BAB VI

KESIMPULAN DAN SARAN

6.1. Kesimpulan

Berdasarkan hasil penelitian dan analisis studi kuat kekuatan balok beton menggunakan baja profil siku sebagai pengganti baja tulngan tatik yang telah dijelaskan pada bab v maka :

1. Beban maksimum rata-rata yang dapat didukung oleh balok beton bertulang dengan baja profil sebagai pengganti baja tulangan tarik adalah 56,6288 kN dan tegangan lentur rata-rata 2,0228 MPa adalah 0,4984 dari tegangan lentur analisis.
2. Beban yang dihasilkan dari batas defleksi maksimum yaitu 7,4957 mm yaitu 57,3285 kN .
3. Beban rata-rata pada retak pertama pada benda uji 24,3036 kN.
4. Dari hasil penelitian yang telah dilakukan maka baja profil dapat digunakan sebagai pengganti baja tulangan tarik.

6.2. Saran

Untuk melakukan penelitian lebih lanjut dan penerapan tentang studi kuat kekuatan balok beton menggunakan baja profil siku sebagai pengganti baja tulngan tatik ini perlu diperhatikan hal-hal sebagai berikut:

1. Penumbukan pada proses pengecoran harus dilakukan secara teliti dan merata agar agregat kasar dapat terdistribusi secara merata keseluruh balok, karena jarak antar profil siku yang sangat dekat.

2. *Slump* jangan terlalu kecil karena dapat menyebabkan sulitnya adukan beton masuk kerongga-rongga baik rongga antar tulangan ataupun tulangan dengan bekesting.
3. Pada saat pengujian lentur sebisa mungkin elevasi balok sama dengan menambah silinder dengan ketebalan yang sama dengan tumpuan sendi.
4. Penelitian lebih lanjut dapat dipadukan dengan beton ringan, beton mutu tinggi, beton *precast* ataupun pengecekan sambungan antara balok kolom dengan baja profil sebagai pengganti tulangan.

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LAMPIRAN

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LAMPIRAN I

PENGUJIAN BAHAN

PEMERIKSAAN GRADASI BESAR BUTIRAN PASIR

Bahan : Pasir

Asal : Kali Progo

Diperiksa : 25 September 2013

DAFTAR AYAKAN

No. Saringan	Berat Saringan (gram)	Berat Saringan + Tertahan (gram)	Berat Tertahan (gram)	Σ Berat Tertahan (gram)	Persentase Berat Tertahan (%)	Persentase Lolos (%)
¾”	558	558	0	0	0	100
½”	462	466	4	4	0.4	99.6
3/8”	547	553	6	10	1	99
4	416	429	13	23	2.3	97.7
8	329	357	28	51	5.1	94.9
30	295	630	335	386	38.6	61.4
50	294	660	366	752	75.2	24.8
100	286	520	234	986	98.6	1.4
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)

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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 Berat Tertahan (%)	Persentase Lolos (%)
¾”	559	559	0	0	0	100
½”	462	508	46	46	4.6	95.4
3/8”	547	955	408	454	45.4	59.2
4	416	935	519	973	97.3	2.7
8	329	342	13	986	98.6	1.4
30	295	297	2	988	98.8	1.2
50	294	295	1	989	98.9	1.1
100	286	289	3	992	99.2	0.8
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)

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PEMERIKSAAN KANDUNGAN ZAT ORGANIK DALAM PASIR

I. Waktu Pemeriksaan: 26 September 2013

II. Bahan

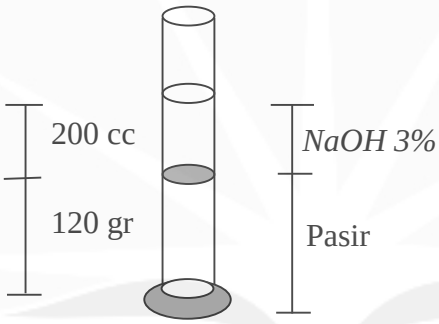
a. Pasir kering tungku, Asal: Kali Progo, Volume: 120 gram

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.

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PEMERIKSAAN KANDUNGAN LUMPUR DALAM PASIR

I. Waktu Pemeriksaan: 26 September 2013

II. Bahan

a. Pasir kering tungku, Asal : Kali Progo, Berat: 100 gram

b. Air jernih asal : LSBB Prodi TS FT-UAJY

III. Alat

a. Gelas ukur, ukuran: 250 cc

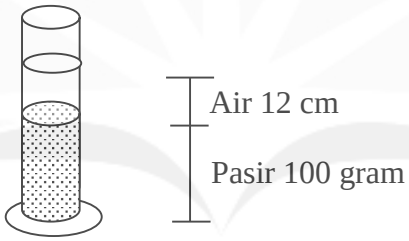
b. Timbangan

c. Tungku (*oven*), suhu dibuat antara 105-110^{o}C

d. Air tetap jernih setelah 5 kali pengocokan

e. Pasir+piring masuk tungku tanggal 25 September jam 09.48 WIB

IV. Sketsa



V. Hasil

Setelah pasir keluar tungku tanggal 26 September jam 10.00 WIB

a. Berat piring+pasir = 223,2 gram

b. Berat piring kosong = 123,5 gram

c. Berat pasir = 99,7 gram

$$\text{Kandungan Lumpur} = \frac{100-99{,}7}{100}\times 100\%$$

$$= 0{,}3\ \%$$

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PEMERIKSAAN KANDUNGAN LUMPUR DALAM *SPLIT*

I. Waktu Pemeriksaan: 26 September 2013

II. Bahan

a. *Split* kering tungku asal : Kali Progo, 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^{o}C

d. Air tetap jernih setelah 5 kali pencucian dalam air

e. *Split*+pan masuk tungku tanggal 25 September jam 10.30 WIB

IV. Hasil

Setelah pasir keluar tungku tanggal 26 September jam 10.45 WIB

a. Berat pan+*split* = 227 gram

b. Berat piring kosong = 128 gram

c. Berat *split* = 99 gram

$$\text{KandunganLumpur} = \frac{100-99}{100} \times 100\%$$

$$= 1\%$$

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

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PEMERIKSAAN BERAT JENIS DAN PENYERAPAN PASIR

Bahan : Pasir
Asal : Kali Progo
Diperiksa : 27 September 2013

	Nomor Pemeriksaan	I
A	Berat Contoh Jenuh Kering Permukaan (SSD) – (500)	500 gram
B	Berat Contoh Kering	487 gram
C	Berat Labu+Air, Temperatur 25ºC	707 gram
D	Berat Labu+Contoh (SSD) + Air, Temperatur 25ºC	1020 gram
E	Berat Jenis *Bulk* $= \frac{(A)}{(C+500-D)}$	2,6738
F	BJ Jenuh Kering Permukaan (SSD) $= \frac{(B)}{(C+500-D)}$	2,6043
G	Berat Jenis Semu (*Apparent*) $= \frac{(B)}{(C+B-D)}$	2,7989
H	Penyerapan (*Absorption*) $= \frac{(500-B)}{(B)} \times 100\,\%$	2,6694%

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PEMERIKSAAN BERAT JENIS DAN PENYERAPAN *SPLIT*

Bahan : Batu Pecah (*Split*)

Asal : Clereng

Diperiksa : 27 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	BJ Jenuh Kering Permukaan (SSD) $= \frac{(B)}{(B)-(C)}$	2,7147
F	Berat Jenis Semu (*Apparent*) $= \frac{(A)}{(A)-(C)}$	2,7875
G	Penyerapan (*Absorption*) $= \frac{(B)-(A)}{(A)} \times 100\,\%$	1,5244%

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PEMERIKSAAN *LOS ANGELES ABRASION TEST*

Bahan : Agregat kasar

Asal : Kali Progo

Diperiksa : 25 September 2013

Gradasi Saringan		**Nomor Contoh**
		I
Lolos	***Tertahan***	***Berat Masing-Masing Agregat***
$^{3}/_{4}$"	$^{1}/_{2}$"	2500 gram
$^{1}/_{2}$"	$^{3}/_{8}$"	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
Keausan = $\frac{(A)-(B)}{(A)} X 100\%$		24,96%
Keausan Rata-rata		24,96%

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PEMERIKSAAN KADAR AIR PADA PASIR

Bahan : Pasir

Asal : Kali Progo

Diperiksa : 26 Maret 2013

No.	Pemeriksaan		H1	H2
1.	Cawan	gram	9,520	9,247
2.	Cawan+berat pasir basah	gram	72,643	81,215
3.	Cawan+berat pasir kering	gram	71,148	79,555
4.	Berat air = (2) - (3)	gram	1,495	1,66
5.	Berat contoh kering = (3) - (1)	gram	61,628	70,308
6.	Kadar air (w) = $\frac{(4)}{(5)} x100\%$		2,4258%	2,3610%
Rata – rata			2,3934%	

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PEMERIKSAAN KADAR AIR PADA *SPLIT*

Bahan : Split
Asal : Clereng
Diperiksa : 26 Maret 2013

No.	Pemeriksaan		K1	K2
1.	Cawan	gram	9,678	8,391
2.	Cawan+berat *split* basah	gram	82,936	75,626
3.	Cawan+berat *split* kering	gram	82,045	74,671
4.	Berat air = (2) - (3)	gram	0,891	0,955
5.	Berat contoh kering = (3) - (1)	gram	72,367	66,28
6.	Kadar air (w) = $\frac{(4)}{(5)} x100\%$		1,23%	1,44%
Rata - rata			1,335%	

Yogyakarta, 27 September 2013
Mengetahui,

Ir. JF.Soandrijanie Linggo, M.T.
(Kepala Lab. Transportasi UAJY)

LAMPIRAN II

DATA PENGUJIAN KUAT TARIK BAJA

Baja Siku 30x30x3 mm

Tebal = 2,05 mm

Lebar = 16 mm

Luas = 32,8 mm^2

P_o = 104 mm

Beban (kgf)	Bacaan pada Strainometer (ΔP)(10^{-2})	Beban (N)	*f* (MPa)	ε (10^{-4})	ε terkoreksi (10^{-4})
0	0	0,0000	0,0000	0,0000	0,0
100	1,5	980,6710	29,8985	1,4423	1,8269
200	3	1961,3420	59,7970	2,8846	3,6539
300	5	2942,0130	89,6955	4,8077	5,4808
400	6,5	3922,6840	119,5940	6,2500	7,3077
500	8	4903,3550	149,4925	7,6923	9,0737
600	10	5884,0260	179,3910	9,6154	10,9007
700	12	6864,6970	209,2895	11,5385	12,7276
800	15	7845,3680	239,1880	14,4231	14,5545
900	17	8826,0390	269,0866	16,3462	16,3815
1000	**20**	**9806,7100**	**298,9851**	**19,2308**	**18,2084**
1030	85	10100,9113	307,9546	81,7308	82,4217
1420	11500	13925,5282	424,5588	11057,6923	11058,3832
1520	**12000**	**14906,1992**	**454,4573**	**11538,4615**	**11539,1524**

Beban Maksimum =1530 kgf

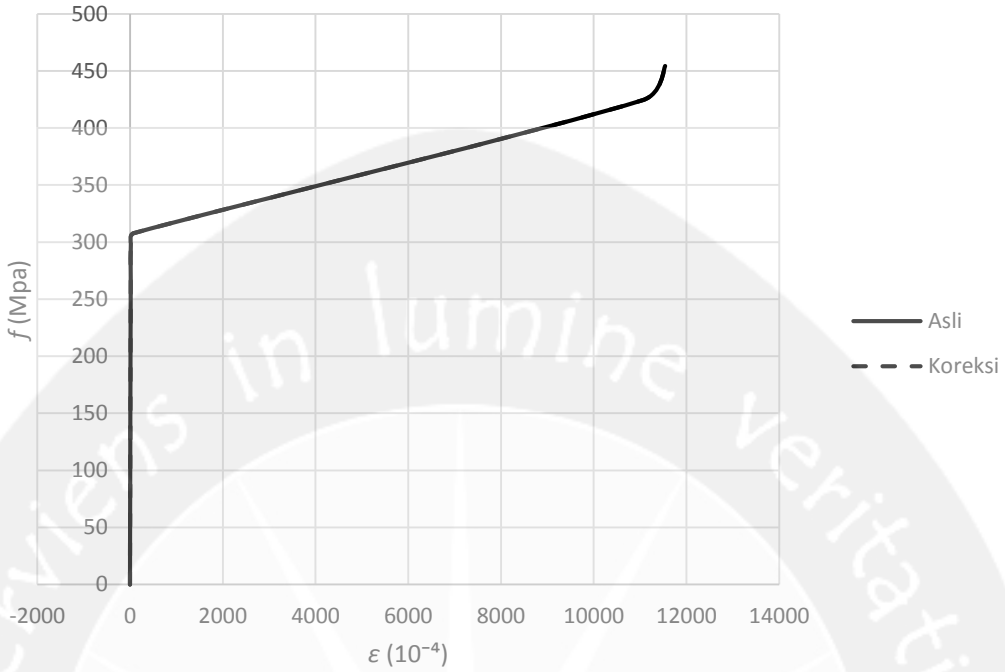
Tegangan Leleh = 307,954 MPa

Tegangan Maksimum = 457,4471 MPa

Regangan Koreksi = 0,6909 x 10^{-4}

Modulus Elastis = 164201,817 MPa

Lampiran 2	65
Data Pengujian Kuat Tarik Baja	



Grafik Hasil Pengujian Kuat Tarik Profil Siku

Baja Tulangan P6

Diameter = 5,63 mm

Luas = 24,8947 mm^2

P_o = 104,4 mm

Beban Maksimum =1235 kgf

Tegangan Leleh = 323,0207 MPa

Tegangan Maksimum = 486,5006 MPa

LAMPIRAN III

PERENCANAAN ADUKAN UNTUK BETON NORMAL

(SNI 03-2834-2000)

A. Data Bahan

1. Bahan Agregat halus (pasir) : Sungai Progo, Yogyakarta.
2. Bahan Agregat kasar : Clereng, Yogyakarta.
3. Jenis semen : Gresik (Tipe 1)

B. Data *Specific Gravity*

1. *Specific grafity* agregat halus (pasir) : 2,7311 kg/cm^3.
2. *Specific grafity* agregat kasar (krikil) : 2,7307 kg/cm^3.
3. *Absorption* agregat halus (pasir) : 0,0267%
4. *Absorption* agregat kasar (krikil) : 0,0152%

C. Hitungan

1. Kuat tekan beton yang disyaratkan (f_c') pada umur 28 hari. f_c'= 20 MPa.
2. Menentukan nilai devisiasi standar berdasarkan tingkat mutu pengendalian pelaksanaan campuran.
3. Berdasarkan SNI butir 4.2.3.1 1 (5) nilai margin ditentukan sebesar 12 MPa.
4. Menetapkan kuat tekan beton rata-rata yang direncanakan berdasarkan SNI butir 4.2.3.1 3.

   $f_c' = f_c' + M = 20 + 12 = 32$ MPa.
5. Menentukan jenis semen

   Jenis semen kelas I (PC).

6. Menetapkan jenis agregat

   a) Agregat halus : pasir alam.

      Direncanakan golongan 2.

   b) Agregat kasar : batu pecah

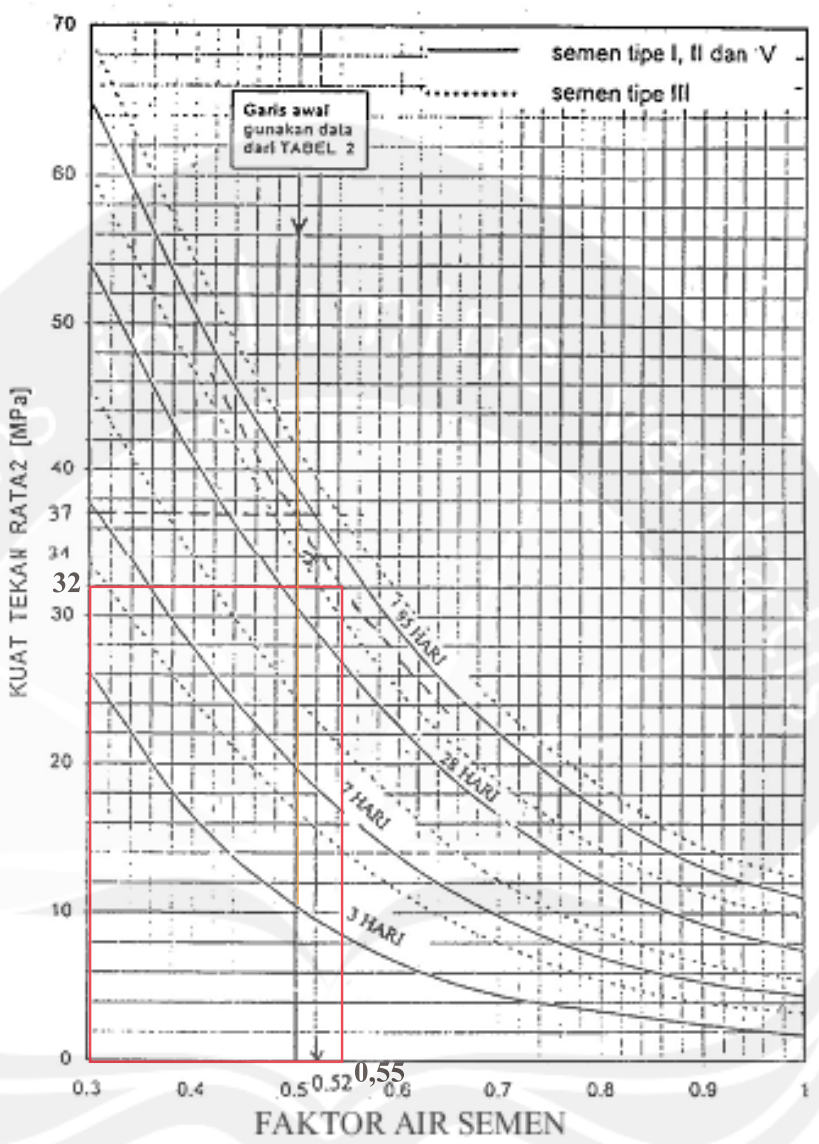
7. Menetapkan faktor air – semen, berdasarkan jenis semen yang dipakai dan kuat tekan rata-rata silinder beton yang direncanakan pada umur tertentu.

Perkiraan kekuatan tekan (MPa) beton dengan faktor air semen, dan agregat kasar yang biasa dipakai di Indonesia

Jenis semen … …	Jenis agregat Kasar	Kekuatan tekan (MPa)				
		Pada umur (hari)				Bentuk
		3	7	28	29	Bentuk uji
Semen Portland Tipe 1	Batu tak dipecahkan	17	23	33	40	Silinder
	Batu pecah	19	27	37	45	
Semen tahan sulfat Tipe II, V	Batu tak dipecahkan	20	28	40	48	Kubus
	Batu pecah	25	32	45	54	
Semen Portland tipe III	Batu tak dipecahkan	21	28	38	44	Silinder
	Batu pecah	25	33	44	48	
	Batu tak dipecahkan	25	31	46	53	Kubus
	Batu pecah	30	40	53	60	

(SNI 03-2834-2000 : tabel 2)

Berdasarkan tabel 2 SNI 03-2834-2000 didapat kuat tekan 37 MPa, Dari titik kekuatan tekan 37 Mpa tarik garis datar hingga memotong garis tengah yang menunjukan faktor air semen 0,50. Melalui titik potong ini lalu gambarkan kurva yang berbentuk kira-kira sama dengan kurva disebelah atas dan di sebelah bawahnya (garis dengan warna kuning). Kemudian dari titik kekuatan tekan beton yang dirancang (dalam hal ini 32 MPa) tarik garis datar hingga memotong kurva garis kuning tadi. Dari titik potong ini tarik garis tegak ke bawah hingga memotong sumbu X (absiska) dan dibaca faktor air semen yang diperoleh. Didapatkan sebesar 0,55.



Hubungan Kuat Tekan Silinder dengan Fas

(SNI 03-2834-2000 : grafik 1)

8. Menetapkan faktor air semen maksimum.

Persyaratan jumlah semen minimum dan faktor air semen maksimum untuk berbagi macam pembetonan dalam lingkungan khusus

Lokasi	Jumlah Semen minimum Per m^3 beton (kg)	Nilai Faktor Air Semen Maksimum
Beton di dalam ruang bangunan :		
a. Keadaan keliling non-korosif	**275**	**0,6**
b. Keadaan keliling korosif disebabkan oleh kondensasi atau uap korosif	325	0,52
Beton diluar 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
Beton masuk kedalam tanah :		
a. mengalami keadaan basah dan kering berganti-ganti	325	0,55
b. mendapat pengaruh sulfat dan alkali dari tanah		Lihat Tabel 5
Beton yang kontinu berhubungan:		
a. Air tawar		
b. Air laut		Liahat Tabel 6

(SNI 03-2834-2000 : Tabel 4)

Berdasarkan tabel 4 SNI 03-2834-2000, untuk beton dalam ruang bangunan sekeliling non-korosif fas maksimum 0,6. Dibandingkan dengan no.7, dipakai terkecil. Jadi digunakan fas 0,55.

9. Menetapkan nilai "*slump*"

   Jenis konstruksi balok, berdasarkan SK SNI T-15-1990-03 digunakan nilai *slump* dengan nilai maksimum 150 mm dan minimum 75 mm.

Slump dalam cm

Pemakaian beton	Maks.	Min.
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
Pelat, balok, kolom, dan dinding	15,0	7,5
Pengerasan jalan	7,5	5,0
Pembetonan massa	7,5	2,5

10. Ukuran butiran maksimum (krikil) adalah 10 mm.

11. Menetapkan jumlah air yang diperlukan tiap m^3 beton.

Lampiran 3	70
Perencanaan Adukan untuk Beton Normal	

Perkiraan kadar air bebas (Kg/m^3) yang dibutuhkan untuk beberapa tingkat kemudahan pengerjaan adukan beton

Slump (mm)		0-10	10-30	30-60	60-180
Ukuran besar butir agregat maksimum	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

Catatan : Koreksi suhu udara :
Untuk suhu di atas 25 °C, setiap kenaikan 5 °C harus ditambah air 5 liter per m^2 adukan beton.

(SNI 03-2834-2000 : Tabel 3)

a) Ukuran butir maksimum 10 mm.

b) Nilai *Slump* 75-150 mm.

c) Agregat halus berupa batu tak di pecah, maka W_h = 225

d) Agregat kasar berupa batu pecah, maka W_k = 250

$$W = \frac{2}{3}W_h + \frac{1}{3}W_k$$

dengan : W_h adalah perkiraan jumlah air untuk agregat halus

W_k adalah perkiraan jumlah air untuk agregat kasar

$$W = \frac{2}{3} \times 225 + \frac{1}{3} \times 250 = 233{,}3333\ kg$$

12. Menghitung berat semen yang diperlukan :

a) Berdasarkan tabel 4 SNI 03-2834-2000, diperoleh semen minimum 275 kg.

b) Berdasarkan *fas* = 0,55. Semen per m^3 beton = $\frac{A}{fas} = \frac{233{,}3333}{0{,}55}$

$$= 424{,}2424\ kg$$

Dipilih berat semen yang paling besar. Digunakan berat semen 424,2424 kg.

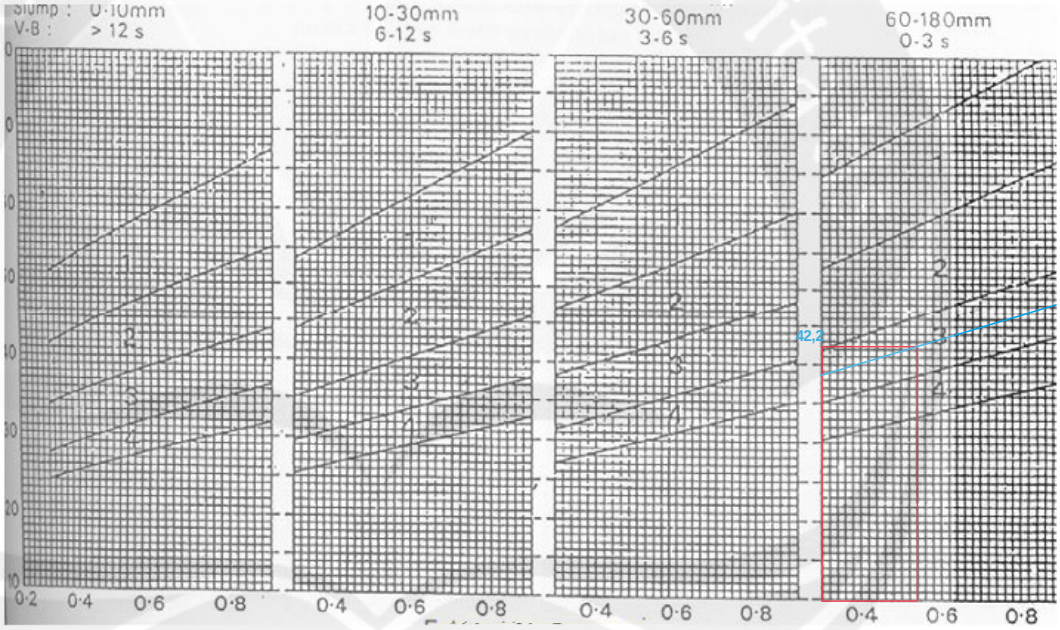
13. Penyesuaian jumlah air atau fas.

    $f_{as\ rencana}$ = 0,55

    $f_{as\ mak} > f_{as\ rencana}$

    0,6 > 0,55 ……. oke

14. Perbandingan agregat halus dan kasar



Persen pasir terhadap kadar total agregat yang dianjurkan untuk ukuran butir maksimum 10 mm
(SNI 03-2834-2000 : Tabel 13)

a) Ukuran maksimum 10 mm.

b) Nilai *Slump* 75 mm – 150 mm

c) *fas* 0,55.

d) Jenis gradasi pasir no. 3.

Diambil proporsi pasir = 42,2%.

15. Berat jeis agregat campuran :

$$= \frac{P}{100} \times Bj\ agregat\ halus + \frac{K}{100} \times Bj\ agregat\ kasar$$

$$= \frac{42{,}2}{100} \times 2{,}7311 + \frac{57{,}8}{100} \times 2{,}7307$$

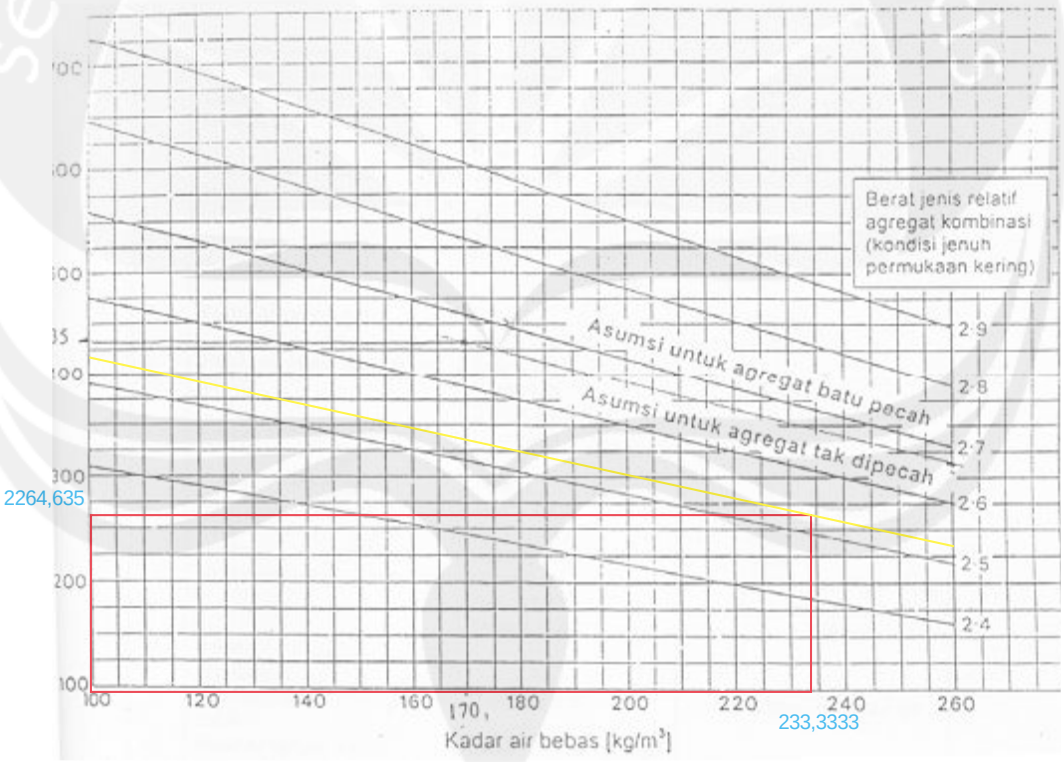
$$= 2{,}7309$$

dimana :

P = % agregat halus terhadap agregat campuran

K = % agregat kasar terhadap agregat campuran

16. Berat jenis beton



Perkiraan berat isi beton yang telah selesai didapatkan
(SNI 03-2834-2000 : Grafik 16)

Bj campuran (langkah 15) → 2,7331 kg/m^3 →dibuat garis bantu diantara 2,5 dan 2,6.

Keperluan air yaitu 233,3333 kg (langkah 11) → ditarik garis vertical ke atas sampai menyentuh garis bantu, kemudian tarik ke kiri di dapat 2264,635 kg/m^3.

17. Berat agregat campuran

    = berat tiap m^3 – keperluan air dan semen

    = 2264,635 – (233,3333 + 424,2424)

    = 1607,0593 kg

18. Menghitung berat agregat halus

    berat agregat halus = % berat agregat halus x keperluan agregat campuran

    = 42,2% x 1607,0593 kg

    = 678,179 kg

19. Menghitung berat agregat kasar

    berat agregat kasar = % berat agregat kasar x keperluan agregat campuran

    = 57,8% x 1607,0593 kg

    = 928,8803 kg

Kebutuhan Bahan Susun Adukan Beton Normal :

a) **Semen = 424,2424 kg/m^3**
b) **Pasir = 678,179 kg/m^3**
c) **Krikil = 928,8803 kg/m^3**
d) **Air = 233,3333 liter/m^3**

LAMPIRAN IV

PERHITUNGAN DESAIN BALOK BERTULANG

(SNI 03-2847-2002)

A. Perencanaan Balok Bertulang dengan Sengkang Baja Tulangan Ø 6 mm

1. Diketahui :

   a) Dimensi balok :

      1) Tinggi balok = 200 mm
      2) Lebar balok = 125 mm
      3) Panjang balok (l_n) = 1800 mm
      4) Selimut beton = 10 mm
      5) f_c' = 20 MPa

   b) Dimensi profil :

      1) Lebar siku = 30 mm
      2) Tinggi siku = 30 mm
      3) Tebal = 3 mm
      4) Pusat berat (C_x=C_z) = 8,44 mm
      5) Jenis baja = BJ34
      6) F_u = 340 MPa
      7) f_y = 210 MPa
      8) A_g = 172,7 mm^2

   c) Dimensi sengkang :

      1) Ø sengkang = 6 mm

2. Perhitungan :

$d' = Selimut\ beton + \emptyset sengkang + C_z$

$d' = 10 + 6 + 8{,}44$

$d' = 24{,}44\ mm$

$d = h - d'$

$d = 200 - 24{,}44$

$d = 175{,}6\ mm$

Mencari nilai a dengan rumus 3.8 keseimbangan gaya :

$\sum F_H = 0$

$C_c = T_s$

$a \times b \times 0{,}85 \times f_c' = A_s \times f_y$

$a = \dfrac{A_s \times f_y}{0{,}85 \times f_c' \times b}$

$a = \dfrac{2 \times 172{,}7}{0{,}85 \times 20 \times 125}$

a = 34,1336 mm

$C_c = T_s = As\ x\ f_y$

$C_c =$ 2 x 172,7 x 210

C_s = 72534 N

$M_n = C_c \times Z$

dimana :

$Z = d - \dfrac{a}{2} = 175{,}56 - \dfrac{34{,}1336}{2} = 158{,}4932\ mm$

M_n = 72534 x 158,4932

M_n = 11496145 Nmm

M_n = 11,4961 kNm

$M_u \leq \emptyset M_n$, dimana $\emptyset$ = 0,8

Maka,

M_u = 0,8 x 11,4961 kNm

M_u = 9,1969 kNm

Mencari beban maksimum :

$$M_u = \frac{1}{6} \times P \times L$$

P = (6 x M_u)/L

P = (6 x 9,1969)/1

P = 30,6563 kN

Menghitung gaya geser ultimit yang mampu ditahan oleh balok :

$$V_u = \frac{1}{2} \times P$$

V_u = ½ x 30,6563

V_u = 15,3282 kN

$$V_c = \frac{1}{6} \times \sqrt{f_c'} \times b \times d$$

V_c = 1/6 x √20 x 125 x 175,6

V_c = 16356,8373 N

V_c = *16,3568* N

Pengecekan jenis keruntuhan :

$V_u < V_c$

15,3282 kN < 16,3568 kN → Lentur lebih lemah dari pada geser, maka balok akan mengalami keruntuhan lentur.

LAMPIRAN V

DATA PENGUJIAN SILINDER BETON

Slump ke-			Slump	Dimensi (mm)		Berat (kg)	Berat jenis (ton/m^3)	Umur beton (hari)	*F* (kN)	*fc'* (MPa)	Koreksi Umur	*fc'* 28 hari (MPa)
1	2	3		*d*	*h*							
7,5	8	9	8,1667	15,0867	30,2333	12,72	2,3536	29	820	45,8709	1,0032	45,7234
13	13,2	12,8	13,0	10,1	20,6967	3,76	2,2675	29	165	20,5945	1,0032	20,5283
10,2	10,3	10,5	10,3333	15,0467	30,0933	12,52	2,3397	31	580	32,618	1,0097	32,3054
10,2	10	10,5	10,2333	15,08	30,2667	13	2,4048	31	620	34,7136	1,0097	34,3808

LAMPIRAN VI

DATA PENGUJIAN BALOK BETON BETULANG DENGAN PROFIL SIKU SEBAGAI PENGGANTI TULANGAN MEMANJANG

Tabel Data Logger Pengujian Benda Uji BBTS1

No.	LOAD CELL; AVE	LVDT1; AVE	LVDT2; AVE	LVDT3; AVE
	KG	mm	mm	mm
1	0,0000	0,00000000	0,00000000	0,00000000
2	282,0828	0,04182648	0,38585368	0,08109338
3	300,8402	0,05074068	0,40339679	0,09397634
4	334,5540	0,06676623	0,42550111	0,11103161
5	410,3987	0,10544729	0,46309346	0,14603917
6	475,1252	0,14533839	0,50087959	0,18192701
7	520,0441	0,17206877	0,52376235	0,20879328
8	558,1973	0,19264820	0,55141962	0,23218265
9	592,2736	0,21173787	0,57409555	0,25481528
10	622,0336	0,22841477	0,59366596	0,27365768
11	623,0430	0,23068522	0,59870273	0,27948210
12	675,1981	0,25482967	0,63401693	0,31387323
13	755,8485	0,30608836	0,68174785	0,35986784
14	851,9821	0,36214894	0,74137616	0,42084667
15	938,9203	0,42095646	0,79954702	0,47977659
16	1006,8182	0,47677064	0,84973043	0,52778369
17	1046,3593	0,51195168	0,88700849	0,56249511
18	1042,7947	0,51809376	0,89065611	0,56739181
19	1078,4972	0,54088426	0,91349822	0,59226114
20	1169,7661	0,59040678	0,96935338	0,64655328
21	1245,8523	0,63593167	1,03063940	0,69760209
22	1300,2637	0,67615211	1,07850060	0,73896259
23	1360,5732	0,72553062	1,12430190	0,78362650
24	1408,6000	0,76930225	1,16024630	0,82205659
25	1441,1941	0,78734618	1,18716430	0,84891838
26	1468,3059	0,80838424	1,20974250	0,87139964
27	1462,2543	0,81299990	1,21415880	0,87561244
28	1491,3093	0,84717101	1,23946790	0,90528238
29	1528,5527	0,87520170	1,26207390	0,92888600
30	1558,8379	0,89211524	1,28142610	0,95113868
31	1589,2131	0,91561162	1,30229120	0,97442460
32	1605,4846	0,93199742	1,31550750	0,99009192
33	1620,1404	0,94481325	1,33037670	1,00561940
34	1632,8334	0,95750475	1,34405720	1,02009320
35	1647,3014	0,97395480	1,35820820	1,03449170
36	1664,9824	0,98940706	1,37185290	1,05041750
37	1672,3055	1,00049980	1,38297680	1,06028500
38	1688,3717	1,01423700	1,39828730	1,07421180
39	1708,7859	1,03505870	1,41532230	1,09055700

Lanjutan Tabel Data Logger Pengujian Benda Uji BBTS1

No.	LOAD CELL; AVE	LVDT1; AVE	LVDT2; AVE	LVDT3; AVE
	KG	mm	mm	mm
40	1732,6912	1,05472490	1,43592360	1,11030420
41	1750,6002	1,07210860	1,45055830	1,12781270
42	1764,9888	1,08555140	1,46076200	1,14232440
43	1783,2678	1,10113630	1,47634120	1,15915230
44	1790,3276	1,11136290	1,48655470	1,17022900
45	1797,5939	1,11780910	1,49697180	1,18054560
46	1810,5785	1,12808130	1,51025330	1,19323020
47	1828,1096	1,14491690	1,52588950	1,21031490
48	1829,6831	1,16729180	1,55260400	1,23739620
49	1851,1781	1,18601060	1,56841110	1,25169740
50	1871,0212	1,19834910	1,58367930	1,26676830
51	1892,5541	1,21301020	1,59692820	1,28415290
52	1920,6146	1,23308940	1,62189040	1,30672570
53	1935,4103	1,25216040	1,64107010	1,32397210
54	1951,2802	1,26880090	1,65463980	1,34096850
55	1974,3286	1,29243540	1,67401980	1,36312780
56	2005,9971	1,31743940	1,70030110	1,39137640
57	2036,8260	1,35182340	1,72831010	1,42417590
58	2058,5447	1,38276540	1,75453590	1,45334140
59	2092,6575	1,41623640	1,78671550	1,48974790
60	2117,2485	1,44893400	1,81362200	1,52366570
61	2142,6396	1,47649800	1,84438470	1,55688940
62	2167,9705	1,50925650	1,87938790	1,59384520
63	2175,3999	1,53276670	1,90570500	1,61793610
64	2219,5603	1,63153770	2,00140620	1,71010080
65	2243,2214	1,66851090	2,04256650	1,75318830
66	2289,9812	1,72840740	2,10172410	1,81451570
67	2317,4436	1,77458200	2,14657120	1,86622630
68	2339,5408	1,81208880	2,18114780	1,90770050
69	2355,9861	1,84648430	2,21827100	1,94253420
70	2377,6458	1,88583310	2,25715470	1,97967620
71	2393,9863	1,92036350	2,28501890	2,01004390
72	2411,2554	1,95083960	2,31534840	2,04264260
73	2425,3582	1,97783590	2,34667280	2,07563590
74	2443,8235	2,00980730	2,37344430	2,10890510
75	2452,3325	2,04183390	2,40345980	2,13621640
76	2462,2537	2,10596470	2,51046540	2,24161620
77	2540,6333	2,16987820	2,58014440	2,30966020
78	2593,8191	2,22701790	2,63953520	2,36851240
79	2620,6150	2,26544760	2,67622210	2,40748620
80	2644,9485	2,30036120	2,70792270	2,44039490
81	2663,8640	2,32590030	2,73696400	2,47082920
82	2664,2202	2,36637450	2,77604460	2,51196360
83	2742,3311	2,42524720	2,83540440	2,57320400
84	2813,8796	2,50170640	2,91147180	2,65020700

Lanjutan Tabel Data Logger Pengujian Benda Uji BBTS1

No.	LOAD CELL; AVE	LVDT1; AVE	LVDT2; AVE	LVDT3; AVE
	KG	mm	mm	mm
85	2858,6582	2,57380890	2,97316480	2,71492340
86	2893,3667	2,62392000	3,02118060	2,77017810
87	2929,5942	2,67777040	3,08041500	2,82448340
88	2955,6162	2,74123530	3,13803530	2,87464760
89	2970,9951	2,77679680	3,18126230	2,91436980
90	3002,2188	2,85882900	3,26908520	3,00758460
91	3029,0464	2,89055010	3,29072860	3,03646140
92	3074,7432	3,01736310	3,40265080	3,16707850
93	3135,1958	3,07300970	3,45295450	3,22475550
94	3199,6167	3,13862300	3,52291680	3,29094650
95	3256,7722	3,20919970	3,58570100	3,36159300
96	3290,8491	3,25245330	3,62463050	3,40974860
97	3327,4709	3,29367400	3,67142650	3,45879530
98	3360,5586	3,33593460	3,71263720	3,50587030
99	3390,4954	3,38359430	3,75845480	3,55149960
100	3390,8850	3,44857070	3,82123420	3,61549930
101	3430,6172	3,48779650	3,85097740	3,65073110
102	3468,5947	3,52073880	3,88679650	3,69075920
103	3489,9404	3,55146600	3,91567210	3,72123890
104	3526,5713	3,59719680	3,95903060	3,76550890
105	3544,5115	3,63228110	3,99608400	3,79771380
106	3580,5769	3,66746140	4,04268170	3,84371380
107	3606,2029	3,71977710	4,07695480	3,88431170
108	3633,1819	3,75623250	4,11062770	3,92498780
109	3658,0437	3,79951140	4,14734080	3,96406170
110	3681,9299	3,82980350	4,17727140	4,00084640
111	3705,6548	3,86753960	4,21011500	4,03910590
112	3764,2000	4,05535130	4,36804680	4,19966130
113	3804,8779	4,09277960	4,41017440	4,24213120
114	3817,8848	4,12123730	4,43628310	4,26492020
115	3821,6111	4,15226940	4,46246190	4,29345180
116	3886,8501	4,19725800	4,50886730	4,34711550
117	3937,6741	4,24642900	4,56449940	4,40278630
118	3981,9795	4,30922320	4,61979290	4,45932390
119	4014,6748	4,35633180	4,66393180	4,50729040
120	4050,1594	4,41020580	4,71495530	4,55922890
121	4092,0671	4,45674230	4,77268650	4,61737870
122	4133,6465	4,52075480	4,83392860	4,67894170
123	4162,6108	4,57042650	4,88234660	4,73018500
124	4182,0825	4,60075280	4,91899440	4,77093410
125	4226,9312	4,69289830	5,01255270	4,86521720
126	4278,4189	4,75778390	5,08126260	4,92927360
127	4324,3813	4,90816970	5,20635080	5,08536580
128	4343,9028	4,94102720	5,23381280	5,11222270
129	4364,9907	4,97232250	5,27749680	5,15227510

Lanjutan Tabel Data Logger Pengujian Benda Uji BBTS1

No.	LOAD CELL; AVE	LVDT1; AVE	LVDT2; AVE	LVDT3; AVE
	KG	mm	mm	mm
130	4431,0469	5,02700850	5,33914950	5,21168140
131	4479,8901	5,08671710	5,39754630	5,26977780
132	4521,9248	5,13828090	5,44134470	5,32371710
133	4564,1274	5,19045160	5,49384550	5,38200950
134	4612,3906	5,25334640	5,55414010	5,44522000
135	4660,9521	5,31647540	5,61726620	5,51482200
136	4684,1001	5,36472990	5,66123680	5,56122060
137	4706,8657	5,40017320	5,69306280	5,59915450
138	4713,9146	5,42494820	5,71443270	5,62343120
139	4767,6899	5,51398130	5,80776790	5,71558000
140	4832,5889	5,58483080	5,86988120	5,79030850
141	4877,4385	5,64824580	5,93527940	5,85623740
142	4931,8516	5,72749610	6,02013210	5,93154570
143	4972,5737	5,79480120	6,08249900	5,99969820
144	4999,6313	5,84193560	6,13131000	6,05212350
145	5008,0923	5,92532110	6,20878700	6,13687940
146	5067,0532	5,98706530	6,26622200	6,19823980
147	5104,8003	6,03182410	6,31740050	6,24989130
148	5145,9917	6,08719590	6,37001040	6,30802680
149	5195,2974	6,15371610	6,43622730	6,37671380
150	5252,1450	6,23905750	6,52206180	6,46262930
151	5296,0415	6,31543060	6,59332180	6,54209660
152	5328,0444	6,38070580	6,66285280	6,60724450
153	5330,4868	6,41189100	6,69923210	6,64365960
154	5365,9448	6,50841470	6,78725190	6,74363990
155	5422,2061	6,57539560	6,85158970	6,81415080
156	5461,9766	6,63358690	6,91189190	6,87944270
157	5501,4038	6,70355990	6,96973560	6,94857410
158	5549,3252	6,78401520	7,04253630	7,03213070
159	5582,6489	6,85830930	7,12800650	7,10840510
160	5601,9727	6,91354610	7,19308330	7,16824630
161	**5618,9380**	**6,96597480**	**7,24207780**	**7,22368860**
162	5678,8765	7,31215000	7,57514910	7,56843900
163	5724,2783	7,37992100	7,64017250	7,63802190
164	5762,2627	7,44777630	7,71387480	7,70899960
165	5771,9092	7,49576470	7,75724840	7,75693180
166	5802,4727	7,58469770	7,84414820	7,85426660
167	5885,4668	7,69832900	7,94560580	7,97020100
168	5945,9243	7,81982520	8,07761000	8,09688000
169	5983,1167	7,94113400	8,19354440	8,21860790
170	5994,8218	8,03284260	8,29226680	8,31160160
171	6003,3618	8,09414200	8,35266020	8,38054470
172	6007,0601	8,14119630	8,40342810	8,43564990
173	6019,7676	8,25642970	8,51931100	8,55182080
174	6093,4453	8,36136910	8,64419360	8,66528320

Lanjutan Tabel Data Logger Pengujian Benda Uji BBTS1

No.	LOAD CELL; AVE	LVDT1; AVE	LVDT2; AVE	LVDT3; AVE
	KG	mm	mm	mm
175	6130,4683	8,46622470	8,74959950	8,77252290
176	6167,8105	8,57934760	8,85871030	8,88483720
177	6189,8994	8,68527980	8,94974330	8,99109080
178	6200,1094	8,75545880	9,03615190	9,07910350
179	6200,9951	8,81733320	9,10906310	9,14286900
180	6185,9302	8,86276250	9,15078740	9,18008710
181	6246,6138	9,06913570	9,33712100	9,37587740
182	6306,4019	9,19044970	9,46146490	9,50458910
183	6329,5322	9,30732060	9,57686140	9,62547110
184	6350,5039	9,40902330	9,66132740	9,73147300
185	6371,2231	9,50683400	9,77447510	9,83890530
186	6390,5483	10,05161000	10,30606100	10,39809600
187	6421,5850	10,13793800	10,38121900	10,48202200
188	6431,5239	10,18740100	10,43788100	10,54297100
189	6443,9170	10,24439600	10,48841000	10,60356300
190	6452,6338	10,40404600	10,64054700	10,75911000
191	6511,3379	10,49050700	10,72308600	10,84830200
192	6535,3833	10,57210200	10,81042300	10,93457800
193	6565,5972	10,67083700	10,90457100	11,02899500
194	6585,2305	10,76786300	11,00012300	11,12922000
195	6598,5010	10,85272100	11,08400900	11,21900300
196	6606,4824	10,92470800	11,15474500	11,29888800
197	6604,6509	10,98099300	11,20926400	11,36100900
198	6577,5254	11,00317000	11,22925500	11,38694200
199	**7008,6807**			

Lampiran 6	83
Data Pengujian Balok Beton Betulang dengan Profil Siku Sebagai Pengganti Tulangan Memanjang	

Tabel Hasil Pengujian Benda Uji BBTS2

No.	LOAD CELL; AVE	LVDT1; AVE	LVDT2; AVE	LVDT3; AVE
	KG	mm	mm	mm
1	0,0000	0,000000000	0,000000000	0,000000000
2	1,8285	0,003266588	0,031635545	0,000018816
3	1,9049	0,003562590	0,031379882	0,000018816
4	2,4017	0,004031801	0,030721996	0,000029042
5	41,0384	0,028827623	0,084891781	0,024147335
6	106,5987	0,079439819	0,139704790	0,065423563
7	227,7424	0,163584750	0,191671310	0,139050990
8	277,6925	0,208272840	0,210960090	0,173508380
9	331,6655	0,245244590	0,234836150	0,210552600
10	341,6713	0,255701420	0,242281350	0,220470790
11	339,4547	0,256399120	0,243417990	0,220543190
12	396,2913	0,301780050	0,270169850	0,253560330
13	545,8909	0,413143310	0,376796330	0,359979510
14	653,8535	0,493978590	0,456854910	0,441811620
15	671,9058	0,510519680	0,473191350	0,459962730
16	931,5258	0,674345140	0,642475010	0,625145790
17	1110,5001	0,798666600	0,773874820	0,748999770
18	1136,7847	0,823552670	0,806077000	0,780512870
19	1333,7437	0,967807050	0,928818460	0,917790170
20	1539,6975	1,134066500	1,105599400	1,090264400
21	1613,7194	1,223395500	1,188872600	1,173839600
22	1675,1660	1,288163700	1,267659300	1,258732700
23	1894,0073	1,459173700	1,449045400	1,435189500
24	2006,2290	1,573785700	1,583443200	1,571555500
25	2047,3914	1,646016600	1,650622500	1,631418000
26	2229,8035	1,834048300	1,831313400	1,832848400
27	2364,6716	1,986743600	1,992839100	1,986962700
28	2422,3577	2,080149200	2,088615200	2,087101200
29	2405,9146	2,112783200	2,119731400	2,112674000
30	2575,2407	2,283146600	2,294086000	2,294540200
31	2721,6135	2,478351800	2,497916700	2,498925700
32	2758,8074	2,591100700	2,587879400	2,601913700
33	2806,2341	2,801681300	2,765938800	2,779661900
34	2908,6675	2,903296900	2,862398900	2,883363700
35	3079,3425	3,071246900	3,028727100	3,059463700
36	3183,0449	3,224561700	3,183481700	3,214624600
37	3216,4016	3,318504800	3,267119600	3,302053500
38	3284,5491	3,449027800	3,427608000	3,456009400
39	3381,2275	3,552396500	3,534089600	3,566279600
40	3467,1956	3,663505100	3,631894800	3,674223400
41	3533,0359	3,761112500	3,733162200	3,777827700
42	3548,1411	3,825394400	3,792147200	3,839338800
43	3590,3591	3,927196300	3,892202900	3,946486200
44	3605,4778	3,954029800	3,915383800	3,973114700
45	3702,4980	4,049030300	4,007201200	4,070413100

Lanjutan Tabel Hasil Pengujian Benda Uji BBTS2

No.	LOAD CELL; AVE	LVDT1; AVE	LVDT2; AVE	LVDT3; AVE
	KG	mm	mm	mm
46	3773,4084	4,152560700	4,101884400	4,174491400
47	3793,2402	4,193411400	4,156321500	4,230813000
48	3802,5659	4,276900300	4,242325300	4,330443900
49	3827,6675	4,309948900	4,271984600	4,361650900
50	3832,2292	4,316616500	4,285044200	4,379576700
51	3838,7742	4,457828000	4,408543100	4,511800300
52	4022,3999	4,622632000	4,554403300	4,666415200
53	4147,5752	4,764326100	4,683736300	4,808066800
54	4211,2471	4,850553000	4,767364500	4,900236600
55	4233,0786	4,890972100	4,805722200	4,946220400
56	4242,4116	4,922421900	4,833710200	4,977444600
57	4295,4160	5,013040100	4,922409500	5,069247700
58	4368,5708	5,088171000	5,001445300	5,148805600
59	4409,6724	5,141206700	5,053952200	5,207208600
60	4458,5010	5,201290100	5,111310500	5,270402400
61	4515,4219	5,281624800	5,202965300	5,350812000
62	4540,5830	5,328520300	5,254975800	5,402284600
63	4580,6104	5,387251400	5,310399500	5,462187800
64	4599,3657	5,428381400	5,347667700	5,502409500
65	4606,6362	5,459419700	5,372522800	5,531622900
66	4633,7246	5,539233200	5,462107200	5,617685800
67	4635,3208	5,551721100	5,478497500	5,632919800
68	4715,9922	5,635509500	5,556330200	5,712622200
69	4768,1670	5,694488000	5,624189900	5,779074700
70	4817,5298	5,760979200	5,690165500	5,844395600
71	4861,4775	5,824282200	5,758403300	5,912270100
72	4889,7305	5,883260300	5,806599100	5,964138500
73	4891,1401	5,900682900	5,832660700	5,990238700
74	4909,8281	5,923964000	5,864742300	6,020596500
75	4925,9990	5,959023000	5,889977500	6,052639000
76	4921,6484	5,971519500	5,900110200	6,065773500
77	4932,1270	6,105655200	6,047010900	6,204059600
78	5002,7949	6,178813500	6,121757500	6,273512400
79	5086,6772	6,263414400	6,207310200	6,361260400
80	5133,6104	6,328498800	6,277072000	6,428023300
81	5127,7319	6,344472400	6,295412100	6,445572900
82	5116,8169	6,346773600	6,301560900	6,449312700
83	5234,0396	6,485762600	6,424476100	6,582799900
84	5360,4292	6,635234800	6,565855500	6,733603000
85	5411,3428	6,736566500	6,665056200	6,836788200
86	5449,7178	6,806982000	6,743937500	6,910270700
87	5458,4727	6,846018800	6,797753800	6,952737300
88	5483,9121	6,897644500	6,843525900	7,002225400
89	5554,8081	7,046520700	6,996793300	7,156485600
90	5687,0752	7,235011600	7,173926400	7,342423400

Lanjutan Tabel Hasil Pengujian Benda Uji BBTS2

No.	LOAD CELL; AVE	LVDT1; AVE	LVDT2; AVE	LVDT3; AVE
	KG	mm	mm	mm
91	5693,9248	7,297635600	7,238811000	7,406855600
92	5683,7441	7,317721400	7,260423700	7,428477800
93	**5732,8545**	**7,381387700**	**7,326064600**	**7,495672700**
94	5769,6958	7,449600700	7,391974900	7,563690700
95	5788,5342	7,515358900	7,456278300	7,621503400
96	5782,9521	7,543760800	7,476808100	7,650071600
97	5835,4536	7,662864700	7,601892900	7,779872400
98	5902,2627	7,758106200	7,702113200	7,876337500
99	6020,4268	8,219074200	8,137414000	8,328197500
100	6106,1470	8,351229700	8,270768200	8,457289700
101	6150,6011	8,448958400	8,367491700	8,558550800
102	6183,5630	8,526280400	8,435728100	8,638361000
103	6209,4927	8,595633500	8,504663500	8,710233700
104	6223,2622	8,649393100	8,557793600	8,764157300
105	6270,3301	8,816422500	8,723525000	8,931306800
106	6318,7144	8,894891700	8,803418200	9,017260600
107	6347,7524	8,968208300	8,874803500	9,088852900
108	6367,7925	9,024811700	8,940804500	9,152836800
109	6383,8584	9,086928400	8,998137500	9,214473700
110	6395,1465	9,138214100	9,046125400	9,267227200
111	6417,6421	9,193783800	9,096477500	9,325013200
112	6442,0625	9,260270100	9,165227900	9,397952100
113	6451,0317	9,317345600	9,212006600	9,452398300
114	6456,2803	9,361043000	9,261754000	9,499840700
115	6519,4614	9,528314600	9,431540500	9,683529900
116	6586,0786	9,661945300	9,560326600	9,825701700
117	6612,7813	9,768648100	9,666681300	9,944248200
118	6639,2568	9,872485200	9,765252100	10,054343000
119	6641,3936	9,946432100	9,848303800	10,143892000
120	6644,4014	10,396195000	10,292871000	10,620484000
121	6692,7935	10,485979000	10,384182000	10,710697000
122	6741,4390	10,605942000	10,485846000	10,825780000
123	6745,6499	10,677605000	10,561419000	10,906938000
124	6801,2290	10,898002000	10,782815000	11,152097000
125	6818,6963	10,965606000	10,847869000	11,226538000
126	6869,8696	11,094381000	10,979924000	11,360714000
127	6877,0776	11,192410000	11,097620000	11,472719000
128	6889,5884	11,296796000	11,209140000	11,580052000
129	6904,6328	11,394336000	11,313561000	11,689667000
130	6883,6533	11,454258000	11,383149000	11,759350000
131	6908,1997	11,659794000	11,580183000	11,980792000
132	6917,9023	11,791001000	11,721046000	12,130353000
133	6939,8311	11,856318000	11,779728000	12,203178000
134	6947,2065	11,919764000	11,837027000	12,271165000
135	6959,9775	11,983366000	11,906901000	12,346953000

Lanjutan Tabel Hasil Pengujian Benda Uji BBTS2

No.	LOAD CELL; AVE	LVDT1; AVE	LVDT2; AVE	LVDT3; AVE
	KG	mm	mm	mm
136	6971,0308	12,056664000	11,969908000	12,424121000
137	6990,0361	12,161319000	12,075792000	12,517817000
138	7035,1855	12,796948000	12,701909000	13,208183000
139	7057,5356	12,902407000	12,824820000	13,328474000
140	**7273,8403**			

Tabel Hasil Pengujian Benda Uji BBTS3

No.	LOAD CELL; AVE	LVDT1; AVE	LVDT2; AVE	LVDT3; AVE
	KG	mm	mm	mm
1	0,0000	0,000000000	0,000000000	0,000000000
2	53,7135	0,015115595	0,012854841	0,062176540
3	122,4131	0,057287678	0,048170645	0,100113700
4	142,8526	0,069517262	0,059414968	0,114716310
5	203,4414	0,100399810	0,087007113	0,150089580
6	284,6680	0,146133680	0,134892780	0,199713650
7	369,0214	0,201934840	0,191401000	0,262070150
8	435,9482	0,235899390	0,237023140	0,313427810
9	475,8087	0,259585200	0,270415750	0,345484500
10	481,1997	0,265875250	0,280248220	0,355425980
11	592,8074	0,358164280	0,351376530	0,427749780
12	736,6455	0,460086410	0,454498590	0,524468360
13	814,1437	0,516431630	0,518494310	0,586899340
14	867,9291	0,568927170	0,567816260	0,632608410
15	975,5939	0,649791660	0,649615710	0,716350440
16	1082,4358	0,731651540	0,734698000	0,797466280
17	1169,6847	0,806636690	0,801061450	0,869997860
18	1216,9009	0,868603470	0,845519240	0,916092280
19	1218,2234	0,873128830	0,859303950	0,929533120
20	1233,7919	0,893973410	0,884702560	0,956736510
21	1369,8732	0,974168660	0,981263760	1,045745800
22	1383,5912	1,002980800	1,007001000	1,067604500
23	1401,4739	1,020897000	1,031746700	1,095735500
24	1434,5243	1,045178200	1,055911100	1,118521100
25	1453,4266	1,063957100	1,067787300	1,134513300
26	1502,7137	1,118210800	1,100235300	1,168037700
27	1528,4561	1,138491900	1,125422400	1,191879900
28	1538,5096	1,149765000	1,137461300	1,204843800
29	1566,9905	1,167826900	1,163656200	1,227336500
30	1595,5551	1,184522500	1,189501000	1,251681100
31	1602,9347	1,195428100	1,202307100	1,264500600
32	1697,6703	1,270484900	1,268732400	1,339519100
33	1751,7032	1,329941400	1,315592200	1,386972100
34	1785,8727	1,367252200	1,349413000	1,422372200
35	1812,7524	1,393090500	1,379982000	1,451892000
36	1825,2240	1,407738600	1,400992000	1,473036600
37	1833,4315	1,465524700	1,450481800	1,527411500
38	1838,5198	1,470436300	1,455822900	1,533647800
39	1865,8256	1,492763400	1,474659100	1,552521700
40	1906,7760	1,520787600	1,503283600	1,583800700
41	1924,5095	1,535310400	1,523052800	1,604517700
42	1954,9526	1,591745900	1,570850500	1,655798100
43	2019,4348	1,646870400	1,625241800	1,707408900
44	2059,3235	1,689562900	1,668201400	1,753003000
45	2065,0100	1,700549100	1,689160900	1,774280400

Lanjutan Tabel Hasil Pengujian Benda Uji BBTS3

No.	LOAD CELL; AVE	LVDT1; AVE	LVDT2; AVE	LVDT3; AVE
	KG	mm	mm	mm
46	2084,1724	1,720785300	1,716523500	1,801013400
47	2110,0166	1,762834700	1,750650600	1,834013000
48	2118,8772	1,792185900	1,778278500	1,858874900
49	2115,3445	1,900631400	1,879498600	1,965115000
50	2134,6133	1,910014200	1,887230400	1,979340400
51	2215,0381	1,965342800	1,938366400	2,041271400
52	2271,1965	2,023251800	2,003840700	2,098404400
53	2277,7271	2,049167400	2,031713000	2,123529200
54	2292,8035	2,074558500	2,056492800	2,152170200
55	2309,3125	2,116000200	2,089224600	2,188975600
56	2339,7803	2,147403200	2,130394500	2,228767600
57	2364,6091	2,177636100	2,163826000	2,265286700
58	2385,5632	2,210701200	2,202970300	2,303550200
59	2400,1660	2,242522200	2,234159700	2,336647500
60	2422,7759	2,275526500	2,270890700	2,377853400
61	2440,9414	2,336488700	2,331502400	2,447651400
62	2497,5347	2,404502400	2,381371700	2,502358900
63	2556,6199	2,474183300	2,451885900	2,573771200
64	2608,1912	2,549875000	2,527240000	2,648867100
65	2630,7332	2,597352500	2,577284800	2,698939100
66	2687,9717	2,672318900	2,647369400	2,773290900
67	2707,2939	2,722231600	2,698539700	2,825370300
68	2723,0286	2,748803600	2,734853500	2,863565400
69	2740,0798	2,781018300	2,764318500	2,896943300
70	2743,8333	2,949599000	2,899909700	3,044908300
71	2780,2632	2,975695100	2,927423700	3,076333800
72	2838,7085	3,029749600	2,977494700	3,128491400
73	2863,5813	3,066306600	3,011284800	3,160915400
74	2876,9241	3,083983700	3,035489800	3,180953000
75	2899,6111	3,105034100	3,061963300	3,207156900
76	2900,6279	3,120565200	3,073202600	3,219800000
77	2950,1709	3,181154500	3,136698500	3,289102600
78	3001,5662	3,235372300	3,187684800	3,342802000
79	3036,3481	3,280358800	3,223754400	3,385863300
80	3094,2888	3,350259100	3,304469300	3,457353400
81	3112,1563	3,387286200	3,327024700	3,498073300
82	3114,7112	3,445774800	3,385706900	3,548313400
83	3123,9648	3,456911600	3,396677700	3,562606300
84	3152,1831	3,483244400	3,424965100	3,591691500
85	3174,8020	3,513835900	3,464633700	3,620999300
86	3197,7776	3,541611900	3,499358400	3,649761700
87	3223,2156	3,575418700	3,536716200	3,684242200
88	3250,5073	3,612225300	3,575324800	3,720976100
89	3254,3406	3,670228700	3,620976200	3,781950200
90	3290,4700	3,702076400	3,659330600	3,816787200

Lanjutan Tabel Hasil Pengujian Benda Uji BBTS3

No.	LOAD CELL; AVE	LVDT1; AVE	LVDT2; AVE	LVDT3; AVE
	KG	mm	mm	mm
91	3312,0552	3,738980800	3,687115000	3,846644200
92	3343,9575	3,867569700	3,826811600	3,990093000
93	3380,3169	3,905720700	3,863404300	4,027000400
94	3429,7910	3,964973000	3,922208500	4,087156800
95	3483,5105	4,016299200	3,975725200	4,137661900
96	3486,3347	4,031952400	3,988335600	4,153439000
97	3496,4136	4,044291500	4,006481200	4,167412300
98	3543,8174	4,087130500	4,048241100	4,211092900
99	3592,6824	4,149417900	4,095442300	4,266945800
100	3638,4563	4,199567300	4,152211200	4,323019000
101	3680,6577	4,254141800	4,203635700	4,378206300
102	3713,0176	4,306706400	4,250586500	4,427514600
103	3749,4636	4,356186900	4,296700500	4,478174700
104	3762,6821	4,384070400	4,328951800	4,509779000
105	3773,6038	4,406551400	4,356056700	4,535065200
106	3831,1389	4,503604400	4,445267200	4,632871200
107	3855,3638	4,536996800	4,481210200	4,665348500
108	3871,9854	4,558659100	4,509592100	4,689400700
109	3935,3252	4,625338600	4,572877400	4,754367400
110	3954,8870	4,668409300	4,619281300	4,795179800
111	3964,6699	4,685108700	4,635853800	4,816589800
112	3975,0076	4,703015800	4,657629000	4,836564100
113	4003,3489	4,742355800	4,688048400	4,870253100
114	4026,7441	4,772054200	4,719535800	4,904439000
115	4042,0850	4,792357400	4,741692100	4,930312600
116	4076,6809	4,834815000	4,776389100	4,971836100
117	4087,4717	4,865055100	4,806931000	4,998046400
118	4093,7588	4,883776200	4,828163600	5,014833500
119	4111,7749	4,902245500	4,852664900	5,039799700
120	4130,7178	4,923870100	4,879154700	5,067143900
121	4140,9614	4,979805500	4,933086900	5,122920500
122	4177,8940	5,011372600	4,967360000	5,159575500
123	4241,7261	5,187665900	5,142646300	5,342859700
124	4297,4165	5,244003300	5,201688300	5,399767400
125	4352,9443	5,303867800	5,256329100	5,457551500
127	4388,5005	5,349237400	5,302758700	5,504040700
128	4400,2515	5,394455400	5,346910500	5,547820100
129	4408,3032	5,404561000	5,359480400	5,559330900
130	4463,2607	5,447363400	5,409480100	5,611414900
131	4487,0112	5,479926600	5,435811000	5,639831100
132	4517,9331	5,519825500	5,477273000	5,680534800
133	4553,9624	5,558938000	5,514157300	5,723040100
134	4567,7754	5,583879900	5,539793000	5,748543700
135	4584,5083	5,612472500	5,565696700	5,775564700
136	4602,9561	5,637803600	5,595586800	5,803947400

Lanjutan Tabel Hasil Pengujian Benda Uji BBTS3

No.	LOAD CELL; AVE	LVDT1; AVE	LVDT2; AVE	LVDT3; AVE
	KG	mm	mm	mm
137	4623,6777	5,669782200	5,622761700	5,833031700
138	4644,9541	5,698326100	5,647033700	5,863316500
139	4665,5098	5,718625500	5,677519800	5,892288200
140	4692,4126	5,758479600	5,716280900	5,928721000
141	4718,3223	5,789358100	5,755714900	5,966564700
142	4740,2373	5,823792900	5,785422800	5,999825500
143	4758,6548	5,852541400	5,811531500	6,030745500
144	4768,7080	5,908328500	5,865747000	6,091097800
145	4789,4941	5,935698500	5,888634200	6,114392800
146	4806,6904	5,961963700	5,917157600	6,139918300
147	4842,9155	6,000763900	5,955652700	6,180550100
148	4851,7920	6,018402100	5,971632500	6,198461500
149	4870,8647	6,048737500	6,001232100	6,227651600
150	4891,0986	6,070928100	6,027488700	6,252516300
151	4909,5410	6,098955600	6,060235500	6,282364400
152	4948,8081	6,140878700	6,108604400	6,327229500
153	4951,4277	6,163538000	6,129029800	6,346991500
154	4979,1733	6,193252100	6,161416100	6,380228500
155	4987,0493	6,219052300	6,180625000	6,403657900
156	5009,2349	6,249785400	6,207634000	6,432044500
157	5017,0410	6,266082300	6,223861700	6,452506500
158	5044,1084	6,296947000	6,257485400	6,485772600
159	5067,1670	6,330624600	6,286864300	6,519329100
160	5079,5386	6,349640800	6,309495900	6,544872300
161	5079,9683	6,371085200	6,332232500	6,567288900
162	5089,5293	6,389285100	6,344913000	6,582941500
163	5100,9834	6,410519100	6,365706000	6,602117500
164	5155,5732	6,579395800	6,539080100	6,781543700
165	5203,7568	6,634773700	6,587649800	6,829821600
166	5251,4380	6,682892300	6,643806900	6,886478900
167	5263,8784	6,699756100	6,663092100	6,907865000
168	5265,3281	6,708685900	6,672722800	6,918356400
169	5288,3608	6,732905400	6,698104900	6,942800500
170	5321,7319	6,776513600	6,735147000	6,980908400
171	5325,5088	6,803785800	6,761576200	7,010267300
172	5361,9004	6,835734800	6,794065500	7,047014700
173	5382,6484	6,858298300	6,820901900	7,074341800
174	5383,2979	6,870805300	6,832206200	7,086306600
175	5458,9229	6,967265100	6,934317600	7,182515100
176	5526,4937	7,053637500	7,016339800	7,267331600
177	5550,6216	7,090637200	7,047751900	7,305232500
178	5604,9800	7,156297700	7,125755300	7,381626600
179	5626,2212	7,190142200	7,165707600	7,421306100
180	5639,7725	7,224040000	7,200416100	7,452082200
181	**5664,3940**	**7,264103900**	**7,248226600**	**7,495087600**

Lanjutan Tabel Hasil Pengujian Benda Uji BBTS3

No.	LOAD CELL; AVE	LVDT1; AVE	LVDT2; AVE	LVDT3; AVE
	KG	mm	mm	mm
182	5687,0156	7,295472100	7,282109300	7,529901000
183	5695,4199	7,323112500	7,307075000	7,557743500
184	5713,9492	7,353635300	7,333538500	7,589103200
185	5727,5576	7,380891800	7,358792800	7,613719000
186	5747,4150	7,412721600	7,391318800	7,649097400
187	5802,6621	7,529302100	7,491462200	7,761666300
188	5840,6499	7,570970100	7,544642000	7,812313600
189	5886,4463	7,628704500	7,609403100	7,878340200
190	5928,4434	7,690109300	7,668613000	7,938067000
191	5944,3481	7,720188600	7,706739400	7,975656500
192	5974,5781	7,773836100	7,761526100	8,030345000
193	5958,6904	7,782992400	7,766177200	8,036935800
194	5993,3389	7,836712800	7,811905400	8,089294400
195	5996,9497	7,858538200	7,834906600	8,112369500
196	6015,0166	7,886666300	7,863500600	8,139827700
197	6036,1406	7,918374500	7,898307800	8,174555800
198	6048,7432	7,941119700	7,923666500	8,202479400
199	6054,1699	7,962002300	7,941125900	8,222153700
200	6062,5532	7,980704300	7,958766900	8,243578900
201	6075,4038	8,205901100	8,182098400	8,482685100
202	6089,9668	8,222887000	8,198983200	8,502143900
203	6105,3203	8,240268700	8,216306700	8,519207000
204	6132,2310	8,264638900	8,248970000	8,547945000
205	6155,2603	8,293493300	8,276720000	8,575697900
206	6167,7559	8,317247400	8,297723800	8,595934900
207	6180,8174	8,331538200	8,313148500	8,614642100
208	6195,1680	8,349130600	8,331609700	8,635564800
209	6205,9839	8,368073500	8,348296200	8,652277000
210	6220,4551	8,391037900	8,368126900	8,674057000
211	6225,9111	8,399629600	8,381154100	8,687548600
212	6235,4478	8,417687400	8,395635600	8,703146900
213	6237,0566	8,427269900	8,405368800	8,711472500
214	6258,7686	8,447411500	8,429741900	8,736282300
215	6257,6328	8,457908600	8,438423200	8,746192000
216	6263,6611	8,475604100	8,451545700	8,757096300
217	6272,9009	8,514926900	8,488514900	8,795759200
218	6288,8052	8,534199700	8,510526700	8,818114300
219	6328,0391	8,565894100	8,552538900	8,859072700
220	6334,7422	8,580462500	8,567294100	8,875044800
221	6358,5039	8,617912300	8,596669200	8,908335700
222	6387,6094	8,650912300	8,632073400	8,945396400
223	6406,8481	8,679365200	8,659339900	8,977151900
224	6428,0957	8,719285000	8,698851600	9,015414200
225	6457,4482	8,771312700	8,747171400	9,062279700
226	6480,9233	8,804289800	8,782259900	9,102489500

Lanjutan Tabel Hasil Pengujian Benda Uji BBTS3

No.	LOAD CELL; AVE	LVDT1; AVE	LVDT2; AVE	LVDT3; AVE
	KG	mm	mm	mm
227	6493,8267	8,839628200	8,811586400	9,134507200
228	6509,3794	8,871128100	8,848752000	9,169788400
229	6525,9556	8,897798500	8,886274300	9,205390000
230	6547,3145	8,935393300	8,917218200	9,242717700
231	6564,2974	8,972229000	8,948174500	9,277774800
232	6571,9111	9,006139800	8,978682500	9,306251500
233	6584,6182	9,043536200	9,011635800	9,337219200
234	6587,9551	9,059557000	9,032863600	9,358545300
235	6596,7798	9,141457600	9,112012900	9,454007100
236	6625,3013	9,174419400	9,146605500	9,490886700
237	6658,8950	9,213809000	9,180588700	9,530564300
238	6678,3721	9,272053700	9,219038000	9,574029000
239	6717,3906	9,309594200	9,268592800	9,625300400
240	6722,3071	9,349229800	9,307148900	9,661644000
241	6726,4922	9,360535600	9,331564900	9,681326900
242	6756,6411	9,405935300	9,390004200	9,731189700
243	6780,5664	9,462201100	9,448671300	9,790361400
244	6791,0586	9,509412800	9,497754100	9,838418000
245	6799,2700	9,541117700	9,531384500	9,870645500
246	6803,2397	9,807376900	9,804399500	10,170786000
247	6838,6611	9,846308700	9,838000300	10,211151000
248	6866,0815	9,875899300	9,873284300	10,246021000
249	6901,2261	9,931589100	9,925067900	10,292152000
250	6915,4790	9,963634500	9,960758200	10,323831000
251	6924,4854	9,997373600	9,986343400	10,350216000
252	6949,2910	10,021221000	10,018524000	10,387740000
253	6968,7588	10,059760000	10,050141000	10,422926000
254	6979,6924	10,094015000	10,077820000	10,452188000
255	6989,9951	10,114847000	10,103466000	10,479258000
256	6999,2773	10,142331000	10,131849000	10,506529000
257	7006,8027	10,162413000	10,154246000	10,530918000
258	7022,8169	10,190006000	10,176125000	10,559241000
259	7040,6172	10,234203000	10,211122000	10,595886000
260	7044,8105	10,259399000	10,232154000	10,621365000
261	7045,0933	10,293566000	10,271012000	10,654948000
262	7048,0815	10,487830000	10,478663000	10,884124000
263	7093,8594	10,544446000	10,535062000	10,938378000
264	7117,3491	10,582393000	10,567477000	10,973628000
265	7137,0732	10,615761000	10,598969000	11,007300000
266	7156,2041	10,657966000	10,631658000	11,046356000
267	7177,4297	10,689661000	10,678082000	11,085753000
268	7197,0942	10,720154000	10,712778000	11,123007000
269	7204,7290	10,750401000	10,743812000	11,154217000
270	7215,3594	10,785340000	10,775563000	11,185272000
271	7228,8867	10,814502000	10,811568000	11,219851000

Lanjutan Tabel Hasil Pengujian Benda Uji BBTS3

No.	LOAD CELL; AVE	LVDT1; AVE	LVDT2; AVE	LVDT3; AVE
	KG	mm	mm	mm
272	7247,5752	10,865611000	10,846242000	11,259692000
273	7252,2246	10,891180000	10,876058000	11,291284000
274	7252,6743	10,924091000	10,917279000	11,334338000
275	7260,6870	11,019160000	11,005327000	11,439388000
276	7282,4722	11,049644000	11,039148000	11,473019000
277	7304,6665	11,089828000	11,079522000	11,510346000
278	7314,8477	11,127218000	11,118206000	11,550751000
279	7334,0098	11,451659000	11,390531000	11,844598000
280	7373,2739	11,500539000	11,446220000	11,903020000
281	7397,4199	11,543391000	11,490920000	11,951168000
282	7410,4355	11,580745000	11,522676000	11,985345000
283	7436,4019	11,632515000	11,570218000	12,037488000
284	7422,9800	11,649678000	11,585555000	12,054104000
285	7431,7695	11,755820000	11,715011000	12,178928000
286	7472,5840	11,819351000	11,768984000	12,235930000
287	7519,8335	11,901857000	11,838719000	12,315947000
288	7523,3745	11,944779000	11,880040000	12,361380000
289	7545,6074	11,994390000	11,944841000	12,424544000
290	7554,7305	12,051453000	11,989556000	12,479251000
291	7553,2207	12,079049000	12,016087000	12,512795000
292	7570,7148	12,125139000	12,065052000	12,564901000
293	7583,9868	12,175865000	12,120649000	12,619686000
294	7633,6406	12,530516000	12,474808000	13,016819000
295	7669,8418	12,606802000	12,554440000	13,098072000
296	7697,7954	12,694453000	12,637927000	13,187421000
297	7716,9097	12,755461000	12,706194000	13,266177000
298	7717,5581	12,823273000	12,759198000	13,327598000
299	7743,7427	12,894687000	12,840260000	13,412267000
300	7744,2944	12,998317000	12,939136000	13,522451000
301	7753,6797	13,312343000	13,239725000	13,872457000
302	7790,8413	13,382995000	13,312121000	13,954993000
303	7799,3101	13,441065000	13,366385000	14,016078000
304	7801,8364	13,478037000	13,402948000	14,055045000
305	7806,8857	13,525418000	13,449187000	14,107594000
306	7784,9487	13,537903000	13,457504000	14,121450000
325	**8212,0859**			

Lampiran 6	94
Data Pengujian Balok Beton Betulang dengan Profil Siku Sebagai Pengganti Tulangan Memanjang	

Keterangan :

Retak Pertama

Kelendutan maks < 7,5 mm

Beban makssimum

LVDT1 = y_{i-1}
LVDT2 = y_{i+2}
LVDT3 = y_i

LAMPIRAN VII

PERHITUNGAN BALOK BERTULANG BBTS1

A. Balok Bertulang dengan Sengkang Baja Tulangan P6

1. Diketahui :

   a) Dimensi balok :

      1) Tinggi balok = 200 mm
      2) Lebar balok = 125 mm
      3) Panjang balok (l_n) = 1800 mm
      4) Selimut beton = 10 mm
      5) f_c' = 33,6601 MPa
      6) β = 0,85-0,008x(33,6601-30) = 0,8207
      7) E_c = 4700√33,6601 = 27268,1427 MPa

   b) Dimensi profil :

      1) Lebar siku = 29,4 mm
      2) Tinggi siku = 29,4 mm
      3) Tebal = 3 mm
      4) Pusat berat (C_x=C_z) = 8,44 mm
      5) Jenis baja = BJ41
      6) F_u = 457,4471 MPa
      7) f_y = 298,9851 MPa
      8) A_g = 172,7 mm^2
      9) E_s = 200.000 MPa

c) Dimensi sengkang :

1) Ø sengkang = 5,63 mm

2) f_y = 323,0207 MPa

2. Perhitungan :

$d' = Selimut\ beton + Øsengkang + C_z$

$d' = 10 + 5{,}63 + 8{,}44$

$d' = 24{,}07\ mm$

$d = h - d'$

$d = 200 - 24{,}07$

$d = 175{,}93\ mm$

y = h/2 = 200/2 = 100 mm

$A_s = n \times A_{1\,tul} = 2 \times 172{,}7 = 345{,}4 mm^2$

$$\rho = \frac{A_s}{b.d} = \frac{365{,}4}{125 \times 175{,}93} = 0{,}0157$$

$$n = \frac{E_s}{E_c} = \frac{200000}{27268{,}1427} = 7{,}3346$$

Mencari nilai a dengan rumus 3.8 keseimbangan gaya :

$$\sum F_{H} = 0$$

$C_c = T_s$

$a \times b \times 0{,}85 \times f_c' = A_s \times f_y$

$$a = \frac{A_s \times f_y}{0{,}85 \times f_c' \times b}$$

$$a = \frac{2 \times 172{,}7 \times 298{,}9851}{0{,}85 \times 33{,}6601 \times 125}$$

a = 28,8754 mm

Lampiran 7	97
Perhitungan Berdasarkan Teori	

Mencari Momen maksimum (M_{maks}) analisis :

$C_c = T_s = As \; x \; f_y$

C_c = 2 x 172,7 x 298,9851

C_c = 103269,4535 N

$M_n = C_c \times Z$

dimana :

$$Z = d - \frac{a}{2} = 175{,}93 - \frac{28{,}8754}{2} = 161{,}4923 \; mm$$

M_n = 103269,4535 x 161,4923

M_n = 16677221,5719 Nmm

M_n = 16,6772 kNm

$M_u \leq \emptyset M_n$, dimana $\emptyset$ = 0,8

Maka,

M_u = 0,8 x 16,6772 kNm

M_u = 13,3418 kNm

Mencari beban maksimum (P_{maks}) analisis :

$$M_u = \frac{1}{6} \times P \times L$$

P = (6 x M_u)/L

P = (6 x 13,3418)/1,8

P = 44,4727 kN

Momen Inersia (I)

$$I = \frac{1}{12} \times b \times h^3$$

$$I = \frac{1}{12} \times 125 \times 200^3 = 83333333{,}3333 mm^4$$

Pada Retak Pertama

Modulus retak (f_r)

$$f_r = 0{,}7 \times \sqrt{f_c'}$$

$$f_r = 0{,}7 \times \sqrt{33{,}6601} = 4{,}0612\ MPa$$

Momen dan beban teoristis :

$$M_{cr} = \frac{f_r \times I}{y} = \frac{4{,}0612 \times 83333333{,}3333}{100} = 3384333{,}333\ Nmm$$

$$M_{cr} = 3{,}3843\ kNm$$

P_{cr} = (6 x M)/L

P_{cr} = (6 x 3,3843)/1,8 = 11,2811 kN =1128,1111 kg

Kelengkungan teoristis :

$$\phi_{retak} = \frac{f_r/E_c}{y} = \frac{4{,}0612/27268{,}1427}{100} = 1{,}4894 \times 10^{-6}\ 1/mm$$

$$\phi_{retak} = 0{,}0014894\ 1/m$$

Setelah Retak Pada Saat Leleh Pertama

Dengan menganggap beban elastis, maka :

Momen dan beban teoristis :

$M_y = A_s\ x\ f_y\ x\ z$

M_y = 345,4 *x* 298,9851 *x* 161,4923

M_y =16677221,5719 Nmm

M_y =16,677221 kNm

P_y = (6 x M)/L

P_y = (6 x 16,6772)/1,8 = 55,5907 kN =5559,0667 kg

Kelengkungan teoristis :

$$k = \sqrt{[(\rho^2.n^2) + 2\rho n]} - (\rho.n)$$

$$k = \sqrt{[(0{,}0157^2 \times 7{,}3346^2) + 2 \times 0{,}0157 \times 7{,}3346]} - (0{,}0157 \times 7{,}3346)$$

k =0,3784

Maka, kd = 0,3784 x 175,93 = 66,5719 mm

$$\phi_y = \frac{f_y/E_s}{d - kd} = \frac{298{,}9851/200000}{175{,}93 - 66{,}5719} = 1{,}367 \times 10^{-5}\ 1/mm$$

$$= 0{,}01367\ 1/m$$

Lampiran 7	100
Perhitungan Berdasarkan Teori	

PERHITUNGAN BALOK BERTULANG BBTS2

A. Balok Bertulang dengan Sengkang Baja Tulangan P6

1. Diketahui :

   a) Dimensi balok :

      1) Tinggi balok = 200 mm
      2) Lebar balok = 125 mm
      3) Panjang balok (l_n) = 1800 mm
      4) Selimut beton = 10 mm
      5) f_c' = 32,7222 MPa
      6) β = 0,85-0,008x(32,305-30) = 0,8282
      7) E_c = 4700√32,7222 = 26885,5611 MPa

   b) Dimensi profil :

      1) Lebar siku = 29,4 mm
      2) Tinggi siku = 29,4 mm
      3) Tebal = 3 mm
      4) Pusat berat (C_x=C_z) = 8,44 mm
      5) Jenis baja = BJ41
      6) F_u = 457,4471 MPa
      7) f_y = 298,9851 MPa
      8) A_g = 172,7 mm^2
      9) E_s = 200.000 MPa

c) Dimensi sengkang :

1) Ø sengkang = 5,63 mm

2) f_y = 323,0207 MPa

2. Perhitungan :

$d' = Selimut\ beton + Øsengkang + C_z$

$d' = 10 + 5{,}63 + 8{,}44$

$d' = 24{,}07\ mm$

$d = h - d'$

$d = 200 - 24{,}07$

$d = 175{,}93\ mm$

y = h/2 = 200/2 = 100 mm

$A_s = n \times A_{1\,tul} = 2 \times 172{,}7 = 345{,}4 mm^2$

$$\rho = \frac{A_s}{b.d} = \frac{365{,}4}{125 \times 175{,}93} = 0{,}0157$$

$$n = \frac{E_s}{E_c} = \frac{200000}{26885{,}5611} = 7{,}4389$$

Mencari nilai a dengan rumus 3.8 keseimbangan gaya :

$$\sum F_H = 0$$

$C_c = T_s$

$a \times b \times 0{,}85 \times f_c' = A_s \times f_y$

$$a = \frac{A_s \times f_y}{0{,}85 \times f_c' \times b}$$

$$a = \frac{345{,}4 \times 298{,}9851}{0{,}85 \times 32{,}7222 \times 125}$$

a = 29,703 mm

Mencari Momen maksimum (M_{maks}) analisis :

$C_c = T_s = As \times f_y$

C_c = 354,4 x 298,9851

C_c = 103269,4535 N

$M_n = C_c \times Z$

dimana :

$$Z = d - \frac{a}{2} = 175{,}93 - \frac{29{,}703}{2} = 161{,}0785\ mm$$

M_n = 103269,4535 x 161,0785

M_n = 16634488,672 Nmm

M_n = 16,6345 kNm

$M_u \leq \emptyset M_n$, dimana $\emptyset$ = 0,8

Maka,

M_u = 0,8 x 16,6345 kNm

M_u = 13,3076 kNm

Mencari beban maksimum (P_{maks}) analisis :

$$M_u = \frac{1}{6} \times P \times L$$

P = (6 x M_u)/L

P = (6 x 13,3076)/1,8

P = 44,3587 kN

Momen Inersia (I)

$$I = \frac{1}{12} \times b \times h^3$$

$$I = \frac{1}{12} \times 125 \times 200^3 = 83333333{,}3333 mm^4$$

Pada retak pertama

Modulus retak (f_r)

$$f_r = 0{,}7 \times \sqrt{f_c'}$$

$$f_r = 0{,}7 \times \sqrt{32{,}7222} = 3{,}9842 MPa$$

Momen dan beban teoristis :

$$M_{cr} = \frac{f_r \times I}{y} = \frac{3{,}9842 \times 83333333{,}3333}{100} = 3320167{,}14\ Nmm$$

$$M_{cr} = 3{,}32017\ kNm$$

P = (6 x M)/L

P = (6 x 3,32017)/1,8 = 11,0672 kN =1106,7233 kg

Kelengkungan teoristis :

$$\phi_{retak} = \frac{f_r / E_c}{y} = \frac{3{,}9842 / 26885{,}5611}{100} = 1{,}4893 \times 10^{-6}\ 1/mm$$

$$\phi_{retak} = 0{,}0014893\ 1/m$$

Setelah retak pada saat leleh pertama

Dengan menganggap beban elastis, maka :

Momen dan beban teoristis :

$M_y = A_s\ x\ f_y\ x\ z$

M_y = 345,4 *x* 298,9851 *x* 161,0785

M_y =16634488,672 Nmm

M_y =16,6345 kNm

P = (6 x M)/L

P = (6 x 16,6345)/1,8 = 55,4483 kN =5544,8333 kg

Kelengkungan teoristis :

$$k = \sqrt{[(\rho^2.n^2) + 2\rho n]} - (\rho.n)$$

$$k = \sqrt{[(0{,}0157^2 \times 7{,}4389^2) + 2 \times 0{,}0157 \times 7{,}4389]} - (0{,}0157 \times 7{,}4389)$$

k =0,3804

Maka, kd = 0,3804 x 175,93 = 66,9238 mm

$$\phi_y = \frac{f_y/E_s}{d - kd} = \frac{298{,}9851/200000}{175{,}93 - 66{,}9238} = 1{,}3714 \times 10^{-5}\ 1/mm$$

$$= 0{,}013714\ 1/m$$

Lampiran 7	105
Perhitungan Berdasarkan Teori	

PERHITUNGAN BALOK BERTULANG BBTS3

A. Balok Bertulang dengan Sengkang Baja Tulangan P6

1. Diketahui :

   a) Dimensi balok :

      1) Tinggi balok = 200 mm
      2) Lebar balok = 125 mm
      3) Panjang balok (l_n) = 1800 mm
      4) Selimut beton = 10 mm
      5) f_c' = 34,8245 MPa
      6) β = 0,85-0,008x(34,8245-30) = 0,8114
      7) E_c = 4700√34,8245 = 27735,7748 MPa

   b) Dimensi profil :

      1) Lebar siku = 29,4 mm
      2) Tinggi siku = 29,4 mm
      3) Tebal = 3 mm
      4) Pusat berat (C_x=C_z) = 8,44 mm
      5) Jenis baja = BJ41
      6) F_u = 457,4471 MPa
      7) f_y = 298,9851 MPa
      8) A_g = 172,7 mm^2
      9) E_s = 200.000 MPa

c) Dimensi sengkang :

1) Ø sengkang = 5,63 mm

2) f_y = 323,0207 MPa

2. Perhitungan :

$d' = Selimut\ beton + Øsengkang + C_z$

$d' = 10 + 5{,}63 + 8{,}44$

$d' = 24{,}07\ mm$

$d = h - d'$

$d = 200 - 24{,}07$

$d = 175{,}93\ mm$

y = h/2 = 200/2 = 100 mm

$A_s = n \times A_{1\,tul} = 2 \times 172{,}7 = 345{,}4 mm^2$

$$\rho = \frac{A_s}{b.d} = \frac{365{,}4}{125 \times 175{,}93} = 0{,}0157$$

$$n = \frac{E_s}{E_c} = \frac{200000}{27735{,}7748} = 7{,}2109$$

Mencari nilai a dengan rumus 3.8 keseimbangan gaya :

$$\sum F_{H} = 0$$

$C_c = T_s$

$a \times b \times 0{,}85 \times f_c' = A_s \times f_y$

$$a = \frac{A_s \times f_y}{0{,}85 \times f_c' \times b}$$

$$a = \frac{2 \times 172{,}7 \times 298{,}9851}{0{,}85 \times 34{,}8245 \times 125}$$

a = 27,9099 mm

Mencari Momen maksimum (M_{maks}) analisis :

$C_c = T_s = As \times f_y$

C_c = 345,4 x 298,9851

C_c = 103269,4535 N

$M_n = C_c \times Z$

dimana :

$$Z = d - \frac{a}{2} = 175{,}93 - \frac{27{,}9099}{2} = 161{,}9751\ mm$$

M_n = 103269,4535 x 161,9751

M_n = 16727074,9006 Nmm

M_n = 16,7271 kNm

$M_u \leq \emptyset M_n$, dimana $\emptyset$ = 0,8

Maka,

M_u = 0,8 x 16,7271 kNm

M_u = 13,3817 kNm

Mencari beban maksimum (P_{maks}) analisis :

$$M_u = \frac{1}{6} \times P \times L$$

P = (6 x M_u)/L

P = (6 x 13,3817)/1,8

P = 44,6057 kN

Momen Inersia (I)

$$I = \frac{1}{12} \times b \times h^3$$

$$I = \frac{1}{12} \times 125 \times 200^3 = 83333333{,}3333 mm^4$$

Pada retak pertama

Modulus retak (f_r)

$$f_r = 0{,}7 \times \sqrt{f_c'}$$

$$f_r = 0{,}7 \times \sqrt{34{,}8245} = 4{,}1309\ MPa$$

Momen dan beban teoristis :

$$M_{cr} = \frac{f_r \times I}{y} = \frac{4{,}1309 \times 83333333{,}3333}{100} = 3442416{,}667\ Nmm$$

$$M_{cr} = 3{,}4424\ kNm$$

P = (6 x M)/L

P = (6 x 3,4424)/1,8 = 11,4747 kN =1147,4667 kg

Kelengkungan teoristis :

$$\phi_{retak} = \frac{{}^{f_r}/_{E_c}}{y} = \frac{{}^{4{,}1309}/_{27735{,}7748}}{100} = 1{,}4437 \times 10^{-6}\ {}^{1}/_{mm}$$

$$\phi_{retak} = 0{,}0014437\ {}^{1}/_{m}$$

Setelah retak pada saat leleh pertama

Dengan menganggap beban elastis, maka :

Momen dan beban teoristis :

$M_y = A_s\ x\ f_y\ x\ z$

M_y = 345,4 *x* 298,9851 *x* 161,9751

M_y =16727074,9006 Nmm

M_y =16,7271 kNm

P = (6 x M)/L

P = (6 x 16,7271)/1,8 = 55,757 kN =5575,7 kg

Kelengkungan teoristis :

$$k = \sqrt{[(\rho^2.n^2) + 2\rho n]} - (\rho.n)$$

$$k = \sqrt{[(0{,}0157^2 \times 7{,}2109^2) + 2 \times 0{,}0157 \times 7{,}2109]} - (0{,}0157 \times 7{,}2109)$$

k =0,3759

Maka, kd = 0,3759 x 175,93 = 66,1321 mm

$$\phi_y = \frac{f_y/E_s}{d - kd} = \frac{298{,}9851/200000}{175{,}93 - 66{,}1321} = 1{,}3615 \times 10^{-5}\ 1/mm$$

$$= 0{,}013615\ 1/m$$

LAMPIRAN VIII

TABEL DAN GRAFIK BEBAN, MOMEN, LENDUTAN, DAN KELENGKUNGAN

Tabel Beban- Momen- Lendutan-Kelengkungan BBTS1

No.	Beban (*P*) (kg)	Momen (*M*) (kNm)	Lendutan (δ) (mm)	Kelengkungan (ϕ) (1/m)	*EI* (kN/m)
1	0	0	0	0,0000000	0,0000
2	282,08276	0,84624828	0,081093378	-0,0026549	-318,7455
3	300,84024	0,90252072	0,093976341	-0,0026618	-339,0580
4	334,55396	1,00366188	0,11103161	-0,0027020	-371,4458
5	410,39868	1,23119604	0,14603917	-0,0027646	-445,3394
6	475,12524	1,42537572	0,18192701	-0,0028236	-504,8009
7	520,04413	1,56013239	0,20879328	-0,0027824	-560,7054
8	558,19727	1,67459181	0,23218265	-0,0027970	-598,7046
9	592,27362	1,77682086	0,25481528	-0,0027620	-643,3028
10	622,03363	1,86610089	0,27365768	-0,0027477	-679,1616
11	623,04303	1,86912909	0,2794821	-0,0027042	-691,1853
12	675,19806	2,02559418	0,31387323	-0,0026110	-775,7921
13	755,84845	2,26754535	0,35986784	-0,0026810	-845,7817
14	851,98206	2,55594618	0,42084667	-0,0026183	-976,1788
15	938,92029	2,81676087	0,47977659	-0,0026095	-1079,4243
16	1006,8182	3,0204546	0,52778369	-0,0027093	-1114,8317
17	1046,3593	3,1390779	0,56249511	-0,0027397	-1145,7745
18	1042,7947	3,1283841	0,56739181	-0,0027397	-1141,8867
19	1078,4972	3,2354916	0,59226114	-0,0026986	-1198,9510
20	1169,7661	3,5092983	0,64655328	-0,0026665	-1316,0513
21	1245,8523	3,7375569	0,69760209	-0,0027137	-1377,3076
22	1300,2637	3,9007911	0,73896259	-0,0027673	-1409,6144
23	1360,5732	4,0817196	0,7836265	-0,0028258	-1444,4499
24	1408,6	4,2258	0,82205659	-0,0028544	-1480,4752
25	1441,1941	4,3235823	0,84891838	-0,0027667	-1562,7008
26	1468,3059	4,4049177	0,87139964	-0,0027533	-1599,8832
27	1462,2543	4,3867629	0,87561244	-0,0027593	-1589,7881
28	1491,3093	4,4739279	0,90528238	-0,0027607	-1620,5530
29	1528,5527	4,5856581	0,928886	-0,0027950	-1640,6437
30	1558,8379	4,6765137	0,95113868	-0,0027126	-1723,9715
31	1589,2131	4,7676393	0,9744246	-0,0026905	-1772,0034
32	1605,4846	4,8164538	0,99009192	-0,0026732	-1801,7486
33	1620,1404	4,8604212	1,0056194	-0,0026395	-1841,4094
34	1632,8334	4,8985002	1,0200932	-0,0026138	-1874,1233
35	1647,3014	4,9419042	1,0344917	-0,0026318	-1877,7687
36	1664,9824	4,9949472	1,0504175	-0,0026042	-1917,9986
37	1672,3055	5,0169165	1,060285	-0,0026291	-1908,2505
38	1688,3717	5,0651151	1,0742118	-0,0026410	-1917,8727

Lanjutan Tabel Beban- Momen- Lendutan-Kelengkungan BBTS1

No.	Beban (P) (kg)	Momen (M) (kNm)	Lendutan (δ) (mm)	Kelengkungan (ϕ) (1/m)	EI (kN/m)
39	1708,7859	5,1263577	1,090557	-0,0026927	-1903,8195
40	1732,6912	5,1980736	1,1103042	-0,0027004	-1924,9266
41	1750,6002	5,2518006	1,1278127	-0,0026704	-1966,6608
42	1764,9888	5,2949664	1,1423244	-0,0026166	-2023,5700
43	1783,2678	5,3498034	1,1591523	-0,0025917	-2064,1832
44	1790,3276	5,3709828	1,170229	-0,0025746	-2086,1459
45	1797,5939	5,3927817	1,1805456	-0,0025369	-2125,7393
46	1810,5785	5,4317355	1,1932302	-0,0025187	-2156,5271
47	1828,1096	5,4843288	1,2103149	-0,0025018	-2192,1830
48	1829,6831	5,4890493	1,2373962	-0,0024510	-2239,4831
49	1851,1781	5,5535343	1,2516974	-0,0025103	-2212,3264
50	1871,0212	5,6130636	1,2667683	-0,0024849	-2258,8526
51	1892,5541	5,6776623	1,2841529	-0,0024163	-2349,7087
52	1920,6146	5,7618438	1,3067257	-0,0024153	-2385,5761
53	1935,4103	5,8062309	1,3239721	-0,0024529	-2367,1240
54	1951,2802	5,8538406	1,3409685	-0,0024150	-2423,9134
55	1974,3286	5,9229858	1,3631278	-0,0024020	-2465,8600
56	2005,9971	6,0179913	1,3913764	-0,0023499	-2560,9814
57	2036,826	6,110478	1,4241759	-0,0023178	-2636,3074
58	2058,5447	6,1756341	1,4533414	-0,0023062	-2677,8572
59	2092,6575	6,2779725	1,4897479	-0,0022346	-2809,4881
60	2117,2485	6,3517455	1,5236657	-0,0021522	-2951,2172
61	2142,6396	6,4279188	1,5568894	-0,0020710	-3103,7169
62	2167,9705	6,5039115	1,5938452	-0,0020095	-3236,5176
63	2175,3999	6,5261997	1,6179361	-0,0020260	-3221,2319
64	2219,5603	6,6586809	1,7101008	-0,0021274	-3129,9280
65	2243,2214	6,7296642	1,7531883	-0,0020470	-3287,5613
66	2289,9812	6,8699436	1,8145157	-0,0020110	-3416,1811
67	2317,4436	6,9523308	1,8662263	-0,0018870	-3684,3183
68	2339,5408	7,0186224	1,9077005	-0,0017784	-3946,6914
69	2355,9861	7,0679583	1,9425342	-0,0017969	-3933,4856
70	2377,6458	7,1329374	1,9796762	-0,0018364	-3884,2932
71	2393,9863	7,1819589	2,0100439	-0,0018529	-3875,9677
72	2411,2554	7,2337662	2,0426426	-0,0018090	-3998,7033
73	2425,3582	7,2760746	2,0756359	-0,0017324	-4200,0720
74	2443,8235	7,3314705	2,1089051	-0,0016544	-4431,4606
75	2452,3325	7,3569975	2,1362164	-0,0017286	-4256,0217
76	2462,2537	7,3867611	2,2416162	-0,0013320	-5545,7122
77	2540,6333	7,6218999	2,3096602	-0,0013070	-5831,5008
78	2593,8191	7,7814573	2,3685124	-0,0012953	-6007,5345
79	2620,615	7,861845	2,4074862	-0,0012670	-6205,2191
80	2644,9485	7,9348455	2,4403949	-0,0012749	-6223,6962
81	2663,864	7,991592	2,4708292	-0,0012121	-6593,4018
82	2664,2202	7,9926606	2,5119636	-0,0011849	-6745,3223
83	2742,3311	8,2269933	2,573204	-0,0011424	-7201,2728

Lanjutan Tabel Beban- Momen- Lendutan-Kelengkungan BBTS1

No.	Beban (P) (kg)	Momen (M) (kNm)	Lendutan (δ) (mm)	Kelengkungan (ϕ) (1/m)	EI (kN/m)
84	2813,8796	8,4416388	2,650207	-0,0011276	-7486,0982
85	2858,6582	8,5759746	2,7149234	-0,0011713	-7321,9513
86	2893,3667	8,6801001	2,7701781	-0,0010474	-8286,9348
87	2929,5942	8,7887826	2,8244834	-0,0010922	-8046,9651
88	2955,6162	8,8668486	2,8746476	-0,0012998	-6821,9437
89	2970,9951	8,9129853	2,9143698	-0,0012932	-6892,2207
90	3002,2188	9,0066564	3,0075846	-0,0011275	-7988,5196
91	3029,0464	9,0871392	3,0364614	-0,0010836	-8386,3815
92	3074,7432	9,2242296	3,1670785	-0,0008586	-10743,7254
93	3135,1958	9,4055874	3,2247555	-0,0007645	-12302,4117
94	3199,6167	9,5988501	3,2909465	-0,0007965	-12051,7712
95	3256,7722	9,7703166	3,361593	-0,0007171	-13623,8687
96	3290,8491	9,8725473	3,4097486	-0,0005759	-17143,8274
97	3327,4709	9,9824127	3,4587953	-0,0004751	-21011,2265
98	3360,5586	10,0816758	3,5058703	-0,0003683	-27372,6509
99	3390,4954	10,1714862	3,5514996	-0,0003905	-26047,4065
100	3390,885	10,172655	3,6154993	-0,0003881	-26213,9266
101	3430,6172	10,2918516	3,6507311	-0,0003731	-27583,4433
102	3468,5947	10,4057841	3,6907592	-0,0002602	-39996,2490
103	3489,9404	10,4698212	3,7212389	-0,0002466	-42456,1794
104	3526,5713	10,5797139	3,7655089	-0,0002521	-41967,0042
105	3544,5115	10,6335345	3,7977138	-0,0003294	-32283,9757
106	3580,5769	10,7417307	3,8437138	-0,0002272	-47288,1103
107	3606,2029	10,8186087	3,8843117	-0,0002811	-38488,7443
108	3633,1819	10,8995457	3,9249878	-0,0001688	-64553,1769
109	3658,0437	10,9741311	3,9640617	-0,0001873	-58594,9506
110	3681,9299	11,0457897	4,0008464	-0,0000538	-205231,9671
111	3705,6548	11,1169644	4,0391059	0,0000056	1995147,9541
112	3764,2	11,2926	4,1996613	-0,0002408	-46904,9449
113	3804,8779	11,4146337	4,2421312	-0,0001869	-61068,2537
114	3817,8848	11,4536544	4,2649202	-0,0002768	-41378,8092
115	3821,6111	11,4648333	4,2934518	-0,0002783	-41199,3564
116	3886,8501	11,6605503	4,3471155	-0,0001189	-98034,7755
117	3937,6741	11,8130223	4,4027863	-0,0000536	-220565,0379
118	3981,9795	11,9459385	4,4593239	-0,0001037	-115215,9804
119	4014,6748	12,0440244	4,5072904	-0,0000568	-211938,2065
120	4050,1594	12,1504782	4,5592289	-0,0000670	-181261,1430
121	4092,0671	12,2762013	4,6173787	0,0000533	230383,2395
122	4133,6465	12,4009395	4,6789417	0,0000320	387529,3594
123	4162,6108	12,4878324	4,730185	0,0000760	164380,6342
124	4182,0825	12,5462475	4,7709341	0,0002212	56716,4572
125	4226,9312	12,6807936	4,8652172	0,0002498	50756,8770
126	4278,4189	12,8352567	4,9292736	0,0001950	65819,4665
127	4324,3813	12,9731439	5,0853658	0,0005621	23079,3276
128	4343,9028	13,0317084	5,1122227	0,0004961	26270,7455

Lanjutan Tabel Beban- Momen- Lendutan-Kelengkungan BBTS1

No.	Beban (P) (kg)	Momen (M) (kNm)	Lendutan (δ) (mm)	Kelengkungan (ϕ) (1/m)	EI (kN/m)
129	4364,9907	13,0949721	5,1522751	0,0005473	23926,1041
130	4431,0469	13,2931407	5,2116814	0,0005720	23237,8064
131	4479,8901	13,4396703	5,2697778	0,0005529	24306,6297
132	4521,9248	13,5657744	5,3237171	0,0006781	20005,9792
133	4564,1274	13,6923822	5,3820095	0,0007972	17175,1830
134	4612,3906	13,8371718	5,44522	0,0008295	16680,6365
135	4660,9521	13,9828563	5,514822	0,0009590	14580,2986
136	4684,1001	14,0523003	5,5612206	0,0009647	14565,8182
137	4706,8657	14,1205971	5,5991545	0,0010507	13438,8445
138	4713,9146	14,1417438	5,6234312	0,0010748	13157,3748
139	4767,6899	14,3030697	5,71558	0,0010941	13072,8134
140	4832,5889	14,4977667	5,7903085	0,0012591	11514,8459
141	4877,4385	14,6323155	5,8562374	0,0012895	11347,3136
142	4931,8516	14,7955548	5,9315457	0,0011546	12814,0869
143	4972,5737	14,9177211	5,9996982	0,0012210	12218,0060
144	4999,6313	14,9988939	6,0521235	0,0013100	11449,4150
145	5008,0923	15,0242769	6,1368794	0,0013965	10758,4687
146	5067,0532	15,2011596	6,1982398	0,0014319	10615,9057
147	5104,8003	15,3144009	6,2498913	0,0015056	10171,7616
148	5145,9917	15,4379751	6,3080268	0,0015885	9718,7520
149	5195,2974	15,5858922	6,3767138	0,0016348	9533,5771
150	5252,145	15,756435	6,4626293	0,0016414	9599,4287
151	5296,0415	15,8881245	6,5420966	0,0017544	9056,1172
152	5328,0444	15,9841332	6,6072445	0,0017093	9351,2524
153	5330,4868	15,9914604	6,6436596	0,0017620	9075,9446
154	5365,9448	16,0978344	6,7436399	0,0019161	8401,2137
155	5422,2061	16,2666183	6,8141508	0,0020132	8080,1298
156	5461,9766	16,3859298	6,8794427	0,0021341	7678,2676
157	5501,4038	16,5042114	6,9485741	0,0022385	7372,7998
158	5549,3252	16,6479756	7,0321307	0,0023771	7003,4843
159	5582,6489	16,7479467	7,1084051	0,0023049	7266,0970
160	5601,9727	16,8059181	7,1682463	0,0022986	7311,2695
161	**5618,938**	**16,856814**	**7,2236886**	**0,0023932**	**7043,4941**
162	5678,8765	17,0366295	7,568439	0,0024958	6826,1498
163	5724,2783	17,1728349	7,6380219	0,0025595	6709,4412
164	5762,2627	17,2867881	7,7089996	0,0025635	6743,4820
165	5771,9092	17,3157276	7,7569318	0,0026085	6638,1807
166	5802,4727	17,4074181	7,8542666	0,0027969	6223,8858
167	5885,4668	17,6564004	7,970201	0,0029647	5955,5999
168	5945,9243	17,8377729	8,09688	0,0029632	6019,6693
169	5983,1167	17,9493501	8,2186079	0,0030254	5932,9359
170	5994,8218	17,9844654	8,3116016	0,0029809	6033,1565
171	6003,3618	18,0100854	8,3805447	0,0031429	5730,4546
172	6007,0601	18,0211803	8,4356499	0,0032668	5516,5404
173	6019,7676	18,0593028	8,5518208	0,0032790	5507,5490

Lanjutan Tabel Beban- Momen- Lendutan-Kelengkungan BBTS1

No.	Beban (P) (kg)	Momen (M) (kNm)	Lendutan (δ) (mm)	Kelengkungan (ϕ) (1/m)	EI (kN/m)
174	6093,4453	18,2803359	8,6652832	0,0032500	5624,6547
175	6130,4683	18,3914049	8,7725229	0,0032922	5586,3300
176	6167,8105	18,5034315	8,8848372	0,0033162	5579,7680
177	6189,8994	18,5696982	8,9910908	0,0034716	5349,0547
178	6200,1094	18,6003282	9,0791035	0,0036660	5073,7905
179	6200,9951	18,6029853	9,142869	0,0035934	5176,9626
180	6185,9302	18,5577906	9,1800871	0,0034662	5353,8631
181	6246,6138	18,7398414	9,3758774	0,0034550	5424,0071
182	6306,4019	18,9192057	9,5045891	0,0035726	5295,5873
183	6329,5322	18,9885966	9,6254711	0,0036676	5177,3875
184	6350,5039	19,0515117	9,731473	0,0039260	4852,7101
185	6371,2231	19,1136693	9,8389053	0,0039650	4820,5793
186	6390,5483	19,1716449	10,398096	0,0043852	4371,8875
187	6421,585	19,264755	10,482022	0,0044489	4330,2580
188	6431,5239	19,2945717	10,542971	0,0046066	4188,4626
189	6443,917	19,331751	10,603563	0,0047432	4075,6770
190	6452,6338	19,3579014	10,75911	0,0047363	4087,1617
191	6511,3379	19,5340137	10,848302	0,0048301	4044,2172
192	6535,3833	19,6061499	10,934578	0,0048663	4028,9562
193	6565,5972	19,6967916	11,028995	0,0048258	4081,5430
194	6585,2305	19,7556915	11,12922	0,0049045	4028,0417
195	6598,501	19,795503	11,219003	0,0050128	3949,0227
196	6606,4824	19,8194472	11,298888	0,0051832	3823,7638
197	6604,6509	19,8139527	11,361009	0,0053176	3726,1011
198	6577,5254	19,7325762	11,386942	0,0054146	3644,3343
199	**7008,6807**				

Tabel Beban- Momen- Lendutan-Kelengkungan BBTS2

No.	Beban (P) (kg)	Momen (M) (kNm)	Lendutan (δ) (mm)	Kelengkungan (ϕ) (1/m)	EI (kN/m)
1	0,0000	0,0000	0,000000000	0,0000000	0,0000
2	1,8285	0,0055	0,000018816	-0,0003486	-15,7338
3	1,9049	0,0057	0,000018816	-0,0003490	-16,3721
4	2,4017	0,0072	0,000029042	-0,0003470	-20,7667
5	41,0384	0,1231	0,024147335	-0,0006542	-188,1783
6	106,5987	0,3198	0,065423563	-0,0008830	-362,1804
7	227,7424	0,6832	0,139050990	-0,0007715	-885,5361
8	277,6925	0,8331	0,173508380	-0,0007222	-1153,5886
9	331,6655	0,9950	0,210552600	-0,0005898	-1687,1340
10	341,6713	1,0250	0,220470790	-0,0005704	-1796,9715
11	339,4547	1,0184	0,220543190	-0,0005873	-1733,9542
12	396,2913	1,1889	0,253560330	-0,0006483	-1833,8544
13	545,8909	1,6377	0,359979510	-0,0006998	-2340,1805
14	653,8535	1,9616	0,441811620	-0,0006721	-2918,5430
15	671,9058	2,0157	0,459962730	-0,0006379	-3160,1465
16	931,5258	2,7946	0,625145790	-0,0006653	-4200,5672
17	1110,5001	3,3315	0,748999770	-0,0007454	-4469,3001
18	1136,7847	3,4104	0,780512870	-0,0006860	-4971,0769
19	1333,7437	4,0012	0,917790170	-0,0006105	-6554,5417
20	1539,6975	4,6191	1,090264400	-0,0005914	-7810,8201
21	1613,7194	4,8412	1,173839600	-0,0006459	-7495,3408
22	1675,1660	5,0255	1,258732700	-0,0003836	-13101,7008
23	1894,0073	5,6820	1,435189500	-0,0003784	-15015,8744
24	2006,2290	6,0187	1,571555500	-0,0001412	-42631,6024
25	2047,3914	6,1422	1,631418000	-0,0003380	-18170,4465
26	2229,8035	6,6894	1,832848400	0,0000034	1996243,0618
27	2364,6716	7,0940	1,986962700	-0,0000566	-125395,7683
28	2422,3577	7,2671	2,087101200	0,0000544	133635,0331
29	2405,9146	7,2177	2,112674000	-0,0000717	-100713,6411
30	2575,2407	7,7257	2,294540200	0,0001185	65208,0732
31	2721,6135	8,1648	2,498925700	0,0002158	37830,1364
32	2758,8074	8,2764	2,601913700	0,0002485	33309,1410
33	2806,2341	8,4187	2,779661900	-0,0000830	-101475,3842
34	2908,6675	8,7260	2,883363700	0,0000103	845870,7348
35	3079,3425	9,2380	3,059463700	0,0001895	48740,7404
36	3183,0449	9,5491	3,214624600	0,0002121	45030,7685
37	3216,4016	9,6492	3,302053500	0,0001848	52206,9666
38	3284,5491	9,8536	3,456009400	0,0003538	27848,5355
39	3381,2275	10,1437	3,566279600	0,0004607	22016,4966
40	3467,1956	10,4016	3,674223400	0,0005305	19608,2840
41	3533,0359	10,5991	3,777827700	0,0006138	17267,8182
42	3548,1411	10,6444	3,839338800	0,0006114	17411,0562
43	3590,3591	10,7711	3,946486200	0,0007357	14639,9467
44	3605,4778	10,8164	3,973114700	0,0007682	14081,0008

Lanjutan Tabel Beban- Momen- Lendutan-Kelengkungan BBTS2

No.	Beban (P) (kg)	Momen (M) (kNm)	Lendutan (δ) (mm)	Kelengkungan (ϕ) (1/m)	EI (kN/m)
45	3702,4980	11,1075	4,070413100	0,0008459	13130,2481
46	3773,4084	11,3202	4,174491400	0,0009454	11974,2972
47	3793,2402	11,3797	4,230813000	0,0011189	10170,1719
48	3802,5659	11,4077	4,330443900	0,0014166	8052,7464
49	3827,6675	11,4830	4,361650900	0,0014137	8122,7563
50	3832,2292	11,4967	4,379576700	0,0015749	7299,8225
51	3838,7742	11,5163	4,511800300	0,0015723	7324,5304
52	4022,3999	12,0672	4,666415200	0,0015580	7745,5579
53	4147,5752	12,4427	4,808066800	0,0016807	7403,2467
54	4211,2471	12,6337	4,900236600	0,0018256	6920,4858
55	4233,0786	12,6992	4,946220400	0,0019575	6487,5928
56	4242,4116	12,7272	4,977444600	0,0019876	6403,4114
57	4295,4160	12,8862	5,069247700	0,0020305	6346,4736
58	4368,5708	13,1057	5,148805600	0,0020799	6300,9778
59	4409,6724	13,2290	5,207208600	0,0021926	6033,5309
60	4458,5010	13,3755	5,270402400	0,0022820	5861,1993
61	4515,4219	13,5463	5,350812000	0,0021703	6241,5437
62	4540,5830	13,6217	5,402284600	0,0022107	6161,6492
63	4580,6104	13,7418	5,462187800	0,0022672	6061,0208
64	4599,3657	13,7981	5,502409500	0,0022877	6031,4303
65	4606,6362	13,8199	5,531622900	0,0023130	5974,7996
66	4633,7246	13,9012	5,617685800	0,0023403	5939,8806
67	4635,3208	13,9060	5,632919800	0,0023562	5901,8349
68	4715,9922	14,1480	5,712622200	0,0023340	6061,5646
69	4768,1670	14,3045	5,779074700	0,0023947	5973,3626
70	4817,5298	14,4526	5,844395600	0,0023765	6081,5494
71	4861,4775	14,5844	5,912270100	0,0024185	6030,2456
72	4889,7305	14,6692	5,964138500	0,0023842	6152,7301
73	4891,1401	14,6734	5,990238700	0,0024713	5937,4397
74	4909,8281	14,7295	6,020596500	0,0025249	5833,7664
75	4925,9990	14,7780	6,052639000	0,0025628	5766,4044
76	4921,6484	14,7649	6,065773500	0,0025992	5680,6320
77	4932,1270	14,7964	6,204059600	0,0025545	5792,2104
78	5002,7949	15,0084	6,273512400	0,0024645	6089,7356
79	5086,6772	15,2600	6,361260400	0,0025180	6060,4694
80	5133,6104	15,4008	6,428023300	0,0025048	6148,6304
81	5127,7319	15,3832	6,445572900	0,0025126	6122,3896
82	5116,8169	15,3505	6,449312700	0,0025029	6133,0439
83	5234,0396	15,7021	6,582799900	0,0025536	6148,9862
84	5360,4292	16,0813	6,733603000	0,0026612	6042,9684
85	5411,3428	16,2340	6,836788200	0,0027195	5969,4089
86	5449,7178	16,3492	6,910270700	0,0026962	6063,7335
87	5458,4727	16,3754	6,952737300	0,0026170	6257,2766
88	5483,9121	16,4517	7,002225400	0,0026328	6248,7509
89	5554,8081	16,6644	7,156485600	0,0026966	6179,8551

Lanjutan Tabel Beban- Momen- Lendutan-Kelengkungan BBTS2

No.	Beban (P) (kg)	Momen (M) (kNm)	Lendutan (δ) (mm)	Kelengkungan (ϕ) (1/m)	EI (kN/m)
90	5687,0752	17,0612	7,342423400	0,0027591	6183,6468
91	5693,9248	17,0818	7,406855600	0,0027726	6160,8205
92	5683,7441	17,0512	7,428477800	0,0027881	6115,7067
93	**5732,8545**	**17,1986**	**7,495672700**	**0,0028389**	**6058,1125**
94	5769,6958	17,3091	7,563690700	0,0028581	6056,2408
95	5788,5342	17,3656	7,621503400	0,0027137	6399,2439
96	5782,9521	17,3489	7,650071600	0,0027957	6205,4546
97	5835,4536	17,5064	7,779872400	0,0029499	5934,6171
98	5902,2627	17,7068	7,876337500	0,0029246	6054,5218
99	6020,4268	18,0613	8,328197500	0,0029991	6022,2977
100	6106,1470	18,3184	8,457289700	0,0029258	6260,9704
101	6150,6011	18,4518	8,558550800	0,0030065	6137,2730
102	6183,5630	18,5507	8,638361000	0,0031471	5894,4688
103	6209,4927	18,6285	8,710233700	0,0032017	5818,3012
104	6223,2622	18,6698	8,764157300	0,0032113	5813,8164
105	6270,3301	18,8110	8,931306800	0,0032267	5829,8626
106	6318,7144	18,9561	9,017260600	0,0033621	5638,1636
107	6347,7524	19,0433	9,088852900	0,0033469	5689,7516
108	6367,7925	19,1034	9,152836800	0,0034006	5617,6920
109	6383,8584	19,1516	9,214473700	0,0034388	5569,2368
110	6395,1465	19,1854	9,267227200	0,0035011	5479,7552
111	6417,6421	19,2529	9,325013200	0,0035977	5351,5270
112	6442,0625	19,3262	9,397952100	0,0037041	5217,5659
113	6451,0317	19,3531	9,452398300	0,0037544	5154,7167
114	6456,2803	19,3688	9,499840700	0,0037688	5139,1994
115	6519,4614	19,5584	9,683529900	0,0040720	4803,0841
116	6586,0786	19,7582	9,825701700	0,0042913	4604,2380
117	6612,7813	19,8383	9,944248200	0,0045317	4377,7115
118	6639,2568	19,9178	10,054343000	0,0047095	4229,2866
119	6641,3936	19,9242	10,143892000	0,0049305	4041,0217
120	6644,4014	19,9332	10,620484000	0,0055190	3611,7289
121	6692,7935	20,0784	10,710697000	0,0055123	3642,4489
122	6741,4390	20,2243	10,825780000	0,0055977	3612,9562
123	6745,6499	20,2369	10,906938000	0,0057485	3520,3756
124	6801,2290	20,4037	11,152097000	0,0062338	3273,0895
125	6818,6963	20,4561	11,226538000	0,0063960	3198,2578
126	6869,8696	20,6096	11,360714000	0,0064712	3184,8055
127	6877,0776	20,6312	11,472719000	0,0065541	3147,8457
128	6889,5884	20,6688	11,580052000	0,0065417	3159,5500
129	6904,6328	20,7139	11,689667000	0,0067144	3085,0100
130	6883,6533	20,6510	11,759350000	0,0068129	3031,1422
131	6908,1997	20,7246	11,980792000	0,0072161	2872,0064
132	6917,9023	20,7537	12,130353000	0,0074866	2772,1175
133	6939,8311	20,8195	12,203178000	0,0077031	2702,7422
134	6947,2065	20,8416	12,271165000	0,0078554	2653,1617

Lanjutan Tabel Beban- Momen- Lendutan-Kelengkungan BBTS2

No.	Beban (P) (kg)	Momen (M) (kNm)	Lendutan (δ) (mm)	Kelengkungan (ϕ) (1/m)	EI (kN/m)
135	6959,9775	20,8799	12,346953000	0,0080364	2598,1731
136	6971,0308	20,9131	12,424121000	0,0082167	2545,1936
137	6990,0361	20,9701	12,517817000	0,0079852	2626,1120
138	7035,1855	21,1056	13,208183000	0,0091751	2300,3106
139	7057,5356	21,1726	13,328474000	0,0092972	2277,3076
140	**7273,8403**				

Tabel Beban- Momen- Lendutan-Kelengkungan BBTS3

No.	Beban (P) (kg)	Momen (M) (kNm)	Lendutan (δ) (mm)	Kelengkungan (ϕ) (1/m)	EI (kN/m)
1	0,0000	0,0000	0,000000000	0,000000000	0,0000
2	53,7135	0,1611	0,062176540	0,000963826	167,1883
3	122,4131	0,3672	0,100113700	0,000947691	387,5097
4	142,8526	0,4286	0,114716310	0,001005004	426,4240
5	203,4414	0,6103	0,150089580	0,001127722	541,2006
6	284,6680	0,8540	0,199713650	0,001184008	721,2821
7	369,0214	1,1071	0,262070150	0,001308045	846,3504
8	435,9482	1,3078	0,313427810	0,001539331	849,6188
9	475,8087	1,4274	0,345484500	0,001609681	886,7760
10	481,1997	1,4436	0,355425980	0,001647285	876,3506
11	592,8074	1,7784	0,427749780	0,001459588	1218,4416
12	736,6455	2,2099	0,524468360	0,001343517	1644,8889
13	814,1437	2,4424	0,586899340	0,001388727	1758,7550
14	867,9291	2,6038	0,632608410	0,001284734	2026,7133
15	975,5939	2,9268	0,716350440	0,001332935	2195,7420
16	1082,4358	3,2473	0,797466280	0,001285830	2525,4558
17	1169,6847	3,5091	0,869997860	0,001322976	2652,3948
18	1216,9009	3,6507	0,916092280	0,001180619	3092,1951
19	1218,2234	3,6547	0,929533120	0,001266335	2886,0225
20	1233,7919	3,7014	0,956736510	0,001347971	2745,8878
21	1369,8732	4,1096	1,045745800	0,001360592	3020,4648
22	1383,5912	4,1508	1,067604500	0,001252272	3314,5943
23	1401,4739	4,2044	1,095735500	0,001388273	3028,5266
24	1434,5243	4,3036	1,118521100	0,001359529	3165,4881
25	1453,4266	4,3603	1,134513300	0,001372822	3176,1436
26	1502,7137	4,5081	1,168037700	0,001176293	3832,4985
27	1528,4561	4,5854	1,191879900	0,001198455	3826,0663
28	1538,5096	4,6155	1,204843800	0,001224613	3768,9693
29	1566,9905	4,7010	1,227336500	0,001231899	3816,0365
30	1595,5551	4,7867	1,251681100	0,001293387	3700,8763
31	1602,9347	4,8088	1,264500600	0,001312660	3663,4042
32	1697,6703	5,0930	1,339519100	0,001398209	3642,5248
33	1751,7032	5,2551	1,386972100	0,001284106	4092,4266
34	1785,8727	5,3576	1,422372200	0,001280792	4183,0509
35	1812,7524	5,4383	1,451892000	0,001307115	4160,5040
36	1825,2240	5,4757	1,473036600	0,001373426	3986,8708
37	1833,4315	5,5003	1,527411500	0,001388165	3962,2772
38	1838,5198	5,5156	1,533647800	0,001410364	3910,7347
39	1865,8256	5,5975	1,552521700	0,001376209	4067,3159
40	1906,7760	5,7203	1,583800700	0,001435302	3985,4525
41	1924,5095	5,7735	1,604517700	0,001506722	3831,8472
42	1954,9526	5,8649	1,655798100	0,001489998	3936,1515

Lanjutan Tabel Beban- Momen- Lendutan-Kelengkungan BBTS3

No.	Beban (P) (kg)	Momen (M) (kNm)	Lendutan (δ) (mm)	Kelengkungan (ϕ) (1/m)	EI (kN/m)
43	2019,4348	6,0583	1,707408900	0,001427056	4245,3165
44	2059,3235	6,1780	1,753003000	0,001482417	4167,4984
45	2065,0100	6,1950	1,774280400	0,001588508	3899,9048
46	2084,1724	6,2525	1,801013400	0,001647180	3795,8919
47	2110,0166	6,3300	1,834013000	0,001545407	4096,0406
48	2118,8772	6,3566	1,858874900	0,001472854	4315,8600
49	2115,3445	6,3460	1,965115000	0,001501000	4227,8704
50	2134,6133	6,4038	1,979340400	0,001614362	3966,7930
51	2215,0381	6,6451	2,041271400	0,001788336	3715,8086
52	2271,1965	6,8136	2,098404400	0,001697163	4014,6936
53	2277,7271	6,8332	2,123529200	0,001661780	4111,9651
54	2292,8035	6,8784	2,152170200	0,001732891	3969,3267
55	2309,3125	6,9279	2,188975600	0,001727264	4010,9314
56	2339,7803	7,0193	2,228767600	0,001797375	3905,3291
57	2364,6091	7,0938	2,265286700	0,001891113	3751,1388
58	2385,5632	7,1567	2,303550200	0,001934289	3699,9071
59	2400,1660	7,2005	2,336647500	0,001966131	3662,2677
60	2422,7759	7,2683	2,377853400	0,002092896	3472,8566
61	2440,9414	7,3228	2,447651400	0,002273117	3221,4902
62	2497,5347	7,4926	2,502358900	0,002188437	3423,7239
63	2556,6199	7,6699	2,573771200	0,002214732	3463,1096
64	2608,1912	7,8246	2,648867100	0,002206192	3546,6422
65	2630,7332	7,8922	2,698939100	0,002232409	3535,2839
66	2687,9717	8,0639	2,773290900	0,002268935	3554,0529
67	2707,2939	8,1219	2,825370300	0,002299693	3531,7243
68	2723,0286	8,1691	2,863565400	0,002434737	3355,2231
69	2740,0798	8,2202	2,896943300	0,002485498	3307,2806
70	2743,8333	8,2315	3,044908300	0,002403079	3425,3971
71	2780,2632	8,3408	3,076333800	0,002495488	3342,3481
72	2838,7085	8,5161	3,128491400	0,002497385	3410,0171
73	2863,5813	8,5907	3,160915400	0,002442394	3517,3456
74	2876,9241	8,6308	3,180953000	0,002424325	3560,0723
75	2899,6111	8,6988	3,207156900	0,002473164	3517,2893
76	2900,6279	8,7019	3,219800000	0,002458322	3539,7656
77	2950,1709	8,8505	3,289102600	0,002603522	3399,4384
78	3001,5662	9,0047	3,342802000	0,002625469	3429,7486
79	3036,3481	9,1090	3,385863300	0,002676134	3403,8072
80	3094,2888	9,2829	3,457353400	0,002599784	3570,6299
81	3112,1563	9,3365	3,498073300	0,002818357	3312,7347
82	3114,7112	9,3441	3,548313400	0,002651451	3524,1585
83	3123,9648	9,3719	3,562606300	0,002716233	3450,3279

Lanjutan Tabel Beban- Momen- Lendutan-Kelengkungan BBTS3

No.	Beban (P) (kg)	Momen (M) (kNm)	Lendutan (δ) (mm)	Kelengkungan (ϕ) (1/m)	EI (kN/m)
84	3152,1831	9,4565	3,591691500	0,002751735	3436,5770
85	3174,8020	9,5244	3,620999300	0,002635290	3614,1776
86	3197,7776	9,5933	3,649761700	0,002585531	3710,3917
87	3223,2156	9,6696	3,684242200	0,002563495	3772,0560
88	3250,5073	9,7515	3,720976100	0,002544021	3833,1138
89	3254,3406	9,7630	3,781950200	0,002726955	3580,1918
90	3290,4700	9,8714	3,816787200	0,002721674	3626,9627
91	3312,0552	9,9362	3,846644200	0,002671926	3718,7278
92	3343,9575	10,0319	3,990093000	0,002858047	3510,0446
93	3380,3169	10,1410	4,027000400	0,002848758	3559,7796
94	3429,7910	10,2894	4,087156800	0,002871321	3583,4980
95	3483,5105	10,4505	4,137661900	0,002832994	3688,8647
96	3486,3347	10,4590	4,153439000	0,002865900	3649,4658
97	3496,4136	10,4892	4,167412300	0,002840519	3692,7198
98	3543,8174	10,6315	4,211092900	0,002868142	3706,7384
99	3592,6824	10,7780	4,266945800	0,002890314	3729,0229
100	3638,4563	10,9154	4,323019000	0,002942595	3709,4364
101	3680,6577	11,0420	4,378206300	0,002986351	3697,4800
102	3713,0176	11,1391	4,427514600	0,002977363	3741,2478
103	3749,4636	11,2484	4,478174700	0,003034620	3706,6884
104	3762,6821	11,2880	4,509779000	0,003065358	3682,4561
105	3773,6038	11,3208	4,535065200	0,003075223	3681,2977
106	3831,1389	11,4934	4,632871200	0,003168708	3627,1618
107	3855,3638	11,5661	4,665348500	0,003124900	3701,2677
108	3871,9854	11,6160	4,689400700	0,003105502	3740,4440
109	3935,3252	11,8060	4,754367400	0,003105188	3802,0164
110	3954,8870	11,8647	4,795179800	0,003026690	3920,0120
111	3964,6699	11,8940	4,816589800	0,003122171	3809,5318
112	3975,0076	11,9250	4,836564100	0,003124834	3816,2100
113	4003,3489	12,0100	4,870253100	0,003101020	3872,9343
114	4026,7441	12,0802	4,904439000	0,003172880	3807,3398
115	4042,0850	12,1263	4,930312600	0,003265757	3713,1529
116	4076,6809	12,2300	4,971836100	0,003324681	3678,5613
117	4087,4717	12,2624	4,998046400	0,003241067	3783,4500
118	4093,7588	12,2813	5,014833500	0,003177272	3865,3525
119	4111,7749	12,3353	5,039799700	0,003246890	3799,1200
120	4130,7178	12,3922	5,067143900	0,003312630	3740,8806
121	4140,9614	12,4229	5,122920500	0,003329486	3731,1718
122	4177,8940	12,5337	5,159575500	0,003404184	3681,8462
123	4241,7261	12,7252	5,342859700	0,003554072	3580,4503
124	4297,4165	12,8922	5,399767400	0,003538432	3643,4922

Lanjutan Tabel Beban- Momen- Lendutan-Kelengkungan BBTS3

No.	Beban (P) (kg)	Momen (M) (kNm)	Lendutan (δ) (mm)	Kelengkungan (ϕ) (1/m)	EI (kN/m)
125	4352,9443	13,0588	5,457551500	0,003549061	3679,5177
126	4388,5005	13,1655	5,504040700	0,003560853	3697,2887
127	4400,2515	13,2008	5,547820100	0,003542743	3726,1395
128	4408,3032	13,2249	5,559330900	0,003546204	3729,3144
129	4463,2607	13,3898	5,611414900	0,003659863	3658,5474
130	4487,0112	13,4610	5,639831100	0,003639246	3698,8523
131	4517,9331	13,5538	5,680534800	0,003639711	3723,8669
132	4553,9624	13,6619	5,723040100	0,003729849	3662,8526
133	4567,7754	13,7033	5,748543700	0,003734145	3669,7360
134	4584,5083	13,7535	5,775564700	0,003729602	3687,6656
135	4602,9561	13,8089	5,803947400	0,003745044	3687,2379
136	4623,6777	13,8710	5,833031700	0,003735195	3713,6035
137	4644,9541	13,9349	5,863316500	0,003812732	3654,8234
138	4665,5098	13,9965	5,892288200	0,003884311	3603,3493
139	4692,4126	14,0772	5,928721000	0,003826815	3678,5781
140	4718,3223	14,1550	5,966564700	0,003880564	3647,6571
141	4740,2373	14,2207	5,999825500	0,003904353	3642,2710
142	4758,6548	14,2760	6,030745500	0,003974181	3592,1777
143	4768,7080	14,3061	6,091097800	0,004081201	3505,3711
144	4789,4941	14,3685	6,114392800	0,004044529	3552,5725
145	4806,6904	14,4201	6,139918300	0,004007153	3598,5826
146	4842,9155	14,5287	6,180550100	0,004046836	3590,1496
147	4851,7920	14,5554	6,198461500	0,004068884	3577,2403
148	4870,8647	14,6126	6,227651600	0,004053336	3605,0784
149	4891,0986	14,6733	6,252516300	0,004066158	3608,6389
150	4909,5410	14,7286	6,282364400	0,004055377	3631,8752
151	4948,8081	14,8464	6,327229500	0,004049759	3666,0019
152	4951,4277	14,8543	6,346991500	0,004014152	3700,4785
153	4979,1733	14,9375	6,380228500	0,004057888	3681,1070
154	4987,0493	14,9611	6,403657900	0,004076385	3670,1999
155	5009,2349	15,0277	6,432044500	0,004066696	3695,3106
156	5017,0410	15,0511	6,452506500	0,004150690	3626,1737
157	5044,1084	15,1323	6,485772600	0,004171128	3627,8736
158	5067,1670	15,2015	6,519329100	0,004211693	3609,3564
159	5079,5386	15,2386	6,544872300	0,004306079	3538,8612
160	5079,9683	15,2399	6,567288900	0,004312601	3533,8082
161	5089,5293	15,2686	6,582941500	0,004316849	3536,9752
162	5100,9834	15,3030	6,602117500	0,004280099	3575,3730
163	5155,5732	15,4667	6,781543700	0,004446115	3478,7044
164	5203,7568	15,6113	6,829821600	0,004372197	3570,5780
165	5251,4380	15,7543	6,886478900	0,004462586	3530,3105

Lanjutan Tabel Beban- Momen- Lendutan-Kelengkungan BBTS3

No.	Beban (P) (kg)	Momen (M) (kNm)	Lendutan (δ) (mm)	Kelengkungan (ϕ) (1/m)	EI (kN/m)
166	5263,8784	15,7916	6,907865000	0,004528818	3486,9220
167	5265,3281	15,7960	6,918356400	0,004553041	3469,3262
168	5288,3608	15,8651	6,942800500	0,004545907	3489,9707
169	5321,7319	15,9652	6,980908400	0,004501562	3546,5902
170	5325,5088	15,9765	7,010267300	0,004551726	3509,9930
171	5361,9004	16,0857	7,047014700	0,004642291	3465,0351
172	5382,6484	16,1479	7,074341800	0,004694834	3439,5136
173	5383,2979	16,1499	7,086306600	0,004696017	3439,0620
174	5458,9229	16,3768	7,182515100	0,004634475	3533,6837
175	5526,4937	16,5795	7,267331600	0,004646859	3567,8899
176	5550,6216	16,6519	7,305232500	0,004720759	3527,3702
177	5604,9800	16,8149	7,381626600	0,004812002	3494,3751
178	5626,2212	16,8787	7,421306100	0,004867624	3467,5364
179	5639,7725	16,9193	7,452082200	0,004797083	3527,0012
180	**5664,3940**	**16,9932**	**7,495087600**	**0,004778447**	**3556,2144**
181	5687,0156	17,0610	7,529901000	0,004822206	3538,0170
182	5695,4199	17,0863	7,557743500	0,004852995	3520,7660
183	5713,9492	17,1418	7,589103200	0,004910326	3490,9795
184	5727,5576	17,1827	7,613719000	0,004877534	3522,8197
185	5747,4150	17,2422	7,649097400	0,004941544	3489,2424
186	5802,6621	17,4080	7,761666300	0,005025683	3463,8051
187	5840,6499	17,5219	7,812313600	0,005090151	3442,3241
188	5886,4463	17,6593	7,878340200	0,005185728	3405,3732
189	5928,4434	17,7853	7,938067000	0,005174117	3437,3653
190	5944,3481	17,8330	7,975656500	0,005243850	3400,7541
191	5974,5781	17,9237	8,030345000	0,005253278	3411,9143
192	5958,6904	17,8761	8,036935800	0,005247020	3406,8998
193	5993,3389	17,9800	8,089294400	0,005299706	3392,6442
194	5996,9497	17,9908	8,112369500	0,005312942	3386,2310
195	6015,0166	18,0450	8,139827700	0,005294885	3408,0154
196	6036,1406	18,1084	8,174555800	0,005324293	3401,0942
197	6048,7432	18,1462	8,202479400	0,005401726	3359,3391
198	6054,1699	18,1625	8,222153700	0,005411792	3356,0990
199	6062,5532	18,1877	8,243578900	0,005476866	3320,8152
200	6075,4038	18,2262	8,482685100	0,005773707	3156,7607
201	6089,9668	18,2699	8,502143900	0,005824176	3136,9073
202	6105,3203	18,3160	8,519207000	0,005818386	3147,9453
203	6132,2310	18,3967	8,547945000	0,005822811	3159,4178
204	6155,2603	18,4658	8,575697900	0,005811825	3177,2775
205	6167,7559	18,5033	8,595934900	0,005768986	3207,3691
206	6180,8174	18,5425	8,614642100	0,005845975	3171,8323

Lanjutan Tabel Beban- Momen- Lendutan-Kelengkungan BBTS3

No.	Beban (P) (kg)	Momen (M) (kNm)	Lendutan (δ) (mm)	Kelengkungan (ϕ) (1/m)	EI (kN/m)
207	6195,1680	18,5855	8,635564800	0,005903893	3148,0083
208	6205,9839	18,6180	8,652277000	0,005881843	3165,3262
209	6220,4551	18,6614	8,674057000	0,005889492	3168,5866
210	6225,9111	18,6777	8,687548600	0,005943135	3142,7409
211	6235,4478	18,7063	8,703146900	0,005929708	3154,6821
212	6237,0566	18,7112	8,711472500	0,005903063	3169,7391
213	6258,7686	18,7763	8,736282300	0,005954112	3153,5023
214	6257,6328	18,7729	8,746192000	0,005960522	3149,5393
215	6263,6611	18,7910	8,757096300	0,005870428	3200,9563
216	6272,9009	18,8187	8,795759200	0,005880766	3200,0428
217	6288,8052	18,8664	8,818114300	0,005915022	3189,5766
218	6328,0391	18,9841	8,859072700	0,005997124	3165,5369
219	6334,7422	19,0042	8,875044800	0,006023330	3155,1030
220	6358,5039	19,0755	8,908335700	0,006020899	3168,2165
221	6387,6094	19,1628	8,945396400	0,006078071	3152,7812
222	6406,8481	19,2205	8,977151900	0,006155987	3122,2523
223	6428,0957	19,2843	9,015414200	0,006126918	3147,4694
224	6457,4482	19,3723	9,062279700	0,006060753	3196,3594
225	6480,9233	19,4428	9,102489500	0,006184293	3143,8953
226	6493,8267	19,4815	9,134507200	0,006177998	3153,3646
227	6509,3794	19,5281	9,169788400	0,006196967	3151,2413
228	6525,9556	19,5779	9,205390000	0,006267072	3123,9256
229	6547,3145	19,6419	9,242717700	0,006328239	3103,8561
230	6564,2974	19,6929	9,277774800	0,006351461	3100,5295
231	6571,9111	19,7157	9,306251500	0,006276807	3141,0450
232	6584,6182	19,7539	9,337219200	0,006192664	3189,8799
233	6587,9551	19,7639	9,358545300	0,006246700	3163,8890
234	6596,7798	19,7903	9,454007100	0,006545437	3023,5322
235	6625,3013	19,8759	9,490886700	0,006607485	3008,0891
236	6658,8950	19,9767	9,530564300	0,006667309	2996,2141
237	6678,3721	20,0351	9,574029000	0,006569663	3049,6414
238	6717,3906	20,1522	9,625300400	0,006724138	2996,9896
239	6722,3071	20,1669	9,661644000	0,006669093	3023,9376
240	6726,4922	20,1795	9,681326900	0,006705533	3009,3770
241	6756,6411	20,2699	9,731189700	0,006664399	3041,5231
242	6780,5664	20,3417	9,790361400	0,006698504	3036,7526
243	6791,0586	20,3732	9,838418000	0,006696691	3042,2750
244	6799,2700	20,3978	9,870645500	0,006687888	3049,9629
245	6803,2397	20,4097	10,170786000	0,007297956	2796,6350
246	6838,6611	20,5160	10,211151000	0,007379930	2779,9699
247	6866,0815	20,5982	10,246021000	0,007428584	2772,8359

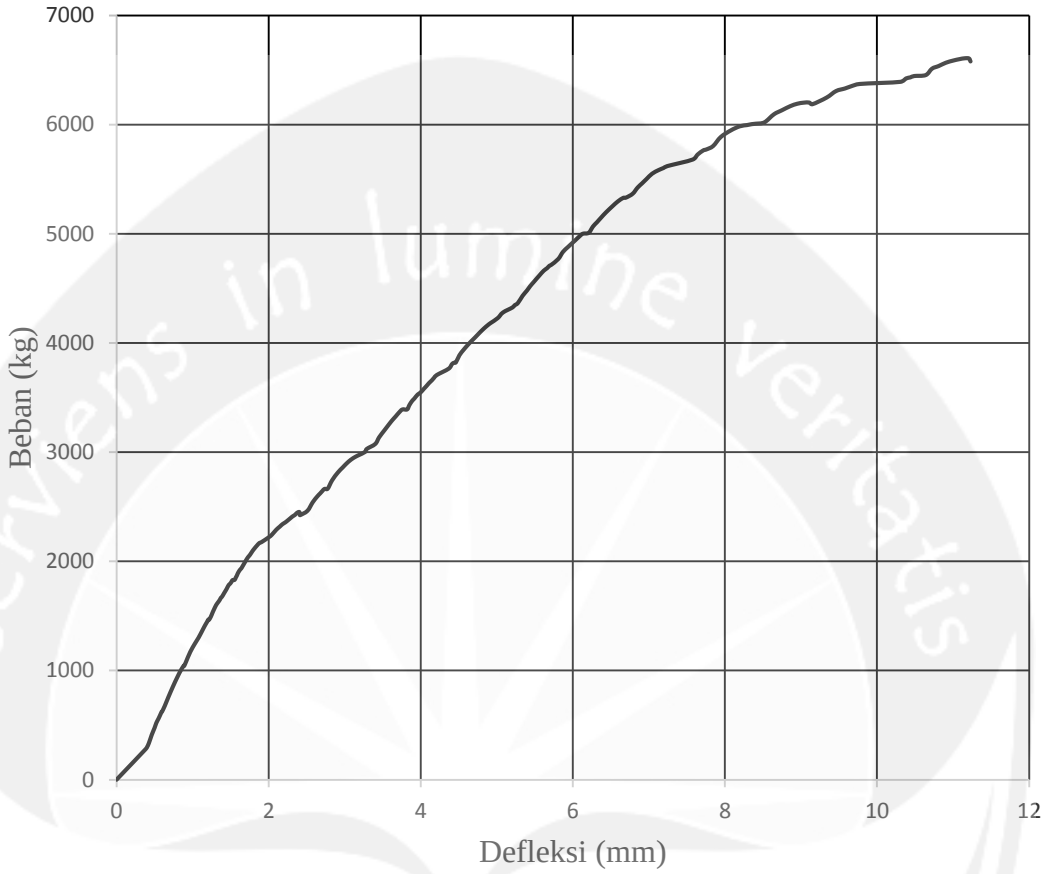
Lanjutan Tabel Beban- Momen- Lendutan-Kelengkungan BBTS3

No.	Beban (P) (kg)	Momen (M) (kNm)	Lendutan (δ) (mm)	Kelengkungan (ϕ) (1/m)	EI (kN/m)
248	6901,2261	20,7037	10,292152000	0,007276470	2845,2915
249	6915,4790	20,7464	10,323831000	0,007232693	2868,4249
250	6924,4854	20,7735	10,350216000	0,007167150	2898,4263
251	6949,2910	20,8479	10,387740000	0,007357350	2833,6117
252	6968,7588	20,9063	10,422926000	0,007359510	2840,7158
253	6979,6924	20,9391	10,452188000	0,007325410	2858,4171
254	6989,9951	20,9700	10,479258000	0,007402030	2833,0046
255	6999,2773	20,9978	10,506529000	0,007388780	2841,8537
256	7006,8027	21,0204	10,530918000	0,007451770	2820,8611
257	7022,8169	21,0685	10,559241000	0,007523510	2800,3486
258	7040,6172	21,1219	10,595886000	0,007464470	2829,6519
259	7044,8105	21,1344	10,621365000	0,007511770	2813,5089
260	7045,0933	21,1353	10,654948000	0,007453180	2835,7399
261	7048,0815	21,1442	10,884124000	0,008017550	2637,2451
262	7093,8594	21,2816	10,938378000	0,007972480	2669,3799
263	7117,3491	21,3520	10,973628000	0,007973860	2677,7555
264	7137,0732	21,4112	11,007300000	0,007998700	2676,8374
265	7156,2041	21,4686	11,046356000	0,008030880	2673,2578
266	7177,4297	21,5323	11,085753000	0,008037630	2678,9351
267	7197,0942	21,5913	11,123007000	0,008130820	2655,4865
268	7204,7290	21,6142	11,154217000	0,008142210	2654,5848
269	7215,3594	21,6461	11,185272000	0,008096410	2673,5403
270	7228,8867	21,6867	11,219851000	0,008136320	2665,4139
271	7247,5752	21,7427	11,259692000	0,008075310	2692,4942
272	7252,2246	21,7567	11,291284000	0,008153300	2668,4501
273	7252,6743	21,7580	11,334338000	0,008273060	2629,9849
274	7260,6870	21,7821	11,439388000	0,008542890	2549,7298
275	7282,4722	21,8474	11,473019000	0,008572460	2548,5586
276	7304,6665	21,9140	11,510346000	0,008513420	2574,0536
277	7314,8477	21,9445	11,550751000	0,008560780	2563,3813
278	7334,0098	22,0020	11,844598000	0,008470060	2597,6238
279	7373,2739	22,1198	11,903020000	0,008592810	2574,2245
280	7397,4199	22,1923	11,951168000	0,008680250	2556,6383
281	7410,4355	22,2313	11,985345000	0,008672690	2563,3692
282	7436,4019	22,3092	12,037488000	0,008722430	2557,6824
283	7422,9800	22,2689	12,054104000	0,008729750	2550,9253
284	7431,7695	22,2953	12,178928000	0,008870250	2513,4927
285	7472,5840	22,4178	12,235930000	0,008835250	2537,3082
286	7519,8335	22,5595	12,315947000	0,008913180	2531,0271
287	7523,3745	22,5701	12,361380000	0,008979410	2513,5419
288	7545,6074	22,6368	12,424544000	0,009098570	2487,9538

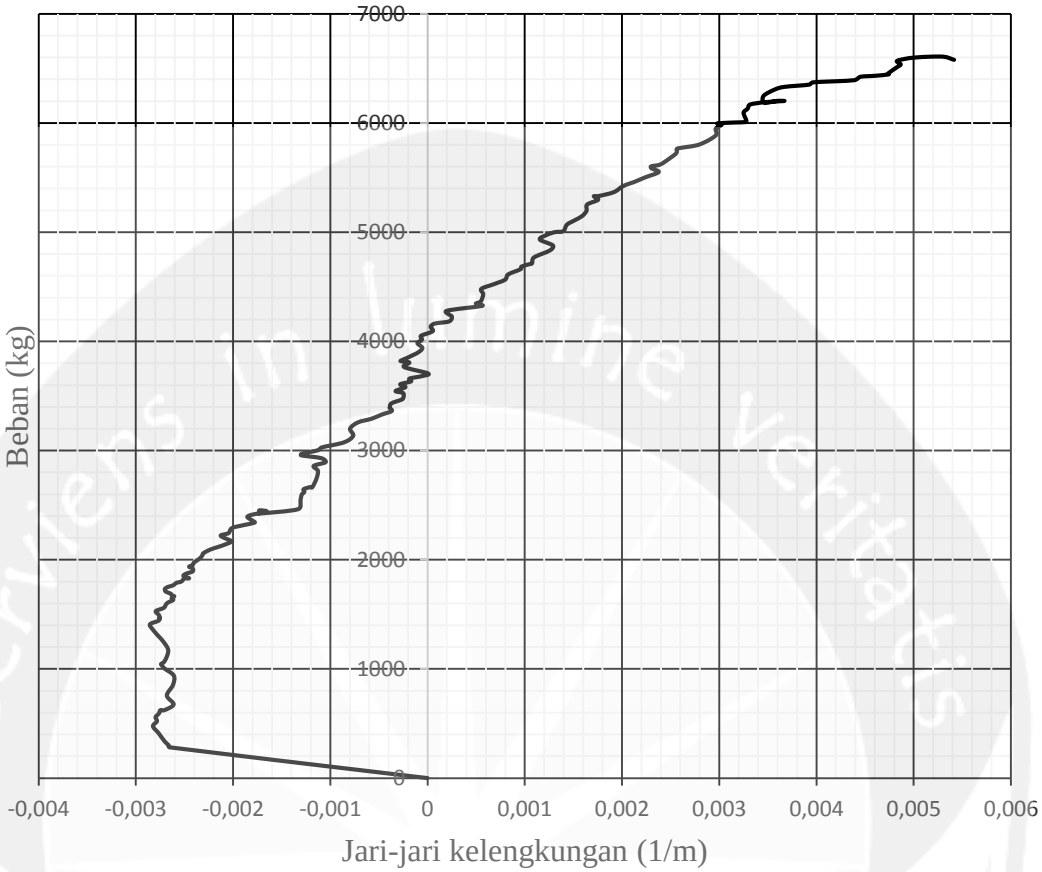
Lanjutan Tabel Beban- Momen- Lendutan-Kelengkungan BBTS3

No.	Beban (P) (kg)	Momen (M) (kNm)	Lendutan (δ) (mm)	Kelengkungan (ϕ) (1/m)	EI (kN/m)
289	7554,7305	22,6642	12,479251000	0,009174930	2470,2305
290	7553,2207	22,6597	12,512795000	0,009304540	2435,3339
291	7570,7148	22,7121	12,564901000	0,009396110	2417,1859
292	7583,9868	22,7520	12,619686000	0,009428580	2413,0845
293	7633,6406	22,9009	13,016819000	0,010283140	2227,0359
294	7669,8418	23,0095	13,098072000	0,010349020	2223,3531
295	7697,7954	23,0934	13,187421000	0,010424620	2215,2737
296	7716,9097	23,1507	13,266177000	0,010706990	2162,2070
297	7717,5581	23,1527	13,327598000	0,010727250	2158,3047
298	7743,7427	23,2312	13,412267000	0,010895870	2132,1132
299	7744,2944	23,2329	13,522451000	0,011074490	2097,8739
300	7753,6797	23,2610	13,872457000	0,011928460	1950,0454
301	7790,8413	23,3725	13,954993000	0,012148700	1923,8704
302	7799,3101	23,3979	14,016078000	0,012247060	1910,4936
303	7801,8364	23,4055	14,055045000	0,012291050	1904,2726
304	7806,8857	23,4207	14,107594000	0,012405830	1887,8751
305	7784,9487	23,3548	14,121450000	0,012474930	1872,1425
324	**8212,0859**				

Grafik Hasil Pengujian



Gambar Grafik *P-δ* Hasil Pengujian BBTS1



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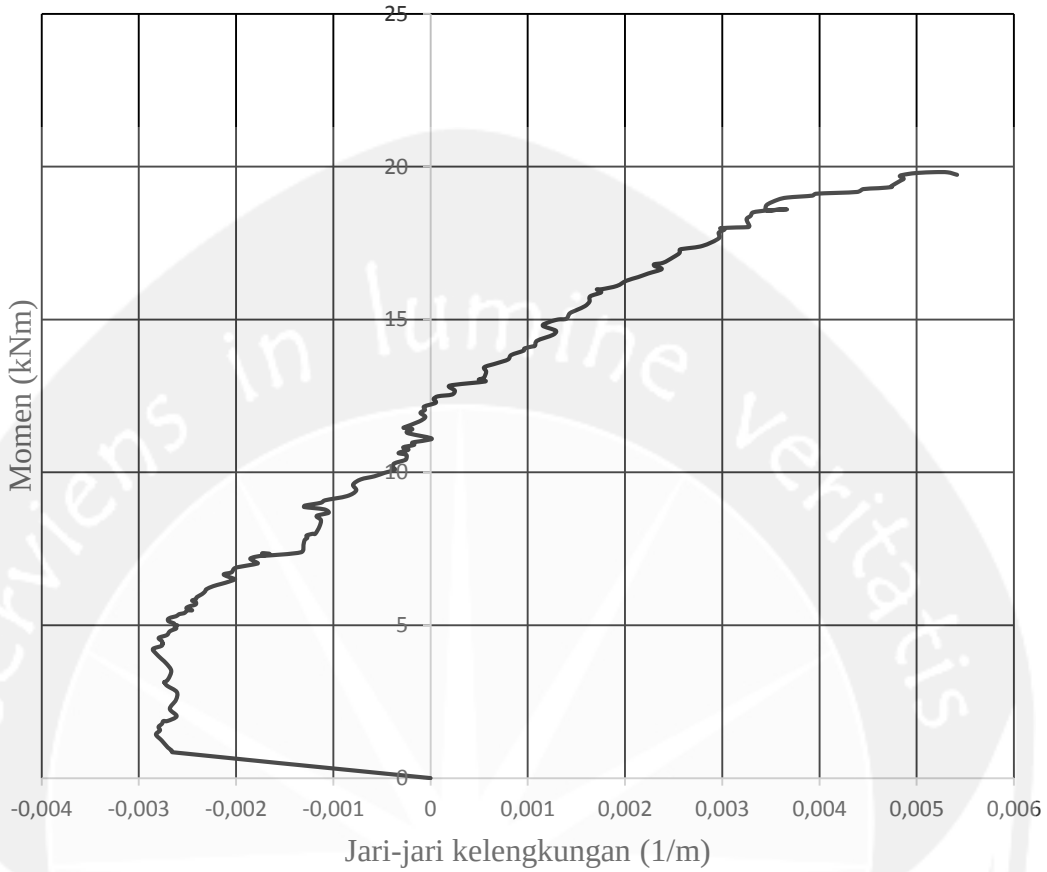
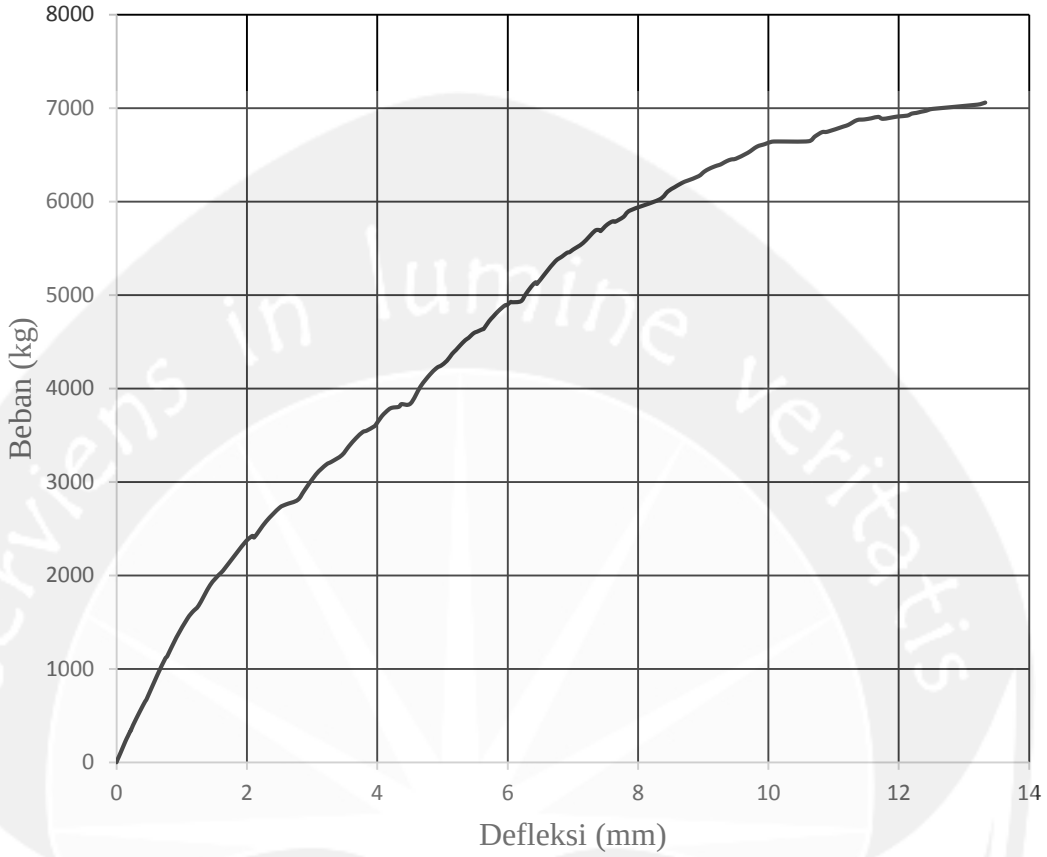
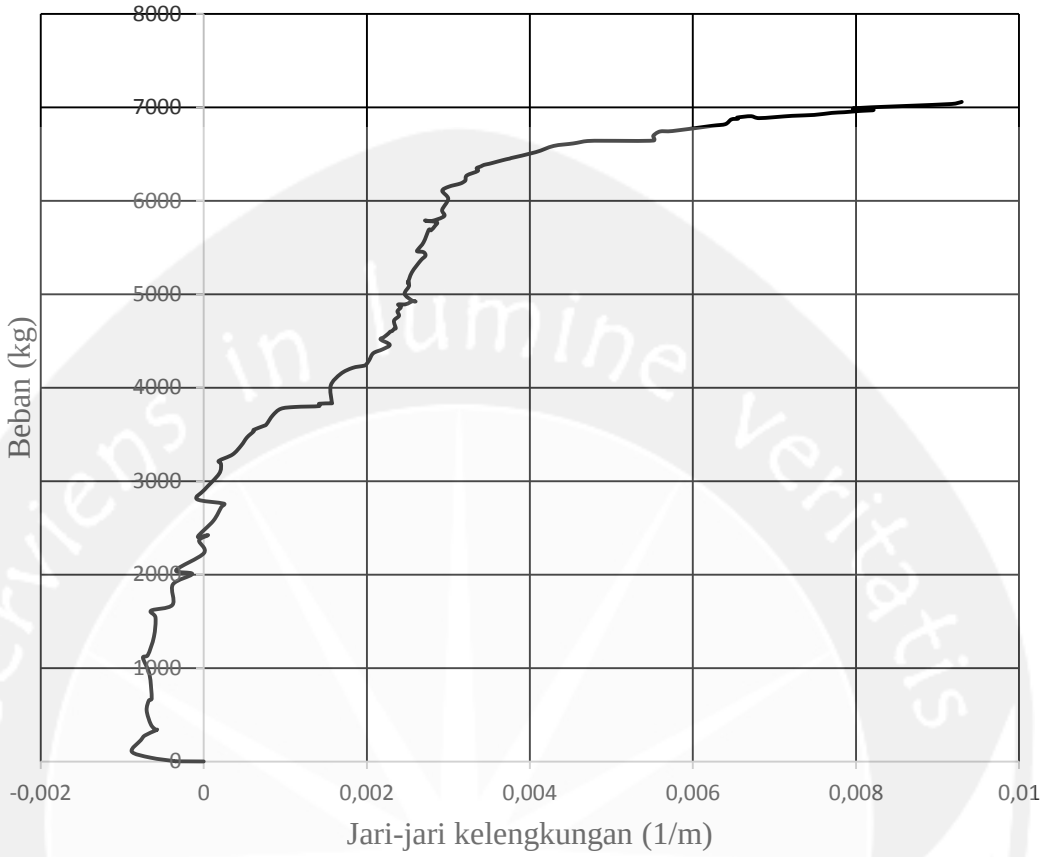


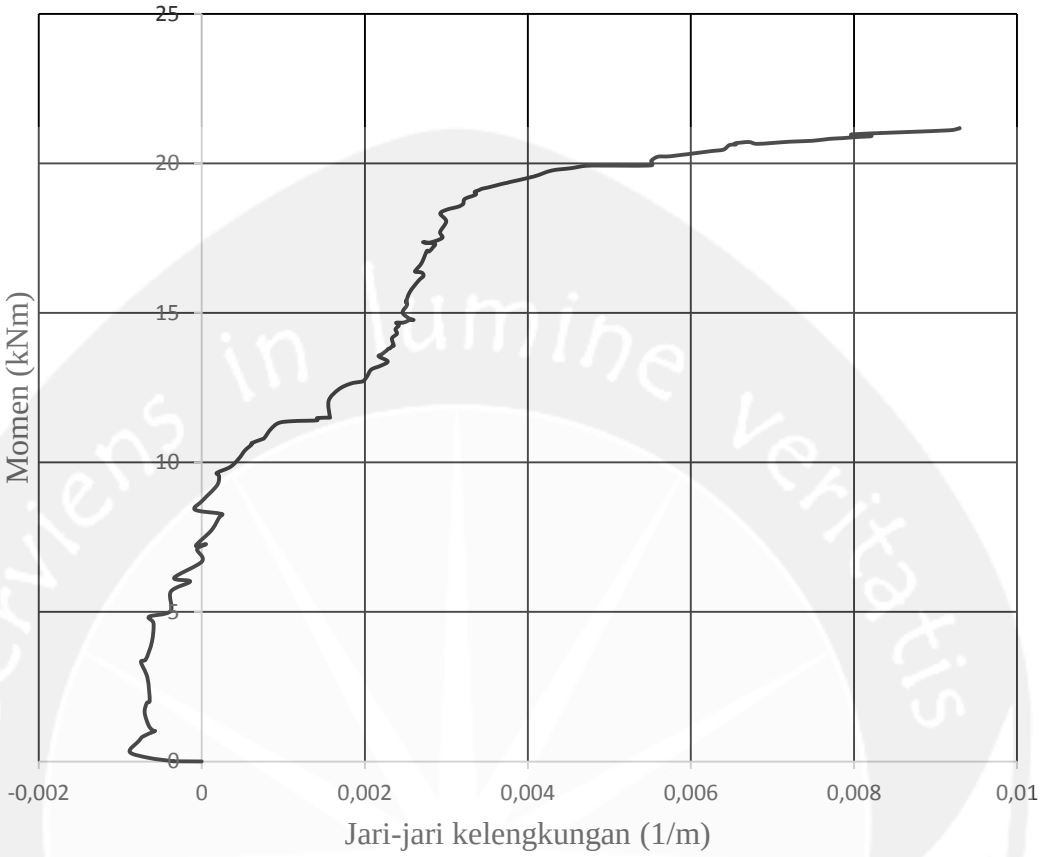
Gambar Grafik *M-ϕ* Hasil Pengujian BBTS1



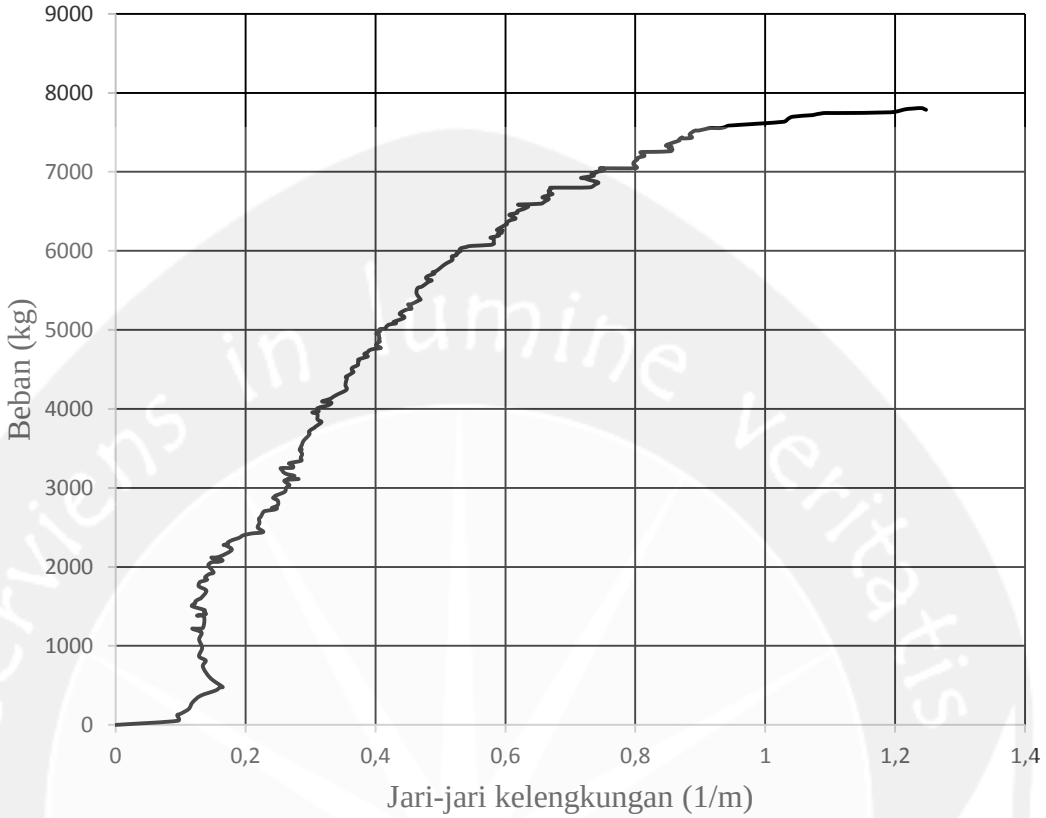
Gambar Grafik *P-δ* Hasil Pengujian BBTS2



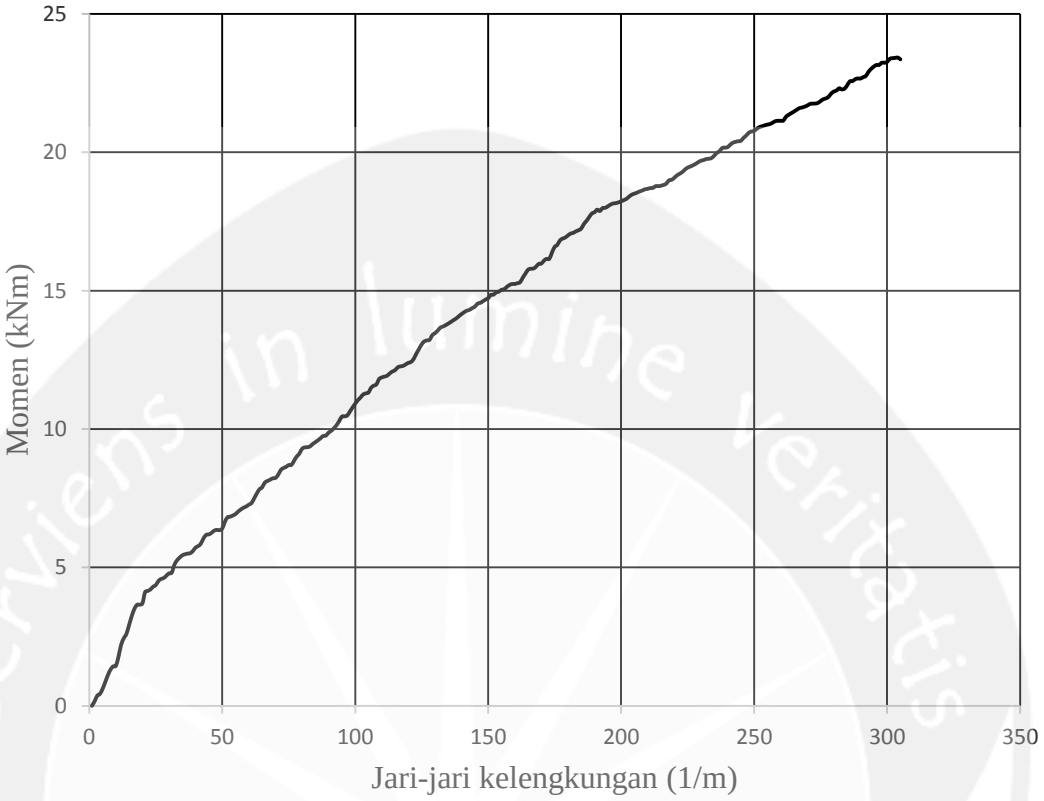
Gambar Grafik *P-ϕ* Hasil Pengujian BBTS2



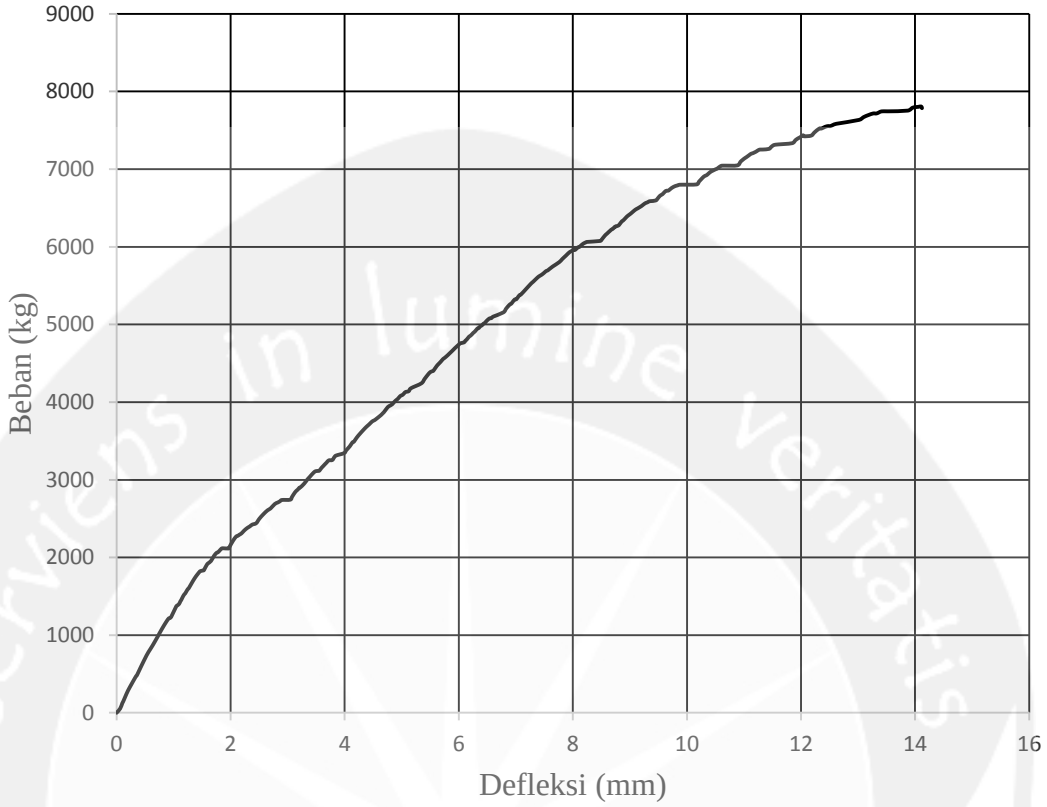
Gambar Grafik *M-ϕ* Hasil Pengujian BBTS2



Gambar Grafik *P-δ* Hasil Pengujian BBTS3



Gambar Grafik *P-ϕ* Hasil Pengujian BBTS3



Gambar Grafik *M-ϕ* Hasil Pengujian BBTS3

LAMPIRAN IX

DOKUMENTASI

Gambar Pengujian Kuat Tarik Profil Baja Siku

Gambar Profil Baja Siku Hasil Pengujian Kuat Tarik

Lampiran 9	137
Dokumentasi	

Gambar Baja Tulangan P6 Hasil Pengujian Kuat Tarik

Gambar Pembuatan Bekesting Balok

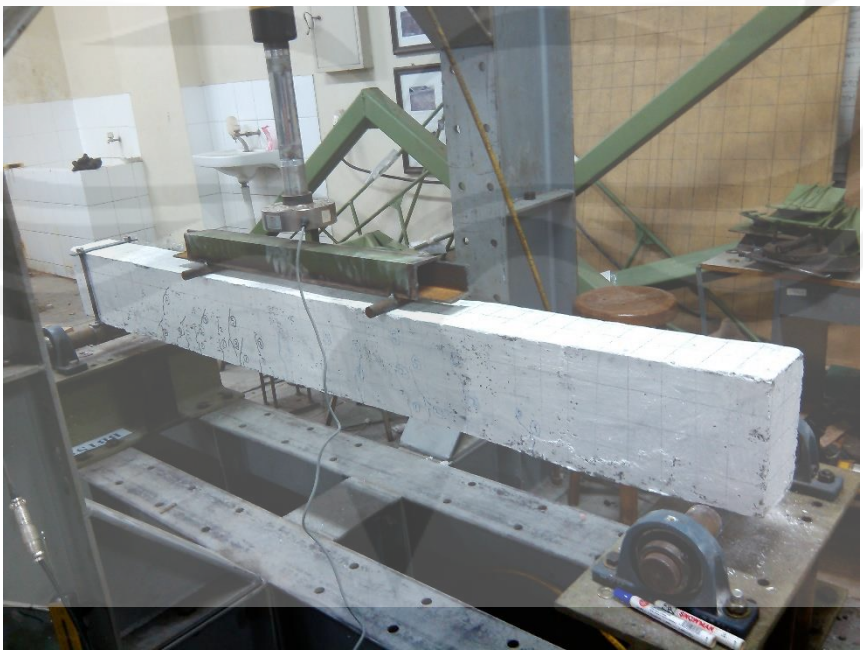
Lampiran 9	138
Dokumentasi	

Gambar Penulangan Balok

Gambar Pengujian *Slump*

Lampiran 9	139
Dokumentasi	

Gambar Silinder Beton Hasil Pengujian Kuat Desak



Gambar Balok Hasil Pengujian Lentur

Lampiran 9	140
Dokumentasi	

Gambar Retakan pada Balok setelah Pengujian