

BAB VI

KESIMPULAN DAN SARAN

6.1. Kesimpulan

Berdasarkan hasil penelitian mengenai Pengaruh Penambahan Variasi Kadar *Fly Ash* Terhadap Sifat Mekanik Beton Pada Beton Serat Memadat Mandiri ini, dapat ditarik kesimpulan seperti tercantum di bawah ini.

1. Beton yang memenuhi ketiga syarat sifat beton memadat mandiri yang ditetapkan EFNARC (2005) hanyalah beton dengan kode BS SCC (beton yang mengandung *superplasticizer*, tidak mengandung serat, dan tidak mengandung *fly ash*), sedangkan beton yang mengandung serat kawat bendrat di dalam campurannya, yaitu BSC0, BSC5, BSC10, BSC15, dan BSC20 hanya memenuhi 2 syarat sifat beton segar SCC, yaitu syarat *flow ability* dan *viscosity*.
2. Penambahan kawat bendrat sebagai serat sebanyak 0,5% dari volume silinder beton menurunkan kualitas *workability* beton segar secara signifikan terhadap beton BS SCC. Hal ini dibuktikan oleh menurunnya nilai *flow ability* sebesar 13,28% dan menurunnya nilai *passing ability* sebesar 75,30%.
3. Penambahan kawat bendrat sebagai serat sebanyak 0,5% dari volume silinder beton pada beton BSC0 justru mengurangi kuat tekan beton terhadap beton tanpa serat kawat bendrat (BS SCC) sebesar 17,17%. Kuat tekan beton BS SCC dan BSC0 secara berturut-turut adalah 47,87 MPa dan 39,65 MPa.

4. Variasi kadar *fly ash* dengan nilai kuat tekan dan modulus elastisitas optimum ditunjukkan pada beton BSC10 yang mengandung *fly ash* sebanyak 10% dari berat semen dengan kuat tekan sebesar 42,13 MPa.
5. Penambahan kawat bendrat sebagai serat sebanyak 0,5% dari volume silinder beton pada beton BSC0 meningkatkan kuat tarik belah terhadap beton tanpa serat kawat bendrat (BSCC) sebesar 26,50%. Kuat tarik belah beton BSCC dan BSC0 secara berturut-turut adalah 3,40 MPa dan 4,30 MPa.
6. Penambahan *fly ash* justru mengurangi nilai kuat tarik walaupun tidak signifikan. Hal tersebut tampak pada penurunan nilai kuat tarik pada beton BSC5, BSC10, BSC15, BSC20 terhadap BSC0 berturut-turut sebesar 7,28%; 12,06%; 12,66%; dan 13,00%.
7. Nilai modulus elastisitas yang paling tinggi terdapat pada beton dengan kode BSCC, yaitu 31440 MPa. Sedangkan nilai modulus elastisitas terendah terdapat pada beton dengan kode BSC20, yaitu 22976 MPa.

7.2. Saran

Saran yang penulis berikan setelah melalui proses dan melihat hasil penelitian ini adalah seperti berikut.

1. Perlu dilakukan penelitian lebih lanjut untuk mencari kadar optimum *superplasticizer* sika viscocrete-1003 pada beton yang menggunakan serat kawat bendrat sebanyak 0,5% dari volume silinder beton supaya dapat memenuhi karakteristik beton segar SCC menurut EFNARC (2005).

2. Perlu dilakukan penelitian lebih lanjut dengan melakukan pengujian *viscosity* yang menggunakan metode *V-funnel* supaya parameter beton segar yang penulis buat menjadi lebih lengkap.
3. Campuran beton yang menggunakan *superplasticizer* dengan merk sika viscoconcrete-1003 cepat mengeras, maka dari itu beton segar harus selalu diaduk sebelum dicor ke dalam silinder beton.
4. Urutan pencampuran kawat bendrat yang benar adalah pencampuran basah, yaitu kawat bendrat dicampurkan setelah air ditambahkan untuk mencegah terjadinya penggumpalan.
5. Pentingnya mengetahui cara penggunaan peralatan untuk menguji beton segar memadat mandiri supaya proses pengambilan data menjadi lebih lancar.
6. Dalam proses pencampuran beton perlu ketelitian dan kecermatan supaya bahan yang digunakan tidak ada yang terbuang.

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A. PENGUJIAN BAHAN

A.1 PENGUJIAN KANDUNGAN LUMPUR AGREGAT HALUS

- I. Waktu Pemeriksaan : 2 April 2019
- II. Bahan
 - a. Pasir Kering Tungku, asal: Sungai Progo, berat : 100 gram
 - b. Air Jernih, asal : LSBB Prodi TS FT - UAJY
- III. Alat
 - a. Gelas Ukur, ukuran : 250 cc
 - b. Timbangan
 - c. Oven, suhu 105 – 110°C
- IV. Pasir + Piring Masuk Tungku
- V. Hasil
Pasir + Piring Keluar Tungku
 - a. Berat Pasir : 93,48 gramKandungan Lumpur :
$$\frac{100,00 - 93,48}{100,00} \times 100\% = 6,52\%$$

Kesimpulan : Kandungan lumpur 6,52% > 5%, maka pasir harus dicuci terlebih dahulu. (**OK**)



A.2 PENGUJIAN KANDUNGAN ZAT ORGANIK AGREGAT HALUS

I. Waktu Pemeriksaan : 2 April 2019

II. Bahan

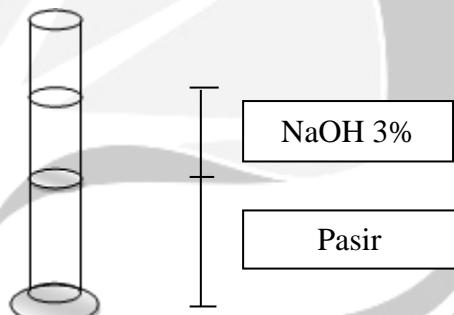
a. Pasir Kering Tungku, asal : Sungai Progo

b. Larutan NaOH 3%

III. Alat

a. Gelas Ukur, ukuran : 250 cc

IV. Sketsa



V. Hasil

Setelah didiamkan selama 24 jam, warna larutan di atas pasir sesuai dengan *Gardner Standart Colour* no.5.

Kesimpulan : Warna *Gardner Standart Colour* No. 5, maka pasir tersebut sangat baik untuk digunakan.



A.3 PENGUJIAN BERAT JENIS DAN PENYERAPAN AGREGAT HALUS

- I. Waktu Pemeriksaan : 2 April 2019
II. Bahan : Pasir
III. Asal : Sungai Progo
IV. Lokasi Pengujian : Laboratorium Struktur dan Bahan Bangunan (LSBB), Jurusan Teknik Sipil, Universitas Atma Jaya, Yogyakarta

| Pengujian Berat Jenis & Penyerapan Agregat Halus | | |
|---|---------|----|
| Berat Labu Ukur + Air | 706,2 | gr |
| Berat Labu Ukur + Air + Pasir | 1012,01 | gr |
| Berat Awal (V) | 500 | gr |
| Berat Kering Oven (A) | 489,97 | gr |



| | | |
|-----------------------------|-------|--------------------|
| Berat Jenis Bulk | 2,523 | gr/cm ³ |
| Berat Jenis SSD | 2,575 | gr/cm ³ |
| Berat Jenis Semu (Apparent) | 2,661 | gr/cm ³ |
| Penyerapan (Absorption) | 2,047 | % |

$$\text{Berat Jenis Agregat Halus} = \frac{2,523 + 2,661}{2} = 2,592 \text{ gr/cm}^3$$



A.4 PENGUJIAN ANALISIS SARINGAN AGREGAT HALUS

- I. Waktu Pemeriksaan : 2 April 2019
II. Bahan : Pasir
III. Asal : Sungai Progo
IV. Lokasi Pengujian :Laboratorium Struktur dan Bahan Bangunan (LSBB), Jurusan Teknik Sipil, Universitas Atma Jaya, Yogyakarta.

| Ayakan | Berat Saringan | Berat Saringan + Pasir | Berat Pasir | Kumulatif | % Tertahan | % Lolos |
|----------------|----------------|------------------------|-------------|-----------|------------|---------|
| 3/8" (9,52mm) | 543 | 543 | 0 | 0 | 0 | 100,00 |
| No.4(4,75 mm) | 507 | 507 | 0 | 0 | 0 | 100,00 |
| No.8(2,36 mm) | 329 | 414 | 85 | 85 | 8,5 | 91,5 |
| No.30(0,60mm) | 402 | 948 | 546 | 631 | 63,1 | 36,9 |
| No.50(0,30mm) | 373 | 642 | 269 | 900 | 90 | 10 |
| No.100(0,15mm) | 289 | 371 | 82 | 982 | 98,2 | 1,8 |
| Pan | 369 | 407 | 36 | 1000 | 100 | 0 |

Kesimpulan : MHB (Modulus Halus Butir) pasir didapatkan sebesar 3,598.

Berdasarkan SK SNI S-04-1989-F (Spesifikasi Bahan Bangunan Bagian A), maka nilai MHB agregat halus tersebut memenuhi syarat karena berada pada nilai 1,50 – 3,80 (**OK**).



Penentuan golongan pasir berdasarkan SNI 03-2834-2000 dapat dilihat pada tabel di bawah ini. Berdasarkan data yang dipaparkan di atas, persentase lolos (% lolos) dicocokkan pada tabel tersebut dan dapat ditentukan bahwa pasir tergolong ke dalam gradasi no.2, yaitu pasir sedang.. Penentuan golongan pasir ini digunakan untuk perencanaan *mix design*.

| | | | | % Lolos Saringan/Ayakan | | | |
|-----------------|------|---------|--------|-------------------------|---------------|------------------|---------------|
| Ukuran Saringan | | | | SNI 03-2834-2000 | | | |
| (Ayakan) | | | | Pasir Kasar | Pasir Sedang | Pasir Agak Halus | Pasir Halus |
| mm | SNI | ASTM | inch | Gradasi No. 1 | Gradasi No. 2 | Gradasi No. 3 | Gradasi No. 4 |
| 9,50 | 9,6 | % in | 0,3750 | 100 - 100 | 100 - 100 | 100 - 100 | 100 - 100 |
| 4,75 | 4,8 | no. 4 | 0,1870 | 90 - 100 | 90 - 100 | 90 - 100 | 95 - 100 |
| 2,36 | 2,4 | no. 8 | 0,0937 | 60 - 95 | 75 - 100 | 85 - 100 | 95 - 100 |
| 1,18 | 1,2 | no. 16 | 0,0469 | 30 - 70 | 55 - 90 | 75 - 100 | 90 - 100 |
| 0,60 | 0,6 | no. 30 | 0,0234 | 15 - 34 | 35 - 59 | 60 - 79 | 80 - 100 |
| 0,30 | 0,3 | no. 50 | 0,0117 | 5 - 20 | 8 - 30 | 12 - 40 | 15 - 50 |
| 0,15 | 0,15 | no. 100 | 0,0059 | 0 - 10 | 0 - 10 | 0 - 10 | 0 - 15 |



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Fakultas Teknik Program Studi Teknik Sipil

Laboratorium Transportasi

Jl. Babarsari No.44 Yogyakarta 55281 Indonesia Kotak Pos 1086

Telp.+62-274-487711 (hunting) Fax. +62-274-487748

A.5 PENGUJIAN BERAT JENIS DAN PENYERAPAN AGREGAT KASAR

- I. Waktu Pemeriksaan : 8 April 2019
II. Bahan : Kerikil (10 mm)
III. Asal : Clereng
IV. Lokasi Pengujian : Laboratorium Transportasi, Jurusan Teknik Sipil,
Universitas Atma Jaya, Yogyakarta

| | NOMOR PEMERIKSAAN | I | Sat. |
|---|--|-------|--------------------|
| A | Berat Contoh Kering | 988 | gr |
| B | Berat Contoh Jenuh Kering Permukaan (SSD) | 1016 | gr |
| C | Berat Contoh Dalam Air | 610 | gr |
| D | Berat Jenis Bulk $= \frac{(A)}{(B)-(C)}$ | 2,55 | gr/cm ³ |
| E | BJ.Jenuh Kering Permukaan (SSD) $= \frac{(B)}{(B)-(C)}$ | 2,615 | gr/cm ³ |
| F | Berat Jenis Semu (<i>Apparent</i>) $= \frac{(A)}{(A)-(C)}$ | 2,722 | gr/cm ³ |
| G | Penyerapan (<i>Absorption</i>) $= \frac{(B)-(A)}{(A)} \times 100 \%$ | 2,43 | % |
| H | Berat Jenis Agregat Kasar $= \frac{(D)+(F)}{2}$ | 2,636 | gr/cm ³ |

PERSYARATAN UMUM :

- *Absorption* : < 5%
- Berat Jenis Agregat Kasar Normal : 2,5 – 2,7



A.6 PENGUJIAN ANALISIS SARINGAN AGREGAT KASAR

- I. Waktu Pemeriksaan : 8 April 2019
II. Bahan : Kerikil (10 mm)
III. Asal : Clereng
IV. Lokasi Pengujian : Laboratorium Transportasi, Jurusan Teknik Sipil, Universitas Atma Jaya, Yogyakarta

| Ayakan | Berat Saringan | Berat Saringan + Kerikil | Berat Kerikil | Kumulatif | % Tertahan | % Lolos |
|----------------|----------------|--------------------------|---------------|-----------|------------|---------|
| 3/4" (19,1 mm) | 570 | 644 | 74 | 74 | 7,4 | 92,6 |
| 3/8" (9,52mm) | 543 | 1225 | 777 | 851 | 85,1 | 14,9 |
| No.4(4,75 mm) | 508 | 510 | 147 | 998 | 99,8 | 0,2 |
| No.8(2,36 mm) | 329 | 0 | 2 | 1000 | 100 | 0 |
| No.30(0,60mm) | 402 | 0 | 0 | 1000 | 100 | 0 |
| No.50(0,30mm) | 373 | 0 | 0 | 1000 | 100 | 0 |
| No.100(0,15mm) | 284 | 0 | 0 | 1000 | 100 | 0 |
| PAN | 369 | 0 | 0 | 1000 | 100 | 0 |

Kesimpulan : MHB (Modulus Halus Butir) kerikil didapatkan sebesar 7,923.

Berdasarkan SK SNI S-04-1989-F (Spesifikasi Bahan Bangunan Bagian A), maka nilai MHB agregat halus tersebut memenuhi syarat karena berada pada nilai 5,00 – 8,00. (**OK**)



A.7 PENGUJIAN KEAUSAN AGREGAT KASAR DENGAN MESIN
LOS ANGELES ABRATION

- I. Waktu Pemeriksaan : 8 April 2019
II. Bahan : Kerikil (10 mm)
III. Asal : Clereng
IV. Lokasi Pengujian : Laboratorium Transportasi, Jurusan Teknik Sipil, Fakultas Teknik, Universitas Atma Jaya Yogyakarta.

| Gradasi Saringan | | Nomor Contoh | |
|------------------|----------|----------------------|----------------------|
| | | I | II |
| Lolos | Tertahan | Berat Setiap Agregat | Berat Setiap Agregat |
| 3/4" | 1/2" | 2500 | - |
| 1/2" | 3/8" | 2500 | - |

| Nomor Contoh | | I |
|--------------------------------------|-------------------------|-----------|
| Berat Sebelumnya | (A) | 5000 gram |
| Berat Sesudah Diayak Saringan No. 12 | (B) | 3836 gram |
| Berat Sesudah | (A) - (B) | 1164 gram |
| Keausan | $\frac{(A) - (B)}{(A)}$ | 23,28 % |

Kesimpulan : Keausan Agregat didapat sebesar $23,28\% \leq 40\%$, memenuhi syarat.

(OK)

| UKURAN SARINGAN | | BERAT AGREGAT | | | |
|------------------|----------|---------------|------|------|------|
| LOLOS | TERTAHAN | A | B | C | D |
| 1 1/2" | 1" | 1250 | - | - | - |
| 1" | 3/4" | 1250 | - | - | - |
| 3/4" | 1/2" | 1250 | 2500 | - | - |
| 1/2" | 3/8" | 1250 | 2500 | - | - |
| 3/8" | 1/4" | - | - | 2500 | - |
| 1/4" | No. 4 | - | - | 2500 | - |
| No. 4 | No. 8 | - | - | - | 5000 |
| TOTAL | | 5000 | 5000 | 5000 | 5000 |
| JUMLAH BOLA BAJA | | 12 | 11 | 8 | 6 |



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Telp.+62-274-487711 (hunting) Fax. +62-274-487748

A.8 PENGUJIAN BERAT JENIS DAN PENYERAPAN KAWAT BENDRAT

- I. Waktu Pemeriksaan : 8 April 2019
- II. Bahan : Kawat Bendrat (dia. 0,8 mm)
- III. Asal : Toko Bangunan Terdekat
- IV. Lokasi Pengujian : Laboratorium Transportasi, Jurusan Teknik Sipil,
Universitas Atma Jaya, Yogyakarta

| | NOMOR PEMERIKSAAN | I | Sat. |
|---|---|----------|--------------------|
| A | Berat Contoh Kering | 97 | gr |
| B | Berat Contoh Jenuh Kering Permukaan (SSD) | 97 | gr |
| C | Berat Contoh Dalam Air | 84 | gr |
| D | Berat Jenis Bulk $= \frac{(A)}{(B)-(C)}$ | 7,46 | gr/cm ³ |
| E | BJ.Jenuh Kering Permukaan (SSD) $= \frac{(B)}{(B)-(C)}$ | 7,46 | gr/cm ³ |
| F | Berat Jenis Semu (<i>Apparent</i>) $= \frac{(A)}{(A)-(C)}$ | 7,46 | gr/cm ³ |
| G | Penyerapan (<i>Absorption</i>) $= \frac{(B)-(A)}{(A)} \times 100 \%$ | 0 | % |
| H | Berat Jenis Agregat Kasar $= \frac{(D)+(F)}{2}$ | 7,46 | gr/cm ³ |



B. RENCANA ADUKAN BETON (*MIX DESIGN*)
(SNI 03-2834-2000)

I. Data Bahan

1. Bahan agregat halus (pasir) : Sungai Progo, Yogyakarta
2. Bahan agregat kasar (*split*) : Clereng, Yogyakarta
3. Jenis semen : OPC Holcim

II. Hitungan

1. Kuat tekan beton yang direncanakan (f'_c) pada umur 28 hari. $f'_c = 25$ MPa.
2. Menentukan nilai deviasi standar berdasarkan tingkat mutu pengendalian pelaksanaan campuran.
3. Nilai *margin* ditentukan sebesar koefisien \times S_d Prediksi = $1,64 \times 2,8$
4. Menetapkan kuat tekan beton rata-rata yang direncanakan berdasarkan SNI.

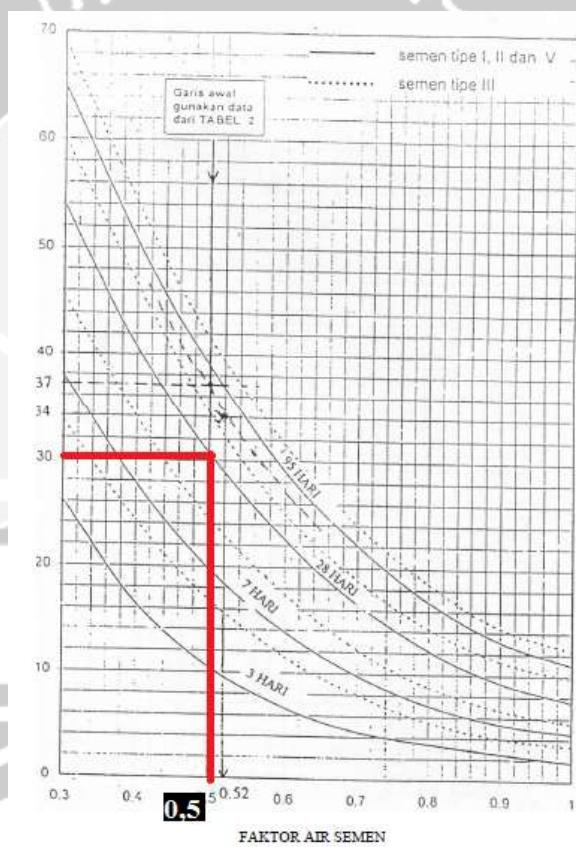
$$f'_c = 25 \text{ MPa} + M = 25 + 1,64 \times 2,8 = 29,592 \text{ MPa}$$

dibulatkan menjadi 30 MPa

5. Menentukan jenis semen
Jenis semen OPC berasal dari Holcim
6. Menetapkan jenis agregat
 - a. Agregat halus : Pasir alam
 - b. Agregat kasar : Batu pecah



7. Menetukan faktor air semen, berdasarkan jenis semen yang dipakai dan kuat tekan rata-rata silinder beton yang direncanakan pada umur tertentu. Direncanakan sebesar 0.50 (lihat gambar 1).



Gambar 1. Menentukan Faktor Air Semen

8. Menetapkan faktor air semen maksimum dengan cara melihat tabel 1 (SNI 03-2834-2000) di bawah



Tabel 1. Persyaratan Jumlah Semen Minimum dan Faktor Air Semen Maksimum Untuk Berbagai Macam Pembetonan dalam Lingkungan Khusus
(SNI 03-2834-2000, Tabel 4)

| 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 | | Lihat Tabel 6 |
| b. Air laut | | |

Berdasarkan tabel 4 SNI 03-2834-2000, untuk beton dalam ruang bangunan sekeliling non-korosif fas maksimum 0,6. Dibandingkan dengan fas pada no.7, dipakai terkecil. Jadi digunakan fas 0,50.

9. Menetapkan nilai *Slump*, direncanakan sebesar 60-180 mm.
10. Ukuran butiran maksimum (kerikil) adalah 10 mm.
11. Menetapkan jumlah air yang diperlukan tiap m^3 beton.
 - a. Ukuran butir maksimum 10 mm.
 - b. Nilai *Slump* 60-180 mm.
 - c. Agregat halus berupa batu tak di pecah, maka dapat dilihat pada tabel 2.



Tabel 2. Perkiraan Kadar Air Bebas (kg/m^3) yang dibutuhkan untuk beberapa tingkat kemudahan penggerjaan adukan beton
(SNI 03-2834-2000, Tabel 3)

| 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 |

$$W_h = 225 \text{ liter}$$

d. Agregat kasar berupa batu pecah, maka

$$W_k = 250 \text{ liter}$$

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

Dengan :

W_h adalah perkiraan jumlah air untuk agregat halus

W_k adalah perkiraan jumlah air untuk agregat kasar

$$W = \frac{2}{3} 225 + \frac{1}{3} 250 = 233,33 \text{ liter/m}^3$$

12. Menghitung berat semen yang diperlukan :

a. Berdasarkan tabel 1, diperoleh semen minimum 275 kg.

b. Berdasarkan grafik, $fas = 0,50$.

$$\begin{aligned} \text{Semen per } \text{m}^3 \text{ beton} &= \frac{\text{air}}{\text{fas}} = \frac{233,33}{0,5} \\ &= 466,66 \text{ kg} \end{aligned}$$



Dipilih berat semen paling besar. Digunakan berat semen 466,66 kg.

13. Penyesuaian jumlah air atau fas.

$$\text{fas rencana} = 0,50$$

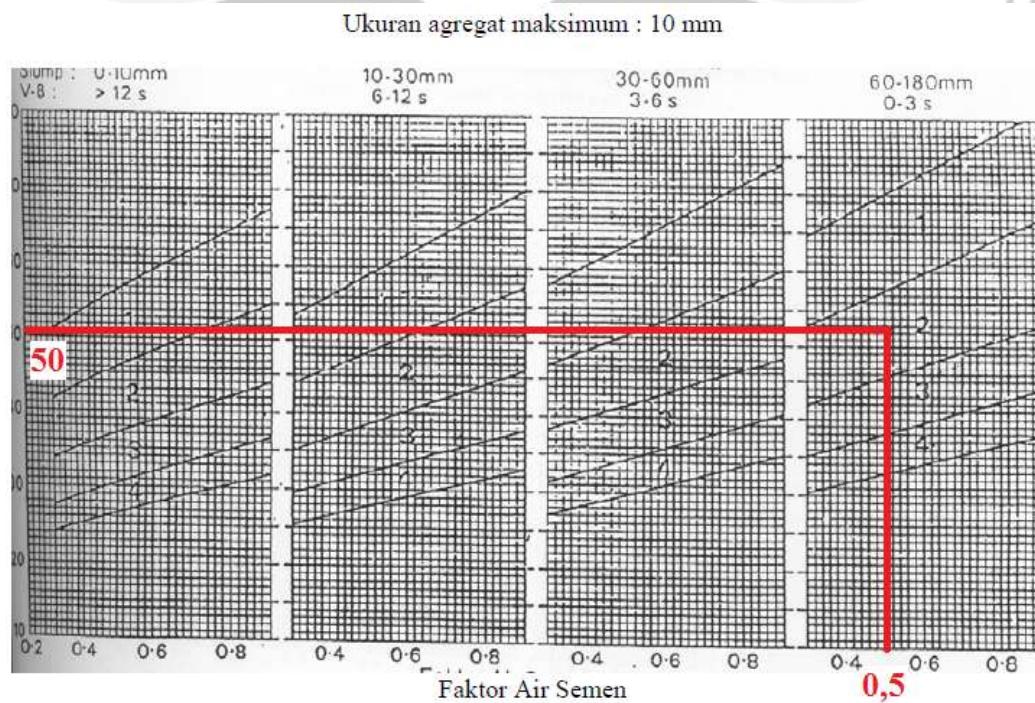
$$\text{fas maks.} > \text{fas rencana}$$

$$0,6 > 0,50 \dots\dots\dots \text{Ok!}$$

14. Perbandingan agregat halus dan kasar.

- Ukuran maksimum 10 mm.
- Nilai *Slump* 60 mm – 180 mm
- fas 0,50.
- Jenis gradasi pasir no. 2.

Menurut Grafik proporsi pasir pada gambar 2, dihasilkan proporsi 50%



Gambar 2. Menentukan Proporsi Agregat Halus



15. Berat jenis agregat campuran

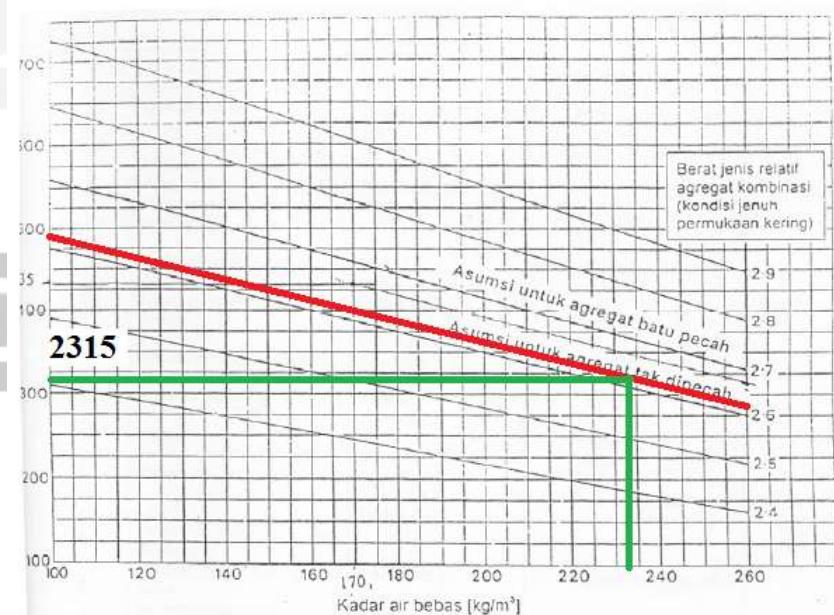
$$\begin{aligned} &= \frac{P}{100} \text{ BJ Agregat Halus} + \frac{K}{100} \text{ BJ Agregat Kasar} \\ &= \frac{50}{100} \times 2,592 + \frac{50}{100} \times 2,636 \\ &= 2,614 \end{aligned}$$

Dimana :

P = % agregat halus terhadap agregat campuran

K = % agregat kasar terhadap agregat campuran

16. Berat jenis beton, menurut grafik pada gambar 3 diperoleh hasil 2315 kg/m³



Gambar 3. Perkiraan Berat Isi Beton Basah yang Telah Selesai Didapatkan



17. Berat agregat campuran

= berat tiap m^3 – keperluan air dan semen

$$= 2315 - (233,33 + 466,66)$$

$$= 1615,01 \text{ kg/m}^3$$

18. Menghitung berat agregat halus

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

$$= \frac{50}{100} \times 1615,01 \text{ kg/m}^3 = 807,505 \text{ kg/m}^3$$

19. Menghitung berat agregat kasar

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

$$= \frac{50}{100} \times 1615,01 \text{ kg/m}^3 = 807,505 \text{ kg/m}^3$$

20. Rekapitulasi jumlah kebutuhan untuk 1 m^3

Pasir : 807,505 kg

Kerikil : 807,505 kg

Semen : 466,66 kg

Air : 233,33 liter. Karena kebutuhan air dikurangi sebanyak 30%,

maka kebutuhannya menjadi $= 233,33 \times 0,7 = 163,33$ liter



Tabel 1. Variasi Benda Uji

| Kode | Jenis Pengujian | | | Jumlah Benda Uji (Silinder 150 mm x 300 mm) | |
|------------------------|---------------------------|-------------------------|--------------------------|---|---|
| | Kadar Viscocrete-1003 (%) | Fraksi volume Serat (%) | Kadar <i>fly ash</i> (%) | Kuat Tekan dan Modulus Elastisitas (silinder 150 mm x 300 mm) | Kuat Tarik Belah (silinder 150 mm x 300 mm) |
| BSCC | 1,5 | 0 | 0 | 4 | 3 |
| BSC0 | 1,5 | 0,5 | 0 | 4 | 3 |
| BSC5 | 1,5 | 0,5 | 5 | 4 | 3 |
| BSC10 | 1,5 | 0,5 | 10 | 4 | 3 |
| BSC15 | 1,5 | 0,5 | 15 | 4 | 3 |
| BSC20 | 1,5 | 0,5 | 20 | 4 | 3 |
| Jumlah Total Benda Uji | | | | 24 | 18 |

Keterangan :

- a. BSCL : Beton yang mengandung superplasticizer (SP), tidak mengandung serat, dan tidak mengandung fly ash
- b. BSC0 : Beton yang mengandung SP, mengandung serat, tetapi tidak mengandung fly ash
- c. BSC5 : Beton yang mengandung SP, mengandung serat, dan mengandung fly ash dengan kadar substitusi 5% dari berat semen



- d. BSC10 : Beton yang mengandung SP, mengandung serat, dan mengandung fly ash dengan kadar substitusi 10% dari berat semen
- e. BSC15 : Beton yang mengandung SP, mengandung serat, dan mengandung fly ash dengan kadar substitusi 15% dari berat semen
- f. BSC20 : Beton yang mengandung SP, mengandung serat, dan mengandung *fly ash* dengan kadar substitusi 20% dari berat semen

21. Perhitungan Jumlah kebutuhan untuk 1 silinder ukuran (10x20) cm

$$\text{Luas silinder} = \pi \times r^2 \times t = \pi \times 0,05^2 \times 0,2 = 0,0015708 \text{ m}^3$$

$$\text{Safe Factor} = 1,4$$

$$\text{Pasir} : 807,505 \text{ kg/m}^3 \cdot 0,0015708 \text{ m}^3 \cdot 1,40 = 1,776 \text{ kg}$$

$$\text{Kerikil} : 807,505 \text{ kg/m}^3 \cdot 0,0015708 \text{ m}^3 \cdot 1,40 = 1,776 \text{ kg}$$

$$\text{Semen} : 466,66 \text{ kg/m}^3 \cdot 0,0015708 \text{ m}^3 \cdot 1,40 = 1,03 \text{ kg}$$

$$\text{Air} : 233,33 \text{ liter/m}^3 \cdot 0,0015708 \text{ m}^3 \cdot 1,40 = 0,51 \text{ liter}$$

22. Perhitungan Jumlah kebutuhan untuk 1 silinder (15x30) cm

$$\text{Luas silinder} = \pi \times r^2 \times t = \pi \times 0,075^2 \times 0,3 = 0,0053014 \text{ m}^3$$

$$\text{Safe Factor} = 1,4$$

$$\text{Pasir} : 807,505 \text{ kg/m}^3 \cdot 0,0053014 \text{ m}^3 \cdot 1,40 = 5,993 \text{ kg}$$

$$\text{Kerikil} : 807,505 \text{ kg/m}^3 \cdot 0,0053014 \text{ m}^3 \cdot 1,40 = 5,993 \text{ kg}$$



Semen : $466,66 \text{ kg/m}^3 \cdot 0,0053014 \text{ m}^3 \cdot 1,40 = 3,464 \text{ kg}$

Air : $233,33 \text{ liter/m}^3 \cdot 0,0053014 \text{ m}^3 \cdot 1,40 = 1,732 \text{ liter}$

Karena jumlah benda uji adalah 7 buah per variasi benda uji, maka kebutuhan bahan disajikan menurut tabel 2.

Tabel 2. Kebutuhan Bahan

| Kode | Kebutuhan Semen per 4 silinder kecil dan 3 silinder besar (kg) | Kebutuhan fly ash per 4 silinder kecil dan 3 silinder besar (kg) | Kebutuhan kerikil per 4 silinder kecil dan 3 silinder besar (kg) | Kebutuhan pasir per 4 silinder kecil dan 3 silinder besar (kg) | Kebutuhan air per 4 silinder kecil dan 3 silinder besar (lt) | Kawat Bendrat 0,5% dari volume (kg) | Superplasticizer 1,5% berat binder (kg) |
|--------------|--|--|--|--|--|-------------------------------------|---|
| BSCC | 14.512 | 0 | 25.083 | 25.083 | 5.0652 | 0 | 0.21768 |
| BSC0 | 14.512 | 0 | 25.083 | 25.083 | 5.0652 | 1.158626 | 0.21768 |
| BSC5 | 13.7864 | 0.7256 | 25.083 | 25.083 | 5.0652 | 1.158626 | 0.21768 |
| BSC10 | 13.0608 | 1.4512 | 25.083 | 25.083 | 5.0652 | 1.158626 | 0.21768 |
| BSC15 | 12.3352 | 2.1768 | 25.083 | 25.083 | 5.0652 | 1.158626 | 0.21768 |
| BSC20 | 11.6096 | 2.9024 | 25.083 | 25.083 | 5.0652 | 1.158626 | 0.21768 |
| Total | 79.816 | 7.256 | 150.498 | 150.498 | 30.3912 | 5.79313 | 1.30608 |

Jadi total kebutuhan bahan yang dibutuhkan adalah:

Semen OPC = 79,816 kg

Fly ash = 7,256 kg

Pasir = 150,498 kg

Kerikil = 150,498 kg

Air = 30,391 lt

Bendrat = 5,79 kg (dengan berat jenis 7460 kg/m³)

SP = 1,31 kg



C. HASIL PENGUJIAN BENDA UJI

C.1 PENGUJIAN KUAT TEKAN DAN KUAT TARIK BELAH SILINDER BETON

| Kode | Umur (hari) | No. | Berat Beton (kg) | Diameter (cm) | Tinggi (cm) | BJ (kg/m ³) | Beban Maks (kN) | Kuat Tekan (Mpa) | Kuat Tarik Belah (Mpa) | Rata-Rata |
|-------|-------------|-----|------------------|---------------|-------------|-------------------------|-----------------|------------------|------------------------|-----------|
| BSCC | 28 | 1 | 3.92 | 9.990 | 20.253 | 2469.27 | 365 | 48.43 | - | 47.87 |
| | | 2 | 3.96 | 10.037 | 20.137 | 2485.64 | 390 | 51.27 | | |
| | | 3 | 3.96 | 10.103 | 20.367 | 2425.25 | 305 | 39.57 | | |
| | | 4 | 3.88 | 10.007 | 20.303 | 2429.94 | 395 | 52.24 | | |
| | | 5 | 13.00 | 14.980 | 29.950 | 2462.82 | 250 | - | 3.5474 | 3.40 |
| | | 6 | 12.58 | 14.993 | 30.344 | 2348.15 | 245 | | 3.4283 | |
| | | 7 | 13.02 | 15.157 | 29.950 | 2409.44 | 230 | | 3.2256 | |
| BSC0 | 28 | 1 | 3.92 | 10.023 | 20.377 | 2438.03 | 305 | 40.20 | - | 39.65 |
| | | 2 | 4.00 | 9.983 | 20.387 | 2506.53 | 325 | 43.18 | | |
| | | 3 | 3.98 | 10.083 | 20.367 | 2447.17 | 290 | 37.77 | | |
| | | 4 | 3.96 | 10.123 | 20.427 | 2408.58 | 290 | 37.47 | | |
| | | 5 | 12.84 | 15.023 | 30.123 | 2404.58 | 260 | - | 3.6575 | 4.30 |
| | | 6 | 12.94 | 14.953 | 30.347 | 2428.05 | 350 | | 4.9102 | |
| | | 7 | 12.76 | 14.973 | 30.393 | 2384.22 | 310 | | 4.3366 | |
| BSC5 | 28 | 1 | 3.96 | 10.073 | 20.267 | 2451.75 | 330 | 43.06 | - | 40.25 |
| | | 2 | 3.92 | 10.233 | 20.287 | 2349.37 | 290 | 36.67 | | |
| | | 3 | 3.94 | 10.200 | 20.120 | 2396.50 | 320 | 40.73 | | |
| | | 4 | 3.98 | 10.143 | 20.267 | 2430.24 | 315 | 40.54 | | |
| | | 5 | 12.98 | 15.113 | 30.160 | 2399.01 | 320 | - | 4.4693 | 3.99 |
| | | 6 | 13.06 | 14.963 | 30.263 | 2454.03 | 295 | | 4.1472 | |
| | | 7 | 12.94 | 15.063 | 30.297 | 2396.67 | 240 | | 3.3479 | |
| BSC10 | 28 | 1 | 3.92 | 10.090 | 20.370 | 2406.70 | 310 | 40.32 | - | 42.13 |
| | | 2 | 3.90 | 10.113 | 20.123 | 2412.60 | 285 | 36.90 | | |
| | | 3 | 3.96 | 10.027 | 20.127 | 2491.84 | 310 | 40.83 | | |
| | | 4 | 3.94 | 9.983 | 20.200 | 2491.75 | 380 | 50.49 | | |
| | | 5 | 13.26 | 15.047 | 30.293 | 2461.65 | 245 | - | 3.4218 | 3.78 |
| | | 6 | 13.16 | 14.890 | 30.473 | 2480.03 | 275 | | 3.8583 | |
| | | 7 | 12.96 | 14.973 | 30.310 | 2428.24 | 290 | | 4.0679 | |



| Kode | Umur (hari) | No | Berat Beton (kg) | Diameter (cm) | Tinggi (cm) | BJ (kg/m ³) | Beban Maks (kN) | Kuat Tekan (Mpa) | Kuat Tarik Belah (Mpa) | Rata-Rata |
|-------|-------------|----|------------------|---------------|-------------|-------------------------|-----------------|------------------|------------------------|-----------|
| BSC15 | 28 | 1 | 3.96 | 10.137 | 20.370 | 2408.93 | 305 | 39.31 | - | 40.69 |
| | | 2 | 3.96 | 10.037 | 20.123 | 2487.29 | 375 | 49.29 | | |
| | | 3 | 3.90 | 10.160 | 20.127 | 2390.10 | 270 | 34.64 | | |
| | | 4 | 3.88 | 10.027 | 20.200 | 2432.64 | 300 | 39.51 | | |
| | | 5 | 13.16 | 15.017 | 30.413 | 2443.18 | 245 | - | 3.4151 | 3.76 |
| | | 6 | 13.32 | 14.917 | 30.430 | 2504.78 | 275 | | 3.8569 | |
| | | 7 | 13.28 | 15.043 | 30.693 | 2434.31 | 290 | | 3.9984 | |
| BSC20 | 28 | 1 | 3.96 | 10.107 | 20.473 | 2411.02 | 320 | 41.48 | - | 38.00 |
| | | 2 | 3.94 | 10.003 | 20.420 | 2455.05 | 280 | 37.05 | | |
| | | 3 | 3.94 | 10.180 | 20.463 | 2365.56 | 290 | 37.05 | | |
| | | 4 | 3.86 | 10.180 | 20.420 | 2322.45 | 285 | 36.42 | | |
| | | 5 | 12.86 | 15.030 | 30.530 | 2374.14 | 245 | - | 3.3991 | 3.74 |
| | | 6 | 12.90 | 15.037 | 30.470 | 2384.10 | 275 | | 3.8211 | |
| | | 7 | 13.14 | 15.103 | 30.507 | 2404.17 | 290 | | 4.0069 | |

Contoh Perhitungan Kuat Tekan : Kode BSC20

1. Berat Jenis

$$= 3,96 / (0.25 \times \pi \times 0.107^2 \times 0.20473)$$

$$= 2411.02 \text{ kg/m}$$

2. Kuat Tekan

$$= 320 \times 1000 / (0.25 \times \pi \times 101.107^2)$$

$$= 41,48 \text{ MPa}$$



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Laboratorium Struktur dan Bahan Bangunan
Jl. Babarsari No.44 Yogyakarta 55281 Indonesia Kotak Pos 1086
Telp.+62-274-487711 (hunting) Fax. +62-274-487748

Contoh Perhitungan Kuat Tarik : Kode BSC20

1. Berat Jenis

$$= 3,96 / (0.25 \times \pi \times 0.107^2 \times 0.20473)$$

$$= 2411.02 \text{ kg/m}^3$$

2. Kuat Tarik

$$= 2 \times 245 \times 1000 / (\pi \times 101,107 \times 305.3)$$

$$= 3,3991 \text{ MPa}$$



C.2 PENGUJIAN MODULUS ELASTISITAS SILINDER BETON

Kode Beton = BSCC 1

Po1 = 150,9 mm

A1 = 7838,282 mm²

Beban Maks = 11500 Kgf

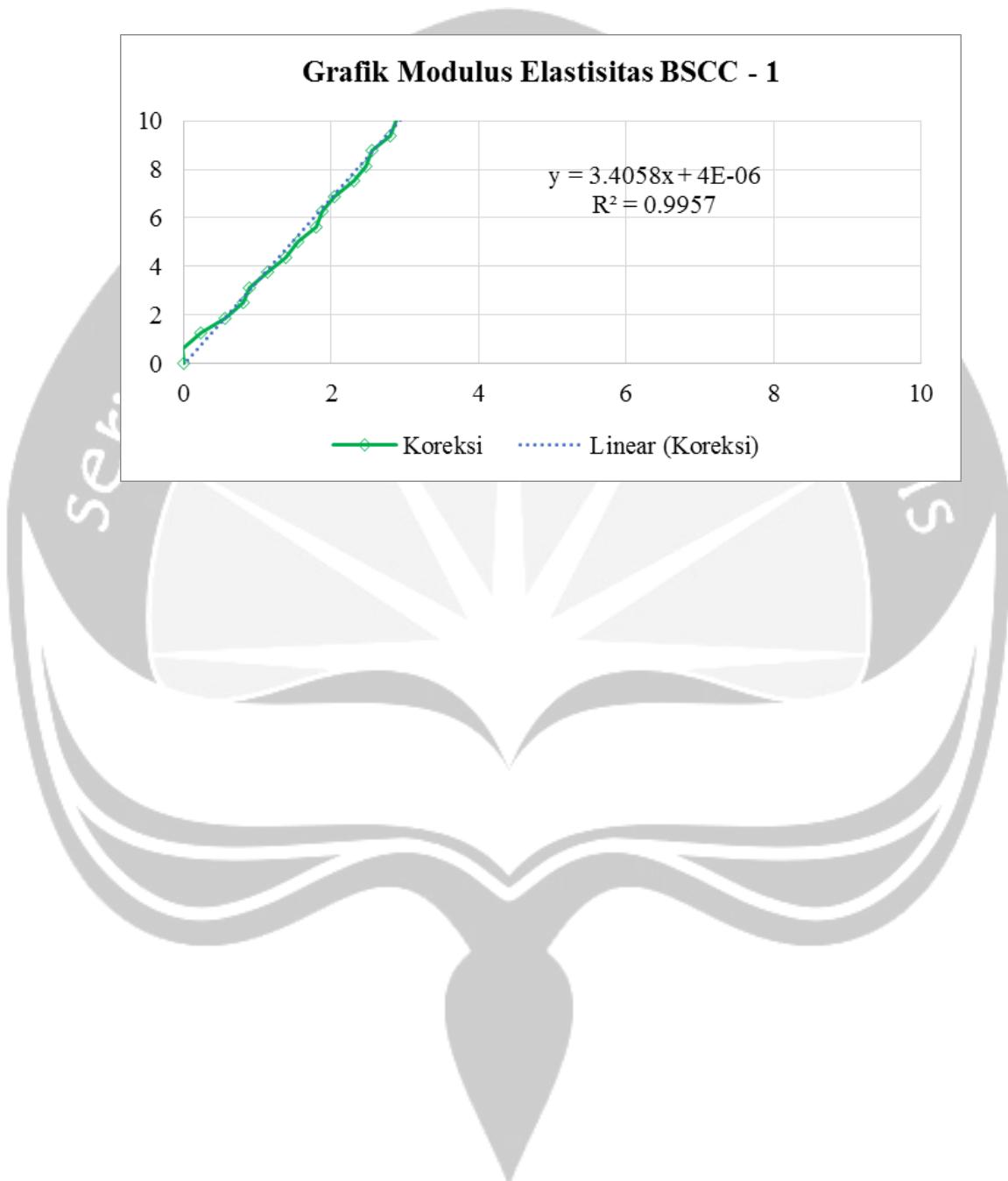
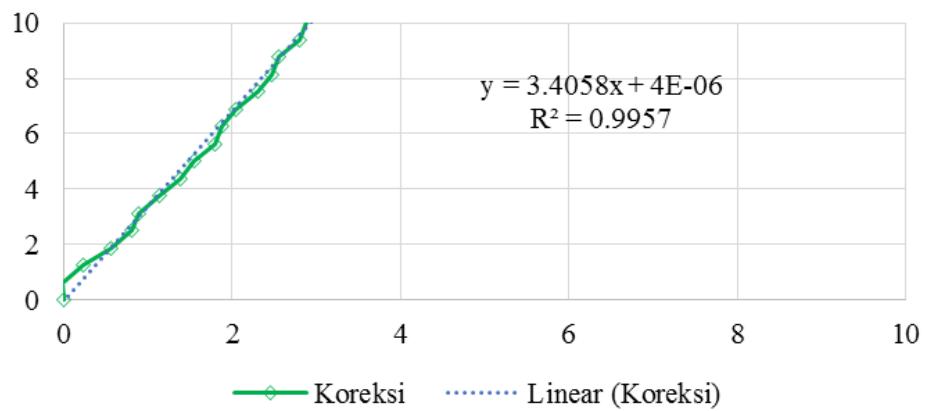
E = 32165,132 MPa

| Beban | | Pembacaan compressome- ter | Pembacaan compressome- ter / 2 | Tegangan | Regangan | Regangan Koreksi |
|-------|----------|----------------------------------|--------------------------------------|----------|------------------|---------------------|
| Kgf | N | 10 ⁻³ | 10 ⁻³ | MPa | 10 ⁻⁴ | 10 ⁻⁴ |
| 0 | 0 | 0.00 | 0.00 | 0.000 | 0.18374 | 0 |
| 500 | 4903.4 | 0.50 | 0.25 | 0.626 | 0.166 | -0.018 |
| 1000 | 9806.7 | 1.25 | 0.63 | 1.251 | 0.414 | 0.230 |
| 1500 | 14710.1 | 2.25 | 1.13 | 1.877 | 0.746 | 0.562 |
| 2000 | 19613.4 | 3.00 | 1.50 | 2.502 | 0.994 | 0.810 |
| 2500 | 24516.8 | 3.25 | 1.63 | 3.128 | 1.077 | 0.893 |
| 3000 | 29420.1 | 4.00 | 2.00 | 3.753 | 1.325 | 1.142 |
| 3500 | 34323.5 | 4.75 | 2.38 | 4.379 | 1.574 | 1.390 |
| 4000 | 39226.8 | 5.25 | 2.63 | 5.005 | 1.740 | 1.556 |
| 4500 | 44130.2 | 6.00 | 3.00 | 5.630 | 1.988 | 1.804 |
| 5000 | 49033.6 | 6.25 | 3.13 | 6.256 | 2.071 | 1.887 |
| 5500 | 53936.9 | 6.75 | 3.38 | 6.881 | 2.237 | 2.053 |
| 6000 | 58840.3 | 7.50 | 3.75 | 7.507 | 2.485 | 2.301 |
| 6500 | 63743.6 | 8.00 | 4.00 | 8.132 | 2.651 | 2.467 |
| 7000 | 68647.0 | 8.25 | 4.13 | 8.758 | 2.734 | 2.550 |
| 7500 | 73550.3 | 9.00 | 4.50 | 9.383 | 2.982 | 2.798 |
| 8000 | 78453.7 | 9.25 | 4.63 | 10.009 | 3.065 | 2.881 |
| 8500 | 83357.0 | 9.75 | 4.88 | 10.635 | 3.231 | 3.047 |
| 9000 | 88260.4 | 10.25 | 5.13 | 11.260 | 3.396 | 3.213 |
| 9500 | 93163.7 | 11.00 | 5.50 | 11.886 | 3.645 | 3.461 |
| 10000 | 98067.1 | 11.50 | 5.75 | 12.511 | 3.810 | 3.627 |
| 10500 | 102970.5 | 12.00 | 6.00 | 13.137 | 3.976 | 3.792 |
| 11000 | 107873.8 | 12.50 | 6.25 | 13.762 | 4.142 | 3.958 |
| 11500 | 112777.2 | 13.50 | 6.75 | 14.388 | 4.473 | 4.289 |



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Jl. Babarsari No.44 Yogyakarta 55281 Indonesia Kotak Pos 1086
Telp.+62-274-487711 (hunting) Fax. +62-274-487748

Grafik Modulus Elastisitas BSCC - 1





Kode Beton = BSCC 3

Po3 = 151,7 mm

A3 = 8017,136 mm²

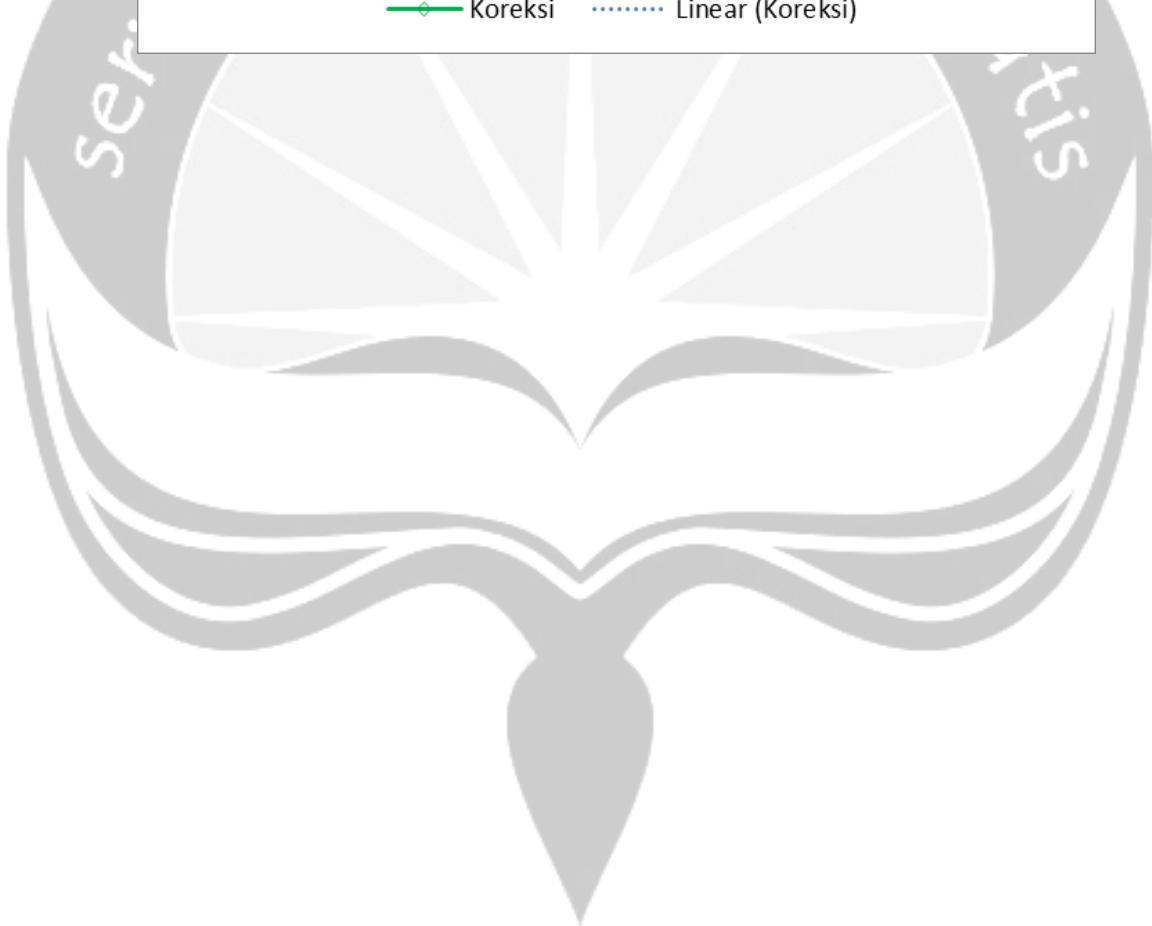
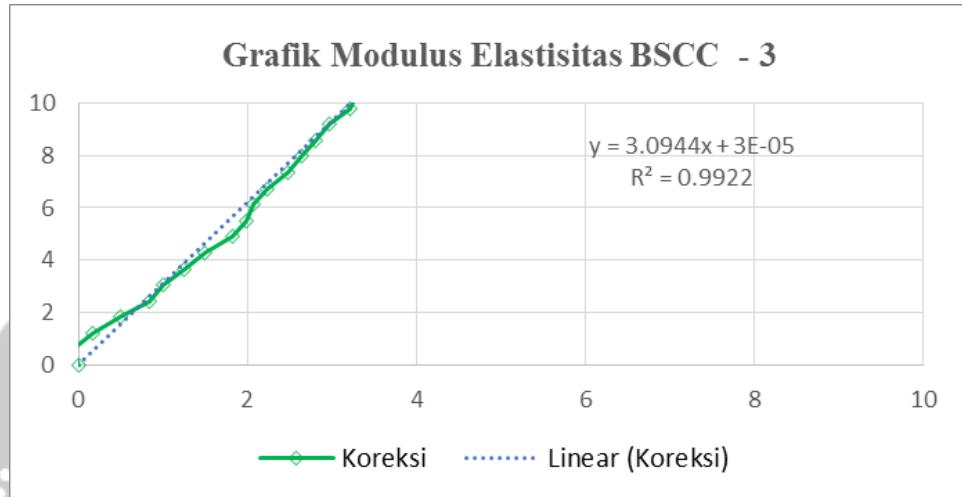
Beban Maks = 11500 Kgf

E = 32130,868 MPa

| Beban | | Pembacaan compressome- ter | Pembacaan compressome- ter / 2 | Tegangan | Regangan | Regangan Koreksi |
|-------|----------|----------------------------------|--------------------------------------|----------|------------------|---------------------|
| Kgf | N | 10 ⁻³ | 10 ⁻³ | MPa | 10 ⁻⁴ | 10 ⁻⁴ |
| 0 | 0 | 0 | 0 | 0 | 0.319 | 0 |
| 500 | 4903.4 | 0.75 | 0.38 | 0.612 | 0.247 | -0.072 |
| 1000 | 9806.7 | 1.50 | 0.75 | 1.223 | 0.494 | 0.176 |
| 1500 | 14710.1 | 2.50 | 1.25 | 1.835 | 0.824 | 0.505 |
| 2000 | 19613.4 | 3.50 | 1.75 | 2.446 | 1.154 | 0.835 |
| 2500 | 24516.8 | 4.00 | 2.00 | 3.058 | 1.318 | 1.000 |
| 3000 | 29420.1 | 4.75 | 2.38 | 3.670 | 1.566 | 1.247 |
| 3500 | 34323.5 | 5.50 | 2.75 | 4.281 | 1.813 | 1.494 |
| 4000 | 39226.8 | 6.50 | 3.25 | 4.893 | 2.142 | 1.824 |
| 4500 | 44130.2 | 7.00 | 3.50 | 5.504 | 2.307 | 1.988 |
| 5000 | 49033.6 | 7.25 | 3.63 | 6.116 | 2.390 | 2.071 |
| 5500 | 53936.9 | 7.75 | 3.88 | 6.728 | 2.554 | 2.236 |
| 6000 | 58840.3 | 8.50 | 4.25 | 7.339 | 2.802 | 2.483 |
| 6500 | 63743.6 | 9.00 | 4.50 | 7.951 | 2.966 | 2.648 |
| 7000 | 68647.0 | 9.50 | 4.75 | 8.563 | 3.131 | 2.812 |
| 7500 | 73550.3 | 10.00 | 5.00 | 9.174 | 3.296 | 2.977 |
| 8000 | 78453.7 | 10.75 | 5.38 | 9.786 | 3.543 | 3.224 |
| 8500 | 83357.0 | 11.00 | 5.50 | 10.397 | 3.626 | 3.307 |
| 9000 | 88260.4 | 11.50 | 5.75 | 11.009 | 3.790 | 3.472 |
| 9500 | 93163.7 | 12.25 | 6.13 | 11.621 | 4.038 | 3.719 |
| 10000 | 98067.1 | 12.75 | 6.38 | 12.232 | 4.202 | 3.884 |
| 10500 | 102970.5 | 13.50 | 6.75 | 12.844 | 4.450 | 4.131 |
| 11000 | 107873.8 | 13.75 | 6.88 | 13.455 | 4.532 | 4.213 |
| 11500 | 112777.2 | 14.25 | 7.13 | 14.067 | 4.697 | 4.378 |



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Kode Beton = BSCC 4

Po1 = 151,2 mm

A4 = 7864,457 mm²

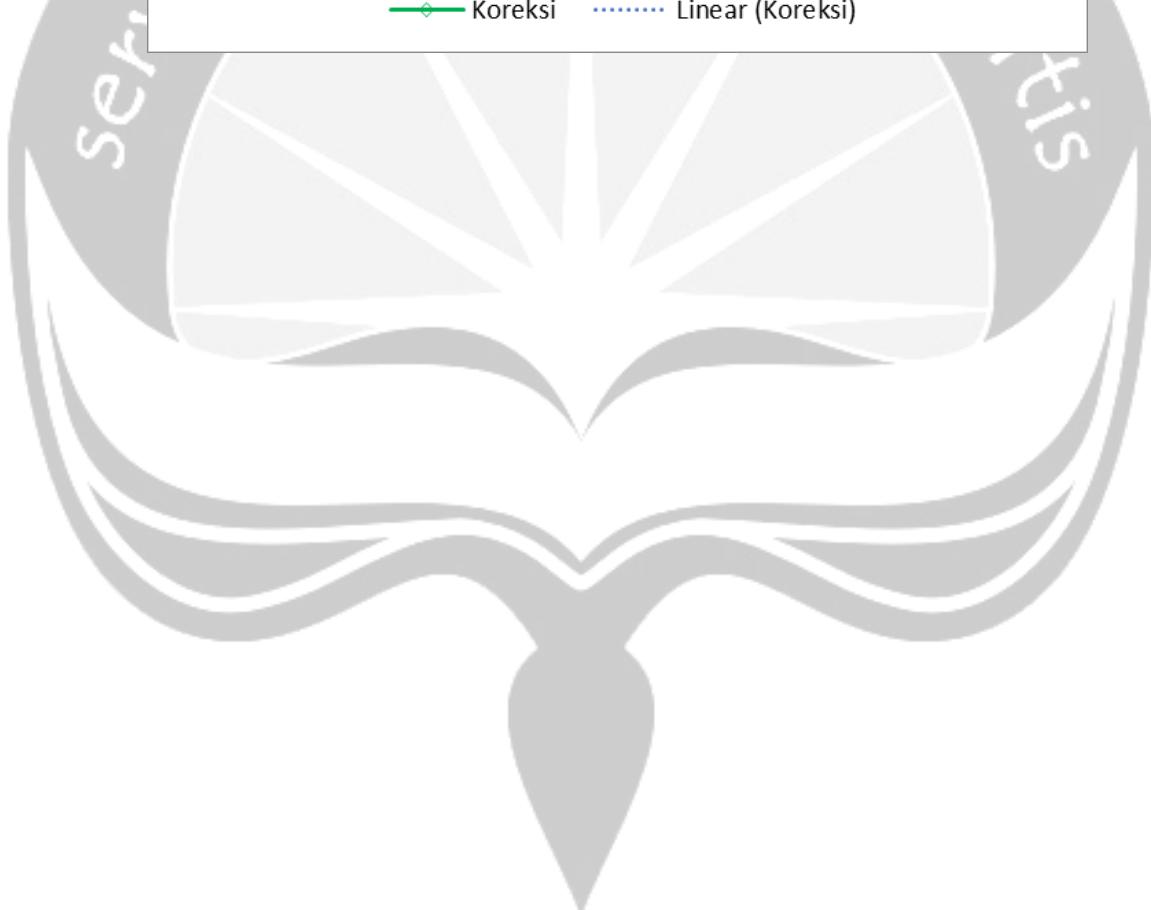
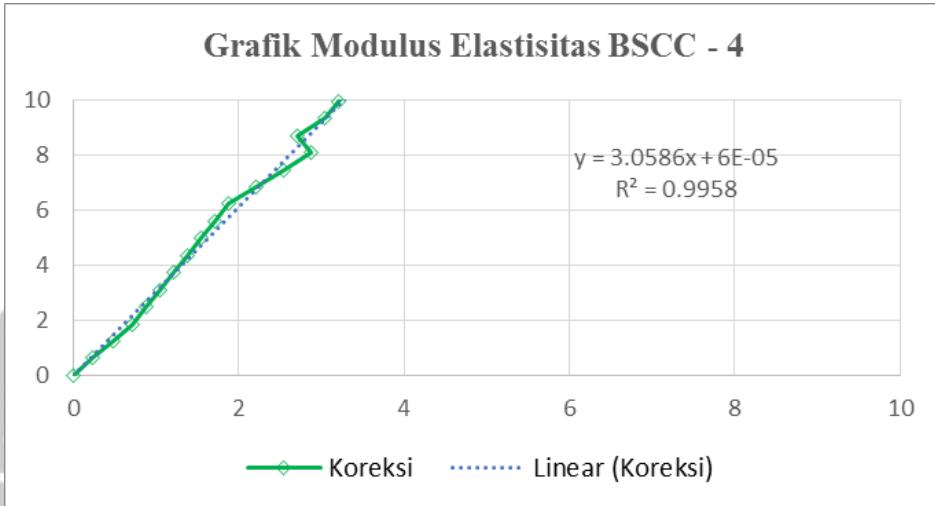
Beban Maks = 11500 Kgf

E = 30025,311 MPa

| Beban | | Pembacaan compressome- ter | Pembacaan compressome- ter / 2 | Tegangan | Regangan | Regangan Koreksi |
|-------|----------|----------------------------------|--------------------------------------|----------|------------------|---------------------|
| Kgf | N | 10 ⁻³ | 10 ⁻³ | MPa | 10 ⁻⁴ | 10 ⁻⁴ |
| 0 | 0 | 0.00 | 0.00 | 0.000 | -0.0637 | 0 |
| 500 | 4903.4 | 0.50 | 0.25 | 0.623 | 0.165 | 0.229 |
| 1000 | 9806.7 | 1.25 | 0.63 | 1.247 | 0.413 | 0.477 |
| 1500 | 14710.1 | 2.00 | 1.00 | 1.870 | 0.661 | 0.725 |
| 2000 | 19613.4 | 2.50 | 1.25 | 2.494 | 0.827 | 0.890 |
| 2500 | 24516.8 | 3.00 | 1.50 | 3.117 | 0.992 | 1.056 |
| 3000 | 29420.1 | 3.50 | 1.75 | 3.741 | 1.157 | 1.221 |
| 3500 | 34323.5 | 4.00 | 2.00 | 4.364 | 1.323 | 1.386 |
| 4000 | 39226.8 | 4.50 | 2.25 | 4.988 | 1.488 | 1.552 |
| 4500 | 44130.2 | 5.00 | 2.50 | 5.611 | 1.653 | 1.717 |
| 5000 | 49033.6 | 5.50 | 2.75 | 6.235 | 1.819 | 1.882 |
| 5500 | 53936.9 | 6.50 | 3.25 | 6.858 | 2.149 | 2.213 |
| 6000 | 58840.3 | 7.50 | 3.75 | 7.482 | 2.480 | 2.544 |
| 6500 | 63743.6 | 8.50 | 4.25 | 8.105 | 2.811 | 2.875 |
| 7000 | 68647.0 | 8.00 | 4.00 | 8.729 | 2.646 | 2.709 |
| 7500 | 73550.3 | 9.00 | 4.50 | 9.352 | 2.976 | 3.040 |
| 8000 | 78453.7 | 9.50 | 4.75 | 9.976 | 3.142 | 3.205 |
| 8500 | 83357.0 | 10.00 | 5.00 | 10.599 | 3.307 | 3.371 |
| 9000 | 88260.4 | 10.50 | 5.25 | 11.223 | 3.472 | 3.536 |
| 9500 | 93163.7 | 11.50 | 5.75 | 11.846 | 3.803 | 3.867 |
| 10000 | 98067.1 | 12.20 | 6.10 | 12.470 | 4.034 | 4.098 |
| 10500 | 102970.5 | 13.00 | 6.50 | 13.093 | 4.299 | 4.363 |
| 11000 | 107873.8 | 13.50 | 6.75 | 13.717 | 4.464 | 4.528 |
| 11500 | 112777.2 | 14.25 | 7.13 | 14.340 | 4.712 | 4.776 |



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Kode Beton = BSC0 2

Po2 = 153 mm

A2 = 7827,8235 mm²

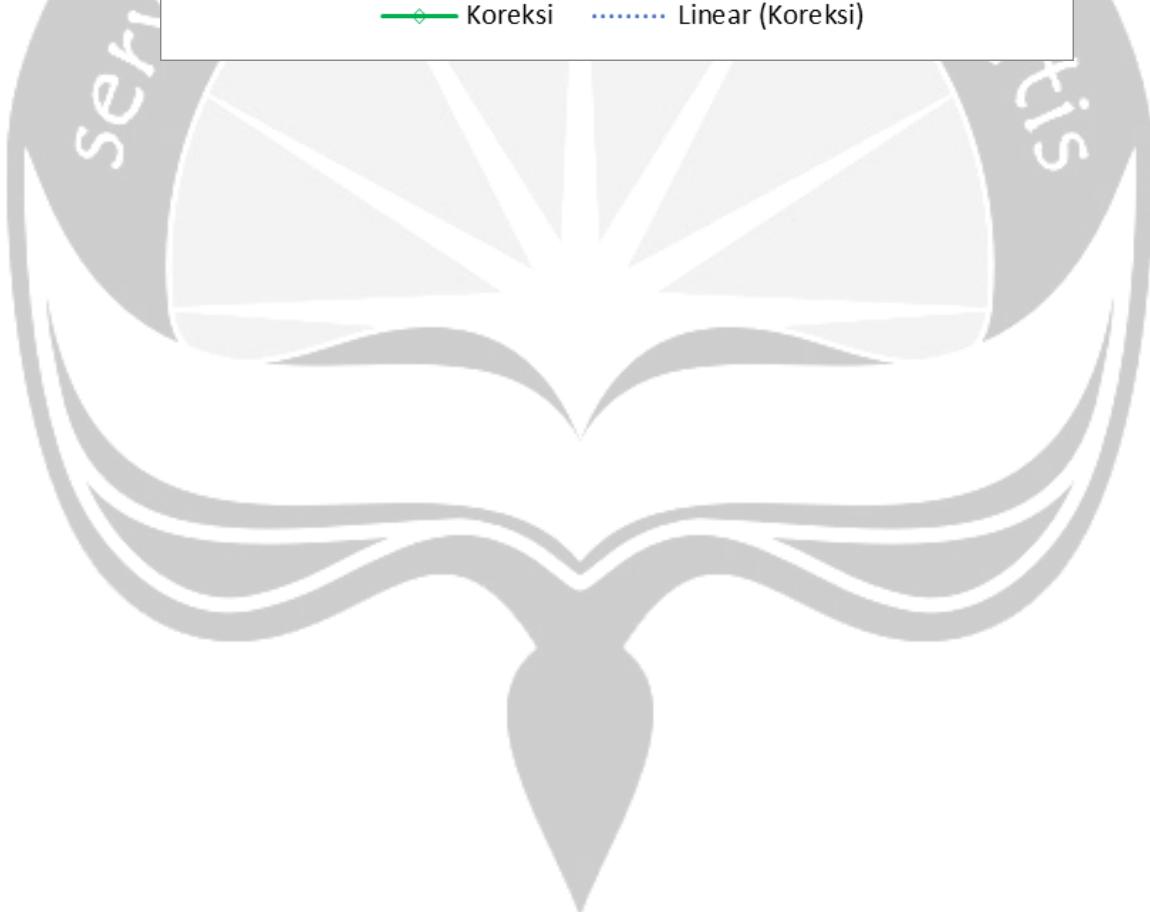
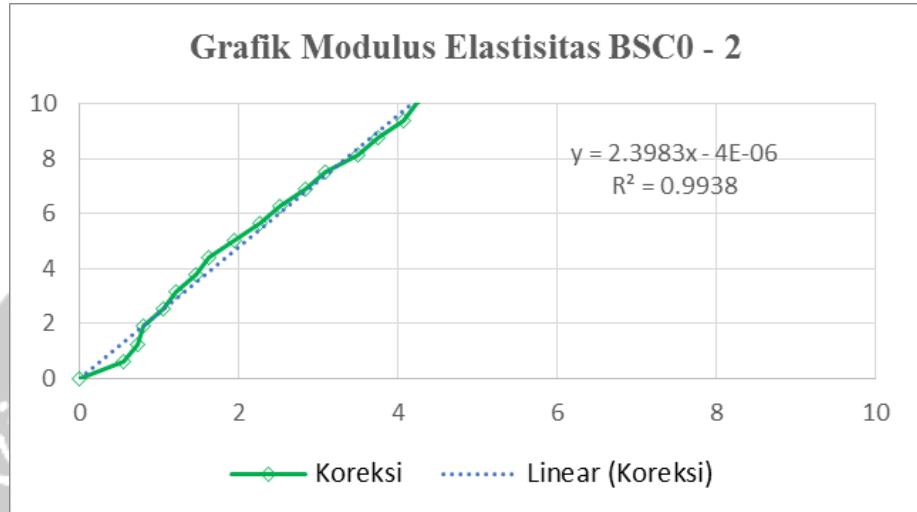
Beban Maks = 9500 Kgf

E = 24377,468 MPa

| Beban | | Pembacaan compressome- ter | Pembacaan compressome- ter / 2 | Tegangan | Regangan | Regangan Koreksi |
|-------|---------|----------------------------------|--------------------------------------|----------|-----------|---------------------|
| Kgf | N | 10^{-3} | 10^{-3} | MPa | 10^{-4} | 10^{-4} |
| 0 | 0 | 0.00 | 0.00 | 0.000 | -0.470 | 0 |
| 500 | 4903.4 | 0.25 | 0.13 | 0.626 | 0.082 | 0.552 |
| 1000 | 9806.7 | 0.75 | 0.38 | 1.253 | 0.245 | 0.716 |
| 1500 | 14710.1 | 1.00 | 0.50 | 1.879 | 0.327 | 0.797 |
| 2000 | 19613.4 | 1.75 | 0.88 | 2.506 | 0.572 | 1.042 |
| 2500 | 24516.8 | 2.25 | 1.13 | 3.132 | 0.735 | 1.206 |
| 3000 | 29420.1 | 3.00 | 1.50 | 3.758 | 0.980 | 1.451 |
| 3500 | 34323.5 | 3.50 | 1.75 | 4.385 | 1.144 | 1.614 |
| 4000 | 39226.8 | 4.50 | 2.25 | 5.011 | 1.471 | 1.941 |
| 4500 | 44130.2 | 5.50 | 2.75 | 5.638 | 1.797 | 2.268 |
| 5000 | 49033.6 | 6.25 | 3.13 | 6.264 | 2.042 | 2.513 |
| 5500 | 53936.9 | 7.25 | 3.63 | 6.890 | 2.369 | 2.840 |
| 6000 | 58840.3 | 8.00 | 4.00 | 7.517 | 2.614 | 3.085 |
| 6500 | 63743.6 | 9.25 | 4.63 | 8.143 | 3.023 | 3.493 |
| 7000 | 68647.0 | 10.00 | 5.00 | 8.770 | 3.268 | 3.738 |
| 7500 | 73550.3 | 11.00 | 5.50 | 9.396 | 3.595 | 4.065 |
| 8000 | 78453.7 | 11.50 | 5.75 | 10.022 | 3.758 | 4.229 |
| 8500 | 83357.0 | 12.25 | 6.13 | 10.649 | 4.003 | 4.474 |
| 9000 | 88260.4 | 13.00 | 6.50 | 11.275 | 4.248 | 4.719 |
| 9500 | 93163.7 | 13.50 | 6.75 | 11.902 | 4.412 | 4.882 |



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Kode Beton = BSC0 3

Po3 = 151,5 mm

A3 = 7985,4267 mm²

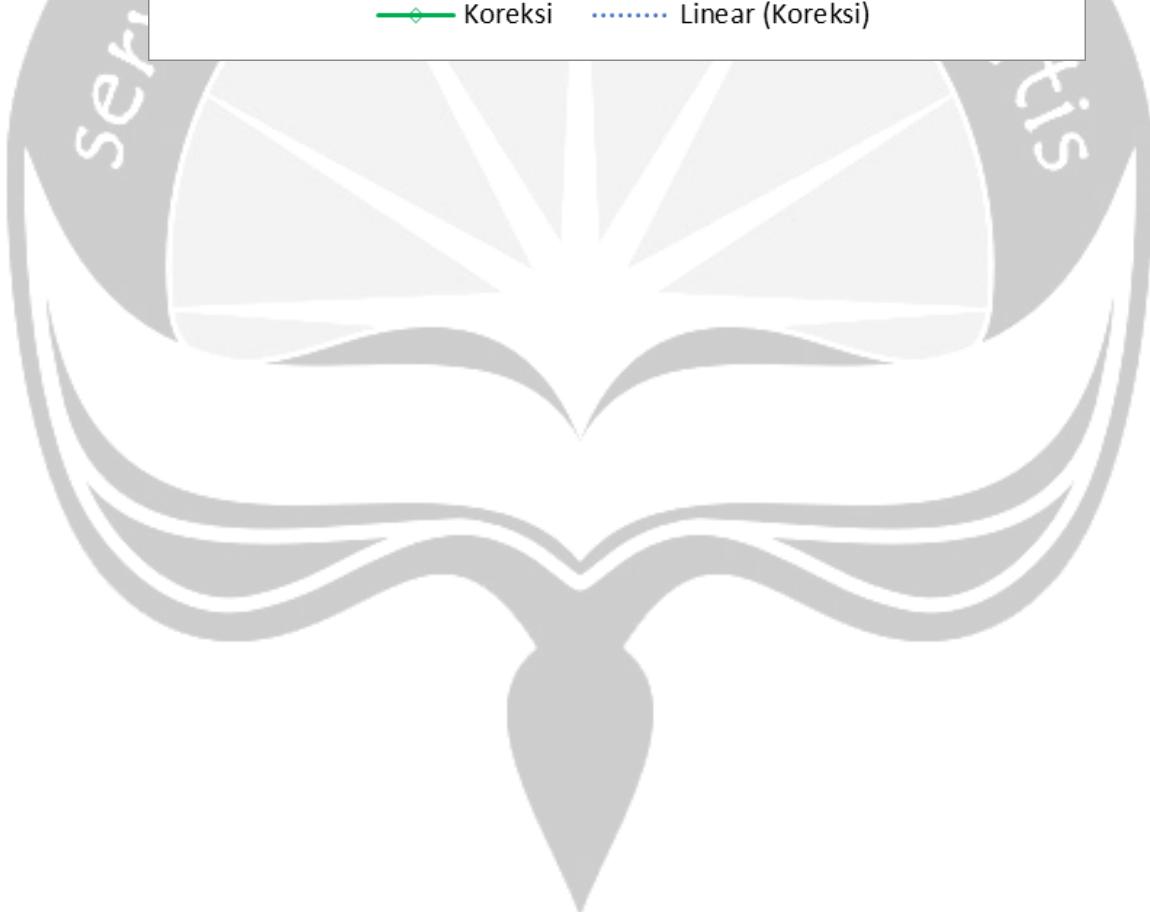
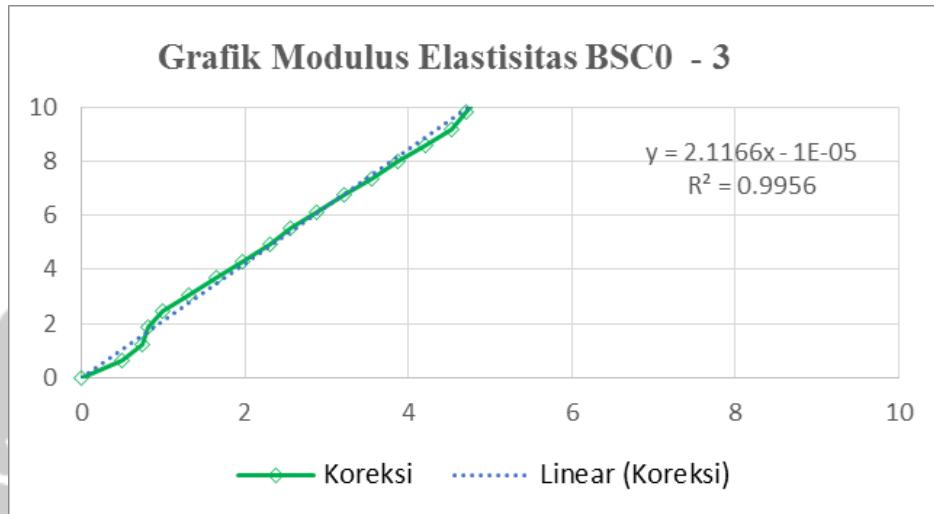
Beban Maks = 9500 Kgf

E = 21770,391 MPa

| Beban | | Pembacaan compressome- ter | Pembacaan compressome- ter / 2 | Tegangan | Regangan | Regangan Koreksi |
|-------|---------|----------------------------------|--------------------------------------|----------|------------------|---------------------|
| Kgf | N | 10 ⁻³ | 10 ⁻³ | MPa | 10 ⁻⁴ | 10 ⁻⁴ |
| 0 | 0 | 0.00 | 0.00 | 0.000 | -0.408 | 0 |
| 500 | 4903.4 | 0.25 | 0.13 | 0.614 | 0.083 | 0.491 |
| 1000 | 9806.7 | 1.00 | 0.50 | 1.228 | 0.330 | 0.739 |
| 1500 | 14710.1 | 1.25 | 0.63 | 1.842 | 0.413 | 0.821 |
| 2000 | 19613.4 | 1.75 | 0.88 | 2.456 | 0.578 | 0.986 |
| 2500 | 24516.8 | 2.75 | 1.38 | 3.070 | 0.908 | 1.316 |
| 3000 | 29420.1 | 3.75 | 1.88 | 3.684 | 1.238 | 1.646 |
| 3500 | 34323.5 | 4.75 | 2.38 | 4.298 | 1.568 | 1.976 |
| 4000 | 39226.8 | 5.75 | 2.88 | 4.912 | 1.898 | 2.306 |
| 4500 | 44130.2 | 6.50 | 3.25 | 5.526 | 2.145 | 2.554 |
| 5000 | 49033.6 | 7.50 | 3.75 | 6.140 | 2.475 | 2.884 |
| 5500 | 53936.9 | 8.50 | 4.25 | 6.754 | 2.805 | 3.214 |
| 6000 | 58840.3 | 9.50 | 4.75 | 7.368 | 3.135 | 3.544 |
| 6500 | 63743.6 | 10.50 | 5.25 | 7.982 | 3.465 | 3.874 |
| 7000 | 68647.0 | 11.50 | 5.75 | 8.597 | 3.795 | 4.204 |
| 7500 | 73550.3 | 12.50 | 6.25 | 9.211 | 4.125 | 4.534 |
| 8000 | 78453.7 | 13.00 | 6.50 | 9.825 | 4.290 | 4.699 |
| 8500 | 83357.0 | 13.50 | 6.75 | 10.439 | 4.455 | 4.864 |
| 9000 | 88260.4 | 14.25 | 7.13 | 11.053 | 4.703 | 5.111 |
| 9500 | 93163.7 | 15.00 | 7.50 | 11.667 | 4.950 | 5.359 |



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Kode Beton = BSC0 4

Po4 = 150,9 mm

A4 = 8048,9079 mm²

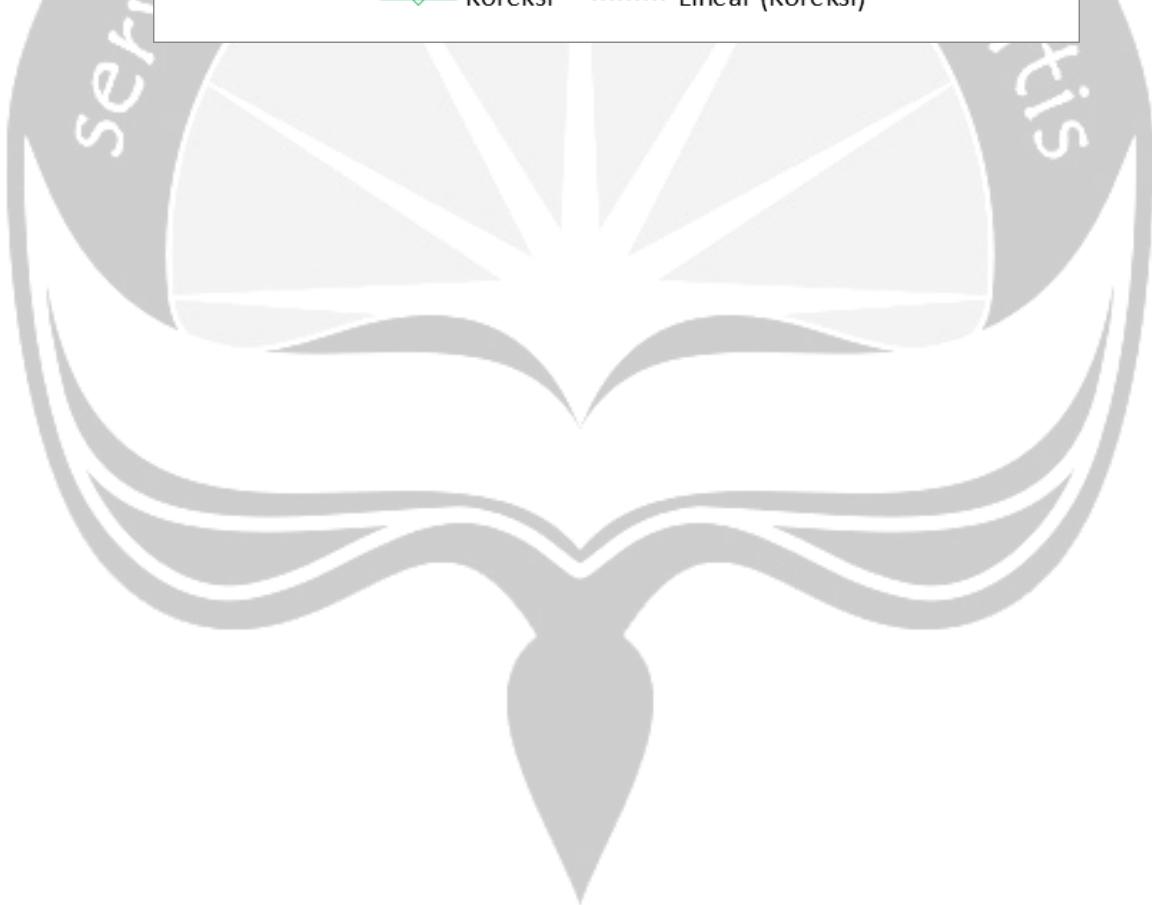
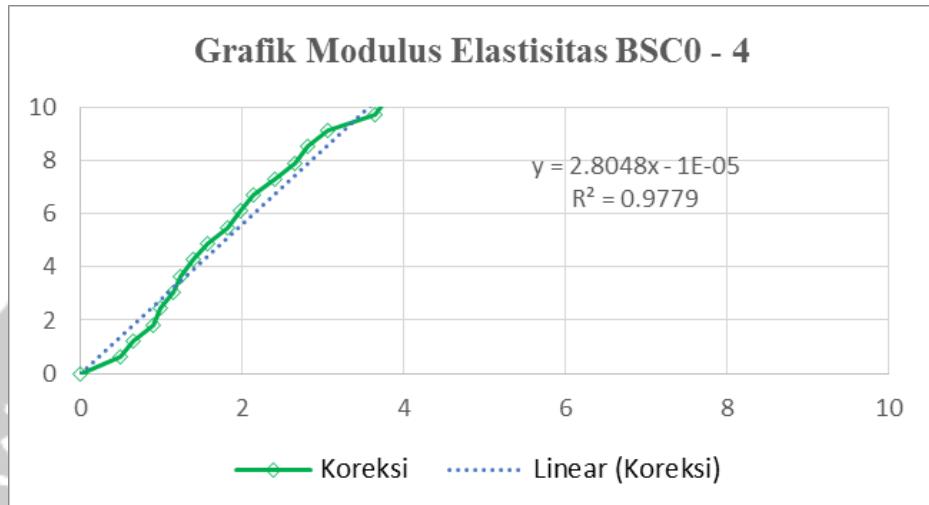
Beban Maks = 9500 Kgf

E = 26385,365 MPa

| Beban | | Pembacaan compressome- ter | Pembacaan compressome- ter / 2 | Tegangan | Regangan | Regangan Koreksi |
|-------|---------|----------------------------------|--------------------------------------|----------|------------------|---------------------|
| Kgf | N | 10 ⁻³ | 10 ⁻³ | MPa | 10 ⁻⁴ | 10 ⁻⁴ |
| 0 | 0 | 0 | 0 | 0 | -0.245 | 0 |
| 500 | 4903.4 | 0.75 | 0.38 | 0.609 | 0.249 | 0.493 |
| 1000 | 9806.7 | 1.25 | 0.63 | 1.218 | 0.414 | 0.659 |
| 1500 | 14710.1 | 2.00 | 1.00 | 1.828 | 0.663 | 0.908 |
| 2000 | 19613.4 | 2.25 | 1.13 | 2.437 | 0.746 | 0.990 |
| 2500 | 24516.8 | 2.75 | 1.38 | 3.046 | 0.911 | 1.156 |
| 3000 | 29420.1 | 3.00 | 1.50 | 3.655 | 0.994 | 1.239 |
| 3500 | 34323.5 | 3.50 | 1.75 | 4.264 | 1.160 | 1.405 |
| 4000 | 39226.8 | 4.00 | 2.00 | 4.874 | 1.325 | 1.570 |
| 4500 | 44130.2 | 4.75 | 2.38 | 5.483 | 1.574 | 1.819 |
| 5000 | 49033.6 | 5.25 | 2.63 | 6.092 | 1.740 | 1.985 |
| 5500 | 53936.9 | 5.75 | 2.88 | 6.701 | 1.905 | 2.150 |
| 6000 | 58840.3 | 6.50 | 3.25 | 7.310 | 2.154 | 2.399 |
| 6500 | 63743.6 | 7.25 | 3.63 | 7.920 | 2.402 | 2.647 |
| 7000 | 68647.0 | 7.75 | 3.88 | 8.529 | 2.568 | 2.813 |
| 7500 | 73550.3 | 8.50 | 4.25 | 9.138 | 2.816 | 3.061 |
| 8000 | 78453.7 | 10.25 | 5.13 | 9.747 | 3.396 | 3.641 |
| 8500 | 83357.0 | 10.75 | 5.38 | 10.356 | 3.562 | 3.807 |
| 9000 | 88260.4 | 11.75 | 5.88 | 10.966 | 3.893 | 4.138 |
| 9500 | 93163.7 | 12.50 | 6.25 | 11.575 | 4.142 | 4.387 |



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Kode Beton = BSC5 1

Po1 = 150,6 mm

A1 = 7969,6 mm²

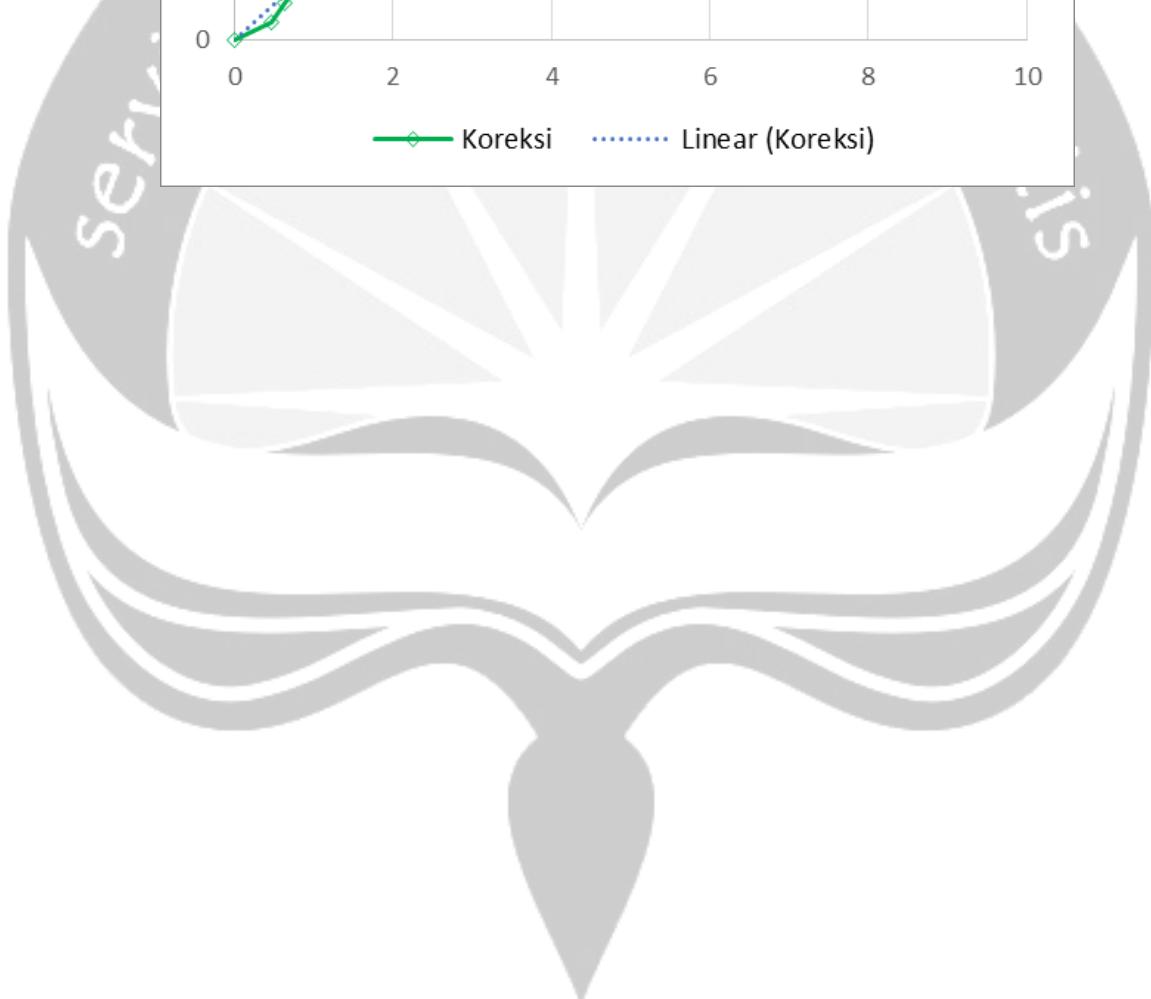
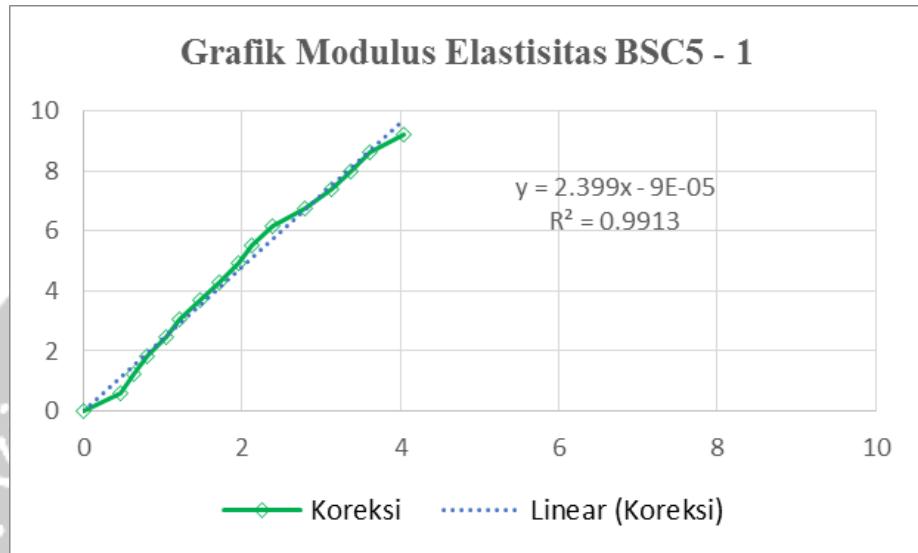
Beban Maks = 9500 Kgf

E = 24860,092 MPa

| Beban | | Pembacaan compressome- ter | Pembacaan compressome- ter / 2 | Tegangan | Regangan | Regangan Koreksi |
|-------|---------|----------------------------------|--------------------------------------|----------|------------------|---------------------|
| Kgf | N | 10 ⁻³ | 10 ⁻³ | MPa | 10 ⁻⁴ | 10 ⁻⁴ |
| 0 | 0 | 0.00 | 0.00 | 0.000 | -0.386 | 0 |
| 500 | 4903.4 | 0.25 | 0.13 | 0.615 | 0.083 | 0.469 |
| 1000 | 9806.7 | 0.75 | 0.38 | 1.231 | 0.249 | 0.635 |
| 1500 | 14710.1 | 1.25 | 0.63 | 1.846 | 0.415 | 0.801 |
| 2000 | 19613.4 | 2.00 | 1.00 | 2.461 | 0.664 | 1.050 |
| 2500 | 24516.8 | 2.50 | 1.25 | 3.076 | 0.830 | 1.216 |
| 3000 | 29420.1 | 3.25 | 1.63 | 3.692 | 1.079 | 1.465 |
| 3500 | 34323.5 | 4.00 | 2.00 | 4.307 | 1.328 | 1.714 |
| 4000 | 39226.8 | 4.75 | 2.38 | 4.922 | 1.577 | 1.963 |
| 4500 | 44130.2 | 5.25 | 2.63 | 5.537 | 1.743 | 2.129 |
| 5000 | 49033.6 | 6.00 | 3.00 | 6.153 | 1.992 | 2.378 |
| 5500 | 53936.9 | 7.25 | 3.63 | 6.768 | 2.407 | 2.793 |
| 6000 | 58840.3 | 8.25 | 4.13 | 7.383 | 2.739 | 3.125 |
| 6500 | 63743.6 | 9.00 | 4.50 | 7.998 | 2.988 | 3.374 |
| 7000 | 68647.0 | 9.75 | 4.88 | 8.614 | 3.237 | 3.623 |
| 7500 | 73550.3 | 11.00 | 5.50 | 9.229 | 3.652 | 4.038 |
| 8000 | 78453.7 | 11.50 | 5.75 | 9.844 | 3.818 | 4.204 |
| 8500 | 83357.0 | 12.00 | 6.00 | 10.459 | 3.984 | 4.370 |
| 9000 | 88260.4 | 12.25 | 6.13 | 11.075 | 4.067 | 4.453 |
| 9500 | 93163.7 | 13.00 | 6.50 | 11.690 | 4.316 | 4.702 |



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Kode Beton = BSC5 3

Po3 = 150,7 mm

A3 = 8171,28 mm²

Beban Maks = 9500 Kgf

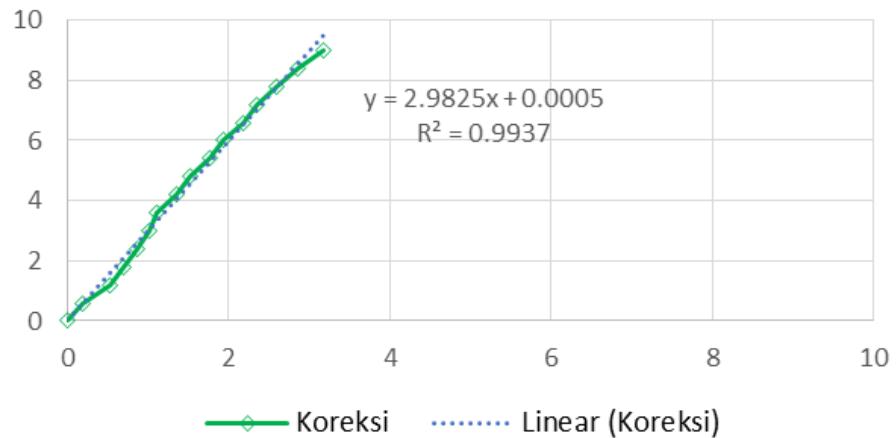
E = 28437,169 MPa

| Beban | | Pembacaan compressometer | Pembacaan compressometer / 2 | Tegangan | Regangan | Regangan Koreksi |
|-------|---------|-----------------------------|---------------------------------|----------|------------------|---------------------|
| Kgf | N | 10 ⁻³ | 10 ⁻³ | MPa | 10 ⁻⁴ | 10 ⁻⁴ |
| 0 | 0 | 0.00 | 0.00 | 0.000 | 0.138 | 0 |
| 500 | 4903.4 | 1.00 | 0.50 | 0.600 | 0.332 | 0.194 |
| 1000 | 9806.7 | 2.00 | 1.00 | 1.200 | 0.664 | 0.526 |
| 1500 | 14710.1 | 2.50 | 1.25 | 1.800 | 0.829 | 0.691 |
| 2000 | 19613.4 | 3.00 | 1.50 | 2.400 | 0.995 | 0.857 |
| 2500 | 24516.8 | 3.50 | 1.75 | 3.000 | 1.161 | 1.023 |
| 3000 | 29420.1 | 3.75 | 1.88 | 3.600 | 1.244 | 1.106 |
| 3500 | 34323.5 | 4.50 | 2.25 | 4.200 | 1.493 | 1.355 |
| 4000 | 39226.8 | 5.00 | 2.50 | 4.801 | 1.659 | 1.521 |
| 4500 | 44130.2 | 5.75 | 2.88 | 5.401 | 1.908 | 1.770 |
| 5000 | 49033.6 | 6.25 | 3.13 | 6.001 | 2.074 | 1.936 |
| 5500 | 53936.9 | 7.00 | 3.50 | 6.601 | 2.322 | 2.184 |
| 6000 | 58840.3 | 7.50 | 3.75 | 7.201 | 2.488 | 2.350 |
| 6500 | 63743.6 | 8.25 | 4.13 | 7.801 | 2.737 | 2.599 |
| 7000 | 68647.0 | 9.00 | 4.50 | 8.401 | 2.986 | 2.848 |
| 7500 | 73550.3 | 10.00 | 5.00 | 9.001 | 3.318 | 3.180 |
| 8000 | 78453.7 | 10.25 | 5.13 | 9.601 | 3.401 | 3.263 |
| 8500 | 83357.0 | 10.75 | 5.38 | 10.201 | 3.567 | 3.429 |
| 9000 | 88260.4 | 11.25 | 5.63 | 10.801 | 3.733 | 3.595 |
| 9500 | 93163.7 | 12.50 | 6.25 | 11.401 | 4.147 | 4.009 |



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Grafik Modulus Elastisitas BSC5 - 3





Kode Beton = BSC5 4

Po4 = 151,2 mm

A4 = 8080,74 mm²

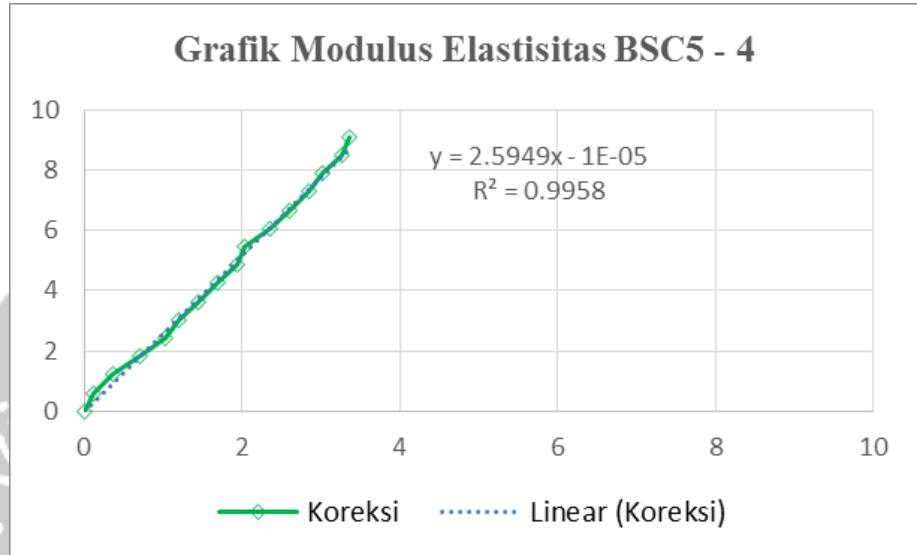
Beban Maks = 9500 kgf

E = 27581,086 MPa

| Beban | | Pembacaan compressome- ter | Pembacaan compressome- ter / 2 | Tegangan | Regangan | Regangan Koreksi |
|-------|---------|----------------------------------|--------------------------------------|----------|------------------|---------------------|
| Kgf | N | 10 ⁻³ | 10 ⁻³ | MPa | 10 ⁻⁴ | 10 ⁻⁴ |
| 0 | 0 | 0.00 | 0.00 | 0.000 | -0.046 | 0 |
| 500 | 4903.4 | 0.25 | 0.13 | 0.607 | 0.083 | 0.129 |
| 1000 | 9806.7 | 1.00 | 0.50 | 1.214 | 0.331 | 0.377 |
| 1500 | 14710.1 | 2.00 | 1.00 | 1.820 | 0.661 | 0.708 |
| 2000 | 19613.4 | 3.00 | 1.50 | 2.427 | 0.992 | 1.039 |
| 2500 | 24516.8 | 3.50 | 1.75 | 3.034 | 1.157 | 1.204 |
| 3000 | 29420.1 | 4.25 | 2.13 | 3.641 | 1.405 | 1.452 |
| 3500 | 34323.5 | 5.00 | 2.50 | 4.248 | 1.653 | 1.700 |
| 4000 | 39226.8 | 5.75 | 2.88 | 4.854 | 1.901 | 1.948 |
| 4500 | 44130.2 | 6.00 | 3.00 | 5.461 | 1.984 | 2.031 |
| 5000 | 49033.6 | 7.00 | 3.50 | 6.068 | 2.315 | 2.361 |
| 5500 | 53936.9 | 7.75 | 3.88 | 6.675 | 2.563 | 2.609 |
| 6000 | 58840.3 | 8.50 | 4.25 | 7.282 | 2.811 | 2.857 |
| 6500 | 63743.6 | 9.00 | 4.50 | 7.888 | 2.976 | 3.023 |
| 7000 | 68647.0 | 9.75 | 4.88 | 8.495 | 3.224 | 3.271 |
| 7500 | 73550.3 | 10.00 | 5.00 | 9.102 | 3.307 | 3.353 |
| 8000 | 78453.7 | 10.25 | 5.13 | 9.709 | 3.390 | 3.436 |
| 8500 | 83357.0 | 11.00 | 5.50 | 10.316 | 3.638 | 3.684 |
| 9000 | 88260.4 | 11.75 | 5.88 | 10.922 | 3.886 | 3.932 |
| 9500 | 93163.7 | 12.50 | 6.25 | 11.529 | 4.134 | 4.180 |



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Kode Beton = BSC10 1

Po1 = 156,7 mm

A1 = 150,8 mm²

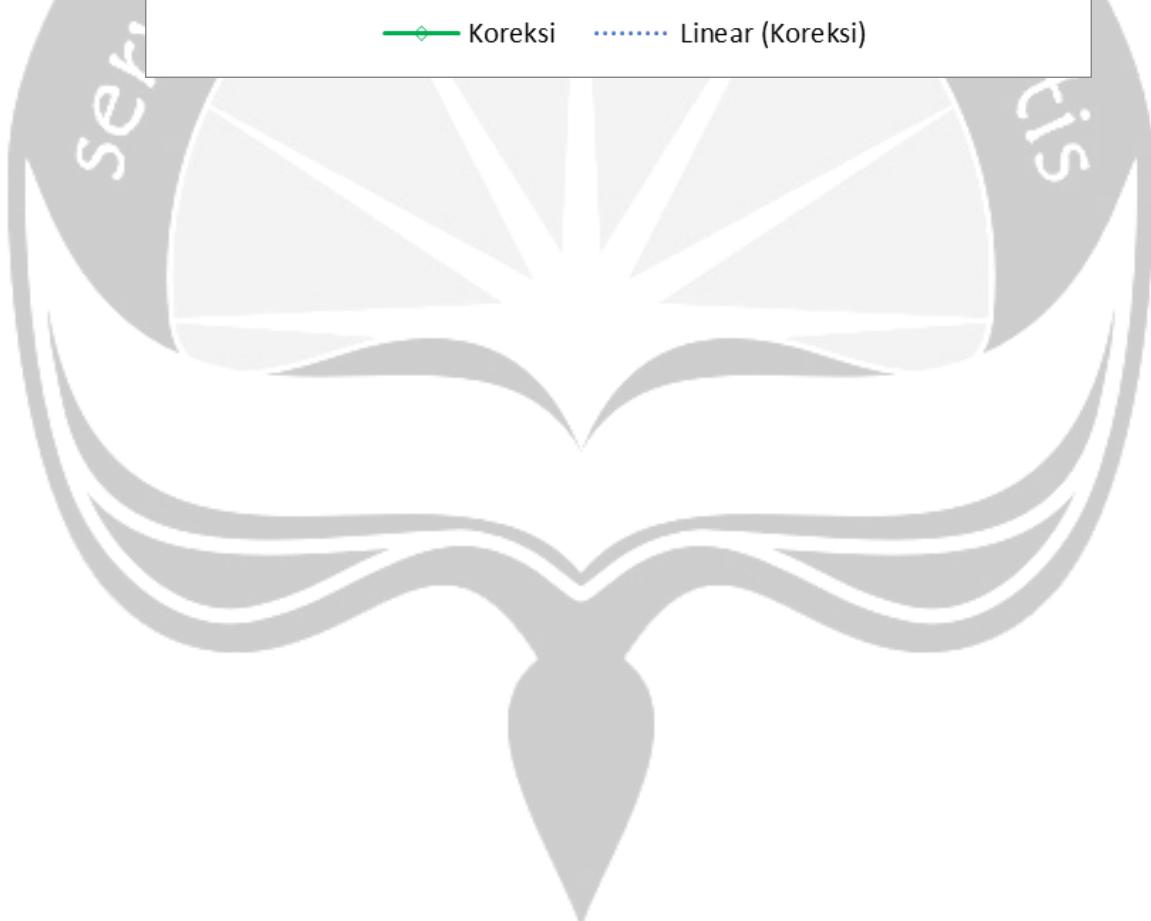
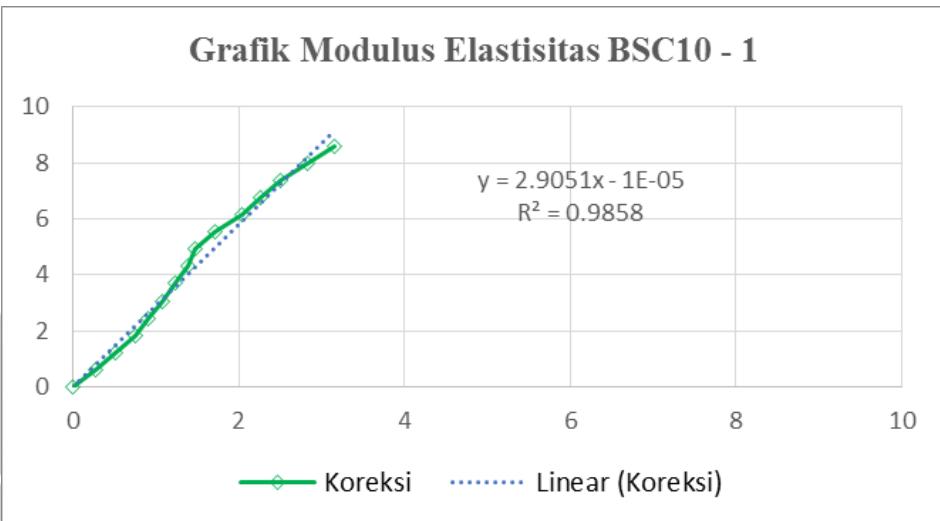
Beban Maks = 7000 Kgf

E = 29258,015 MPa

| Beban | | Pembacaan <i>compressometer</i> | Pembacaan <i>compressometer / 2</i> | Tegangan | Regangan | Regangan Koreksi |
|-------|---------|------------------------------------|--|----------|-----------|---------------------|
| Kgf | N | 10^{-3} | 10^{-3} | MPa | 10^{-4} | 10^{-4} |
| 0 | 0 | 0.00 | 0.00 | 0.000 | -0.119 | 0 |
| 500 | 4903.4 | 0.50 | 0.25 | 0.613 | 0.160 | 0.278 |
| 1000 | 9806.7 | 1.25 | 0.63 | 1.226 | 0.399 | 0.518 |
| 1500 | 14710.1 | 2.00 | 1.00 | 1.840 | 0.638 | 0.757 |
| 2000 | 19613.4 | 2.50 | 1.25 | 2.453 | 0.798 | 0.917 |
| 2500 | 24516.8 | 3.00 | 1.50 | 3.066 | 0.957 | 1.076 |
| 3000 | 29420.1 | 3.50 | 1.75 | 3.679 | 1.117 | 1.236 |
| 3500 | 34323.5 | 4.00 | 2.00 | 4.293 | 1.276 | 1.395 |
| 4000 | 39226.8 | 4.25 | 2.13 | 4.906 | 1.356 | 1.475 |
| 4500 | 44130.2 | 5.00 | 2.50 | 5.519 | 1.595 | 1.714 |
| 5000 | 49033.6 | 6.00 | 3.00 | 6.132 | 1.914 | 2.033 |
| 5500 | 53936.9 | 6.75 | 3.38 | 6.745 | 2.154 | 2.273 |
| 6000 | 58840.3 | 7.50 | 3.75 | 7.359 | 2.393 | 2.512 |
| 6500 | 63743.6 | 8.50 | 4.25 | 7.972 | 2.712 | 2.831 |
| 7000 | 68647.0 | 9.50 | 4.75 | 8.585 | 3.031 | 3.150 |



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Kode Beton = BSC10 3

Po3 = 150,8 mm

A3 = 7895,93 mm²

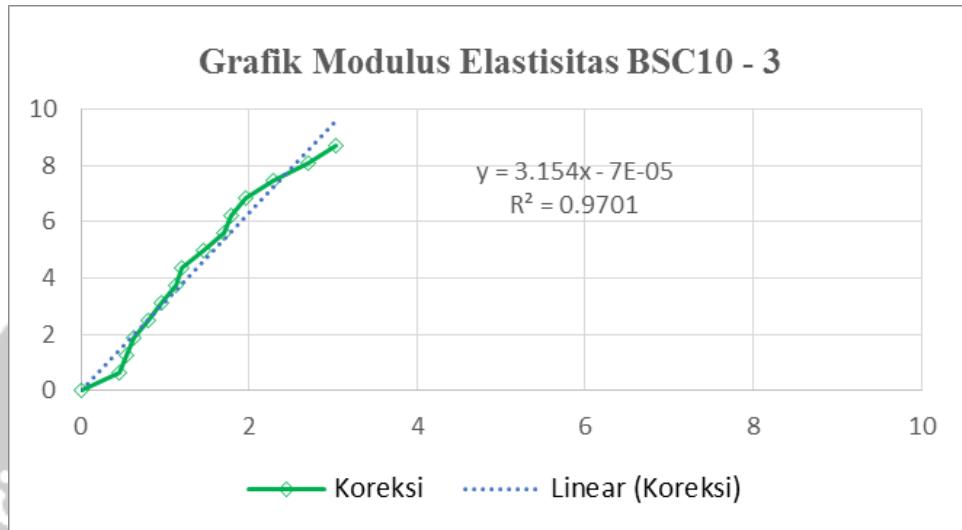
Beban Maks = 7000 Kgf

E = 28656,048 MPa

| Beban | | Pembacaan <i>compressometer</i> | Pembacaan <i>compressometer / 2</i> | Tegangan | Regangan | Regangan Koreksi |
|-------|---------|------------------------------------|--|----------|-----------|---------------------|
| Kgf | N | 10^{-3} | 10^{-3} | MPa | 10^{-4} | 10^{-4} |
| 0 | 0 | 0.00 | 0.00 | 0.000 | -0.216 | 0 |
| 500 | 4903.4 | 0.75 | 0.38 | 0.621 | 0.249 | 0.464 |
| 1000 | 9806.7 | 1.00 | 0.50 | 1.242 | 0.332 | 0.547 |
| 1500 | 14710.1 | 1.25 | 0.63 | 1.863 | 0.414 | 0.630 |
| 2000 | 19613.4 | 1.75 | 0.88 | 2.484 | 0.580 | 0.796 |
| 2500 | 24516.8 | 2.25 | 1.13 | 3.105 | 0.746 | 0.962 |
| 3000 | 29420.1 | 2.75 | 1.38 | 3.726 | 0.912 | 1.127 |
| 3500 | 34323.5 | 3.00 | 1.50 | 4.347 | 0.995 | 1.210 |
| 4000 | 39226.8 | 3.75 | 1.88 | 4.968 | 1.243 | 1.459 |
| 4500 | 44130.2 | 4.50 | 2.25 | 5.589 | 1.492 | 1.708 |
| 5000 | 49033.6 | 4.75 | 2.38 | 6.210 | 1.575 | 1.791 |
| 5500 | 53936.9 | 5.25 | 2.63 | 6.831 | 1.741 | 1.956 |
| 6000 | 58840.3 | 6.25 | 3.13 | 7.452 | 2.072 | 2.288 |
| 6500 | 63743.6 | 7.50 | 3.75 | 8.073 | 2.487 | 2.702 |
| 7000 | 68647.0 | 8.50 | 4.25 | 8.694 | 2.818 | 3.034 |



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Kode Beton = BSC10 4

Po4 = 156,7 mm

A4 = 7827,82 mm²

Beban Maks = 7000 Kgf

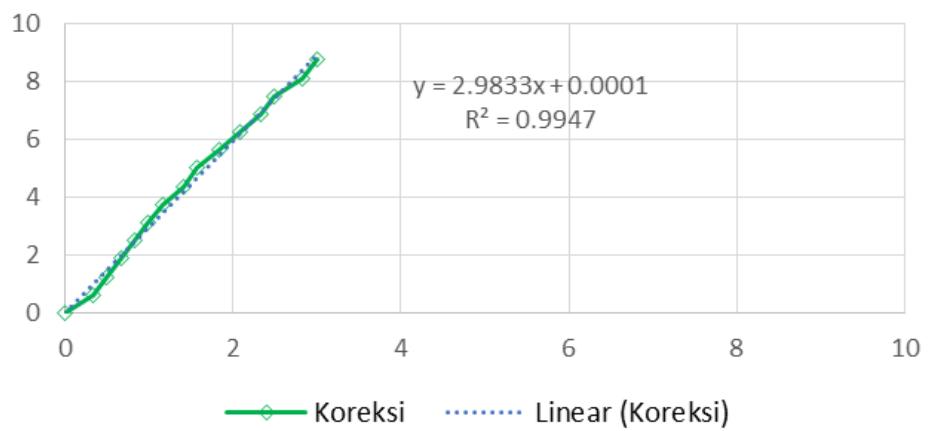
E = 29258,015 MPa

| Beban | | Pembacaan compressome- ter | Pembacaan compressome- ter / 2 | Tegangan | Regangan | Regangan Koreksi |
|-------|---------|----------------------------------|--------------------------------------|----------|-----------|---------------------|
| Kgf | N | 10^{-3} | 10^{-3} | MPa | 10^{-4} | 10^{-4} |
| 0 | 0 | 0.00 | 0.00 | 0.000 | -0.164 | 0 |
| 500 | 4903.4 | 0.50 | 0.25 | 0.626 | 0.167 | 0.331 |
| 1000 | 9806.7 | 1.00 | 0.50 | 1.253 | 0.333 | 0.497 |
| 1500 | 14710.1 | 1.50 | 0.75 | 1.879 | 0.500 | 0.664 |
| 2000 | 19613.4 | 2.00 | 1.00 | 2.506 | 0.667 | 0.831 |
| 2500 | 24516.8 | 2.50 | 1.25 | 3.132 | 0.833 | 0.997 |
| 3000 | 29420.1 | 3.00 | 1.50 | 3.758 | 1.000 | 1.164 |
| 3500 | 34323.5 | 3.75 | 1.88 | 4.385 | 1.250 | 1.414 |
| 4000 | 39226.8 | 4.25 | 2.13 | 5.011 | 1.417 | 1.581 |
| 4500 | 44130.2 | 5.00 | 2.50 | 5.638 | 1.667 | 1.831 |
| 5000 | 49033.6 | 5.75 | 2.88 | 6.264 | 1.917 | 2.081 |
| 5500 | 53936.9 | 6.50 | 3.25 | 6.890 | 2.167 | 2.331 |
| 6000 | 58840.3 | 7.00 | 3.50 | 7.517 | 2.333 | 2.497 |
| 6500 | 63743.6 | 8.00 | 4.00 | 8.143 | 2.667 | 2.831 |
| 7000 | 68647.0 | 8.50 | 4.25 | 8.770 | 2.833 | 2.997 |



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Grafik Modulus Elastisitas BSC10 - 4





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Kode Beton = BSC15 2

Po2 = 151,2 mm

A2 = 7911,68 mm²

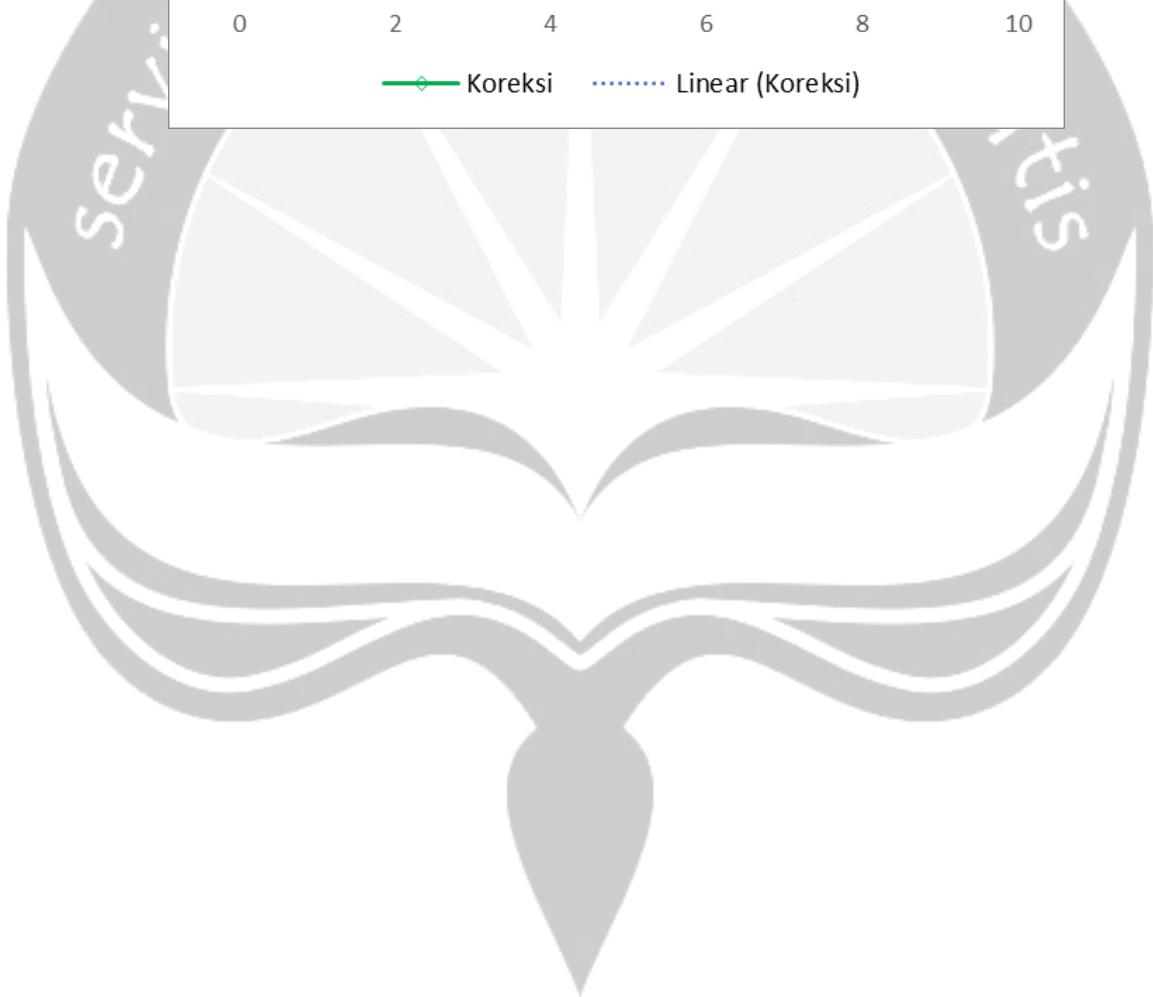
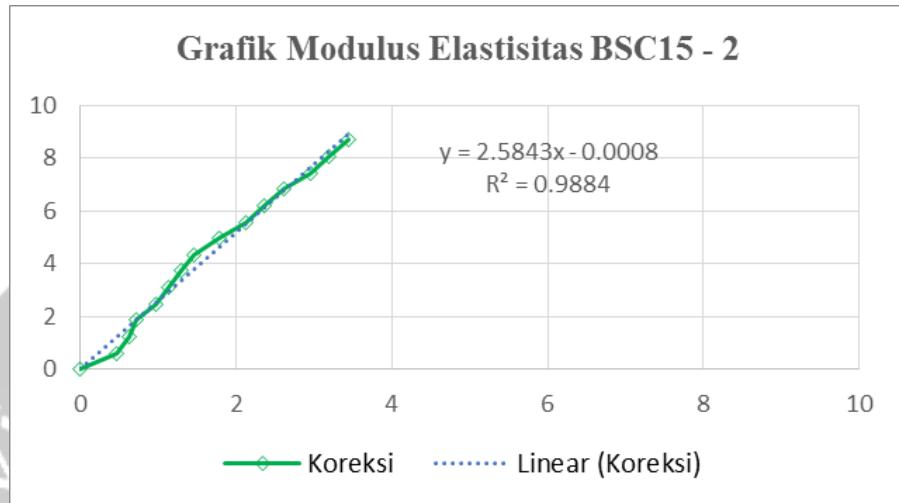
Beban Maks = 7000 Kgf

E = 25174,997 MPa

| Beban | | Pembacaan compressome- ter | Pembacaan compressome- ter / 2 | Tegangan | Regangan | Regangan Koreksi |
|-------|---------|----------------------------------|--------------------------------------|----------|-----------|---------------------|
| Kgf | N | 10^{-3} | 10^{-3} | MPa | 10^{-4} | 10^{-4} |
| 0 | 0 | 0.00 | 0.00 | 0.000 | -0.305 | 0 |
| 500 | 4903.4 | 0.50 | 0.25 | 0.620 | 0.165 | 0.470 |
| 1000 | 9806.7 | 1.00 | 0.50 | 1.240 | 0.331 | 0.636 |
| 1500 | 14710.1 | 1.25 | 0.63 | 1.859 | 0.413 | 0.718 |
| 2000 | 19613.4 | 2.00 | 1.00 | 2.479 | 0.661 | 0.966 |
| 2500 | 24516.8 | 2.50 | 1.25 | 3.099 | 0.827 | 1.132 |
| 3000 | 29420.1 | 3.00 | 1.50 | 3.719 | 0.992 | 1.297 |
| 3500 | 34323.5 | 3.50 | 1.75 | 4.338 | 1.157 | 1.462 |
| 4000 | 39226.8 | 4.50 | 2.25 | 4.958 | 1.488 | 1.793 |
| 4500 | 44130.2 | 5.50 | 2.75 | 5.578 | 1.819 | 2.124 |
| 5000 | 49033.6 | 6.25 | 3.13 | 6.198 | 2.067 | 2.372 |
| 5500 | 53936.9 | 7.00 | 3.50 | 6.817 | 2.315 | 2.620 |
| 6000 | 58840.3 | 8.00 | 4.00 | 7.437 | 2.646 | 2.951 |
| 6500 | 63743.6 | 8.75 | 4.38 | 8.057 | 2.894 | 3.199 |
| 7000 | 68647.0 | 9.50 | 4.75 | 8.677 | 3.142 | 3.447 |



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Kode Beton = BSC15 3

Po3 = 149,5 mm

A3 = 8107,32 mm²

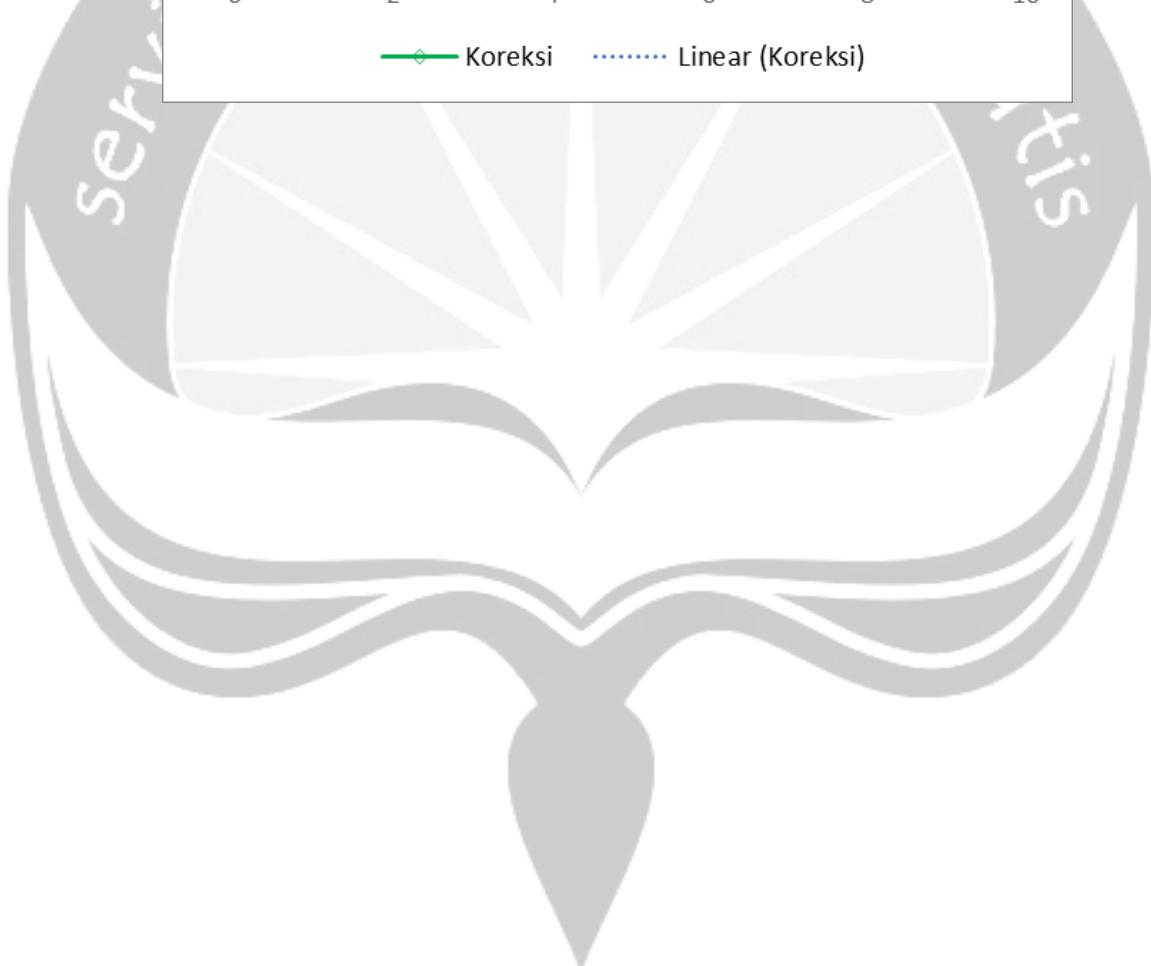
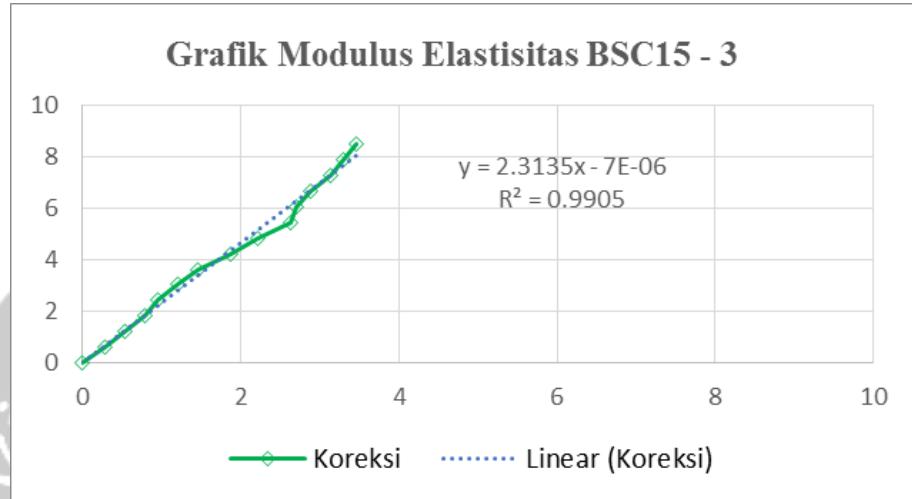
Beban Maks = 7000 Kgf

E = 24431,772 MPa

| Beban | | Pembacaan <i>compressometer</i> | Pembacaan <i>compressometer / 2</i> | Tegangan | Regangan | Regangan Koreksi |
|-------|---------|------------------------------------|--|----------|-----------|---------------------|
| Kgf | N | 10^{-3} | 10^{-3} | MPa | 10^{-4} | 10^{-4} |
| 0 | 0 | 0.00 | 0.00 | 0.000 | -0.121 | 0 |
| 500 | 4903.4 | 0.50 | 0.25 | 0.605 | 0.167 | 0.288 |
| 1000 | 9806.7 | 1.25 | 0.63 | 1.210 | 0.418 | 0.539 |
| 1500 | 14710.1 | 2.00 | 1.00 | 1.814 | 0.669 | 0.790 |
| 2000 | 19613.4 | 2.50 | 1.25 | 2.419 | 0.836 | 0.957 |
| 2500 | 24516.8 | 3.25 | 1.63 | 3.024 | 1.087 | 1.208 |
| 3000 | 29420.1 | 4.00 | 2.00 | 3.629 | 1.338 | 1.459 |
| 3500 | 34323.5 | 5.25 | 2.63 | 4.234 | 1.756 | 1.877 |
| 4000 | 39226.8 | 6.25 | 3.13 | 4.838 | 2.090 | 2.212 |
| 4500 | 44130.2 | 7.50 | 3.75 | 5.443 | 2.508 | 2.630 |
| 5000 | 49033.6 | 7.75 | 3.88 | 6.048 | 2.592 | 2.713 |
| 5500 | 53936.9 | 8.25 | 4.13 | 6.653 | 2.759 | 2.880 |
| 6000 | 58840.3 | 9.00 | 4.50 | 7.258 | 3.010 | 3.131 |
| 6500 | 63743.6 | 9.50 | 4.75 | 7.862 | 3.177 | 3.298 |
| 7000 | 68647.0 | 10.00 | 5.00 | 8.467 | 3.344 | 3.466 |



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Kode Beton = BSC15 4

Po4 = 150,8 mm

A4 = 7895,93 mm²

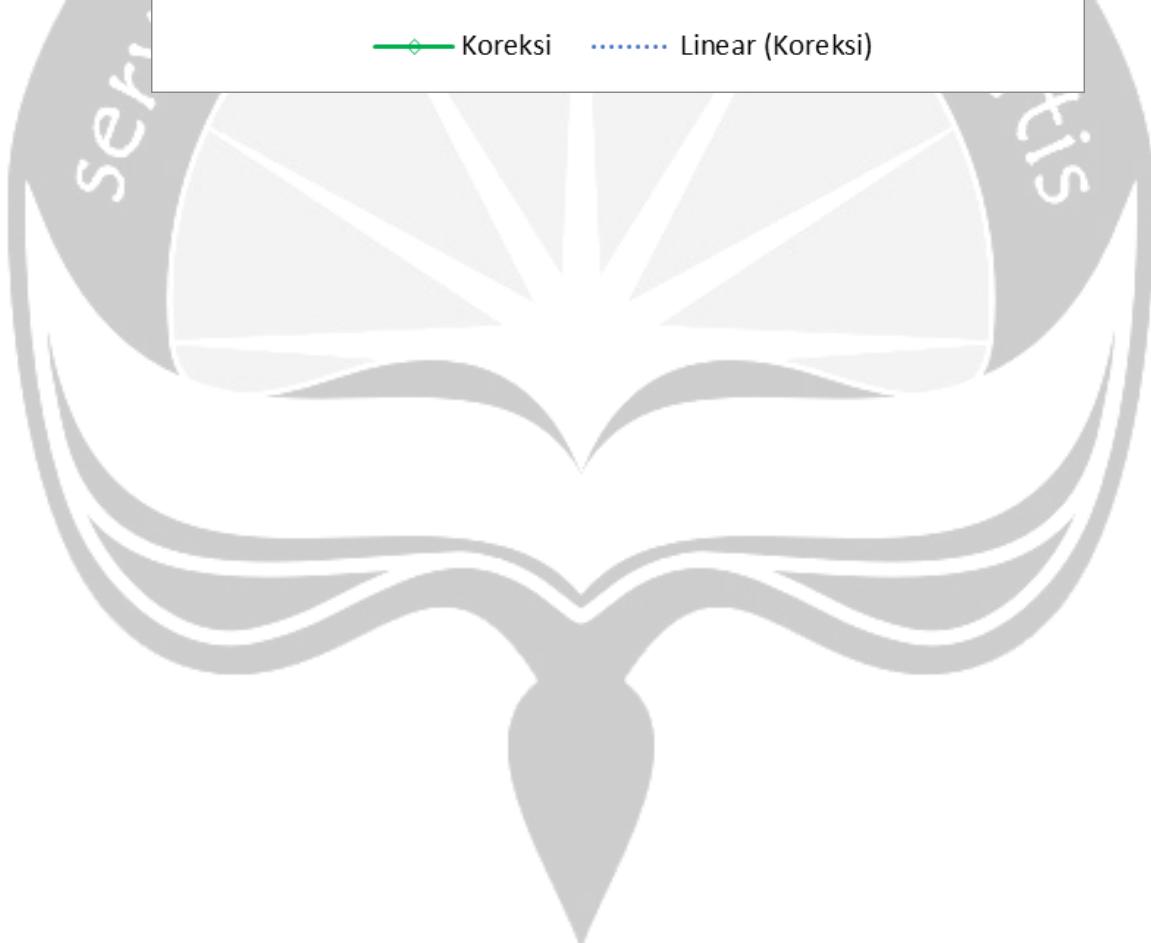
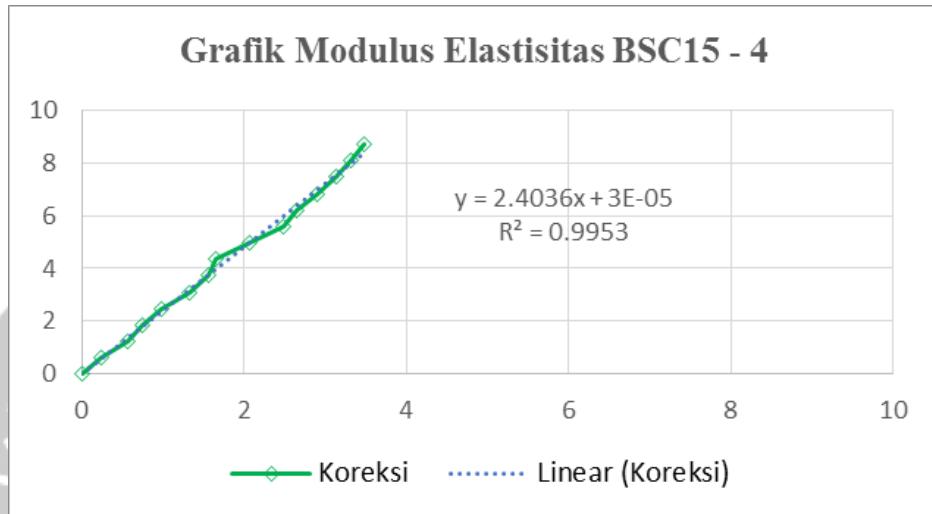
Beban Maks = 7000 Kgf

E = 25003,262 MPa

| Beban | | Pembacaan <i>compressometer</i> | Pembacaan <i>compressometer / 2</i> | Tegangan | Regangan | Regangan Koreksi |
|-------|---------|------------------------------------|--|----------|-----------|---------------------|
| Kgf | N | 10^{-3} | 10^{-3} | MPa | 10^{-4} | 10^{-4} |
| 0 | 0 | 0.00 | 0.00 | 0.000 | 0.0043 | 0 |
| 500 | 4903.4 | 0.75 | 0.38 | 0.621 | 0.249 | 0.244 |
| 1000 | 9806.7 | 1.75 | 0.88 | 1.242 | 0.580 | 0.576 |
| 1500 | 14710.1 | 2.25 | 1.13 | 1.863 | 0.746 | 0.742 |
| 2000 | 19613.4 | 3.00 | 1.50 | 2.484 | 0.995 | 0.990 |
| 2500 | 24516.8 | 4.00 | 2.00 | 3.105 | 1.326 | 1.322 |
| 3000 | 29420.1 | 4.75 | 2.38 | 3.726 | 1.575 | 1.571 |
| 3500 | 34323.5 | 5.00 | 2.50 | 4.347 | 1.658 | 1.654 |
| 4000 | 39226.8 | 6.25 | 3.13 | 4.968 | 2.072 | 2.068 |
| 4500 | 44130.2 | 7.50 | 3.75 | 5.589 | 2.487 | 2.482 |
| 5000 | 49033.6 | 8.00 | 4.00 | 6.210 | 2.653 | 2.648 |
| 5500 | 53936.9 | 8.75 | 4.38 | 6.831 | 2.901 | 2.897 |
| 6000 | 58840.3 | 9.50 | 4.75 | 7.452 | 3.150 | 3.146 |
| 6500 | 63743.6 | 10.00 | 5.00 | 8.073 | 3.316 | 3.311 |
| 7000 | 68647.0 | 10.50 | 5.25 | 8.694 | 3.481 | 3.477 |



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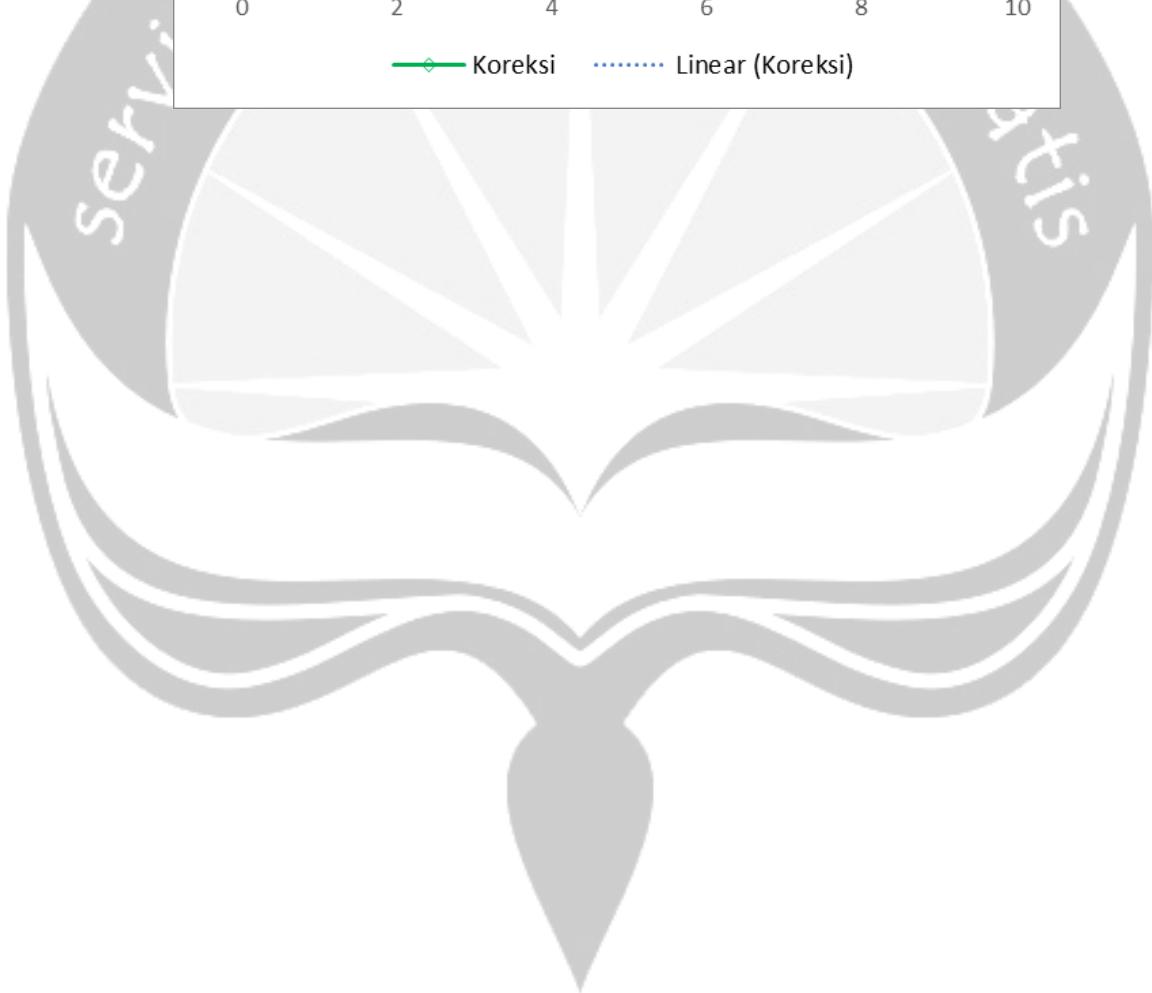
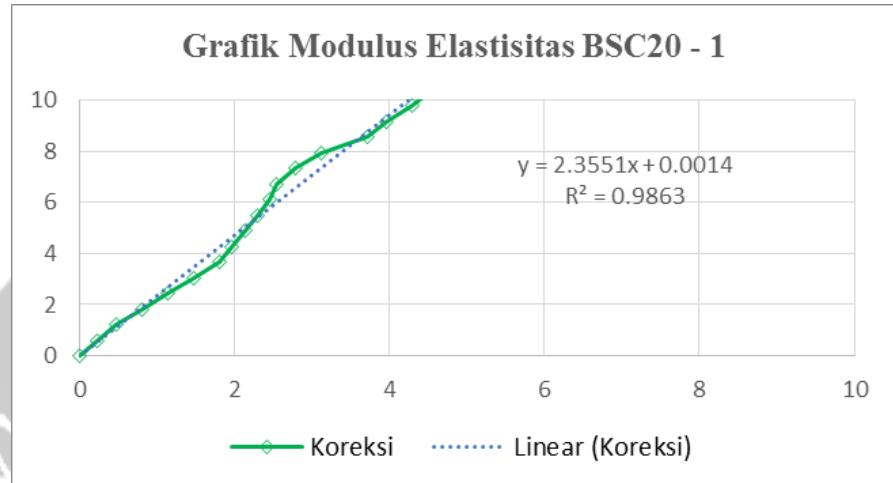


Kode Beton = BSC20 1
Po1 = 150,6 mm
A1 = 8022,43 mm²
Beban Maks = 8500 Kgf
E = 22901,321 MPa

| Beban | | Pembacaan <i>compressome-</i> <i>ter</i> | Pembacaan <i>compressome-</i> <i>ter / 2</i> | Tegangan | Regangan | Regangan Koreksi |
|-------|---------|--|--|----------|-----------|---------------------|
| Kgf | N | 10^{-3} | 10^{-3} | MPa | 10^{-4} | 10^{-4} |
| 0 | 0 | 0.00 | 0.00 | 0.000 | -0.138 | 0 |
| 500 | 4903.4 | 0.25 | 0.13 | 0.611 | 0.083 | 0.221 |
| 1000 | 9806.7 | 1.00 | 0.50 | 1.222 | 0.332 | 0.470 |
| 1500 | 14710.1 | 2.00 | 1.00 | 1.834 | 0.664 | 0.802 |
| 2000 | 19613.4 | 3.00 | 1.50 | 2.445 | 0.996 | 1.134 |
| 2500 | 24516.8 | 4.00 | 2.00 | 3.056 | 1.328 | 1.466 |
| 3000 | 29420.1 | 5.00 | 2.50 | 3.667 | 1.660 | 1.798 |
| 3500 | 34323.5 | 5.50 | 2.75 | 4.278 | 1.826 | 1.964 |
| 4000 | 39226.8 | 6.00 | 3.00 | 4.890 | 1.992 | 2.130 |
| 4500 | 44130.2 | 6.50 | 3.25 | 5.501 | 2.158 | 2.296 |
| 5000 | 49033.6 | 7.00 | 3.50 | 6.112 | 2.324 | 2.462 |
| 5500 | 53936.9 | 7.25 | 3.63 | 6.723 | 2.407 | 2.545 |
| 6000 | 58840.3 | 8.00 | 4.00 | 7.334 | 2.656 | 2.794 |
| 6500 | 63743.6 | 9.00 | 4.50 | 7.946 | 2.988 | 3.126 |
| 7000 | 68647.0 | 10.75 | 5.38 | 8.557 | 3.569 | 3.707 |
| 7500 | 73550.3 | 11.50 | 5.75 | 9.168 | 3.818 | 3.956 |
| 8000 | 78453.7 | 12.50 | 6.25 | 9.779 | 4.150 | 4.288 |
| 8500 | 83357.0 | 13.25 | 6.63 | 10.390 | 4.399 | 4.537 |



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Kode Beton = BSC20 2

Po2 = 150,6 mm

A2 = 7859,22 mm²

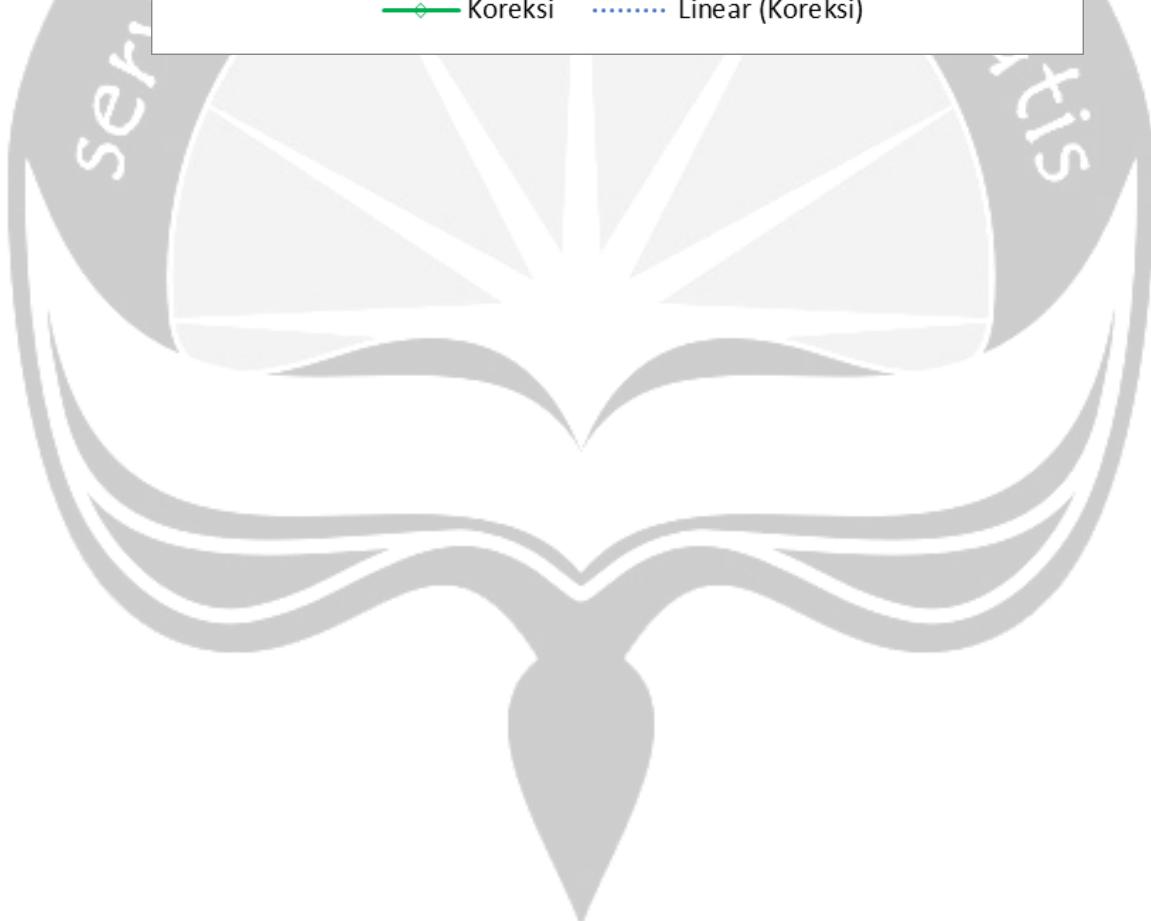
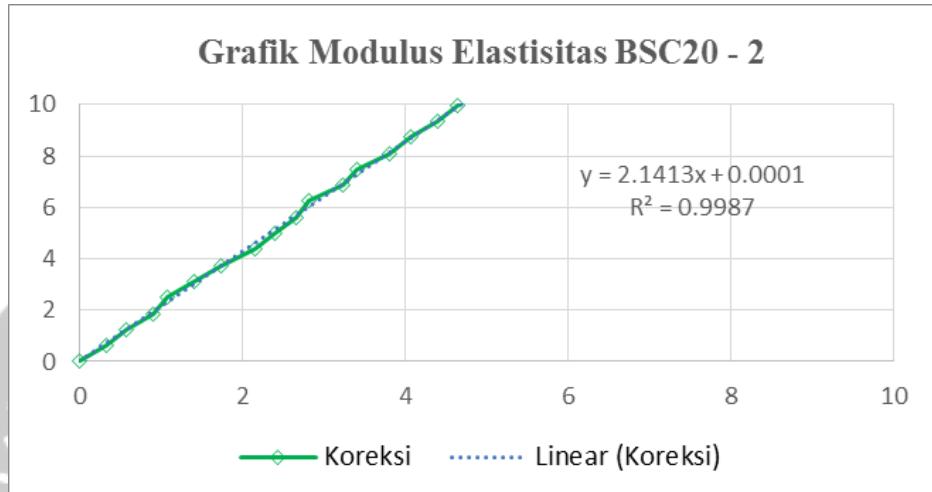
Beban Maks = 8500 Kgf

E = 21316,646 MPa

| Beban | | Pembacaan compressome- ter | Pembacaan compressome- ter / 2 | Tegangan | Regangan | Regangan Koreksi |
|-------|---------|----------------------------------|--------------------------------------|----------|-----------|---------------------|
| Kgf | N | 10^{-3} | 10^{-3} | MPa | 10^{-4} | 10^{-4} |
| 0 | 0 | 0.00 | 0.00 | 0.000 | -0.079 | 0 |
| 500 | 4903.4 | 0.75 | 0.38 | 0.624 | 0.249 | 0.328 |
| 1000 | 9806.7 | 1.50 | 0.75 | 1.248 | 0.498 | 0.577 |
| 1500 | 14710.1 | 2.50 | 1.25 | 1.872 | 0.830 | 0.909 |
| 2000 | 19613.4 | 3.00 | 1.50 | 2.496 | 0.996 | 1.075 |
| 2500 | 24516.8 | 4.00 | 2.00 | 3.119 | 1.328 | 1.407 |
| 3000 | 29420.1 | 5.00 | 2.50 | 3.743 | 1.660 | 1.739 |
| 3500 | 34323.5 | 6.25 | 3.13 | 4.367 | 2.075 | 2.154 |
| 4000 | 39226.8 | 7.00 | 3.50 | 4.991 | 2.324 | 2.403 |
| 4500 | 44130.2 | 7.75 | 3.88 | 5.615 | 2.573 | 2.652 |
| 5000 | 49033.6 | 8.25 | 4.13 | 6.239 | 2.739 | 2.818 |
| 5500 | 53936.9 | 9.50 | 4.75 | 6.863 | 3.154 | 3.233 |
| 6000 | 58840.3 | 10.00 | 5.00 | 7.487 | 3.320 | 3.399 |
| 6500 | 63743.6 | 11.25 | 5.63 | 8.111 | 3.735 | 3.814 |
| 7000 | 68647.0 | 12.00 | 6.00 | 8.735 | 3.984 | 4.063 |
| 7500 | 73550.3 | 13.00 | 6.50 | 9.358 | 4.316 | 4.395 |
| 8000 | 78453.7 | 13.75 | 6.88 | 9.982 | 4.565 | 4.644 |
| 8500 | 83357.0 | 14.75 | 7.38 | 10.606 | 4.897 | 4.976 |



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Kode Beton = BSC20 3

Po3 = 151 mm

A3 = 8139,27 mm²

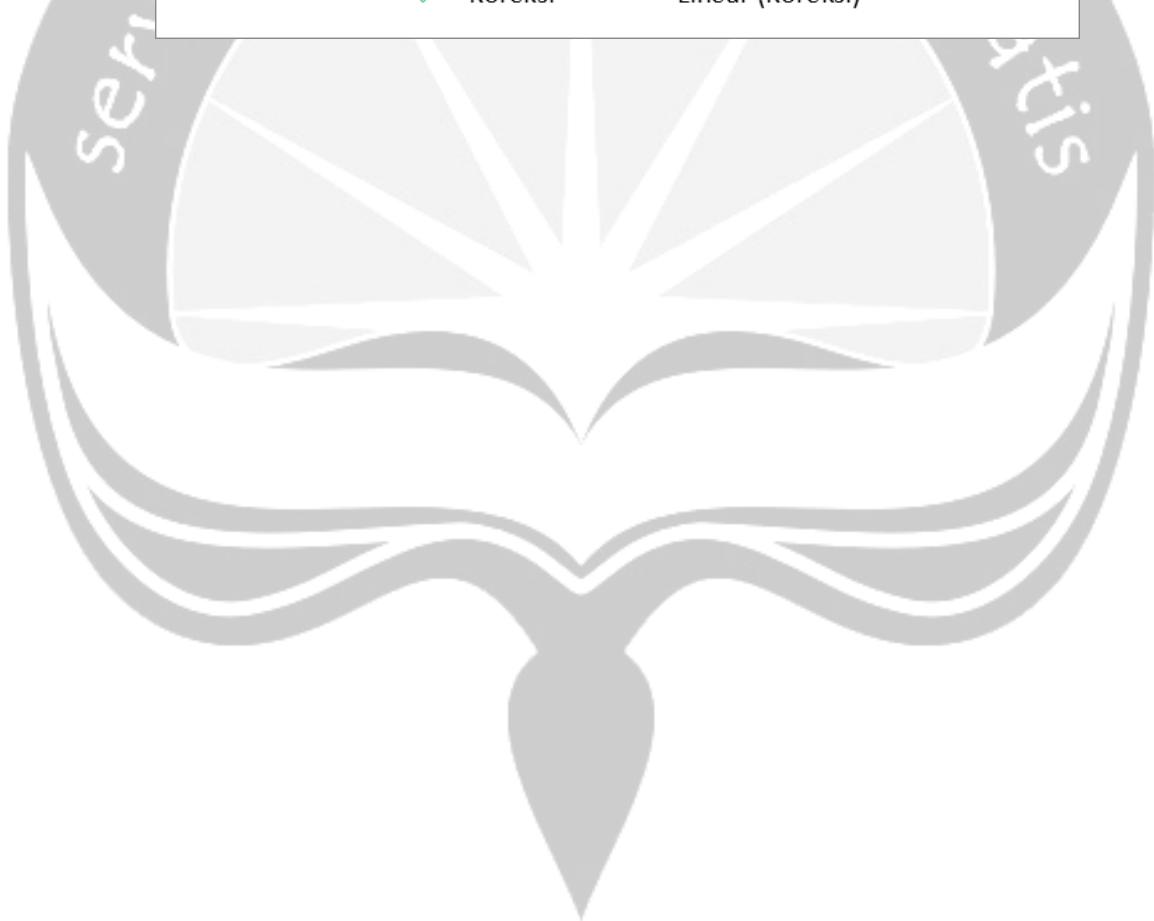
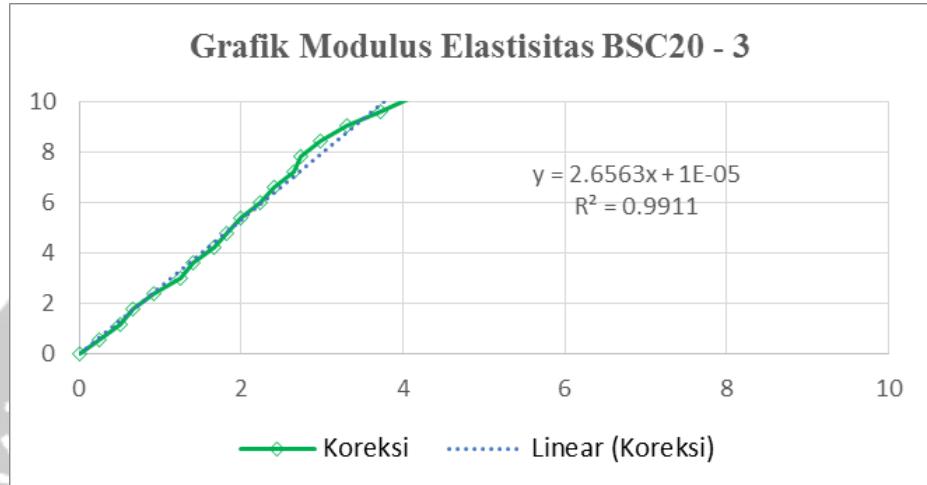
Beban Maks = 8500 Kgf

E = 24708,916 MPa

| Beban | | Pembacaan <i>compressometer</i> | Pembacaan <i>compressometer / 2</i> | Tegangan | Regangan | Regangan Koreksi |
|-------|---------|------------------------------------|--|----------|-----------|---------------------|
| Kgf | N | 10^{-3} | 10^{-3} | MPa | 10^{-4} | 10^{-4} |
| 0 | 0 | 0.00 | 0.00 | 0.000 | -0.0885 | 0 |
| 500 | 4903.4 | 0.50 | 0.25 | 0.602 | 0.166 | 0.254 |
| 1000 | 9806.7 | 1.25 | 0.63 | 1.205 | 0.414 | 0.502 |
| 1500 | 14710.1 | 1.75 | 0.88 | 1.807 | 0.579 | 0.668 |
| 2000 | 19613.4 | 2.50 | 1.25 | 2.410 | 0.828 | 0.916 |
| 2500 | 24516.8 | 3.50 | 1.75 | 3.012 | 1.159 | 1.247 |
| 3000 | 29420.1 | 4.00 | 2.00 | 3.615 | 1.325 | 1.413 |
| 3500 | 34323.5 | 4.75 | 2.38 | 4.217 | 1.573 | 1.661 |
| 4000 | 39226.8 | 5.25 | 2.63 | 4.819 | 1.738 | 1.827 |
| 4500 | 44130.2 | 5.75 | 2.88 | 5.422 | 1.904 | 1.992 |
| 5000 | 49033.6 | 6.50 | 3.25 | 6.024 | 2.152 | 2.241 |
| 5500 | 53936.9 | 7.00 | 3.50 | 6.627 | 2.318 | 2.406 |
| 6000 | 58840.3 | 7.75 | 3.88 | 7.229 | 2.566 | 2.655 |
| 6500 | 63743.6 | 8.00 | 4.00 | 7.832 | 2.649 | 2.738 |
| 7000 | 68647.0 | 8.75 | 4.38 | 8.434 | 2.897 | 2.986 |
| 7500 | 73550.3 | 9.75 | 4.88 | 9.036 | 3.228 | 3.317 |
| 8000 | 78453.7 | 11.00 | 5.50 | 9.639 | 3.642 | 3.731 |
| 8500 | 83357.0 | 12.25 | 6.13 | 10.241 | 4.056 | 4.145 |



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**LEMBAGA ILMU PENGETAHUAN INDONESIA
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LABORATORIUM PENGUJIAN**

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55861, PO.BOX : 174 WNO Telp : (+62 274) 392570, Faks : (+62 274) 391168
website : <http://bptba.lipi.go.id/>, e-mail : bptba@mail.lipi.go.id



Komite Akreditasi Nasional

Laboratorium Pengujian

LP-1237-02H



Asosiasi Pengujian dan Inspeksi

Laporan Hasil Uji

Laporan No. : 70/LHU/BPTBA/IV/2019

Data Pelanggan

Nama : Trevi Arga

Institusi : Universitas Atmajaya Yogyakarta

Alamat : Jl. Jangkarbumi Blok F Puluhdadi Rt/Rw 005/002 Caturtunggal Depok

Jumlah Sampel Uji : 1 (satu)

Nama Sampel Uji : Abu Flyas

Tanggal Penerimaan : 30 April 2019

Tanggal Pengujian : 30 April 2019

Parameter Uji : SEM - EDX

: *Instruction Manual for Model SU3500 Scanning Electron Microscope*

Acuan Standar

Hasil Pengujian : Hasil pengujian tersimpan dalam CD dengan nomor "70/LHU/BPTBA/IV/2019".

Gunungkidul, 30 April 2019



"Laporan hasil uji merupakan hasil pengukuran, analisa dari sampel yang hanya disebutkan dalam dokumen ini serta tidak diperbolehkan mengubah, menggandakan atau mendistribusikan sebagian atau keseluruhan dari laporan hasil uji ini dalam segala bentuk untuk kepentingan apapun juga tanpa persetujuan tertulis dari Manajer Mutu Laboratorium Pengujian BPTBA LIPI"



Scanned with
CamScanner

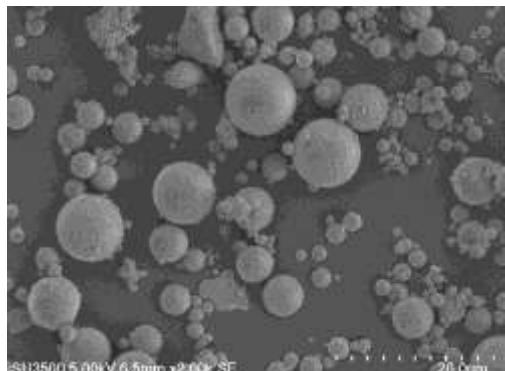


Foto *fly ash* dengan skala 20 μm

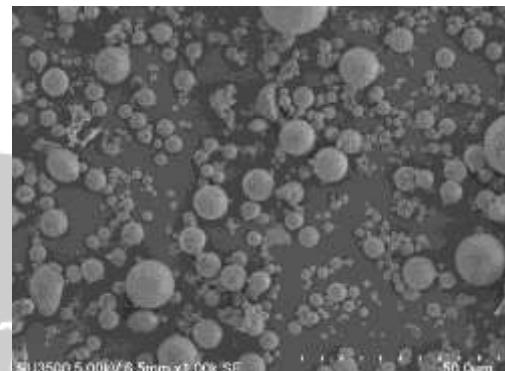


Foto *fly ash* dengan skala 50 μm

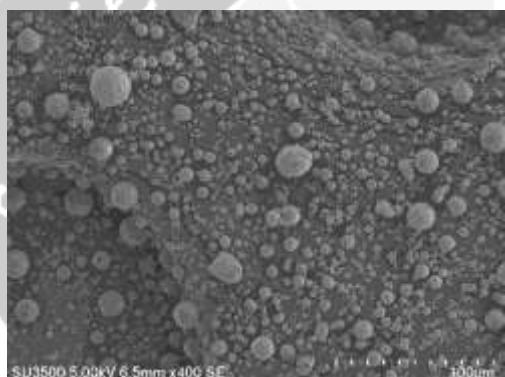


Foto *fly ash* dengan skala 100 μm

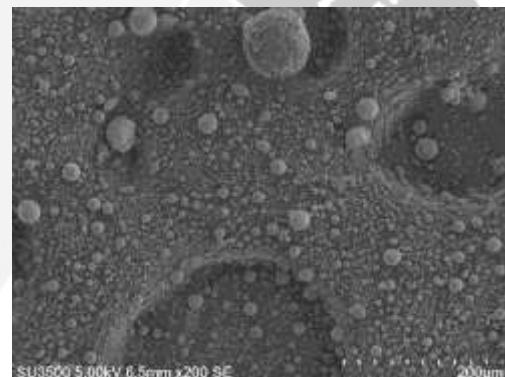


Foto *fly ash* dengan skala 200 μm

PRODUCT DATA SHEET

Sika® ViscoCrete®-1003

CONCRETE ADMIXTURE FOR HIGH FLOW / SELF-COMPACTING CONCRETE

DESCRIPTION

Sika® ViscoCrete®-1003 is a third generation superplasticiser for concrete and mortar. It is particularly developed for the production of high flow concrete with exceptional flow retention properties and significant reduction in bleeding and segregation.

USES

Sika® ViscoCrete®-1003 facilitates extreme water reduction, excellent flowability with optimal cohesion and strong self-compacting behaviour.

Sika® ViscoCrete®-1003 is used for the following types of concrete:

- High flow concrete
- Self-compacting concrete (S.C.C.)
- Concrete with very high water reduction (up to 30 %)
- High strength concrete
- Concrete in hot weather and with extended transportation and workability requirements etc.

The combination of high water reduction, excellent flowability and high early strength provides clear benefits in the above mentioned applications.

CHARACTERISTICS / ADVANTAGES

Sika® ViscoCrete®-1003 acts by surface adsorption on the cement particles producing a sterical separation effect. Concrete produced with Sika® ViscoCrete®-1003 exhibits the following properties:

- Excellent flowability (resulting in highly reduced placing and compacting efforts)
- Strong self-compacting behaviour
- Extremely high water reduction (resulting in high density and strengths)
- Improved shrinkage and creep behaviour
- Increased carbonation resistance of the concrete
- Improved finish
- Reduce tendency to bleeding and segregation

Sika® ViscoCrete®-1003 does not contain chlorides or other ingredients which promotes steel corrosion. Therefore, it may be used without restriction for reinforced and pre-stressed concrete construction.

Sika® ViscoCrete®-1003 gives the concrete extended workability and depending on the mix design and the quality of materials used, self-compacting properties can be maintained for more than 1 hour at 30°C.

PRODUCT INFORMATION

| | |
|----------------------------|--|
| Chemical Base | Aqueous solution of modified polycarboxylate copolymers |
| Packaging | 200 liters drums and bulk deliveries |
| Appearance / Colour | Brownish |
| Shelf Life | 12 months from the date of production when stored in original unopened packaging |
| Storage Conditions | in a cool, dry place |
| Density | 1.065 ± 0.01 kg/l |

PRODUCT DATA SHEET
Sika® ViscoCrete®-1003
August 2016
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Specific Advice

With the use of Sika® Viscocrete®-1003, concrete of the highest quality is produced. The standard rules of good concreting practice (production as well as placing) must also be observed with Sika® Viscocrete®-1003 concrete.

Fresh concrete must be cured properly.

APPLICATION INFORMATION

| | | |
|---------------------------|--|--|
| Recommended Dosage | For soft plastic concrete For flowing and self compacting concrete (S.C.C.) | 0.2 - 0.6% by weight of binder 0.6 - 1.6% by weight of binder |
| Compatibility | Sika® Viscocrete®-1003 may be combined with the following products: • Plastiment VZ • SikaFume • SikaAER • Sika Control Pre-trials are recommended if combinations with the above products are required. Please consult our Technical Service Department. To produce flowing and/or self-compacting concrete, special concrete mix design is required. Pre-trials are mandatory. Please consult our Technical Service Department. | |

APPLICATION INSTRUCTIONS**DISPENSING**

Sika® Viscocrete®-1003 is added to the gauging water or simultaneously poured with it into the concrete mixer. For optimum utilisation of its high water reduction property, we recommend thorough mixing at a minimal wet mixing time of 60 seconds.

The addition of the remaining gauging water (to fine tune concrete consistency) may only be started after two-thirds of the wet mixing time, to avoid surplus water in the concrete.

BASIS OF PRODUCT DATA

All technical data stated in this Product Data Sheet are based on laboratory tests. Actual measured data may vary due to circumstances beyond our control.

LOCAL RESTRICTIONS

Please note that as a result of specific local regulations the declared data and recommended uses for this product may vary from country to country. Please consult the local Product Data Sheet for the exact product data and uses.

ECOLOGY, HEALTH AND SAFETY

For information and advice on the safe handling, storage and disposal of chemical products, users shall refer to the most recent Safety Data Sheet (SDS) containing physical, ecological, toxicological and other safety-related data.

LEGAL NOTES

The information, and, in particular, the recommendations relating to the application and end-use of Sika products, are given in good faith based on Sika's current knowledge and experience of the products when properly stored, handled and applied under normal conditions in accordance with Sika's recommendations. In practice, the differences in materials, substrates and actual site conditions are such that no warranty in respect of merchantability or of fitness for a particular purpose, nor any liability arising out of any legal relationship whatsoever, can be inferred either from this information, or from any written recommendations, or from any other advice offered. The user of the product must test the product's suitability for the intended application and purpose. Sika reserves the right to change the properties of its products. The proprietary rights of third parties must be observed. All orders are accepted subject to our current terms of sale and delivery. Users must always refer to the most recent issue of the local Product Data Sheet for the product concerned, copies of which will be supplied on request.

PT. Sika Indonesia
Jl. Raya Cibinong-Bekasi km.20.
Cileungsli, Bogor 16820 - Indonesia
Tel. +62 21 8230025
Fax. +62 21 8230026
Website: idn.sika.com
email: sikacare@id.sika.com



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 **Sika®**
BUILDING TRUST



UNIVERSITAS ATMA JAYA YOGYAKARTA
Fakultas Teknik Program Studi Teknik Sipil
Laboratorium Struktur dan Bahan Bangunan
Jl. Babarsari No.44 Yogyakarta 55281 Indonesia Kotas Pos 1086
Fax. +62-274-487748

F. DOKUMENTASI PENELITIAN



Penimbangan Beton



Proses Pemotongan Kawat Bendrat



Penimbangan Superplasticizer



Penimbangan Kawat Bendrat



Pengujian Kandungan Organik



Pengujian Keausan Agregat Kasar



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Fakultas Teknik Program Studi Teknik Sipil
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Agregat Kasar



Agregat Halus



Pengadukan dengan *Concrete Mixer*



Pengujian *Passing Ability*



Pengujian T₅₀₀



Proses Kaping Beton



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Fax. +62-274-487748



Pengecoran Beton ke Silinder



Beton yang dikeluarkan dari silinder



Pengujian Kuat Tekan



Pengujian Modulus Elastisitas



Beton yang Dibelah



Pengujian Kuat Tarik Belah