}{d} \right)} \right] \\
 &= 0,85 \times 21,6572 \times 120 \times 95 \\
 &= \left[\frac{120 - 2 \times 70}{2 \times 95} + \sqrt{\left(\frac{120 - 2 \times 70}{2 \times 95} \right)^2 + 2 \times 17,1175 \times 8,8185 \times 10^{-3} \left(1 - \frac{25}{95} \right)} \right] \\
 &= 79324,4010 \text{ N}
 \end{aligned}$$

Cek regangan tulangan tekan ε'_s

$$\begin{aligned}
 C_c &= 0,85 f'_c b \beta_1 c_b = 0,85 \times 21,6572 \times 120 \times 0,85 \times c \\
 &= 1877,6792c
 \end{aligned}$$

$$\begin{aligned}
 C_s &= A'_s (f_y - 0,85 f'_c) = 100,531(315,1103 - 0,85 \times 21,6572) \\
 &= 29827,7166 \text{ N}
 \end{aligned}$$

$$\begin{aligned}
 T_s &= A_s f_y = 100,531 \times 315,1103 \\
 &= 31678,3536 \text{ N}
 \end{aligned}$$

$$Pn = C_c + C_s - T_s$$

$$79324,4010 \text{ N} = 1877,6792c + 29827,7166 - 31678,3536$$

$$c = 43,2316 \text{ mm}$$

$$\begin{aligned}
 \varepsilon_y &= \frac{f_y}{E_s} = \frac{315,1103}{196498,7817} \\
 &= 1,6036 \cdot 10^{-3}
 \end{aligned}$$

$$\begin{aligned}
 \varepsilon'_s &= \frac{c - d'_s}{c} 0,003 = \frac{43,2316 - 25}{43,2316} 0,003 \\
 &= 1,2652 \cdot 10^{-3} < \varepsilon_y (1,6036 \cdot 10^{-3}), \text{ maka belum luluh, asumsi salah}
 \end{aligned}$$

$$\Sigma Ma = C_c \left\{ e - \left(\frac{h}{2} - \frac{\beta_1 c}{2} \right) \right\} + C_s \left\{ e - \left(\frac{h}{2} - d'_s \right) \right\} - T \left(d - \frac{h}{2} + e \right)$$

$$\begin{aligned}
 0 &= 1877,6792c \left\{ 70 - \left(\frac{120}{2} - \frac{0,85c}{2} \right) \right\} \\
 &+ 100,531 \left\{ \left(196498,7817 \frac{c - 25}{c} 0,003 \right) - 0,85 \times 21,6572 \right\} \left\{ 70 - \left(\frac{120}{2} - 25 \right) \right\} \\
 &- 31678,3536 \left(95 - \frac{120}{2} + 70 \right)
 \end{aligned}$$

$$c = 45,0706 \text{ mm}$$

$$\begin{aligned} C_c &= 1877,6792c = 1877,6792 \times 45,0706 \\ &= 84628,1282 \text{ N} \end{aligned}$$

$$\begin{aligned} C_s &= A'_s (f'_s - 0,85 f'_c) \\ &= 100,531(196498,7817 \frac{45,0706 - 25}{45,0706} - 0,85 \times 21,6572) \\ &= 24539,8944 \text{ N} \end{aligned}$$

$$\begin{aligned} T_s &= A_s f_y = 100,531 \times 315,1103 \\ &= 31678,3536 \text{ N} \end{aligned}$$

$$\begin{aligned} P_n &= C_c + C_s - T_s = 84628,1282 + 24539,8944 - 31678,3536 \\ &= 77489,669 \text{ N} = 77,4897 \text{ kN} \end{aligned}$$

3. Kolom normal dengan eksentrisitas 70 mm (keruntuhan tarik) $\Leftrightarrow$ E70N2 dan E70N3

$$\begin{aligned} d &= 8 \text{ mm} \\ b = h &= 120 \text{ mm} \\ f'_c &= 30,5397 \text{ MPa} \\ \beta_1 &= 0,8461 \\ f_y &= 315,1103 \text{ MPa} \\ E_s &= 196498,7817 \\ \text{Selimut beton} &= 15 \text{ mm} \\ \text{Sengkang} &= 6 \text{ mm} \\ d'_s &= 25 \text{ mm} \\ d &= 95 \text{ mm} \end{aligned}$$

Asumsi tulangan tekan sudah luluh ($f'_s = f_y$)

$$\begin{aligned} m &= \frac{f_y}{0,85 f'_c} = \frac{315,1103}{0,85 \times 30,5397} \\ &= 12,1389 \end{aligned}$$

$$\begin{aligned} \rho &= \frac{A_s}{bd} = \frac{100,531}{120 \times 95} \\ &= 8,8185 \cdot 10^{-3} \end{aligned}$$

$$\begin{aligned}
 P_n &= 0,85 f'_c b d \left[\frac{h-2e}{2d} + \sqrt{\left(\frac{h-2e}{2d} \right)^2 + 2m\rho \left(1 - \frac{d'}{d} \right)} \right] \\
 &= 0,85 \times 30,5397 \times 120 \times 95 \\
 &= \times \left[\frac{120 - 2 \times 70}{2 \times 95} + \sqrt{\left(\frac{120 - 2 \times 70}{2 \times 95} \right)^2 + 2 \times 12,1389 \times 8,8185 \times 10^{-3} \left(1 - \frac{25}{95} \right)} \right] \\
 &= 90445,1564 \text{ N}
 \end{aligned}$$

Cek regangan tulangan tekan ε'_s

$$\begin{aligned}
 C_c &= 0,85 f'_c b \beta_1 c_b = 0,85 \times 30,5397 \times 120 \times 0,8461 \times c \\
 &= 2635,6433c
 \end{aligned}$$

$$\begin{aligned}
 C_s &= A'_s (f_y - 0,85 f'_c) = 100,531(315,1103 - 0,85 \times 30,5397) \\
 &= 29068,695 \text{ N}
 \end{aligned}$$

$$\begin{aligned}
 T_s &= A_s f_y = 100,531 \times 315,1103 \\
 &= 31678,3536 \text{ N}
 \end{aligned}$$

$$\begin{aligned}
 P_n &= C_c + C_s - T_s \\
 90445,1564 \text{ N} &= 2635,6433c + 29068,695 - 31678,3536
 \end{aligned}$$

$$c = 35,3063 \text{ mm}$$

$$\begin{aligned}
 \varepsilon_y &= \frac{f_y}{E_s} = \frac{315,1103}{196498,7817} \\
 &= 1,6036 \cdot 10^{-3}
 \end{aligned}$$

$$\begin{aligned}
 \varepsilon'_s &= \frac{c - d'_s}{c} 0,003 = \frac{35,3063 - 25}{35,3063} 0,003 \\
 &= 8,7573 \cdot 10^{-4} < \varepsilon_y (1,6036 \cdot 10^{-3}), \text{ maka belum luluh, asumsi salah}
 \end{aligned}$$

$$\Sigma M_a = C_c \left\{ e - \left(\frac{h}{2} - \frac{\beta_1 c}{2} \right) \right\} + C_s \left\{ e - \left(\frac{h}{2} - d'_s \right) \right\} - T \left(d - \frac{h}{2} + e \right)$$

$$\begin{aligned}
 0 &= 2635,6433c \left\{ 70 - \left(\frac{120}{2} - \frac{0,8461c}{2} \right) \right\} \\
 &+ 100,531 \left\{ \left(196498,7817 \frac{c-25}{c} 0,003 \right) - 0,85 \times 30,5397 \right\} \left\{ 70 - \left(\frac{120}{2} - 25 \right) \right\} \\
 &- 31678,3536 \left(95 - \frac{120}{2} + 70 \right) \\
 c &= 38,6549 \text{ mm} \\
 C_c &= 2635,6433c = 2635,6433 \times 38,6549 \\
 &= 101880,5282 \text{ N} \\
 C_s &= A'_s (f'_s - 0,85 f'_c) \\
 &= 100,531 (196498,7817 \frac{38,6549 - 25}{38,6549} 0,003 - 0,85 \times 30,5397) \\
 &= 18324,9618 \text{ N} \\
 T_s &= A_s f_y = 100,531 \times 315,1103 \\
 &= 31678,3536 \text{ N} \\
 P_n &= C_c + C_s - T_s = 101880,5282 + 18324,9618 - 31678,3536 \\
 &= 88527,1364 \text{ N} = 88,5271 \text{ kN}
 \end{aligned}$$

4. Kolom normal dengan eksentrisitas 90 mm (keruntuhan tarik) $\Leftrightarrow$ E90N1

$$\begin{aligned}
 d &= 8 \text{ mm} \\
 b = h &= 120 \text{ mm} \\
 f'_c &= 30,5397 \text{ MPa} \\
 \beta_1 &= 0,8461 \\
 f_y &= 315,1103 \text{ MPa} \\
 E_s &= 196498,7817 \\
 \text{Selimut beton} &= 15 \text{ mm} \\
 \text{Sengkang} &= 6 \text{ mm} \\
 d'_s &= 25 \text{ mm} \\
 d &= 95 \text{ mm}
 \end{aligned}$$

Asumsi tulangan tekan sudah luluh ($f'_s = f_y$)

$$\begin{aligned}
 m &= \frac{f_y}{0,85 f'_c} = \frac{315,1103}{0,85 \times 30,5397} \\
 &= 12,1389
 \end{aligned}$$

$$\rho = \frac{A_s}{bd} = \frac{100,531}{120 \times 95} = 8,8185 \cdot 10^{-3}$$

$$P_n = 0,85 f'_c b d \left[\frac{h - 2e}{2d} + \sqrt{\left(\frac{h - 2e}{2d} \right)^2 + 2m\rho \left(1 - \frac{d'}{d} \right)} \right]$$

$$= 0,85 \times 30,5397 \times 120 \times 95$$

$$\times \left[\frac{120 - 2 \times 90}{2 \times 95} + \sqrt{\left(\frac{120 - 2 \times 90}{2 \times 95} \right)^2 + 2 \times 12,1389 \times 8,8185 \times 10^{-3} \left(1 - \frac{25}{95} \right)} \right]$$

$$= 56709,5263 \text{ N}$$

Cek regangan tulangan tekan ε'_s

$$C_c = 0,85 f'_c b \beta_1 c_b = 0,85 \times 30,5397 \times 120 \times 0,8461 \times c$$

$$= 2635,6433c$$

$$C_s = A_s (f_y - 0,85 f'_c) = 100,531(315,1103 - 0,85 \times 30,5397)$$

$$= 29068,695 \text{ N}$$

$$T_s = A_s f_y = 100,531 \times 315,1103$$

$$= 31678,3536 \text{ N}$$

$$P_n = C_c + C_s - T_s$$

$$56709,5263 \text{ N} = 2635,6433c + 29068,695 - 31678,3536$$

$$c = 22,5065 \text{ mm}$$

$$\varepsilon_y = \frac{f_y}{E_s} = \frac{315,1103}{196498,7817}$$

$$= 1,6036 \cdot 10^{-3}$$

$$\varepsilon'_s = \frac{c - d'_s}{c} 0,003 = \frac{22,5065 - 25}{22,5065} 0,003$$

$$= -3,3237 \cdot 10^{-4} < \varepsilon_y (1,6036 \cdot 10^{-3}), \text{ maka belum luluh, asumsi salah}$$

$$\Sigma M_a = C_c \left\{ e - \left(\frac{h}{2} - \frac{\beta_1 c}{2} \right) \right\} + C_s \left\{ e - \left(\frac{h}{2} - d'_s \right) \right\} - T \left(d - \frac{h}{2} + e \right)$$

$$\begin{aligned}
 0 &= 2635,6433c \left\{ 90 - \left(\frac{120}{2} - \frac{0,8461c}{2} \right) \right\} \\
 &+ 100,531 \left\{ \left(196498,7817 \frac{c-25}{c} 0,003 \right) - 0,85 \times 30,5397 \right\} \left\{ 90 - \left(\frac{120}{2} - 25 \right) \right\} \\
 &- 31678,3536 \left(95 - \frac{120}{2} + 90 \right)
 \end{aligned}$$

$$c = 30,7848 \text{ mm}$$

$$\begin{aligned}
 C_c &= 2635,6433c = 2635,6433 \times 30,7848 \\
 &= 81137,7519 \text{ N}
 \end{aligned}$$

$$\begin{aligned}
 C_s &= A'_s (f'_s - 0,85 f'_c) \\
 &= 100,531 (196498,7817 \frac{30,7848 - 25}{30,7848} 0,003 - 0,85 \times 30,5397) \\
 &= 8526,4416 \text{ N}
 \end{aligned}$$

$$\begin{aligned}
 T_s &= A_s f_y = 100,531 \times 315,1103 \\
 &= 31678,3536 \text{ N}
 \end{aligned}$$

$$\begin{aligned}
 P_n &= C_c + C_s - T_s = 81137,7519 + 8526,4416 - 31678,3536 \\
 &= 57985,8399 \text{ N} = 57,9858 \text{ kN}
 \end{aligned}$$

5. Kolom dengan perkuatan *fiber glass* dengan eksentrisitas 70 mm (keruntuhan tarik) $\Leftrightarrow$ E70FG1

$$\begin{aligned}
 d &= 8 \text{ mm} \\
 b = h &= 120 \text{ mm} \\
 f'_c &= 32,4858 \text{ MPa} \\
 \beta_1 &= 0,8322 \\
 f_y &= 315,1103 \text{ MPa} \\
 E_s &= 196498,7817 \\
 \text{Selimut beton} &= 15 \text{ mm} \\
 \text{Sengkang} &= 6 \text{ mm} \\
 d'_s &= 25 \text{ mm} \\
 d &= 95 \text{ mm}
 \end{aligned}$$

Asumsi tulangan tekan sudah luluh ($f'_s = f_y$)

$$\begin{aligned}
 m &= \frac{f_y}{0,85 f'_c} = \frac{315,1103}{0,85 \times 32,4858} \\
 &= 11,4117
 \end{aligned}$$

$$P = \frac{A_s}{bd} = \frac{100,531}{120 \times 95} = 8,8185 \cdot 10^{-3}$$

$$P_n = 0,85 f'_c b d \left[\frac{h-2e}{2d} + \sqrt{\left(\frac{h-2e}{2d} \right)^2 + 2m\rho \left(1 - \frac{d'}{d} \right)} \right]$$

$$= 0,85 \times 32,4858 \times 120 \times 95 \times \left[\frac{120 - 2 \times 70}{2 \times 95} + \sqrt{\left(\frac{120 - 2 \times 70}{2 \times 95} \right)^2 + 2 \times 11,4117 \times 8,8185 \times 10^{-3} \left(1 - \frac{25}{95} \right)} \right]$$

$$= 92536,5022 \text{ N}$$

Cek regangan tulangan tekan ε'_s

$$C_c = 0,85 f'_c b \beta_1 c_b = 0,85 \times 32,4858 \times 120 \times 0,8322 \times c = 2757,5376c$$

$$C_s = A_s (f_y - 0,85 f'_c) = 100,531(315,1103 - 0,85 \times 32,4858) = 28902,3981 \text{ N}$$

$$T_s = A_s f_y = 100,531 \times 315,1103 = 31678,3536 \text{ N}$$

$$P_n = C_c + C_s - T_s$$

$$92536,5022 \text{ N} = 2757,5376c + 28902,3981 - 31678,3536$$

$$c = 34,5643 \text{ mm}$$

$$\varepsilon_y = \frac{f_y}{E_s} = \frac{315,1103}{196498,7817} = 1,6036 \cdot 10^{-3}$$

$$\varepsilon'_s = \frac{c - d'_s}{c} 0,003 = \frac{34,5643 - 25}{34,5643} 0,003 = 8,3013 \cdot 10^{-4} < \varepsilon_y (1,6036 \cdot 10^{-3}), \text{ maka belum luluh, asumsi salah}$$

$$\Sigma M_a = C_c \left\{ e - \left(\frac{h}{2} - \frac{\beta_1 c}{2} \right) \right\} + C_s \left\{ e - \left(\frac{h}{2} - d'_s \right) \right\} - T \left(d - \frac{h}{2} + e \right)$$

$$\begin{aligned}
 0 &= 2757,5376c \left\{ 70 - \left(\frac{120}{2} - \frac{0,8322c}{2} \right) \right\} \\
 &+ 100,531 \left\{ \left(196498,7817 \frac{c-25}{c} 0,003 \right) - 0,85 \times 32,4858 \right\} \left\{ 70 - \left(\frac{120}{2} - 25 \right) \right\} \\
 &- 31678,3536 \left(95 - \frac{120}{2} + 70 \right)
 \end{aligned}$$

$$c = 38,0602 \text{ mm}$$

$$\begin{aligned}
 C_c &= 2757,5376c = 2757,5376 \times 38,0602 \\
 &= 104952,4326 \text{ N}
 \end{aligned}$$

$$\begin{aligned}
 C_s &= A'_s (f'_s - 0,85 f'_c) \\
 &= 100,531 (196498,7817 \frac{38,0602 - 25}{38,0602} 0,003 - 0,85 \times 32,4858) \\
 &= 17559,7799 \text{ N}
 \end{aligned}$$

$$\begin{aligned}
 T_s &= A_s f_y = 100,531 \times 315,1103 \\
 &= 31678,3536 \text{ N}
 \end{aligned}$$

$$\begin{aligned}
 P_n &= C_c + C_s - T_s = 104952,4326 + 17559,7799 - 31678,3536 \\
 &= 90833,8589 \text{ N} = 90,8339 \text{ kN}
 \end{aligned}$$

6. Kolom dengan perkuatan *fiber glass* dengan eksentrisitas 70 mm (keruntuhan tarik) $\Leftrightarrow$ E70FG2 dan E70FG3

$$\begin{aligned}
 d &= 8 \text{ mm} \\
 b = h &= 120 \text{ mm} \\
 f'_c &= 45,8096 \text{ MPa} \\
 \beta_1 &= 0,7371 \\
 f_y &= 315,1103 \text{ MPa} \\
 E_s &= 196498,7817 \\
 \text{Selimut beton} &= 15 \text{ mm} \\
 \text{Sengkang} &= 6 \text{ mm} \\
 d'_s &= 25 \text{ mm} \\
 d &= 95 \text{ mm}
 \end{aligned}$$

Asumsi tulangan tekan sudah luluh ($f'_s = f_y$)

$$\begin{aligned}
 m &= \frac{f_y}{0,85 f'_c} = \frac{315,1103}{0,85 \times 45,8096} \\
 &= 8,0926
 \end{aligned}$$

$$\rho = \frac{A_s}{bd} = \frac{100,531}{120 \times 95} = 8,8185 \cdot 10^{-3}$$

$$P_n = 0,85 f'_c b d \left[\frac{h-2e}{2d} + \sqrt{\left(\frac{h-2e}{2d} \right)^2 + 2m\rho \left(1 - \frac{d'}{d} \right)} \right]$$

$$= 0,85 \times 45,8096 \times 120 \times 95$$

$$\times \left[\frac{120 - 2 \times 70}{2 \times 95} + \sqrt{\left(\frac{120 - 2 \times 70}{2 \times 95} \right)^2 + 2 \times 8,0926 \times 8,8185 \times 10^{-3} \left(1 - \frac{25}{95} \right)} \right]$$

$$= 104621,7162 \text{ N}$$

Cek regangan tulangan tekan ε'_s

$$C_c = 0,85 f'_c b \beta_1 c_b = 0,85 \times 45,8096 \times 120 \times 0,7371 \times c$$

$$= 3444,1581c$$

$$C_s = A'_s (f_y - 0,85 f'_c) = 100,531(315,1103 - 0,85 \times 45,8096)$$

$$= 27763,8614 \text{ N}$$

$$T_s = A_s f_y = 100,531 \times 315,1103$$

$$= 31678,3536 \text{ N}$$

$$P_n = C_c + C_s - T_s$$

$$104621,7162 \text{ N} = 3444,1581c + 27763,8614 - 31678,3536$$

$$c = 31,5131 \text{ mm}$$

$$\varepsilon_y = \frac{f_y}{E_s} = \frac{315,1103}{196498,7817}$$

$$= 1,6036 \cdot 10^{-3}$$

$$\varepsilon'_s = \frac{c - d'_s}{c} 0,003 = \frac{31,5131 - 25}{31,5131} 0,003$$

$$= 6,2004 \cdot 10^{-4} < \varepsilon_y (1,6036 \cdot 10^{-3}), \text{ maka belum luluh, asumsi salah}$$

$$\Sigma Ma = C_c \left\{ e - \left(\frac{h}{2} - \frac{\beta_1 c}{2} \right) \right\} + C_s \left\{ e - \left(\frac{h}{2} - d'_s \right) \right\} - T \left(d - \frac{h}{2} + e \right)$$

$$\begin{aligned}
 0 &= 3444,1581c \left\{ 70 - \left(\frac{120}{2} - \frac{0,7371c}{2} \right) \right\} \\
 &+ 100,531 \left\{ \left(196498,7817 \frac{c-25}{c} 0,003 \right) - 0,85 \times 45,8096 \right\} \left\{ 70 - \left(\frac{120}{2} - 25 \right) \right\} \\
 &- 31678,3536 \left(95 - \frac{120}{2} + 70 \right)
 \end{aligned}$$

$$c = 35,6652 \text{ mm}$$

$$\begin{aligned}
 C_c &= 3444,1581c = 3444,1581 \times 35,6652 \\
 &= 122836,5875 \text{ N}
 \end{aligned}$$

$$\begin{aligned}
 C_s &= A'_s (f'_s - 0,85 f'_c) \\
 &= 100,531 (196498,7817 \frac{35,6652 - 25}{35,6652} 0,003 - 0,85 \times 45,8096) \\
 &= 13807,2111 \text{ N}
 \end{aligned}$$

$$\begin{aligned}
 T_s &= A_s f_y = 100,531 \times 315,1103 \\
 &= 31678,3536 \text{ N}
 \end{aligned}$$

$$\begin{aligned}
 P_n &= C_c + C_s - T_s = 122836,5875 + 13807,2111 - 31678,3536 \\
 &= 104965,445 \text{ N} = 104,9654 \text{ kN}
 \end{aligned}$$

7. Kolom dengan perkuatan *fiber glass* dengan eksentrisitas 90 mm (keruntuhan tarik) $\Leftrightarrow$ E90FG1

$$\begin{aligned}
 D &= 8 \text{ mm} \\
 b = h &= 120 \text{ mm} \\
 f'_c &= 45,8096 \text{ MPa} \\
 \beta_1 &= 0,7371 \\
 f_y &= 315,1103 \text{ MPa} \\
 E_s &= 196498,7817 \\
 \text{Selimut beton} &= 15 \text{ mm} \\
 \text{Sengkang} &= 6 \text{ mm} \\
 d'_s &= 25 \text{ mm} \\
 d &= 95 \text{ mm}
 \end{aligned}$$

Asumsi tulangan tekan sudah luluh ($f'_s = f_y$)

$$\begin{aligned}
 m &= \frac{f_y}{0,85 f'_c} = \frac{315,1103}{0,85 \times 45,8096} \\
 &= 8,0926
 \end{aligned}$$

$$\rho = \frac{A_s}{bd} = \frac{100,531}{120 \times 95} = 8,8185 \cdot 10^{-3}$$

$$P_n = 0,85 f'_c b d \left[\frac{h-2e}{2d} + \sqrt{\left(\frac{h-2e}{2d} \right)^2 + 2m\rho \left(1 - \frac{d'}{d} \right)} \right]$$

$$= 0,85 \times 45,8096 \times 120 \times 95$$

$$\times \left[\frac{120 - 2 \times 90}{2 \times 95} + \sqrt{\left(\frac{120 - 2 \times 90}{2 \times 95} \right)^2 + 2 \times 8,0926 \times 8,8185 \times 10^{-3} \left(1 - \frac{25}{95} \right)} \right]$$

$$= 60751,6298 \text{ N}$$

Cek regangan tulangan tekan ε'_s

$$C_c = 0,85 f'_c b \beta_1 c_b = 0,85 \times 45,8096 \times 120 \times 0,7371 \times c$$

$$= 3444,1581c$$

$$C_s = A_s (f_y - 0,85 f'_c) = 100,531(315,1103 - 0,85 \times 45,8096)$$

$$= 27763,8614 \text{ N}$$

$$T_s = A_s f_y = 100,531 \times 315,1103$$

$$= 31678,3536 \text{ N}$$

$$P_n = C_c + C_s - T_s$$

$$60751,6298 \text{ N} = 3444,1581c + 27763,8614 - 31678,3536$$

$$c = 18,7756 \text{ mm}$$

$$\varepsilon_y = \frac{f_y}{E_s} = \frac{315,1103}{196498,7817}$$

$$= 1,6036 \cdot 10^{-3}$$

$$\varepsilon'_s = \frac{c - d'_s}{c} 0,003 = \frac{18,7756 - 25}{18,7756} 0,003$$

$$= -9,9455 \cdot 10^{-4} < \varepsilon_y (1,6036 \cdot 10^{-3}), \text{ maka belum luluh, asumsi salah}$$

$$\Sigma M_a = C_c \left\{ e - \left(\frac{h}{2} - \frac{\beta_1 c}{2} \right) \right\} + C_s \left\{ e - \left(\frac{h}{2} - d'_s \right) \right\} - T \left(d - \frac{h}{2} + e \right)$$

$$\begin{aligned}
 0 &= 3444,1581c \left\{ 90 - \left(\frac{120}{2} - \frac{0,7371c}{2} \right) \right\} \\
 &+ 100,531 \left\{ \left(196498,7817 \frac{c-25}{c} 0,003 \right) - 0,85 \times 45,8096 \right\} \left\{ 90 - \left(\frac{120}{2} - 25 \right) \right\} \\
 &- 31678,3536 \left(95 - \frac{120}{2} + 90 \right) \\
 c &= 27,7763 \text{ mm} \\
 C_c &= 3444,1581c = 3444,1581 \times 27,7763 \\
 &= 95665,9686 \text{ N} \\
 C_s &= A'_s (f'_s - 0,85 f'_c) \\
 &= 100,531 (196498,7817 \frac{27,7763-25}{27,7763} 0,003 - 0,85 \times 45,8096) \\
 &= 2008,9359 \text{ N} \\
 T_s &= A_s f_y = 100,531 \times 315,1103 \\
 &= 31678,3536 \text{ N} \\
 P_n &= C_c + C_s - T_s = 95665,9686 + 2008,9359 - 31678,3536 \\
 &= 65996,5509 \text{ N} = 65,9966 \text{ kN}
 \end{aligned}$$



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PENGUJIAN KUAT TEKAN BETON

Nama Benda Uji	Tanggal Pembuatan	Tanggal Pengujian	Diameter (mm)	Luas (mm ²)	Beban Maksimum (N)	Kuat Tekan (MPa)
Silinder 1	16 Oktober 2013	13 November 2013	153,3500	18469,5980	400000	21,6572
Silinder 2	17 Oktober 2013	14 November 2013	148,8670	17405,5100	530000	30,4501
Silinder 3	18Oktober 2013	15 November 2013	150,2500	17730,4126	540000	30,4561
Silinder 4	21Oktober 2013	18 November 2013	151,0000	17907,8635	550000	30,7128

Yogyakarta, 16 Desember 2013

Pemeriksa

Lisa Caroline/ 10 02 13436

HASIL PENGUJIAN KOLOM NORMAL

E70N1		E70N2		E70N3		E90N1	
Beban (kg)	Defleksi (mm)	Beban (kg)	Defleksi (mm)	Beban (kg)	Defleksi (mm)	Beban (kg)	Defleksi (mm)
2,2891	0,0049	131,6792	0,8924	170,5443	0,0342	708,6691	0,0430
50,3638	0,0043	150,2311	0,8924	204,6355	0,0341	757,7997	0,0707
100,3641	0,0202	210,1697	0,8951	250,1247	0,0351	850,5324	0,1176
151,7806	0,0439	271,0383	0,9085	307,3366	0,0363	1038,7982	0,2408
202,9418	0,0624	305,8980	0,9263	351,0948	0,0349	1103,2531	0,2969
252,7469	0,0860	363,4233	0,9501	415,3286	0,0352	1301,8119	0,4483
306,6842	0,0980	406,0930	0,9752	457,7101	0,0354	1475,9076	0,6019
353,9220	0,1066	464,7092	1,0070	518,3240	0,0359	1503,9976	0,6489
405,5146	0,1103	506,6639	1,0369	559,7374	0,0365	1706,8600	0,9578
450,5022	0,1286	554,1609	1,0911	606,4013	0,0360	1922,7471	1,2173
500,8455	0,1518	623,4415	1,1695	650,3004	0,0366	2003,1289	1,3846
554,4901	0,1706	648,0505	1,1947	709,1215	0,0360	2041,3287	1,3964
603,0100	0,1874	704,4683	1,2535	759,9846	0,0362	2073,9590	1,4287
649,0915	0,2013	755,0346	1,2947	820,2410	0,0359	2117,1685	1,4755
708,6657	0,2282	817,1360	1,3324	863,0082	0,0361	2150,8738	1,5142
752,3643	0,2530	869,8112	1,3633	903,2073	0,0356	2191,0488	1,5561
805,8413	0,2835	899,4807	1,3758	953,2114	0,0361	2260,9080	1,6402
851,0873	0,3100	933,7709	1,3881	1015,9337	0,0356	2361,7273	1,7682
909,9282	0,3478	971,5944	1,4068	1059,2970	0,0348	2442,0325	1,8631
956,5097	0,3799	1011,4529	1,4307	1109,7988	0,0362	2581,0681	2,0134
1001,5339	0,4032	1050,1464	1,4485	1137,2606	0,0362	2679,1372	2,1748
1066,1718	0,4205	1108,0914	1,4811	1203,3422	0,1112	2809,0674	2,2853
1101,8462	0,4381	1151,7670	1,5077	1250,1776	0,1504	2932,6685	2,4232
1163,3787	0,4733	1202,5945	1,5320	1342,0226	0,1512	3037,0535	2,5367
1201,4869	0,5015	1255,9871	1,5556	1422,6290	0,1520	3142,0505	2,6569
1256,3274	0,5318	1301,1498	1,5790	1497,2061	0,1518	3229,1614	2,7582
1305,6477	0,5649	1356,6520	1,6153	1572,9081	0,1519	3329,9775	2,8649
1350,7185	0,5772	1406,7142	1,5663	1646,6876	0,1524	3397,7434	2,9539
1400,5076	0,6186	1450,2767	1,5705	1711,2538	0,1595	3407,5969	3,0243
1450,0078	0,6525	1514,6844	1,5939	1755,0439	0,1706	3471,7109	3,0628
1514,4536	0,6784	1541,5231	1,6040	1852,4330	0,2079	3566,9478	3,1629
1556,0819	0,6920	1622,2970	1,6281	1928,9034	0,2159	3635,0310	3,2324
1621,3547	0,7261	1666,2307	1,6427	2003,9407	0,2345	3679,9739	3,2826
1655,2394	0,7434	1705,3558	1,6585	2076,9907	0,2564	3758,6467	3,3698
1703,3173	0,7711	1750,0352	1,6939	2153,8728	0,2840	3800,4258	3,4234
1753,3997	0,7938	1811,7144	1,7055	2246,0540	0,3197	3856,9421	3,4873
1804,4724	0,8202	1861,2642	1,7187	2343,3003	0,3595	3921,7966	3,5572
1859,1003	0,8796	1901,7324	1,7516	2401,5254	0,3918	3963,0403	3,6048
1907,5989	0,9008	1954,2233	1,7743	2456,9087	0,4199	4007,0701	3,6552
1953,8765	0,9220	2002,8856	1,7878	2526,2795	0,5200	4049,0757	3,6968
2006,2770	0,9603	2056,4731	1,8114	2599,9844	0,5450	4105,3726	3,7598
2057,2598	0,9867	2116,1636	1,8469	2675,3130	0,5736	4167,0537	3,8365
2100,6489	1,0157	2152,3162	1,8701	2751,2285	0,6103	4197,3267	3,8740
2158,2634	1,0567	2202,9646	1,8974	2841,8936	0,6504	4225,4326	3,9161
2234,9595	1,1428	2248,7603	1,9211	2928,6001	0,7088	4369,3623	4,0576
2278,4827	1,1682	2300,4199	1,9721	3016,4907	0,7694	4476,5093	4,1828
2302,9565	1,1825	2343,6807	1,9937	3106,5217	0,8384	4568,1553	4,2813
2352,3882	1,2210	2402,3662	2,0252	3204,8872	1,0450	4658,6108	4,3878
2401,9800	1,2505	2450,0156	2,1044	3234,1484	1,0549	4730,4165	4,4755
2469,6902	1,2782	2500,2002	2,1125	3321,2573	1,0913	4772,8354	4,5472
2500,1172	1,2994	2562,6667	2,1591	3436,8464	1,1496	4833,8071	4,6137
2567,2842	1,3482	2645,3188	2,2001	3551,6736	1,2265	4886,1470	4,6870

2605,3865	1,3935	2710,8994	2,2288	3664,8572	1,3175	4904,5259	4,8504
2666,9258	1,4395	2816,4189	2,3013	3766,4861	1,4132	4918,9014	4,8673
2712,6665	1,4719	2852,4128	2,3848	3842,4038	1,4994	5082,5728	5,0197
2768,7861	1,5178	2906,0286	2,4158	3900,2073	1,6852	5262,3730	5,3260
2816,3848	1,5636	2960,5508	2,4479	3918,5381	1,7284	5316,3901	5,9079
2869,6328	1,6053	3012,8457	2,4909	4030,4844	1,7866	5332,9063	6,2999
2907,5476	1,7380	3055,0881	2,5241	4105,0576	1,8390		
2961,8459	1,7674	3103,2336	2,5669	4193,6685	1,9035		
3000,9475	1,7953	3146,5271	2,6009	4285,2002	1,9809		
3051,6797	1,8308	3215,3499	2,6408	4390,1934	2,0707		
3118,2544	1,8923	3256,1326	2,6702	4490,3794	2,1650		
3163,5315	1,9252	3301,3181	2,7850	4503,0039	2,2929		
3219,4524	1,9681	3345,7915	2,8490	4564,8726	2,3313		
3251,7356	1,9966	3408,2285	2,8792	4642,3345	2,3701		
3314,6858	2,0650	3455,7754	2,9028	4736,6172	2,4298		
3351,7070	2,1171	3514,0403	2,9371	4835,3730	2,4970		
3405,3027	2,1649	3550,3303	2,9647	4943,6182	2,5963		
3453,5583	2,2061	3601,9641	3,0046	5037,7627	2,6914		
3508,8357	2,2580	3653,1892	3,0798	5110,3623	2,7670		
3562,6179	2,3140	3734,1392	3,1134	5156,5127	2,8222		
3623,0515	2,3704	3785,8352	3,1374	5209,0239	2,8792		
3682,3467	2,5534	3825,9373	3,1655	5263,5361	3,2836		
3724,0520	2,5719	3853,2119	3,1873	5389,3979	3,3505		
3761,2068	2,5898	3901,1470	3,2491	5534,1851	3,4410		
3835,7141	2,6454	3951,5979	3,3090	5652,7256	3,5476		
3867,6741	2,6648	4002,7834	3,4182	5744,1318	3,6465		
3918,6509	2,7318	4050,0347	3,6140	5831,6313	3,7390		
3944,4158	2,7548	4100,7173	3,7292	5933,0654	3,8663		
4008,2852	2,7992	4159,2446	3,7711	5995,5015	3,9810		
4042,5212	2,8396	4219,1567	3,8009	6132,4126	4,2242		
4120,3218	2,8999	4255,7202	3,8193	6300,7671	4,3902		
4158,1738	2,9475	4322,0156	3,8552	6411,0469	4,5318		
4229,1567	3,0320	4352,7759	3,8724	6486,0034	4,6523		
4257,5181	3,0730	4408,0815	3,9068	6572,3169	4,7786		
4307,8506	3,1352	4455,8237	3,9440	6626,9551	4,9057		
4341,6050	3,1777	4502,7412	3,9836	6746,4316	5,2132		
4405,1934	3,5507	4559,9336	4,0276	6896,6689	5,3754		
4455,5952	3,5802	4613,5728	4,0714	7006,6865	6,1935		
4500,1138	3,6075	4645,5479	4,0897	7075,9067	6,2637		
4558,4907	3,6560	4709,6138	4,1559	7206,1118	6,4143		
4602,2832	3,7206	4751,3394	4,2067	7305,6123	6,5164		
4662,6113	3,7696	4810,1660	4,3045	7445,1191	6,6677		
4700,5938	3,8011	4851,1055	4,3362	7504,1938	7,2566		
4763,8955	3,8643	4901,2876	4,3879	7683,0713	8,9682		
4808,9502	3,9006	4973,9434	4,4378	7815,9634	9,1620		
4853,0991	3,9405	5013,5811	4,4716	7858,2310	9,3121		
4905,7886	4,0018	5047,0684	4,5068	8020,1123	10,0227		
4961,6719	4,0732	5109,0156	4,5744	8115,0581	10,4158		
5000,9121	4,2251	5142,1143	4,6007				
5065,3545	4,4144	5217,2314	4,6709				
5145,2480	4,4609	5249,1377	4,7090				
5170,4780	4,4883	5303,7197	4,7943				
5219,9863	4,5447	5362,2935	4,8566				
5246,1416	4,5639	5410,8735	4,9032				
5345,7031	4,6230	5457,9927	4,9450				
5410,5034	4,6815	5513,8101	5,0169				

5453,3179	4,7403	5552,2119	5,1676
5502,2891	4,7842	5606,3271	5,2143
5556,7852	4,8522	5652,4292	5,2567
5609,4399	4,9371	5701,4951	5,2849
5654,9409	4,9977	5749,1255	5,3308
5703,6899	5,0400	5801,5898	5,3872
5758,6230	5,1133	5850,9014	5,4330
5806,5015	5,1852	5914,7002	5,4854
5856,3057	5,2663	5955,3657	5,5213
5917,7192	5,6218	6059,5752	5,7472
5950,7871	5,6438	6104,8105	5,8929
6020,7236	5,6937	6157,1611	5,9284
6051,5259	5,7359	6202,2729	5,9577
6115,3105	5,8247	6258,3262	5,9955
6169,6748	5,8691	6310,6187	6,0357
6198,7417	5,8954	6356,6426	6,0800
6235,7739	5,9295	6410,1646	6,2567
6253,6309	5,9672	6445,6802	6,2814
6300,1504	6,0315	6520,5996	6,3456
6361,7183	6,1124	6545,1870	6,3637
6403,7837	6,1630	6610,5332	6,4336
6463,9683	6,2689	6654,4458	6,4822
6543,9414	6,3958	6700,8188	6,5639
6552,3418	6,4648	6762,5879	6,7442
6631,4966	6,9677	6821,1172	6,8112
6664,7412	7,0019	6851,5942	6,8462
6702,8179	7,0357	6904,0791	6,9657
6784,2012	7,1186	6953,8237	7,1112
6820,2915	7,1615	7001,3950	7,2272
6853,6182	7,2034	7040,4648	7,3154
6905,8306	7,2834	7099,3369	7,3601
6953,1714	7,3525	7155,2471	7,3994
7007,9326	7,4707	7209,1450	7,4372
7058,8027	7,5596	7262,7451	7,4762
7105,8965	7,6745	7308,1187	7,5170
7155,4971	7,8077	7344,9917	7,5580
7201,4824	8,5637	7405,7388	7,6332
7272,9961	8,6745	7461,7749	7,7026
7309,2534	8,7582	7509,4844	7,7713
7339,6416	8,9111	7557,3057	7,8640
		7637,1436	8,3731
		7675,3999	8,4134
		7712,5430	8,4628
		7746,0889	8,4988
		7814,4375	8,5874
		7848,9131	8,6439
		7902,0869	9,1045
		7954,6157	9,4870
		8002,7676	9,7792
		8038,8174	10,0323

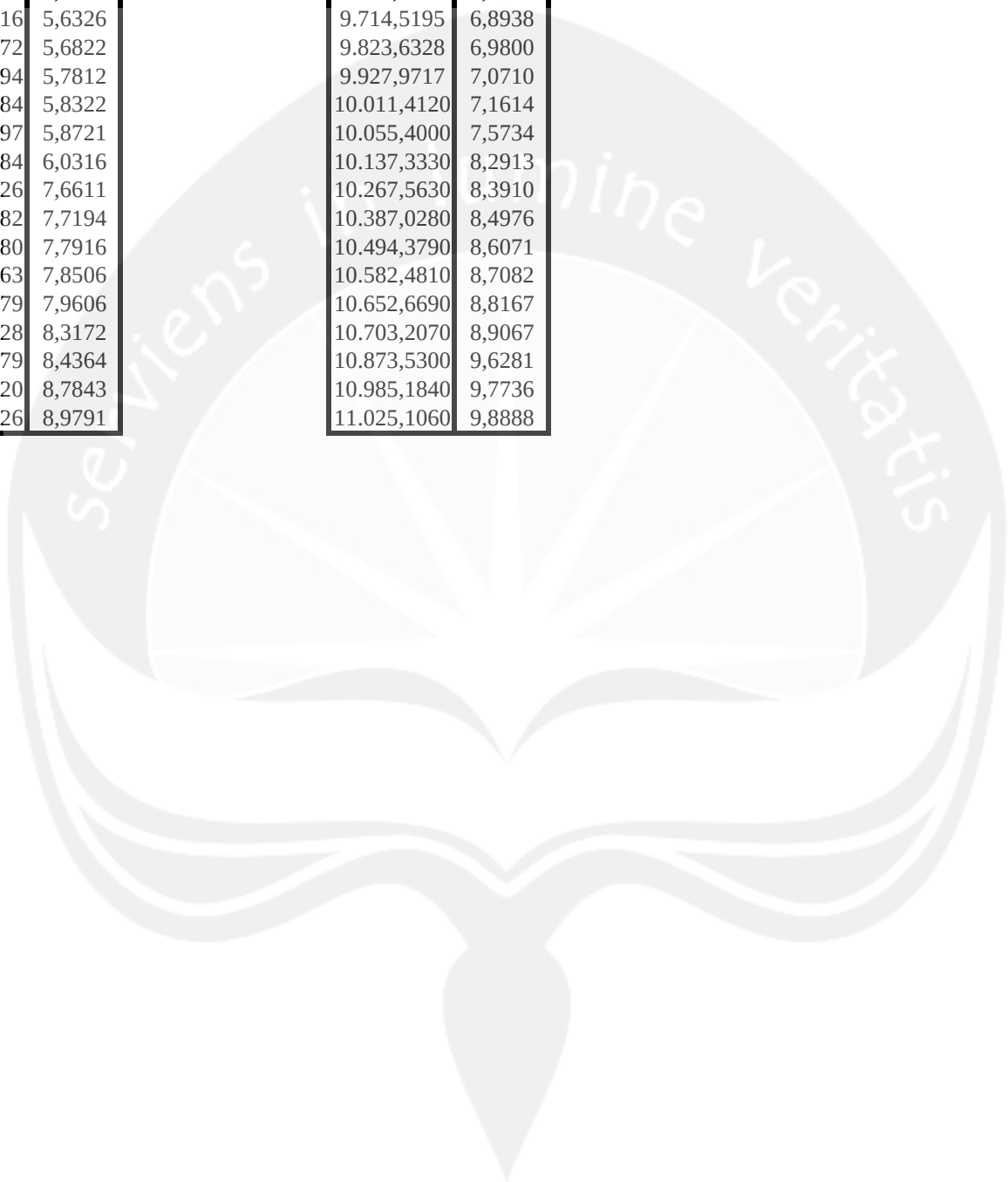
HASIL PENGUJIAN KOLOM DENGAN PERKUATAN FIBER GLASS

E70FG1		E70FG2		E70FG3		E90FG1	
Beban	Defleksi	Beban	Defleksi	Beban	Defleksi	Beban	Defleksi
(kg)	(mm)	(kg)	(mm)	(kg)	(mm)	(kg)	(mm)
168,2819	0,0018	148,8688	0,0003	65,1341	0,1392	352,1844	0,1463
201,5651	0,0094	202,7733	0,0100	114,2570	0,1390	504,3958	0,1521
242,2956	0,0102	258,6368	0,0193	151,1959	0,1386	606,2294	0,1772
294,0521	0,0148	313,2640	0,0330	206,1089	0,1794	881,8218	0,2573
359,7418	0,0187	365,7591	0,0500	288,8893	0,1650	965,0013	0,2976
413,6082	0,0212	411,1881	0,0615	350,5170	0,1449	1.224,6553	0,3659
451,6570	0,0326	460,0045	0,0723	413,5411	0,1278	1.379,7853	0,4629
503,3815	0,0350	512,8572	0,0816	444,5863	0,1329	1.536,9822	0,4869
550,9181	0,0446	563,2622	0,0928	501,0879	0,1512	1.989,2887	0,7582
598,8237	0,0447	608,2421	0,1031	567,0330	0,1541	2.018,2097	0,7650
663,9647	0,0612	649,1830	0,1122	617,5371	0,1605	2.417,5776	0,9524
705,9650	0,0852	727,2274	0,1316	665,3184	0,1651	2.659,7708	1,3118
748,1750	0,1001	764,5460	0,1448	713,2392	0,1743	2.894,8853	1,4666
801,0985	0,1138	808,0877	0,2169	750,7537	0,1947	3.205,3638	2,1056
857,7487	0,1259	850,3296	0,2192	842,2321	0,2177	3.381,3218	2,2194
906,5797	0,1381	939,2560	0,2347	919,1111	0,2522	3.763,4194	2,5911
961,9477	0,1512	1.056,1008	0,2588	989,4042	0,2770	3.854,0576	2,8891
1.004,0936	0,1874	1.182,1530	0,3029	1.052,9993	0,3134	3.985,5652	2,9742
1.049,7200	0,2747	1.311,9639	0,3500	1.109,1570	0,3331	4.309,7983	3,2503
1.125,3092	0,2718	1.426,4236	0,3905	1.164,2438	0,3521	4.568,6611	3,5455
1.162,1056	0,2770	1.522,8369	0,4345	1.205,6572	0,3718	4.601,1973	3,8521
1.186,5353	0,2926	1.564,0338	0,5001	1.224,1885	0,4322	4.922,0093	4,0856
1.220,0822	0,3048	1.698,3015	0,5147	1.322,5242	0,4533	5.251,9087	4,6442
1.263,8091	0,3272	1.837,0948	0,5422	1.406,0797	0,4736	5.301,1655	4,7062
1.312,5768	0,3440	1.991,0205	0,5932	1.479,1626	0,5030	5.516,6611	4,8790
1.358,9319	0,3457	2.132,9312	0,6454	1.545,5811	0,5282	5.793,6182	5,1638
1.403,1154	0,3564	2.243,5400	0,6895	1.602,5430	0,5581	6.003,4238	5,4335
1.459,6244	0,3744	2.338,8223	0,7260	1.663,2103	0,6402	6.244,0386	5,7716
1.497,3577	0,3830	2.426,9392	0,7486	1.786,3560	0,6773	6.585,7939	6,1352
1.558,2864	0,3992	2.500,7959	0,7548	1.891,2113	0,7148	6.602,7505	6,3296
1.601,4561	0,4079	2.601,8633	0,8477	1.970,7793	0,7410	6.773,7031	6,5344
1.656,2738	0,4272	2.723,2917	0,9054	2.039,3962	0,7592	7.155,1797	6,9483
1.700,4885	0,4367	2.846,7651	0,9766	2.100,5559	0,8016	7.319,6875	7,2144
1.760,9415	0,4521	2.967,4014	1,0735	2.211,8020	0,8194	7.414,8140	7,6124
1.816,9696	0,4760	3.091,7925	1,1749	2.304,6289	0,8416	7.712,7163	8,0051
1.845,7273	0,4839	3.195,1890	1,2649	2.389,7288	0,8630	7.779,3091	8,2908
1.920,5398	0,5085	3.282,3765	1,3550	2.480,5120	0,8898	7.937,1929	9,0244
1.952,9692	0,5166	3.302,6580	1,5616	2.551,1787	0,9108	8.042,8452	9,3237
2.006,6794	0,5385	3.402,5417	1,5969	2.615,4827	0,9283	8.077,4722	9,5392
2.056,3862	0,5536	3.550,3877	1,6799	2.683,5713	0,9475	8.156,4907	10,0001
2.102,6970	0,5686	3.685,6038	1,7741	2.703,1877	0,9679	8.299,8721	10,3643
2.149,1995	0,5786	3.808,7988	1,8841	2.817,6431	0,9947	8.401,2793	10,7396
2.199,3391	0,5971	3.927,7209	2,0049	2.976,4685	1,0284		
2.222,0779	0,6039	4.030,7361	2,1105	3.120,8279	1,0710		
2.252,4358	0,6175	4.150,3188	2,4853	3.266,6467	1,1605		
2.301,7820	0,6532	4.202,2700	2,4917	3.384,6021	1,1918		
2.346,8076	0,6673	4.343,6304	2,5493	3.408,6589	1,2328		
2.413,4397	0,7092	4.509,3130	2,6712	3.442,7588	1,2570		
2.451,5029	0,7248	4.651,1592	2,7871	3.616,2939	1,3198		
2.501,5427	0,7663	4.806,5435	2,9269	3.772,8279	1,3935		
2.551,3113	0,7920	4.935,1416	3,0703	3.933,9082	1,4638		

2.608,6338	0,8200	5.012,9209	3,4789	4.102,2749	1,6755
2.654,3289	0,8602	5.053,8594	3,4844	4.132,7637	1,6792
2.704,7688	0,9012	5.203,8931	3,5461	4.279,1860	1,7183
2.756,7981	0,9432	5.403,3345	3,6972	4.418,8843	1,7796
2.806,4470	1,0018	5.562,3560	3,8390	4.559,1494	1,8530
2.849,2852	1,0328	5.715,2485	3,9952	4.703,1689	1,9415
2.901,4656	1,1597	5.850,3037	4,1470	4.828,4199	2,0310
2.956,2502	1,1748	5.959,5000	4,2904	4.922,4707	2,1159
3.000,3767	1,2589	6.090,8262	4,7055	5.001,5503	2,1831
3.053,2437	1,2930	6.256,1396	4,8736	5.092,5630	2,3137
3.103,6548	1,3190	6.391,8594	5,0671	5.198,8901	2,3654
3.153,9287	1,3476	6.512,0786	5,3029	5.328,5684	2,4431
3.202,1636	1,3744	6.590,8975	5,5517	5.458,3989	2,5296
3.255,1191	1,4017	6.657,0615	5,7859	5.575,3452	2,6182
3.300,1062	1,4275	6.762,2261	7,1214	5.666,3350	2,6941
3.350,8281	1,4640	6.843,7607	7,2573	5.751,0591	2,8306
3.427,2998	1,5592	6.894,9717	7,3768	5.792,5029	2,9667
3.488,8232	1,5949	6.951,2056	7,5728	5.903,7109	3,0241
3.528,6086	1,6112	7.006,8965	8,1668	6.008,8447	3,0833
3.550,8518	1,6370	7.104,0967	8,3037	6.114,9741	3,1470
3.625,0896	1,6977	7.191,7549	8,4636	6.222,6641	3,2167
3.679,5596	1,7235	7.260,8872	8,6352	6.326,1558	3,2884
3.718,5322	1,7468	7.314,3032	8,7985	6.415,8965	3,3546
3.768,0623	1,7719	7.357,8330	8,9568	6.486,2866	3,4130
3.812,3101	1,8007	7.408,8677	10,1203	6.506,3525	3,5526
3.841,2512	1,8265	7.579,7266	10,9215	6.636,4238	3,6165
3.914,3005	1,8738			6.784,7490	3,6927
3.962,2566	1,9003			6.930,8286	3,7791
4.005,4011	1,9387			7.066,1772	3,8697
4.048,5706	1,9709			7.183,0469	3,9598
4.088,6240	1,9989			7.263,5918	4,0437
4.130,9189	2,0325			7.319,1245	4,1197
4.180,3755	2,0701			7.345,3726	4,1963
4.233,0913	2,1124			7.389,8716	4,4876
4.267,1494	2,1568			7.465,8442	4,5313
4.300,2085	2,2006			7.548,9614	4,5833
4.344,0410	2,3085			7.636,3828	4,6431
4.574,0630	2,4442			7.734,6396	4,7135
4.760,6543	2,5945			7.839,6797	4,7980
4.880,6416	2,7338			7.939,5811	4,8848
5.003,5796	2,8688			8.006,4497	5,1661
5.101,4248	2,9975			8.078,3071	5,2130
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5.546,0557	3,5765			8.334,2822	5,3824
5.659,9946	3,7099			8.403,9492	5,4226
5.749,2349	3,8681			8.482,5713	5,4456
5.803,7808	3,9856			8.569,4639	5,5037
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5.964,5352	4,3655			8.757,3623	5,6459
6.030,7451	4,4407			8.843,5303	5,7195
6.108,6851	4,5307			8.907,6924	5,7850
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6.200,2017	5,1816			9.044,2705	6,0267

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6.561,6016	5,6326
6.587,6372	5,6822
6.663,8794	5,7812
6.685,6484	5,8322
6.714,4697	5,8721
6.753,0684	6,0316
6.801,1226	7,6611
6.842,1982	7,7194
6.907,4180	7,7916
6.946,9863	7,8506
7.007,3379	7,9606
7.055,1128	8,3172
7.104,3779	8,4364
7.150,0420	8,7843
7.194,8926	8,9791

9.167,3145	6,1164
9.275,8213	6,2001
9.361,7461	6,2809
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9.493,1211	6,4240
9.542,3105	6,4819
9.603,3574	6,8132
9.714,5195	6,8938
9.823,6328	6,9800
9.927,9717	7,0710
10.011,4120	7,1614
10.055,4000	7,5734
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10.267,5630	8,3910
10.387,0280	8,4976
10.494,3790	8,6071
10.582,4810	8,7082
10.652,6690	8,8167
10.703,2070	8,9067
10.873,5300	9,6281
10.985,1840	9,7736
11.025,1060	9,8888



DOKUMENTASI PENELITIAN



Gambar 1. Proses Pengujian Kuat Tarik Baja Tulangan



Gambar 2. Proses Pemeriksaan Kandungan Zat Organik Dalam Pasir



Gambar 3. Proses Pemeriksaan Kandungan Lumpur Dalam Pasir



Gambar 4. Proses Pembuatan Adukan Beton



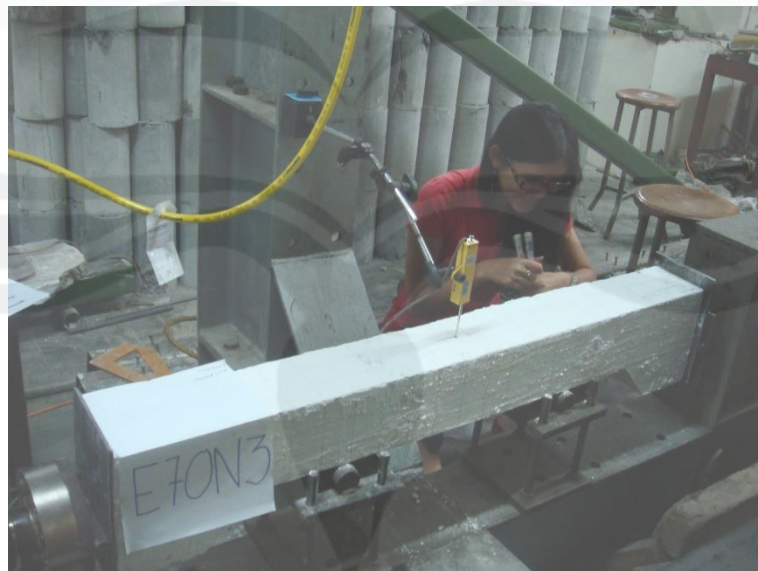
Gambar 5. Proses Pengujian Nilai *Slump*



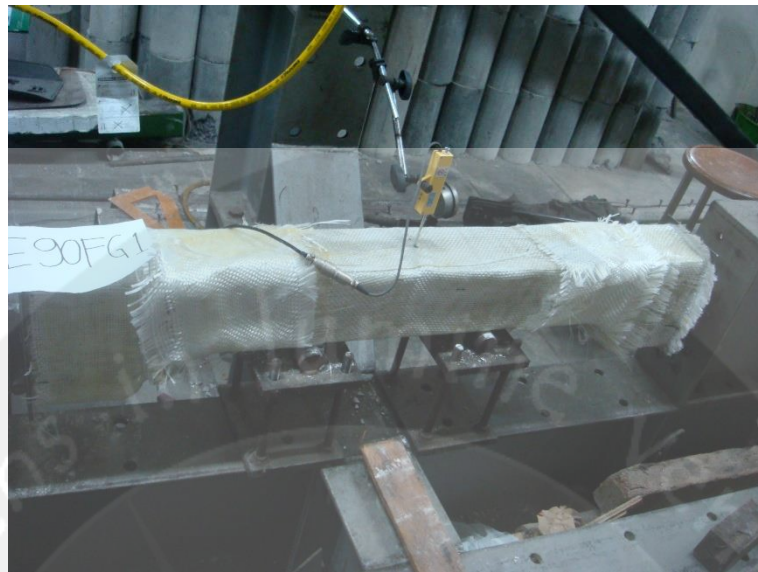
Gambar 6. Proses Pengujian Kuat Tekan Beton



Gambar 7. Proses Perekatan *Fiber Glass* Pada Kolom



Gambar 8. Proses Pengujian Kolom Normal



Gambar 9. Proses Pengujian Kolom Yang Diperkuat Dengan *Fiber Glass*