

## BAB VI

### KESIMPULAN DAN SARAN

#### 6.1. Kesimpulan

Berdasarkan hasil penelitian mengenai terak logam sebagai substitusi agregat kasar dengan *fly ash* 15% terhadap sifat mekanik beton didapatkan kesimpulan seperti dibawah ini.

1. Nilai kuat tekan rata-rata beton normal dan beton terak logam sebagai substitusi agregat kasar dan *fly ash* sebagai substitusi sebagian semen pada beton umur 28 hari untuk beton BN, BTL 0, BTL 15, BTL 30, BTL 45, BTL 60 berturut-turut adalah 26,5951 MPa, 28,5538 MPa, 33,0716 MPa, 34,4435 MPa, 36,1706 MPa, dan 30,0197 MPa. Presentase kenaikan kuat tekan beton terak logam terhadap beton normal berturut-turut adalah 7,3649%, 24,3522%, 29,5108%, 36,0049% dan 12,8769%. Presentase kenaikan terhadap beton terak logam 0% berturut-turut adalah 15,8220%, 20,6267%, 26,6753% dan 5,1339%. Nilai kuat tekan optimum terletak pada substitusi terak logam 45% sebesar 36,1706 MPa dengan kenaikan terhadap BN dan BTL 0 adalah 36,0049% dan 26,6753%.
2. Nilai modulus elastisitas rata-rata untuk beton BN, BTL 0, BTL 15, BTL 30, BTL 45, BTL 60 berturut-turut adalah 23257,6728 MPa, 23856,3072 MPa, 24018,9262 MPa, 25451,5107 MPa, 25648,6207 MPa dan 21900,2783 MPa. Presentase kenaikan pada pengujian modulus elastisitas pada beton terak logam terhadap beton normal adalah 2,5739%, 3,2731%,

9,4327%, 10,2803% dan -5,8363%. Presentase kenaikan pada pengujian modulus elastisitas terhadap beton terak logam 0% adalah 0,6817%, 6,6867%, 7,5130% dan -8,1992%. Nilai modulus elastisitas optimum terletak pada substitusi terak logam 45% sebesar 25648,6207 MPa dengan kenaikan terhadap BN dan BTL 0 adalah 10,2803% dan 7,5130%, nilai ini berbanding lurus dengan nilai kuat tekan.

3. Nilai kuat tarik belah beton untuk beton BN, BTL 0, BTL 15, BTL 30, BTL 45, BTL 60 berturut-turut adalah 3,0431 MPa, 3,3345 MPa, 3,6733 MPa, 3,4907 MPa, 3,7856 MPa dan 3,0488 MPa. Presentase kenaikan beton terak logam terhadap beton normal adalah 9,5752%, 20,7102%, 14,7092%, 24,3988% dan 0,1876%. Presentase kenaikan terhadap beton terak logam 0% adalah 10,1620%, 4,6854%, 13,5283% dan -8,5672%. Nilai kuat tarik belah beton optimum pada substitusi 45% sebesar 3,7856 MPa dengan kenaikan terhadap BN dan BTL 0 adalah 24,3988% dan 13,5283%.
4. Kenaikan kuat tekan dan modulus elastisitas juga dipengaruhi oleh penggunaan *fly ash* sebanyak 15%, dimana *fly ash* digunakan sebagai substitusi sebagian semen. Terbukti pada variasi substitusi 0%, 15%, 30% sampai 45% terus mengalami kenaikan. Selain itu juga bahan yang digunakan dengan mutu yang baik, nilai slump yang masuk dalam rencana 75-150 mm, cara pengerjaan benda uji dan perawatan benda uji yang baik.
5. Terak logam layak dijadikan sebagai campuran beton dan substitusi agregat kasar. Terak logam yang digunakan pada penelitian ini berdiameter 5-10

mm sehingga beton mempunyai *interlocking* yang baik sehingga menaikkan nilai kuat tekan, modulus elastisitas dan kuat tarik belah beton.

## 6.2. **Saran**

Saran yang dapat diberikan penulis untuk penelitian selanjutnya seperti dibawah ini.

1. Pada proses pengerjaan pencampuran beton agar lebih diperhatikan agar adukan tercampur merata dan dapat menghasilkan kuat tekan, modulus elastisitas, dan kuat tarik belah beton yang lebih maksimal.
2. Perlu penelitian lebih lanjut mengenai beton mutu tinggi pada terak logam sebagai substitusi agregat kasar.
3. Dapat dilakukan penelitian sampai pada umur beton 56 hari dan variasi beton yang lebih beragam agar mengetahui kuat tekan yang paling tinggi secara rinci.
4. Pada penelitian lanjutan perlunya penambahan pengujian penyerapan (*absorption*) untuk mengetahui kadar air optimum yang digunakan.

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## **A. PENGUJIAN BAHAN**

### **A.1. PENGUJIAN KANDUNGAN LUMPUR AGREGAT HALUS**

- I. Waktu Pemeriksaan : 31 Maret 2019
- II. Bahan
- a. Pasir Kering Tungku, asal : Kali Progo, berat : 100,00 gram
  - b. Air Jernih, asal : LSBB Prodi TS FT - UAJY
- III. Alat
- a. Gelas Ukur, ukuran : 250 cc
  - b. Timbangan
  - c. Tungku (oven), suhu antara 105 – 110°C
- IV. Pasir + Piring Masuk Tungku
- V. Hasil
- Pasir + Piring Keluar Tungku
- a. Berat Pasir : 93,48 gram
- Kandungan Lumpur :  $\frac{100 - 93,48}{100} \times 100\%$
- : 6,52 %

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



## A.2. PENGUJIAN KANDUNGAN ZAT ORGANIK AGREGAT HALUS

I. Waktu Pemeriksaan : 31 Maret 2019

II. Bahan

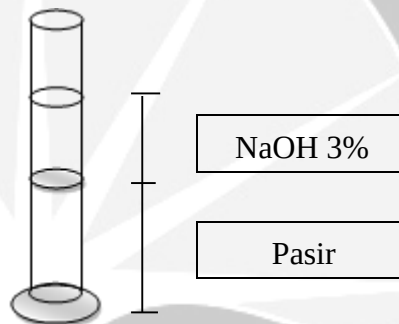
c. Pasir Kering Tungku, asal : Kali Progo

d. Larutan NaOH 3%

III. Alat

d. Gelas Ukur, ukuran : 250 cc

IV. Sketsa



V. Hasil

Setelah didiamkan selama 24 jam, warna larutan di atas pasir sesuai dengan *Gardner Standart Colour*.

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



### **A.3. PENGUJIAN BERAT JENIS DAN PENYERAPAN AGREGAT HALUS**

- I. Waktu Pemeriksaan : 31 Maret 2019
- II. Bahan : Pasir
- III. Asal : Kali Progo
- IV. Lokasi Pengujian : Laboratorium Struktur dan Bahan Bangunan (LSBB), Jurusan Teknik Sipil, Universitas Atma Jaya Yogyakarta

Sampel (a)

| <b>Pengujian Berat Jenis &amp; Penyerapan Agregat Halus</b> |        |    |
|-------------------------------------------------------------|--------|----|
| Berat Awal (V)                                              | 508    | gr |
| Berat Kering Oven (A)                                       | 497,81 | gr |
| Jumlah Air Masuk Sebelum Digoncang                          | 295,71 | ml |
| Jumlah Air Masuk Sesudah Digoncang                          | 15     | ml |
| Jumlah Air Total yang Digunakan (W)                         | 310,71 | ml |



|                                       |       |                    |
|---------------------------------------|-------|--------------------|
| Berat Jenis Bulk                      | 2,523 | gr/cm <sup>3</sup> |
| Berat Jenis SSD                       | 2,575 | gr/cm <sup>3</sup> |
| Berat Jenis Semua ( <i>Apparent</i> ) | 2,661 | gr/cm <sup>3</sup> |
| Penyerapan ( <i>Absorption</i> )      | 2,048 | %                  |

Berat Jenis Agregat Halus SSD = 2,575 gr/cm<sup>3</sup>



#### **A.4. PENGUJIAN ANALISIS SARINGAN AGREGAT HALUS**

- I. Waktu Pemeriksaan : 31 Maret 2019
- II. Bahan : Pasir
- III. Asal : Kali Progo
- IV. Lokasi Pengujian : Laboratorium Transportasi Jurusan Teknik Sipil, Universitas Atma Jaya, Yogyakarta.

| <b>Ayakan</b>  | <b>Berat Saringan</b> | <b>Berat Saringan + Pasir</b> | <b>Berat Pasir</b> | <b>Kumulatif</b> | <b>% Tertahan</b> | <b>% Lolos</b> |
|----------------|-----------------------|-------------------------------|--------------------|------------------|-------------------|----------------|
| 3/8" (9,52mm)  | 543                   | 543                           | 0                  | 0                | 0                 | 100            |
| No.4(4,75 mm)  | 507                   | 507                           | 0                  | 0                | 0                 | 100            |
| 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                   | 387                           | 18                 | 1000             | 100               | 0              |

Kesimpulan : Dari data diatas maka didapat nilai MHB (Modulus Halus Butir) 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 kisaran 1,50 – 3,80 (OK).



Berdasarkan data analisis saringan tersebut, maka dapat ditentukan untuk daerah golongan pasirnya. Untuk menentukan pasir tersebut termasuk di golongan pasir berapa, dapat dilihat pada grafik di bawah ini.



Setelah angka %lolos saringan dimasukkan ke dalam grafik di atas, maka dapat disimpulkan bahwa agregat halus tersebut termasuk ke dalam pasir golongan 2. Penentuan golongan pasir ini digunakan untuk perencanaan *mix design*.



#### A.5. PENGUJIAN BERAT SATUAN VOLUME AGREGAT HALUS

- I. Waktu Pemeriksaan : 31 Maret 2019
- II. Bahan : Pasir
- III. Asal : Kali Progo
- IV. Lokasi Pengujian : Laboratorium Struktur dan Bahan  
Bangunan (LSBB), Jurusan Teknik Sipil,  
Universitas Atma Jaya, Yogyakarta.

| Shoveled               |                           | Rodded               |                            |
|------------------------|---------------------------|----------------------|----------------------------|
| Berat Tabung           | 3520 gram                 | Berat Tabung         | 3520 gram                  |
| Berat Tabung + Pasir   | 7080 gram                 | Berat Tabung + Pasir | 8380 gram                  |
| Berat Pasir            | 3560 gram                 | Berat Pasir          | 4860 gram                  |
| Berat Tabung + Air     | 6380 gram                 | Berat Tabung + Air   | 6380 gram                  |
| Air                    | 2860 cm <sup>3</sup>      | Air                  | 2860 cm <sup>3</sup>       |
| Berat Satuan           | 1,245gram/cm <sup>3</sup> | Berat Satuan         | 1,699 gram/cm <sup>3</sup> |
| Berat Satuan Rata-rata |                           |                      | 1,472gram/cm <sup>3</sup>  |

Kesimpulan : Jadi berat satuan volume untuk pasir yang didapatkan sebesar  
1,472 gram/cm<sup>3</sup>.



**A.6. PENGUJIAN BERAT JENIS DAN PENYERAPAN AGREGAT KASAR**

- I. Waktu Pemeriksaan : 1 April 2019
- II. Bahan : Kerikil / Split
- III. Asal : Clereng
- IV. Lokasi Pengujian : Laboratorium Struktur dan Bahan Bangunan (LSBB), Jurusan Teknik Sipil, Universitas Atma Jaya, Yogyakarta

|   | NOMOR PEMERIKSAAN                                                          | I      | II |
|---|----------------------------------------------------------------------------|--------|----|
| A | Berat Contoh Kering                                                        | 972    | -  |
| B | Berat Contoh Jenuh Kering Permukaan (SSD)                                  | 1010   | -  |
| C | Berat Contoh Dalam Air                                                     | 592    | -  |
| D | Berat Jenis Bulk $\square$<br>$\frac{(A)}{(B) - (C)}$                      | 2,325  | -  |
| E | BJ.Jenuh Kering Permukaan (SSD) $\square$<br>$\frac{(B)}{(B) - (C)}$       | 2,416  | -  |
| F | Berat Jenis Semu (Apparent) $\square$<br>$\frac{(A)}{(A) - (C)}$           | 2,558  | -  |
| G | Penyerapan (Absorption) $\square$<br>$\frac{(B) - (A)}{(A)} \times 100 \%$ | 3,909% | -  |
| H | Berat Jenis Agregat Kasar                                                  | 2,416  | -  |
| I | Rata – Rata                                                                | 2,416  |    |

**PERSYARATAN UMUM :**

- Absorption : 5%
- Berat Jenis : 2,3 – 2,6



#### **A.7. PENGUJIAN ANALISIS SARINGAN AGREGAT KASAR**

- I. Waktu Pemeriksaan : 1 April 2019
- II. Bahan : Kerikil/*Split*
- III. Asal : Clereng
- IV. Lokasi Pengujian : Laboratorium Transportasi, Jurusan Teknik Sipil,  
Universitas Atma Jaya, Yogyakarta

| <b>Ayakan</b> | <b>Berat Saringan</b> | <b>Berat Saringan + Kerikil</b> | <b>Berat Kerikil</b> | <b>Kumulatif</b> | <b>% Tertahan</b> | <b>% Lolos</b> |
|---------------|-----------------------|---------------------------------|----------------------|------------------|-------------------|----------------|
| 3/4"          | 570                   | 834                             | 264                  | 264              | 26,4              | 73,6           |
| 1/2"          | 448                   | 839                             | 391                  | 655              | 65,5              | 34,5           |
| 3/8"          | 543                   | 883                             | 340                  | 995              | 99,5              | 0,5            |
| No.4          | 508                   | 513                             | 5                    | 1000             | 100               | 0              |
| No.8          | 329                   | 39                              | 0                    | 1000             | 100               | 0              |
| No.30         | 402                   | 402                             | 0                    | 1000             | 100               | 0              |
| No.50         | 373                   | 373                             | 0                    | 1000             | 100               | 0              |
| No.100        | 284                   | 284                             | 0                    | 1000             | 100               | 0              |
| PAN           | 369                   | 369                             | 0                    | 1000             | 100               | 0              |

Kesimpulan : Dari data diatas maka didapat nilai MHB (Modulus Halus Butir) sebesar 7,914. Berdasarkan SK SNI S-04-1989-F (Spesifikasi Bahan Bangunan Bagian A), maka nilai MHB agregat kasar tersebut memenuhi syarat karena berada pada kisaran 5,00 – 8,00 (OK).



**A.8. PENGUJIAN KEAUSAN AGREGAT KASAR DENGAN MESIN  
 LOS ANGELES ABRATION**

- I. Waktu Pemeriksaan : 1 April 2019
- II. Bahan : Kerikil/*Split*
- 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    |



#### A.9. PENGUJIAN BERAT SATUAN VOLUME AGREGAT KASAR

- I. Waktu Pemeriksaan : 1 April 2019
- II. Bahan : Kerikil
- III. Asal : Clereng
- IV. Lokasi Pengujian : Laboratorium Struktur dan Bahan  
Bangunan (LSBB), Jurusan Teknik Sipil,  
Universitas Atma Jaya, Yogyakarta.

| Shoveled               |                           | Rodded                 |                           |
|------------------------|---------------------------|------------------------|---------------------------|
| Berat Tabung           | 3520 gram                 | Berat Tabung           | 3520 gram                 |
| Berat Tabung + Kerikil | 7120 gram                 | Berat Tabung + Kerikil | 7620 gram                 |
| Berat Kerikil          | 3600 gram                 | Berat Kerikil          | 4100 gram                 |
| Berat Tabung + Air     | 6380 gram                 | Berat Tabung + Air     | 6380 gram                 |
| Air                    | 2860 cm <sup>3</sup>      | Air                    | 2860 cm <sup>3</sup>      |
| Berat Satuan           | 1,259gram/cm <sup>3</sup> | Berat Satuan           | 1,434gram/cm <sup>3</sup> |
| Berat Satuan Rata-rata |                           |                        | 1,346gram/cm <sup>3</sup> |

Kesimpulan : Jadi berat satuan volume untuk kerikil yang didapatkan sebesar 1,346 gram/cm<sup>3</sup>.



#### A.10. PENGUJIAN BERAT JENIS DAN PENYERAPAN TERAK LOGAM

- I. Waktu Pemeriksaan : 6 April 2019
- II. Bahan : Terak Logam
- III. Asal : Batur Ceper, Klaten
- IV. Lokasi Pengujian : Laboratorium Transportasi, Jurusan Teknik Sipil, Universitas Atma Jaya, Yogyakarta.

|   | NOMOR PEMERIKSAAN                                                                          | I      | II |
|---|--------------------------------------------------------------------------------------------|--------|----|
| A | Berat Contoh Kering                                                                        | 982    | -  |
| B | Berat Contoh Jenuh Kering Permukaan (SSD)                                                  | 1001   | -  |
| C | Berat Contoh Dalam Air                                                                     | 705    | -  |
| D | $\frac{\text{Berat Jenis Bulk} \quad \square}{(A)}$ $(B) - (C)$                            | 3,318  | -  |
| E | $\frac{\text{BJ. Jenuh Kering Permukaan (SSD)} \quad \square}{(B)}$ $(B) - (C)$            | 3,382  | -  |
| F | $\frac{\text{Berat Jenis Semu (Apparent)} \quad \square}{(A)}$ $(A) - (C)$                 | 3,545  | -  |
| G | $\frac{\text{Penyerapan (Absorption)} \quad \square}{(B) - (A)}$ $(A) \quad \times 100 \%$ | 1,935% | -  |
| H | Berat Jenis Agregat Kasar                                                                  | 3,382  | -  |
| I | Rata – Rata                                                                                | 3,382  |    |

**PERSYARATAN UMUM :**

- Absorption : 5%
- Berat Jenis : 2,3 – 2,6



#### **A.11. PENGUJIAN BERAT SATUAN VOLUME TERAK LOGAM**

- I. Waktu Pemeriksaan : 6 April 2019
- II. Bahan : Terak Logam
- III. Asal : Batur Ceper, Klaten.
- IV. Lokasi Pengujian : Laboratorium Struktur dan Bahan  
Bangunan (LSBB), Jurusan Teknik Sipil,  
Universitas Atma Jaya, Yogyakarta.

| Shoveled                      |                           | Rodded                        |                           |
|-------------------------------|---------------------------|-------------------------------|---------------------------|
| Berat Tabung                  | 3520 gram                 | Berat Tabung                  | 3520 gram                 |
| Berat Tabung +<br>Terak Logam | 10400 gram                | Berat Tabung +<br>Terak Logam | 11680 gram                |
| Berat Terak Logam             | 6880 gram                 | Berat Terak Logam             | 8160 gram                 |
| Berat Tabung + Air            | 6380 gram                 | Berat Tabung + Air            | 6380 gram                 |
| Air                           | 2860 cm <sup>3</sup>      | Air                           | 2860 cm <sup>3</sup>      |
| Berat Satuan                  | 2,406gram/cm <sup>3</sup> | Berat Satuan                  | 2,853gram/cm <sup>3</sup> |
| Berat Satuan Rata-rata        |                           | 2,629gram/cm <sup>3</sup>     |                           |

Kesimpulan : Jadi berat satuan volume untuk *bottom ash* yang didapatkan sebesar  
2,629 gram/cm<sup>3</sup>.



#### **A.12. PENGUJIAN ANALISIS SARINGAN TERAK LOGAM**

- I. Waktu Pemeriksaan : 6 April 2019
- II. Bahan : Terak Logam
- III. Asal : Batur Ceper , Klaten.
- IV. Lokasi Pengujian : Laboratorium Transportasi Jurusan Teknik  
Sipil, Universitas Atma Jaya, Yogyakarta

| <b>Ayakan</b> | <b>Berat Saringan</b> | <b>Berat Saringan + Bottom ash</b> | <b>Berat Bottom ash</b> | <b>Kumulatif</b> | <b>% Tertahan</b> | <b>% Lolos</b> |
|---------------|-----------------------|------------------------------------|-------------------------|------------------|-------------------|----------------|
| 3/4"          | 502                   | 528                                | 26                      | 26               | 2,6               | 97,4           |
| 1/2"          | 449                   | 533                                | 85                      | 111              | 11,1              | 88,9           |
| 3/8"          | 543                   | 834                                | 291                     | 402              | 40,2              | 59,8           |
| No.4          | 508                   | 1090                               | 582                     | 984              | 98,4              | 1,6            |
| No.8          | 329                   | 344                                | 15                      | 999              | 99,9              | 0,1            |
| No.30         | 402                   | 403                                | 1                       | 1000             | 100               | 0              |
| No.50         | 373                   | 373                                | 0                       | 1000             | 100               | 0              |
| No.100        | 284                   | 284                                | 0                       | 1000             | 100               | 0              |
| PAN           | 369                   | 369                                | 0                       | 1000             | 100               | 0              |

Kesimpulan : Dari data diatas maka didapat nilai MHB (Modulus Halus Butir) sebesar 6,522. Berdasarkan SK SNI S-04-1989-F (Spesifikasi Bahan Bangunan Bagian A), maka nilai MHB agregat kasar tersebut memenuhi syarat karena berada pada kisaran 5,00 – 8,00 (OK).



**A.13. PENGUJIAN KEAUSAN TERAK LOGAM DENGAN MESIN LOS ANGELES ABRATION**

- I. Waktu Pemeriksaan : 6 April 2019  
 II. Bahan : Terak Logam  
 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) |          |                      | 4116 gram            |
| Berat Sesudah (A) - (B)                  |          |                      | 884 gram             |
| Keausan $\frac{(A) - (B)}{(A)}$          |          |                      | 17,68 %              |

Kesimpulan : Keausan Agregat didapat sebesar  $17,68\% \leq 40\%$ , 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    |



#### A.14. PENGUJIAN BERAT JENIS FLY ASH

- I. Waktu Pemeriksaan : 2 April 2019  
II. Bahan : Fly Ash type F  
III. Asal : PLTU Tanjung Jati B Jepara

| Pemeriksaan                                         | Berat (gram) |
|-----------------------------------------------------|--------------|
| Berat <i>fly ash</i> ( $W_1$ )                      | 5,178        |
| Berat fly ash + minyak tanah + labu takar ( $W_2$ ) | 74,423       |
| Berat labu takar + minyak tanah ( $W_3$ )           | 71,047       |

Maka berat jenis *fly ash* dapat dihitung dengan rumus :

$$\begin{aligned}\text{Berat jenis fly ash} &= \frac{0,8 \times W_1}{W_1 + W_3 - W_2} \\ &= \frac{0,8 \times 5,178}{5,178 + 71,047 - 74,423} \\ &= 2,298 \text{ gram/cc}\end{aligned}$$

Kesimpulan :

- Berat jenis fly ash yang didapat dalam pengujian ini adalah 2,298 gram/cc.



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

**I. Data Bahan**

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

**II. Hitungan**

1. Kuat tekan beton yang direncanakan ( $f'_c$ ) adalah 25 MPa untuk umur 28 hari.
2. Nilai deviasi standar berdasarkan tingkat atau pengendalian pelaksanaan campuran senilai 2,8 MPa.
3. Nilai margin yang digunakan

$$M = 1,64 \times s_r = 1,64 \times 2,8 = 4,592 \text{ MPa.}$$

4. Kuat tekan beton rata-rata yang direncanakan.

$$f'_{cr} = f'_c + M = 25 + 4,592 = 29,59 \text{ MPa.}$$

5. Menentukan jenis semen yang digunakan adalah semen OPC (Ordinary Portland Cement) merk Holcim.
6. Menetapkan jenis agregat kasar dan agregat halus
  - a. Agregat halus : Pasir alam (Golongan 2)
  - b. Agregat kasar : Batu Pecah
7. Faktor air semen berdasarkan Grafik 1 dalam SNI 03-2834-2000, hubungan antara kuat tekan dan faktor air semen yang direncanakan pada umur



tertentu untuk silinder 15x30 mm. Direncanakan faktor air semen sebesar 0.51.

8. Faktor air semen maksimum

**Tabel 4**  
**Persyaratan jumlah semen minimum dan factor air semen maksimum untuk berbagai**  
**Macam pembetonan dalam lingkungan khusus**

| Lokasi<br>---                                                                                    | Jumlah Semen<br>minimum<br>Per m <sup>3</sup> beton (kg) | Nilai Faktor Air-<br>Semen Maksimum |
|--------------------------------------------------------------------------------------------------|----------------------------------------------------------|-------------------------------------|
| Beton di dalam ruang bangunan:<br>a. keadaan keliling non-korosif                                | 275                                                      | 0,60                                |
| b. keadaan keliling korosif<br>disebabkan oleh kondensasi<br>atau uap korosif                    | 325                                                      | 0,52                                |
| Beton di luar ruangan bangunan:<br>a. tidak terlindung dari hujan dan<br>terik matahari langsung | 325                                                      | 0,60                                |
| b. terlindung dari hujan dan terik<br>matahari langsung                                          | 275                                                      | 0,60                                |
| Beton masuk ke dalam tanah:<br>a. mengalami keadaan basah dan<br>kering berganti-ganti           | 325                                                      | 0,55                                |
| b. mendapat pengaruh sulfat dan<br>alkali dari tanah                                             |                                                          | Lihat Tabel 5                       |
| Beton yang kontinu berhubungan:<br>a. air tawar                                                  |                                                          | Lihat Tabel 6                       |
| b. air laut                                                                                      |                                                          | Lihat Tabel 6                       |

(Sumber : SNI 03-2834-2000 : Tabel 4)

Berdasarkan tabel 4 SNI 03-2834-2000, untuk beton yang terlindung dari hujan dan terik matahari langsung fas maksimum 0,60. Dibandingkan dengan no.7, maka digunakan nilai fas terkecil yaitu 0,51.

9. Nilai slump, direncanakan sebesar 75-150 mm.

10. Ukuran butiran maksimum (kerikil) adalah 20 mm.

11. Menetapkan jumlah air yang diperlukan tiap m<sup>3</sup> beton berdasarkan Tabel 3 SNI 03-2834-2000.

a. Ukuran butir maksimum 20 mm.



- b. Nilai slump 75-150 mm.
- c. Agregat halus berupa batu tidak dipecah, maka  $W_h = 195$  liter.
- d. Agregat kasar berupa batu pecah, maka  $W_k = 225$  liter.

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

Dengan keterangan :

$W_h$  = perkiraan jumlah air untuk agregat halus

$W_k$  = perkiraan jumlah air untuk agregat kasar

$$W = \frac{2}{3}195 + \frac{1}{3}225 = 205 \text{ liter}$$

12. Menghitung berat semen yang diperlukan :

- a. Berdasarkan table 4 SNI 03-2834-2000 diperoleh semen minimum 275 kg.
- b. Berdasarkan  $f_{as} = 0,51$

$$\text{Semen per m}^3 \text{ beton} = \frac{W}{f_{as}} = 401,961 \text{ kg}$$

Dipilih berat semen yang paling besar, maka digunakan berat semen 401,961 kg.

13. Perbandingan agregat halus dan kasar.

- a. Ukuran maksimum 20 mm.
- b. Nilai slump 75-150 mm.



c.  $f_{as}$  0,51

d. Jenis gradasi pasir no. 2

Diambil proporsi pasir = 42 %

14. Berat jenis agregat campuran

$$= \frac{P}{100} BJ_{AgregatHalus} + \frac{K}{100} BJ_{AgregatKasar}$$

$$= \frac{42}{100} 2,575 + \frac{58}{100} 2,416$$

$$= 2,483$$

Dengan keterangan :

P = % agregat halus terhadap kadar total agregat

K = % agregat kasar terhadap kadar total agregat

15. Berat isi beton basah diperoleh hasil 2275 kg/m<sup>3</sup>

16. Kebutuhan agregat campuran

= Berat tiap m<sup>3</sup> – kebutuhan air dan semen

$$= 2275 - (205 + 401,961)$$

$$= 1668,039 \text{ kg/m}^3$$

17. Menghitung kebutuhan agregat halus

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

$$= \frac{42}{100} \times 1668,039$$

$$= 700,576 \text{ kg/m}^3$$

18. Menghitung kebutuhan agregat kasar

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



$$= \frac{58}{100} \times 1668,039$$

$$= 967,463 \text{ kg/m}^3$$

19. Menghitung kebutuhan material berdasarkan hasil analisis berat volume agregat dan berat jenis agregat.

| Material       | Berat Volume (gr/cm <sup>3</sup> ) | Berat Jenis (gr/cm <sup>3</sup> ) |
|----------------|------------------------------------|-----------------------------------|
| Semen          | -                                  | -                                 |
| Agregat kasar  | 1.346                              | 2.416                             |
| Agregat Halus  | 1.472                              | 2.575                             |
| Terak Logam    | 2.629                              | 3.382                             |
| <i>Fly ash</i> | -                                  | 2.298                             |
| Air            | -                                  | -                                 |

20. Menentukan presentase pemakaian material dalam satu kali adukan

| Kode    | Jumlah B.U | Semen | Pasir | Terak Logam | Split | Air  | FA  |
|---------|------------|-------|-------|-------------|-------|------|-----|
| BN      | 7          | 100%  | 100%  | 0%          | 100%  | 100% | 0%  |
| BTL 0%  | 7          | 85%   | 100%  | 0%          | 100%  | 100% | 15% |
| BTL 15% | 7          | 85%   | 100%  | 15%         | 85%   | 100% | 15% |
| BTL 30% | 7          | 85%   | 100%  | 30%         | 70%   | 100% | 15% |
| BTL 45% | 7          | 85%   | 100%  | 45%         | 55%   | 100% | 15% |
| BTL 60% | 7          | 85%   | 100%  | 60%         | 40%   | 100% | 15% |

21. Menghitung kebutuhan material dalam satu kali adukan

Diketahui :

$$\text{a. Volume silinder} = \frac{1}{4} \times \pi \times 15^2 \times 30 \text{ cm} = 5301,4376 \text{ cm}^3$$

$$= 0,005301438 \text{ m}^3$$



b. Safety factor = 1,3

## 22. Contoh perhitungan

### 1. Semen BN

= *Berat semen x Vol. silinder x SF x (%) semen x jumlah silinder*

=  $401,961 \times 0,0053 \times 1,3 \times 100\% \times 7$

= 19,400 kg

Semen BTL 15%

= *Berat semen BN – berat fly ash*

=  $19,400 - 2,910$

= 16,490 kg

### 2. Fly Ash

= *berat semen BN x % fly ash*

=  $19,400 \times 15\%$

= 2,910 kg

### 3. Agregat Halus

= *kebutuhan agregat halus x vol. silinder x SF x % agregat halus x jumlah benda uji*

=  $700,576 \times 0,0053 \times 1,3 \times 100\% \times 7$

= 33,798 kg

### 4. Terak Logam

a. Berat agregat kasar untuk 1 silinder

= *kebutuhan agregat kasar x vol.silinder x jumlah benda uji*

=  $967,463 \times 0,0053 \times 1$



$$= 5,1289 \text{ kg}$$

- b. Volume agregat kasar untuk 1 silinder

$$= \frac{\text{berat agregat kasar untuk 1 silinder}}{\text{berat jenis agregat kasar}}$$

$$= \frac{5,1289}{2,416 \times 10^3}$$

$$= 0,0021 \text{ cm}^3$$

- c. Kebutuhan terak logam

$$= \text{volume agregat kasar untuk 1 silinder} \times \% \text{ terak logam} \times \text{berat jenis terak logam}$$

$$= 0,0021 \times 15\% \times 3,382 \times 10^3$$

$$= 1,077 \text{ kg}$$

- d. Berat terak logam untuk 7 silinder

$$= \text{kebutuhan terak logam} \times \text{jumlah benda uji} \times SF$$

$$= 1,077 \times 7 \times 1,3$$

$$= 9,8 \text{ kg}$$

#### 5. Agregat Kasar

- a. Berat agregat kasar untuk 1 silinder

$$= \text{kebutuhan agregat kasar} \times \text{vol.silinder} \times \text{jumlah benda uji}$$

$$= 967,463 \times 0,0053 \times 1$$

$$= 5,1289 \text{ kg}$$

- b. Volume agregat kasar untuk 1 silinder

$$= \frac{\text{berat agregat kasar untuk 1 silinder}}{\text{berat jenis agregat kasar}}$$



$$= \frac{5,1289}{2,416 \times 10^3}$$

$$= 0,0021 \text{ cm}^3$$

c. Kebutuhan agregat kasar

*= volume agregat kasar untuk 1 silinder x % agregat kasar x berat jenis agregat kasar*

$$= 0,0021 \times 85\% \times 2,416 \times 10^3$$

$$= 4,3596 \text{ kg}$$

d. Berat agregat kasar untuk 7 silinder

*= kebutuhan agregat kasar x jumlah benda uji x SF*

$$= 4,3596 \times 7 \times 1,3$$

$$= 39,672 \text{ kg}$$

6. Air

*= kebutuhan air x vol. silinder x SF x % kebutuhan air x jumlah benda uji*

$$= 205 \times 0,005301438 \times 1,3 \times 100\% \times 7$$

$$= 9,89 \text{ liter.}$$



**Proporsi Campuran Adukan Beton untuk Setiap Variasi Per Satu Kali**

**Adukan**

| Kode         | Jumlah B.U | Semen (Kg)     | Pasir (Kg)     | Terak Logam (Kg) | Split (Kg)     | Air (Lt)     | FA            |
|--------------|------------|----------------|----------------|------------------|----------------|--------------|---------------|
| BN           | 7          | 19,400         | 33,798         | 0,000            | 46,673         | 9,890        | 0             |
| BTL 0        | 7          | 16,490         | 33,798         | 0,000            | 46,673         | 9,890        | 2,910         |
| BTL 15       | 7          | 16,490         | 33,798         | 9,800            | 39,672         | 9,890        | 2,910         |
| BTL 30       | 7          | 16,490         | 33,798         | 19,601           | 32,671         | 9,890        | 2,910         |
| BTL 45       | 7          | 16,490         | 33,798         | 29,401           | 25,670         | 9,890        | 2,910         |
| BTL 60       | 7          | 16,490         | 33,798         | 39,201           | 18,669         | 9,890        | 2,910         |
| <b>TOTAL</b> | <b>42</b>  | <b>101,850</b> | <b>202,788</b> | <b>98,003</b>    | <b>210,030</b> | <b>59,34</b> | <b>14,550</b> |

**Proporsi Campuran Adukan Beton per 1 m<sup>3</sup>**

| Kode   | Semen (Kg) | Pasir (Kg) | Terak Logam (Kg) | Split (Kg) | Air (Lt) | FA     |
|--------|------------|------------|------------------|------------|----------|--------|
| BN     | 401,961    | 1225,533   | 0                | 1736,545   | 205      | 0      |
| BTL 0  | 341,667    | 1225,533   | 0                | 1736,545   | 205      | 51,250 |
| BTL 15 | 341,667    | 1225,533   | 365              | 1476,064   | 205      | 51,250 |
| BTL 30 | 341,667    | 1225,533   | 729              | 1215,582   | 205      | 51,250 |
| BTL 45 | 341,667    | 1225,533   | 1094             | 955,100    | 205      | 51,250 |
| BTL 60 | 341,667    | 1225,533   | 1459             | 694,618    | 205      | 51,250 |



### C. PENGUJIAN KANDUNGAN KIMIA

 **KEMENTERIAN KESEHATAN REPUBLIK INDONESIA**  
**DIREKTORAT JENDERAL**  
**PENCEGAHAN DAN PENGENDALIAN PENYAKIT**  
**BALAI BESAR TEKNIK KESEHATAN LINGKUNGAN**  
**DAN PENGENDALIAN PENYAKIT YOGYAKARTA**  
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Laman : [www.btkljogja.or.id](http://www.btkljogja.or.id) Surat Elektronik info@btkljogja.or.id

 **GERMAS**

FR/VIII.3/12-P/Rev.7 **LAPORAN HASIL UJI** hal 1 dari 1 hal  
P/ 12018

**Pengujian Laboratorium Fisika Kimia Padatan dan B3**

Nomor contoh uji : 22.690 P  
Jenis contoh uji : Padatan.  
Asal contoh uji : Clara Monica P, Mhs.Fak.Teknik Sipil Universitas Atmajaya, Yogyakarta.  
.Pengambil contoh uji : Clara Monica P ( Pelanggan )  
Tgl diambil/diterima : 30-10-2018 / 30-10-2018  
Tgl pengujian : 30-10-2018 s.d 12 -11 -2018  
Uraian :

22.690 P: Contoh uji iron slag.

| No | Parameter                           | Satuan | Hasil Uji | Metode Uji                                  |
|----|-------------------------------------|--------|-----------|---------------------------------------------|
|    |                                     |        | 22.690 P  |                                             |
| 1  | Silikat total ( $\text{SiO}_2$ )    | %      | 21,54     | AOAC International 17 <sup>th</sup> Edition |
| 2  | Besi ( $\text{Fe}_2\text{O}_3$ )    | %      | 80,51     | USEPA 3051,SW 846-7000B.2007                |
| 3  | Kalsium ( $\text{CaO}_2$ )          | %      | 0,16      | USEPA 3051,SW 846-7000B.2007                |
| 4  | Kalsium ( $\text{Ca(OH)}_2$ )       | %      | 0,02      | USEPA 3051,SW 846-7000B.2007                |
| 5  | Magnesium ( Mg )                    | %      | 0,02      | USEPA 3051,SW 846-7000B.2007                |
| 6  | Kalium ( $\text{K}_2\text{O}$ )     | %      | 0,05      | USEPA , APHA 2012 Section 3500              |
| 7  | Natrium ( $\text{Na}_2\text{O}_2$ ) | %      | 0,36      | USEPA , APHA 2012 Section 3500              |
| 8  | Kadar Lemas                         | %      | 0,31      | SNI 13-4719-1998                            |

Yogyakarta, 13 November 2018

Catatan : 1. Hasil uji hanya berlaku untuk contoh yang diuji  
2. Laporan Hasil Uji ini tidak boleh digandakan tanpa ijin Manajer Puncak Laboratorium Pengujian dan Kalibrasi BBTCL PP Yogyakarta, kecuali secara lengkap  
3. Hasil uji dihitung dalam berat kering

Deputi Manajer Teknik  
Fisika Kimia Padatan dan B3  
Rinisti Winarti, SKM  
NIP.196310271983032001





INSTITUT PERTANIAN STIPER  
**INSTIPER**  
YOGYAKARTA

## UPT LABORATORIUM

### HASIL ANALISIS

NOMOR KODE LAB : LS.21.11.18/ 294  
NAMA PEMOHON : Gabriel Selo  
JENIS ANALISIS : Kadar air, Al<sub>2</sub>O<sub>3</sub>, MgO, SO<sub>3</sub>, K<sub>2</sub>O, Na<sub>2</sub>O, LOI  
JUMLAH SAMPEL : 4  
TANGGAL MASUK : 21 November 2018  
TANGGAL PENGUJIAN : 26 November - 18 Desember 2018

| NO | Kode        | Kadar Air | LOI  | Al <sub>2</sub> O <sub>3</sub>               | MgO  | SO <sub>3</sub> | K <sub>2</sub> O | Na <sub>2</sub> O |
|----|-------------|-----------|------|----------------------------------------------|------|-----------------|------------------|-------------------|
|    | Sampel      |           |      | Ekstrak HNO <sub>3</sub> + HClO <sub>4</sub> |      |                 |                  |                   |
|    |             | %         | %    | %                                            |      |                 |                  |                   |
| 1  | Kalatis     | 0,88      | 1,31 |                                              |      |                 |                  |                   |
| 2  | Fly Ash     | 0,82      | 1,69 | 0,98                                         | 0,75 | 0,11            | 0,75             | 0,98              |
| 3  | Terak Logam | 1,46      | 2,38 | 0,87                                         | 0,98 | 0,09            | 0,56             | 0,87              |
| 4  | Sekam Padi  | 1,60      | 2,25 | 0,67                                         | 0,32 | 0,14            | 2,21             | 1,56              |

Ka.UPT.Laboratorium&Perpustakaan

Dr.Ir. Candra Ginting, MP.

Yogyakarta, 18 Desember 2018

Ka Bag UPT Lab

Roostriyanti



# 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

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## LEMBAGA ILMU PENGETAHUAN INDONESIA BALAI PENELITIAN TEKNOLOGI BAHAN ALAM LABORATORIUM PENGUJIAN

Jln. Jogja-Wonosari Km 31.5, Gading, Playen, Gunungkidul, Yogyakarta  
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](mailto:bptba@mail.lipi.go.id)



### 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

Manajer Teknik  
Laboratorium Pengujian  
BPTBA LIPI  
  
Wuri Apriyana, M.Sc.  
NIP. 198705032015022001

"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"



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## D. HASIL PENGUJIAN SIFAT MEKANIK BETON

### D.1. PENGUJIAN KUAT TEKAN BETON

| Kode      | No | Dimensi   |           | Luas<br>(mm <sup>2</sup> ) | Berat<br>(kg) | Berat<br>Jenis<br>(KN/m <sup>3</sup> ) | Beban<br>Tekan<br>(KN) | Kuat<br>Tekan<br>(MPa) | Rata-<br>Rata<br>(MPa) |
|-----------|----|-----------|-----------|----------------------------|---------------|----------------------------------------|------------------------|------------------------|------------------------|
|           |    | D<br>(mm) | T<br>(mm) |                            |               |                                        |                        |                        |                        |
| BN        | 1  | 154.4     | 306.4     | 18727.4                    | 12.42         | 21.23                                  | 500                    | 26.70                  | 26.60                  |
|           | 2  | 151.1     | 302.6     | 17935.5                    | 12.58         | 22.74                                  | 470                    | 26.20                  |                        |
|           | 3  | 154.3     | 305.1     | 18699.1                    | 12.54         | 21.56                                  | 520                    | 27.81                  |                        |
|           | 4  | 150.2     | 304.1     | 17726.5                    | 12.40         | 22.56                                  | 455                    | 25.67                  |                        |
| BTL<br>0  | 1  | 152.6     | 305.7     | 18297.4                    | 13.84         | 24.27                                  | 420                    | 22.95                  | 28.55                  |
|           | 2  | 153.8     | 303.0     | 18574.1                    | 13.74         | 23.95                                  | 650                    | 34.99                  |                        |
|           | 3  | 153.6     | 305.0     | 18521.8                    | 13.82         | 24.00                                  | 620                    | 33.47                  |                        |
|           | 4  | 149.5     | 302.8     | 17549.9                    | 13.66         | 25.21                                  | 400                    | 22.79                  |                        |
| BTL<br>15 | 1  | 153.4     | 306.1     | 18489.7                    | 12.64         | 21.91                                  | 535                    | 28.94                  | 33.07                  |
|           | 2  | 153.5     | 303.7     | 18513.8                    | 12.86         | 22.44                                  | 700                    | 37.81                  |                        |
|           | 3  | 154.2     | 305.7     | 18683                      | 12.82         | 22.02                                  | 450                    | 24.09                  |                        |
|           | 4  | 153.8     | 306.1     | 18574.1                    | 12.66         | 21.84                                  | 770                    | 41.46                  |                        |
| BTL<br>30 | 1  | 152.1     | 304.3     | 18165.7                    | 13.08         | 23.21                                  | 655                    | 36.06                  | 34.44                  |
|           | 2  | 155.8     | 303.4     | 19060.4                    | 12.86         | 21.82                                  | 530                    | 27.81                  |                        |
|           | 3  | 153.7     | 302.5     | 18562.1                    | 13.08         | 22.85                                  | 630                    | 33.94                  |                        |
|           | 4  | 154.6     | 304.5     | 18763.8                    | 12.82         | 22.01                                  | 750                    | 39.97                  |                        |
| BTL<br>45 | 1  | 149.8     | 302.0     | 17616.5                    | 14.32         | 26.40                                  | 740                    | 42.01                  | 36.17                  |
|           | 2  | 150.0     | 302.4     | 17663.6                    | 14.04         | 25.79                                  | 575                    | 32.55                  |                        |
|           | 3  | 150.8     | 300.9     | 17856.5                    | 14.60         | 26.65                                  | 485                    | 27.16                  |                        |
|           | 4  | 149.6     | 303.3     | 17573.4                    | 14.16         | 26.06                                  | 755                    | 42.96                  |                        |
| BTL<br>60 | 1  | 150.1     | 300.5     | 17702.9                    | 14.50         | 26.74                                  | 455                    | 25.70                  | 30.02                  |
|           | 2  | 151.9     | 303.4     | 18114                      | 14.30         | 25.52                                  | 630                    | 34.78                  |                        |
|           | 3  | 150.4     | 303.4     | 17765.8                    | 14.60         | 26.57                                  | 605                    | 34.05                  |                        |
|           | 4  | 150.6     | 300.7     | 17813.1                    | 14.38         | 26.34                                  | 455                    | 25.54                  |                        |

Dengan Keterangan :

D = Diameter

T = Tinggi



Contoh Perhitungan: Kode BTL 0 No.1

1. Berat Jenis  $= 13,84 \times 9,81 / (0,25 \times \pi \times 152,6^2 \times 305,7 \times 10^{-9})$   
 $= 24265,9 \text{ N/m}^3$   
 $= 24,27 \text{ KN/m}^3$

2. Kuat Tekan  $= \frac{P}{A}$   
 $= \frac{420 \times 1000}{18297,4}$   
 $= 22,95 \text{ MPa}$



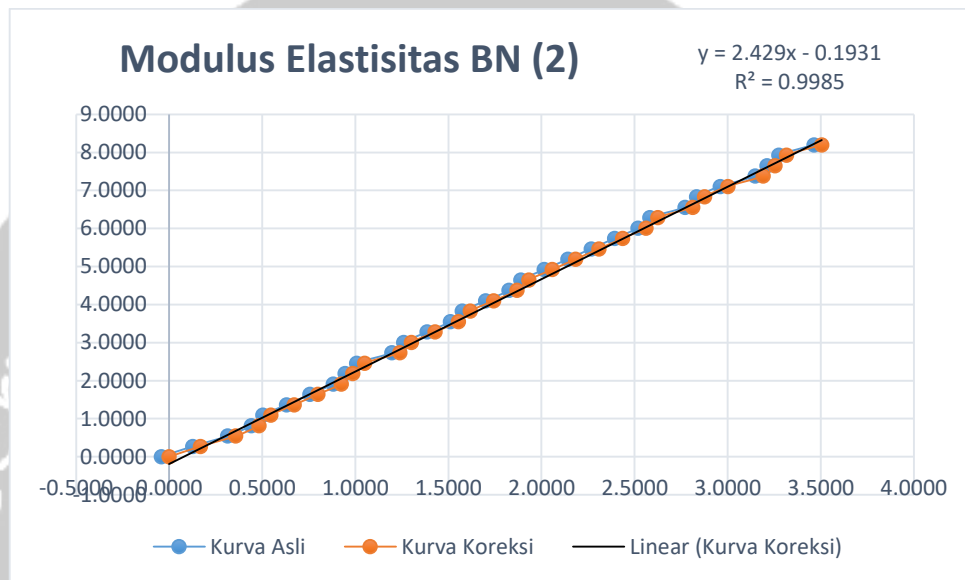
## D.2. PENGUJIAN MODULUS ELASTISITAS BETON

Kode Benda Uji                      BN    No. 2  
 Ao                                      17935.55    mm<sup>2</sup>  
 diameter baut                      7.5            mm  
 P<sub>0</sub>                                      198.5        mm  
 E<sub>c</sub>                                      23393.23    MPa  
 x koreksi                              0.0425

| Beban |         | Compressometer ( $\Delta P$ ) |                        | Tegangan | Regangan awal    | Regangan koreksi |
|-------|---------|-------------------------------|------------------------|----------|------------------|------------------|
| Kgf   | N       | $1 \times 10^{-2}$            | $(1 \times 10^{-2})/2$ | MPa      | $\times 10^{-4}$ | $\times 10^{-4}$ |
| 0     | 0       | 0.00                          | 0.000                  | 0.0000   | -0.0425          | 0.0000           |
| 500   | 4903.36 | 0.50                          | 0.250                  | 0.2734   | 0.1259           | 0.1685           |
| 1000  | 9806.71 | 1.25                          | 0.625                  | 0.5468   | 0.3149           | 0.3574           |
| 1500  | 14710.1 | 1.75                          | 0.875                  | 0.8202   | 0.4408           | 0.4833           |
| 2000  | 19613.4 | 2.00                          | 1.000                  | 1.0936   | 0.5038           | 0.5463           |
| 2500  | 24516.8 | 2.50                          | 1.250                  | 1.3669   | 0.6297           | 0.6722           |
| 3000  | 29420.1 | 3.00                          | 1.500                  | 1.6403   | 0.7557           | 0.7982           |
| 3500  | 34323.5 | 3.50                          | 1.750                  | 1.9137   | 0.8816           | 0.9241           |
| 4000  | 39226.8 | 3.75                          | 1.875                  | 2.1871   | 0.9446           | 0.9871           |
| 4500  | 44130.2 | 4.00                          | 2.000                  | 2.4605   | 1.0076           | 1.0501           |
| 5000  | 49033.6 | 4.75                          | 2.375                  | 2.7339   | 1.1965           | 1.2390           |
| 5500  | 53936.9 | 5.00                          | 2.500                  | 3.0073   | 1.2594           | 1.3020           |
| 6000  | 58840.3 | 5.50                          | 2.750                  | 3.2807   | 1.3854           | 1.4279           |
| 6500  | 63743.6 | 6.00                          | 3.000                  | 3.5540   | 1.5113           | 1.5538           |
| 7000  | 68647   | 6.25                          | 3.125                  | 3.8274   | 1.5743           | 1.6168           |
| 7500  | 73550.3 | 6.75                          | 3.375                  | 4.1008   | 1.7003           | 1.7428           |
| 8000  | 78453.7 | 7.25                          | 3.625                  | 4.3742   | 1.8262           | 1.8687           |
| 8500  | 83357   | 7.50                          | 3.750                  | 4.6476   | 1.8892           | 1.9317           |
| 9000  | 88260.4 | 8.00                          | 4.000                  | 4.9210   | 2.0151           | 2.0576           |
| 9500  | 93163.7 | 8.50                          | 4.250                  | 5.1944   | 2.1411           | 2.1836           |
| 10000 | 98067.1 | 9.00                          | 4.500                  | 5.4678   | 2.2670           | 2.3095           |
| 10500 | 102970  | 9.50                          | 4.750                  | 5.7411   | 2.3929           | 2.4355           |
| 11000 | 107874  | 10.00                         | 5.000                  | 6.0145   | 2.5189           | 2.5614           |
| 11500 | 112777  | 10.25                         | 5.125                  | 6.2879   | 2.5819           | 2.6244           |
| 12000 | 117681  | 11.00                         | 5.500                  | 6.5613   | 2.7708           | 2.8133           |
| 12500 | 122584  | 11.25                         | 5.625                  | 6.8347   | 2.8338           | 2.8763           |
| 13000 | 127487  | 11.75                         | 5.875                  | 7.1081   | 2.9597           | 3.0022           |
| 13500 | 132391  | 12.50                         | 6.250                  | 7.3815   | 3.1486           | 3.1911           |



|       |        |       |       |        |        |        |
|-------|--------|-------|-------|--------|--------|--------|
| 14000 | 137294 | 12.75 | 6.375 | 7.6549 | 3.2116 | 3.2541 |
| 14500 | 142197 | 13.00 | 6.500 | 7.9282 | 3.2746 | 3.3171 |
| 15000 | 147101 | 13.75 | 6.875 | 8.2016 | 3.4635 | 3.5060 |



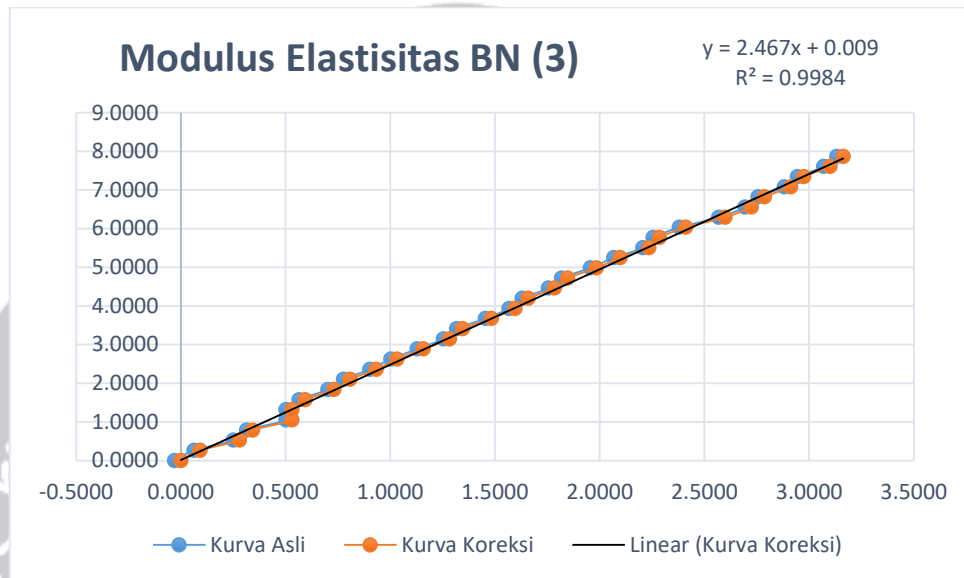


Kode Benda Uji                      BN    No. 3  
 Ao                                      18699.14    mm<sup>2</sup>  
 diameter baut                      7.5            mm  
 P<sub>0</sub>                                      199.5        mm  
 E<sub>c</sub>                                      24871.50    MPa  
 x koreksi                              0.0301

| Beban |         | Compressometer ( $\Delta P$ ) |                        | Tegangan | Regangan awal    | Regangan koreksi |
|-------|---------|-------------------------------|------------------------|----------|------------------|------------------|
| Kgf   | N       | $1 \times 10^{-2}$            | $(1 \times 10^{-2})/2$ | MPa      | $\times 10^{-4}$ | $\times 10^{-4}$ |
| 0     | 0       | 0.00                          | 0.000                  | 0.0000   | -0.0301          | 0.0000           |
| 500   | 4903.36 | 0.25                          | 0.125                  | 0.2622   | 0.0627           | 0.0928           |
| 1000  | 9806.71 | 1.00                          | 0.500                  | 0.5244   | 0.2506           | 0.2807           |
| 1500  | 14710.1 | 1.25                          | 0.625                  | 0.7867   | 0.3133           | 0.3434           |
| 2000  | 19613.4 | 2.00                          | 1.000                  | 1.0489   | 0.5013           | 0.5314           |
| 2500  | 24516.8 | 2.00                          | 1.000                  | 1.3111   | 0.5013           | 0.5314           |
| 3000  | 29420.1 | 2.25                          | 1.125                  | 1.5733   | 0.5639           | 0.5940           |
| 3500  | 34323.5 | 2.80                          | 1.400                  | 1.8356   | 0.7018           | 0.7319           |
| 4000  | 39226.8 | 3.10                          | 1.550                  | 2.0978   | 0.7769           | 0.8070           |
| 4500  | 44130.2 | 3.60                          | 1.800                  | 2.3600   | 0.9023           | 0.9324           |
| 5000  | 49033.6 | 4.00                          | 2.000                  | 2.6222   | 1.0025           | 1.0326           |
| 5500  | 53936.9 | 4.50                          | 2.250                  | 2.8845   | 1.1278           | 1.1579           |
| 6000  | 58840.3 | 5.00                          | 2.500                  | 3.1467   | 1.2531           | 1.2832           |
| 6500  | 63743.6 | 5.25                          | 2.625                  | 3.4089   | 1.3158           | 1.3459           |
| 7000  | 68647   | 5.80                          | 2.900                  | 3.6711   | 1.4536           | 1.4837           |
| 7500  | 73550.3 | 6.25                          | 3.125                  | 3.9334   | 1.5664           | 1.5965           |
| 8000  | 78453.7 | 6.50                          | 3.250                  | 4.1956   | 1.6291           | 1.6592           |
| 8500  | 83357   | 7.00                          | 3.500                  | 4.4578   | 1.7544           | 1.7845           |
| 9000  | 88260.4 | 7.25                          | 3.625                  | 4.7200   | 1.8170           | 1.8471           |
| 9500  | 93163.7 | 7.80                          | 3.900                  | 4.9822   | 1.9549           | 1.9850           |
| 10000 | 98067.1 | 8.25                          | 4.125                  | 5.2445   | 2.0677           | 2.0978           |
| 10500 | 102970  | 8.80                          | 4.400                  | 5.5067   | 2.2055           | 2.2356           |
| 11000 | 107874  | 9.00                          | 4.500                  | 5.7689   | 2.2556           | 2.2857           |
| 11500 | 112777  | 9.50                          | 4.750                  | 6.0311   | 2.3810           | 2.4111           |
| 12000 | 117681  | 10.25                         | 5.125                  | 6.2934   | 2.5689           | 2.5990           |
| 12500 | 122584  | 10.75                         | 5.375                  | 6.5556   | 2.6942           | 2.7243           |
| 13000 | 127487  | 11.00                         | 5.500                  | 6.8178   | 2.7569           | 2.7870           |
| 13500 | 132391  | 11.50                         | 5.750                  | 7.0800   | 2.8822           | 2.9123           |
| 14000 | 137294  | 11.75                         | 5.875                  | 7.3423   | 2.9449           | 2.9750           |
| 14500 | 142197  | 12.25                         | 6.125                  | 7.6045   | 3.0702           | 3.1003           |



|       |        |       |       |        |        |        |
|-------|--------|-------|-------|--------|--------|--------|
| 15000 | 147101 | 12.50 | 6.250 | 7.8667 | 3.1328 | 3.1629 |
|-------|--------|-------|-------|--------|--------|--------|



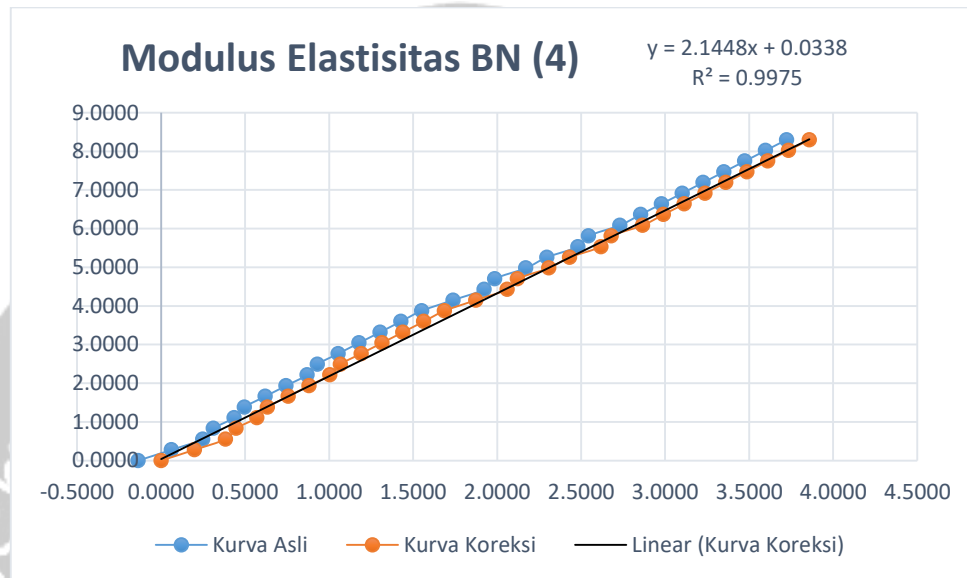


Kode Benda Uji                      BN    No. 4  
 Ao                                      17726.48    mm<sup>2</sup>  
 diameter baut                      7.5            mm  
 P<sub>0</sub>                                      201.5        mm  
 E<sub>c</sub>                                      21508.28    MPa  
 x koreksi                              0.1361

| Beban |         | Compressometer ( $\Delta P$ ) |                        | Tegangan | Regangan awal    | Regangan koreksi |
|-------|---------|-------------------------------|------------------------|----------|------------------|------------------|
| Kgf   | N       | $1 \times 10^{-2}$            | $(1 \times 10^{-2})/2$ | MPa      | $\times 10^{-4}$ | $\times 10^{-4}$ |
| 0     | 0       | 0.00                          | 0.000                  | 0.0000   | -0.1361          | 0.0000           |
| 500   | 4903.36 | 0.25                          | 0.125                  | 0.2766   | 0.0620           | 0.1982           |
| 1000  | 9806.71 | 1.00                          | 0.500                  | 0.5532   | 0.2481           | 0.3843           |
| 1500  | 14710.1 | 1.25                          | 0.625                  | 0.8298   | 0.3102           | 0.4463           |
| 2000  | 19613.4 | 1.75                          | 0.875                  | 1.1064   | 0.4342           | 0.5704           |
| 2500  | 24516.8 | 2.00                          | 1.000                  | 1.3831   | 0.4963           | 0.6324           |
| 3000  | 29420.1 | 2.50                          | 1.250                  | 1.6597   | 0.6203           | 0.7565           |
| 3500  | 34323.5 | 3.00                          | 1.500                  | 1.9363   | 0.7444           | 0.8805           |
| 4000  | 39226.8 | 3.50                          | 1.750                  | 2.2129   | 0.8685           | 1.0046           |
| 4500  | 44130.2 | 3.75                          | 1.875                  | 2.4895   | 0.9305           | 1.0667           |
| 5000  | 49033.6 | 4.25                          | 2.125                  | 2.7661   | 1.0546           | 1.1907           |
| 5500  | 53936.9 | 4.75                          | 2.375                  | 3.0427   | 1.1787           | 1.3148           |
| 6000  | 58840.3 | 5.25                          | 2.625                  | 3.3193   | 1.3027           | 1.4389           |
| 6500  | 63743.6 | 5.75                          | 2.875                  | 3.5960   | 1.4268           | 1.5629           |
| 7000  | 68647   | 6.25                          | 3.125                  | 3.8726   | 1.5509           | 1.6870           |
| 7500  | 73550.3 | 7.00                          | 3.500                  | 4.1492   | 1.7370           | 1.8731           |
| 8000  | 78453.7 | 7.75                          | 3.875                  | 4.4258   | 1.9231           | 2.0592           |
| 8500  | 83357   | 8.00                          | 4.000                  | 4.7024   | 1.9851           | 2.1212           |
| 9000  | 88260.4 | 8.75                          | 4.375                  | 4.9790   | 2.1712           | 2.3073           |
| 9500  | 93163.7 | 9.25                          | 4.625                  | 5.2556   | 2.2953           | 2.4314           |
| 10000 | 98067.1 | 10.00                         | 5.000                  | 5.5322   | 2.4814           | 2.6175           |
| 10500 | 102970  | 10.25                         | 5.125                  | 5.8088   | 2.5434           | 2.6796           |
| 11000 | 107874  | 11.00                         | 5.500                  | 6.0855   | 2.7295           | 2.8657           |
| 11500 | 112777  | 11.50                         | 5.750                  | 6.3621   | 2.8536           | 2.9897           |
| 12000 | 117681  | 12.00                         | 6.000                  | 6.6387   | 2.9777           | 3.1138           |
| 12500 | 122584  | 12.50                         | 6.250                  | 6.9153   | 3.1017           | 3.2379           |
| 13000 | 127487  | 13.00                         | 6.500                  | 7.1919   | 3.2258           | 3.3619           |
| 13500 | 132391  | 13.50                         | 6.750                  | 7.4685   | 3.3499           | 3.4860           |
| 14000 | 137294  | 14.00                         | 7.000                  | 7.7451   | 3.4739           | 3.6101           |
| 14500 | 142197  | 14.50                         | 7.250                  | 8.0217   | 3.5980           | 3.7341           |



|       |        |       |       |        |        |        |
|-------|--------|-------|-------|--------|--------|--------|
| 15000 | 147101 | 15.00 | 7.500 | 8.2984 | 3.7221 | 3.8582 |
|-------|--------|-------|-------|--------|--------|--------|





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Fakultas Teknik Program Studi Teknik Sipil

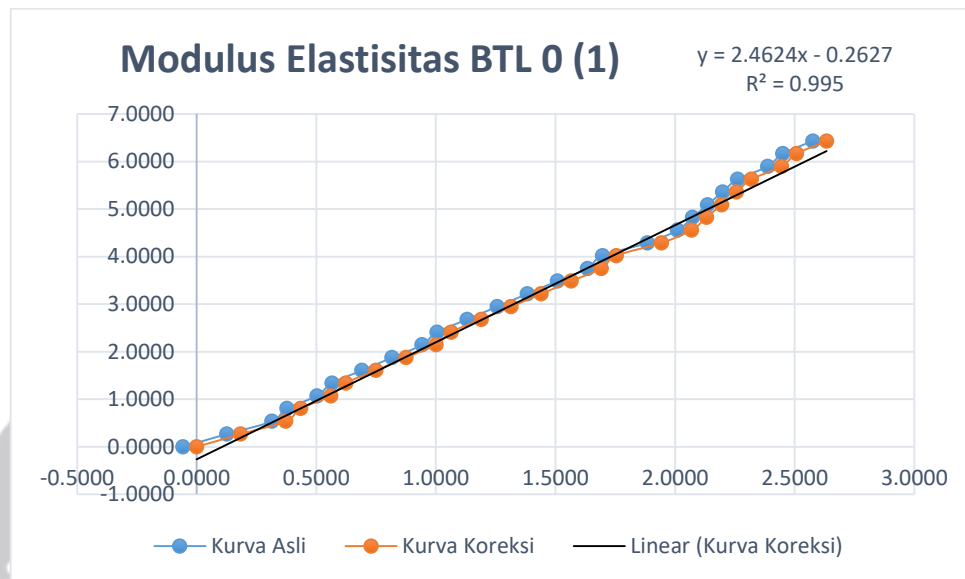
Laboratorium Struktur dan Bahan Bangunan

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

Fax. +62-274-487748

Kode Benda Uji                      BTL 0    No. 1  
 Ao                                      18297.37    mm<sup>2</sup>  
 diameter baut                      7.5            mm  
 P0                                      199           mm  
 Ec                                      24421.82    MPa  
 x koreksi                              0.0582

| Beban |         | Compressometer ( $\Delta P$ ) |                        | Tegangan | Regangan awal    | Regangan koreksi |
|-------|---------|-------------------------------|------------------------|----------|------------------|------------------|
| Kgf   | N       | $1 \times 10^{-2}$            | $(1 \times 10^{-2})/2$ | MPa      | $\times 10^{-4}$ | $\times 10^{-4}$ |
| 0     | 0       | 0.00                          | 0.000                  | 0.0000   | -0.0582          | 0.0000           |
| 500   | 4903.36 | 0.50                          | 0.250                  | 0.2680   | 0.1256           | 0.1838           |
| 1000  | 9806.71 | 1.25                          | 0.625                  | 0.5360   | 0.3141           | 0.3722           |
| 1500  | 14710.1 | 1.50                          | 0.750                  | 0.8039   | 0.3769           | 0.4350           |
| 2000  | 19613.4 | 2.00                          | 1.000                  | 1.0719   | 0.5025           | 0.5607           |
| 2500  | 24516.8 | 2.25                          | 1.125                  | 1.3399   | 0.5653           | 0.6235           |
| 3000  | 29420.1 | 2.75                          | 1.375                  | 1.6079   | 0.6910           | 0.7491           |
| 3500  | 34323.5 | 3.25                          | 1.625                  | 1.8759   | 0.8166           | 0.8747           |
| 4000  | 39226.8 | 3.75                          | 1.875                  | 2.1439   | 0.9422           | 1.0004           |
| 4500  | 44130.2 | 4.00                          | 2.000                  | 2.4118   | 1.0050           | 1.0632           |
| 5000  | 49033.6 | 4.50                          | 2.250                  | 2.6798   | 1.1307           | 1.1888           |
| 5500  | 53936.9 | 5.00                          | 2.500                  | 2.9478   | 1.2563           | 1.3144           |
| 6000  | 58840.3 | 5.50                          | 2.750                  | 3.2158   | 1.3819           | 1.4401           |
| 6500  | 63743.6 | 6.00                          | 3.000                  | 3.4838   | 1.5075           | 1.5657           |
| 7000  | 68647   | 6.50                          | 3.250                  | 3.7517   | 1.6332           | 1.6913           |
| 7500  | 73550.3 | 6.75                          | 3.375                  | 4.0197   | 1.6960           | 1.7541           |
| 8000  | 78453.7 | 7.50                          | 3.750                  | 4.2877   | 1.8844           | 1.9426           |
| 8500  | 83357   | 8.00                          | 4.000                  | 4.5557   | 2.0101           | 2.0682           |
| 9000  | 88260.4 | 8.25                          | 4.125                  | 4.8237   | 2.0729           | 2.1310           |
| 9500  | 93163.7 | 8.50                          | 4.250                  | 5.0916   | 2.1357           | 2.1938           |
| 10000 | 98067.1 | 8.75                          | 4.375                  | 5.3596   | 2.1985           | 2.2566           |
| 10500 | 102970  | 9.00                          | 4.500                  | 5.6276   | 2.2613           | 2.3195           |
| 11000 | 107874  | 9.50                          | 4.750                  | 5.8956   | 2.3869           | 2.4451           |
| 11500 | 112777  | 9.75                          | 4.875                  | 6.1636   | 2.4497           | 2.5079           |
| 12000 | 117681  | 10.25                         | 5.125                  | 6.4316   | 2.5754           | 2.6335           |





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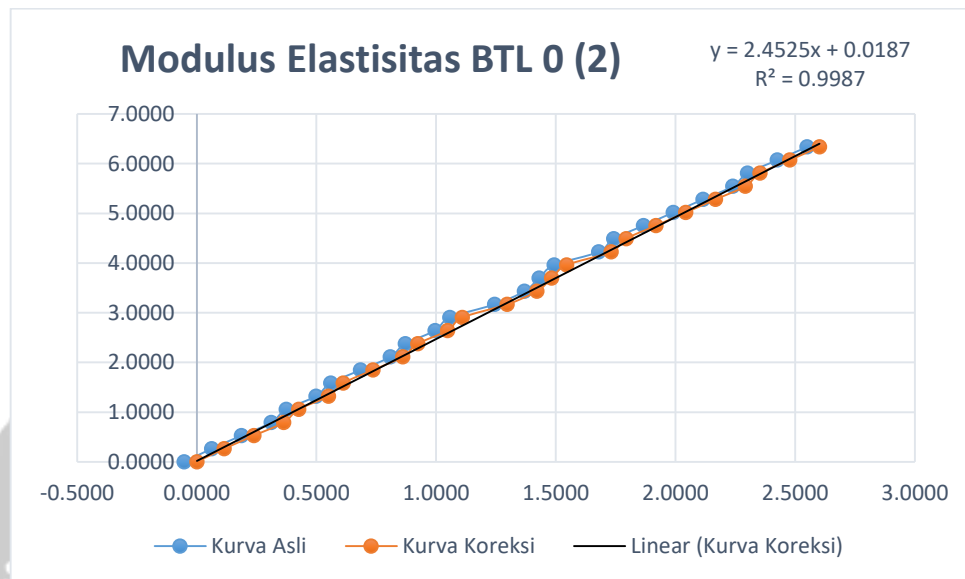
Laboratorium Struktur dan Bahan Bangunan

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

Fax. +62-274-487748

|                |          |                 |
|----------------|----------|-----------------|
| Kode Benda Uji | BTL 0    | No. 2           |
| Ao             | 18574.13 | mm <sup>2</sup> |
| diameter baut  | 7.5      | mm              |
| P0             | 201      | mm              |
| Ec             | 24348.63 | MPa             |
| x koreksi      | 0.0523   |                 |

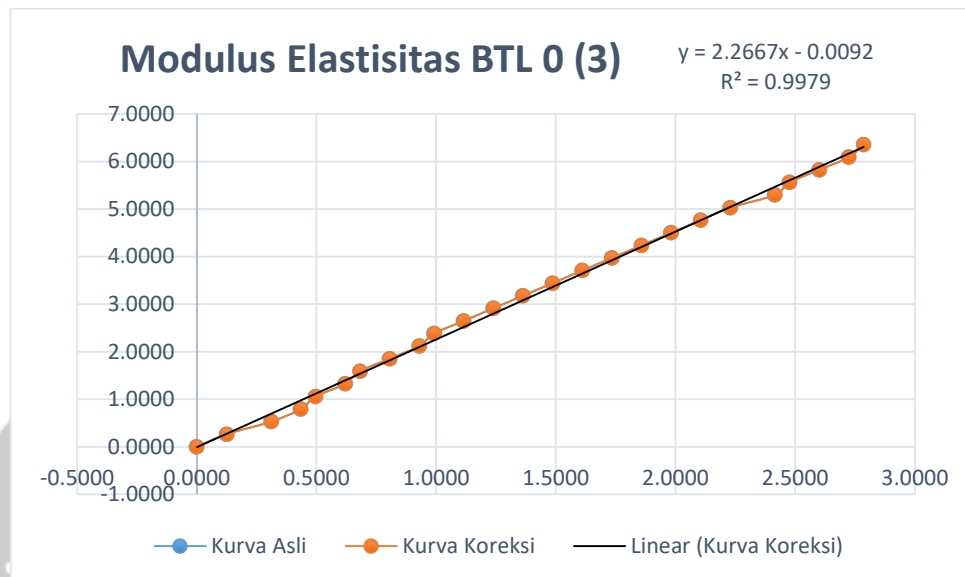
| Beban |         | Compressometer ( $\Delta P$ ) |                        | Tegangan | Regangan awal    | Regangan koreksi |
|-------|---------|-------------------------------|------------------------|----------|------------------|------------------|
| Kgf   | N       | $1 \times 10^{-2}$            | $(1 \times 10^{-2})/2$ | MPa      | $\times 10^{-4}$ | $\times 10^{-4}$ |
| 0     | 0       | 0.00                          | 0.000                  | 0.0000   | -0.0523          | 0.0000           |
| 500   | 4903.36 | 0.25                          | 0.125                  | 0.2640   | 0.0622           | 0.1145           |
| 1000  | 9806.71 | 0.75                          | 0.375                  | 0.5280   | 0.1866           | 0.2389           |
| 1500  | 14710.1 | 1.25                          | 0.625                  | 0.7920   | 0.3109           | 0.3633           |
| 2000  | 19613.4 | 1.50                          | 0.750                  | 1.0560   | 0.3731           | 0.4255           |
| 2500  | 24516.8 | 2.00                          | 1.000                  | 1.3199   | 0.4975           | 0.5498           |
| 3000  | 29420.1 | 2.25                          | 1.125                  | 1.5839   | 0.5597           | 0.6120           |
| 3500  | 34323.5 | 2.75                          | 1.375                  | 1.8479   | 0.6841           | 0.7364           |
| 4000  | 39226.8 | 3.25                          | 1.625                  | 2.1119   | 0.8085           | 0.8608           |
| 4500  | 44130.2 | 3.50                          | 1.750                  | 2.3759   | 0.8706           | 0.9230           |
| 5000  | 49033.6 | 4.00                          | 2.000                  | 2.6399   | 0.9950           | 1.0474           |
| 5500  | 53936.9 | 4.25                          | 2.125                  | 2.9039   | 1.0572           | 1.1095           |
| 6000  | 58840.3 | 5.00                          | 2.500                  | 3.1679   | 1.2438           | 1.2961           |
| 6500  | 63743.6 | 5.50                          | 2.750                  | 3.4318   | 1.3682           | 1.4205           |
| 7000  | 68647   | 5.75                          | 2.875                  | 3.6958   | 1.4303           | 1.4827           |
| 7500  | 73550.3 | 6.00                          | 3.000                  | 3.9598   | 1.4925           | 1.5449           |
| 8000  | 78453.7 | 6.75                          | 3.375                  | 4.2238   | 1.6791           | 1.7314           |
| 8500  | 83357   | 7.00                          | 3.500                  | 4.4878   | 1.7413           | 1.7936           |
| 9000  | 88260.4 | 7.50                          | 3.750                  | 4.7518   | 1.8657           | 1.9180           |
| 9500  | 93163.7 | 8.00                          | 4.000                  | 5.0158   | 1.9900           | 2.0424           |
| 10000 | 98067.1 | 8.50                          | 4.250                  | 5.2798   | 2.1144           | 2.1668           |
| 10500 | 102970  | 9.00                          | 4.500                  | 5.5438   | 2.2388           | 2.2911           |
| 11000 | 107874  | 9.25                          | 4.625                  | 5.8077   | 2.3010           | 2.3533           |
| 11500 | 112777  | 9.75                          | 4.875                  | 6.0717   | 2.4254           | 2.4777           |
| 12000 | 117681  | 10.25                         | 5.125                  | 6.3357   | 2.5498           | 2.6021           |





Kode Benda Uji                      BTL 0    No. 3  
 Ao                                      18521.83    mm<sup>2</sup>  
 diameter baut                      7.5            mm  
 P0                                      202           mm  
 Ec                                      22798.47    MPa  
 x koreksi                              0.0022

| Beban |         | Compressometer ( $\Delta P$ ) |                        | Tegangan | Regangan awal    | Regangan koreksi |
|-------|---------|-------------------------------|------------------------|----------|------------------|------------------|
| Kgf   | N       | $1 \times 10^{-2}$            | $(1 \times 10^{-2})/2$ | MPa      | $\times 10^{-4}$ | $\times 10^{-4}$ |
| 0     | 0       | 0.00                          | 0.000                  | 0.0000   | -0.0022          | 0.0000           |
| 500   | 4903.36 | 0.50                          | 0.250                  | 0.2647   | 0.1238           | 0.1260           |
| 1000  | 9806.71 | 1.25                          | 0.625                  | 0.5295   | 0.3094           | 0.3116           |
| 1500  | 14710.1 | 1.75                          | 0.875                  | 0.7942   | 0.4332           | 0.4354           |
| 2000  | 19613.4 | 2.00                          | 1.000                  | 1.0589   | 0.4950           | 0.4973           |
| 2500  | 24516.8 | 2.50                          | 1.250                  | 1.3237   | 0.6188           | 0.6210           |
| 3000  | 29420.1 | 2.75                          | 1.375                  | 1.5884   | 0.6807           | 0.6829           |
| 3500  | 34323.5 | 3.25                          | 1.625                  | 1.8531   | 0.8045           | 0.8067           |
| 4000  | 39226.8 | 3.75                          | 1.875                  | 2.1179   | 0.9282           | 0.9304           |
| 4500  | 44130.2 | 4.00                          | 2.000                  | 2.3826   | 0.9901           | 0.9923           |
| 5000  | 49033.6 | 4.50                          | 2.250                  | 2.6473   | 1.1139           | 1.1161           |
| 5500  | 53936.9 | 5.00                          | 2.500                  | 2.9121   | 1.2376           | 1.2398           |
| 6000  | 58840.3 | 5.50                          | 2.750                  | 3.1768   | 1.3614           | 1.3636           |
| 6500  | 63743.6 | 6.00                          | 3.000                  | 3.4415   | 1.4851           | 1.4874           |
| 7000  | 68647   | 6.50                          | 3.250                  | 3.7063   | 1.6089           | 1.6111           |
| 7500  | 73550.3 | 7.00                          | 3.500                  | 3.9710   | 1.7327           | 1.7349           |
| 8000  | 78453.7 | 7.50                          | 3.750                  | 4.2357   | 1.8564           | 1.8586           |
| 8500  | 83357   | 8.00                          | 4.000                  | 4.5005   | 1.9802           | 1.9824           |
| 9000  | 88260.4 | 8.50                          | 4.250                  | 4.7652   | 2.1040           | 2.1062           |
| 9500  | 93163.7 | 9.00                          | 4.500                  | 5.0299   | 2.2277           | 2.2299           |
| 10000 | 98067.1 | 9.75                          | 4.875                  | 5.2947   | 2.4134           | 2.4156           |
| 10500 | 102970  | 10.00                         | 5.000                  | 5.5594   | 2.4752           | 2.4775           |
| 11000 | 107874  | 10.50                         | 5.250                  | 5.8241   | 2.5990           | 2.6012           |
| 11500 | 112777  | 11.00                         | 5.500                  | 6.0889   | 2.7228           | 2.7250           |
| 12000 | 117681  | 11.25                         | 5.625                  | 6.3536   | 2.7847           | 2.7869           |





Kode Benda Uji                      BTL 15    No. 1  
 Ao                                      18489.68    mm<sup>2</sup>  
 diameter baut                      7.5            mm  
 P<sub>0</sub>                                      202.3        mm  
 E<sub>c</sub>                                      23983.98    MPa  
 x koreksi                              0.0716

| Beban |         | Compressometer ( $\Delta P$ ) |                        | Tegangan | Regangan awal    | Regangan koreksi |
|-------|---------|-------------------------------|------------------------|----------|------------------|------------------|
| Kgf   | N       | $1 \times 10^{-2}$            | $(1 \times 10^{-2})/2$ | MPa      | $\times 10^{-4}$ | $\times 10^{-4}$ |
| 0     | 0       | 0.00                          | 0.000                  | 0.0000   | -0.0716          | 0.0000           |
| 500   | 4903.36 | 0.50                          | 0.250                  | 0.2652   | 0.1236           | 0.1952           |
| 1000  | 9806.71 | 1.00                          | 0.500                  | 0.5304   | 0.2472           | 0.3187           |
| 1500  | 14710.1 | 1.25                          | 0.625                  | 0.7956   | 0.3089           | 0.3805           |
| 2000  | 19613.4 | 1.75                          | 0.875                  | 1.0608   | 0.4325           | 0.5041           |
| 2500  | 24516.8 | 2.00                          | 1.000                  | 1.3260   | 0.4943           | 0.5659           |
| 3000  | 29420.1 | 2.50                          | 1.250                  | 1.5912   | 0.6179           | 0.6895           |
| 3500  | 34323.5 | 2.75                          | 1.375                  | 1.8564   | 0.6797           | 0.7513           |
| 4000  | 39226.8 | 3.25                          | 1.625                  | 2.1216   | 0.8033           | 0.8748           |
| 4500  | 44130.2 | 3.50                          | 1.750                  | 2.3867   | 0.8651           | 0.9366           |
| 5000  | 49033.6 | 4.00                          | 2.000                  | 2.6519   | 0.9886           | 1.0602           |
| 5500  | 53936.9 | 4.25                          | 2.125                  | 2.9171   | 1.0504           | 1.1220           |
| 6000  | 58840.3 | 4.75                          | 2.375                  | 3.1823   | 1.1740           | 1.2456           |
| 6500  | 63743.6 | 5.25                          | 2.625                  | 3.4475   | 1.2976           | 1.3692           |
| 7000  | 68647   | 5.75                          | 2.875                  | 3.7127   | 1.4212           | 1.4927           |
| 7500  | 73550.3 | 6.00                          | 3.000                  | 3.9779   | 1.4829           | 1.5545           |
| 8000  | 78453.7 | 6.50                          | 3.250                  | 4.2431   | 1.6065           | 1.6781           |
| 8500  | 83357   | 7.00                          | 3.500                  | 4.5083   | 1.7301           | 1.8017           |
| 9000  | 88260.4 | 7.50                          | 3.750                  | 4.7735   | 1.8537           | 1.9253           |
| 9500  | 93163.7 | 8.00                          | 4.000                  | 5.0387   | 1.9773           | 2.0488           |
| 10000 | 98067.1 | 8.50                          | 4.250                  | 5.3039   | 2.1008           | 2.1724           |
| 10500 | 102970  | 9.00                          | 4.500                  | 5.5691   | 2.2244           | 2.2960           |
| 11000 | 107874  | 9.50                          | 4.750                  | 5.8343   | 2.3480           | 2.4196           |
| 11500 | 112777  | 10.00                         | 5.000                  | 6.0995   | 2.4716           | 2.5432           |
| 12000 | 117681  | 10.50                         | 5.250                  | 6.3647   | 2.5952           | 2.6667           |
| 12500 | 122584  | 10.75                         | 5.375                  | 6.6299   | 2.6569           | 2.7285           |
| 13000 | 127487  | 11.25                         | 5.625                  | 6.8950   | 2.7805           | 2.8521           |
| 13500 | 132391  | 11.75                         | 5.875                  | 7.1602   | 2.9041           | 2.9757           |
| 14000 | 137294  | 12.00                         | 6.000                  | 7.4254   | 2.9659           | 3.0375           |
| 14500 | 142197  | 12.25                         | 6.125                  | 7.6906   | 3.0277           | 3.0993           |

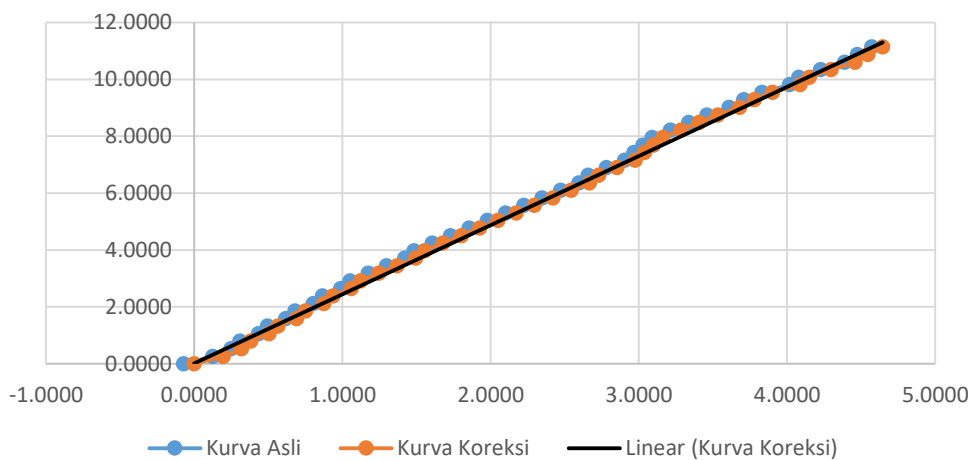


|       |        |       |       |         |        |        |
|-------|--------|-------|-------|---------|--------|--------|
| 15000 | 147101 | 12.50 | 6.250 | 7.9558  | 3.0895 | 3.1611 |
| 15500 | 152004 | 13.00 | 6.500 | 8.2210  | 3.2130 | 3.2846 |
| 16000 | 156907 | 13.50 | 6.750 | 8.4862  | 3.3366 | 3.4082 |
| 16500 | 161811 | 14.00 | 7.000 | 8.7514  | 3.4602 | 3.5318 |
| 17000 | 166714 | 14.60 | 7.300 | 9.0166  | 3.6085 | 3.6801 |
| 17500 | 171617 | 15.00 | 7.500 | 9.2818  | 3.7074 | 3.7789 |
| 18000 | 176521 | 15.50 | 7.750 | 9.5470  | 3.8309 | 3.9025 |
| 18500 | 181424 | 16.25 | 8.125 | 9.8122  | 4.0163 | 4.0879 |
| 19000 | 186327 | 16.50 | 8.250 | 10.0774 | 4.0781 | 4.1497 |
| 19500 | 191231 | 17.10 | 8.550 | 10.3426 | 4.2264 | 4.2980 |
| 20000 | 196134 | 17.75 | 8.875 | 10.6078 | 4.3870 | 4.4586 |
| 20500 | 201038 | 18.10 | 9.050 | 10.8730 | 4.4736 | 4.5451 |
| 21000 | 205941 | 18.50 | 9.250 | 11.1382 | 4.5724 | 4.6440 |

### Modulus Elastisitas BTL 15 (1)

$$y = 2.4313x + 0.0146$$

$$R^2 = 0.9984$$



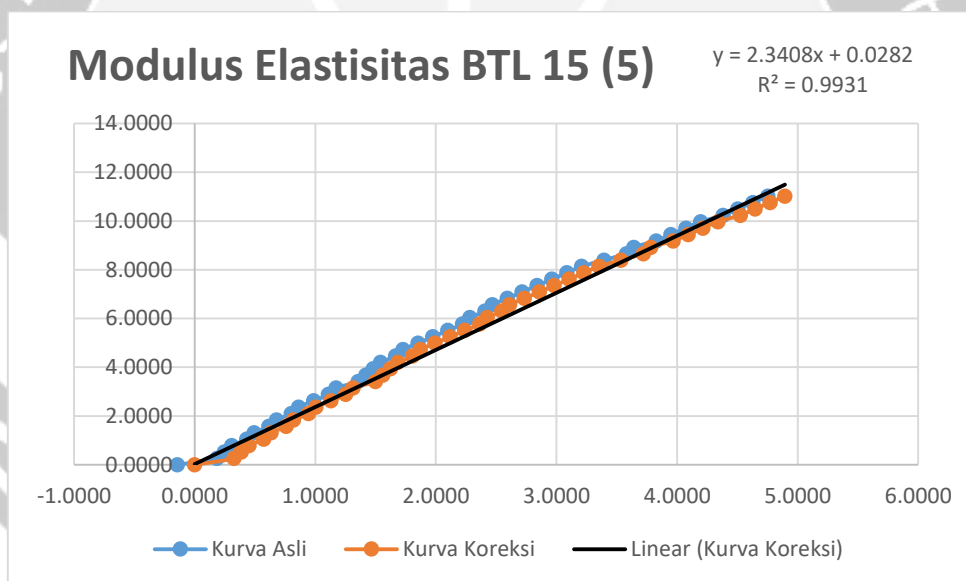


Kode Benda Uji                      BTL 15    No. 5  
 Ao                                      18682.99    mm<sup>2</sup>  
 diameterr baut                      7.5            mm  
 P0                                      202.5        mm  
 Ec                                      22517.59    MPa  
 x koreksi                              0.1422

| Beban |         | Compressometer ( $\Delta P$ ) |                        | Tegangan | Regangan awal    | Regangan koreksi |
|-------|---------|-------------------------------|------------------------|----------|------------------|------------------|
| Kgf   | N       | $1 \times 10^{-2}$            | $(1 \times 10^{-2})/2$ | MPa      | $\times 10^{-4}$ | $\times 10^{-4}$ |
| 0     | 0       | 0.00                          | 0.000                  | 0.0000   | -0.1422          | 0.0000           |
| 500   | 4903.36 | 0.75                          | 0.375                  | 0.2625   | 0.1852           | 0.3273           |
| 1000  | 9806.71 | 1.00                          | 0.500                  | 0.5249   | 0.2469           | 0.3891           |
| 1500  | 14710.1 | 1.25                          | 0.625                  | 0.7874   | 0.3086           | 0.4508           |
| 2000  | 19613.4 | 1.75                          | 0.875                  | 1.0498   | 0.4321           | 0.5743           |
| 2500  | 24516.8 | 2.00                          | 1.000                  | 1.3123   | 0.4938           | 0.6360           |
| 3000  | 29420.1 | 2.50                          | 1.250                  | 1.5747   | 0.6173           | 0.7594           |
| 3500  | 34323.5 | 2.75                          | 1.375                  | 1.8372   | 0.6790           | 0.8212           |
| 4000  | 39226.8 | 3.25                          | 1.625                  | 2.0996   | 0.8025           | 0.9446           |
| 4500  | 44130.2 | 3.50                          | 1.750                  | 2.3621   | 0.8642           | 1.0064           |
| 5000  | 49033.6 | 4.00                          | 2.000                  | 2.6245   | 0.9877           | 1.1298           |
| 5500  | 53936.9 | 4.50                          | 2.250                  | 2.8870   | 1.1111           | 1.2533           |
| 6000  | 58840.3 | 4.75                          | 2.375                  | 3.1494   | 1.1728           | 1.3150           |
| 6500  | 63743.6 | 5.50                          | 2.750                  | 3.4119   | 1.3580           | 1.5002           |
| 7000  | 68647   | 5.75                          | 2.875                  | 3.6743   | 1.4198           | 1.5619           |
| 7500  | 73550.3 | 6.00                          | 3.000                  | 3.9368   | 1.4815           | 1.6236           |
| 8000  | 78453.7 | 6.25                          | 3.125                  | 4.1992   | 1.5432           | 1.6854           |
| 8500  | 83357   | 6.75                          | 3.375                  | 4.4617   | 1.6667           | 1.8088           |
| 9000  | 88260.4 | 7.00                          | 3.500                  | 4.7241   | 1.7284           | 1.8706           |
| 9500  | 93163.7 | 7.50                          | 3.750                  | 4.9866   | 1.8519           | 1.9940           |
| 10000 | 98067.1 | 8.00                          | 4.000                  | 5.2490   | 1.9753           | 2.1175           |
| 10500 | 102970  | 8.50                          | 4.250                  | 5.5115   | 2.0988           | 2.2409           |
| 11000 | 107874  | 9.00                          | 4.500                  | 5.7739   | 2.2222           | 2.3644           |
| 11500 | 112777  | 9.25                          | 4.625                  | 6.0364   | 2.2840           | 2.4261           |
| 12000 | 117681  | 9.75                          | 4.875                  | 6.2988   | 2.4074           | 2.5496           |
| 12500 | 122584  | 10.00                         | 5.000                  | 6.5613   | 2.4691           | 2.6113           |
| 13000 | 127487  | 10.50                         | 5.250                  | 6.8237   | 2.5926           | 2.7347           |
| 13500 | 132391  | 11.00                         | 5.500                  | 7.0862   | 2.7160           | 2.8582           |
| 14000 | 137294  | 11.50                         | 5.750                  | 7.3486   | 2.8395           | 2.9817           |
| 14500 | 142197  | 12.00                         | 6.000                  | 7.6111   | 2.9630           | 3.1051           |



|       |        |       |       |         |        |        |
|-------|--------|-------|-------|---------|--------|--------|
| 15000 | 147101 | 12.50 | 6.250 | 7.8735  | 3.0864 | 3.2286 |
| 15500 | 152004 | 13.00 | 6.500 | 8.1360  | 3.2099 | 3.3520 |
| 16000 | 156907 | 13.75 | 6.875 | 8.3984  | 3.3951 | 3.5372 |
| 16500 | 161811 | 14.50 | 7.250 | 8.6609  | 3.5802 | 3.7224 |
| 17000 | 166714 | 14.75 | 7.375 | 8.9233  | 3.6420 | 3.7841 |
| 17500 | 171617 | 15.50 | 7.750 | 9.1858  | 3.8272 | 3.9693 |
| 18000 | 176521 | 16.00 | 8.000 | 9.4482  | 3.9506 | 4.0928 |
| 18500 | 181424 | 16.50 | 8.250 | 9.7107  | 4.0741 | 4.2162 |
| 19000 | 186327 | 17.00 | 8.500 | 9.9731  | 4.1975 | 4.3397 |
| 19500 | 191231 | 17.75 | 8.875 | 10.2356 | 4.3827 | 4.5249 |
| 20000 | 196134 | 18.25 | 9.125 | 10.4980 | 4.5062 | 4.6483 |
| 20500 | 201038 | 18.75 | 9.375 | 10.7605 | 4.6296 | 4.7718 |
| 21000 | 205941 | 19.25 | 9.625 | 11.0229 | 4.7531 | 4.8952 |





# UNIVERSITAS ATMA JAYA YOGYAKARTA

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Laboratorium Struktur dan Bahan Bangunan

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Kode Benda Uji                      BTL 15    No. 6  
 Ao                                      18574.13    mm<sup>2</sup>  
 diameter baut                      7.5            mm  
 P<sub>0</sub>                                      204.5        mm  
 E<sub>c</sub>                                      25555.21    MPa  
 x koreksi                              0.0599

| Beban |         | Compressometer ( $\Delta P$ ) |                        | Tegangan | Regangan awal    | Regangan koreksi |
|-------|---------|-------------------------------|------------------------|----------|------------------|------------------|
| Kgf   | N       | $1 \times 10^{-2}$            | $(1 \times 10^{-2})/2$ | MPa      | $\times 10^{-4}$ | $\times 10^{-4}$ |
| 0     | 0       | 0.00                          | 0.000                  | 0.0000   | -0.0599          | 0.0000           |
| 500   | 4903.36 | 0.20                          | 0.100                  | 0.2640   | 0.0489           | 0.1088           |
| 1000  | 9806.71 | 0.80                          | 0.400                  | 0.5280   | 0.1956           | 0.2555           |
| 1500  | 14710.1 | 1.00                          | 0.500                  | 0.7920   | 0.2445           | 0.3044           |
| 2000  | 19613.4 | 1.50                          | 0.750                  | 1.0560   | 0.3667           | 0.4267           |
| 2500  | 24516.8 | 1.80                          | 0.900                  | 1.3199   | 0.4401           | 0.5000           |
| 3000  | 29420.1 | 2.10                          | 1.050                  | 1.5839   | 0.5134           | 0.5734           |
| 3500  | 34323.5 | 2.50                          | 1.250                  | 1.8479   | 0.6112           | 0.6712           |
| 4000  | 39226.8 | 3.00                          | 1.500                  | 2.1119   | 0.7335           | 0.7934           |
| 4500  | 44130.2 | 3.20                          | 1.600                  | 2.3759   | 0.7824           | 0.8423           |
| 5000  | 49033.6 | 3.80                          | 1.900                  | 2.6399   | 0.9291           | 0.9890           |
| 5500  | 53936.9 | 4.20                          | 2.100                  | 2.9039   | 1.0269           | 1.0868           |
| 6000  | 58840.3 | 5.25                          | 2.625                  | 3.1679   | 1.2836           | 1.3435           |
| 6500  | 63743.6 | 5.60                          | 2.800                  | 3.4318   | 1.3692           | 1.4291           |
| 7000  | 68647   | 6.00                          | 3.000                  | 3.6958   | 1.4670           | 1.5269           |
| 7500  | 73550.3 | 6.50                          | 3.250                  | 3.9598   | 1.5892           | 1.6492           |
| 8000  | 78453.7 | 7.00                          | 3.500                  | 4.2238   | 1.7115           | 1.7714           |
| 8500  | 83357   | 7.50                          | 3.750                  | 4.4878   | 1.8337           | 1.8937           |
| 9000  | 88260.4 | 7.90                          | 3.950                  | 4.7518   | 1.9315           | 1.9915           |
| 9500  | 93163.7 | 8.25                          | 4.125                  | 5.0158   | 2.0171           | 2.0770           |
| 10000 | 98067.1 | 8.60                          | 4.300                  | 5.2798   | 2.1027           | 2.1626           |
| 10500 | 102970  | 9.00                          | 4.500                  | 5.5438   | 2.2005           | 2.2604           |
| 11000 | 107874  | 9.50                          | 4.750                  | 5.8077   | 2.3227           | 2.3827           |
| 11500 | 112777  | 10.00                         | 5.000                  | 6.0717   | 2.4450           | 2.5049           |
| 12000 | 117681  | 10.50                         | 5.250                  | 6.3357   | 2.5672           | 2.6272           |
| 12500 | 122584  | 11.00                         | 5.500                  | 6.5997   | 2.6895           | 2.7494           |
| 13000 | 127487  | 11.40                         | 5.700                  | 6.8637   | 2.7873           | 2.8472           |
| 13500 | 132391  | 11.60                         | 5.800                  | 7.1277   | 2.8362           | 2.8961           |
| 14000 | 137294  | 12.00                         | 6.000                  | 7.3917   | 2.9340           | 2.9939           |
| 14500 | 142197  | 12.60                         | 6.300                  | 7.6557   | 3.0807           | 3.1406           |

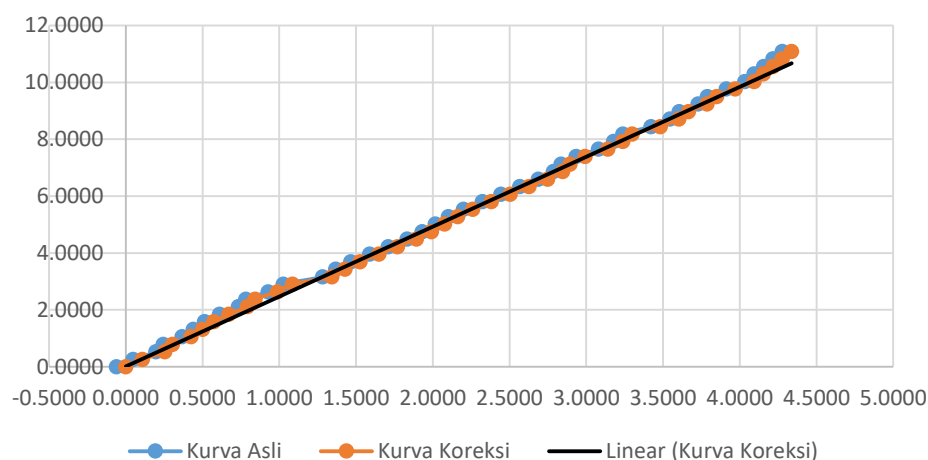


|       |        |       |       |         |        |        |
|-------|--------|-------|-------|---------|--------|--------|
| 15000 | 147101 | 13.00 | 6.500 | 7.9197  | 3.1785 | 3.2384 |
| 15500 | 152004 | 13.25 | 6.625 | 8.1836  | 3.2396 | 3.2995 |
| 16000 | 156907 | 14.00 | 7.000 | 8.4476  | 3.4230 | 3.4829 |
| 16500 | 161811 | 14.50 | 7.250 | 8.7116  | 3.5452 | 3.6052 |
| 17000 | 166714 | 14.75 | 7.375 | 8.9756  | 3.6064 | 3.6663 |
| 17500 | 171617 | 15.25 | 7.625 | 9.2396  | 3.7286 | 3.7885 |
| 18000 | 176521 | 15.50 | 7.750 | 9.5036  | 3.7897 | 3.8497 |
| 18500 | 181424 | 16.00 | 8.000 | 9.7676  | 3.9120 | 3.9719 |
| 19000 | 186327 | 16.50 | 8.250 | 10.0316 | 4.0342 | 4.0942 |
| 19500 | 191231 | 16.75 | 8.375 | 10.2955 | 4.0954 | 4.1553 |
| 20000 | 196134 | 17.00 | 8.500 | 10.5595 | 4.1565 | 4.2164 |
| 20500 | 201038 | 17.25 | 8.625 | 10.8235 | 4.2176 | 4.2775 |
| 21000 | 205941 | 17.50 | 8.750 | 11.0875 | 4.2787 | 4.3387 |

### Modulus Elastisitas BTL 15 (6)

$$y = 2.4573x + 0.013$$

$$R^2 = 0.9981$$





# 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

Kode Benda Uji      BTL 30    No. 1  
 Ao                      18165.74    mm<sup>2</sup>  
 diameter baut        7.5        mm  
 P<sub>0</sub>                      200.5       mm  
 E<sub>c</sub>                      24731.79    MPa  
 x koreksi                0.0012

| Beban |         | Compressometer ( $\Delta P$ ) |                        | Tegangan | Regangan awal    | Regangan koreksi |
|-------|---------|-------------------------------|------------------------|----------|------------------|------------------|
| Kgf   | N       | $1 \times 10^{-2}$            | $(1 \times 10^{-2})/2$ | MPa      | $\times 10^{-4}$ | $\times 10^{-4}$ |
| 0     | 0       | 0.00                          | 0.000                  | 0.0000   | -0.0012          | 0.0000           |
| 500   | 4903.36 | 0.75                          | 0.375                  | 0.2699   | 0.1870           | 0.1882           |
| 1000  | 9806.71 | 1.25                          | 0.625                  | 0.5398   | 0.3117           | 0.3129           |
| 1500  | 14710.1 | 1.75                          | 0.875                  | 0.8098   | 0.4364           | 0.4376           |
| 2000  | 19613.4 | 2.00                          | 1.000                  | 1.0797   | 0.4988           | 0.5000           |
| 2500  | 24516.8 | 2.25                          | 1.125                  | 1.3496   | 0.5611           | 0.5623           |
| 3000  | 29420.1 | 2.75                          | 1.375                  | 1.6195   | 0.6858           | 0.6870           |
| 3500  | 34323.5 | 3.00                          | 1.500                  | 1.8895   | 0.7481           | 0.7493           |
| 4000  | 39226.8 | 3.50                          | 1.750                  | 2.1594   | 0.8728           | 0.8740           |
| 4500  | 44130.2 | 3.75                          | 1.875                  | 2.4293   | 0.9352           | 0.9364           |
| 5000  | 49033.6 | 4.25                          | 2.125                  | 2.6992   | 1.0599           | 1.0611           |
| 5500  | 53936.9 | 4.75                          | 2.375                  | 2.9692   | 1.1845           | 1.1858           |
| 6000  | 58840.3 | 5.25                          | 2.625                  | 3.2391   | 1.3092           | 1.3104           |
| 6500  | 63743.6 | 5.75                          | 2.875                  | 3.5090   | 1.4339           | 1.4351           |
| 7000  | 68647   | 6.00                          | 3.000                  | 3.7789   | 1.4963           | 1.4975           |
| 7500  | 73550.3 | 6.50                          | 3.250                  | 4.0488   | 1.6209           | 1.6222           |
| 8000  | 78453.7 | 7.00                          | 3.500                  | 4.3188   | 1.7456           | 1.7469           |
| 8500  | 83357   | 7.50                          | 3.750                  | 4.5887   | 1.8703           | 1.8715           |
| 9000  | 88260.4 | 8.00                          | 4.000                  | 4.8586   | 1.9950           | 1.9962           |
| 9500  | 93163.7 | 8.75                          | 4.375                  | 5.1285   | 2.1820           | 2.1833           |
| 10000 | 98067.1 | 9.25                          | 4.625                  | 5.3985   | 2.3067           | 2.3079           |
| 10500 | 102970  | 10.00                         | 5.000                  | 5.6684   | 2.4938           | 2.4950           |
| 11000 | 107874  | 10.50                         | 5.250                  | 5.9383   | 2.6185           | 2.6197           |
| 11500 | 112777  | 11.00                         | 5.500                  | 6.2082   | 2.7431           | 2.7444           |
| 12000 | 117681  | 11.25                         | 5.625                  | 6.4782   | 2.8055           | 2.8067           |
| 12500 | 122584  | 11.50                         | 5.750                  | 6.7481   | 2.8678           | 2.8690           |
| 13000 | 127487  | 12.25                         | 6.125                  | 7.0180   | 3.0549           | 3.0561           |
| 13500 | 132391  | 12.50                         | 6.250                  | 7.2879   | 3.1172           | 3.1184           |
| 14000 | 137294  | 12.75                         | 6.375                  | 7.5578   | 3.1796           | 3.1808           |
| 14500 | 142197  | 13.00                         | 6.500                  | 7.8278   | 3.2419           | 3.2431           |



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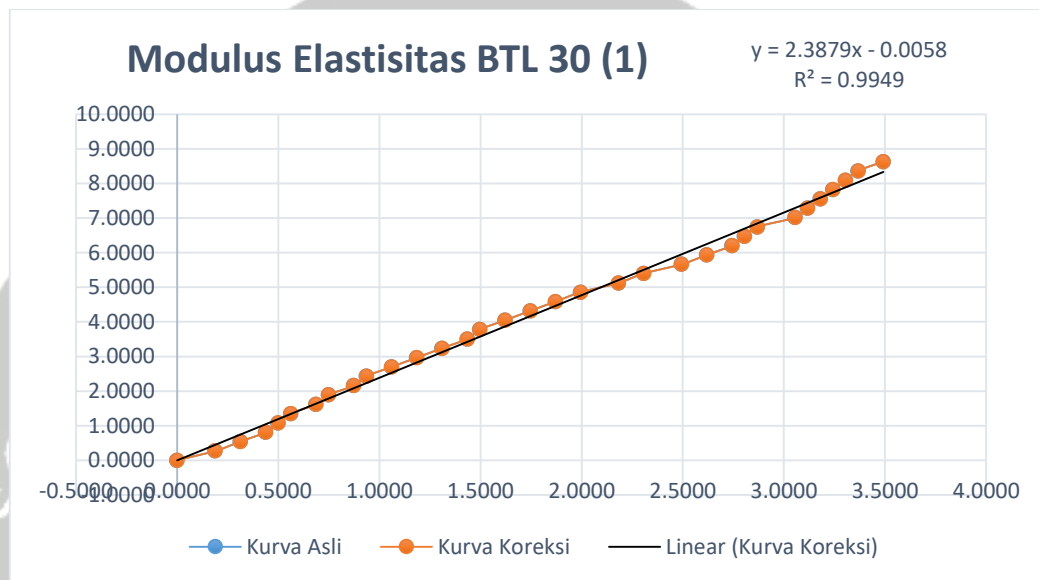
**Fakultas Teknik Program Studi Teknik Sipil**

**Laboratorium Struktur dan Bahan Bangunan**

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

Fax. +62-274-487748

|       |        |       |       |        |        |        |
|-------|--------|-------|-------|--------|--------|--------|
| 15000 | 147101 | 13.25 | 6.625 | 8.0977 | 3.3042 | 3.3055 |
| 15500 | 152004 | 13.50 | 6.750 | 8.3676 | 3.3666 | 3.3678 |
| 16000 | 156907 | 14.00 | 7.000 | 8.6375 | 3.4913 | 3.4925 |





# UNIVERSITAS ATMA JAYA YOGYAKARTA

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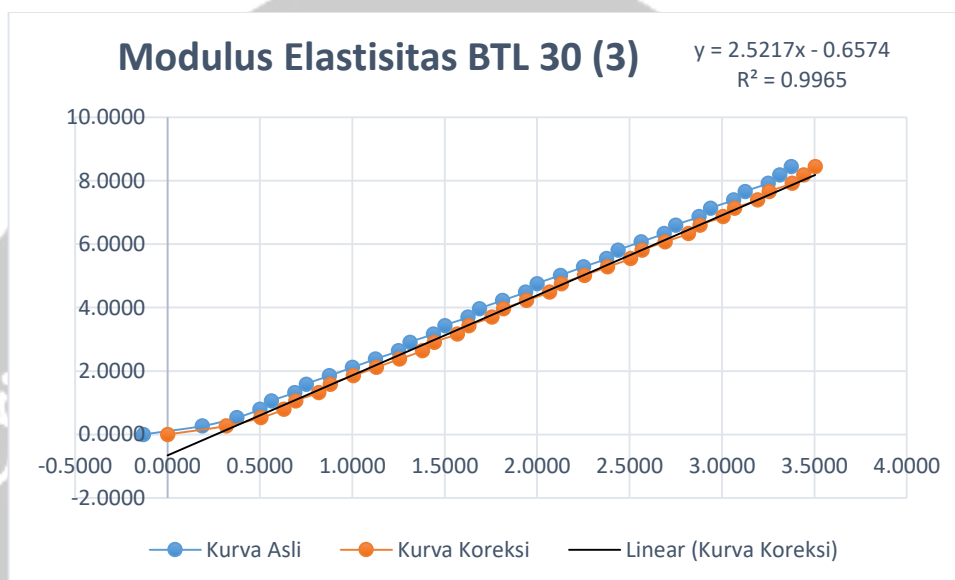
Fax. +62-274-487748

Kode Benda Uji      BTL 30    No. 3  
 Ao                      18562.05    mm<sup>2</sup>  
 diameter baut        7.5        mm  
 P0                      200        mm  
 Ec                      24116.64    MPa  
 x koreksi              0.1301

| Beban |         | Compressometer ( $\Delta P$ ) |                        | Tegangan | Regangan awal    | Regangan koreksi |
|-------|---------|-------------------------------|------------------------|----------|------------------|------------------|
| Kgf   | N       | $1 \times 10^{-2}$            | $(1 \times 10^{-2})/2$ | MPa      | $\times 10^{-4}$ | $\times 10^{-4}$ |
| 0     | 0       | 0.00                          | 0.000                  | 0.0000   | -0.1301          | 0.0000           |
| 500   | 4903.36 | 0.75                          | 0.375                  | 0.2642   | 0.1875           | 0.3176           |
| 1000  | 9806.71 | 1.50                          | 0.750                  | 0.5283   | 0.3750           | 0.5051           |
| 1500  | 14710.1 | 2.00                          | 1.000                  | 0.7925   | 0.5000           | 0.6301           |
| 2000  | 19613.4 | 2.25                          | 1.125                  | 1.0566   | 0.5625           | 0.6926           |
| 2500  | 24516.8 | 2.75                          | 1.375                  | 1.3208   | 0.6875           | 0.8176           |
| 3000  | 29420.1 | 3.00                          | 1.500                  | 1.5850   | 0.7500           | 0.8801           |
| 3500  | 34323.5 | 3.50                          | 1.750                  | 1.8491   | 0.8750           | 1.0051           |
| 4000  | 39226.8 | 4.00                          | 2.000                  | 2.1133   | 1.0000           | 1.1301           |
| 4500  | 44130.2 | 4.50                          | 2.250                  | 2.3774   | 1.1250           | 1.2551           |
| 5000  | 49033.6 | 5.00                          | 2.500                  | 2.6416   | 1.2500           | 1.3801           |
| 5500  | 53936.9 | 5.25                          | 2.625                  | 2.9058   | 1.3125           | 1.4426           |
| 6000  | 58840.3 | 5.75                          | 2.875                  | 3.1699   | 1.4375           | 1.5676           |
| 6500  | 63743.6 | 6.00                          | 3.000                  | 3.4341   | 1.5000           | 1.6301           |
| 7000  | 68647   | 6.50                          | 3.250                  | 3.6982   | 1.6250           | 1.7551           |
| 7500  | 73550.3 | 6.75                          | 3.375                  | 3.9624   | 1.6875           | 1.8176           |
| 8000  | 78453.7 | 7.25                          | 3.625                  | 4.2266   | 1.8125           | 1.9426           |
| 8500  | 83357   | 7.75                          | 3.875                  | 4.4907   | 1.9375           | 2.0676           |
| 9000  | 88260.4 | 8.00                          | 4.000                  | 4.7549   | 2.0000           | 2.1301           |
| 9500  | 93163.7 | 8.50                          | 4.250                  | 5.0190   | 2.1250           | 2.2551           |
| 10000 | 98067.1 | 9.00                          | 4.500                  | 5.2832   | 2.2500           | 2.3801           |
| 10500 | 102970  | 9.50                          | 4.750                  | 5.5474   | 2.3750           | 2.5051           |
| 11000 | 107874  | 9.75                          | 4.875                  | 5.8115   | 2.4375           | 2.5676           |
| 11500 | 112777  | 10.25                         | 5.125                  | 6.0757   | 2.5625           | 2.6926           |
| 12000 | 117681  | 10.75                         | 5.375                  | 6.3398   | 2.6875           | 2.8176           |
| 12500 | 122584  | 11.00                         | 5.500                  | 6.6040   | 2.7500           | 2.8801           |
| 13000 | 127487  | 11.50                         | 5.750                  | 6.8682   | 2.8750           | 3.0051           |
| 13500 | 132391  | 11.75                         | 5.875                  | 7.1323   | 2.9375           | 3.0676           |
| 14000 | 137294  | 12.25                         | 6.125                  | 7.3965   | 3.0625           | 3.1926           |
| 14500 | 142197  | 12.50                         | 6.250                  | 7.6606   | 3.1250           | 3.2551           |



|       |        |       |       |        |        |        |
|-------|--------|-------|-------|--------|--------|--------|
| 15000 | 147101 | 13.00 | 6.500 | 7.9248 | 3.2500 | 3.3801 |
| 15500 | 152004 | 13.25 | 6.625 | 8.1890 | 3.3125 | 3.4426 |
| 16000 | 156907 | 13.50 | 6.750 | 8.4531 | 3.3750 | 3.5051 |





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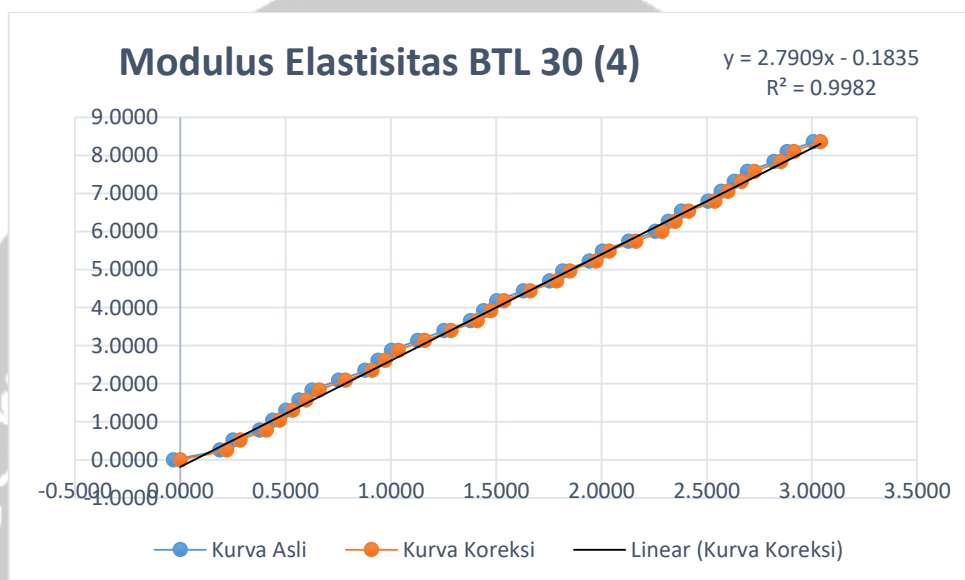
Fax. +62-274-487748

Kode Benda Uji      BTL 30    No. 4  
 Ao                      18763.83    mm<sup>2</sup>  
 diameter baut        7.5        mm  
 P<sub>0</sub>                      199.5       mm  
 E<sub>c</sub>                      27506.11    MPa  
 x koreksi                0.0326

| Beban |         | Compressometer ( $\Delta P$ ) |                        | Tegangan | Regangan awal    | Regangan koreksi |
|-------|---------|-------------------------------|------------------------|----------|------------------|------------------|
| Kgf   | N       | $1 \times 10^{-2}$            | $(1 \times 10^{-2})/2$ | MPa      | $\times 10^{-4}$ | $\times 10^{-4}$ |
| 0     | 0       | 0.00                          | 0.000                  | 0.0000   | -0.0326          | 0.0000           |
| 500   | 4903.36 | 0.75                          | 0.375                  | 0.2613   | 0.1880           | 0.2206           |
| 1000  | 9806.71 | 1.00                          | 0.500                  | 0.5226   | 0.2506           | 0.2832           |
| 1500  | 14710.1 | 1.50                          | 0.750                  | 0.7840   | 0.3759           | 0.4086           |
| 2000  | 19613.4 | 1.75                          | 0.875                  | 1.0453   | 0.4386           | 0.4712           |
| 2500  | 24516.8 | 2.00                          | 1.000                  | 1.3066   | 0.5013           | 0.5339           |
| 3000  | 29420.1 | 2.25                          | 1.125                  | 1.5679   | 0.5639           | 0.5965           |
| 3500  | 34323.5 | 2.50                          | 1.250                  | 1.8292   | 0.6266           | 0.6592           |
| 4000  | 39226.8 | 3.00                          | 1.500                  | 2.0906   | 0.7519           | 0.7845           |
| 4500  | 44130.2 | 3.50                          | 1.750                  | 2.3519   | 0.8772           | 0.9098           |
| 5000  | 49033.6 | 3.75                          | 1.875                  | 2.6132   | 0.9398           | 0.9725           |
| 5500  | 53936.9 | 4.00                          | 2.000                  | 2.8745   | 1.0025           | 1.0351           |
| 6000  | 58840.3 | 4.50                          | 2.250                  | 3.1358   | 1.1278           | 1.1604           |
| 6500  | 63743.6 | 5.00                          | 2.500                  | 3.3972   | 1.2531           | 1.2857           |
| 7000  | 68647   | 5.50                          | 2.750                  | 3.6585   | 1.3784           | 1.4111           |
| 7500  | 73550.3 | 5.75                          | 2.875                  | 3.9198   | 1.4411           | 1.4737           |
| 8000  | 78453.7 | 6.00                          | 3.000                  | 4.1811   | 1.5038           | 1.5364           |
| 8500  | 83357   | 6.50                          | 3.250                  | 4.4424   | 1.6291           | 1.6617           |
| 9000  | 88260.4 | 7.00                          | 3.500                  | 4.7038   | 1.7544           | 1.7870           |
| 9500  | 93163.7 | 7.25                          | 3.625                  | 4.9651   | 1.8170           | 1.8497           |
| 10000 | 98067.1 | 7.75                          | 3.875                  | 5.2264   | 1.9424           | 1.9750           |
| 10500 | 102970  | 8.00                          | 4.000                  | 5.4877   | 2.0050           | 2.0376           |
| 11000 | 107874  | 8.50                          | 4.250                  | 5.7490   | 2.1303           | 2.1629           |
| 11500 | 112777  | 9.00                          | 4.500                  | 6.0103   | 2.2556           | 2.2883           |
| 12000 | 117681  | 9.25                          | 4.625                  | 6.2717   | 2.3183           | 2.3509           |
| 12500 | 122584  | 9.50                          | 4.750                  | 6.5330   | 2.3810           | 2.4136           |
| 13000 | 127487  | 10.00                         | 5.000                  | 6.7943   | 2.5063           | 2.5389           |
| 13500 | 132391  | 10.25                         | 5.125                  | 7.0556   | 2.5689           | 2.6015           |
| 14000 | 137294  | 10.50                         | 5.250                  | 7.3169   | 2.6316           | 2.6642           |
| 14500 | 142197  | 10.75                         | 5.375                  | 7.5783   | 2.6942           | 2.7268           |



|       |        |       |       |        |        |        |
|-------|--------|-------|-------|--------|--------|--------|
| 15000 | 147101 | 11.25 | 5.625 | 7.8396 | 2.8195 | 2.8522 |
| 15500 | 152004 | 11.50 | 5.750 | 8.1009 | 2.8822 | 2.9148 |
| 16000 | 156907 | 12.00 | 6.000 | 8.3622 | 3.0075 | 3.0401 |





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Laboratorium Struktur dan Bahan Bangunan

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Fax. +62-274-487748

Kode Benda Uji                      BTL 45    No. 1  
 Ao                                      17616.52    mm<sup>2</sup>  
 diameter baut                      7.5            mm  
 P0                                      201           mm  
 Ec                                      27638.80    MPa  
 x koreksi                              0.2792

| Beban |         | Compressometer ( $\Delta P$ ) |                        | Tegangan | Regangan awal    | Regangan koreksi |
|-------|---------|-------------------------------|------------------------|----------|------------------|------------------|
| Kgf   | N       | $1 \times 10^{-2}$            | $(1 \times 10^{-2})/2$ | MPa      | $\times 10^{-4}$ | $\times 10^{-4}$ |
| 0     | 0       | 0.00                          | 0.000                  | 0.0000   | -0.2792          | 0.0000           |
| 500   | 4903.36 | 0.75                          | 0.375                  | 0.2783   | 0.1866           | 0.4658           |
| 1000  | 9806.71 | 1.50                          | 0.750                  | 0.5567   | 0.3731           | 0.6524           |
| 1500  | 14710.1 | 1.75                          | 0.875                  | 0.8350   | 0.4353           | 0.7146           |
| 2000  | 19613.4 | 2.25                          | 1.125                  | 1.1134   | 0.5597           | 0.8389           |
| 2500  | 24516.8 | 2.75                          | 1.375                  | 1.3917   | 0.6841           | 0.9633           |
| 3000  | 29420.1 | 3.25                          | 1.625                  | 1.6700   | 0.8085           | 1.0877           |
| 3500  | 34323.5 | 3.75                          | 1.875                  | 1.9484   | 0.9328           | 1.2121           |
| 4000  | 39226.8 | 4.00                          | 2.000                  | 2.2267   | 0.9950           | 1.2743           |
| 4500  | 44130.2 | 4.50                          | 2.250                  | 2.5050   | 1.1194           | 1.3986           |
| 5000  | 49033.6 | 4.75                          | 2.375                  | 2.7834   | 1.1816           | 1.4608           |
| 5500  | 53936.9 | 5.50                          | 2.750                  | 3.0617   | 1.3682           | 1.6474           |
| 6000  | 58840.3 | 6.00                          | 3.000                  | 3.3401   | 1.4925           | 1.7718           |
| 6500  | 63743.6 | 6.50                          | 3.250                  | 3.6184   | 1.6169           | 1.8961           |
| 7000  | 68647   | 7.25                          | 3.625                  | 3.8967   | 1.8035           | 2.0827           |
| 7500  | 73550.3 | 7.50                          | 3.750                  | 4.1751   | 1.8657           | 2.1449           |
| 8000  | 78453.7 | 8.00                          | 4.000                  | 4.4534   | 1.9900           | 2.2693           |
| 8500  | 83357   | 8.25                          | 4.125                  | 4.7318   | 2.0522           | 2.3315           |
| 9000  | 88260.4 | 8.50                          | 4.250                  | 5.0101   | 2.1144           | 2.3937           |
| 9500  | 93163.7 | 9.00                          | 4.500                  | 5.2884   | 2.2388           | 2.5180           |
| 10000 | 98067.1 | 9.50                          | 4.750                  | 5.5668   | 2.3632           | 2.6424           |
| 10500 | 102970  | 9.75                          | 4.875                  | 5.8451   | 2.4254           | 2.7046           |
| 11000 | 107874  | 10.00                         | 5.000                  | 6.1234   | 2.4876           | 2.7668           |
| 11500 | 112777  | 10.25                         | 5.125                  | 6.4018   | 2.5498           | 2.8290           |
| 12000 | 117681  | 10.75                         | 5.375                  | 6.6801   | 2.6741           | 2.9534           |
| 12500 | 122584  | 11.00                         | 5.500                  | 6.9585   | 2.7363           | 3.0155           |
| 13000 | 127487  | 11.50                         | 5.750                  | 7.2368   | 2.8607           | 3.1399           |
| 13500 | 132391  | 11.75                         | 5.875                  | 7.5151   | 2.9229           | 3.2021           |
| 14000 | 137294  | 12.00                         | 6.000                  | 7.7935   | 2.9851           | 3.2643           |
| 14500 | 142197  | 12.25                         | 6.125                  | 8.0718   | 3.0473           | 3.3265           |



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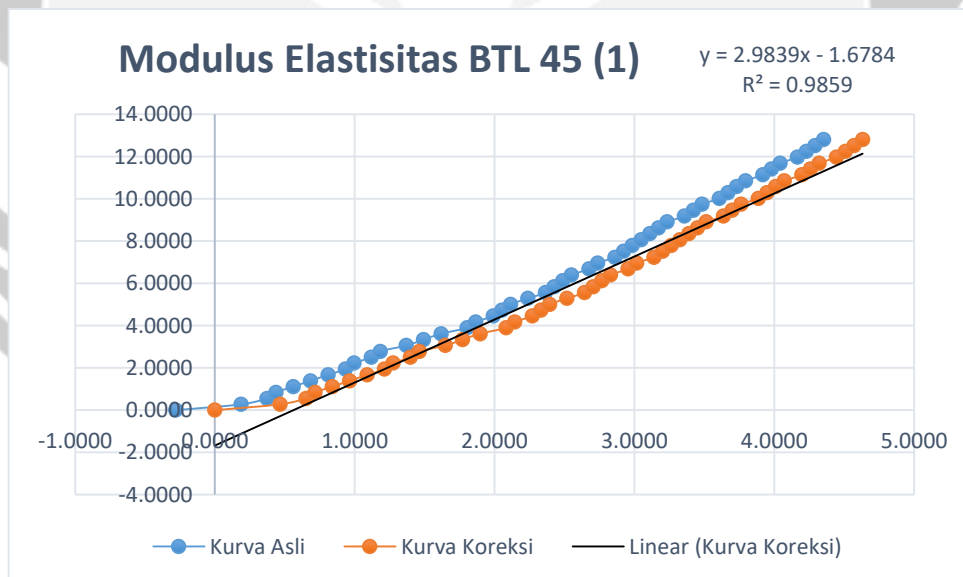
Fakultas Teknik Program Studi Teknik Sipil

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|       |        |       |       |         |        |        |
|-------|--------|-------|-------|---------|--------|--------|
| 15000 | 147101 | 12.50 | 6.250 | 8.3502  | 3.1095 | 3.3887 |
| 15500 | 152004 | 12.75 | 6.375 | 8.6285  | 3.1716 | 3.4509 |
| 16000 | 156907 | 13.00 | 6.500 | 8.9068  | 3.2338 | 3.5131 |
| 16500 | 161811 | 13.50 | 6.750 | 9.1852  | 3.3582 | 3.6374 |
| 17000 | 166714 | 13.75 | 6.875 | 9.4635  | 3.4204 | 3.6996 |
| 17500 | 171617 | 14.00 | 7.000 | 9.7418  | 3.4826 | 3.7618 |
| 18000 | 176521 | 14.50 | 7.250 | 10.0202 | 3.6070 | 3.8862 |
| 18500 | 181424 | 14.75 | 7.375 | 10.2985 | 3.6692 | 3.9484 |
| 19000 | 186327 | 15.00 | 7.500 | 10.5769 | 3.7313 | 4.0106 |
| 19500 | 191231 | 15.25 | 7.625 | 10.8552 | 3.7935 | 4.0728 |
| 20000 | 196134 | 15.75 | 7.875 | 11.1335 | 3.9179 | 4.1971 |
| 20500 | 201038 | 16.00 | 8.000 | 11.4119 | 3.9801 | 4.2593 |
| 21000 | 205941 | 16.25 | 8.125 | 11.6902 | 4.0423 | 4.3215 |
| 21500 | 210844 | 16.75 | 8.375 | 11.9686 | 4.1667 | 4.4459 |
| 22000 | 215748 | 17.00 | 8.500 | 12.2469 | 4.2289 | 4.5081 |
| 22500 | 220651 | 17.25 | 8.625 | 12.5252 | 4.2910 | 4.5703 |
| 23000 | 225554 | 17.50 | 8.750 | 12.8036 | 4.3532 | 4.6325 |





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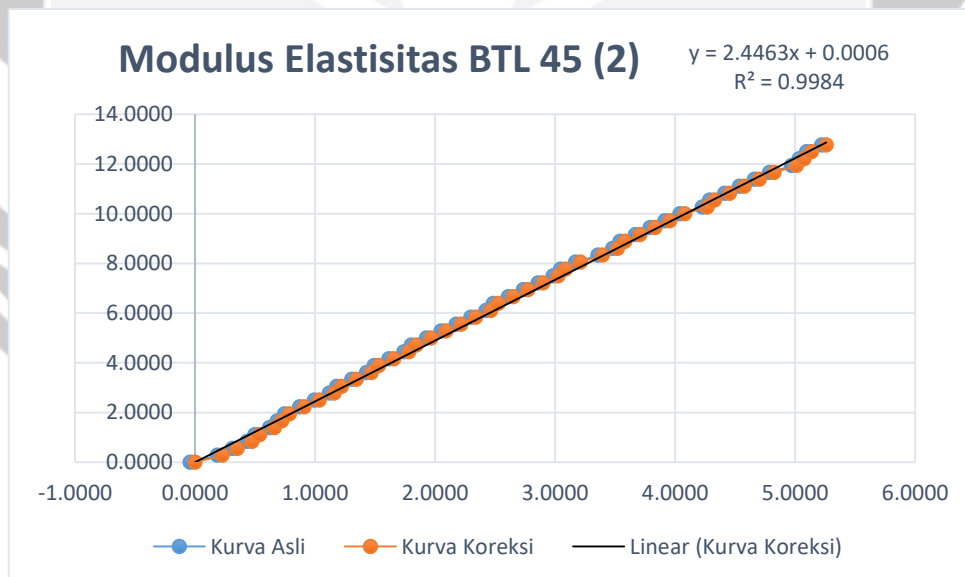
Fax. +62-274-487748

Kode Benda Uji      BTL 45    No. 2  
 Ao                      17663.61    mm<sup>2</sup>  
 diameter baut        7.5        mm  
 P<sub>0</sub>                      201.1       mm  
 E<sub>c</sub>                      24272.75    MPa  
 x koreksi                0.0395

| Beban |         | Compressometer ( $\Delta P$ ) |                        | Tegangan | Regangan awal    | Regangan koreksi |
|-------|---------|-------------------------------|------------------------|----------|------------------|------------------|
| Kgf   | N       | $1 \times 10^{-2}$            | $(1 \times 10^{-2})/2$ | MPa      | $\times 10^{-4}$ | $\times 10^{-4}$ |
| 0     | 0       | 0.00                          | 0.000                  | 0.0000   | -0.0395          | 0.0000           |
| 500   | 4903.36 | 0.75                          | 0.375                  | 0.2776   | 0.1865           | 0.2260           |
| 1000  | 9806.71 | 1.25                          | 0.625                  | 0.5552   | 0.3108           | 0.3503           |
| 1500  | 14710.1 | 1.75                          | 0.875                  | 0.8328   | 0.4351           | 0.4746           |
| 2000  | 19613.4 | 2.00                          | 1.000                  | 1.1104   | 0.4973           | 0.5368           |
| 2500  | 24516.8 | 2.50                          | 1.250                  | 1.3880   | 0.6216           | 0.6611           |
| 3000  | 29420.1 | 2.75                          | 1.375                  | 1.6656   | 0.6837           | 0.7233           |
| 3500  | 34323.5 | 3.00                          | 1.500                  | 1.9432   | 0.7459           | 0.7854           |
| 4000  | 39226.8 | 3.50                          | 1.750                  | 2.2208   | 0.8702           | 0.9097           |
| 4500  | 44130.2 | 4.00                          | 2.000                  | 2.4984   | 0.9945           | 1.0341           |
| 5000  | 49033.6 | 4.50                          | 2.250                  | 2.7760   | 1.1188           | 1.1584           |
| 5500  | 53936.9 | 4.75                          | 2.375                  | 3.0536   | 1.1810           | 1.2205           |
| 6000  | 58840.3 | 5.25                          | 2.625                  | 3.3312   | 1.3053           | 1.3448           |
| 6500  | 63743.6 | 5.75                          | 2.875                  | 3.6088   | 1.4296           | 1.4692           |
| 7000  | 68647   | 6.00                          | 3.000                  | 3.8864   | 1.4918           | 1.5313           |
| 7500  | 73550.3 | 6.50                          | 3.250                  | 4.1639   | 1.6161           | 1.6556           |
| 8000  | 78453.7 | 7.00                          | 3.500                  | 4.4415   | 1.7404           | 1.7800           |
| 8500  | 83357   | 7.25                          | 3.625                  | 4.7191   | 1.8026           | 1.8421           |
| 9000  | 88260.4 | 7.75                          | 3.875                  | 4.9967   | 1.9269           | 1.9664           |
| 9500  | 93163.7 | 8.25                          | 4.125                  | 5.2743   | 2.0512           | 2.0907           |
| 10000 | 98067.1 | 8.75                          | 4.375                  | 5.5519   | 2.1755           | 2.2151           |
| 10500 | 102970  | 9.25                          | 4.625                  | 5.8295   | 2.2999           | 2.3394           |
| 11000 | 107874  | 9.75                          | 4.875                  | 6.1071   | 2.4242           | 2.4637           |
| 11500 | 112777  | 10.00                         | 5.000                  | 6.3847   | 2.4863           | 2.5259           |
| 12000 | 117681  | 10.50                         | 5.250                  | 6.6623   | 2.6106           | 2.6502           |
| 12500 | 122584  | 11.00                         | 5.500                  | 6.9399   | 2.7350           | 2.7745           |
| 13000 | 127487  | 11.50                         | 5.750                  | 7.2175   | 2.8593           | 2.8988           |
| 13500 | 132391  | 12.00                         | 6.000                  | 7.4951   | 2.9836           | 3.0231           |
| 14000 | 137294  | 12.25                         | 6.125                  | 7.7727   | 3.0457           | 3.0853           |
| 14500 | 142197  | 12.75                         | 6.375                  | 8.0503   | 3.1701           | 3.2096           |



|       |        |       |        |         |        |        |
|-------|--------|-------|--------|---------|--------|--------|
| 15000 | 147101 | 13.50 | 6.750  | 8.3279  | 3.3565 | 3.3961 |
| 15500 | 152004 | 14.00 | 7.000  | 8.6055  | 3.4809 | 3.5204 |
| 16000 | 156907 | 14.25 | 7.125  | 8.8831  | 3.5430 | 3.5825 |
| 16500 | 161811 | 14.76 | 7.378  | 9.1607  | 3.6686 | 3.7081 |
| 17000 | 166714 | 15.25 | 7.625  | 9.4383  | 3.7916 | 3.8312 |
| 17500 | 171617 | 15.75 | 7.875  | 9.7159  | 3.9160 | 3.9555 |
| 18000 | 176521 | 16.25 | 8.125  | 9.9935  | 4.0403 | 4.0798 |
| 18500 | 181424 | 17.00 | 8.500  | 10.2711 | 4.2268 | 4.2663 |
| 19000 | 186327 | 17.25 | 8.625  | 10.5487 | 4.2889 | 4.3284 |
| 19500 | 191231 | 17.75 | 8.875  | 10.8263 | 4.4132 | 4.4528 |
| 20000 | 196134 | 18.25 | 9.125  | 11.1039 | 4.5375 | 4.5771 |
| 20500 | 201038 | 18.75 | 9.375  | 11.3815 | 4.6619 | 4.7014 |
| 21000 | 205941 | 19.25 | 9.625  | 11.6591 | 4.7862 | 4.8257 |
| 21500 | 210844 | 20.00 | 10.000 | 11.9366 | 4.9727 | 5.0122 |
| 22000 | 215748 | 20.25 | 10.125 | 12.2142 | 5.0348 | 5.0743 |
| 22500 | 220651 | 20.50 | 10.250 | 12.4918 | 5.0970 | 5.1365 |
| 23000 | 225554 | 21.00 | 10.500 | 12.7694 | 5.2213 | 5.2608 |





# 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

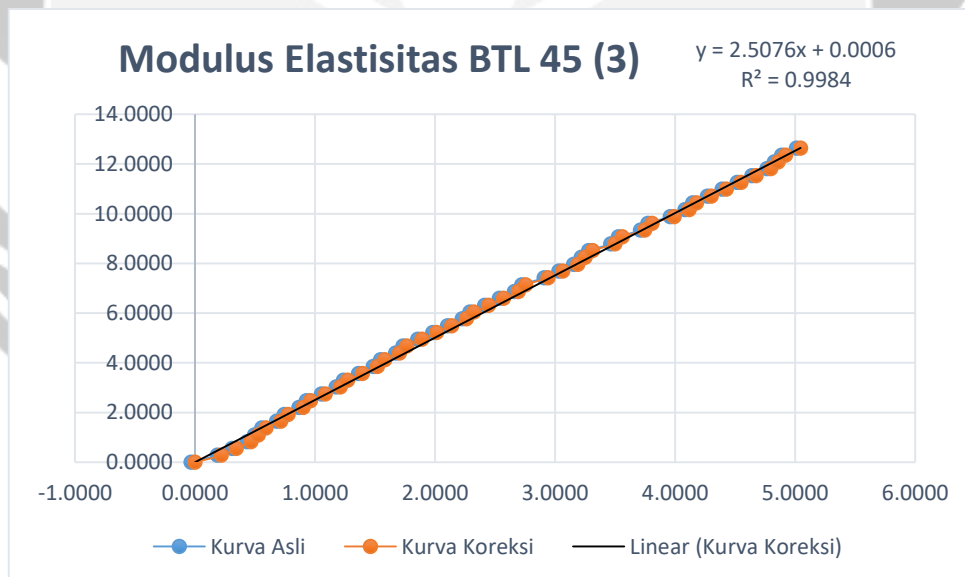
Fax. +62-274-487748

Kode Benda Uji      BTL 45    No. 3  
 Ao                      17856.51    mm<sup>2</sup>  
 diameter baut        7.5        mm  
 P0                      202        mm  
 Ec                      25034.31    MPa  
 x koreksi              0.0333

| Beban |         | Compressometer ( $\Delta P$ ) |                        | Tegangan | Regangan awal    | Regangan koreksi |
|-------|---------|-------------------------------|------------------------|----------|------------------|------------------|
| Kgf   | N       | $1 \times 10^{-2}$            | $(1 \times 10^{-2})/2$ | MPa      | $\times 10^{-4}$ | $\times 10^{-4}$ |
| 0     | 0       | 0.00                          | 0.000                  | 0.0000   | -0.0333          | 0.0000           |
| 500   | 4903.36 | 0.75                          | 0.375                  | 0.2746   | 0.1856           | 0.2189           |
| 1000  | 9806.71 | 1.25                          | 0.625                  | 0.5492   | 0.3094           | 0.3427           |
| 1500  | 14710.1 | 1.75                          | 0.875                  | 0.8238   | 0.4332           | 0.4665           |
| 2000  | 19613.4 | 2.00                          | 1.000                  | 1.0984   | 0.4950           | 0.5283           |
| 2500  | 24516.8 | 2.25                          | 1.125                  | 1.3730   | 0.5569           | 0.5902           |
| 3000  | 29420.1 | 2.75                          | 1.375                  | 1.6476   | 0.6807           | 0.7140           |
| 3500  | 34323.5 | 3.00                          | 1.500                  | 1.9222   | 0.7426           | 0.7759           |
| 4000  | 39226.8 | 3.50                          | 1.750                  | 2.1968   | 0.8663           | 0.8996           |
| 4500  | 44130.2 | 3.75                          | 1.875                  | 2.4714   | 0.9282           | 0.9615           |
| 5000  | 49033.6 | 4.25                          | 2.125                  | 2.7460   | 1.0520           | 1.0853           |
| 5500  | 53936.9 | 4.75                          | 2.375                  | 3.0206   | 1.1757           | 1.2090           |
| 6000  | 58840.3 | 5.00                          | 2.500                  | 3.2952   | 1.2376           | 1.2709           |
| 6500  | 63743.6 | 5.50                          | 2.750                  | 3.5698   | 1.3614           | 1.3947           |
| 7000  | 68647   | 6.00                          | 3.000                  | 3.8444   | 1.4851           | 1.5184           |
| 7500  | 73550.3 | 6.25                          | 3.125                  | 4.1190   | 1.5470           | 1.5803           |
| 8000  | 78453.7 | 6.75                          | 3.375                  | 4.3936   | 1.6708           | 1.7041           |
| 8500  | 83357   | 7.00                          | 3.500                  | 4.6682   | 1.7327           | 1.7660           |
| 9000  | 88260.4 | 7.50                          | 3.750                  | 4.9428   | 1.8564           | 1.8897           |
| 9500  | 93163.7 | 8.00                          | 4.000                  | 5.2174   | 1.9802           | 2.0135           |
| 10000 | 98067.1 | 8.50                          | 4.250                  | 5.4920   | 2.1040           | 2.1373           |
| 10500 | 102970  | 9.00                          | 4.500                  | 5.7666   | 2.2277           | 2.2610           |
| 11000 | 107874  | 9.25                          | 4.625                  | 6.0411   | 2.2896           | 2.3229           |
| 11500 | 112777  | 9.75                          | 4.875                  | 6.3157   | 2.4134           | 2.4467           |
| 12000 | 117681  | 10.25                         | 5.125                  | 6.5903   | 2.5371           | 2.5704           |
| 12500 | 122584  | 10.75                         | 5.375                  | 6.8649   | 2.6609           | 2.6942           |
| 13000 | 127487  | 11.00                         | 5.500                  | 7.1395   | 2.7228           | 2.7561           |
| 13500 | 132391  | 11.75                         | 5.875                  | 7.4141   | 2.9084           | 2.9417           |
| 14000 | 137294  | 12.25                         | 6.125                  | 7.6887   | 3.0322           | 3.0655           |
| 14500 | 142197  | 12.75                         | 6.375                  | 7.9633   | 3.1559           | 3.1892           |



|       |        |       |        |         |        |        |
|-------|--------|-------|--------|---------|--------|--------|
| 15000 | 147101 | 13.00 | 6.500  | 8.2379  | 3.2178 | 3.2511 |
| 15500 | 152004 | 13.25 | 6.625  | 8.5125  | 3.2797 | 3.3130 |
| 16000 | 156907 | 14.00 | 7.000  | 8.7871  | 3.4653 | 3.4986 |
| 16500 | 161811 | 14.25 | 7.125  | 9.0617  | 3.5272 | 3.5605 |
| 17000 | 166714 | 15.00 | 7.500  | 9.3363  | 3.7129 | 3.7462 |
| 17500 | 171617 | 15.25 | 7.625  | 9.6109  | 3.7748 | 3.8080 |
| 18000 | 176521 | 16.00 | 8.000  | 9.8855  | 3.9604 | 3.9937 |
| 18500 | 181424 | 16.50 | 8.250  | 10.1601 | 4.0842 | 4.1175 |
| 19000 | 186327 | 16.75 | 8.375  | 10.4347 | 4.1460 | 4.1793 |
| 19500 | 191231 | 17.25 | 8.625  | 10.7093 | 4.2698 | 4.3031 |
| 20000 | 196134 | 17.75 | 8.875  | 10.9839 | 4.3936 | 4.4269 |
| 20500 | 201038 | 18.25 | 9.125  | 11.2585 | 4.5173 | 4.5506 |
| 21000 | 205941 | 18.75 | 9.375  | 11.5331 | 4.6411 | 4.6744 |
| 21500 | 210844 | 19.25 | 9.625  | 11.8077 | 4.7649 | 4.7981 |
| 22000 | 215748 | 19.50 | 9.750  | 12.0823 | 4.8267 | 4.8600 |
| 22500 | 220651 | 19.75 | 9.875  | 12.3569 | 4.8886 | 4.9219 |
| 23000 | 225554 | 20.25 | 10.125 | 12.6315 | 5.0124 | 5.0457 |





# UNIVERSITAS ATMA JAYA YOGYAKARTA

Fakultas Teknik Program Studi Teknik Sipil

Laboratorium Struktur dan Bahan Bangunan

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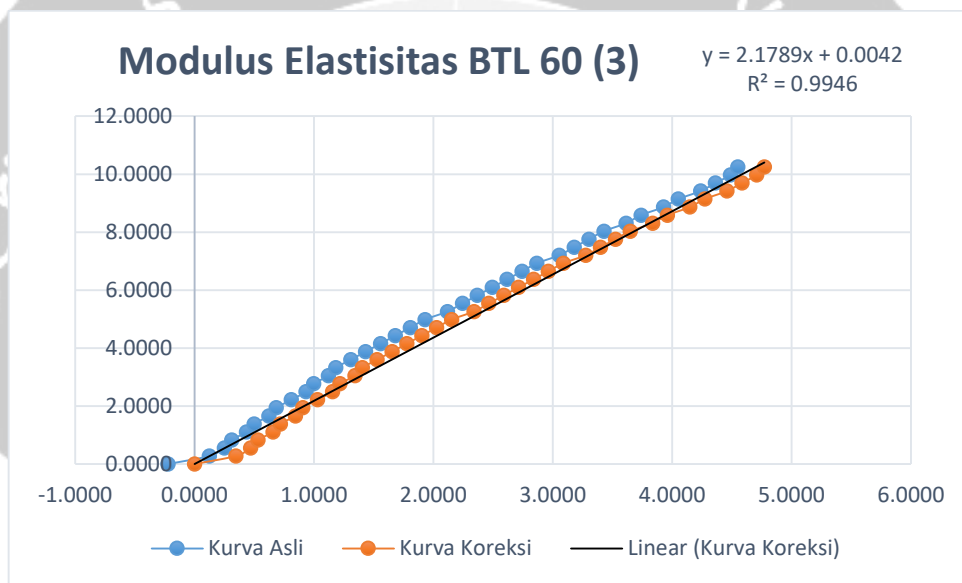
Fax. +62-274-487748

Kode Benda Uji      BTL 60    No. 3  
 Ao                      17702.89    mm<sup>2</sup>  
 diameter baut        7.5        mm  
 P<sub>0</sub>                      200.5       mm  
 E<sub>c</sub>                      21474.53    MPa  
 x koreksi                0.2212

| Beban |         | Compressometer ( $\Delta P$ ) |                        | Tegangan | Regangan awal    | Regangan koreksi |
|-------|---------|-------------------------------|------------------------|----------|------------------|------------------|
| Kgf   | N       | $1 \times 10^{-2}$            | $(1 \times 10^{-2})/2$ | MPa      | $\times 10^{-4}$ | $\times 10^{-4}$ |
| 0     | 0       | 0.00                          | 0.000                  | 0.0000   | -0.2212          | 0.0000           |
| 500   | 4903.36 | 0.50                          | 0.250                  | 0.2770   | 0.1247           | 0.3459           |
| 1000  | 9806.71 | 1.00                          | 0.500                  | 0.5540   | 0.2494           | 0.4705           |
| 1500  | 14710.1 | 1.25                          | 0.625                  | 0.8309   | 0.3117           | 0.5329           |
| 2000  | 19613.4 | 1.75                          | 0.875                  | 1.1079   | 0.4364           | 0.6576           |
| 2500  | 24516.8 | 2.00                          | 1.000                  | 1.3849   | 0.4988           | 0.7199           |
| 3000  | 29420.1 | 2.50                          | 1.250                  | 1.6619   | 0.6234           | 0.8446           |
| 3500  | 34323.5 | 2.75                          | 1.375                  | 1.9389   | 0.6858           | 0.9070           |
| 4000  | 39226.8 | 3.25                          | 1.625                  | 2.2158   | 0.8105           | 1.0316           |
| 4500  | 44130.2 | 3.75                          | 1.875                  | 2.4928   | 0.9352           | 1.1563           |
| 5000  | 49033.6 | 4.00                          | 2.000                  | 2.7698   | 0.9975           | 1.2187           |
| 5500  | 53936.9 | 4.50                          | 2.250                  | 3.0468   | 1.1222           | 1.3434           |
| 6000  | 58840.3 | 4.75                          | 2.375                  | 3.3238   | 1.1845           | 1.4057           |
| 6500  | 63743.6 | 5.25                          | 2.625                  | 3.6007   | 1.3092           | 1.5304           |
| 7000  | 68647   | 5.75                          | 2.875                  | 3.8777   | 1.4339           | 1.6551           |
| 7500  | 73550.3 | 6.25                          | 3.125                  | 4.1547   | 1.5586           | 1.7798           |
| 8000  | 78453.7 | 6.75                          | 3.375                  | 4.4317   | 1.6833           | 1.9045           |
| 8500  | 83357   | 7.25                          | 3.625                  | 4.7087   | 1.8080           | 2.0292           |
| 9000  | 88260.4 | 7.75                          | 3.875                  | 4.9856   | 1.9327           | 2.1538           |
| 9500  | 93163.7 | 8.50                          | 4.250                  | 5.2626   | 2.1197           | 2.3409           |
| 10000 | 98067.1 | 9.00                          | 4.500                  | 5.5396   | 2.2444           | 2.4656           |
| 10500 | 102970  | 9.50                          | 4.750                  | 5.8166   | 2.3691           | 2.5902           |
| 11000 | 107874  | 10.00                         | 5.000                  | 6.0936   | 2.4938           | 2.7149           |
| 11500 | 112777  | 10.50                         | 5.250                  | 6.3706   | 2.6185           | 2.8396           |
| 12000 | 117681  | 11.00                         | 5.500                  | 6.6475   | 2.7431           | 2.9643           |
| 12500 | 122584  | 11.50                         | 5.750                  | 6.9245   | 2.8678           | 3.0890           |
| 13000 | 127487  | 12.25                         | 6.125                  | 7.2015   | 3.0549           | 3.2760           |
| 13500 | 132391  | 12.75                         | 6.375                  | 7.4785   | 3.1796           | 3.4007           |
| 14000 | 137294  | 13.25                         | 6.625                  | 7.7555   | 3.3042           | 3.5254           |
| 14500 | 142197  | 13.75                         | 6.875                  | 8.0324   | 3.4289           | 3.6501           |



|       |        |       |       |         |        |        |
|-------|--------|-------|-------|---------|--------|--------|
| 15000 | 147101 | 14.50 | 7.250 | 8.3094  | 3.6160 | 3.8371 |
| 15500 | 152004 | 15.00 | 7.500 | 8.5864  | 3.7406 | 3.9618 |
| 16000 | 156907 | 15.75 | 7.875 | 8.8634  | 3.9277 | 4.1489 |
| 16500 | 161811 | 16.25 | 8.125 | 9.1404  | 4.0524 | 4.2735 |
| 17000 | 166714 | 17.00 | 8.500 | 9.4173  | 4.2394 | 4.4606 |
| 17500 | 171617 | 17.50 | 8.750 | 9.6943  | 4.3641 | 4.5853 |
| 18000 | 176521 | 18.00 | 9.000 | 9.9713  | 4.4888 | 4.7100 |
| 18500 | 181424 | 18.25 | 9.125 | 10.2483 | 4.5511 | 4.7723 |





# UNIVERSITAS ATMA JAYA YOGYAKARTA

Fakultas Teknik Program Studi Teknik Sipil

Laboratorium Struktur dan Bahan Bangunan

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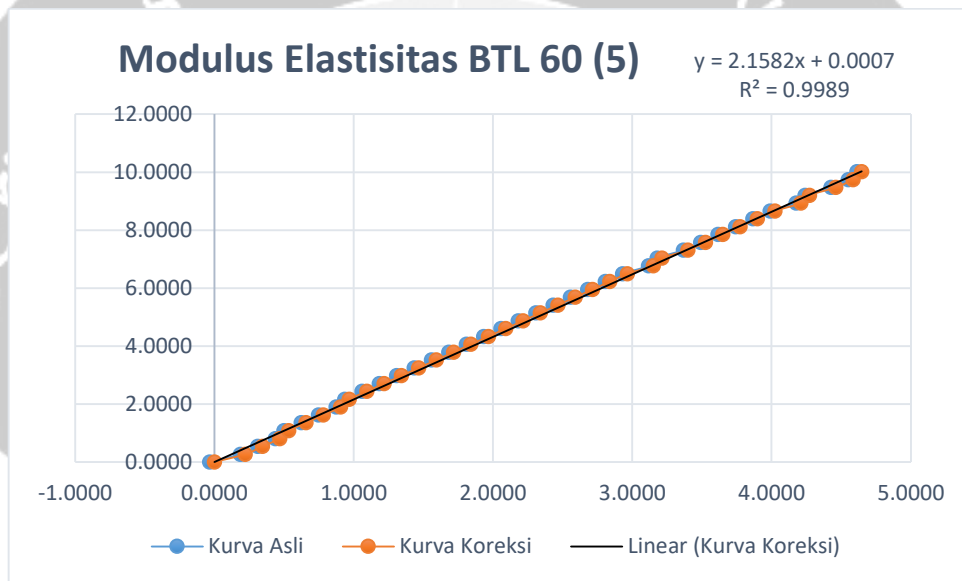
Fax. +62-274-487748

Kode Benda Uji      BTL 60    No. 5  
 Ao                      18114.02    mm<sup>2</sup>  
 diameter baut        7.5        mm  
 P<sub>0</sub>                      200.5       mm  
 E<sub>c</sub>                      21551.45    MPa  
 x koreksi                0.0339

| Beban |         | Compressometer ( $\Delta P$ ) |                        | Tegangan | Regangan awal    | Regangan koreksi |
|-------|---------|-------------------------------|------------------------|----------|------------------|------------------|
| Kgf   | N       | $1 \times 10^{-2}$            | $(1 \times 10^{-2})/2$ | MPa      | $\times 10^{-4}$ | $\times 10^{-4}$ |
| 0     | 0       | 0.00                          | 0.000                  | 0.0000   | -0.0339          | 0.0000           |
| 500   | 4903.36 | 0.75                          | 0.375                  | 0.2707   | 0.1870           | 0.2209           |
| 1000  | 9806.71 | 1.25                          | 0.625                  | 0.5414   | 0.3117           | 0.3456           |
| 1500  | 14710.1 | 1.75                          | 0.875                  | 0.8121   | 0.4364           | 0.4703           |
| 2000  | 19613.4 | 2.00                          | 1.000                  | 1.0828   | 0.4988           | 0.5326           |
| 2500  | 24516.8 | 2.50                          | 1.250                  | 1.3535   | 0.6234           | 0.6573           |
| 3000  | 29420.1 | 3.00                          | 1.500                  | 1.6242   | 0.7481           | 0.7820           |
| 3500  | 34323.5 | 3.50                          | 1.750                  | 1.8949   | 0.8728           | 0.9067           |
| 4000  | 39226.8 | 3.75                          | 1.875                  | 2.1656   | 0.9352           | 0.9690           |
| 4500  | 44130.2 | 4.25                          | 2.125                  | 2.4362   | 1.0599           | 1.0937           |
| 5000  | 49033.6 | 4.75                          | 2.375                  | 2.7069   | 1.1845           | 1.2184           |
| 5500  | 53936.9 | 5.25                          | 2.625                  | 2.9776   | 1.3092           | 1.3431           |
| 6000  | 58840.3 | 5.75                          | 2.875                  | 3.2483   | 1.4339           | 1.4678           |
| 6500  | 63743.6 | 6.25                          | 3.125                  | 3.5190   | 1.5586           | 1.5925           |
| 7000  | 68647   | 6.75                          | 3.375                  | 3.7897   | 1.6833           | 1.7172           |
| 7500  | 73550.3 | 7.25                          | 3.625                  | 4.0604   | 1.8080           | 1.8418           |
| 8000  | 78453.7 | 7.75                          | 3.875                  | 4.3311   | 1.9327           | 1.9665           |
| 8500  | 83357   | 8.25                          | 4.125                  | 4.6018   | 2.0574           | 2.0912           |
| 9000  | 88260.4 | 8.75                          | 4.375                  | 4.8725   | 2.1820           | 2.2159           |
| 9500  | 93163.7 | 9.25                          | 4.625                  | 5.1432   | 2.3067           | 2.3406           |
| 10000 | 98067.1 | 9.75                          | 4.875                  | 5.4139   | 2.4314           | 2.4653           |
| 10500 | 102970  | 10.25                         | 5.125                  | 5.6846   | 2.5561           | 2.5900           |
| 11000 | 107874  | 10.75                         | 5.375                  | 5.9553   | 2.6808           | 2.7147           |
| 11500 | 112777  | 11.25                         | 5.625                  | 6.2260   | 2.8055           | 2.8394           |
| 12000 | 117681  | 11.75                         | 5.875                  | 6.4967   | 2.9302           | 2.9640           |
| 12500 | 122584  | 12.50                         | 6.250                  | 6.7673   | 3.1172           | 3.1511           |
| 13000 | 127487  | 12.75                         | 6.375                  | 7.0380   | 3.1796           | 3.2134           |
| 13500 | 132391  | 13.50                         | 6.750                  | 7.3087   | 3.3666           | 3.4004           |
| 14000 | 137294  | 14.00                         | 7.000                  | 7.5794   | 3.4913           | 3.5251           |
| 14500 | 142197  | 14.50                         | 7.250                  | 7.8501   | 3.6160           | 3.6498           |



|       |        |       |       |         |        |        |
|-------|--------|-------|-------|---------|--------|--------|
| 15000 | 147101 | 15.00 | 7.500 | 8.1208  | 3.7406 | 3.7745 |
| 15500 | 152004 | 15.50 | 7.750 | 8.3915  | 3.8653 | 3.8992 |
| 16000 | 156907 | 16.00 | 8.000 | 8.6622  | 3.9900 | 4.0239 |
| 16500 | 161811 | 16.75 | 8.375 | 8.9329  | 4.1771 | 4.2109 |
| 17000 | 166714 | 17.00 | 8.500 | 9.2036  | 4.2394 | 4.2733 |
| 17500 | 171617 | 17.75 | 8.875 | 9.4743  | 4.4264 | 4.4603 |
| 18000 | 176521 | 18.25 | 9.125 | 9.7450  | 4.5511 | 4.5850 |
| 18500 | 181424 | 18.50 | 9.250 | 10.0157 | 4.6135 | 4.6473 |





# UNIVERSITAS ATMA JAYA YOGYAKARTA

Fakultas Teknik Program Studi Teknik Sipil

Laboratorium Struktur dan Bahan Bangunan

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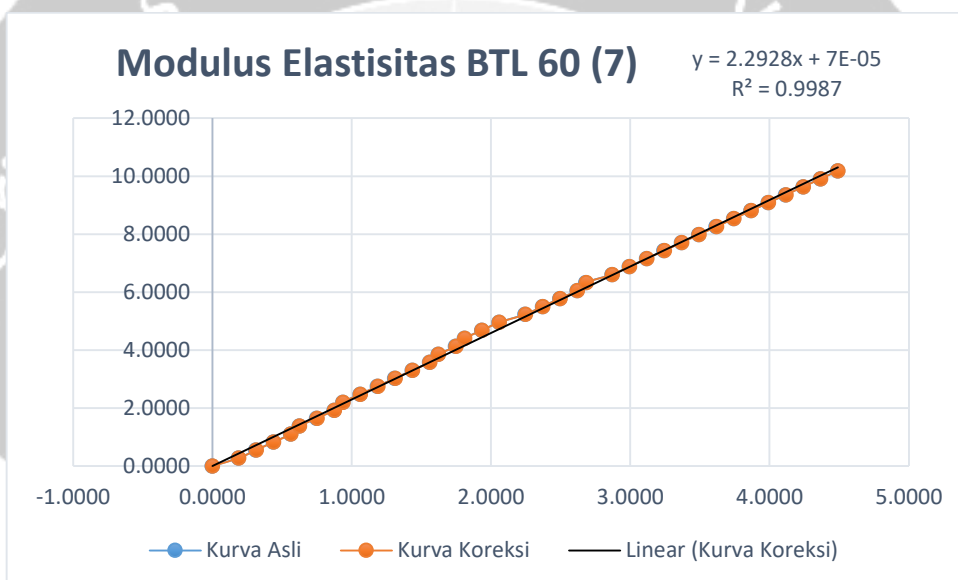
Fax. +62-274-487748

Kode Benda Uji      BTL 60    No. 7  
 Ao                      17813.11    mm<sup>2</sup>  
 diameter baut        7.5        mm  
 P0                      200.5       mm  
 Ec                      22674.85    MPa  
 x koreksi              0.0029

| Beban |         | Compressometer ( $\Delta P$ ) |                        | Tegangan | Regangan awal    | Regangan koreksi |
|-------|---------|-------------------------------|------------------------|----------|------------------|------------------|
| Kgf   | N       | $1 \times 10^{-2}$            | $(1 \times 10^{-2})/2$ | MPa      | $\times 10^{-4}$ | $\times 10^{-4}$ |
| 0     | 0       | 0.00                          | 0.000                  | 0.0000   | -0.0029          | 0.0000           |
| 500   | 4903.36 | 0.75                          | 0.375                  | 0.2753   | 0.1870           | 0.1900           |
| 1000  | 9806.71 | 1.25                          | 0.625                  | 0.5505   | 0.3117           | 0.3146           |
| 1500  | 14710.1 | 1.75                          | 0.875                  | 0.8258   | 0.4364           | 0.4393           |
| 2000  | 19613.4 | 2.25                          | 1.125                  | 1.1011   | 0.5611           | 0.5640           |
| 2500  | 24516.8 | 2.50                          | 1.250                  | 1.3763   | 0.6234           | 0.6264           |
| 3000  | 29420.1 | 3.00                          | 1.500                  | 1.6516   | 0.7481           | 0.7511           |
| 3500  | 34323.5 | 3.50                          | 1.750                  | 1.9269   | 0.8728           | 0.8757           |
| 4000  | 39226.8 | 3.75                          | 1.875                  | 2.2021   | 0.9352           | 0.9381           |
| 4500  | 44130.2 | 4.25                          | 2.125                  | 2.4774   | 1.0599           | 1.0628           |
| 5000  | 49033.6 | 4.75                          | 2.375                  | 2.7527   | 1.1845           | 1.1875           |
| 5500  | 53936.9 | 5.25                          | 2.625                  | 3.0279   | 1.3092           | 1.3121           |
| 6000  | 58840.3 | 5.75                          | 2.875                  | 3.3032   | 1.4339           | 1.4368           |
| 6500  | 63743.6 | 6.25                          | 3.125                  | 3.5785   | 1.5586           | 1.5615           |
| 7000  | 68647   | 6.50                          | 3.250                  | 3.8537   | 1.6209           | 1.6239           |
| 7500  | 73550.3 | 7.00                          | 3.500                  | 4.1290   | 1.7456           | 1.7486           |
| 8000  | 78453.7 | 7.25                          | 3.625                  | 4.4043   | 1.8080           | 1.8109           |
| 8500  | 83357   | 7.75                          | 3.875                  | 4.6795   | 1.9327           | 1.9356           |
| 9000  | 88260.4 | 8.25                          | 4.125                  | 4.9548   | 2.0574           | 2.0603           |
| 9500  | 93163.7 | 9.00                          | 4.500                  | 5.2301   | 2.2444           | 2.2473           |
| 10000 | 98067.1 | 9.50                          | 4.750                  | 5.5053   | 2.3691           | 2.3720           |
| 10500 | 102970  | 10.00                         | 5.000                  | 5.7806   | 2.4938           | 2.4967           |
| 11000 | 107874  | 10.50                         | 5.250                  | 6.0559   | 2.6185           | 2.6214           |
| 11500 | 112777  | 10.75                         | 5.375                  | 6.3311   | 2.6808           | 2.6837           |
| 12000 | 117681  | 11.50                         | 5.750                  | 6.6064   | 2.8678           | 2.8708           |
| 12500 | 122584  | 12.00                         | 6.000                  | 6.8817   | 2.9925           | 2.9954           |
| 13000 | 127487  | 12.50                         | 6.250                  | 7.1569   | 3.1172           | 3.1201           |
| 13500 | 132391  | 13.00                         | 6.500                  | 7.4322   | 3.2419           | 3.2448           |
| 14000 | 137294  | 13.50                         | 6.750                  | 7.7075   | 3.3666           | 3.3695           |
| 14500 | 142197  | 14.00                         | 7.000                  | 7.9827   | 3.4913           | 3.4942           |



|       |        |       |       |         |        |        |
|-------|--------|-------|-------|---------|--------|--------|
| 15000 | 147101 | 14.50 | 7.250 | 8.2580  | 3.6160 | 3.6189 |
| 15500 | 152004 | 15.00 | 7.500 | 8.5333  | 3.7406 | 3.7436 |
| 16000 | 156907 | 15.50 | 7.750 | 8.8085  | 3.8653 | 3.8683 |
| 16500 | 161811 | 16.00 | 8.000 | 9.0838  | 3.9900 | 3.9929 |
| 17000 | 166714 | 16.50 | 8.250 | 9.3591  | 4.1147 | 4.1176 |
| 17500 | 171617 | 17.00 | 8.500 | 9.6343  | 4.2394 | 4.2423 |
| 18000 | 176521 | 17.50 | 8.750 | 9.9096  | 4.3641 | 4.3670 |
| 18500 | 181424 | 18.00 | 9.000 | 10.1849 | 4.4888 | 4.4917 |





### D.3. PENGUJIAN KUAT TARIK BELAH BETON

| Kode      | No | Dimensi   |           | Luas<br>(mm <sup>2</sup> ) | Berat<br>(kg) | Berat<br>Jenis<br>(KN/m <sup>3</sup> ) | Beban<br>Tarik<br>(KN) | Kuat<br>Tarik<br>(MPa) | Rata-<br>Rata<br>(MPa) |
|-----------|----|-----------|-----------|----------------------------|---------------|----------------------------------------|------------------------|------------------------|------------------------|
|           |    | D<br>(mm) | T<br>(mm) |                            |               |                                        |                        |                        |                        |
| BN        | 1  | 155.1     | 305.4     | 18901.7                    | 12.62         | 21.45                                  | 185                    | 2.49                   | 3.04                   |
|           | 2  | 153.1     | 305.4     | 18401.4                    | 12.56         | 21.93                                  | 270                    | 3.68                   |                        |
|           | 3  | 153.8     | 307.1     | 18570.1                    | 12.48         | 21.47                                  | 220                    | 2.97                   |                        |
| BTL<br>0  | 1  | 149.9     | 304.3     | 17647.9                    | 13.82         | 25.25                                  | 200                    | 2.79                   | 3.33                   |
|           | 2  | 150.6     | 304.6     | 17813.1                    | 13.96         | 25.24                                  | 270                    | 3.75                   |                        |
|           | 3  | 150.7     | 305.0     | 17824.9                    | 14.04         | 25.34                                  | 250                    | 3.46                   |                        |
| BTL<br>15 | 1  | 151.4     | 308.1     | 18002.9                    | 12.86         | 22.75                                  | 310                    | 4.23                   | 3.67                   |
|           | 2  | 153.4     | 307.1     | 18477.6                    | 12.82         | 22.17                                  | 250                    | 3.38                   |                        |
|           | 3  | 152.4     | 306.4     | 18233.5                    | 12.86         | 22.58                                  | 250                    | 3.41                   |                        |
| BTL<br>30 | 1  | 148.2     | 303.1     | 17257.6                    | 14.18         | 26.59                                  | 235                    | 3.33                   | 3.49                   |
|           | 2  | 150.2     | 300.6     | 17710.8                    | 14.18         | 26.13                                  | 270                    | 3.81                   |                        |
|           | 3  | 151.2     | 303.0     | 17955.3                    | 14.72         | 26.54                                  | 240                    | 3.33                   |                        |
| BTL<br>45 | 1  | 150.1     | 303.9     | 17683.2                    | 14.68         | 26.80                                  | 255                    | 3.56                   | 3.79                   |
|           | 2  | 149.8     | 306.4     | 17620.4                    | 14.34         | 26.05                                  | 270                    | 3.74                   |                        |
|           | 3  | 150.6     | 302.5     | 17821                      | 14.16         | 25.77                                  | 290                    | 4.05                   |                        |
| BTL<br>60 | 1  | 153.1     | 302.3     | 18401.4                    | 13.12         | 23.13                                  | 200                    | 2.75                   | 3.05                   |
|           | 2  | 152.4     | 303.8     | 18233.5                    | 13.12         | 23.24                                  | 260                    | 3.58                   |                        |
|           | 3  | 155.5     | 305.1     | 18983                      | 13.08         | 22.16                                  | 210                    | 2.82                   |                        |

Dengan Keterangan :

D = Diameter

T = Tinggi

Contoh Perhitungan: Kode BTL 0 No.1

$$\begin{aligned} 1. \text{ Berat Jenis} &= 13,82 \times 9,81 / (0,25 \times \pi \times 149,9^2 \times 304,3 \times 10^{-9}) \\ &= 25245,4 \text{ N/m}^3 \\ &= 25,25 \text{ KN/m}^3 \end{aligned}$$



$$\begin{aligned} 2. \quad \text{Kuat Tarik} &= \frac{2P}{\pi DL} \\ &= \frac{2 \times 200 \times 1000}{\pi \times 149,9 \times 304,3} \\ &= 2,79 \text{ MPa} \end{aligned}$$





### **E. DOKUMENTASI PENELITIAN**



**Pengujian Berat Jenis Terak Logam**



**Pengujian Zat Organik Pasir**



**Pengujian Berat Volume Terak Logam**



**Pengujian Los Angeles Abration**



**Pengujian Nilai Slump**



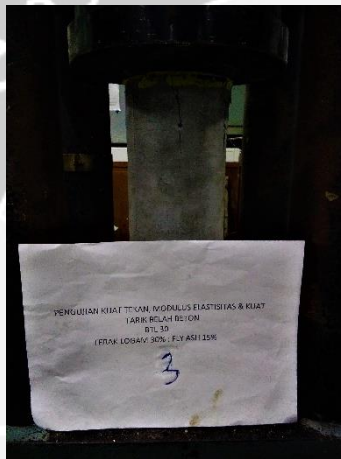
**Perawatan Benda Uji**



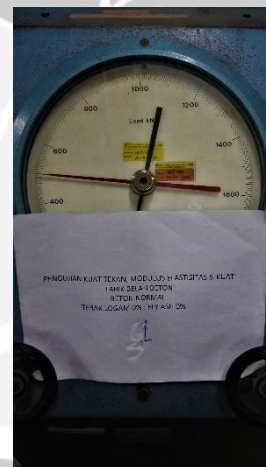
**Proses Mixing**



**Beton Setelah Dicitak**



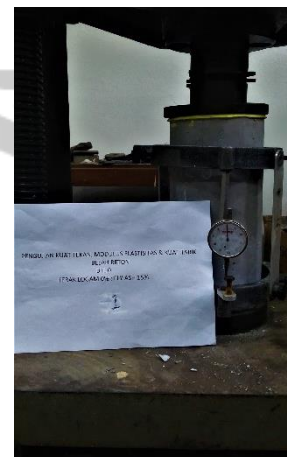
**Pengujian Kuat Tekan**



**Pengujian Kuat Tekan**



**Pengujian Kuat Tarik Belah**



**Pengujian Modulus Elastisitas**