



LAMPIRAN

Lampiran 4. Perhitungan Tegangan Tarik

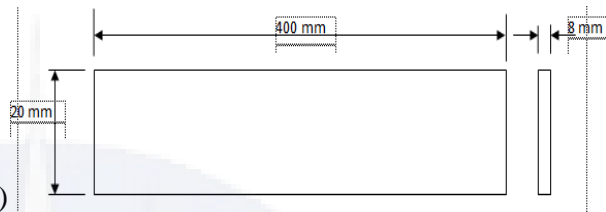
$$\sigma = \frac{F}{A}$$

Dengan :

σ = Kekuatan tarik (MPa)

F = gaya tarik (N)

A = luas penampang (mm^2)



1. Fraksi volume (25% SBP)

Spesimen 1:

$$\sigma = \frac{1340,8 N}{160 mm^2} = 8,38 MPa$$

Spesimen 2:

$$\sigma = \frac{1211,2 N}{160 mm^2} = 7,57 MPa$$

Spesimen 3:

$$\sigma = \frac{1257,6 N}{160 mm^2} = 7,86 MPa$$

$$Rata - rata = \frac{8,38 + 7,57 + 7,86}{3} = 7,93 MPa$$

2. Fraksi volume (30% SBP)

Spesimen 4:

$$\sigma = \frac{1401,6 N}{160 mm^2} = 8,76 MPa$$

Spesimen 5:

$$\sigma = \frac{1457,6 N}{160 mm^2} = 9,11 MPa$$

Spesimen 6:

$$\sigma = \frac{1409,6 N}{160 mm^2} = 8,81 MPa$$

$$\text{Rata - rata} = \frac{8,76 + 9,11 + 8,81}{3} = 8,89 \text{ MPa}$$

3. Fraksi volume (40% SBP)

Spesimen 7:

$$\sigma = \frac{2140,8 \text{ N}}{160 \text{ mm}^2} = 13,38 \text{ MPa}$$

Spesimen 8:

$$\sigma = \frac{1828,8 \text{ N}}{160 \text{ mm}^2} = 11,43 \text{ MPa}$$

Spesimen 9:

$$\sigma = \frac{1814,4 \text{ N}}{160 \text{ mm}^2} = 11,34 \text{ MPa}$$

$$\text{Rata - rata} = \frac{13,38 + 11,43 + 11,34}{3} = 12,05 \text{ MPa}$$

4. Fraksi volume (45% SBP)

Spesimen 10:

$$\sigma = \frac{2025,6 \text{ N}}{160 \text{ mm}^2} = 12,66 \text{ MPa}$$

Spesimen 11:

$$\sigma = \frac{2000 \text{ N}}{160 \text{ mm}^2} = 12,50 \text{ MPa}$$

Spesimen 12:

$$\sigma = \frac{2139,2 \text{ N}}{160 \text{ mm}^2} = 13,37 \text{ MPa}$$

$$\text{Rata - rata} = \frac{12,66 + 12,50 + 13,37}{3} = 12,84 \text{ MPa}$$

5. Fraksi volume (50% SBP)

Spesimen 13:

$$\sigma = \frac{2456 \text{ N}}{160 \text{ mm}^2} = 15,35 \text{ MPa}$$

Spesimen 14:

$$\sigma = \frac{2308,8 \text{ N}}{160 \text{ mm}^2} = 14,43 \text{ MPa}$$

Spesimen 15:

$$\sigma = \frac{2272 N}{160 mm^2} = 14,20 MPa$$

$$Rata - rata = \frac{15,35 + 14,43 + 14,20}{3} = 14,66 MPa$$

6. Fraksi volume (40% SF)

Spesimen 16:

$$\sigma = \frac{4376 N}{160 mm^2} = 27,35 MPa$$

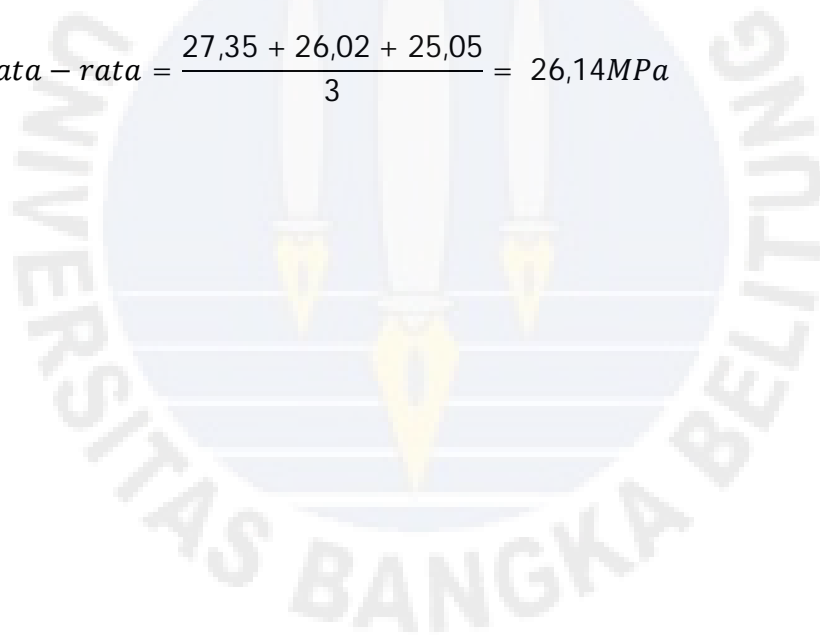
Spesimen 17:

$$\sigma = \frac{4163,2 N}{160 mm^2} = 26,02 MPa$$

Spesimen 18:

$$\sigma = \frac{4008 N}{160 mm^2} = 25,05 MPa$$

$$Rata - rata = \frac{27,35 + 26,02 + 25,05}{3} = 26,14 MPa$$



Lampiran 5. Perhitungan Regangan

$$\varepsilon = \frac{l_i - l_o}{l_o}$$

Dimana : ε : regangan(%)

l_i : panjang spesimen setelah pengujian (mm)

l_o : panjang spesimen sebelum pengujian (mm)

contoh mencari l_i :

$$l_i = (\varepsilon \cdot l_o) + l_o$$

dik: $\varepsilon = 0,002844$

$l_o = 320 \text{ mm}$

dit: $l_i = \dots?$

$$\begin{aligned} l_i &= (0,002844 \times 320) + 320 \\ &= 320,91 \text{ mm} \end{aligned}$$

1 Fraksi volume (25% SBP)

Spesimen 1:

$$\varepsilon = \frac{320,52 \text{ mm} - 320 \text{ mm}}{320 \text{ mm}} = 0,001625$$

Spesimen 2:

$$\varepsilon = \frac{320,37 \text{ mm} - 320 \text{ mm}}{320 \text{ mm}} = 0,001156$$

Spesimen 3:

$$\varepsilon = \frac{320,52 \text{ mm} - 320 \text{ mm}}{320 \text{ mm}} = 0,001625$$

$$\text{Rata - rata} = \frac{0,001625 + 0,001156 + 0,001625}{3} = 0,001468 \text{ atau } 0,14\%$$

2 Fraksi volume (30% SBP)

Spesimen 4:

$$\varepsilon = \frac{320,68 \text{ mm} - 320 \text{ mm}}{320 \text{ mm}} = 0,002125$$

Spesimen 5:

$$\varepsilon = \frac{320,37 \text{ mm} - 320 \text{ mm}}{320 \text{ mm}} = 0,001156$$

Spesimen 6:

$$\varepsilon = \frac{320,43 \text{ mm} - 320 \text{ mm}}{320 \text{ mm}} = 0,001344$$

$$\text{Rata - rata} = \frac{0,002125 + 0,001156 + 0,001344}{3} = 0,001546 \text{ atau } 0,15\%$$

3 Fraksi volume (40% SBP)

Spesimen 7:

$$\varepsilon = \frac{320,71 \text{ mm} - 320 \text{ mm}}{320 \text{ mm}} = 0,002219$$

Spesimen 8:

$$\varepsilon = \frac{320,40 \text{ mm} - 320 \text{ mm}}{320 \text{ mm}} = 0,00125$$

Spesimen 9:

$$\varepsilon = \frac{320,54 \text{ mm} - 320 \text{ mm}}{320 \text{ mm}} = 0,001688$$

$$\text{Rata - rata} = \frac{0,002219 + 0,00125 + 0,001688}{3} = 0,001719 \text{ atau } 0,17\%$$

4 Fraksi volume (45% SBP)

Spesimen 10:

$$\varepsilon = \frac{320,57 \text{ mm} - 320 \text{ mm}}{320 \text{ mm}} = 0,001781$$

Spesimen 11:

$$\varepsilon = \frac{320,60 \text{ mm} - 320 \text{ mm}}{320 \text{ mm}} = 0,001875$$

Spesimen 12:

$$\varepsilon = \frac{320,46 \text{ mm} - 320 \text{ mm}}{320 \text{ mm}} = 0,001438$$

$$\text{Rata - rata} = \frac{0,001781 + 0,001875 + 0,001438}{3} = 0,001698 \text{ atau } 0,16\%$$

5 Fraksi volume (50% SBP)

Spesimen 13:

$$\varepsilon = \frac{321,08 \text{ mm} - 320 \text{ mm}}{320 \text{ mm}} = 0,003375$$

Spesimen 14:

$$\varepsilon = \frac{320,56 \text{ mm} - 320 \text{ mm}}{320 \text{ mm}} = 0,00175$$

Spesimen 15:

$$\varepsilon = \frac{320,63 \text{ mm} - 320 \text{ mm}}{320 \text{ mm}} = 0,001969$$

$$\text{Rata - rata} = \frac{0,003375 + 0,00175 + 0,001969}{3} = 0,002364 \text{ atau } 0,23\%$$

6 Fraksi volume (40% SF)

Spesimen 16:

$$\varepsilon = \frac{320,91 \text{ mm} - 320 \text{ mm}}{320 \text{ mm}} = 0,002844$$

Spesimen 17:

$$\varepsilon = \frac{321,02 \text{ mm} - 320 \text{ mm}}{320 \text{ mm}} = 0,003188$$

Spesimen 18:

$$\varepsilon = \frac{321,35 \text{ mm} - 320 \text{ mm}}{320 \text{ mm}} = 0,004219$$

$$\text{Rata - rata} = \frac{0,002844 + 0,003188 + 0,004219}{3} = 0,003417 \text{ atau } 0,34\%$$

Lampiran 6. Perhitungan Modulus Elastisitas

$$E = \frac{\sigma}{\varepsilon} = \frac{F \cdot L_0}{\Delta L \cdot A}$$

Dimana : σ = Tegangan (MPa)

ε = Regangan

F = Gaya pada benda (N)

A = Luas penampang (mm²)

L₀ = panjang sebelum pengujian

ΔL = perpanjangan Spesimen setelah pengujian

1. Fraksi volume (25% SBP)

Spesimen 1:

$$E = \frac{8,38 \text{ MPa}}{0,16} = 52,37 \text{ MPa}$$

Spesimen 2:

$$E = \frac{7,57 \text{ MPa}}{0,11} = 68,81 \text{ MPa}$$

Spesimen 3:

$$E = \frac{7,86 \text{ MPa}}{0,16} = 49,12 \text{ MPa}$$

$$\text{Rata - rata} = \frac{52,37 + 68,81 + 49,12}{3} = 56,76 \text{ MPa}$$

2. Fraksi volume (30% SBP)

Spesimen 4:

$$E = \frac{8,76 \text{ MPa}}{0,21} = 41,71 \text{ MPa}$$

Spesimen 5:

$$E = \frac{9,11 \text{ MPa}}{0,11} = 82,81 \text{ MPa}$$

Spesimen 6:

$$E = \frac{8,81 \text{ MPa}}{0,13} = 67,76 \text{ MPa}$$

$$\text{Rata - rata} = \frac{41,71 + 82,81 + 67,76}{3} = 64,09 \text{ MPa}$$

3. Fraksi volume (40% SBP)

Spesimen 7:

$$E = \frac{13,38 \text{ MPa}}{0,22} = 60,81 \text{ MPa}$$

Spesimen 8:

$$E = \frac{11,43 \text{ MPa}}{0,12} = 95,25 \text{ MPa}$$

Spesimen 9:

$$E = \frac{11,34 \text{ MPa}}{0,16} = 70,87 \text{ MPa}$$

$$\text{Rata - rata} = \frac{60,81 + 95,25 + 70,87}{3} = 75,64 \text{ MPa}$$

4. Fraksi volume (45% SBP)

Spesimen 10:

$$E = \frac{12,66 \text{ MPa}}{0,17} = 74,47 \text{ MPa}$$

Spesimen 11:

$$E = \frac{12,50 \text{ MPa}}{0,18} = 69,44 \text{ MPa}$$

Spesimen 12:

$$E = \frac{13,37 \text{ MPa}}{0,14} = 95,5 \text{ MPa}$$

$$\text{Rata - rata} = \frac{74,47 + 69,44 + 95,5}{3} = 79,80 \text{ MPa}$$

5. Fraksi volume (50% SBP)

Spesimen 13:

$$E = \frac{15,35 \text{ MPa}}{0,33} = 46,51 \text{ MPa}$$

Spesimen 14:

$$E = \frac{14,43 \text{ MPa}}{0,17} = 84,88 \text{ MPa}$$

Spesimen 15:

$$E = \frac{14,20 \text{ MPa}}{0,19} = 74,73 \text{ MPa}$$
$$\text{Rata - rata} = \frac{46,51 + 84,88 + 74,73}{3} = 68,70 \text{ MPa}$$

6. Fraksi volume (40% SF)

Spesimen 16:

$$E = \frac{27,35 \text{ MPa}}{0,28} = 97,67 \text{ MPa}$$

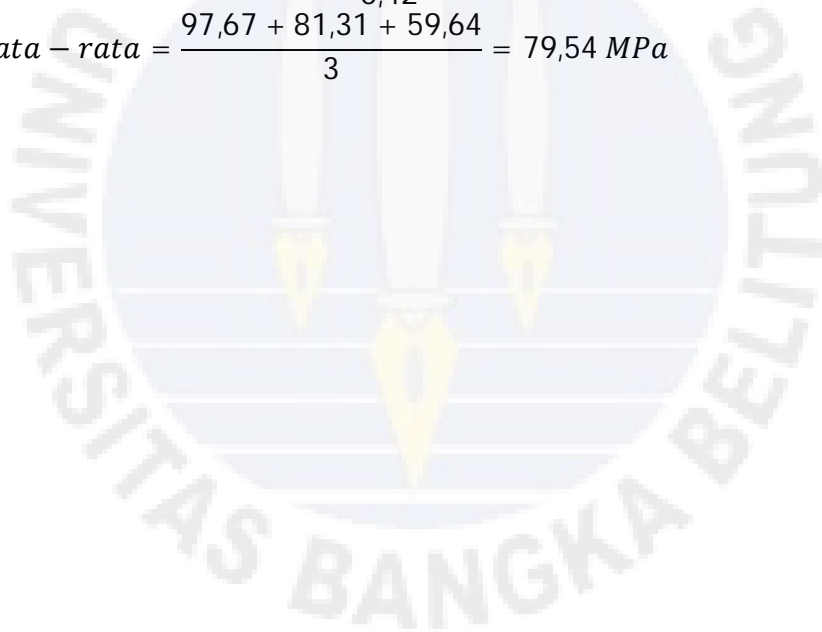
Spesimen 17:

$$E = \frac{26,02 \text{ MPa}}{0,32} = 81,31 \text{ MPa}$$

Spesimen 18:

$$E = \frac{25,05 \text{ MPa}}{0,42} = 59,64 \text{ MPa}$$

$$\text{Rata - rata} = \frac{97,67 + 81,31 + 59,64}{3} = 79,54 \text{ MPa}$$



Lampiran 7. Perhitungan Kerja Patah

$$W = m \cdot g \cdot l (\cos \beta - \cos \alpha)$$

Dimana W = kerja patah (Joule)
 m = beban yang digunakan (kg)
 g = Percepatan gravitasi (m/s^2)
 l = panjang lengan ayun (m)
 β = sudut jatuh (derajat)
 α = sudut awal (derajat)

1 Fraksi volume (40% SF)

Spesimen 1:

$$W = 2,5 \times 9,81 \times 0,4 (\cos 10 - \cos 150) = 18,15 \text{ Joule}$$

Spesimen 2:

$$W = 2,5 \times 9,81 \times 0,4 (\cos 10 - \cos 150) = 18,15 \text{ Joule}$$

Spesimen 3:

$$W = 2,5 \times 9,81 \times 0,4 (\cos 10 - \cos 150) = 18,15 \text{ Joule}$$

$$\text{Rata - rata} = \frac{18,15 + 18,15 + 18,15}{3} = 18,15 \text{ Joule}$$

2 Fraksi volume (25% SBP)

Spesimen 4:

$$W = 2,5 \times 9,81 \times 0,4 (\cos 103 - \cos 150) = 6,28 \text{ Joule}$$

Spesimen 5:

$$W = 2,5 \times 9,81 \times 0,4 (\cos 102 - \cos 150) = 6,45 \text{ Joule}$$

Spesimen 6:

$$W = 2,5 \times 9,81 \times 0,4 (\cos 104 - \cos 150) = 6,12 \text{ Joule}$$

$$\text{Rata - rata} = \frac{6,28 + 6,45 + 6,12}{3} = 6,28 \text{ Joule}$$

3 Fraksi volume (30% SBP)

Spesimen 7:

$$W = 2,5 \times 9,81 \times 0,4(\cos 93 - \cos 150) = 7,98 \text{ Joule}$$

Spesimen 8:

$$W = 2,5 \times 9,81 \times 0,4(\cos 92 - \cos 150) = 8,15 \text{ Joule}$$

Spesimen 9:

$$W = 2,5 \times 9,81 \times 0,4(\cos 94 - \cos 150) = 7,81 \text{ Joule}$$

$$\text{Rata - rata} = \frac{7,98 + 8,15 + 7,81}{3} = 7,98 \text{ Joule}$$

4 Fraksi volume (40% SBP)

Spesimen 10:

$$W = 2,5 \times 9,81 \times 0,4(\cos 70 - \cos 150) = 11,85 \text{ Joule}$$

Spesimen 11:

$$W = 2,5 \times 9,81 \times 0,4(\cos 72 - \cos 150) = 11,52 \text{ Joule}$$

Spesimen 12:

$$W = 2,5 \times 9,81 \times 0,4(\cos 70 - \cos 150) = 11,85 \text{ Joule}$$

$$\text{Rata - rata} = \frac{11,85 + 11,52 + 11,85}{3} = 11,74 \text{ Joule}$$

5 Fraksi volume (45% SBP)

Spesimen 13:

$$W = 2,5 \times 9,81 \times 0,4(\cos 59 - \cos 150) = 13,54 \text{ Joule}$$

Spesimen 14:

$$W = 2,5 \times 9,81 \times 0,4(\cos 60 - \cos 150) = 13,40 \text{ Joule}$$

Spesimen 15:

$$W = 2,5 \times 9,81 \times 0,4(\cos 61 - \cos 150) = 13,25 \text{ Joule}$$

$$\text{Rata - rata} = \frac{13,54 + 13,40 + 13,25}{3} = 13,39 \text{ Joule}$$

6 Fraksi volume (50% SBP)

Spesimen 16:

$$W = 2,5 \times 9,81 \times 0,4(\cos 55 - \cos 150) = 14,12 \text{ Joule}$$

Spesimen 17:

$$W = 2,5 \times 9,81 \times 0,4(\cos 53 - \cos 150) = 14,39 \text{ Joule}$$

Spesimen 18:

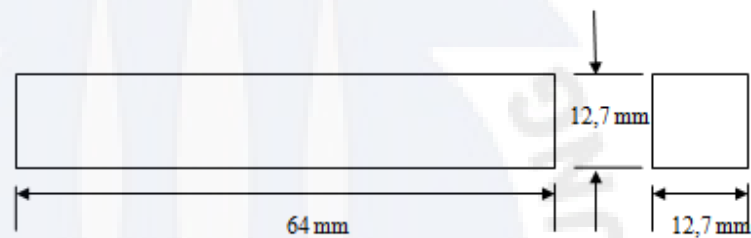
$$W = 2,5 \times 9,81 \times 0,4(\cos 56 - \cos 150) = 13,93 \text{ Joule}$$

$$\text{Rata - rata} = \frac{14,12 + 14,39 + 13,93}{3} = 14,14 \text{ Joule}$$

Lampiran 8. Nilai Ketangguhan atau Impak

$$\text{Nilai ketangguhan}(K) = \frac{\text{Kerja Patah } (W)}{\text{luas penampang dibawah takikan } (A)} \text{ Joule/mm}^2$$

$$\text{Luas } (A) = 12,7 \times 12,7 = 161,29 \text{ mm}^2$$



1 Fraksi volume (40% SF)

Spesimen 1:

$$K = \frac{18,15 \text{ Joule}}{161,29 \text{ mm}^2} = 0,112 \text{ Joule/mm}^2$$

Spesimen 2:

$$K = \frac{18,15 \text{ Joule}}{161,29 \text{ mm}^2} = 0,112 \text{ Joule/mm}^2$$

Spesimen 3:

$$K = \frac{18,15 \text{ Joule}}{161,29 \text{ mm}^2} = 0,112 \text{ Joule/mm}^2$$

$$\text{Rata - rata} = \frac{0,112 + 0,112 + 0,112}{3} = 0,112 \text{ Joule/mm}^2$$

2 Fraksi volume (25% SBP)

Spesimen 4:

$$K = \frac{6,28 \text{ Joule}}{161,29 \text{ mm}} = 0,038 \text{ Joule/mm}^2$$

Spesimen 5:

$$K = \frac{6,45 \text{ Joule}}{161,29 \text{ mm}} = 0,039 \text{ Joule/mm}^2$$

Spesimen 6:

$$K = \frac{6,12 \text{ Joule}}{161,29 \text{ mm}} = 0,037 \text{ Joule/mm}^2$$

$$\text{Rata - rata} = \frac{0,038 + 0,039 + 0,037}{3} = 0,038 \text{ Joule/mm}^2$$

3 Fraksi volume (30% SBP)

Spesimen 7:

$$K = \frac{7,98 \text{ Joule}}{161,29 \text{ mm}} = 0,049 \text{ Joule/mm}^2$$

Spesimen 8:

$$K = \frac{8,15 \text{ Joule}}{161,29 \text{ mm}} = 0,050 \text{ Joule/mm}^2$$

Spesimen 9:

$$K = \frac{7,81 \text{ Joule}}{161,29 \text{ mm}} = 0,048 \text{ Joule/mm}^2$$

$$\text{Rata - rata} = \frac{0,049 + 0,050 + 0,048}{3} = 0,049 \text{ Joule/mm}^2$$

4 Fraksi volume (40% SBP)

Spesimen 10:

$$K = \frac{11,85 \text{ Joule}}{161,29 \text{ mm}} = 0,073 \text{ Joule/mm}^2$$

Spesimen 11:

$$K = \frac{11,52 \text{ Joule}}{161,29 \text{ mm}} = 0,071 \text{ Joule/mm}^2$$

Spesimen 12:

$$K = \frac{11,85 \text{ Joule}}{161,29 \text{ mm}} = 0,073 \text{ Joule/mm}^2$$

$$\text{Rata - rata} = \frac{0,073 + 0,071 + 0,073}{3} = 0,072 \text{ Joule/mm}^2$$

5 Fraksi volume (45% SBP)

Spesimen 13:

$$K = \frac{13,54 \text{ Joule}}{161,29 \text{ mm}} = 0,084 \text{ Joule/mm}^2$$

Spesimen 14:

$$K = \frac{13,40 \text{ Joule}}{161,29 \text{ mm}} = 0,083 \text{ Joule/mm}^2$$

Spesimen 15:

$$K = \frac{13,25 \text{ Joule}}{161,29 \text{ mm}} = 0,082 \text{ Joule/mm}^2$$

$$\text{Rata - rata} = \frac{0,084 + 0,083 + 0,082}{3} = 0,083 \text{ Joule/mm}^2$$

6 Fraksi volume (50% SBP)

Spesimen 16:

$$K = \frac{14,12 \text{ Joule}}{161,29 \text{ mm}} = 0,087 \text{ Joule/mm}^2$$

Spesimen 17:

$$K = \frac{14,39 \text{ Joule}}{161,29 \text{ mm}} = 0,089 \text{ Joule/mm}^2$$

Spesimen 18:

$$K = \frac{13,93 \text{ Joule}}{161,29 \text{ mm}} = 0,086 \text{ Joule/mm}^2$$

$$\text{Rata - rata} = \frac{0,087 + 0,089 + 0,086}{3} = 0,087 \text{ Joule/mm}^2$$

Lampiran 9. Foto Spesimen Sebelum Pengujian



Benda uji sebelum pengujian

Gambar Spesimen sebelum pengujian, Spesimen berupa komposit yang terdiri dari dua unsur yaitu bahan penguat dan bahan pengikat, bahan penguat berupa serat dan bahan pengikat berupa matriks dari bahan resin dan katalis.



Komposit berserat fiber (*chopped strand mat*)

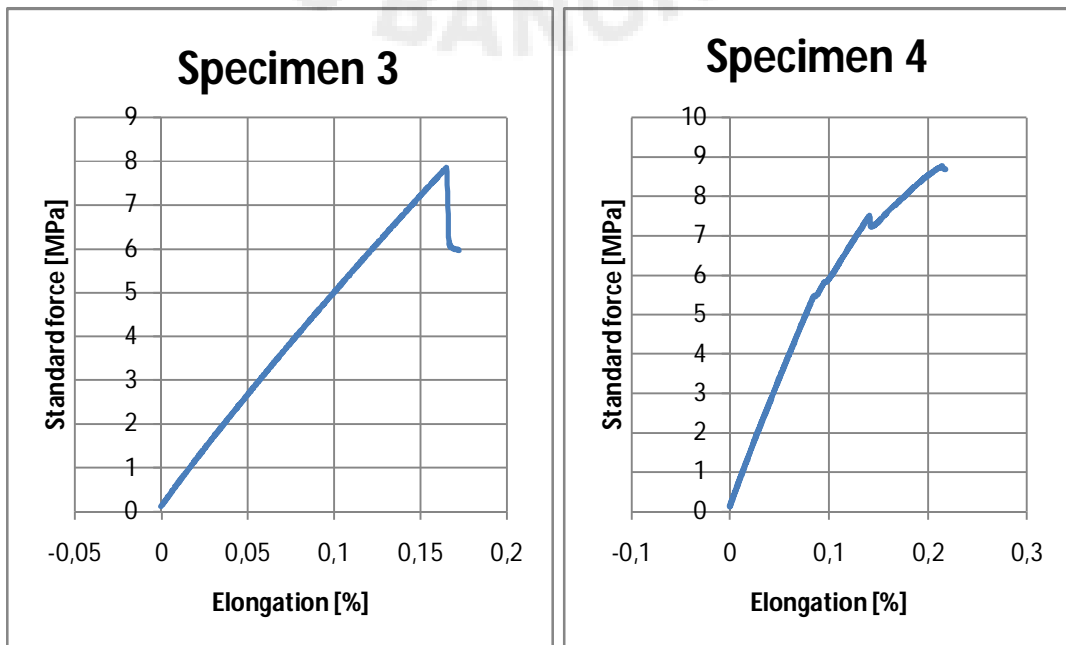
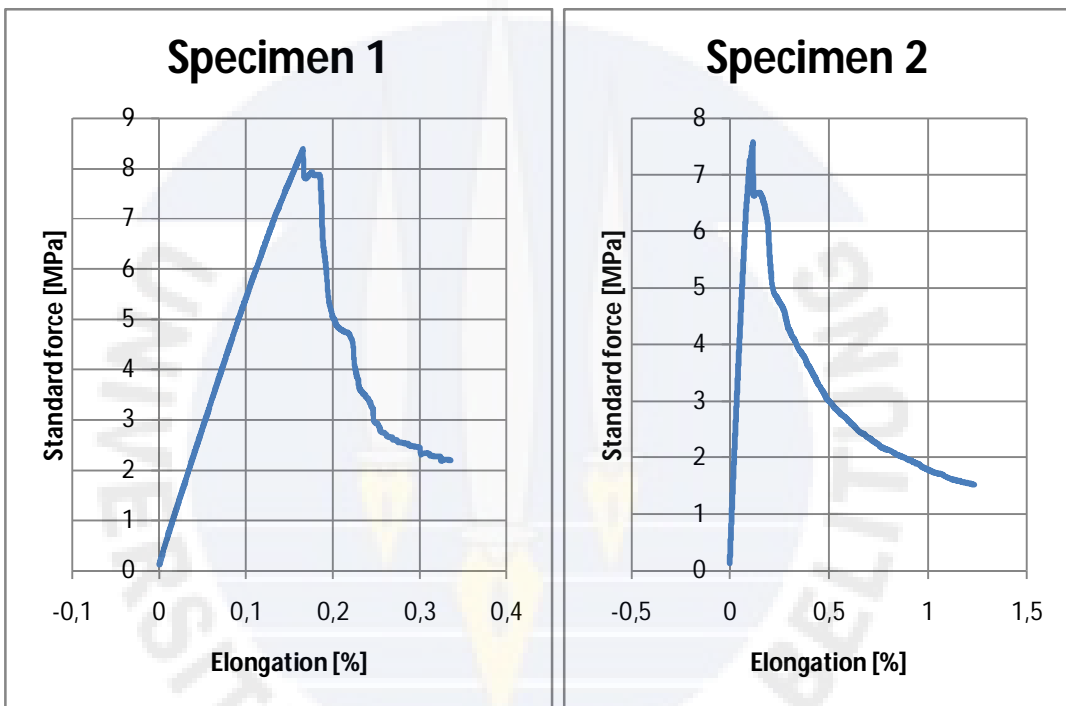
Lampiran 10. Foto Spesimen Sesudah Pengujian

Gambar komposit dengan penguat berupa serat dari serat buah pinang

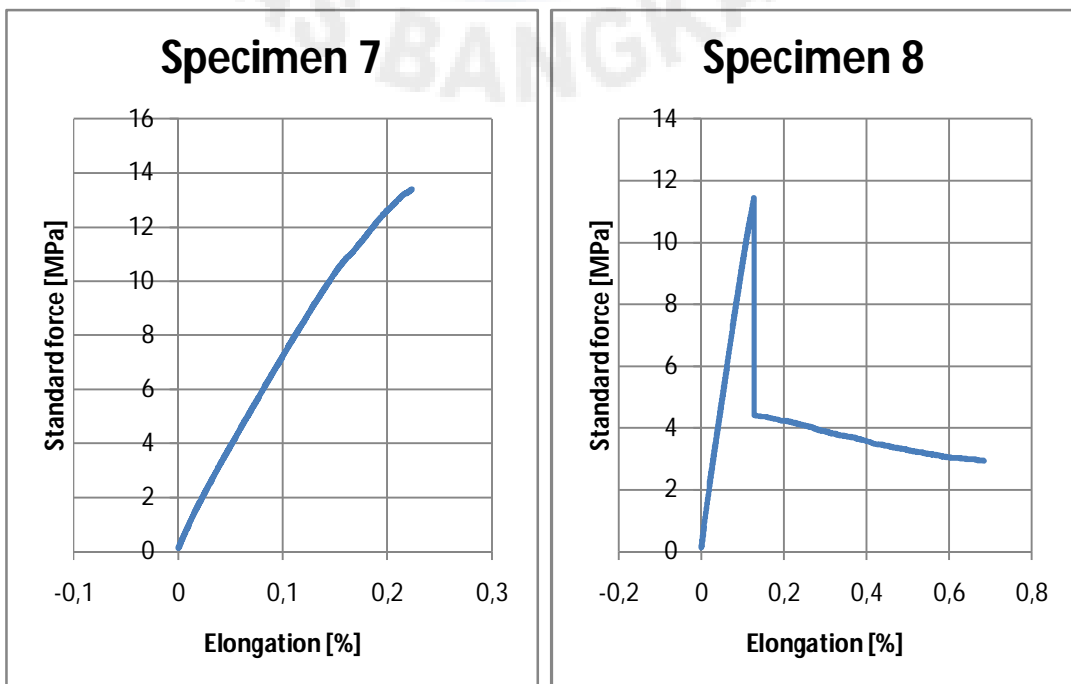
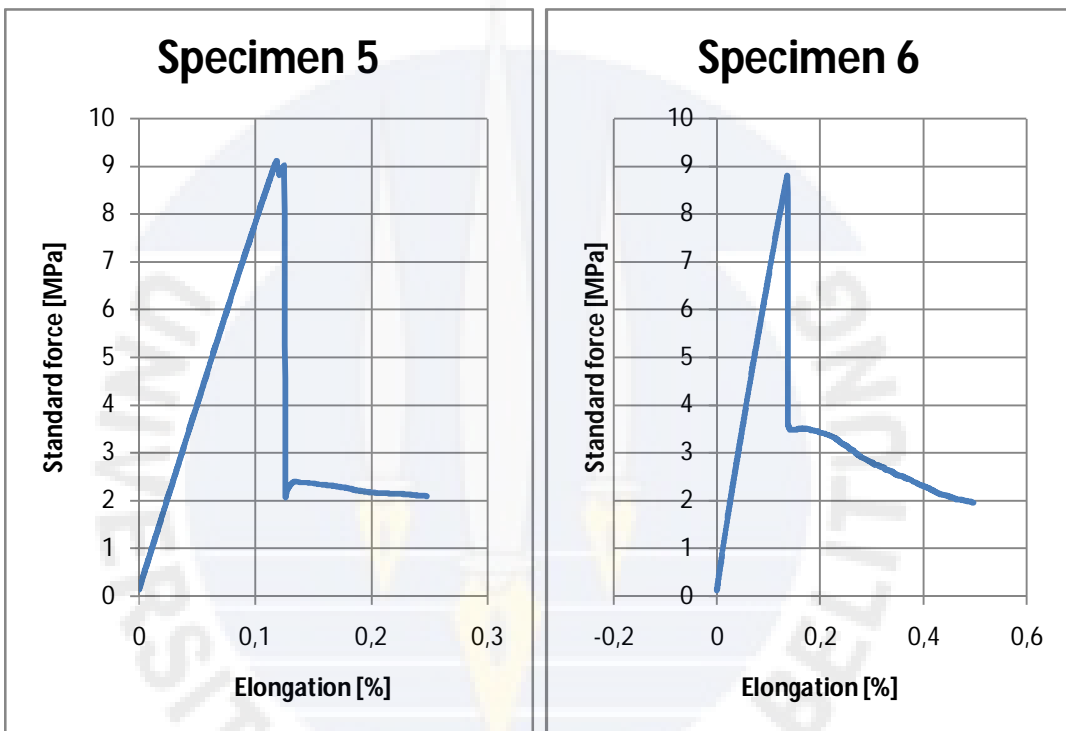


Benda uji berupa komposit setelah pengujian

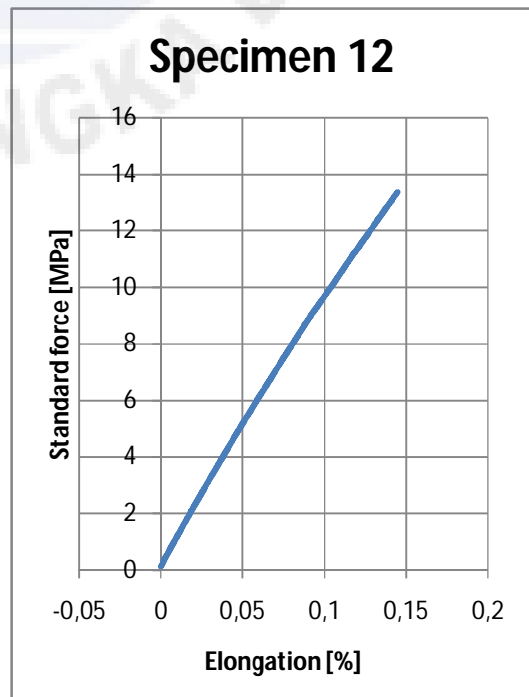
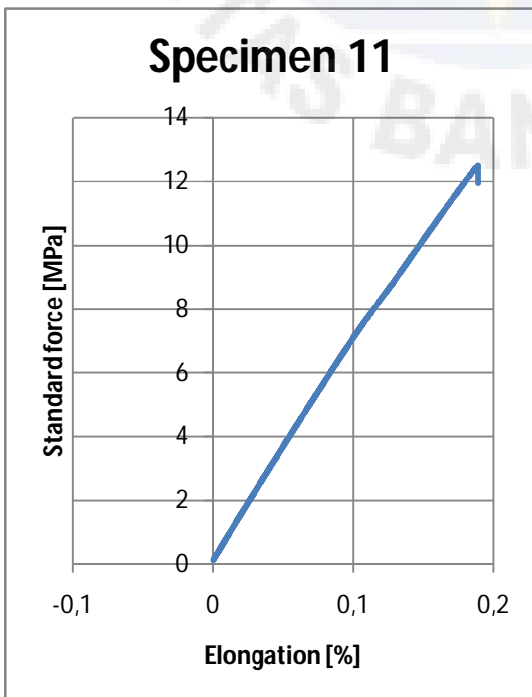
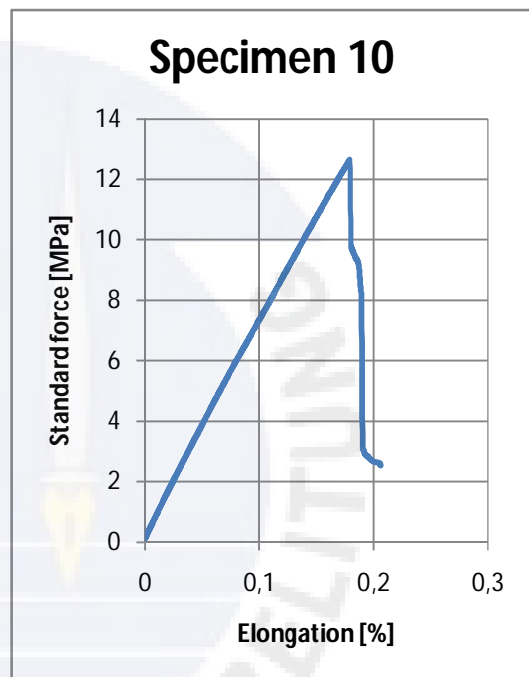
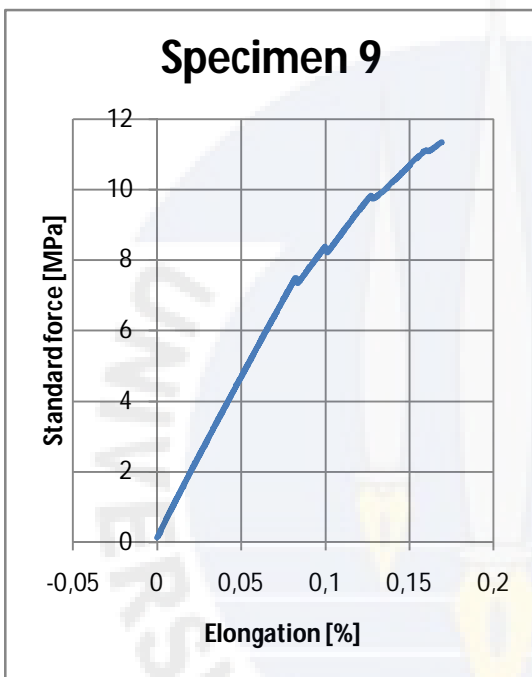
Lampiran 11. Hasil pengujian tarik spesimen 1- 4



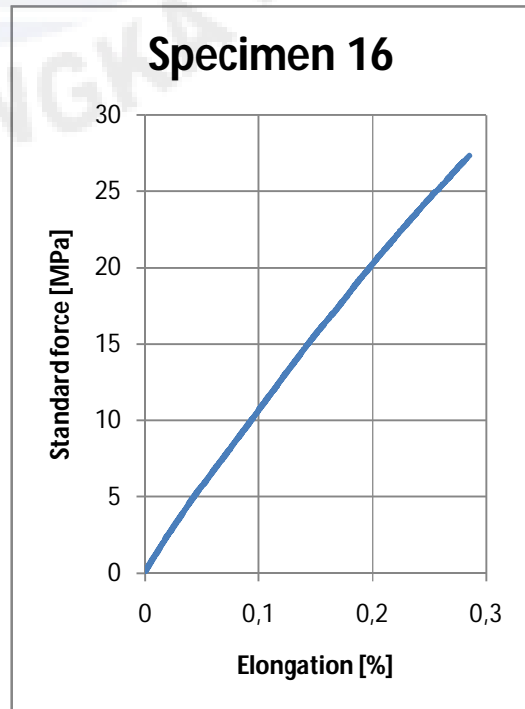
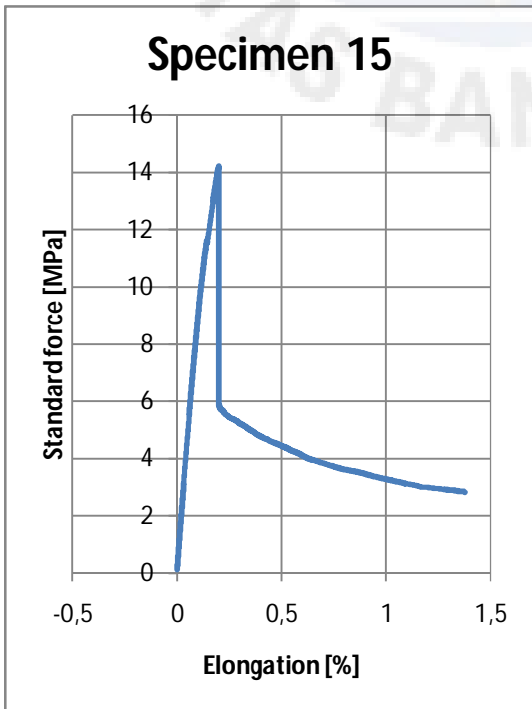
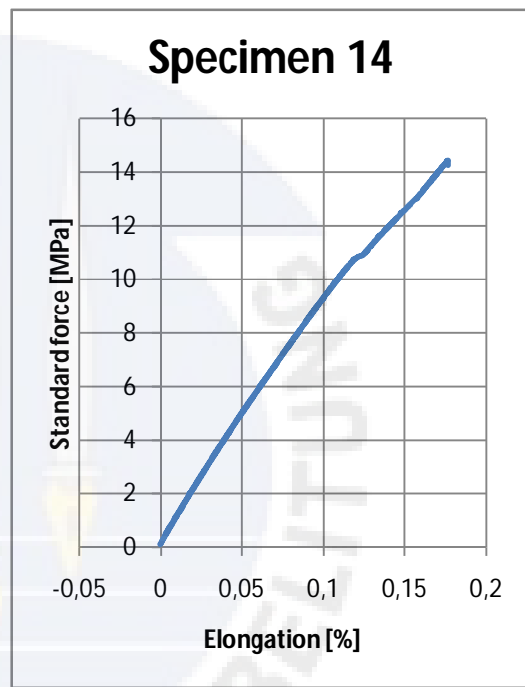
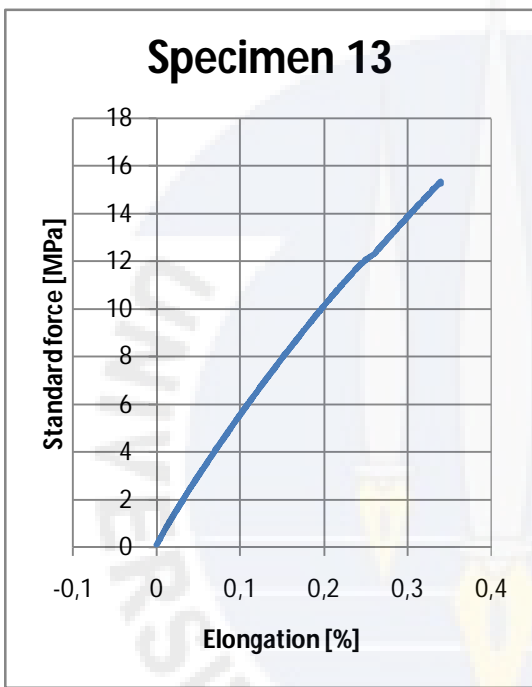
Lampiran 12. Hasil pengujian tarik spesimen 5 - 8



Lampiran 13. Hasil pengujian tarik spesimen 9 -12



Lampiran 14. Hasil pengujian tarik spesimen 13 - 16



Lampiran 15. Hasil pengujian tarik spesimen 17 - 18

