

LAMPIRAN

1. Analisis Saringan dan Hidrometer

1.1. Analisis Saringan

| Saringan | | Tertahan saringan (gram) | Jumlah Tertahan (gram) | Prosentase Tertahan (%) | Prosentase Lolos Saringan (%) |
|----------|---------------|-----------------------------|---------------------------|----------------------------|----------------------------------|
| No. | Diameter (mm) | | | | |
| 4 | 4,75 | 0 | 0 | 0 | 100 |
| 10 | 2 | 0 | 0 | 0 | 100 |
| 20 | 0,85 | 0 | 0 | 0 | 100 |
| 40 | 0,425 | 0 | 0 | 0 | 100 |
| 50 | 0,3 | 0 | 0 | 0 | 100 |
| 80 | 0,18 | 0 | 0 | 0 | 100 |
| 100 | 0,15 | 5,4 | 5,4 | 1,09 | 98,91 |
| 200 | 0,075 | 17,9 | 23,3 | 4,70 | 95,30 |
| Pan | - | 472,7 | 496 | 100 | 0 |
| Total | | 496 | | | |

1.2. Analisis Hidrometer

| t (menit) | T (°C) | Ra | Ct | Rc (Ra + Ct) | a | Finer (%) | Prosentase Lolos Finer (%) | R | L (cm) | L/t | K | D (mm) | Prosentase lolos Saringan no. 200 (%) |
|--------------|-----------|--------|------|-----------------|------|--------------|-------------------------------------|------|-----------|--------|--------|-----------|---|
| 0,5 | 26 | 1,0290 | 1,65 | 2,6790 | 1,01 | 5,4212 | 94,5788 | 30,0 | 9,569 | 19,138 | 0,0129 | 0,0564 | 90,1359 |
| 1 | 26 | 1,0285 | 1,65 | 2,6785 | 1,01 | 5,4202 | 89,1586 | 29,5 | 9,668 | 9,668 | 0,0129 | 0,0401 | 84,9703 |
| 2 | 26 | 1,0280 | 1,65 | 2,6780 | 1,01 | 5,4192 | 83,7395 | 29,0 | 9,767 | 4,883 | 0,0129 | 0,0285 | 79,8058 |
| 15 | 26 | 1,0275 | 1,65 | 2,6775 | 1,01 | 5,4181 | 78,3213 | 28,5 | 9,865 | 0,658 | 0,0129 | 0,0105 | 74,6421 |
| 30 | 26 | 1,0270 | 1,65 | 2,6770 | 1,01 | 5,4171 | 72,9042 | 28,0 | 9,964 | 0,332 | 0,0129 | 0,0074 | 69,4795 |
| 60 | 26 | 1,0260 | 1,65 | 2,6760 | 1,01 | 5,4151 | 67,4891 | 27,0 | 10,16 | 0,169 | 0,0129 | 0,0053 | 64,3187 |
| 120 | 26 | 1,0240 | 1,65 | 2,6740 | 1,01 | 5,4111 | 62,0780 | 25,0 | 10,56 | 0,088 | 0,0129 | 0,0038 | 59,1619 |
| 1440 | 26 | 1,0210 | 1,65 | 2,6710 | 1,01 | 5,4050 | 56,6730 | 22,0 | 11,15 | 0,008 | 0,0129 | 0,0011 | 54,0108 |

Ra = Pembacaan hidrometer aktual

Ct = Faktor koreksi temperatur

Rc = Pembacaan hidrometer koreksi

a = Faktor Koreksi

R = Koreksi hidrometer untuk meniskus

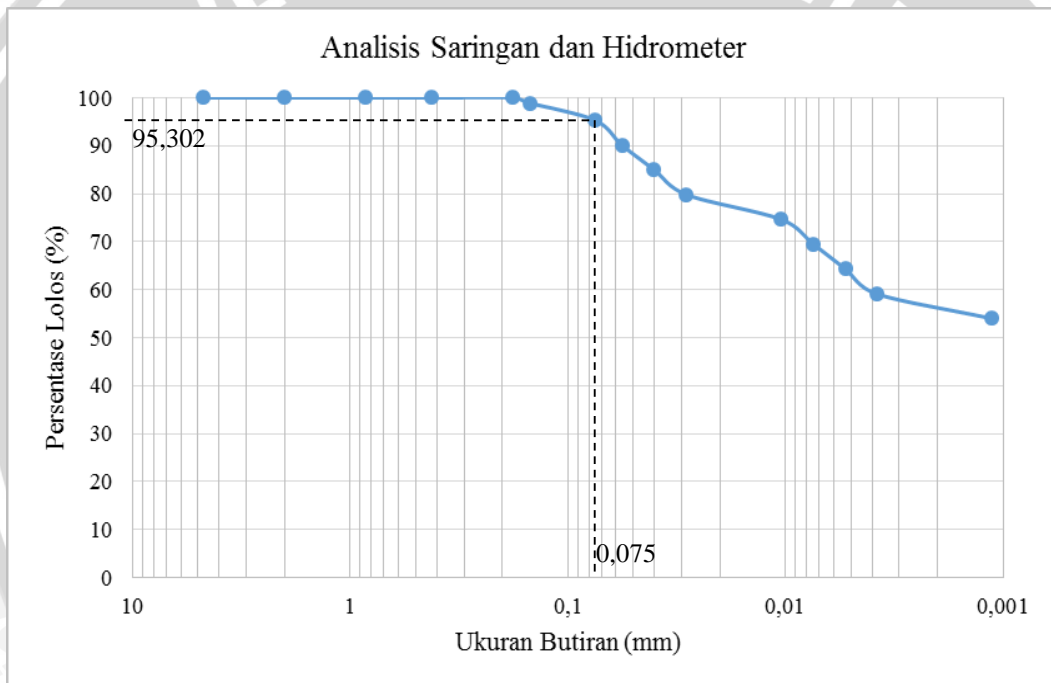
L = Kedalaman efektif

D = Diameter

Contoh Perhitungan:

- $a = \frac{1,65 \times G_s}{2,65 \times (G_s - 1)} = \frac{1,65 \times 2,6}{2,65 \times (2,6 - 1)} = 1,01$
- $Finer = \left(\frac{Ct + a}{W_s} \right) \times 100 = \left(\frac{1,65 + 1,01}{50} \right) \times 100 = 5,4212\%$
- Prosentase lolos finer = $100 - a = 100 - 5,4212 = 94,5788\%$
- $R = \{(Ra-1) \times 1000\} + 1 = \{(1,029-1) \times 1000\} + 1 = 30$
- $L = (-0,1976 \times (Ra)) + 15,497$
 $= (-0,1976 \times (1,029)) + 15,497 = 9,569 \text{ cm}$
- $D = K \times (L/t)^2 = 0,0129 \times (9,569/0,5)^2 = 90,1359\%$

Grafik Gabungan Analisis Sarinan dan Hidrometer



2. BATAS-BATAS ATTERBERG

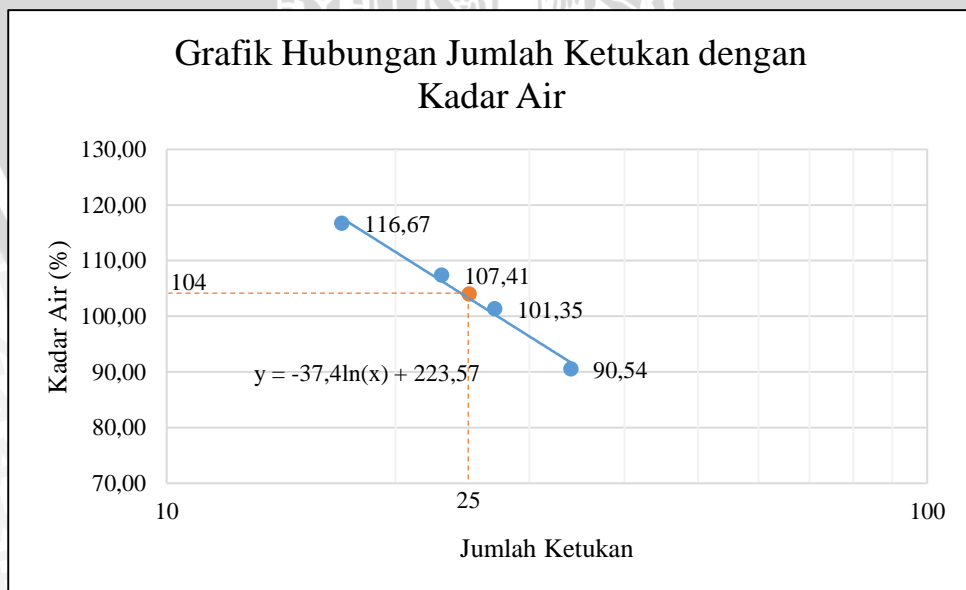
2.1. Batas-Batas Atterberg Tanah Lempung Ekspansif

1) Batas Plastis (*Plastic Limit*)

| Uraian | Satuan | Nomor Cawan | | | |
|----------------------------|--------|-------------|-------|-------|-------|
| | | I | II | III | IV |
| Berat Cawan | gram | 10,90 | 12,60 | 12,80 | 13,40 |
| Berat Cawan + Tanah Basah | gram | 8,70 | 10,50 | 10,70 | 11,20 |
| Berat Cawan + Tanah Kering | gram | 4,30 | 6,10 | 5,70 | 5,40 |
| Berat Air | gram | 4,40 | 4,40 | 5,00 | 5,80 |
| Berat Tanah Kering | gram | 2,20 | 2,10 | 2,10 | 2,20 |
| Kadar Air | % | 50,00 | 47,73 | 42,00 | 37,93 |
| Kadar Air Rata-Rata (PL) | % | 44,41 | | | |

2) Batas Cair (*Liquid Limit*)

| Uraian | Satuan | Jumlah Ketukan | | | |
|----------------------------|--------|----------------|--------|--------|-------|
| | | 17 | 23 | 27 | 34 |
| Berat Cawan | gram | 5,7 | 6 | 5,8 | 5,6 |
| Berat Cawan + Tanah Basah | gram | 21,3 | 22,8 | 20,7 | 19,7 |
| Berat Cawan + Tanah Kering | gram | 12,9 | 14,1 | 13,2 | 13 |
| Berat Air | gram | 8,40 | 8,70 | 7,50 | 6,70 |
| Berat Tanah Kering | gram | 7,20 | 8,10 | 7,40 | 7,40 |
| Kadar Air | % | 116,67 | 107,41 | 101,35 | 90,54 |



Kadar air pada ketukan ke-25:

$$LL = -37,4 \ln(25) + 223,57 = 104\%$$

3) Batas Susut (*Shrinkage Limit*)

| Uraian | Satuan | Hasil |
|------------------------------|--------|-------|
| Berat Cetakan | gram | 19,2 |
| Berat Cetakan + Tanah Basah | gram | 58,2 |
| Berat Cetakan + Tanah Kering | gram | 44,0 |
| Berat Tanah Basah | gram | 39,0 |
| Berat Tanah Kering | gram | 24,8 |
| Berat Air | gram | 14,2 |
| Isi Tanah Basah | mL | 25,50 |
| Isi Tanah Kering | mL | 12,00 |
| Kadar Air | % | 57,26 |
| SL | % | 2,82 |

$$\begin{aligned} SL &= \text{Kadar Air} + \left(\frac{\text{Isi Tanah Basah} - \text{Isi Tanah Kering}}{\text{Berat Tanah Kering}} \right) \times 100 \\ &= 57,26 + \left(\frac{25,5 - 12}{24,8} \right) \times 100 \\ &= 2,82\% \end{aligned}$$

4) Indeks Plastisitas

$$LL - PL = 104 - 2,82 = 59,59\%$$

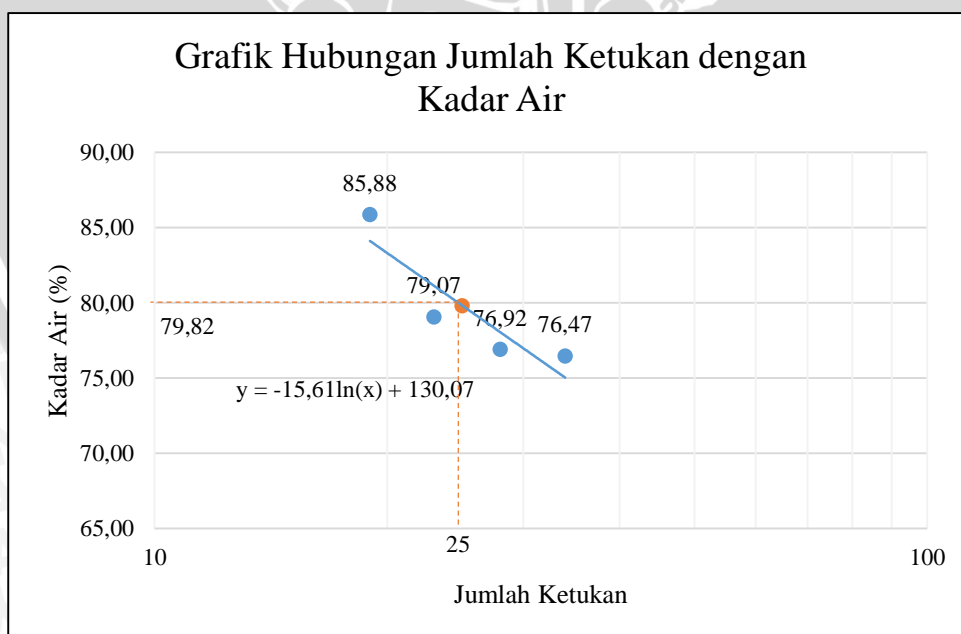
2.2. Batas-Batas Atterberg Tanah Lempung Ekspansif + 8% Abu Ampas Tebu

1) Batas Plastis (*Plastic Limit*)

| Uraian | Satuan | Nomor Cawan | | |
|----------------------------|--------|-------------|-------|-------|
| | | I | II | III |
| Berat Cawan | gr | 6,1 | 4,4 | 5,7 |
| Berat Cawan + Tanah Basah | gr | 8,0 | 6,3 | 7,7 |
| Berat Cawan + Tanah Kering | gr | 7,7 | 6,0 | 7,4 |
| Berat Air | gr | 0,3 | 0,3 | 0,3 |
| Berat Tanah Kering | gr | 1,6 | 1,6 | 1,7 |
| Kadar Air | % | 18,75 | 18,75 | 17,65 |
| Kadar Air Rata-Rata (PL) | % | 18,38 | | |

2) Batas Cair (*Liquid Limit*)

| Uraian | Satuan | Jumlah Ketukan | | | |
|----------------------------|--------|----------------|-------|-------|-------|
| | | 19 | 23 | 28 | 34 |
| Berat Cawan | gr | 6,1 | 5,7 | 4,4 | 6,1 |
| Berat Cawan + Tanah Basah | gr | 21,9 | 21,1 | 20,5 | 21,1 |
| Berat Cawan + Tanah Kering | gr | 14,6 | 14,3 | 13,5 | 14,6 |
| Berat Air | gr | 7,3 | 6,8 | 7,0 | 6,5 |
| Berat Tanah Kering | gr | 8,5 | 8,6 | 9,1 | 8,5 |
| Kadar Air | % | 85,88 | 79,07 | 76,92 | 76,47 |



Kadar air pada ketukan ke-25:

$$LL = -15,61 \ln(25) + 130,07 = 79,823\%$$

3) Batas Susut (*Shrinkage Limit*)

| Uraian | Satuan | Hasil |
|------------------------------|--------|-------|
| Berat Cetakan | gr | 12,8 |
| Berat Cetakan + Tanah Basah | gr | 67,1 |
| Berat Cetakan + Tanah Kering | gr | 42,4 |
| Berat Tanah Basah | gr | 54,3 |
| Berat Tanah Kering | gr | 29,6 |
| Berat Air | gr | 24,7 |
| Isi Tanah Basah | mL | 37,50 |
| Isi Tanah Kering | mL | 18,00 |
| Kadar Air | % | 83,45 |
| SL | % | 17,57 |

$$\begin{aligned}
 SL &= \text{Kadar Air} + \left(\frac{\text{Isi Tanah Basah} - \text{Isi Tanah Kering}}{\text{Berat Tanah Kering}} \right) \times 100 \\
 &= 83,45 + \left(\frac{37,5 - 18}{29,6} \right) \times 100 \\
 &= 17,57\%
 \end{aligned}$$

4) Indeks Plastisitas

$$LL - PL = 79,823 - 18,38 = 61,441\%$$

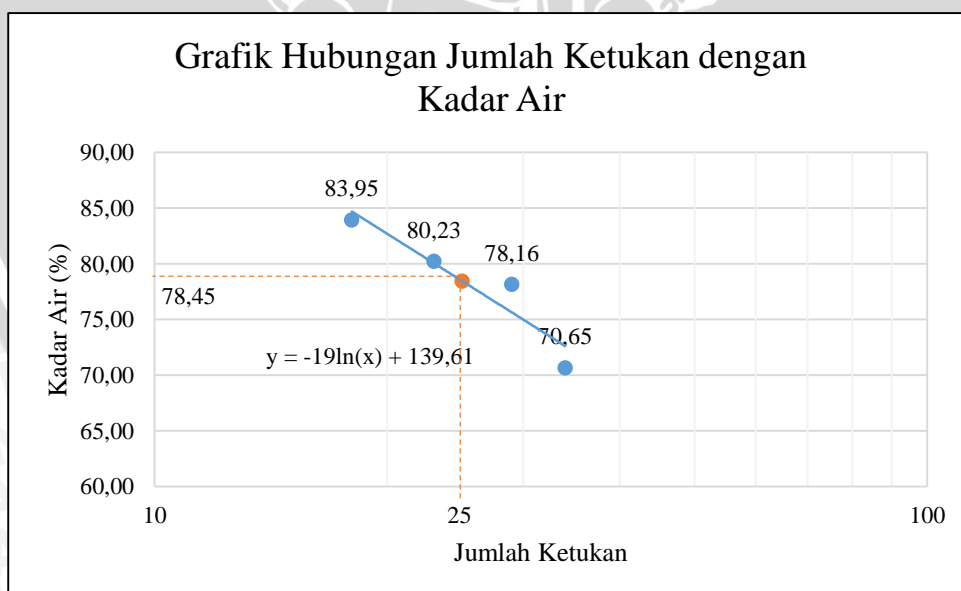
2.3. Batas-Batas *Atterberg* Tanah Lempung Ekspansif + 10% Abu Ampas Tebu

1) Batas Plastis (*Plastic Limit*)

| Uraian | Satuan | Nomor Cawan | | |
|----------------------------|--------|-------------|-------|-------|
| | | I | II | III |
| Berat Cawan | gr | 5,5 | 5,7 | 5,6 |
| Berat Cawan + Tanah Basah | gr | 8,0 | 8,1 | 7,8 |
| Berat Cawan + Tanah Kering | gr | 7,5 | 7,6 | 7,4 |
| Berat Air | gr | 0,5 | 0,5 | 0,4 |
| Berat Tanah Kering | gr | 2,0 | 1,9 | 1,8 |
| Kadar Air | % | 25,00 | 26,32 | 22,22 |
| Kadar Air Rata-Rata (PL) | % | 24,51 | | |

2) Batas Cair (*Liquid Limit*)

| Uraian | Satuan | Jumlah Ketukan | | | |
|----------------------------|--------|----------------|-------|-------|-------|
| | | 18 | 23 | 29 | 34 |
| Berat Cawan | gr | 5,6 | 5,6 | 5,9 | 5,4 |
| Berat Cawan + Tanah Basah | gr | 20,5 | 21,1 | 21,4 | 21,1 |
| Berat Cawan + Tanah Kering | gr | 13,7 | 14,2 | 14,6 | 14,6 |
| Berat Air | gr | 6,8 | 6,9 | 6,8 | 6,5 |
| Berat Tanah Kering | gr | 8,1 | 8,6 | 8,7 | 9,2 |
| Kadar Air | % | 83,95 | 80,23 | 78,16 | 70,65 |



Kadar air pada ketukan ke-25:

$$LL = -19 \ln(25) + 139,823 = 78,451\%$$

3) Batas Susut (*Shrinkage Limit*)

| Uraian | Satuan | Hasil |
|------------------------------|--------|-------|
| Berat Cetakan | gr | 19,2 |
| Berat Cetakan + Tanah Basah | gr | 56,0 |
| Berat Cetakan + Tanah Kering | gr | 39,4 |
| Berat Tanah Basah | gr | 36,8 |
| Berat Tanah Kering | gr | 20,2 |
| Berat Air | gr | 16,6 |
| Isi Tanah Basah | mL | 25,25 |
| Isi Tanah Kering | mL | 12,50 |
| Kadar Air | % | 82,18 |
| SL | % | 19,06 |

$$\begin{aligned}
 SL &= \text{Kadar Air} + \left(\frac{\text{Isi Tanah Basah} - \text{Isi Tanah Kering}}{\text{Berat Tanah Kering}} \right) \times 100 \\
 &= 82,18 + \left(\frac{25,25 - 12,5}{20,2} \right) \times 100 \\
 &= 19,06\%
 \end{aligned}$$

4) Indeks Plastisitas

$$LL - PL = 78,451 - 24,51 = 53,939\%$$

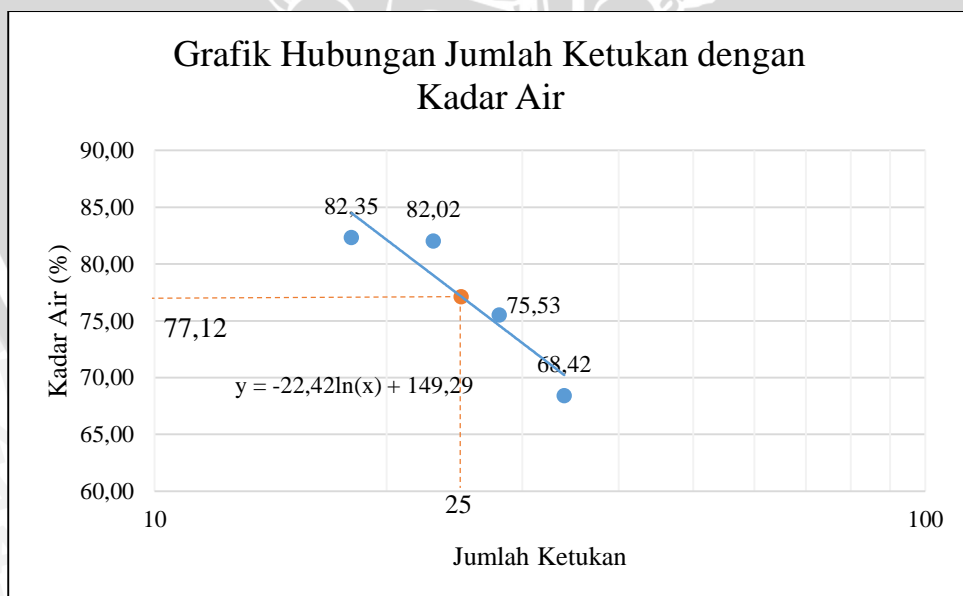
2.4. Batas-Batas *Atterberg* Tanah Lempung Ekspansif + 12% Abu Ampas Tebu

1) Batas Plastis (*Plastic Limit*)

| Uraian | Satuan | Nomor Cawan | | |
|----------------------------|--------|-------------|-------|-------|
| | | I | II | III |
| Berat Cawan | gr | 5,8 | 5,9 | 5,4 |
| Berat Cawan + Tanah Basah | gr | 8,6 | 8,4 | 8,1 |
| Berat Cawan + Tanah Kering | gr | 8,0 | 7,9 | 7,5 |
| Berat Air | gr | 0,6 | 0,5 | 0,6 |
| Berat Tanah Kering | gr | 2,2 | 2,0 | 2,1 |
| Kadar Air | % | 27,27 | 25,00 | 28,57 |
| Kadar Air Rata-Rata (PL) | % | 26,95 | | |

2) Batas Cair (*Liquid Limit*)

| Uraian | Satuan | Jumlah Ketukan | | | |
|----------------------------|--------|----------------|-------|-------|-------|
| | | 18 | 23 | 28 | 34 |
| Berat Cawan | gr | 5,4 | 5,6 | 5,4 | 5,8 |
| Berat Cawan + Tanah Basah | gr | 20,9 | 21,8 | 21,9 | 21,8 |
| Berat Cawan + Tanah Kering | gr | 13,9 | 14,5 | 14,8 | 15,3 |
| Berat Air | gr | 7,0 | 7,3 | 7,1 | 6,5 |
| Berat Tanah Kering | gr | 8,5 | 8,9 | 9,4 | 9,5 |
| Kadar Air | % | 82,35 | 82,02 | 75,53 | 68,42 |



Kadar air pada ketukan ke-25:

$$LL = -22,42 \ln(25) + 149,29 = 77,123\%$$

3) Batas Susut (*Shrinkage Limit*)

| Uraian | Satuan | Hasil |
|------------------------------|--------|-------|
| Berat Cetakan | gr | 19,2 |
| Berat Cetakan + Tanah Basah | gr | 55,7 |
| Berat Cetakan + Tanah Kering | gr | 39,3 |
| Berat Tanah Basah | gr | 36,5 |
| Berat Tanah Kering | gr | 20,1 |
| Berat Air | gr | 16,4 |
| Isi Tanah Basah | mL | 25,00 |
| Isi Tanah Kering | mL | 13,50 |
| Kadar Air | % | 81,59 |
| SL | % | 24,38 |

$$\begin{aligned}
 SL &= \text{Kadar Air} + \left(\frac{\text{Isi Tanah Basah} - \text{Isi Tanah Kering}}{\text{Berat Tanah Kering}} \right) \times 100 \\
 &= 81,59 + \left(\frac{25,00 - 13,5}{20,1} \right) \times 100 \\
 &= 24,38\%
 \end{aligned}$$

4) Indeks Plastisitas

$$LL - PL = 77,123 - 26,95 = 50,175\%$$

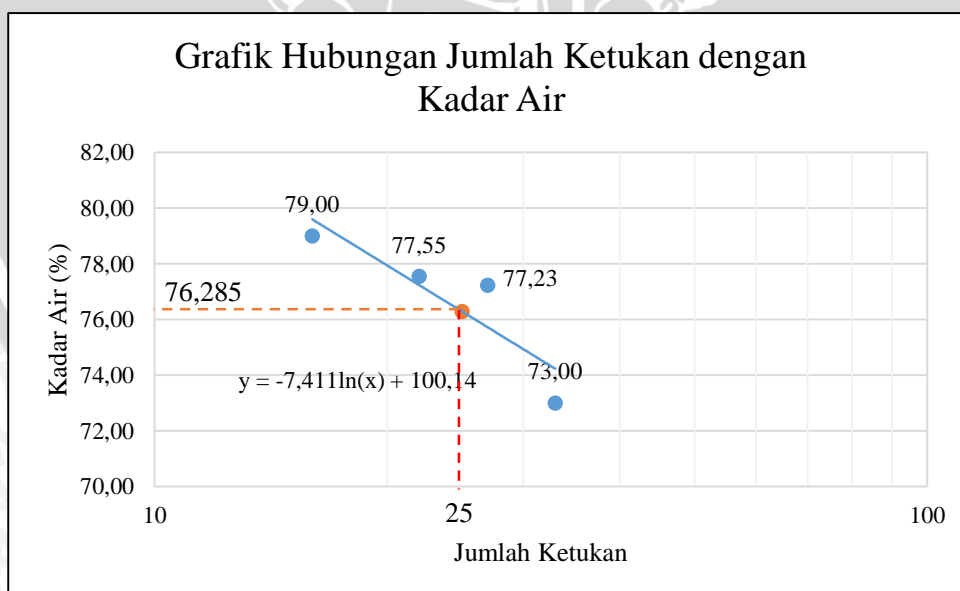
2.5. Batas-Batas *Atterberg* Tanah Lempung Ekspansif + 14% Abu Ampas Tebu

1) Batas Plastis (*Plastic Limit*)

| Uraian | Satuan | Nomor Cawan | | |
|----------------------------|--------|-------------|-------|-------|
| | | I | II | III |
| Berat Cawan | gr | 5,5 | 5,5 | 5,9 |
| Berat Cawan + Tanah Basah | gr | 7,6 | 7,9 | 8,2 |
| Berat Cawan + Tanah Kering | gr | 7,1 | 7,4 | 7,7 |
| Berat Air | gr | 0,5 | 0,5 | 0,5 |
| Berat Tanah Kering | gr | 1,6 | 1,9 | 1,8 |
| Kadar Air | % | 31,25 | 26,32 | 27,78 |
| Kadar Air Rata-Rata (PL) | % | 28,45 | | |

2) Batas Cair (*Liquid Limit*)

| Uraian | Satuan | Jumlah Ketukan | | | |
|----------------------------|--------|----------------|-------|-------|-------|
| | | 16 | 22 | 27 | 33 |
| Berat Cawan | gr | 3,9 | 4,1 | 4,1 | 4,1 |
| Berat Cawan + Tanah Basah | gr | 21,8 | 21,5 | 22 | 21,4 |
| Berat Cawan + Tanah Kering | gr | 13,9 | 13,9 | 14,2 | 14,1 |
| Berat Air | gr | 7,9 | 7,6 | 7,8 | 7,3 |
| Berat Tanah Kering | gr | 10 | 9,8 | 10,1 | 10 |
| Kadar Air | % | 79,00 | 77,55 | 77,23 | 73,00 |



Kadar air pada ketukan ke-25:

$$LL = -7,41 \ln(x) + 100,14 = 76,285\%$$

3) Batas Susut (*Shrinkage Limit*)

| Uraian | Satuan | Hasil |
|------------------------------|--------|-------|
| Berat Cetakan | gr | 12,9 |
| Berat Cetakan + Tanah Basah | gr | 67,9 |
| Berat Cetakan + Tanah Kering | gr | 44,6 |
| Berat Tanah Basah | gr | 55,0 |
| Berat Tanah Kering | gr | 31,7 |
| Berat Air | gr | 23,3 |
| Isi Tanah Basah | mL | 35,30 |
| Isi Tanah Kering | mL | 21,00 |
| Kadar Air | % | 73,50 |
| SL | % | 28,39 |

$$\begin{aligned}
 SL &= \text{Kadar Air} + \left(\frac{\text{Isi Tanah Basah} - \text{Isi Tanah Kering}}{\text{Berat Tanah Kering}} \right) \times 100 \\
 &= 81,59 + \left(\frac{25,00 - 13,5}{20,1} \right) \times 100 \\
 &= 29,34\%
 \end{aligned}$$

4) Indeks Plastisitas

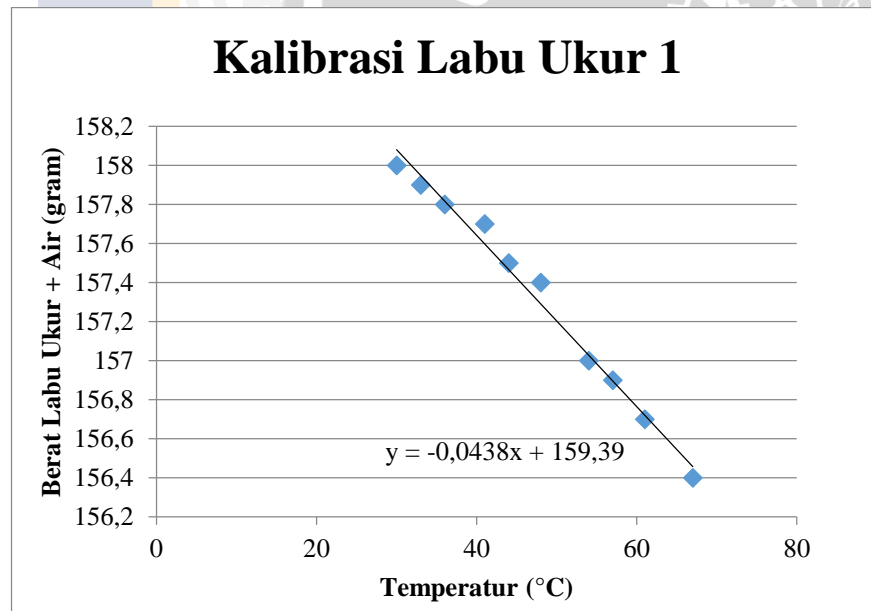
$$LL - PL = 76,285 - 28,45 = 47,837\%$$

3. SPECIFIC GRAVITY

3.1. Kalibrasi Labu Ukur

1) Labu Ukur 1

| Uraian | Nomor Pemeriksaan | | | | | | | | | |
|------------------------------|-------------------|-------|-------|-----|-------|-------|-------|-------|-------|-----|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Temperatur (°C) | 67 | 61 | 57 | 54 | 48 | 44 | 41 | 36 | 33 | 30 |
| Berat Labu Ukur + Air (gram) | 156,4 | 156,7 | 156,9 | 157 | 157,4 | 157,5 | 157,7 | 157,8 | 157,9 | 158 |



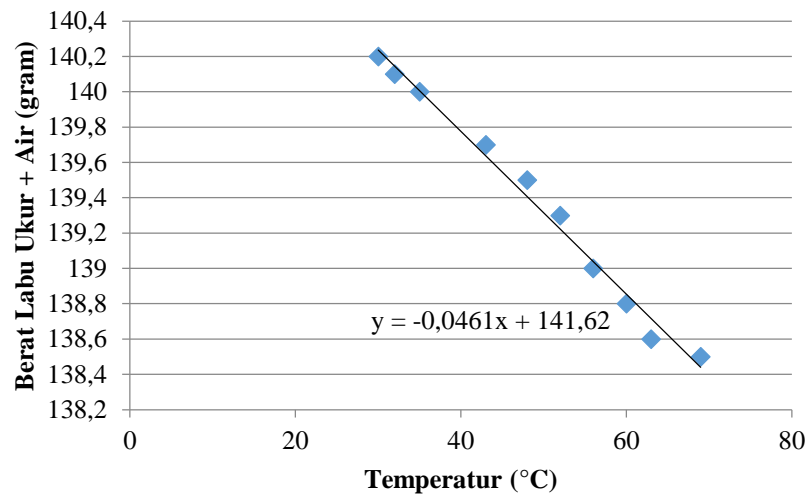
Berat Labu Ukur + Air pada Suhu Kamar (30° C):

$$\begin{aligned}y &= -0,0438 x + 159,39 \\ &= -0,0438 (30) + 159,39 \\ &= 158,076 \text{ gram}\end{aligned}$$

2) Labu Ukur 2

| Uraian | Nomor Pemeriksaan | | | | | | | | | |
|------------------------------|-------------------|-------|-------|-------|-------|-------|-------|-----|-------|-------|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Temperatur (°C) | 69 | 63 | 60 | 56 | 52 | 48 | 43 | 35 | 32 | 30 |
| Berat Labu Ukur + Air (gram) | 138,5 | 138,6 | 138,8 | 139,0 | 139,3 | 139,5 | 139,7 | 140 | 140,1 | 140,2 |

Kalibrasi Labu Ukur 2



Berat Labu Ukur + Air pada Suhu Kamar (30° C):

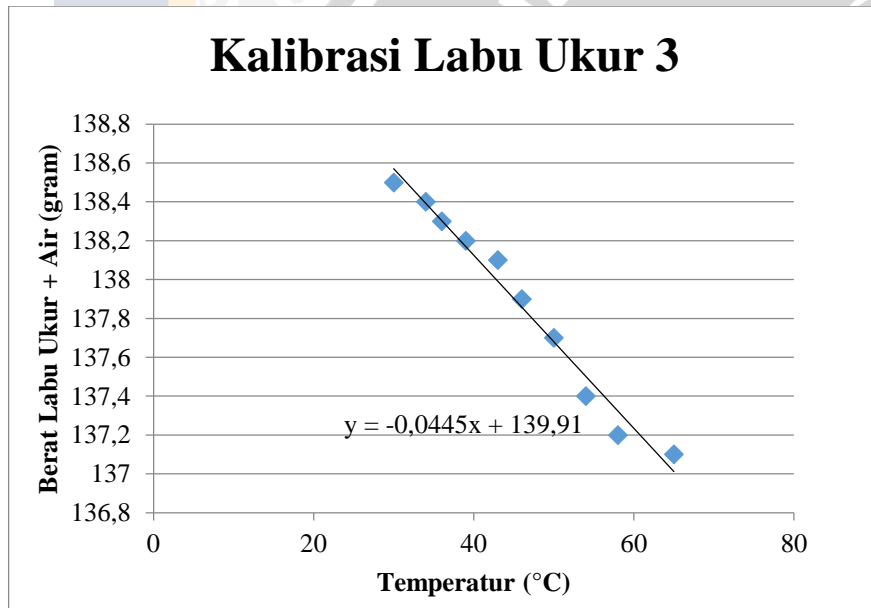
$$y = -0,0461 x + 141,62$$

$$= -0,0461 (30) + 141,62$$

$$= 140,24 \text{ gram}$$

3) Labu Ukur 3

| Uraian | Nomor Pemeriksaan | | | | | | | | | |
|------------------------------|-------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Temperatur (°C) | 65 | 58 | 54 | 50 | 46 | 43 | 39 | 36 | 34 | 30 |
| Berat Labu Ukur + Air (gram) | 137,1 | 137,2 | 137,4 | 137,7 | 137,9 | 138,1 | 138,2 | 138,3 | 138,4 | 138,5 |



Berat Labu Ukur + Air pada Suhu Kamar (30° C):

$$\begin{aligned}
 y &= -0,0445 x + 139,91 \\
 &= -0,0445 (30) + 139,91 \\
 &= 138,575 \text{ gram}
 \end{aligned}$$

3.2. *Specific Gravity* Tanah Lempung Ekspansif

1) Percobaan 1

| Uraian | Satuan | Perhitungan | | | | | | |
|-----------------------------------|--------|-------------|--------|--------|--------|--------|--------|--------|
| Labu Ukur | - | 1 | | | | | | |
| Berat Labu Ukur | gram | 58,2 | | | | | | |
| Berat Tanah Kering | gram | 20 | | | | | | |
| Berat Labu Ukur + Air + Tanah | gram | 167,5 | 167,9 | 168,1 | 168,3 | 168,5 | 168,8 | 169,0 |
| Suhu | (°C) | 71 | 59 | 51 | 47 | 41 | 34 | 30 |
| Berat Labu Ukur + Air | gram | 154,75 | 155,39 | 155,82 | 156,03 | 156,35 | 156,72 | 156,94 |
| <i>Specific Gravity</i> | - | 2,76 | 2,67 | 2,59 | 2,59 | 2,55 | 2,52 | 2,52 |
| Rata-rata <i>Specific Gravity</i> | - | 2,60 | | | | | | |

2) Percobaan 2

| Uraian | Satuan | Perhitungan | | | | | | | | | |
|-----------------------------------|--------|-------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| Labu Ukur | - | 2 | | | | | | | | | |
| Berat Labu Ukur | gram | 43,9 | | | | | | | | | |
| Berat Tanah Kering | gram | 20 | | | | | | | | | |
| Berat Labu Ukur + Air + Tanah | gram | 154,2 | 154,6 | 154,8 | 154,9 | 155 | 155,2 | 155,3 | 155,4 | 155,7 | 155,8 |
| Suhu | (°C) | 75 | 63 | 55 | 49 | 44 | 40 | 39 | 36 | 34 | 30 |
| Berat Labu Ukur + Air | gram | 141,32 | 141,96 | 142,39 | 142,71 | 142,98 | 143,19 | 143,24 | 143,40 | 143,51 | 143,73 |
| <i>Specific Gravity</i> | - | 2,81 | 2,72 | 2,64 | 2,56 | 2,51 | 2,50 | 2,52 | 2,50 | 2,56 | 2,52 |
| Rata-rata <i>Specific Gravity</i> | - | 2,58 | | | | | | | | | |

3) Percobaan 3

| Uraian | Satuan | Perhitungan | | | | | | | | |
|-----------------------------------|--------|-------------|--------|--------|--------|--------|--------|--------|--------|--------|
| Labu Ukur | - | 3 | | | | | | | | |
| Berat Labu Ukur | gram | 50,8 | | | | | | | | |
| Berat Tanah Kering | gram | 20 | | | | | | | | |
| Berat Labu Ukur + Air + Tanah | gram | 161,2 | 161,5 | 161,7 | 161,9 | 162,1 | 162,2 | 162,3 | 162,4 | 162,5 |
| Suhu | (°C) | 76 | 62 | 54 | 50 | 44 | 40 | 35 | 34 | 30 |
| Berat Labu Ukur + Air | gram | 148,15 | 148,87 | 149,29 | 149,50 | 149,81 | 150,01 | 150,27 | 150,33 | 150,53 |
| <i>Specific Gravity</i> | - | 2,88 | 2,71 | 2,64 | 2,63 | 2,60 | 2,56 | 2,51 | 2,52 | 2,49 |
| Rata-rata <i>Specific Gravity</i> | - | 2,62 | | | | | | | | |

Rata-rata *specific gravity* = $(2,60 + 2,58 + 2,62) / 3 = 2,60$

3.3. Specific Gravity Abu Ampas Tebu

1) Percobaan 1

| Uraian | Satuan | Perhitungan | | | | | | | | | |
|-----------------------------------|--------|-------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| Labu Ukur | - | 1 | | | | | | | | | |
| Berat Labu Ukur | gram | 59,1 | | | | | | | | | |
| Berat Tanah Kering | gram | 20 | | | | | | | | | |
| Berat Labu Ukur + Air + Tanah | gram | 166,3 | 167,3 | 167,8 | 168,1 | 168,3 | 168,4 | 168,6 | 168,8 | 169 | 169,1 |
| Suhu | (°C) | 72 | 64 | 57 | 52 | 46 | 44 | 41 | 36 | 34 | 30 |
| Berat Labu Ukur + Air | gram | 156,24 | 156,59 | 156,89 | 157,11 | 157,38 | 157,46 | 157,59 | 157,81 | 157,90 | 158,08 |
| <i>Specific Gravity</i> | - | 2,01 | 2,15 | 2,20 | 2,22 | 2,20 | 2,21 | 2,22 | 2,22 | 2,25 | 2,23 |
| Rata-rata <i>Specific Gravity</i> | - | 2,191 | | | | | | | | | |

2) Percobaan 2

| Uraian | Satuan | Perhitungan | | | | | | | | | |
|-----------------------------------|--------|-------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| Labu Ukur | - | 2 | | | | | | | | | |
| Berat Labu Ukur | gram | 40 | | | | | | | | | |
| Berat Tanah Kering | gram | 20 | | | | | | | | | |
| Berat Labu Ukur + Air + Tanah | gram | 144,1 | 146,5 | 146,8 | 147,1 | 147,3 | 147,5 | 147,7 | 147,8 | 148 | 148,2 |
| Suhu | (°C) | 71 | 63 | 56 | 53 | 51 | 48 | 41 | 36 | 34 | 30 |
| Berat Labu Ukur + Air | gram | 138,35 | 138,72 | 139,04 | 139,18 | 139,27 | 139,41 | 139,73 | 139,96 | 140,05 | 140,24 |
| <i>Specific Gravity</i> | - | 1,40 | 1,64 | 1,63 | 1,66 | 1,67 | 1,68 | 1,66 | 1,64 | 1,66 | 1,66 |
| Rata-rata <i>Specific Gravity</i> | - | 1,631 | | | | | | | | | |

3) Percobaan 3

| Uraian | Satuan | Perhitungan | | | | | | | | | |
|-----------------------------------|--------|-------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| Labu Ukur | - | 3 | | | | | | | | | |
| Berat Labu Ukur | gram | 39,4 | | | | | | | | | |
| Berat Tanah Kering | gram | 20 | | | | | | | | | |
| Berat Labu Ukur + Air + Tanah | gram | 147,1 | 148,6 | 148,9 | 149,3 | 149,6 | 149,8 | 150 | 150,2 | 150,3 | 150,4 |
| Suhu | (°C) | 69 | 62 | 58 | 53 | 46 | 44 | 41 | 36 | 34 | 30 |
| Berat Labu Ukur + Air | gram | 136,84 | 137,15 | 137,33 | 137,55 | 137,86 | 137,95 | 138,09 | 138,31 | 138,40 | 138,58 |
| <i>Specific Gravity</i> | - | 2,05 | 2,34 | 2,37 | 2,42 | 2,42 | 2,45 | 2,47 | 2,47 | 2,47 | 2,45 |
| Rata-rata <i>Specific Gravity</i> | - | 2,392 | | | | | | | | | |

Rata-rata *specific grafity* = $(2,191 + 1,631 + 2,392) / 3 = 2,071$

3.4. *Specific Gravity* Tanah Lempung Ekspansif + 8% Abu Ampas Tebu

1) Percobaan 1

| Uraian | Satuan | Perhitungan | | | | | | | | | |
|-----------------------------------|--------|-------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| Labu Ukur | - | 1 | | | | | | | | | |
| Berat Labu Ukur | gram | 59,1 | | | | | | | | | |
| Berat Tanah Kering | gram | 20 | | | | | | | | | |
| Berat Labu Ukur + Air + Tanah | gram | 167,7 | 168,1 | 168,5 | 168,8 | 169,3 | 169,4 | 169,6 | 169,8 | 170 | 170 |
| Suhu | (°C) | 86 | 78 | 72 | 63 | 54 | 47 | 43 | 37 | 34 | 30 |
| Berat Labu Ukur + Air | gram | 155,62 | 155,97 | 156,24 | 156,63 | 157,02 | 157,33 | 157,51 | 157,77 | 157,90 | 158,08 |
| <i>Specific Gravity</i> | - | 2,52 | 2,54 | 2,59 | 2,55 | 2,59 | 2,52 | 2,53 | 2,51 | 2,53 | 2,48 |
| Rata-rata <i>Specific Gravity</i> | - | 2,536 | | | | | | | | | |

2) Percobaan 2

| Uraian | Satuan | Perhitungan | | | | | | | | | |
|-----------------------------------|--------|-------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| Labu Ukur | - | 2 | | | | | | | | | |
| Berat Labu Ukur | gram | 40 | | | | | | | | | |
| Berat Tanah Kering | gram | 20 | | | | | | | | | |
| Berat Labu Ukur + Air + Tanah | gram | 149,8 | 150,5 | 151,1 | 151,1 | 151,3 | 151,5 | 151,7 | 151,8 | 152 | 152,1 |
| Suhu | (°C) | 73 | 66 | 56 | 50 | 46 | 44 | 42 | 37 | 33 | 30 |
| Berat Labu Ukur + Air | gram | 138,25 | 138,58 | 139,04 | 139,32 | 139,50 | 139,59 | 139,68 | 139,91 | 140,10 | 140,24 |
| <i>Specific Gravity</i> | - | 2,37 | 2,48 | 2,52 | 2,43 | 2,44 | 2,47 | 2,51 | 2,46 | 2,47 | 2,46 |
| Rata-rata <i>Specific Gravity</i> | - | 2,460 | | | | | | | | | |

3) Percobaan 3

| Uraian | Satuan | Perhitungan | | | | | | | | | |
|-----------------------------------|--------|-------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| Labu Ukur | - | 3 | | | | | | | | | |
| Berat Labu Ukur | gram | 39,4 | | | | | | | | | |
| Berat Tanah Kering | gram | 20 | | | | | | | | | |
| Berat Labu Ukur + Air + Tanah | gram | 147,8 | 148,2 | 148,6 | 149,1 | 149,2 | 149,7 | 150,1 | 150,2 | 150,4 | 150,5 |
| Suhu | (°C) | 77 | 72 | 66 | 59 | 52 | 45 | 39 | 35 | 32 | 30 |
| Berat Labu Ukur + Air | gram | 136,48 | 136,71 | 136,97 | 137,28 | 137,60 | 137,91 | 138,17 | 138,35 | 138,49 | 138,58 |
| <i>Specific Gravity</i> | - | 2,30 | 2,35 | 2,39 | 2,44 | 2,38 | 2,44 | 2,48 | 2,45 | 2,47 | 2,48 |
| Rata-rata <i>Specific Gravity</i> | - | 2,419 | | | | | | | | | |

Rata-rata *specific grafity* = $(2,536 + 2,460 + 2,419) / 3 = 2,472$

3.5. *Specific Gravity* Tanah Lempung Ekspansif + 10% Abu Ampas Tebu

1) Percobaan 1

| Uraian | Satuan | Perhitungan | | | | | | | | | |
|-----------------------------------|--------|-------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| Labu Ukur | - | 1 | | | | | | | | | |
| Berat Labu Ukur | gram | 59,1 | | | | | | | | | |
| Berat Tanah Kering | gram | 20 | | | | | | | | | |
| Berat Labu Ukur + Air + Tanah | gram | 167,5 | 168,2 | 168,8 | 169,2 | 169,5 | 169,6 | 169,8 | 169,9 | 169,9 | 170 |
| Suhu | (°C) | 76 | 62 | 58 | 52 | 46 | 42 | 38 | 34 | 32 | 30 |
| Berat Labu Ukur + Air | gram | 156,06 | 156,67 | 156,85 | 157,11 | 157,38 | 157,55 | 157,73 | 157,90 | 157,99 | 158,08 |
| <i>Specific Gravity</i> | - | 2,34 | 2,36 | 2,48 | 2,53 | 2,54 | 2,52 | 2,52 | 2,50 | 2,47 | 2,48 |
| Rata-rata <i>Specific Gravity</i> | - | 2,47 | | | | | | | | | |

2) Percobaan 2

| Uraian | Satuan | Perhitungan | | | | | | | | | |
|-----------------------------------|--------|-------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| Labu Ukur | - | 2 | | | | | | | | | |
| Berat Labu Ukur | gram | 40 | | | | | | | | | |
| Berat Tanah Kering | gram | 20 | | | | | | | | | |
| Berat Labu Ukur + Air + Tanah | gram | 149,9 | 150,3 | 150,5 | 150,7 | 151,1 | 151,3 | 151,5 | 152 | 152,1 | 152,3 |
| Suhu | (°C) | 76 | 69 | 64 | 59 | 55 | 48 | 43 | 38 | 33 | 30 |
| Berat Labu Ukur + Air | gram | 138,12 | 138,44 | 138,67 | 138,90 | 139,08 | 139,41 | 139,64 | 139,87 | 140,10 | 140,24 |
| <i>Specific Gravity</i> | - | 2,43 | 2,46 | 2,45 | 2,44 | 2,50 | 2,47 | 2,46 | 2,54 | 2,50 | 2,52 |
| Rata-rata <i>Specific Gravity</i> | - | 2,48 | | | | | | | | | |

3) Percobaan 3

| Uraian | Satuan | Perhitungan | | | | | | | | | |
|-----------------------------------|--------|-------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| Labu Ukur | - | 3 | | | | | | | | | |
| Berat Labu Ukur | gram | 39,4 | | | | | | | | | |
| Berat Tanah Kering | gram | 20 | | | | | | | | | |
| Berat Labu Ukur + Air + Tanah | gram | 148,1 | 148,6 | 148,7 | 148,9 | 149 | 149,6 | 149,8 | 150,2 | 150,4 | 150,5 |
| Suhu | (°C) | 76 | 74 | 68 | 62 | 58 | 50 | 43 | 38 | 33 | 30 |
| Berat Labu Ukur + Air | gram | 136,53 | 136,62 | 136,88 | 137,15 | 137,33 | 137,69 | 138,00 | 138,22 | 138,44 | 138,58 |
| <i>Specific Gravity</i> | - | 2,37 | 2,49 | 2,44 | 2,42 | 2,40 | 2,47 | 2,44 | 2,49 | 2,49 | 2,48 |
| Rata-rata <i>Specific Gravity</i> | - | 2,45 | | | | | | | | | |

Rata-rata *specific grafity* = $(2,47 + 2,48 + 2,45) / 3 = 2,467$

3.6. *Specific Gravity* Tanah Lempung Ekspansif + 12% Abu Ampas Tebu

1) Percobaan 1

| Uraian | Satuan | Perhitungan | | | | | | | | | |
|-----------------------------------|--------|-------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| Labu Ukur | - | 1 | | | | | | | | | |
| Berat Labu Ukur | gram | 59,1 | | | | | | | | | |
| Berat Tanah Kering | gram | 20 | | | | | | | | | |
| Berat Labu Ukur + Air + Tanah | gram | 166,4 | 167,7 | 169 | 169,4 | 169,6 | 169,9 | 170,1 | 170,2 | 170,3 | 170,5 |
| Suhu | (°C) | 82 | 75 | 65 | 53 | 48 | 44 | 39 | 34 | 33 | 30 |
| Berat Labu Ukur + Air | gram | 155,80 | 156,11 | 156,54 | 157,07 | 157,29 | 157,46 | 157,68 | 157,90 | 157,94 | 158,08 |
| <i>Specific Gravity</i> | - | 2,13 | 2,38 | 2,65 | 2,61 | 2,60 | 2,64 | 2,64 | 2,60 | 2,62 | 2,64 |
| Rata-rata <i>Specific Gravity</i> | - | 2,550 | | | | | | | | | |

2) Percobaan 2

| Uraian | Satuan | Perhitungan | | | | | | | | | |
|-----------------------------------|--------|-------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| Labu Ukur | - | 2 | | | | | | | | | |
| Berat Labu Ukur | gram | 40 | | | | | | | | | |
| Berat Tanah Kering | gram | 20 | | | | | | | | | |
| Berat Labu Ukur + Air + Tanah | gram | 146,5 | 148,3 | 149,7 | 150 | 150,3 | 150,6 | 150,9 | 151,1 | 151,2 | 151,3 |
| Suhu | (°C) | 78 | 72 | 66 | 62 | 56 | 49 | 42 | 36 | 33 | 30 |
| Berat Labu Ukur + Air | gram | 138,02 | 138,30 | 138,58 | 138,76 | 139,04 | 139,36 | 139,68 | 139,96 | 140,10 | 140,24 |
| <i>Specific Gravity</i> | - | 1,74 | 2,00 | 2,25 | 2,28 | 2,29 | 2,28 | 2,28 | 2,26 | 2,25 | 2,24 |
| Rata-rata <i>Specific Gravity</i> | - | 2,186 | | | | | | | | | |

3) Percobaan 3

| Uraian | Satuan | Perhitungan | | | | | | | | | | |
|-----------------------------------|--------|-------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--|
| Labu Ukur | - | 3 | | | | | | | | | | |
| Berat Labu Ukur | gram | 39,4 | | | | | | | | | | |
| Berat Tanah Kering | gram | 20 | | | | | | | | | | |
| Berat Labu Ukur + Air + Tanah | gram | 146,9 | 148,6 | 149,1 | 149,4 | 149,8 | 149,9 | 150,3 | 150,5 | 150,6 | 150,9 | |
| Suhu | (°C) | 78 | 71 | 62 | 59 | 53 | 49 | 41 | 37 | 32 | 30 | |
| Berat Labu Ukur + Air | gram | 136,44 | 136,75 | 137,15 | 137,28 | 137,55 | 137,73 | 138,09 | 138,26 | 138,49 | 138,58 | |
| <i>Specific Gravity</i> | - | 2,10 | 2,45 | 2,48 | 2,54 | 2,58 | 2,55 | 2,57 | 2,58 | 2,54 | 2,61 | |
| Rata-rata <i>Specific Gravity</i> | - | 2,499 | | | | | | | | | | |

Rata-rata *specific grafitiy* = $(2,55 + 2,186 + 2,499) / 3 = 2,412$

3.7. *Specific Gravity* Tanah Lempung Ekspansif + 14% Abu Ampas Tebu

1) Percobaan 1

| Uraian | Satuan | Perhitungan | | | | | | | | | |
|-----------------------------------|--------|-------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| Labu Ukur | - | 1 | | | | | | | | | |
| Berat Labu Ukur | gram | 59,1 | | | | | | | | | |
| Berat Tanah Kering | gram | 20 | | | | | | | | | |
| Berat Labu Ukur + Air + Tanah | gram | 168 | 168,6 | 169,1 | 169,5 | 169,6 | 169,9 | 170,2 | 170,2 | 170,3 | 170,3 |
| Suhu | (°C) | 80 | 63 | 55 | 49 | 45 | 40 | 37 | 35 | 32 | 30 |
| Berat Labu Ukur + Air | gram | 155,89 | 156,63 | 156,98 | 157,24 | 157,42 | 157,64 | 157,77 | 157,86 | 157,99 | 158,08 |
| <i>Specific Gravity</i> | - | 2,54 | 2,49 | 2,54 | 2,58 | 2,56 | 2,58 | 2,64 | 2,61 | 2,60 | 2,57 |
| Rata-rata <i>Specific Gravity</i> | - | 2,572 | | | | | | | | | |

2) Percobaan 2

| Uraian | Satuan | Perhitungan | | | | | | | | | |
|-----------------------------------|--------|-------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| Labu Ukur | - | 2 | | | | | | | | | |
| Berat Labu Ukur | gram | 40 | | | | | | | | | |
| Berat Tanah Kering | gram | 20 | | | | | | | | | |
| Berat Labu Ukur + Air + Tanah | gram | 146,9 | 147,2 | 148 | 148,4 | 148,5 | 148,7 | 149 | 149 | 149,2 | 149,2 |
| Suhu | (°C) | 75 | 62 | 56 | 51 | 46 | 41 | 35 | 33 | 32 | 30 |
| Berat Labu Ukur + Air | gram | 138,16 | 138,76 | 139,04 | 139,27 | 139,50 | 139,73 | 140,01 | 140,10 | 140,14 | 140,24 |
| <i>Specific Gravity</i> | - | 1,78 | 1,73 | 1,81 | 1,84 | 1,82 | 1,81 | 1,82 | 1,80 | 1,83 | 1,81 |
| Rata-rata <i>Specific Gravity</i> | - | 1,805 | | | | | | | | | |

3) Percobaan 3

| Uraian | Satuan | Perhitungan | | | | | | | | | |
|-----------------------------------|--------|-------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| Labu Ukur | - | 3 | | | | | | | | | |
| Berat Labu Ukur | gram | 39,4 | | | | | | | | | |
| Berat Tanah Kering | gram | 20 | | | | | | | | | |
| Berat Labu Ukur + Air + Tanah | gram | 149,7 | 150,1 | 150,2 | 150,7 | 150,9 | 151,2 | 151,5 | 151,5 | 151,6 | 151,9 |
| Suhu | (°C) | 68 | 56 | 53 | 48 | 44 | 39 | 36 | 34 | 32 | 30 |
| Berat Labu Ukur + Air | gram | 136,88 | 137,42 | 137,55 | 137,77 | 137,95 | 138,17 | 138,31 | 138,40 | 138,49 | 138,58 |
| <i>Specific Gravity</i> | - | 2,78 | 2,73 | 2,72 | 2,83 | 2,84 | 2,87 | 2,94 | 2,90 | 2,90 | 3,00 |
| Rata-rata <i>Specific Gravity</i> | - | 2,851 | | | | | | | | | |

Rata-rata *specific grafiti* = $(2,572 + 1,805 + 2,851) / 3 = 2,409$

4. PEMADATAN STANDAR

4.1. Pemadatan Tanah Lempung Ekspansif

Berat cetakan : 2980 gram

Diameter sampel : 15,5 cm

Tinggi sampel : 11,3 cm

1) Kadar Air (*Water Content*)

| Uraian | Satuan | Penambahan Air | | | | | | | | | | | |
|----------------------------|--------|----------------|--------|-------|-------|--------|-------|-------|--------|-------|-------|--------|-------|
| | | 23% | | | 26% | | | 29% | | | 32% | | |
| | | Atas | Tengah | Bawah | Atas | Tengah | Bawah | Atas | Tengah | Bawah | Atas | Tengah | Bawah |
| Berat Cawan | gr | 8,20 | 8,10 | 7,80 | 7,8 | 8,2 | 8,2 | 7,8 | 8,1 | 8,1 | 8,3 | 8,5 | 7,9 |
| Berat Tanah Basah + Cawan | gr | 23,60 | 27,90 | 30,10 | 20,8 | 23,8 | 18,9 | 22 | 26,5 | 25,4 | 22,3 | 18,8 | 20,8 |
| Berat Tanah Kering + Cawan | gr | 20,70 | 24,00 | 25,90 | 18,1 | 20,6 | 16,8 | 18,8 | 22,5 | 21,6 | 19,1 | 16,4 | 17,6 |
| Berat Air | gr | 2,9 | 3,9 | 4,2 | 2,7 | 3,2 | 2,1 | 3,2 | 4 | 3,8 | 3,2 | 2,4 | 3,2 |
| Berat Tanah Kering | gr | 12,5 | 15,9 | 18,1 | 10,3 | 12,4 | 8,6 | 11 | 14,4 | 13,5 | 10,8 | 7,9 | 9,7 |
| Kadar Air | % | 23,20 | 24,53 | 23,20 | 26,21 | 25,81 | 24,42 | 29,09 | 27,78 | 28,15 | 29,63 | 30,38 | 32,99 |
| Kadar Air Rata-Rata | % | 23,64 | | | 25,48 | | | 28,34 | | | 31,00 | | |

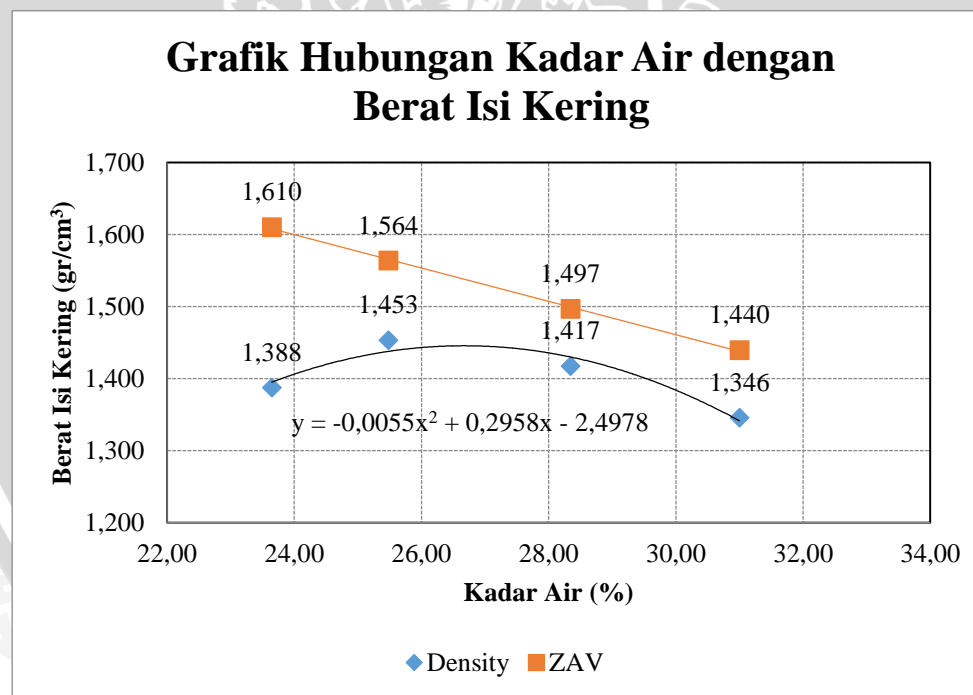
1) Kepadatan (*Density*)

| Uraian | ml | 23% | 26% | 29% | 32% |
|-----------------------------|--------------------|---------|---------|---------|---------|
| Berat Cetakan | gr | 2980 | 2980 | 2980 | 2980 |
| Berat Tanah Basah + Cetakan | gr | 6640 | 6870 | 6860 | 6740 |
| Berat Tanah Basah | gr | 3660 | 3890 | 3880 | 3760 |
| Isi Cetakan | cm ³ | 2133,08 | 2133,08 | 2133,08 | 2133,08 |
| Berat Isi Basah | gr/cm ³ | 1,716 | 1,824 | 1,819 | 1,763 |
| Berat Isi Kering | gr/cm ³ | 1,388 | 1,453 | 1,417 | 1,346 |

2) *Zero Air Void*

| Uraian | ml | 23% | 26% | 29% | 32% |
|------------------------|--------------------|-------|-------|-------|-------|
| Kadar Air | % | 23,64 | 25,48 | 28,34 | 31,00 |
| Gs | - | 2,6 | 2,6 | 2,6 | 2,6 |
| Berat Jenis Air | - | 1 | 1 | 1 | 1 |
| Berat Isi Kering (ZAV) | gr/cm ³ | 1,610 | 1,564 | 1,497 | 1,440 |

Grafik Hubungan Kadar Air dengan Berat Isi Kering



Perhitungan Kepadatan Tanah:

- Kadar Air Optimum:

$$y = -0,0055 x^2 + 0,2958 x - 2,4978$$

$$dy/dx = 0$$

$$0 = -0,011 x + 0,296$$

$$x = 26,891$$

- Berat Isi Kering Maksimum:

$$y = -0,0055 \cdot (26,891)^2 + 0,2958 \cdot (26,891) - 2,4978$$

$$y = 1,479$$

$$\text{Kadar Air Optimum} = 26,891\%$$

$$\text{Berat Isi Kering Maksimum} = 1,479 \text{ gr/cm}^3$$



4.2. Pemadatan Tanah Lempung Ekspansif + 8% Abu Ampas Tebu

Diameter sampel : 15,5 cm

Tinggi sampel : 11,3 cm

1) Kadar Air (*Water Content*)

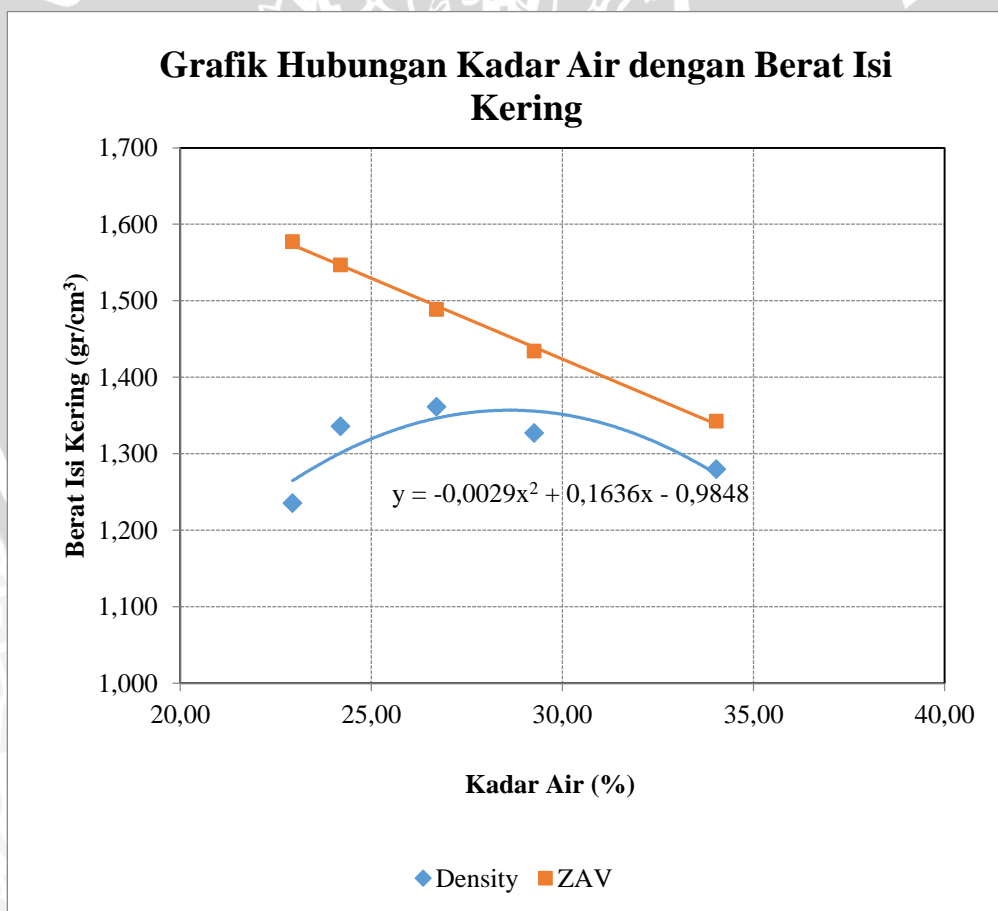
| Uraian | Satuan | Penambahan Air | | | | | | | | | | | | | | |
|----------------------------|--------|----------------|--------|-------|-------|--------|-------|-------|--------|-------|-------|--------|-------|-------|--------|-------|
| | | 20% | | | 22% | | | 24% | | | 26% | | | 28% | | |
| | | Atas | Tengah | Bawah | Atas | Tengah | Bawah | Atas | Tengah | Bawah | Atas | Tengah | Bawah | Atas | Tengah | Bawah |
| Berat Cawan | gr | 7,9 | 7,8 | 8,2 | 5,7 | 5,4 | 8,5 | 5,4 | 5,8 | 6 | 4 | 4 | 3,5 | 3,9 | 4 | 3,5 |
| Berat Tanah Basah + Cawan | gr | 14,9 | 15,5 | 14,9 | 11,3 | 12,1 | 15,7 | 13,3 | 12,5 | 12,8 | 9,9 | 9,5 | 10,7 | 10,3 | 12,3 | 10,4 |
| Berat Tanah Kering + Cawan | gr | 13,6 | 14 | 13,7 | 10,2 | 10,9 | 14,2 | 11,7 | 11,1 | 11,3 | 8,6 | 8,2 | 9,1 | 8,7 | 10,1 | 8,7 |
| Berat Air | gr | 1,3 | 1,5 | 1,2 | 1,1 | 1,2 | 1,5 | 1,6 | 1,4 | 1,5 | 1,3 | 1,3 | 1,6 | 1,6 | 2,2 | 1,7 |
| Berat Tanah Kering | gr | 5,7 | 6,2 | 5,5 | 4,5 | 5,5 | 5,7 | 6,3 | 5,3 | 5,3 | 4,6 | 4,2 | 5,6 | 4,8 | 6,1 | 5,2 |
| Kadar Air | % | 22,81 | 24,19 | 21,82 | 24,44 | 21,82 | 26,32 | 25,40 | 26,42 | 28,30 | 28,26 | 30,95 | 28,57 | 33,33 | 36,07 | 32,69 |
| Kadar Air Rata-rata | % | 22,94 | | | 24,19 | | | 26,70 | | | 29,26 | | | 34,03 | | |

1) Kepadatan (*Density*)

| Uraian | Satuan | 20% | 22% | 24% | 26% | 28% |
|-----------------------------|--------------------|---------|---------|---------|---------|---------|
| Berat Cetakan | gr | 2720 | 2620 | 2720 | 2620 | 2720 |
| Berat Tanah Basah + Cetakan | gr | 5960 | 6160 | 6400 | 6280 | 6380 |
| Berat Tanah Basah | gr | 3240 | 3540 | 3680 | 3660 | 3660 |
| Isi Cetakan | cm ³ | 2133,08 | 2133,08 | 2133,08 | 2133,08 | 2133,08 |
| Berat Isi Basah | gr/cm ³ | 1,519 | 1,660 | 1,725 | 1,716 | 1,716 |
| Berat Isi Kering | gr/cm ³ | 1,236 | 1,336 | 1,362 | 1,327 | 1,280 |

2) *Zero Air Void*

| Uraian | Satuan | 20% | 22% | 24% | 26% | 28% |
|------------------------|--------------------|-------|-------|-------|-------|-------|
| Kadar Air | % | 22,94 | 24,19 | 26,70 | 29,26 | 34,03 |
| Gs | - | 2,472 | 2,472 | 2,472 | 2,472 | 2,472 |
| Berat Jenis Air | - | 1 | 1 | 1 | 1 | 1 |
| Berat Isi Kering (ZAV) | gr/cm ³ | 1,577 | 1,547 | 1,489 | 1,434 | 1,343 |



Perhitungan Kepadatan Tanah:

- Kadar Air Optimum:

$$y = -0,0029 x^2 + 0,1636 x - 0,9848$$

$$dy/dx = 0$$

$$0 = -0,0058 x + 0,1636$$

$$x = 28,21$$

- Berat Isi Kering Maksimum:

$$y = -0,0029 \cdot (28,21)^2 + 0,1636 \cdot (28,21) - 0,9848$$

$$y = 1,323$$

$$\text{Kadar Air Optimum} = 28,21\%$$

$$\text{Berat Isi Kering Maksimum} = 1,323 \text{ gr/cm}^3$$



4.3. Pemadatan Tanah Lempung Ekspansif + 10% Abu Ampas Tebu

Diameter sampel : 15,5 cm

Tinggi sampel : 11,3 cm

1) Kadar Air (*Water Content*)

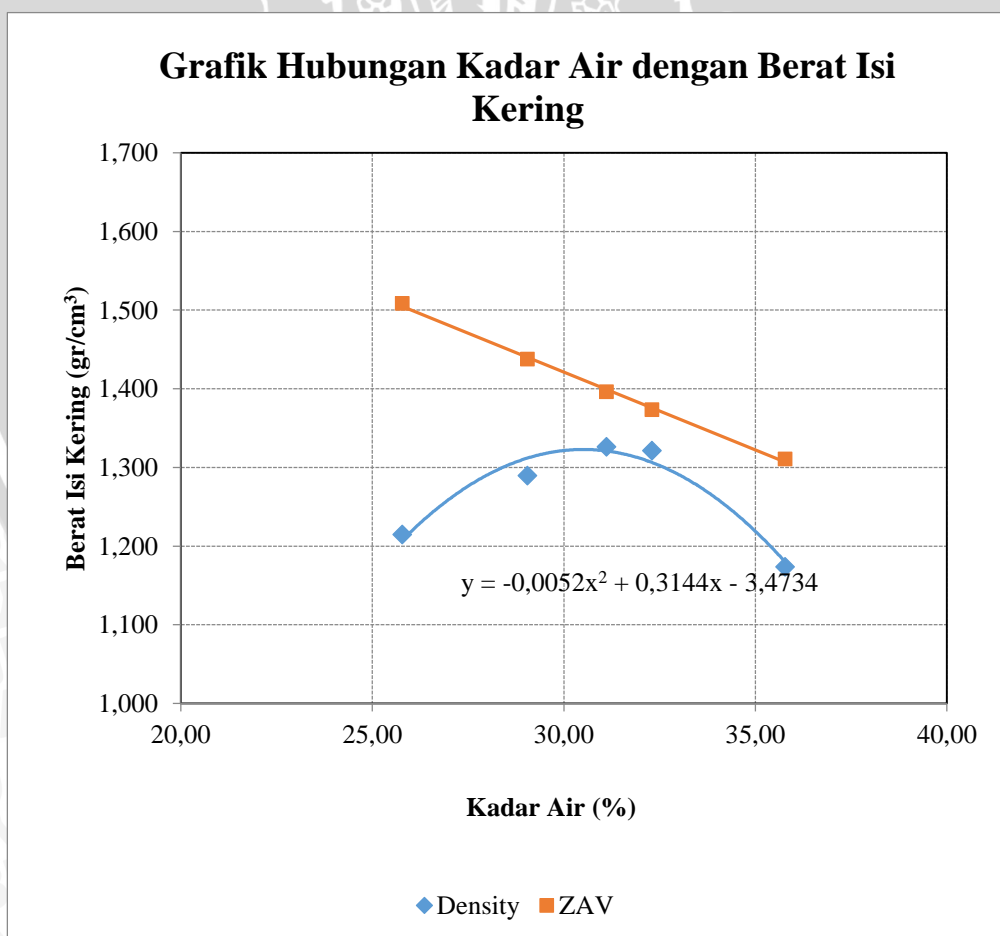
| Uraian | Satuan | Penambahan Air | | | | | | | | | | | | | | |
|----------------------------|--------|----------------|--------|-------|-------|--------|-------|-------|--------|-------|-------|--------|-------|-------|--------|-------|
| | | 20% | | | 22% | | | 24% | | | 26% | | | 28% | | |
| | | Atas | Tengah | Bawah | Atas | Tengah | Bawah | Atas | Tengah | Bawah | Atas | Tengah | Bawah | Atas | Tengah | Bawah |
| Berat Cawan | gr | 8,3 | 4 | 4,1 | 4 | 4,1 | 4 | 3,9 | 4,5 | 3,9 | 5,9 | 6 | 6,2 | 5,4 | 5,5 | 5,8 |
| Berat Tanah Basah + Cawan | gr | 17,1 | 20,8 | 13,5 | 15,5 | 20,1 | 14,1 | 12,9 | 20,2 | 14,5 | 13,7 | 13,6 | 13,3 | 15,7 | 15,8 | 17,5 |
| Berat Tanah Kering + Cawan | gr | 15,3 | 17,3 | 11,6 | 12,9 | 16,4 | 11,9 | 10,6 | 16,6 | 12,1 | 11,7 | 11,7 | 11,7 | 13 | 13 | 14,5 |
| Berat Air | gr | 1,8 | 3,5 | 1,9 | 2,6 | 3,7 | 2,2 | 2,3 | 3,6 | 2,4 | 2 | 1,9 | 1,6 | 2,7 | 2,8 | 3 |
| Berat Tanah Kering | gr | 7 | 13,3 | 7,5 | 8,9 | 12,3 | 7,9 | 6,7 | 12,1 | 8,2 | 5,8 | 5,7 | 5,5 | 7,6 | 7,5 | 8,7 |
| Kadar Air | % | 25,71 | 26,32 | 25,33 | 29,21 | 30,08 | 27,85 | 34,33 | 29,75 | 29,27 | 34,48 | 33,33 | 29,09 | 35,53 | 37,33 | 34,48 |
| Kadar Air Rata-rata | % | 25,79 | | | 29,05 | | | 31,12 | | | 32,30 | | | 35,78 | | |

1) Kepadatan (*Density*)

| Uraian | Satuan | 20% | 22% | 24% | 26% | 28% |
|-----------------------------|--------------------|---------|---------|---------|---------|---------|
| Berat Cetakan | gr | 2720 | 2610 | 2720 | 2610 | 2720 |
| Berat Tanah Basah + Cetakan | gr | 5980 | 6160 | 6430 | 6340 | 6120 |
| Berat Tanah Basah | gr | 3260 | 3550 | 3710 | 3730 | 3400 |
| Isi Cetakan | cm ³ | 2133,08 | 2133,08 | 2133,08 | 2133,08 | 2133,08 |
| Berat Isi Basah | gr/cm ³ | 1,528 | 1,664 | 1,739 | 1,749 | 1,594 |
| Berat Isi Kering | gr/cm ³ | 1,215 | 1,290 | 1,327 | 1,322 | 1,174 |

2) *Zero Air Void*

| Uraian | Satuan | 20% | 22% | 24% | 26% | 28% |
|------------------------|--------------------|-------|-------|-------|-------|-------|
| Kadar Air | % | 25,79 | 29,05 | 31,12 | 32,30 | 35,78 |
| Gs | - | 2,469 | 2,469 | 2,469 | 2,469 | 2,469 |
| Berat Jenis Air | - | 1 | 1 | 1 | 1 | 1 |
| Berat Isi Kering (ZAV) | gr/cm ³ | 1,509 | 1,438 | 1,396 | 1,374 | 1,311 |



Perhitungan Kepadatan Tanah:

- Kadar Air Optimum:

$$y = -0,0052 x^2 + 0,3144 x - 3,4734$$

$$dy/dx = 0$$

$$0 = -0,0104 x + 0,3144$$

$$x = 30,23$$

- Berat Isi Kering Maksimum:

$$y = -0,0052 \cdot (30,23)^2 + 0,3144 \cdot (30,23) - 3,4734$$

$$y = 1,279$$

$$\text{Kadar Air Optimum} = 30,23\%$$

$$\text{Berat Isi Kering Maksimum} = 1,279 \text{ gr/cm}^3$$



4.4. Pemadatan Tanah Lempung Ekspansif + 12% Abu Ampas Tebu

Diameter sampel : 15,5 cm

Tinggi sampel : 11,3 cm

1) Kadar Air (*Water Content*)

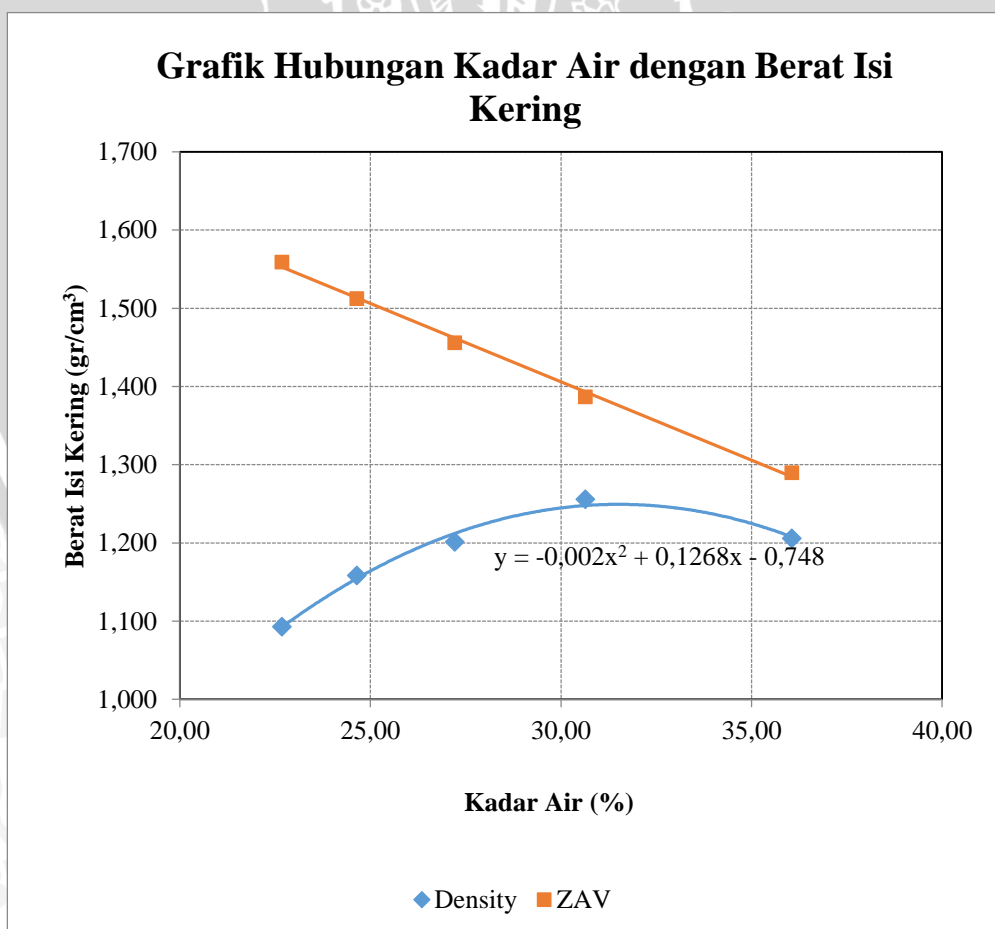
| Uraian | Satuan | Penambahan Air | | | | | | | | | | | | | | |
|----------------------------|--------|----------------|--------|-------|-------|--------|-------|-------|--------|-------|-------|--------|-------|-------|--------|-------|
| | | 20% | | | 22% | | | 24% | | | 26% | | | 28% | | |
| | | Atas | Tengah | Bawah | Atas | Tengah | Bawah | Atas | Tengah | Bawah | Atas | Tengah | Bawah | Atas | Tengah | Bawah |
| Berat Cawan | gr | 6 | 5,8 | 5,5 | 5,5 | 5,8 | 5,9 | 3,9 | 3,9 | 4 | 4 | 3,9 | 3,9 | 5,5 | 6 | 5,7 |
| Berat Tanah Basah + Cawan | gr | 13,2 | 11,7 | 13,5 | 15,5 | 13,6 | 15,4 | 12,9 | 14,9 | 12 | 17,8 | 14,6 | 14,2 | 15,4 | 16,3 | 17,6 |
| Berat Tanah Kering + Cawan | gr | 11,9 | 10,6 | 12 | 13,6 | 12,1 | 13,4 | 11 | 12,5 | 10,3 | 14,4 | 12,1 | 11,9 | 12,8 | 13,5 | 14,5 |
| Berat Air | gr | 1,3 | 1,1 | 1,5 | 1,9 | 1,5 | 2 | 1,9 | 2,4 | 1,7 | 3,4 | 2,5 | 2,3 | 2,6 | 2,8 | 3,1 |
| Berat Tanah Kering | gr | 5,9 | 4,8 | 6,5 | 8,1 | 6,3 | 7,5 | 7,1 | 8,6 | 6,3 | 10,4 | 8,2 | 8 | 7,3 | 7,5 | 8,8 |
| Kadar Air | % | 22,03 | 22,92 | 23,08 | 23,46 | 23,81 | 26,67 | 26,76 | 27,91 | 26,98 | 32,69 | 30,49 | 28,75 | 35,62 | 37,33 | 35,23 |
| Kadar Air Rata-rata | % | 22,68 | | | 24,64 | | | 27,22 | | | 30,64 | | | 36,06 | | |

1) *Kepadatan (Density)*

| Uraian | Satuan | 20% | 22% | 24% | 26% | 28% |
|-----------------------------|--------------------|---------|---------|---------|---------|---------|
| Berat Cetakan | gr | 2720 | 2600 | 2720 | 2610 | 2720 |
| Berat Tanah Basah + Cetakan | gr | 5580 | 5680 | 5980 | 6160 | 6220 |
| Berat Tanah Basah | gr | 2860 | 3080 | 3260 | 3500 | 3500 |
| Isi Cetakan | cm ³ | 2133,08 | 2133,08 | 2133,08 | 2133,08 | 2133,08 |
| Berat Isi Basah | gr/cm ³ | 1,341 | 1,444 | 1,528 | 1,641 | 1,641 |
| Berat Isi Kering | gr/cm ³ | 1,093 | 1,158 | 1,201 | 1,256 | 1,206 |

2) *Zero Air Void*

| Uraian | Satuan | 20% | 22% | 24% | 26% | 28% |
|------------------------|--------------------|-------|-------|-------|-------|-------|
| Kadar Air | % | 22,68 | 24,64 | 27,22 | 30,64 | 36,06 |
| Gs | - | 2,412 | 2,412 | 2,412 | 2,412 | 2,412 |
| Berat Jenis Air | - | 1 | 1 | 1 | 1 | 1 |
| Berat Isi Kering (ZAV) | gr/cm ³ | 1,559 | 1,513 | 1,456 | 1,387 | 1,290 |



Perhitungan Kepadatan Tanah:

- Kadar Air Optimum:

$$y = -0,002 x^2 + 0,1268 x - 0,748$$

$$dy/dx = 0$$

$$0 = -0,004 x + 0,1268$$

$$x = 31,7$$

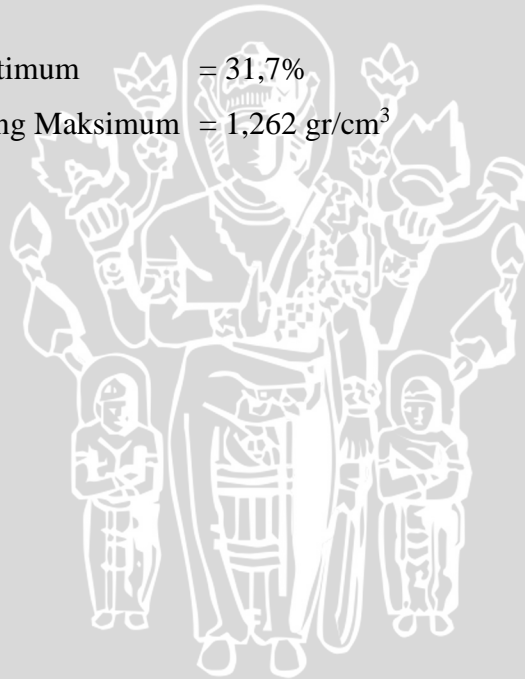
- Berat Isi Kering Maksimum:

$$y = -0,002 \cdot (31,7)^2 + 0,1268 \cdot (31,7) - 0,748$$

$$y = 1,262$$

Kadar Air Optimum = 31,7%

Berat Isi Kering Maksimum = 1,262 gr/cm³



4.5. Pemadatan Tanah Lempung Ekspansif + 14% Abu Ampas Tebu

Diameter sampel : 15,5 cm

Tinggi sampel : 11,3 cm

1) Kadar Air (*Water Content*)

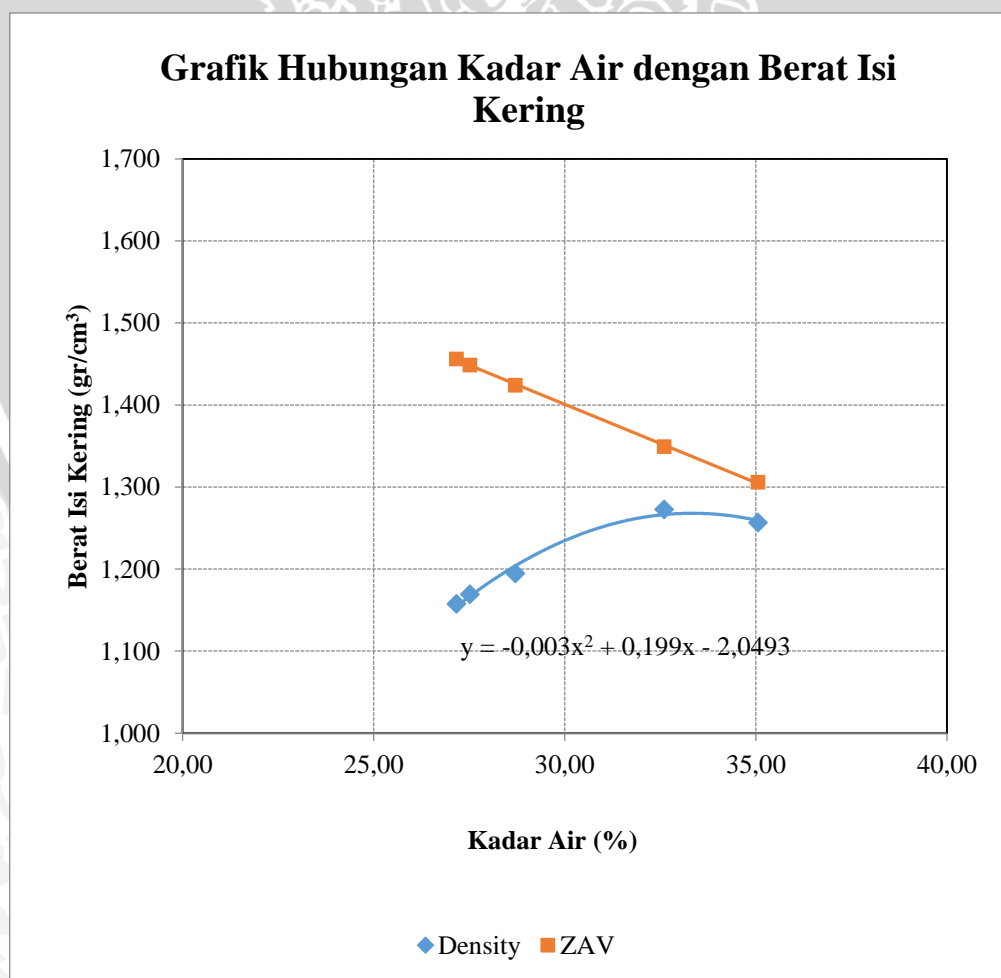
| Uraian | Satuan | Penambahan Air | | | | | | | | | | | | | | |
|----------------------------|--------|----------------|--------|-------|-------|--------|-------|-------|--------|-------|-------|--------|-------|-------|--------|-------|
| | | 20% | | | 22% | | | 24% | | | 26% | | | 28% | | |
| | | Atas | Tengah | Bawah | Atas | Tengah | Bawah | Atas | Tengah | Bawah | Atas | Tengah | Bawah | Atas | Tengah | Bawah |
| Berat Cawan | gr | 5,4 | 6 | 5,5 | 5,3 | 6,1 | 5,7 | 4 | 4 | 4 | 4 | 4,1 | 4 | 5,9 | 5,8 | 6 |
| Berat Tanah Basah + Cawan | gr | 12,5 | 11,8 | 12,7 | 12,6 | 11,4 | 12 | 12 | 12,7 | 13,4 | 11,3 | 11 | 10,1 | 10,9 | 12,6 | 12,3 |
| Berat Tanah Kering + Cawan | gr | 10,9 | 10,6 | 11,2 | 10,9 | 10,3 | 10,7 | 10,1 | 10,8 | 11,4 | 9,5 | 9,2 | 8,7 | 9,6 | 10,8 | 10,7 |
| Berat Air | gr | 1,6 | 1,2 | 1,5 | 1,7 | 1,1 | 1,3 | 1,9 | 1,9 | 2 | 1,8 | 1,8 | 1,4 | 1,3 | 1,8 | 1,6 |
| Berat Tanah Kering | gr | 5,5 | 4,6 | 5,7 | 5,6 | 4,2 | 5 | 6,1 | 6,8 | 7,4 | 5,5 | 5,1 | 4,7 | 3,7 | 5 | 4,7 |
| Kadar Air | % | 29,09 | 26,09 | 26,32 | 30,36 | 26,19 | 26,00 | 31,15 | 27,94 | 27,03 | 32,73 | 35,29 | 29,79 | 35,14 | 36,00 | 34,04 |
| Kadar Air Rata-rata | % | 27,16 | | | 27,52 | | | 28,71 | | | 32,60 | | | 35,06 | | |

1) Kepadatan (*Density*)

| Uraian | Satuan | 20% | 22% | 24% | 26% | 28% |
|-----------------------------|--------------------|---------|---------|---------|---------|---------|
| Berat Cetakan | gr | 2620 | 2720 | 2620 | 2720 | 2620 |
| Berat Tanah Basah + Cetakan | gr | 5760 | 5900 | 5900 | 6320 | 6240 |
| Berat Tanah Basah | gr | 3140 | 3180 | 3280 | 3600 | 3620 |
| Isi Cetakan | cm ³ | 2133,08 | 2133,08 | 2133,08 | 2133,08 | 2133,08 |
| Berat Isi Basah | gr/cm ³ | 1,472 | 1,491 | 1,538 | 1,688 | 1,697 |
| Berat Isi Kering | gr/cm ³ | 1,158 | 1,169 | 1,195 | 1,273 | 1,257 |

2) *Zero Air Void*

| Uraian | Satuan | 20% | 22% | 24% | 26% | 28% |
|------------------------|--------------------|-------|-------|-------|-------|-------|
| Kadar Air | % | 27,16 | 27,52 | 28,71 | 32,60 | 35,06 |
| Gs | - | 2,409 | 2,409 | 2,409 | 2,409 | 2,409 |
| Berat Jenis Air | - | 1 | 1 | 1 | 1 | 1 |
| Berat Isi Kering (ZAV) | gr/cm ³ | 1,456 | 1,449 | 1,424 | 1,349 | 1,306 |



Perhitungan Kepadatan Tanah:

- Kadar Air Optimum:

$$y = -0,003 x^2 + 0,199 x - 2,0493$$

$$dy/dx = 0$$

$$0 = -0,006 x + 0,199$$

$$x = 33,17$$

- Berat Isi Kering Maksimum:

$$y = -0,003 x^2 + 0,199 x - 2,0493$$

$$y = 1,251$$

$$\text{Kadar Air Optimum} = 33,17\%$$

$$\text{Berat Isi Kering Maksimum} = 1,251 \text{ gr/cm}$$



5. CBR (CALIFORNIA BEARING RATIO)

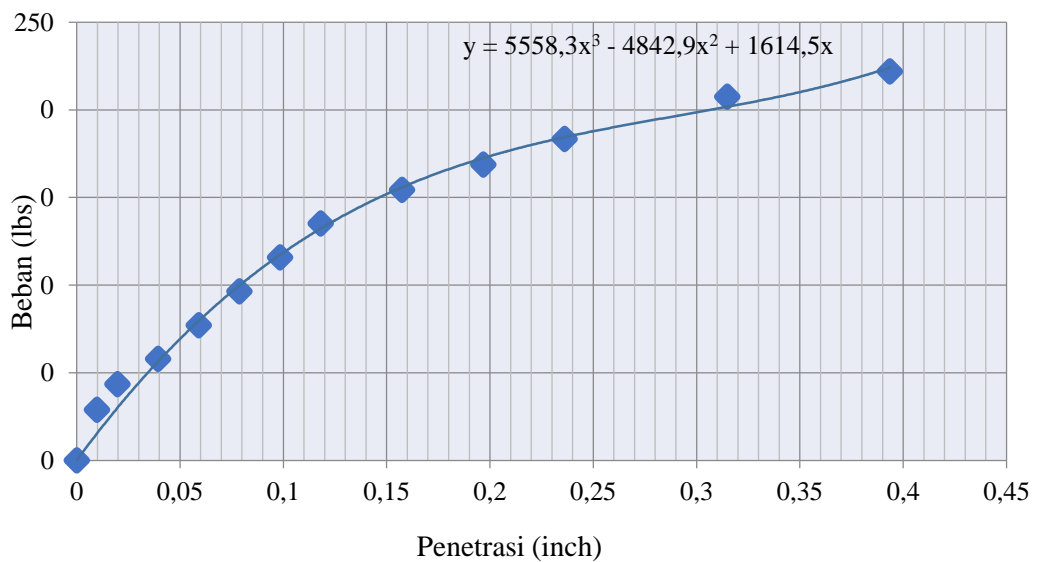
5.1. CBR Tak Terendam (*Unsoaked*)

5.1.1. CBR Tak Terendam Tanah Lempung Ekspansif

Faktor Kalibrasi = 9,65

| Pembacaan Dial | Penetrasi (inch) | Pembacaan Proving Ring | Beban (lbs) |
|----------------|------------------|------------------------|-------------|
| 0 | 0 | 0 | 0 |
| 0,25 | 0,01 | 3 | 28,95 |
| 0,5 | 0,02 | 4,5 | 43,425 |
| 1 | 0,04 | 6 | 57,9 |
| 1,5 | 0,06 | 8 | 77,2 |
| 2 | 0,08 | 10 | 96,5 |
| 2,5 | 0,10 | 12 | 115,8 |
| 3 | 0,12 | 14 | 135,1 |
| 4 | 0,16 | 16 | 154,4 |
| 5 | 0,20 | 17,5 | 168,875 |
| 6 | 0,24 | 19 | 183,35 |
| 8 | 0,31 | 21,5 | 207,475 |
| 10 | 0,39 | 23 | 221,95 |

CBR *Unsoaked* Tanah Lempung Ekspansif



| Penetrasi (inch) | Beban (lbs) | CBR (%) |
|------------------|-------------|---------|
| 0,1 | 118,579 | 3,953 |
| 0,2 | 173,650 | 3,859 |

Perhitungan:

- Penetrasi 0,1 inch:

$$\text{Beban} = 5558,3(0,1)^3 - 4842,9(0,1)^2 + 1614,5(0,1) = 118,579$$

$$\text{Harga CBR} = \frac{118,579}{3000} \times 100\% = 3,953\%$$

- Penetrasi 0,2 inch:

$$\text{Beban} = 5558,3(0,2)^3 - 4842,9(0,2)^2 + 1614,5(0,2) = 173,650$$

$$\text{Harga CBR} = \frac{173,650}{4500} \times 100\% = 3,859\%$$



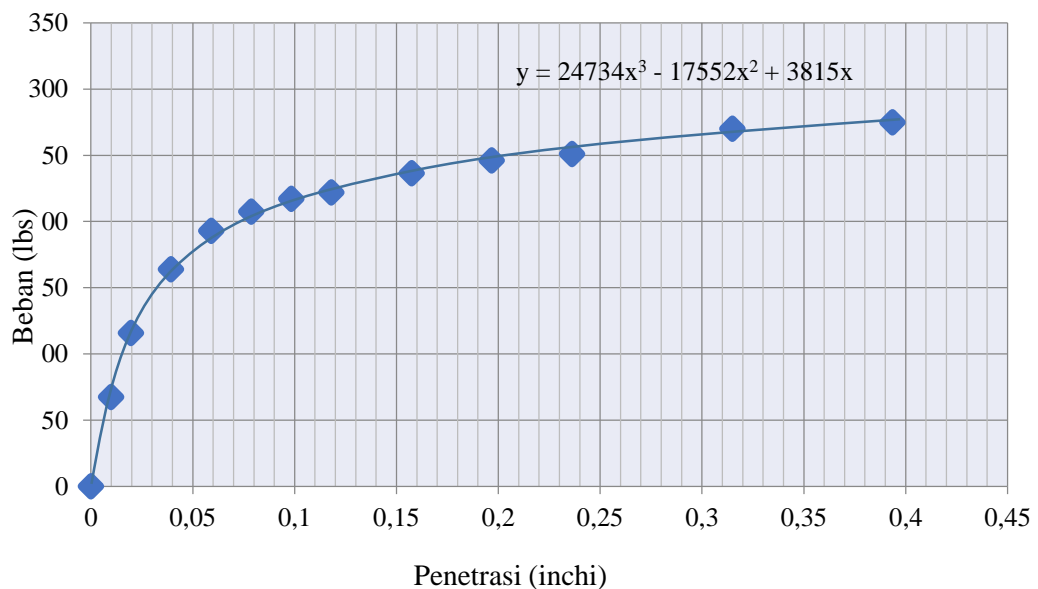
5.1.2. CBR Tak Terendam Campuran Tanpa Pemeraman

1) Tanah Lempung Ekspansif + 8% Abu Ampas Tebu

Faktor Kalibrasi = 9,65

| Pembacaan Dial | Penetrasi (inch) | Pembacaan Proving Ring | Beban (lbs) |
|----------------|------------------|------------------------|-------------|
| 0 | 0 | 0 | 0 |
| 0,25 | 0,01 | 7 | 67,55 |
| 0,5 | 0,02 | 12 | 115,8 |
| 1 | 0,04 | 17 | 164,05 |
| 1,5 | 0,06 | 20 | 193 |
| 2 | 0,08 | 21,5 | 207,475 |
| 2,5 | 0,10 | 22,5 | 217,125 |
| 3 | 0,12 | 23 | 221,95 |
| 4 | 0,16 | 24,5 | 236,425 |
| 5 | 0,20 | 25,5 | 246,075 |
| 6 | 0,24 | 26 | 250,9 |
| 8 | 0,31 | 28 | 270,2 |
| 10 | 0,39 | 28,5 | 275,025 |

CBR Unsoaked Tanah Lempung Ekspansif + 8% Abu Ampas Tebu Tanpa Pemeraman



| Penetrasi (inch) | Beban (lbs) | CBR (%) |
|------------------|-------------|---------|
| 0,1 | 230,714 | 7,690 |
| 0,2 | 258,792 | 5,751 |

Perhitungan:

- Penetrasi 0,1 inch:

$$\text{Beban} = 24734(0,1)^3 - 17552(0,1)^2 + 3815(0,1) = 230,714$$

$$\text{Harga CBR} = \frac{230,714}{3000} \times 100\% = 7,690\%$$

- Penetrasi 0,2 inch:

$$\text{Beban} = -24734(0,2)^3 - 17552(0,2)^2 + 3815(0,2) = 258,792$$

$$\text{Harga CBR} = \frac{258,792}{4500} \times 100\% = 5,751\%$$

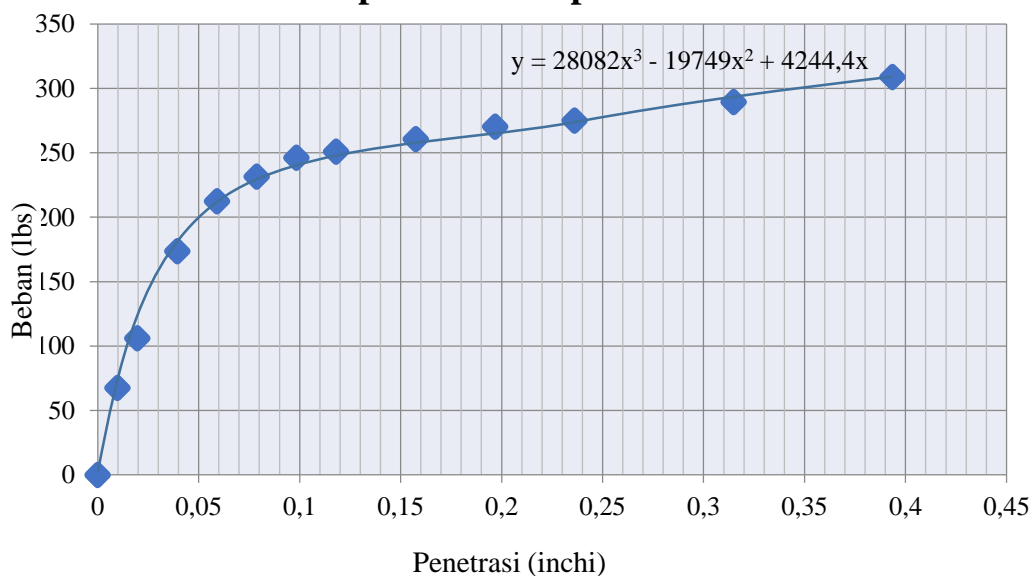


2) Tanah Lempung Ekspansif + 10% Abu Ampas Tebu

Faktor Kalibrasi = 9,65

| Pembacaan Dial | Penetrasi (inch) | Pembacaan Proving Ring | Beban (lbs) |
|----------------|------------------|------------------------|-------------|
| 0 | 0 | 0 | 0 |
| 0,25 | 0,01 | 7 | 67,55 |
| 0,5 | 0,02 | 11 | 106,15 |
| 1 | 0,04 | 18 | 173,7 |
| 1,5 | 0,06 | 22 | 212,3 |
| 2 | 0,08 | 24 | 231,6 |
| 2,5 | 0,10 | 25,5 | 246,075 |
| 3 | 0,12 | 26 | 250,9 |
| 4 | 0,16 | 27 | 260,55 |
| 5 | 0,20 | 28 | 270,2 |
| 6 | 0,24 | 28,5 | 275,025 |
| 8 | 0,31 | 30 | 289,5 |
| 10 | 0,39 | 32 | 308,8 |

CBR Unsoaked Tanah Lempung Ekspansif + 10% Abu Ampas Tebu Tanpa Pemeraman



| Penetrasi (inch) | Beban (lbs) | CBR (%) |
|------------------|-------------|---------|
| 0,1 | 255,032 | 8,501 |
| 0,2 | 283,576 | 6,302 |

Perhitungan:

- Penetrasi 0,1 inch:

$$\text{Beban} = 28082(0,1)^3 - 197492(0,1)^2 + 4244,4(0,1) = 255,032$$

$$\text{Harga CBR} = \frac{255,032}{3000} \times 100\% = 8,501\%$$

- Penetrasi 0,2 inch:

$$\text{Beban} = 28082(0,2)^3 - 197492(0,2)^2 + 4244,4(0,2) = 283,576$$

$$\text{Harga CBR} = \frac{283,576}{4500} \times 100\% = 6,302\%$$

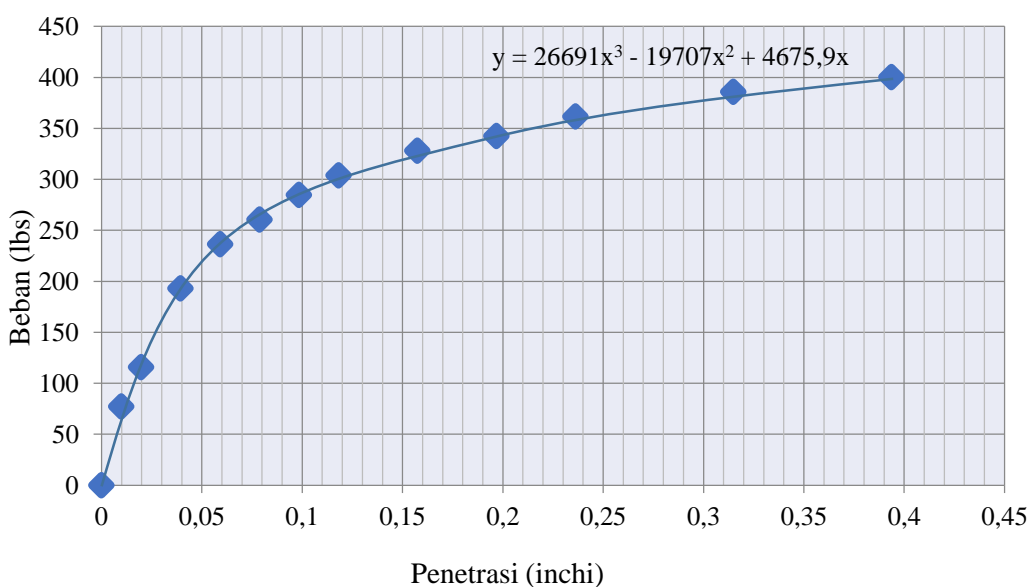


3) Tanah Lempung Ekspansif + 12% Abu Ampas Tebu

Faktor Kalibrasi = 9,65

| Pembacaan Dial | Penetrasi (inch) | Pembacaan Proving Ring | Beban (lbs) |
|----------------|------------------|------------------------|-------------|
| 0 | 0 | 0 | 0 |
| 0,25 | 0,01 | 8,00 | 77,2 |
| 0,5 | 0,02 | 12,00 | 115,8 |
| 1 | 0,04 | 20,00 | 193 |
| 1,5 | 0,06 | 24,50 | 236,425 |
| 2 | 0,08 | 27,00 | 260,55 |
| 2,5 | 0,10 | 29,50 | 284,675 |
| 3 | 0,12 | 31,50 | 303,975 |
| 4 | 0,16 | 34,00 | 328,1 |
| 5 | 0,20 | 35,50 | 342,575 |
| 6 | 0,24 | 37,50 | 361,875 |
| 8 | 0,31 | 40,00 | 386 |
| 10 | 0,39 | 41,50 | 400,475 |

CBR Unsoaked Tanah Lempung Ekspansif + 12% Abu Ampas Tebu Tanpa Pemeraman



| Penetrasi (inch) | Beban (lbs) | CBR (%) |
|------------------|-------------|---------|
| 0,1 | 297,211 | 9,907 |
| 0,2 | 360,428 | 8,010 |

Perhitungan:

- Penetrasi 0,1 inch:

$$\text{Beban} = 26691(0,1)^3 - 19707(0,1)^2 + 4675,9(0,1) = 297,211$$

$$\text{Harga CBR} = \frac{297,211}{3000} \times 100\% = 9,907\%$$

- Penetrasi 0,2 inch:

$$\text{Beban} = 26691(0,2)^3 - 19707(0,2)^2 + 4675,9(0,2) = 360,428$$

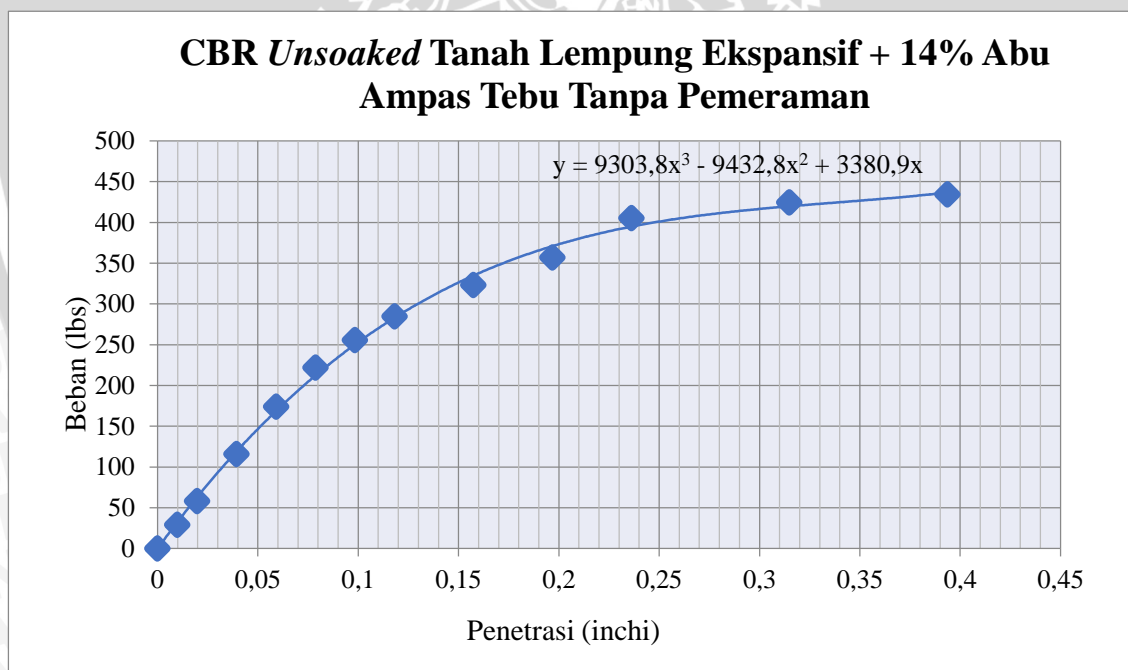
$$\text{Harga CBR} = \frac{360,428}{4500} \times 100\% = 8,010\%$$



4) Tanah Lempung Ekspansif + 14% Abu Ampas Tebu

Faktor Kalibrasi = 9,65

| Pembacaan Dial | Penetrasi (inch) | Pembacaan Proving Ring | Beban (lbs) |
|----------------|------------------|------------------------|-------------|
| 0 | 0 | 0 | 0 |
| 0,25 | 0,01 | 3,00 | 28,95 |
| 0,5 | 0,02 | 6,00 | 57,9 |
| 1 | 0,04 | 12,00 | 115,8 |
| 1,5 | 0,06 | 18,00 | 173,7 |
| 2 | 0,08 | 23,00 | 221,95 |
| 2,5 | 0,10 | 26,50 | 255,725 |
| 3 | 0,12 | 29,50 | 284,675 |
| 4 | 0,16 | 33,50 | 323,275 |
| 5 | 0,20 | 37,00 | 357,05 |
| 6 | 0,24 | 42,00 | 405,3 |
| 8 | 0,31 | 44,00 | 424,6 |
| 10 | 0,39 | 45,00 | 434,25 |



| Penetrasi (inch) | Beban (lbs) | CBR (%) |
|------------------|-------------|---------|
| 0,1 | 253,066 | 8,436 |
| 0,2 | 373,298 | 8,296 |

Perhitungan:

- Penetrasi 0,1 inch:

$$\text{Beban} = 9303,8 (0,1)^3 - 9432,8 (0,1)^2 + 3380,9 (0,1) = 253,066$$

$$\text{Harga CBR} = \frac{253,066}{3000} \times 100\% = 8,436\%$$

- Penetrasi 0,2 inch:

$$\text{Beban} = 9303,8 (0,2)^3 - 9432,8 (0,2)^2 + 3380,9 (0,2) = 373,298$$

$$\text{Harga CBR} = \frac{373,298}{4500} \times 100\% = 8,296\%$$



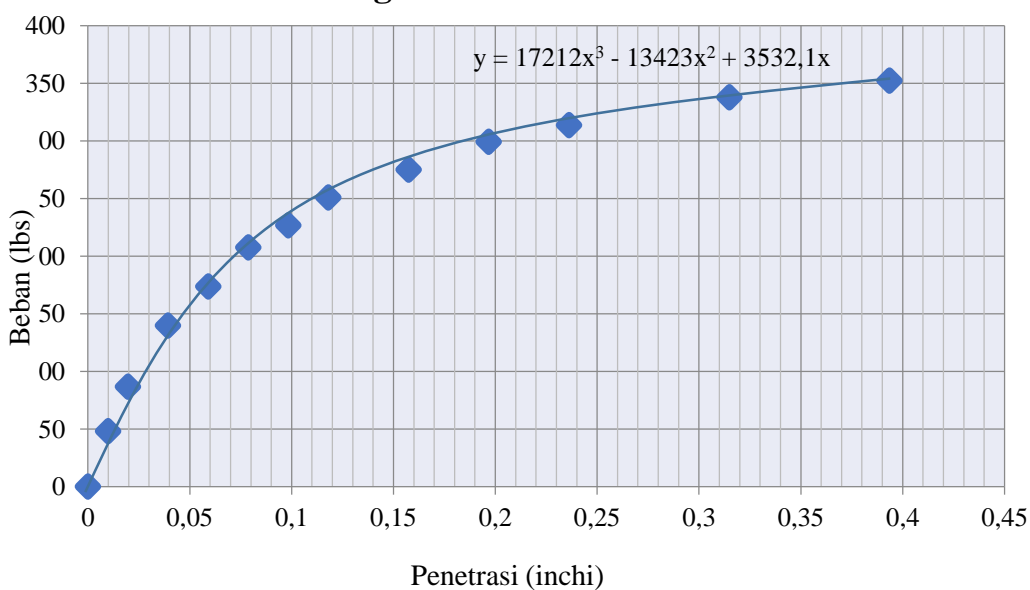
5.1.3. CBR Tak Terendam Campuran dengan Pemeraman

- 1) CBR Tak Terendam Tanah Lempung Ekspansif + 8% Abu Ampas Tebu dengan Waktu Pemeraman 4 Hari

Faktor Kalibrasi = 9,65

| Pembacaan Dial | Penetrasi (inch) | Pembacaan Proving Ring | Beban (lbs) |
|----------------|------------------|------------------------|-------------|
| 0 | 0 | 0 | 0 |
| 0,25 | 0,01 | 5 | 48,25 |
| 0,5 | 0,02 | 9 | 86,85 |
| 1 | 0,04 | 14,5 | 139,925 |
| 1,5 | 0,06 | 18 | 173,7 |
| 2 | 0,08 | 21,5 | 207,475 |
| 2,5 | 0,10 | 23,5 | 226,775 |
| 3 | 0,12 | 26 | 250,9 |
| 4 | 0,16 | 28,5 | 275,025 |
| 5 | 0,20 | 31 | 299,15 |
| 6 | 0,24 | 32,5 | 313,625 |
| 8 | 0,31 | 35 | 337,75 |
| 10 | 0,39 | 36,5 | 352,225 |

CBR Tanah Lempung Ekspansif + 8% Abu Ampas Tebu dengan Waktu Pemeraman 4 Hari



| Penetrasi (inch) | Beban (lbs) | CBR (%) |
|------------------|-------------|---------|
| 0,1 | 236,192 | 7,873 |
| 0,2 | 307,196 | 6,827 |

Perhitungan:

- Penetrasi 0,1 inch:

$$\text{Beban} = 17212(0,1)^3 - 13423(0,1)^2 + 3532,1(0,1) = 236,192$$

$$\text{Harga CBR} = \frac{236,192}{3000} \times 100\% = 7,873\%$$

- Penetrasi 0,2 inch:

$$\text{Beban} = 17212(0,2)^3 - 13423(0,2)^2 + 3532,1(0,2) = 307,196$$

$$\text{Harga CBR} = \frac{307,196}{4500} \times 100\% = 6,827\%$$

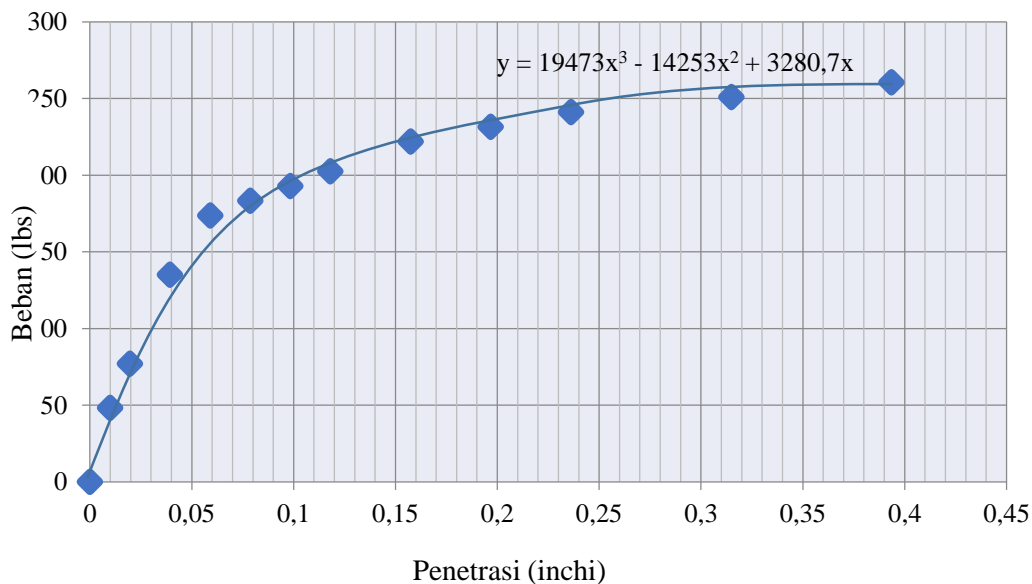


2) CBR Tak Terendam Tanah Lempung Ekspansif + 8% Abu Ampas Tebu dengan Waktu Pemeraman 14 Hari

Faktor Kalibrasi = 9,65

| Pembacaan Dial | Penetrasi (inch) | Pembacaan Proving Ring | Beban (lbs) |
|----------------|------------------|------------------------|-------------|
| 0 | 0 | 0 | 0 |
| 0,25 | 0,01 | 5 | 48,25 |
| 0,5 | 0,02 | 8 | 77,2 |
| 1 | 0,04 | 14 | 135,1 |
| 1,5 | 0,06 | 18 | 173,7 |
| 2 | 0,08 | 19 | 183,35 |
| 2,5 | 0,10 | 20 | 193 |
| 3 | 0,12 | 21 | 202,65 |
| 4 | 0,16 | 23 | 221,95 |
| 5 | 0,20 | 24 | 231,6 |
| 6 | 0,24 | 25 | 241,25 |
| 8 | 0,31 | 26 | 250,9 |
| 10 | 0,39 | 27 | 260,55 |

CBR Tanah Lempung Ekspansif + 8% Abu Ampas Tebu dengan Waktu Pemeraman 14 Hari



| Penetrasi (inch) | Beban (lbs) | CBR (%) |
|------------------|-------------|---------|
| 0,1 | 205,013 | 6,834 |
| 0,2 | 241,804 | 5,373 |

Perhitungan:

- Penetrasi 0,1 inch:

$$\text{Beban} = 19473(0,1)^3 - 14253(0,1)^2 + 3280,7(0,1) = 205,013$$

$$\text{Harga CBR} = \frac{205,013}{3000} \times 100\% = 6,834\%$$

- Penetrasi 0,2 inch:

$$\text{Beban} = 19473(0,2)^3 - 14253(0,2)^2 + 3280,7(0,2) = 241,804$$

$$\text{Harga CBR} = \frac{241,804}{4500} \times 100\% = 5,373\%$$



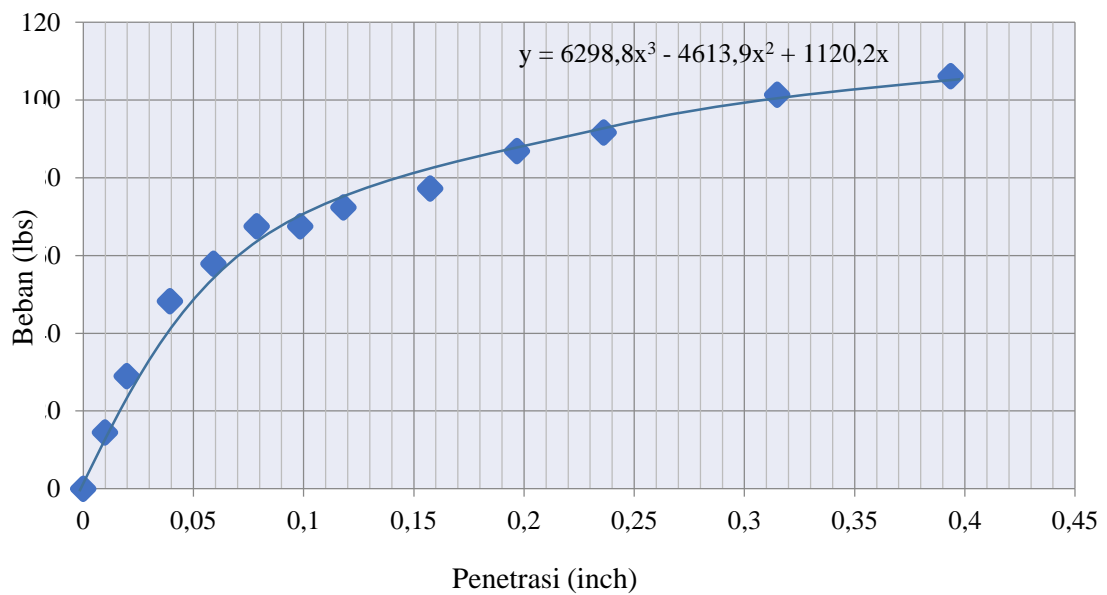
5.2. CBR Terendam (*Soaked*)

5.2.1. CBR Terendam Tanah Lempung Ekspansif

Faktor Kalibrasi = 9,65

| Pembacaan Dial | Penetrasi (inch) | Pembacaan Proving Ring | Beban (lbs) |
|----------------|------------------|------------------------|-------------|
| 0 | 0 | 0 | 0 |
| 0,25 | 0,01 | 1,5 | 14,475 |
| 0,5 | 0,02 | 3 | 28,95 |
| 1 | 0,04 | 5 | 48,25 |
| 1,5 | 0,06 | 6 | 57,9 |
| 2 | 0,08 | 7 | 67,55 |
| 2,5 | 0,10 | 7 | 67,55 |
| 3 | 0,12 | 7,5 | 72,375 |
| 4 | 0,16 | 8 | 77,2 |
| 5 | 0,20 | 9 | 86,85 |
| 6 | 0,24 | 9,5 | 91,675 |
| 8 | 0,31 | 10,5 | 101,325 |
| 10 | 0,39 | 11 | 106,15 |

CBR *Soaked* Tanah Lempung Ekspansif



| Penetrasi (inch) | Beban (lbs) | CBR (%) |
|------------------|-------------|---------|
| 0,1 | 72,180 | 2,406 |
| 0,2 | 89,874 | 1,997 |

Perhitungan:

- Penetrasi 0,1 inch:

$$\text{Beban} = 6298,8(0,1)^3 - 4613,9(0,1)^2 + 1120,2(0,1) = 72,180$$

$$\text{Harga CBR} = \frac{72,180}{3000} \times 100\% = 2,406\%$$

- Penetrasi 0,2 inch:

$$\text{Beban} = 6298,8(0,2)^3 - 4613,9(0,2)^2 + 1120,2(0,2) = 89,874$$

$$\text{Harga CBR} = \frac{89,874}{4500} \times 100\% = 1,997\%$$



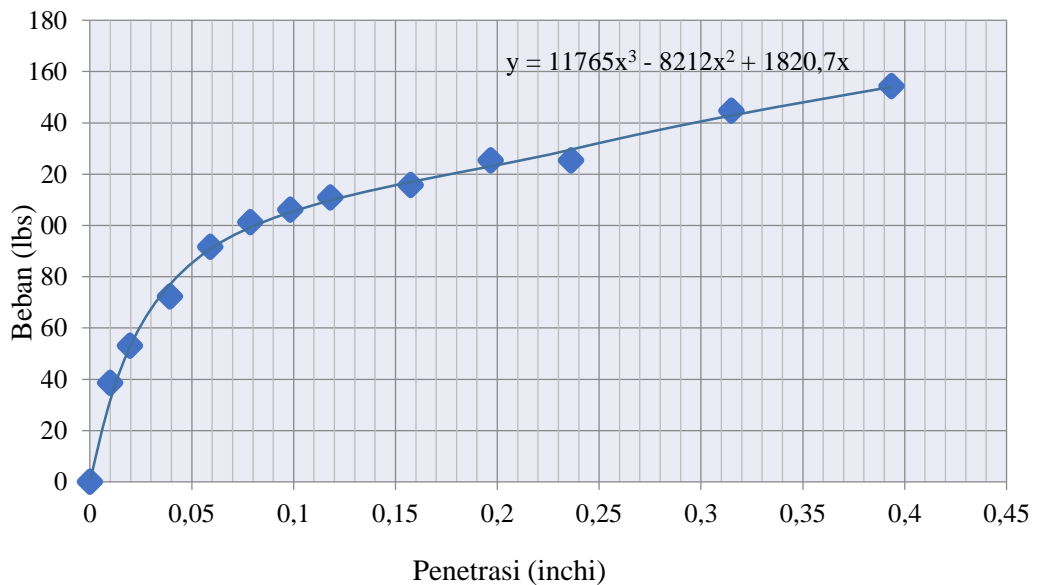
5.2.2. CBR Terendam Campuran Tanpa Pemeraman

1) Tanah Lempung Ekspansif + 8% Abu Ampas Tebu

Faktor Kalibrasi = 9,65

| Pembacaan Dial | Penetrasi (inch) | Pembacaan Proving Ring | Beban (lbs) |
|----------------|------------------|------------------------|-------------|
| 0 | 0 | 0 | 0 |
| 0,25 | 0,01 | 4 | 38,6 |
| 0,5 | 0,02 | 5,5 | 53,075 |
| 1 | 0,04 | 7,5 | 72,375 |
| 1,5 | 0,06 | 9,5 | 91,675 |
| 2 | 0,08 | 10,5 | 101,325 |
| 2,5 | 0,10 | 11 | 106,15 |
| 3 | 0,12 | 11,5 | 110,975 |
| 4 | 0,16 | 12 | 115,8 |
| 5 | 0,20 | 13 | 125,45 |
| 6 | 0,24 | 13 | 125,45 |
| 8 | 0,31 | 15 | 144,75 |
| 10 | 0,39 | 16 | 154,4 |

CBR Soaked Tanah Lempung Ekspansif + 8% Abu Ampas Tebu



| Penetrasi (inch) | Beban (lbs) | CBR (%) |
|------------------|-------------|---------|
| 0,1 | 111,715 | 3,724 |
| 0,2 | 129,780 | 2,884 |

Perhitungan:

- Penetrasi 0,1 inch:

$$\text{Beban} = 11765(0,1)^3 - 8212(0,1)^2 + 1820,7(0,1) = 111,715$$

$$\text{Harga CBR} = \frac{111,715}{3000} \times 100\% = 3,724\%$$

- Penetrasi 0,2 inch:

$$\text{Beban} = 11765(0,2)^3 - 8212(0,2)^2 + 1820,7(0,2) = 129,780$$

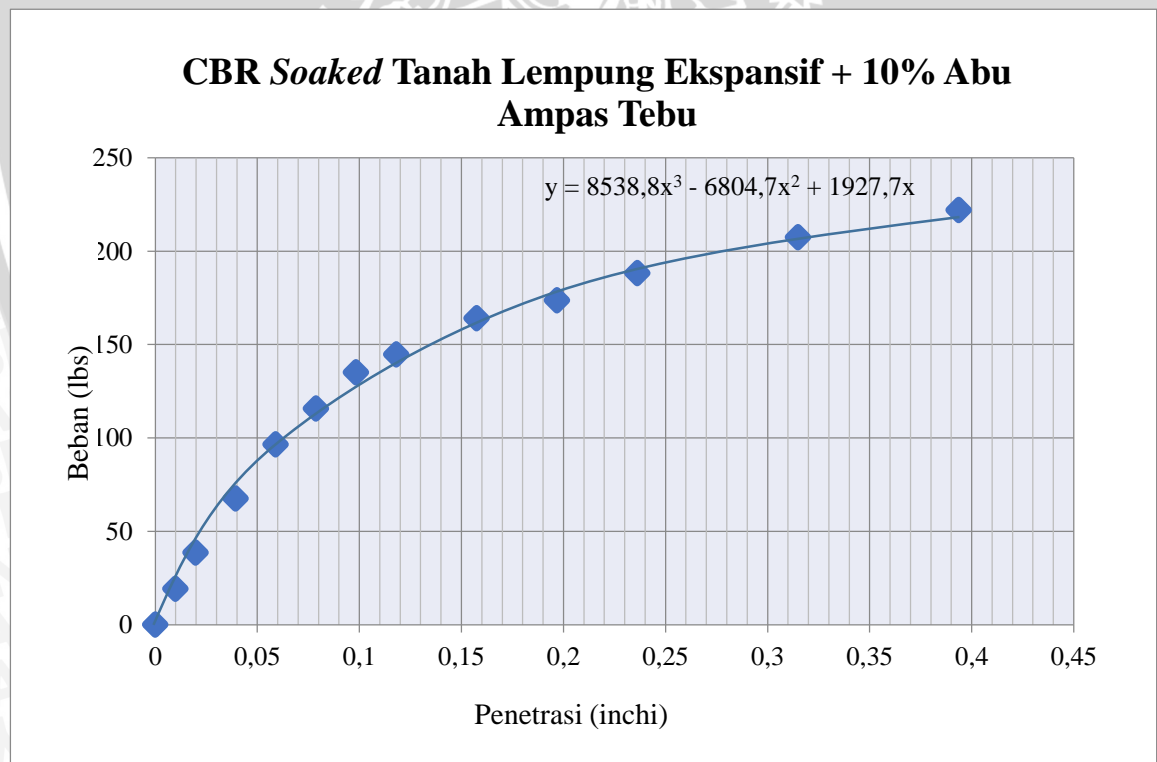
$$\text{Harga CBR} = \frac{129,780}{4500} \times 100\% = 2,884\%$$



2) Tanah Lempung Ekspansif + 10% Abu Ampas Tebu

Faktor Kalibrasi = 9,65

| Pembacaan Dial | Penetrasi (inch) | Pembacaan Proving Ring | Beban (lbs) |
|----------------|------------------|------------------------|-------------|
| 0 | 0 | 0 | 0 |
| 0,25 | 0,01 | 2 | 19,3 |
| 0,5 | 0,02 | 4 | 38,6 |
| 1 | 0,04 | 7 | 67,55 |
| 1,5 | 0,06 | 10 | 96,5 |
| 2 | 0,08 | 12 | 115,8 |
| 2,5 | 0,10 | 14 | 135,1 |
| 3 | 0,12 | 15 | 144,75 |
| 4 | 0,16 | 17 | 164,05 |
| 5 | 0,20 | 18 | 173,7 |
| 6 | 0,24 | 19,5 | 188,175 |
| 8 | 0,31 | 21,5 | 207,475 |
| 10 | 0,39 | 23 | 221,95 |



| Penetrasi (inch) | Beban (lbs) | CBR (%) |
|------------------|-------------|---------|
| 0,1 | 133,262 | 4,442 |
| 0,2 | 181,662 | 4,037 |

Perhitungan:

- Penetrasi 0,1 inch:

$$\text{Beban} = 8538,8(0,1)^3 - 6804,7(0,1)^2 + 1927,7(0,1) = 133,262$$

$$\text{Harga CBR} = \frac{133,262}{3000} \times 100\% = 4,442\%$$

- Penetrasi 0,2 inch:

$$\text{Beban} = 8538,8(0,2)^3 - 6804,7(0,2)^2 + 1927,7(0,2) = 181,662$$

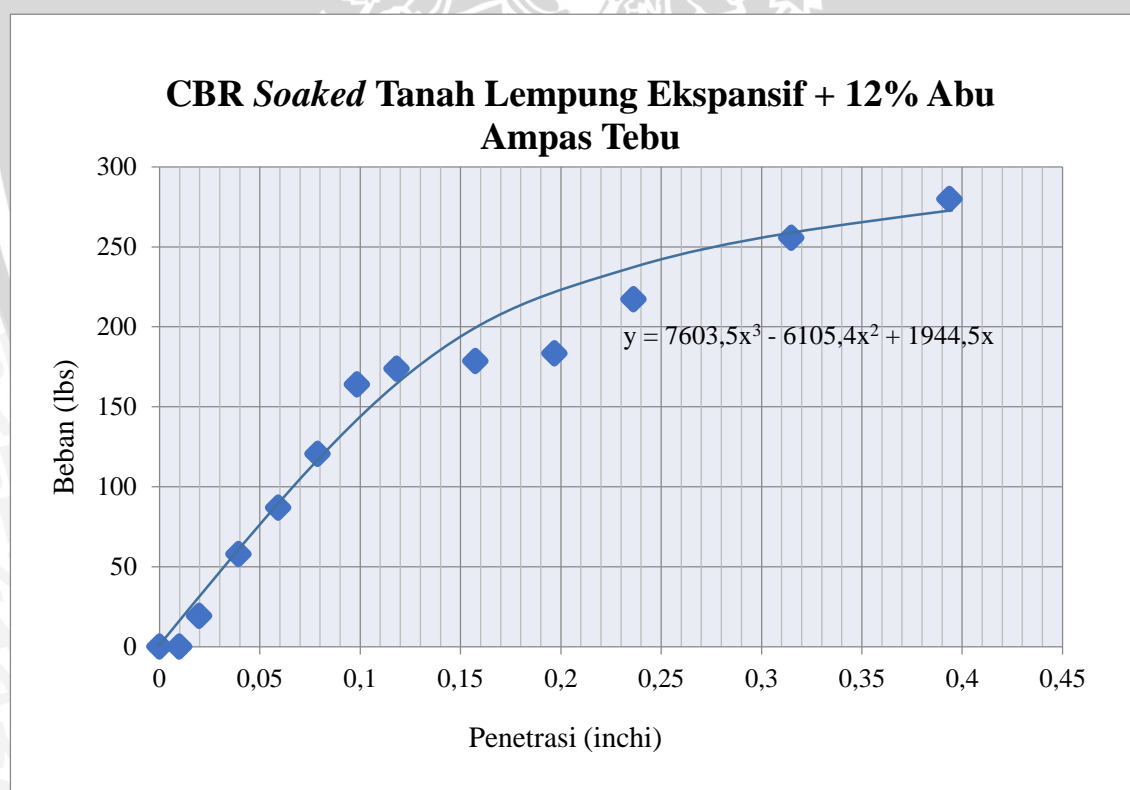
$$\text{Harga CBR} = \frac{181,662}{4500} \times 100\% = 4,037\%$$



3) Tanah Lempung Ekspansif + 12% Abu Ampas Tebu

Faktor Kalibrasi = 9,65

| Pembacaan Dial | Penetrasi (inch) | Pembacaan Proving Ring | Beban (lbs) |
|----------------|------------------|------------------------|-------------|
| 0 | 0 | 0 | 0 |
| 0,25 | 0,01 | 0,00 | 0 |
| 0,5 | 0,02 | 2,00 | 19,3 |
| 1 | 0,04 | 6,00 | 57,9 |
| 1,5 | 0,06 | 9,00 | 86,85 |
| 2 | 0,08 | 12,50 | 120,625 |
| 2,5 | 0,10 | 17,00 | 164,05 |
| 3 | 0,12 | 18,00 | 173,7 |
| 4 | 0,16 | 18,50 | 178,525 |
| 5 | 0,20 | 19,00 | 183,35 |
| 6 | 0,24 | 22,50 | 217,125 |
| 8 | 0,31 | 26,50 | 255,725 |
| 10 | 0,39 | 29,00 | 279,85 |



| Penetrasi (inch) | Beban (lbs) | CBR (%) |
|------------------|-------------|---------|
| 0,1 | 141,000 | 4,700 |
| 0,2 | 205,512 | 4,567 |

Perhitungan:

- Penetrasi 0,1 inch:

$$\text{Beban} = 7603,5(0,1)^3 - 6105,4(0,1)^2 + 1944,5(0,1) = 141,000$$

$$\text{Harga CBR} = \frac{141,000}{3000} \times 100\% = 4,700\%$$

- Penetrasi 0,2 inch:

$$\text{Beban} = 7603,5(0,2)^3 - 6105,4(0,2)^2 + 1944,5(0,2) = 205,512$$

$$\text{Harga CBR} = \frac{248,165}{4500} \times 100\% = 4,567\%$$

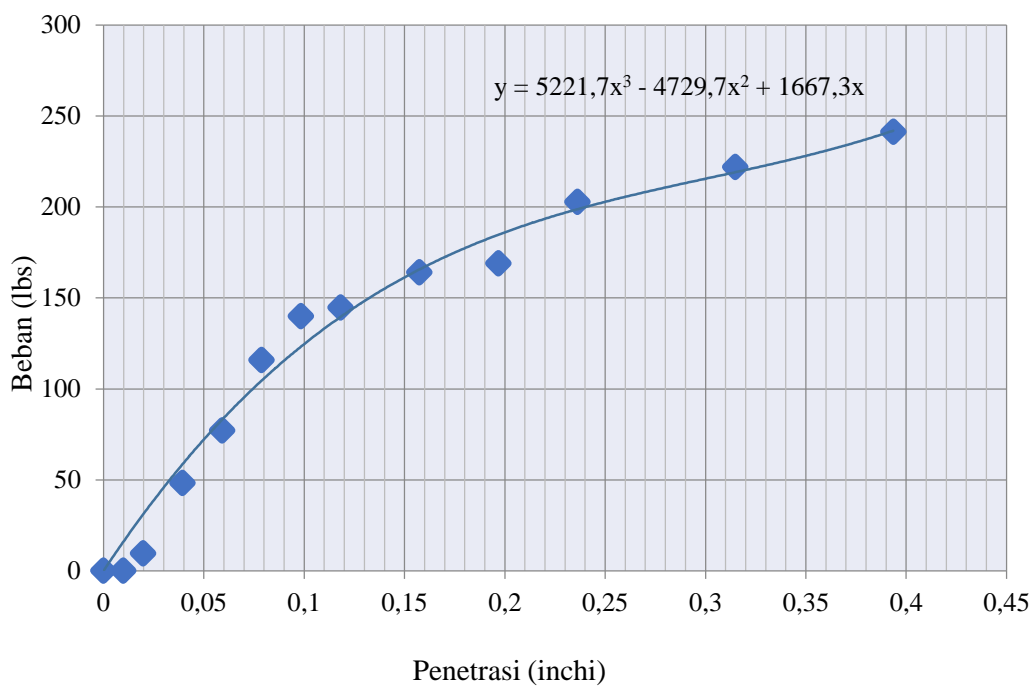


4) Tanah Lempung Ekspansif + 14% Abu Ampas Tebu

Faktor Kalibrasi = 9,65

| Pembacaan Dial | Penetrasi (inch) | Pembacaan Proving Ring | Beban (lbs) |
|----------------|------------------|------------------------|-------------|
| 0 | 0 | 0 | 0 |
| 0,25 | 0,01 | 0,00 | 0 |
| 0,5 | 0,02 | 1,00 | 9,65 |
| 1 | 0,04 | 5,00 | 48,25 |
| 1,5 | 0,06 | 8,00 | 77,2 |
| 2 | 0,08 | 12,00 | 115,8 |
| 2,5 | 0,10 | 14,50 | 139,925 |
| 3 | 0,12 | 15,00 | 144,75 |
| 4 | 0,16 | 17,00 | 164,05 |
| 5 | 0,20 | 17,50 | 168,875 |
| 6 | 0,24 | 21,00 | 202,65 |
| 8 | 0,31 | 23,00 | 221,95 |
| 10 | 0,39 | 25,00 | 241,25 |

CBR Soaked Tanah Lempung Ekspansif + 14% Abu Ampas Tebu



| Penetrasi (inch) | Beban (lbs) | CBR (%) |
|------------------|-------------|---------|
| 0,1 | 124,655 | 4,155 |
| 0,2 | 186,046 | 4,134 |

Perhitungan:

- Penetrasi 0,1 inch:

$$\text{Beban} = 5221,7(0,1)^3 - 4729,7(0,1)^2 + 1667,3(0,1) = 124,655$$

$$\text{Harga CBR} = \frac{218,213}{3000} \times 100\% = 4,155$$

- Penetrasi 0,2 inch:

$$\text{Beban} = 5221,7(0,2)^3 - 4729,7(0,2)^2 + 1667,3(0,2) = 186,046$$

$$\text{Harga CBR} = \frac{186,046}{4500} \times 100\% = 7,169\%$$



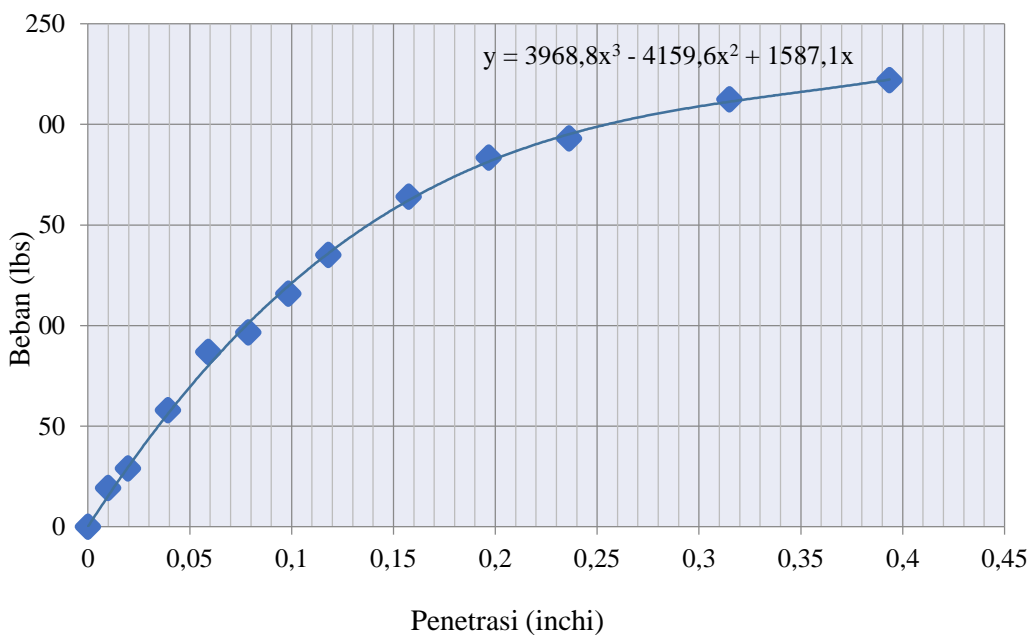
5.2.3. CBR Terendam Campuran dengan Pemeraman

1) CBR Terendam Tanah Lempung Ekspansif + 8% Abu Ampas Tebu dengan Waktu Pemeraman 4 Hari

Faktor Kalibrasi = 9,65

| Pembacaan Dial | Penetrasi (inch) | Pembacaan Proving Ring | Beban (lbs) |
|----------------|------------------|------------------------|-------------|
| 0 | 0 | 0 | 0 |
| 0,25 | 0,01 | 2 | 19,3 |
| 0,5 | 0,02 | 3 | 28,95 |
| 1 | 0,04 | 6 | 57,9 |
| 1,5 | 0,06 | 9 | 86,85 |
| 2 | 0,08 | 10 | 96,5 |
| 2,5 | 0,10 | 12 | 115,8 |
| 3 | 0,12 | 14 | 135,1 |
| 4 | 0,16 | 17 | 164,05 |
| 5 | 0,20 | 19 | 183,35 |
| 6 | 0,24 | 20 | 193 |
| 8 | 0,31 | 22 | 212,3 |
| 10 | 0,39 | 23 | 221,95 |

CBR Soaked Tanah Lempung Ekspansif + 8% Abu Ampas Tebu dengan Waktu Pemeraman 4 Hari



| Penetrasi (inch) | Beban (lbs) | CBR (%) |
|------------------|-------------|---------|
| 0,1 | 128,771 | 4,292 |
| 0,2 | 184,917 | 4,109 |

Perhitungan:

- Penetrasi 0,1 inch:

$$\text{Beban} = 3968,8(0,1)^3 - 4159,6(0,1)^2 + 1587,1(0,1) = 128,771$$

$$\text{Harga CBR} = \frac{128,771}{3000} \times 100\% = 4,292\%$$

- Penetrasi 0,2 inch:

$$\text{Beban} = 3968,8(0,2)^3 - 4159,6(0,2)^2 + 1587,1(0,2) = 184,917$$

$$\text{Harga CBR} = \frac{184,917}{4500} \times 100\% = 4,109\%$$

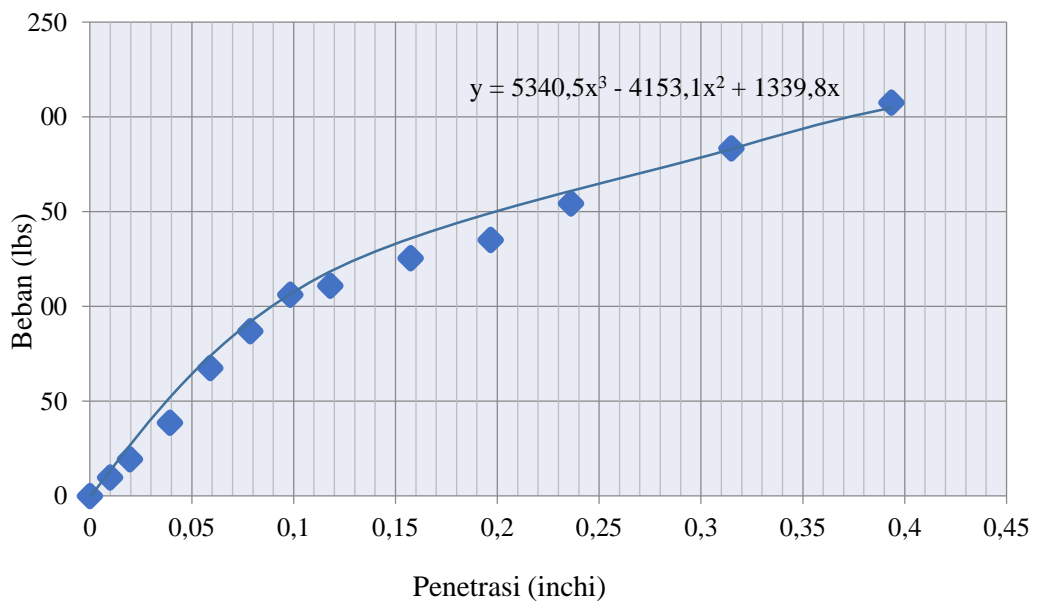


2) CBR Terendam Tanah Lempung Ekspansif + 8% Abu Ampas Tebu dengan Waktu Pemeraman 14 Hari

Faktor Kalibrasi = 9,65

| Pembacaan Dial | Penetrasi (inch) | Pembacaan Proving Ring | Beban (lbs) |
|----------------|------------------|------------------------|-------------|
| 0 | 0 | 0 | 0 |
| 0,25 | 0,01 | 1 | 9,65 |
| 0,5 | 0,02 | 2 | 19,3 |
| 1 | 0,04 | 4 | 38,6 |
| 1,5 | 0,06 | 7 | 67,55 |
| 2 | 0,08 | 9 | 86,85 |
| 2,5 | 0,10 | 11 | 106,15 |
| 3 | 0,12 | 11,5 | 110,975 |
| 4 | 0,16 | 13 | 125,45 |
| 5 | 0,20 | 14 | 135,1 |
| 6 | 0,24 | 16 | 154,4 |
| 8 | 0,31 | 19 | 183,35 |
| 10 | 0,39 | 21,5 | 207,475 |

CBR Soaked Tanah Lempung Ekspansif + 8% Abu Ampas Tebu dengan Waktu Pemeraman 4 Hari



| Penetrasi (inch) | Beban (lbs) | CBR (%) |
|------------------|-------------|---------|
| 0,1 | 97,790 | 3,260 |
| 0,2 | 144,560 | 3,212 |

Perhitungan:

- Penetrasi 0,1 inch:

$$\text{Beban} = 5340,5(0,1)^3 - 4153,1(0,1)^2 + 1339,8(0,1) = 97,790$$

$$\text{Harga CBR} = \frac{97,790}{3000} \times 100\% = 3,260\%$$

- Penetrasi 0,2 inch:

$$\text{Beban} = 5340,5(0,2)^3 - 4153,1(0,2)^2 + 1339,8(0,2) = 144,560$$

$$\text{Harga CBR} = \frac{144,560}{4500} \times 100\% = 3,212\%$$



3. SWELLING

3.1. Swelling Tanah Lempung Ekspansif

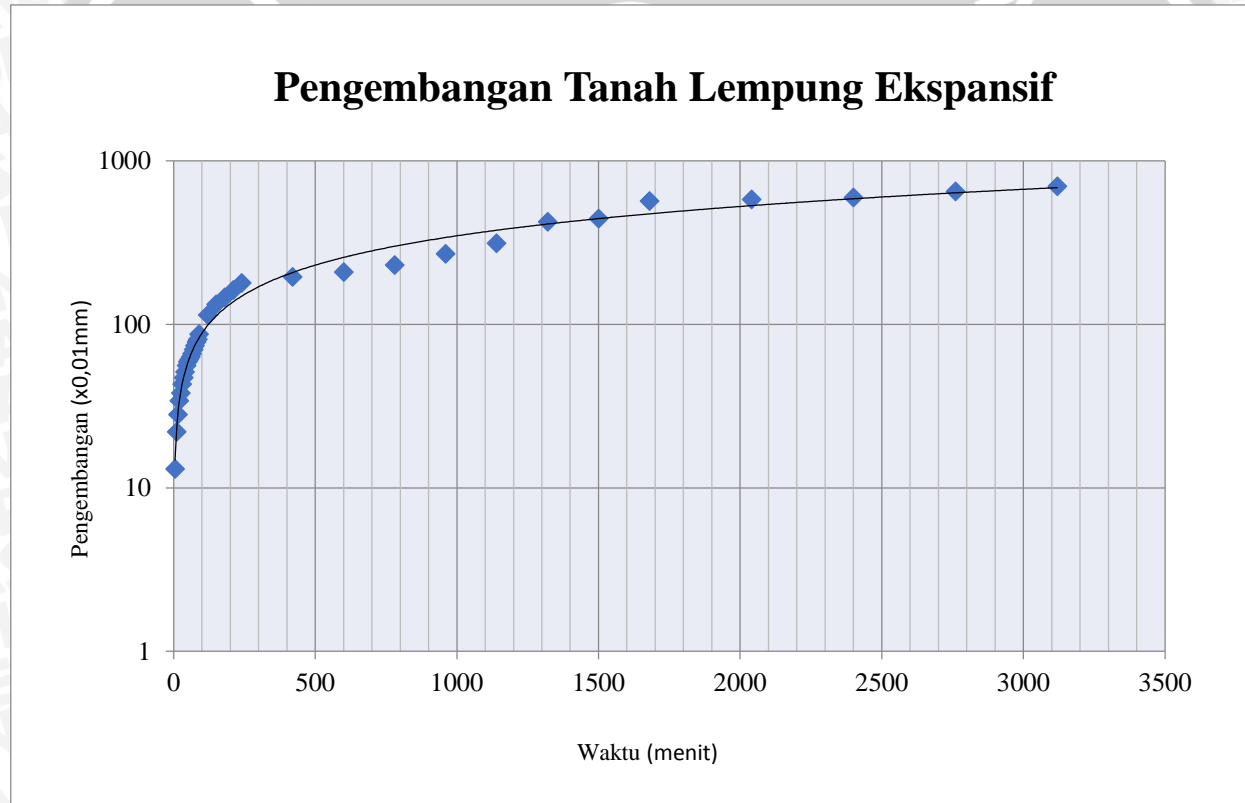
Ht = 113

| Menit | Pembacaan Dial | Prosentase Pengembangan (%) |
|-------|----------------|-----------------------------|
| 5 | 13 | 0,115 |
| 10 | 22 | 0,195 |
| 15 | 28 | 0,248 |
| 20 | 34 | 0,301 |
| 25 | 38 | 0,336 |
| 30 | 43 | 0,381 |
| 35 | 47 | 0,416 |
| 40 | 51 | 0,451 |
| 45 | 56 | 0,496 |
| 50 | 59 | 0,522 |
| 55 | 61 | 0,540 |
| 60 | 63 | 0,558 |
| 65 | 66 | 0,584 |
| 70 | 70 | 0,619 |
| 75 | 74 | 0,655 |
| 80 | 78 | 0,690 |
| 85 | 81 | 0,717 |
| 90 | 87 | 0,770 |

| Menit | Pembacaan Dial | Prosentase Pengembangan (%) |
|-------|----------------|-----------------------------|
| 120 | 114 | 1,009 |
| 150 | 132 | 1,168 |
| 180 | 146 | 1,292 |
| 210 | 162 | 1,434 |
| 240 | 179 | 1,584 |
| 420 | 195 | 1,726 |
| 600 | 209 | 1,850 |
| 780 | 230 | 2,035 |
| 960 | 270 | 2,389 |
| 1140 | 313 | 2,770 |
| 1320 | 424 | 3,752 |
| 1500 | 443 | 3,920 |
| 1680 | 568 | 5,027 |
| 2040 | 581 | 5,142 |
| 2400 | 595 | 5,265 |
| 2760 | 651 | 5,761 |
| 3120 | 699 | 6,186 |

Contoh Perhitungan Prosentase Pengembangan:

$$\begin{aligned} \text{Pengembangan pada menit ke-5} &= (\text{Pembacaan Dial} / \text{Tinggi Awal Tanah}) \times 100\% \\ &= (13 / 113) \times 100\% \\ &= 0,115\% \end{aligned}$$



3.2. *Swelling* Campuran Tanpa Pemeraman

1) *Swelling* Tanah Lempung Ekspansif + 8% Abu Ampas Tebu Tanpa Pemeraman

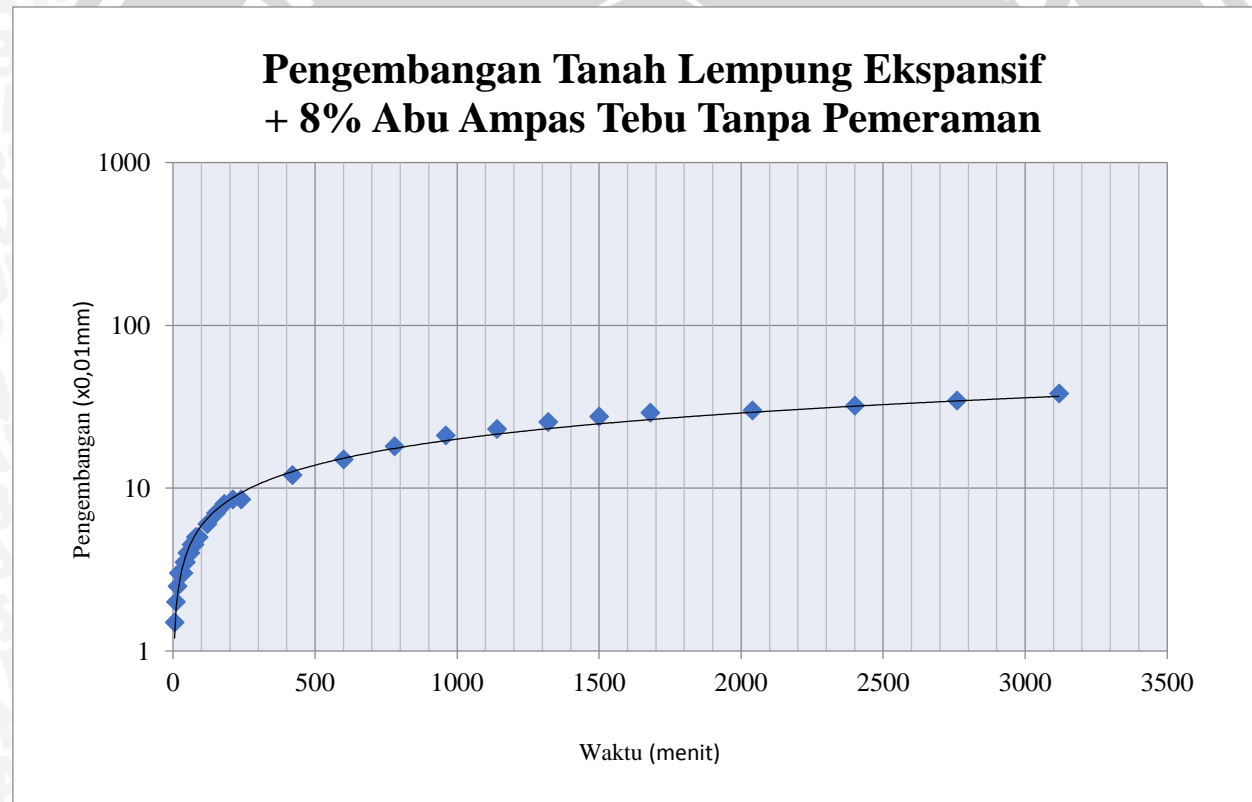
Ht = 113

| Menit | Pembacaan Dial | Prosentase Pengembangan (%) |
|-------|----------------|-----------------------------|
| 5 | 1,5 | 0,013 |
| 10 | 2 | 0,018 |
| 15 | 2,5 | 0,022 |
| 20 | 3 | 0,027 |
| 25 | 3 | 0,027 |
| 30 | 3 | 0,027 |
| 35 | 3 | 0,027 |
| 40 | 3,5 | 0,031 |
| 45 | 3,5 | 0,031 |
| 50 | 4 | 0,035 |
| 55 | 4 | 0,035 |
| 60 | 4 | 0,035 |
| 65 | 4,5 | 0,040 |
| 70 | 4,5 | 0,040 |
| 75 | 4,5 | 0,040 |
| 80 | 5 | 0,044 |
| 85 | 5 | 0,044 |
| 90 | 5 | 0,044 |

| Menit | Pembacaan Dial | Prosentase Pengembangan (%) |
|-------|----------------|-----------------------------|
| 120 | 6 | 0,053 |
| 150 | 7 | 0,062 |
| 180 | 8 | 0,071 |
| 210 | 8,5 | 0,075 |
| 240 | 8,5 | 0,075 |
| 420 | 12 | 0,106 |
| 600 | 15 | 0,133 |
| 780 | 18 | 0,159 |
| 960 | 21 | 0,186 |
| 1140 | 23 | 0,204 |
| 1320 | 25,5 | 0,226 |
| 1500 | 27,5 | 0,243 |
| 1680 | 29 | 0,257 |
| 2040 | 30 | 0,265 |
| 2400 | 32 | 0,283 |
| 2760 | 34,5 | 0,305 |
| 3120 | 38 | 0,336 |

Contoh Perhitungan Prosentase Pengembangan:

$$\begin{aligned}\text{Pengembangan pada menit ke-5} &= (\text{Pembacaan Dial} / \text{Tinggi Awal Tanah}) \times 100\% \\ &= (1,5 / 113) \times 100\% \\ &= 0,013\%\end{aligned}$$



2) *Swelling* Tanah Lempung Ekspansif + 10% Abu Ampas Tebu Tanpa Pemeraman

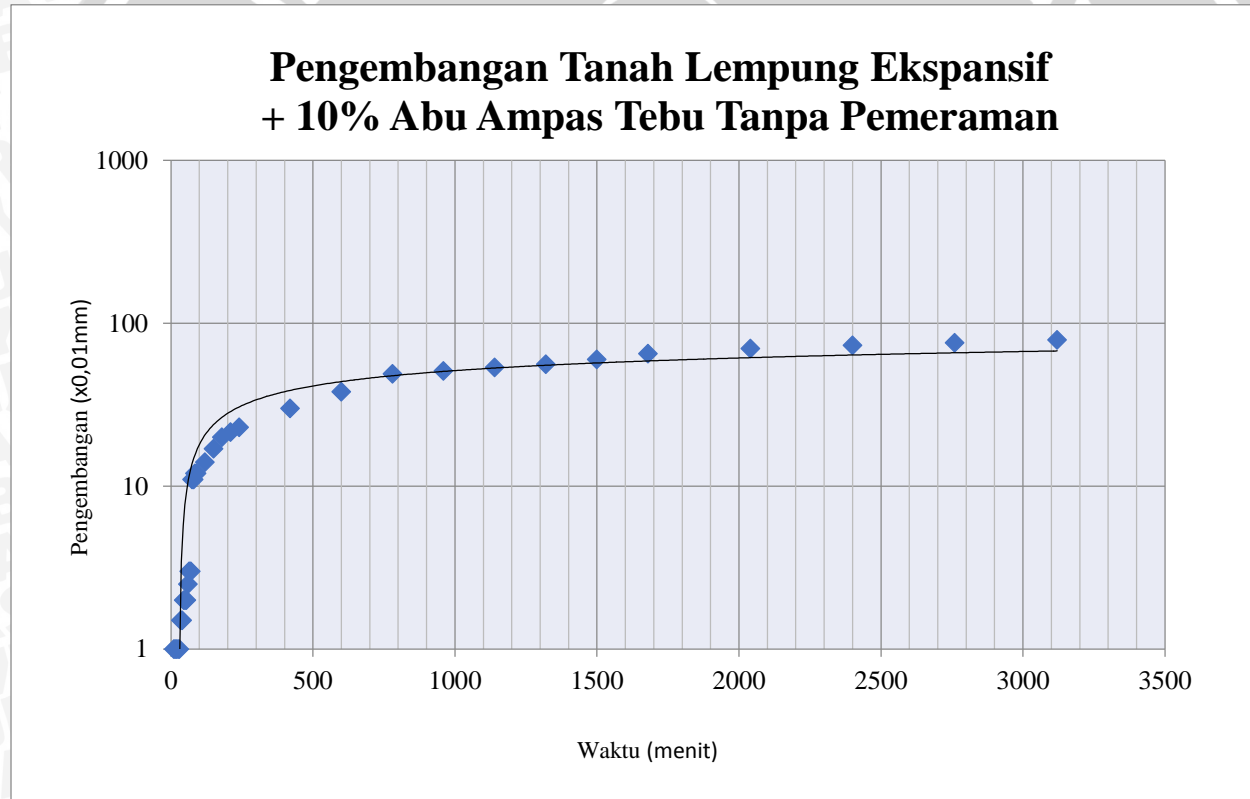
Ht = 113

| Menit | Pembacaan Dial | Prosentase Pengembangan (%) |
|-------|----------------|-----------------------------|
| 5 | 0,5 | 0,004 |
| 10 | 1 | 0,009 |
| 15 | 1 | 0,009 |
| 20 | 1 | 0,009 |
| 25 | 1 | 0,009 |
| 30 | 1 | 0,009 |
| 35 | 1,5 | 0,013 |
| 40 | 1,5 | 0,013 |
| 45 | 2 | 0,018 |
| 50 | 2 | 0,018 |
| 55 | 2 | 0,018 |
| 60 | 2,5 | 0,022 |
| 65 | 3 | 0,027 |
| 70 | 3 | 0,027 |
| 75 | 11 | 0,097 |
| 80 | 11 | 0,097 |
| 85 | 12 | 0,106 |
| 90 | 12 | 0,106 |

| Menit | Pembacaan Dial | Prosentase Pengembangan (%) |
|-------|----------------|-----------------------------|
| 120 | 14 | 0,124 |
| 150 | 17 | 0,150 |
| 180 | 20 | 0,177 |
| 210 | 21,5 | 0,190 |
| 240 | 23 | 0,204 |
| 420 | 30 | 0,265 |
| 600 | 38 | 0,336 |
| 780 | 49 | 0,434 |
| 960 | 51 | 0,451 |
| 1140 | 53,5 | 0,473 |
| 1320 | 56 | 0,496 |
| 1500 | 60 | 0,531 |
| 1680 | 65 | 0,575 |
| 2040 | 70 | 0,619 |
| 2400 | 73 | 0,646 |
| 2760 | 76 | 0,673 |
| 3120 | 79 | 0,699 |

Contoh Perhitungan Prosentase Pengembangan:

$$\begin{aligned} \text{Pengembangan pada menit ke-5} &= (\text{Pembacaan Dial} / \text{Tinggi Awal Tanah}) \times 100\% \\ &= (0,5 / 113) \times 100\% \\ &= 0,004\% \end{aligned}$$



3) *Swelling* Tanah Lempung Ekspansif + 12% Abu Ampas Tebu Tanpa Pemeraman

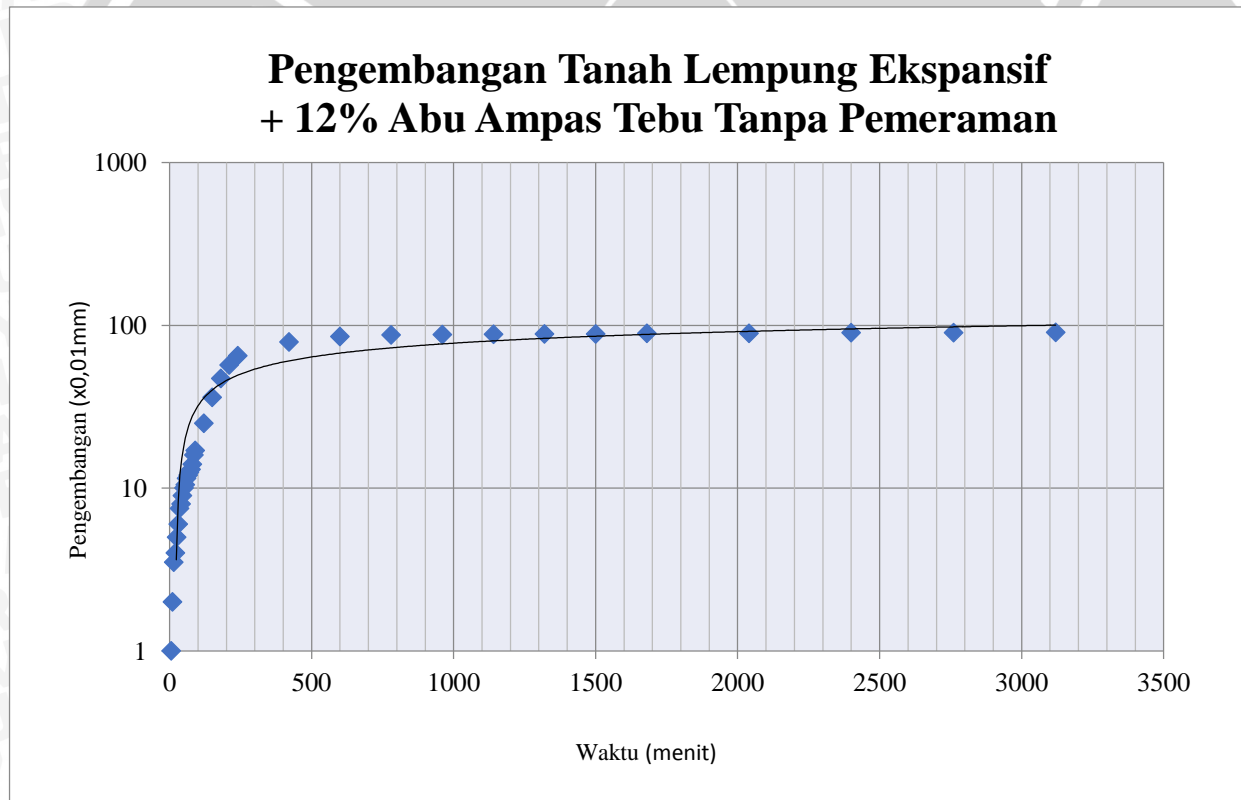
Ht = 113

| Menit | Pembacaan Dial | Prosentase Pengembangan (%) |
|-------|----------------|-----------------------------|
| 5 | 1 | 0,009 |
| 10 | 2 | 0,018 |
| 15 | 3,5 | 0,031 |
| 20 | 4 | 0,035 |
| 25 | 5 | 0,044 |
| 30 | 6 | 0,053 |
| 35 | 7,5 | 0,066 |
| 40 | 8 | 0,071 |
| 45 | 9 | 0,080 |
| 50 | 10 | 0,088 |
| 55 | 10,5 | 0,093 |
| 60 | 11,5 | 0,102 |
| 65 | 12 | 0,106 |
| 70 | 12,5 | 0,111 |
| 75 | 13 | 0,115 |
| 80 | 14 | 0,124 |
| 85 | 16 | 0,142 |
| 90 | 17 | 0,150 |

| Menit | Pembacaan Dial | Prosentase Pengembangan (%) |
|-------|----------------|-----------------------------|
| 120 | 25 | 0,221 |
| 150 | 36 | 0,319 |
| 180 | 47 | 0,416 |
| 210 | 57 | 0,504 |
| 240 | 65 | 0,575 |
| 420 | 79 | 0,699 |
| 600 | 85 | 0,752 |
| 780 | 87 | 0,770 |
| 960 | 87,5 | 0,774 |
| 1140 | 88 | 0,779 |
| 1320 | 88,5 | 0,783 |
| 1500 | 88,5 | 0,783 |
| 1680 | 89 | 0,788 |
| 2040 | 89 | 0,788 |
| 2400 | 90 | 0,796 |
| 2760 | 90 | 0,796 |
| 3120 | 90,5 | 0,801 |

Contoh Perhitungan Prosentase Pengembangan:

$$\begin{aligned} \text{Pengembangan pada menit ke-5} &= (\text{Pembacaan Dial} / \text{Tinggi Awal Tanah}) \times 100\% \\ &= (1 / 113) \times 100\% \\ &= 0,009\% \end{aligned}$$



4) *Swelling* Tanah Lempung Ekspansif + 14% Abu Ampas Tebu Tanpa Pemeraman

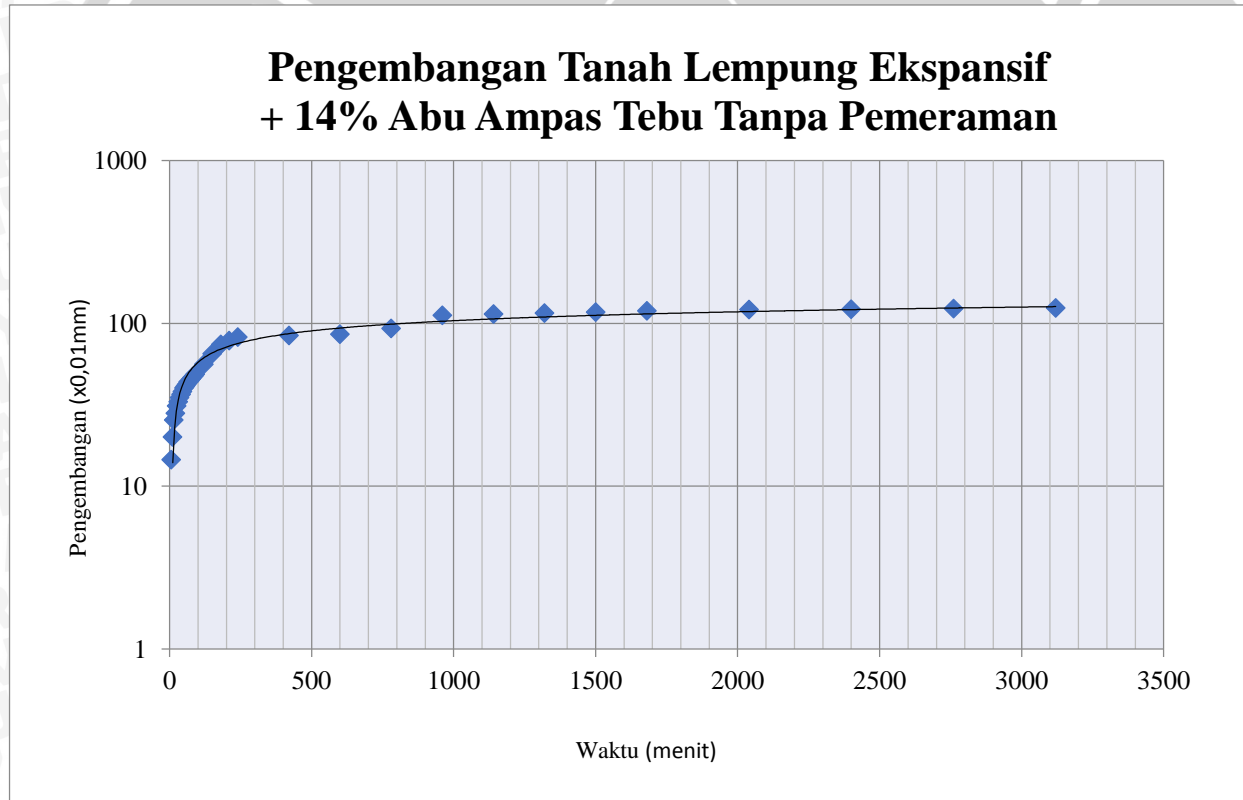
Ht = 113

| Menit | Pembacaan Dial | Prosentase Pengembangan (%) |
|-------|----------------|-----------------------------|
| 5 | 14,5 | 0,128 |
| 10 | 20 | 0,177 |
| 15 | 25,5 | 0,226 |
| 20 | 28 | 0,248 |
| 25 | 31 | 0,274 |
| 30 | 33 | 0,292 |
| 35 | 35 | 0,310 |
| 40 | 36,5 | 0,323 |
| 45 | 38 | 0,336 |
| 50 | 40 | 0,354 |
| 55 | 41 | 0,363 |
| 60 | 42 | 0,372 |
| 65 | 43,5 | 0,385 |
| 70 | 44 | 0,389 |
| 75 | 45,5 | 0,403 |
| 80 | 46,5 | 0,412 |
| 85 | 47,5 | 0,420 |
| 90 | 48,5 | 0,429 |

| Menit | Pembacaan Dial | Prosentase Pengembangan (%) |
|-------|----------------|-----------------------------|
| 120 | 56 | 0,496 |
| 150 | 65 | 0,575 |
| 180 | 74 | 0,655 |
| 210 | 78 | 0,690 |
| 240 | 82 | 0,726 |
| 420 | 84 | 0,743 |
| 600 | 85,5 | 0,757 |
| 780 | 93 | 0,823 |
| 960 | 111,5 | 0,987 |
| 1140 | 114 | 1,009 |
| 1320 | 115,5 | 1,022 |
| 1500 | 117 | 1,035 |
| 1680 | 119 | 1,053 |
| 2040 | 121 | 1,071 |
| 2400 | 122 | 1,080 |
| 2760 | 123 | 1,088 |
| 3120 | 124 | 1,097 |

Contoh Perhitungan Prosentase Pengembangan:

$$\begin{aligned} \text{Pengembangan pada menit ke-5} &= (\text{Pembacaan Dial} / \text{Tinggi Awal Tanah}) \times 100\% \\ &= (14,5 / 113) \times 100\% \\ &= 0,128\% \end{aligned}$$



3.3. *Swelling* Campuran dengan Pemeraman

1) *Swelling* Tanah Lempung Ekspansif + 8% Abu Ampas Tebu dengan Waktu Pemeraman 4 Hari

Ht = 113

| Menit | Pembacaan Dial | Prosentase Pengembangan (%) |
|-------|----------------|-----------------------------|
| 5 | 1,5 | 0,013 |
| 10 | 2 | 0,018 |
| 15 | 2,5 | 0,022 |
| 20 | 3 | 0,027 |
| 25 | 3 | 0,027 |
| 30 | 3,5 | 0,031 |
| 35 | 3,5 | 0,031 |
| 40 | 3,5 | 0,031 |
| 45 | 4 | 0,035 |
| 50 | 4 | 0,035 |
| 55 | 4 | 0,035 |
| 60 | 5 | 0,044 |
| 65 | 5 | 0,044 |
| 70 | 5,5 | 0,049 |
| 75 | 5,5 | 0,049 |
| 80 | 6 | 0,053 |
| 85 | 6 | 0,053 |
| 90 | 6,5 | 0,058 |

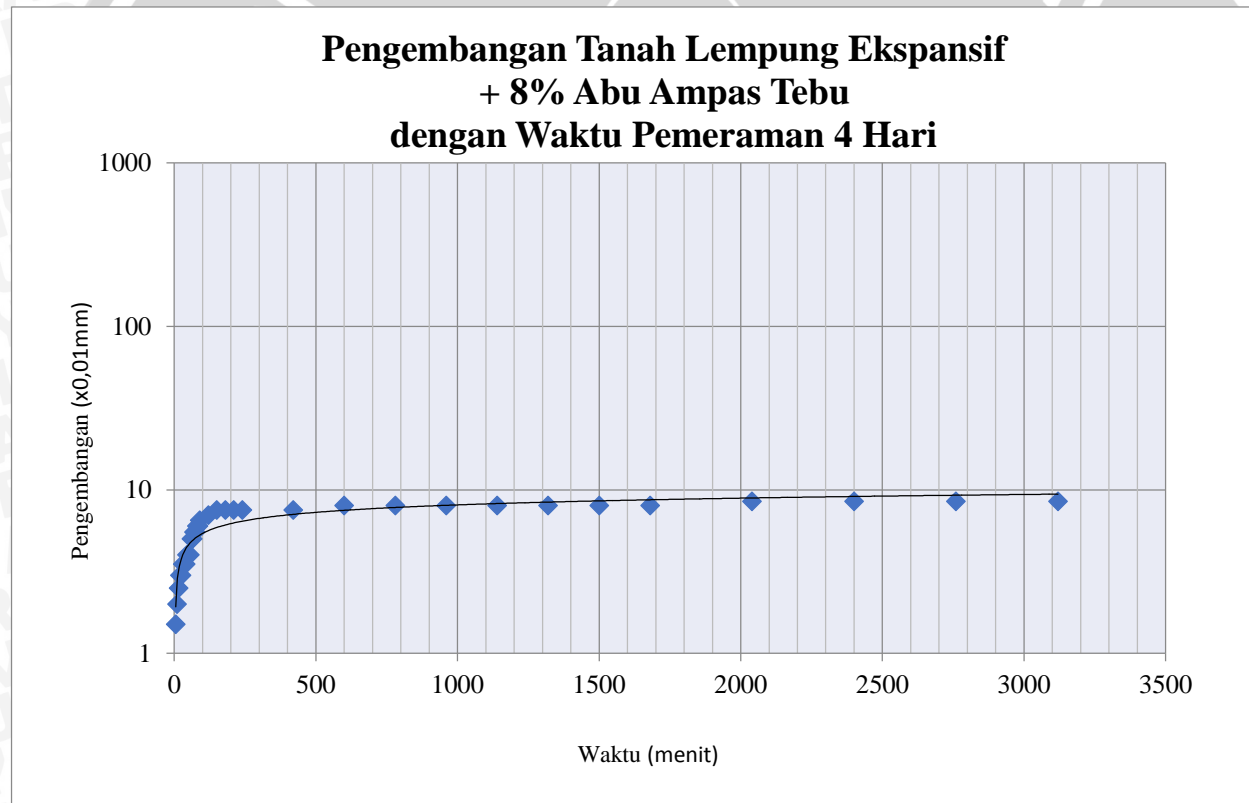
| Menit | Pembacaan Dial | Prosentase Pengembangan (%) |
|-------|----------------|-----------------------------|
| 120 | 7 | 0,062 |
| 150 | 7,5 | 0,066 |
| 180 | 7,5 | 0,066 |
| 210 | 7,5 | 0,066 |
| 240 | 7,5 | 0,066 |
| 420 | 7,5 | 0,066 |
| 600 | 8 | 0,071 |
| 780 | 8 | 0,071 |
| 960 | 8 | 0,071 |
| 1140 | 8 | 0,071 |
| 1320 | 8 | 0,071 |
| 1500 | 8 | 0,071 |
| 1680 | 8 | 0,071 |
| 2040 | 8,5 | 0,075 |
| 2400 | 8,5 | 0,075 |
| 2760 | 8,5 | 0,075 |
| 3120 | 8,5 | 0,075 |

Contoh Perhitungan Prosentase Pengembangan:

Pengembangan pada menit ke-5 = (Pembacaan Dial / Tinggi Awal Tanah) x 100%

$$= (1,5 / 113) \times 100\%$$

$$= 0,013\%$$



2) *Swelling* Tanah Lempung Ekspansif + 8% Abu Ampas Tebu dengan Waktu Pemeraman 14 Hari

Ht = 113

| Menit | Pembacaan Dial | Prosentase Pengembangan (%) |
|-------|----------------|-----------------------------|
| 5 | 3 | 0,027 |
| 10 | 4 | 0,035 |
| 15 | 5 | 0,044 |
| 20 | 6 | 0,053 |
| 25 | 6 | 0,053 |
| 30 | 6 | 0,053 |
| 35 | 6 | 0,053 |
| 40 | 7 | 0,062 |
| 45 | 7 | 0,062 |
| 50 | 8 | 0,071 |
| 55 | 8 | 0,071 |
| 60 | 8 | 0,071 |
| 65 | 9 | 0,080 |
| 70 | 9 | 0,080 |
| 75 | 9 | 0,080 |
| 80 | 10 | 0,088 |
| 85 | 10 | 0,088 |
| 90 | 10 | 0,088 |

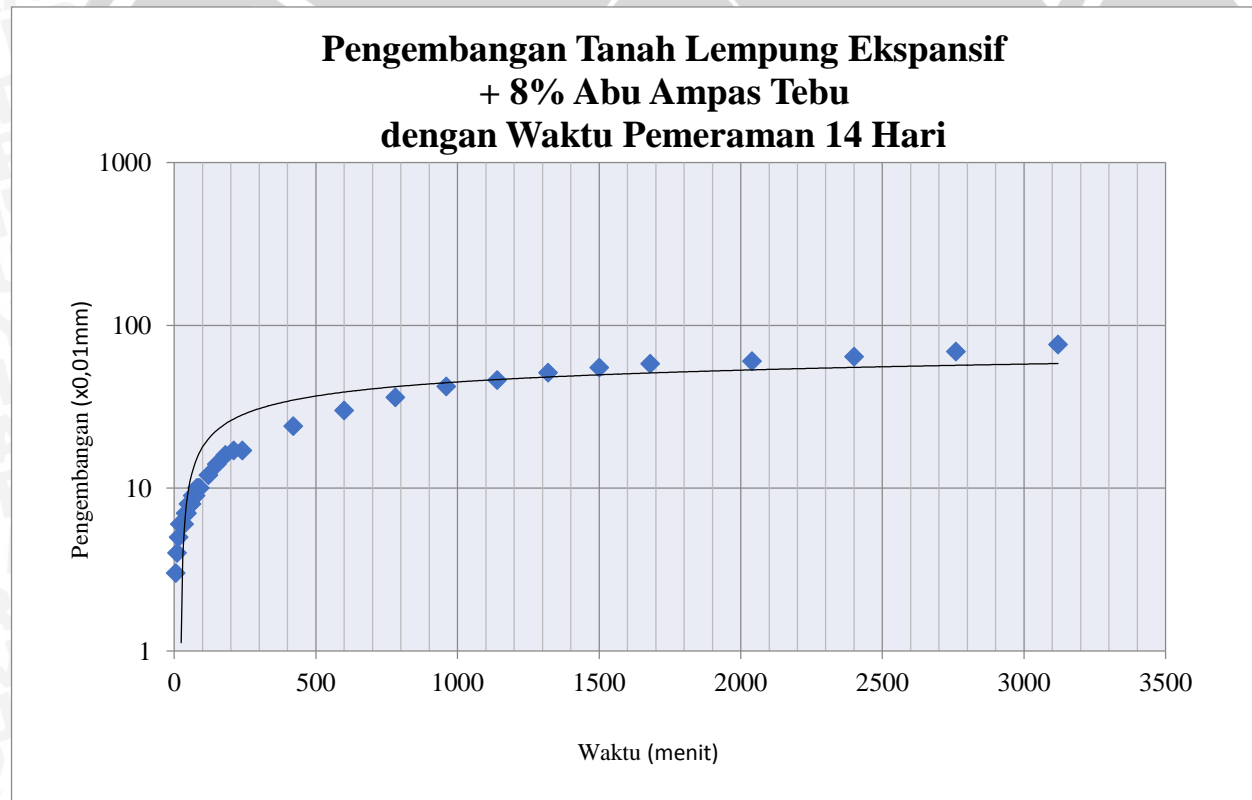
| Menit | Pembacaan Dial | Prosentase Pengembangan (%) |
|-------|----------------|-----------------------------|
| 120 | 12 | 0,106 |
| 150 | 14 | 0,124 |
| 180 | 16 | 0,142 |
| 210 | 17 | 0,150 |
| 240 | 17 | 0,150 |
| 420 | 24 | 0,212 |
| 600 | 30 | 0,265 |
| 780 | 36 | 0,319 |
| 960 | 42 | 0,372 |
| 1140 | 46 | 0,407 |
| 1320 | 51 | 0,451 |
| 1500 | 55 | 0,487 |
| 1680 | 58 | 0,513 |
| 2040 | 60 | 0,531 |
| 2400 | 64 | 0,566 |
| 2760 | 69 | 0,611 |
| 3120 | 76 | 0,673 |

Contoh Perhitungan Prosentase Pengembangan:

Pengembangan pada menit ke-5 = (Pembacaan Dial / Tinggi Awal Tanah) x 100%

$$= (3 / 113) \times 100\%$$

$$= 0,027\%$$



6.4. Swelling Bebas

Dengan persamaan $Free\ Swell = \frac{Volume\ akhir - Volume\ awal}{Volume\ awal} \times 100\%$

Didapatkan nilai pengembangan sebagai berikut:

- Untuk tanah lempung ekspansif:

$$Free\ Swell = (77,5 - 42,5) / 42,5 \times 100\% = 70,59\%$$

- Untuk tanah lempung ekspansif + 8% abu ampas tebu:

$$Free\ Swell = (75,5 - 42,5) / 45 \times 100\% = 72,22\%$$

- Untuk tanah lempung ekspansif + 10% abu ampas tebu:

$$Free\ Swell = (75,25 - 42,5) / 45 \times 100\% = 67,22\%$$

- Untuk tanah lempung ekspansif + 12% abu ampas tebu:

$$Free\ Swell = (73,5 - 42,5) / 45 \times 100\% = 63,33\%$$

- Untuk tanah lempung ekspansif + 14% abu ampas tebu:

$$Free\ Swell = (72 - 42,5) / 45 \times 100\% = 60\%$$

