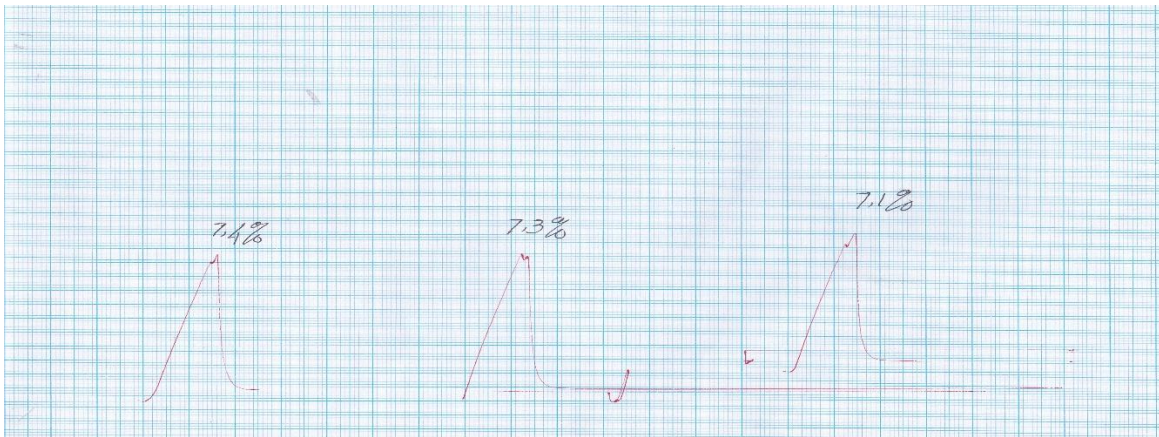
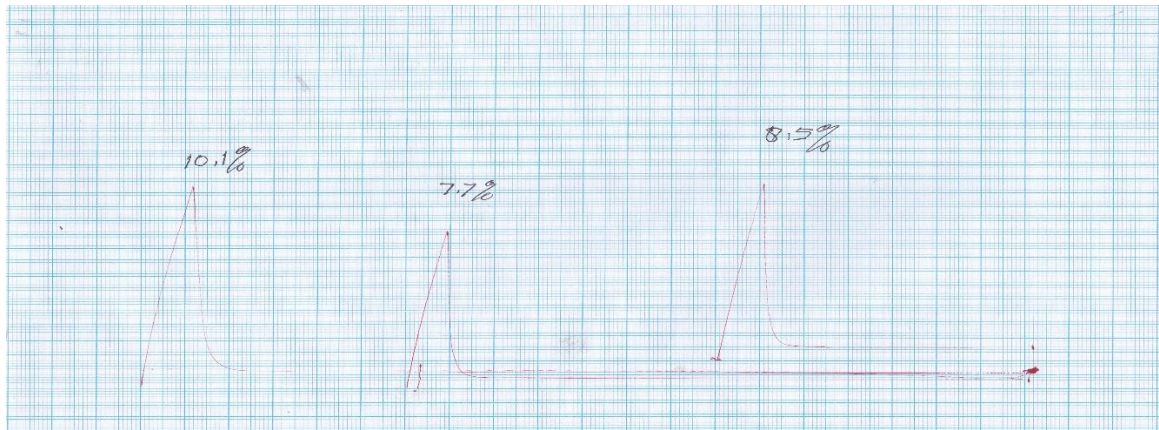


LAMPIRAN

Grafik hasil pengujian tarik serat woven roving 200gr 2 lapis



Grafik hasil pengujian Tarik serat acak 2 lapis



Grafik hasil pengujian tarik acak dan woven roving 200gr 2 lapis

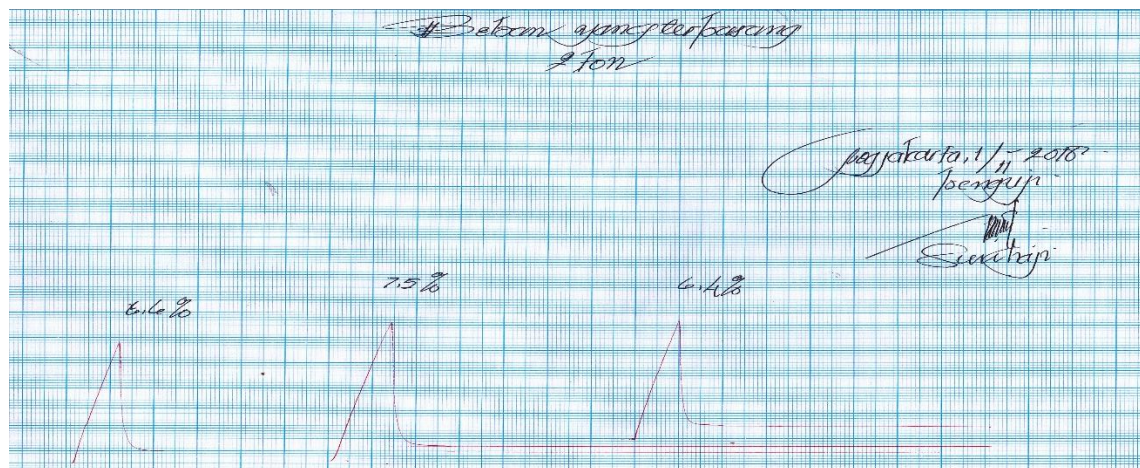
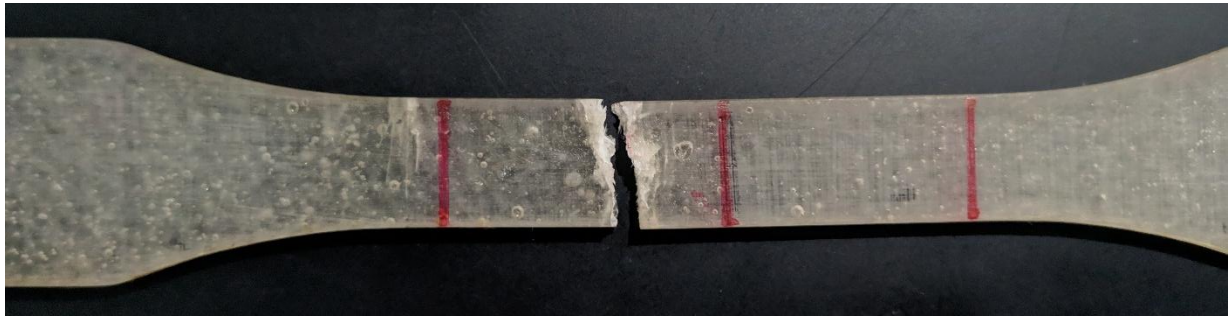


Foto patahan spesimen

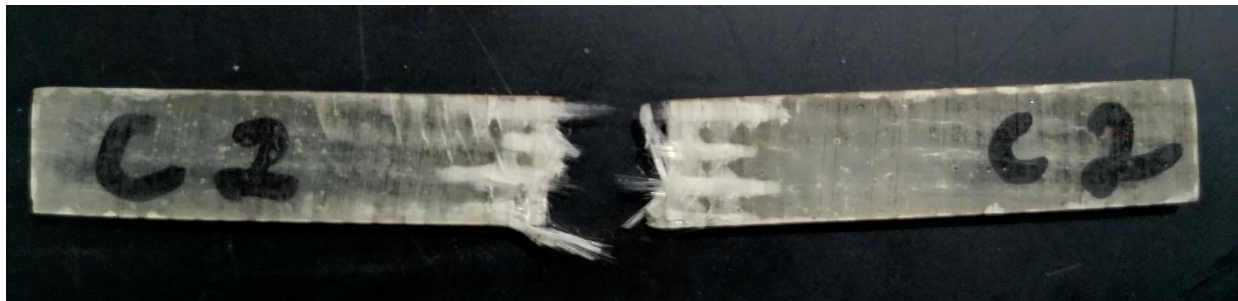
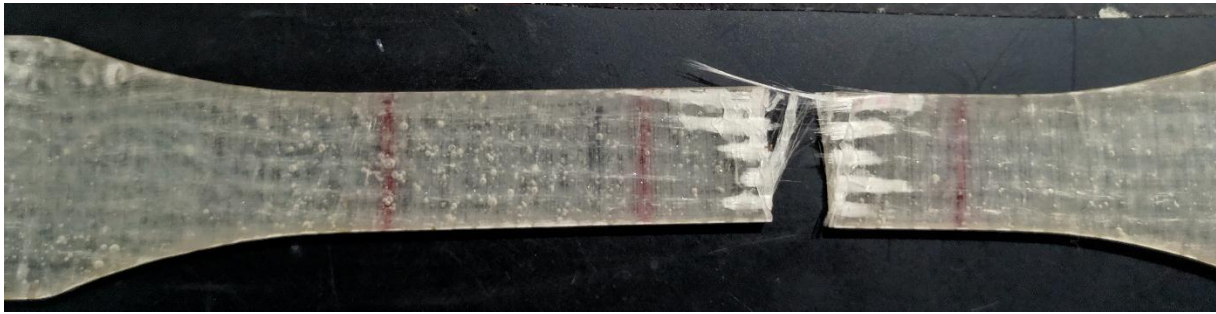
Gambar patahan komposit fiberglass acak 2 lapis



Gambar patahan komposit fiberglass wr200 2 lapis dari pengujian Tarik dan impact



Gambar patahan komposit fiberglass acak dan wr200 2lapis dari pengujian Tarik dan impak.



Perhitungan pengujian Tarik

Serat acak 2 lapis

1. Spesimen 1

a. Luas penampang

Diketahui : Tebal spesimen (t) : 3,15 mm

Lebar spesimen (l) : 12,82 mm

Ditanya (A) luas penampang spesimen ?

$$A = t \times l$$

$$= 3,15 \times 12,82$$

$$= 40,38 \text{ mm}^2$$

b. Rengangan spesimen

$$\epsilon = \frac{\Delta}{L} = \frac{0,60}{194} \times 100\% = 0,30\%$$

c. Tegangan spesimen

$$P = \frac{10,1}{100} \times 2000 \times 9,8 \text{ m/s}^2$$
$$= 1.979,6 \text{ N}$$

$$\sigma = \frac{P}{A} = \frac{1.976,6 \text{ N}}{40,38}$$

$$= 49,02 \text{ N/mm}^2 = 49,02 \text{ Mpa}$$

d. Modulus elastisitas

$$E = \frac{\sigma}{\epsilon} = \frac{49,02}{0,30} = \frac{49,02}{0,0030}$$

$$= \frac{16.340 \text{ Mpa}}{1000} = 16,34 \text{ Gpa}$$

2. Spesimen 2

a. Luas penampang

Diketahui : Tebal spesimen (t) : 3,16 mm

Lebar spesimen (l) : 12,79 mm

Ditanya (A) luas penampang spesimen ?

$$A = t \times l$$

$$= 3,16 \times 12,79$$

$$= 40,41 \text{ mm}^2$$

b. Renggangan spesimen

$$\epsilon = \frac{\Delta}{L} = \frac{0,40}{194} \times 100\% = 0,20\%$$

c. Tegangan spesimen

$$P = \frac{7,7}{100} \times 2000 \times 9,8 \text{ m/s}^2$$

$$= 1.509,2 \text{ N}$$

$$\sigma = \frac{P}{A} = \frac{1.509,2 \text{ N}}{40,41}$$

$$= 37,34 \text{ N/mm}^2 = 37,34 \text{ Mpa}$$

d. Modulus elastisitas

$$E = \frac{\sigma}{\epsilon} = \frac{37,34}{0,20} = \frac{37,34}{0,0020}$$

$$= \frac{18.670 \text{ Mpa}}{1000} = 18,67 \text{ Gpa}$$

3. Spesimen 3

a. Luas penampang

Diketahui : Tebal spesimen (t) : 3,02 mm

Lebar spesimen (l) : 12,86 mm

Ditanya (A) luas penampang spesimen ?

$$A = t \times l$$

$$= 3,02 \times 12,86$$

$$= 38,83 \text{ mm}^2$$

b. Renggangan spesimen

$$\epsilon = \frac{\Delta}{L} = \frac{0,50}{194} \times 100\% = 0,25\%$$

c. Tegangan spesimen

$$P = \frac{8,5}{100} \times 2000 \times 9,8 \text{ m/s}^2$$
$$= 1.666 \text{ N}$$

$$\sigma = \frac{P}{A} = \frac{1.666 \text{ N}}{38,83}$$
$$= 42,90 \text{ N/mm}^2 = 42,90 \text{ Mpa}$$

d. Modulus elastisitas

$$E = \frac{\sigma}{\epsilon} = \frac{42,90}{0,25} = \frac{42,90}{0,0025}$$
$$= \frac{17.161 \text{ Mpa}}{1000} = 17,16 \text{ Gpa}$$

4. Rata-rata tegangan ketiga spesimen

$$\text{Rata-rata} = \frac{\sigma_1 + \sigma_2 + \sigma_3}{3}$$
$$= \frac{49,02 + 37,34 + 42,90}{3}$$
$$= 43,08 \text{ Mpa}$$

5. Rata-rata modulus elastisitas ketiga spesimen

$$\text{Rata-rata} = \frac{E_1 + E_2 + E_3}{3}$$
$$= \frac{16,34 + 18,67 + 17,16}{3}$$
$$= 17,39 \text{ Gpa}$$

Serat woven roving 200gr 2 lapis

1. Spesimen 1

a. Luas penampang

Diketahui : Tebal spesimen (t) : 2,01 mm

Lebar spesimen (l) : 12,74 mm

Ditanya (A) luas penampang spesimen ?

$$\begin{aligned} A &= t \times l \\ &= 2,01 \times 12,74 \\ &= 25,60 \text{ mm}^2 \end{aligned}$$

b. Renggangan spesimen

$$\varepsilon = \frac{\Delta}{L} = \frac{0,50}{194} \times 100\% = 0,25\%$$

c. Tegangan spesimen

$$\begin{aligned} P &= \frac{7,4}{100} \times 2000 \times 9,8 \text{ m/s}^2 \\ &= 1.450,4 \text{ N} \\ \sigma &= \frac{P}{A} = \frac{1.450,4 \text{ N}}{25,60} \\ &= 60,17 \text{ N/mm}^2 = 60,17 \text{ Mpa} \end{aligned}$$

d. Modulus elastisitas

$$\begin{aligned} E &= \frac{\sigma}{\varepsilon} = \frac{60,17}{0,25} = \frac{60,17}{0,0025} \\ &= \frac{24.068 \text{ Mpa}}{1000} = 24,06 \text{ Gpa} \end{aligned}$$

2. Spesimen 2

a. Luas penampang

Diketahui : Tebal spesimen (t) : 2,08 mm
Lebar spesimen (l) : 12,77 mm

Ditanya (A) luas penampang spesimen ?

$$\begin{aligned} A &= t \times l \\ &= 2,08 \times 12,77 \\ &= 26,56 \text{ mm}^2 \end{aligned}$$

b. Renggangan spesimen

$$\varepsilon = \frac{\Delta}{L} = \frac{0,40}{194} \times 100\% = 0,20\%$$

c. Tegangan spesimen

$$\begin{aligned} P &= \frac{7,3}{100} \times 2000 \times 9,8 \text{ m/s}^2 \\ &= 1.430,8 \text{ N} \\ \sigma &= \frac{P}{A} = \frac{1.430,8}{26,56} \end{aligned}$$

$$= 53,87 \text{ N/mm}^2 = 53,87 \text{ Mpa}$$

d. Modulus elastisitas

$$E = \frac{\sigma}{\epsilon} = \frac{53,87}{0,20} = \frac{53,87}{0,0020}$$
$$= \frac{26.935 \text{ Mpa}}{1000} = 26,93 \text{ Gpa}$$

3. Spesimen 3

a. Luas penampang

Diketahui : Tebal spesimen (t) : 2,02 mm

Lebar spesimen (l) : 12,78 mm

Ditanya (A) luas penampang spesimen ?

$$A = t \times l$$

$$= 2,02 \times 12,78$$

$$= 25,81 \text{ mm}^2$$

b. Renggangannya spesimen

$$\epsilon = \frac{\Delta}{L} = \frac{0,40}{194} \times 100\% = 0,20\%$$

c. Tegangan spesimen

$$P = \frac{7,1}{100} \times 2000 \times 9,8 \text{ m/s}^2$$

$$= 1.391,6 \text{ N}$$

$$\sigma = \frac{P}{A} = \frac{1.391,6}{25,81}$$

$$= 53,91 \text{ Mpa}$$

d. Modulus elastisitas

$$E = \frac{\sigma}{\epsilon} = \frac{53,91}{0,23} = \frac{53,91}{0,0023}$$
$$= \frac{23.434 \text{ Mpa}}{1000} = 23,44 \text{ Gpa}$$

4. Rata-rata tegangan ketiga spesimen

$$\text{Rata-rata} = \frac{\sigma_1 + \sigma_2 + \sigma_3}{3}$$
$$= \frac{60,17 + 53,87 + 53,91}{3}$$
$$= 55,98 \text{ Mpa}$$

5. Rata-rata modulus elastisitas ketiga spesimen

$$\begin{aligned}\text{Rata-rata} &= \frac{E1+E2+E3}{3} \\ &= \frac{24,06 + 26,93 + 23,44}{3} \\ &= 24,81 \text{ Gpa}\end{aligned}$$

Serat fiberglass acak dan woven roving 200gr 2 lapis

1. Spesimen 1

- a. Luas penampang

Diketahui : Tebal spesimen (t) : 2,02 mm

Lebar spesimen (l) : 12,72 mm

Ditanya (A) luas penampang spesimen ?

$$\begin{aligned}A &= t \times l \\ &= 2,02 \times 12,72 \\ &= 25,69 \text{ mm}^2\end{aligned}$$

- b. Renggangan spesimen

$$\epsilon = \frac{\Delta}{L} = \frac{0,45}{194} \times 100\% = 0,23\%$$

- c. Tegangan spesimen

$$\begin{aligned}P &= \frac{6,6}{100} \times 2000 \times 9,8 \text{ m/s}^2 \\ &= 1.293,6 \text{ N} \\ \sigma &= \frac{P}{A} = \frac{1.293,6 \text{ N}}{25,69} \\ &= 50,35 \text{ N/mm}^2 = 50,35 \text{ Mpa}\end{aligned}$$

- d. Modulus elastisitas

$$\begin{aligned}E &= \frac{\sigma}{\epsilon} = \frac{50,35}{0,23} = \frac{50,35}{0,0023} \\ &= \frac{21.893 \text{ Mpa}}{1000} = 21,89 \text{ Gpa}\end{aligned}$$

2. Spesimen 2

- a. Luas penampang

Diketahui : Tebal spesimen (t) : 2,14 mm
Lebar spesimen (l) : 12,80 mm

Ditanya (A) luas penampang spesimen ?

$$\begin{aligned}A &= t \times l \\ &= 2,14 \times 12,80 \\ &= 27,39 \text{ mm}^2\end{aligned}$$

b. Renggangan spesimen

$$\epsilon = \frac{\Delta}{L} = \frac{0,50}{194} \times 100\% = 0,25\%$$

c. Tegangan spesimen

$$\begin{aligned}P &= \frac{7,5}{100} \times 2000 \times 9,8 \text{ m/s}^2 \\ &= 1.470 \\ \sigma &= \frac{P}{A} = \frac{1.470}{27,39} \\ &= 53,66 \text{ N/mm}^2 = 53,66 \text{ Mpa}\end{aligned}$$

d. Modulus elastisitas

$$\begin{aligned}E &= \frac{\sigma}{\epsilon} = \frac{53,66}{0,25} = \frac{53,66}{0,0025} \\ &= \frac{21.467 \text{ Mpa}}{1000} = 21,47 \text{ Gpa}\end{aligned}$$

3. Spesimen 3

a. Luas penampang

Diketahui : Tebal spesimen (t) : 2,19 mm
Lebar spesimen (l) : 12,85 mm

Ditanya (A) luas penampang spesimen ?

$$\begin{aligned}A &= t \times l \\ &= 2,19 \times 12,85 \\ &= 28,14 \text{ mm}^2\end{aligned}$$

b. Renggangan spesimen

$$\epsilon = \frac{\Delta}{L} = \frac{0,40}{194} \times 100\% = 0,20\%$$

c. Tegangan spesimen

$$\begin{aligned}P &= \frac{6,4}{100} \times 2000 \times 9,8 \text{ m/s}^2 \\ &= 1.254,4 \text{ N}\end{aligned}$$

$$\sigma = \frac{P}{A} = \frac{128}{28,14}$$

$$= 44,57 \text{ N/mm}^2 = 44,57 \text{ Mpa}$$

d. Modulus elastisitas

$$E = \frac{\sigma}{\epsilon} = \frac{44,57}{0,20} = \frac{44,57}{0,0020}$$

$$= \frac{22.288 \text{ Mpa}}{1000} = 22,28 \text{ Gpa}$$

4. Rata-rata tegangan ketiga spesimen

$$\text{Rata-rata} = \frac{\sigma_1 + \sigma_2 + \sigma_3}{3}$$

$$= \frac{50,35 + 53,66 + 44,57}{3}$$

$$= 49,52 \text{ Mpa}$$

5. Rata-rata modulus elastisitas ketiga spesimen

$$\text{Rata-rata} = \frac{E_1 + E_2 + E_3}{3}$$

$$= \frac{21,89 + 21,47 + 22,28}{3}$$

$$= 21,88 \text{ Gpa}$$

Perhitungan pengujian impak

Diketahui = sudut ayunan bebas (α) = 154°

Panjang lengan (R) = 83 cm = 0,83 m

Massa pendulum (m) = 1 kg

Gaya gravitasi (g) = 9,8 m/s

Serat fiberglass acak 2 lapis

1. Spesimen 1

a. Luas penampang spesimen 1

Diketahui : tebal spesimen (t) = 2,77 mm

Lebar spesimen (L) = 9,48 mm

Sudut ayunan (β) = 145°

$$A = t \times L$$

$$= 2,77 \text{ mm} \times 9,48 \text{ mm}$$

$$= 26,25 \text{ mm}^2$$

b. Energi yang diserap

$$\begin{aligned} E_{ch} &= G \times R (\cos \beta - \cos \alpha) \\ &= 9,8 \text{ m/s} \times 0,83 \text{ m} (-0,81) - (-0,89) \\ &= 8,13 \times 0,08 \\ &= 0,6504 \text{ joule} \end{aligned}$$

c. Kekuatan impact

$$\begin{aligned} A_{iu} &= \frac{E_{ch}}{A} \\ &= \frac{0,6540}{26,25} = 0,024 \text{ joule/mm}^2 \end{aligned}$$

2. Spesimen 2

a. Luas penampang spesimen 1

$$\text{Diketahui : tebal spesimen (t) = 2,75 mm}$$

$$\text{Lebar spesimen (L) = 9,55 mm}$$

$$\text{Sudut ayunan } (\beta) = 146^\circ$$

$$A = t \times L$$

$$= 2,75 \text{ mm} \times 9,55 \text{ mm}$$

$$= 26,26 \text{ mm}^2$$

b. Energi yang diserap

$$\begin{aligned} E_{ch} &= G \times R (\cos \beta - \cos \alpha) \\ &= 9,8 \text{ m/s} \times 0,83 \text{ m} (-0,82) - (-0,89) \\ &= 8,13 \times 0,07 \\ &= 0,5691 \text{ joule} \end{aligned}$$

c. Kekuatan impact

$$\begin{aligned} A_{iu} &= \frac{E_{ch}}{A} \\ &= \frac{0,5691}{26,26} = 0,021 \text{ joule/mm}^2 \end{aligned}$$

3. Spesimen 3

a. Luas penampang spesimen 1

$$\text{Diketahui : tebal spesimen (t) = 2,84 mm}$$

$$\text{Lebar spesimen (L) = 9,45 mm}$$

$$\text{Sudut ayunan } (\beta) = 145^\circ$$

$$A = t \times L$$

$$= 2,77 \text{ mm} \times 9,48 \text{ mm}$$

$$= 26,83 \text{ mm}^2$$

b. Energi yang diserap

$$E_{ch} = G \times R (\cos \beta - \cos \alpha)$$

$$= 9,8 \text{ m/s} \times 0,83 \text{ m} (-0,81) - (-0,89)$$

$$= 8,13 \times 0,08$$

$$= 0,6504 \text{ joule}$$

c. Kekuatan impak

$$A_{iu} = \frac{E_{ch}}{A}$$

$$= \frac{0,6504}{26,83} = 0,024 \text{ joule/mm}^2$$

4. Rata-rata energi yang diserap ketiga spesimen

$$\text{Rata-rata} = \frac{E_{ch 1} + E_{ch 2} + E_{ch 3}}{3}$$

$$= \frac{0,6504 + 0,5691 + 0,6504}{3}$$

$$= 0,6233 \text{ joule}$$

5. Rata-rata kekuatan impak ketiga spesimen

$$\text{Rata-rata} = \frac{A_{iu 1} + A_{iu 2} + A_{iu 3}}{3}$$

$$= \frac{0,024 + 0,021 + 0,024}{3}$$

$$= 0,023 \text{ joule/mm}^2$$

Serat woven roving 200 gr 2 lapis

1. Spesimen 1

a. Luas penampang spesimen 1

Diketahui : tebal spesimen (t) = 2,23 mm

Lebar spesimen (L) = 9,48 mm

Sudut ayunan (β) = 145°

$$A = t \times L$$

$$= 2,23 \text{ mm} \times 9,48 \text{ mm}$$

$$= 21,14 \text{ mm}^2$$

b. Energi yang diserap

$$Ech = G \times R (\cos \beta - \cos \alpha)$$

$$= 9,8 \text{ m/s} \times 0,83 \text{ m} (-0,79) - (-0,89)$$

$$= 8,13 \times 0,1$$

$$= 0,813 \text{ joule}$$

c. Kekuatan impact

$$Aiu = \frac{Ech}{A}$$

$$= \frac{0,813}{21,14} = 0,038 \text{ joule/mm}^2$$

2. Spesimen 2

a. Luas penampang spesimen 1

Diketahui : tebal spesimen (t) = 2,25 mm

Lebar spesimen (L) = 9,52 mm

Sudut ayunan (β) = 144°

$$A = t \times L$$

$$= 2,25 \text{ mm} \times 9,52 \text{ mm}$$

$$= 21,42 \text{ mm}^2$$

b. Energi yang diserap

$$Ech = G \times R (\cos \beta - \cos \alpha)$$

$$= 9,8 \text{ m/s} \times 0,83 \text{ m} (-0,80) - (-0,89)$$

$$= 8,13 \times 0,08$$

$$= 0,7317 \text{ joule}$$

c. Kekuatan impact

$$Aiu = \frac{Ech}{A}$$

$$= \frac{0,7317}{21,42} = 0,034 \text{ joule/mm}^2$$

3. Spesimen 3

a. Luas penampang spesimen 1

Diketahui : tebal spesimen (t) = 2,24 mm

Lebar spesimen (L) = 9,51 mm

Sudut ayunan (β) = 144°

$$A = t \times L$$

$$= 2,24 \text{ mm} \times 9,51 \text{ mm}$$

$$= 20,61 \text{ mm}^2$$

b. Energi yang diserap

$$Ech = G \times R (\cos \beta - \cos \alpha)$$

$$= 9,8 \text{ m/s} \times 0,83 \text{ m} (-0,80) - (-0,89)$$

$$= 8,13 \times 0,09$$

$$= 0,7317 \text{ joule}$$

c. Kekuatan impact

$$Aiu = \frac{Ech}{A}$$

$$= \frac{0,7317}{20,61} = 0,035 \text{ joule/mm}^2$$

4. Rata-rata energi yang diserap ketiga spesimen

$$\text{Rata-rata} = \frac{Ech 1 + Ech 2 + Ech 3}{3}$$

$$= \frac{0,813 + 0,7317 + 0,7317}{3}$$

$$= 0,7588 \text{ joule}$$

5. Rata-rata kekuatan impact ketiga spesimen

$$\text{Rata-rata} = \frac{Aiu 1 + Aiu 2 + Aiu 3}{3}$$

$$= \frac{0,038 + 0,034 + 0,035}{3}$$

$$= 0,035 \text{ joule/mm}^2$$

Serat fiberglass acak dan woven roving 200gr 2 lapis

1. Spesimen 1

a. Luas penampang spesimen 1

$$\text{Diketahui : tebal spesimen (t) = 2,05 mm}$$

$$\text{Lebar spesimen (L) = 9,56 mm}$$

$$\text{Sudut ayunan } (\beta) = 144^\circ$$

$$A = t \times L$$

$$= 2,05 \text{ mm} \times 9,56 \text{ mm}$$

$$= 19,59 \text{ mm}^2$$

b. Energi yang diserap

$$Ech = G \times R (\cos \beta - \cos \alpha)$$

$$= 9,8 \text{ m/s} \times 0,83 \text{ m} (-0,80) - (-0,89)$$

$$= 8,13 \times 0,09$$

$$= 0,7317 \text{ joule}$$

c. Kekuatan impact

$$Aiu = \frac{Ech}{A}$$

$$= \frac{0,7317}{19,59} = 0,037 \text{ joule/mm}^2$$

2. Spesimen 1

a. Luas penampang spesimen 1

$$\text{Diketahui : tebal spesimen (t) = 2,11 mm}$$

$$\text{Lebar spesimen (L) = 9,77 mm}$$

$$\text{Sudut ayunan } (\beta) = 144^\circ$$

$$A = t \times L$$

$$= 2,73 \text{ mm} \times 9,48 \text{ mm}$$

$$= 20,61 \text{ mm}^2$$

b. Energi yang diserap

$$Ech = G \times R (\cos \beta - \cos \alpha)$$

$$= 9,8 \text{ m/s} \times 0,83 \text{ m} (-0,80) - (-0,89)$$

$$= 8,13 \times 0,09$$

$$= 0,7317 \text{ joule}$$

c. Kekuatan impact

$$\begin{aligned} Aiu &= \frac{Ech}{A} \\ &= \frac{0,7317}{20,61} = 0,035 \text{ joule/mm}^2 \end{aligned}$$

3. Spesimen

a. Luas penampang spesimen 1

$$\text{Diketahui : tebal spesimen (t) = 2,02 mm}$$

$$\text{Lebar spesimen (L) = 9,72 mm}$$

$$\text{Sudut ayunan } (\beta) = 145^\circ$$

$$A = t \times L$$

$$= 2,73 \text{ mm} \times 9,48 \text{ mm}$$

$$= 19,63 \text{ mm}^2$$

b. Energi yang diserap

$$\begin{aligned} Ech &= G \times R (\cos \beta - \cos \alpha) \\ &= 9,8 \text{ m/s} \times 0,83 \text{ m} (-0,81) - (-0,89) \\ &= 8,13 \times 0,08 \\ &= 0,6540 \text{ joule} \end{aligned}$$

c. Kekuatan impact

$$\begin{aligned} Aiu &= \frac{Ech}{A} \\ &= \frac{0,6540}{19,63} = 0,033 \text{ joule/mm}^2 \end{aligned}$$

4. Rata-rata energi yang diserap ketiga spesimen

$$\begin{aligned} \text{Rata-rata} &= \frac{Ech 1 + Ech 2 + Ech 3}{3} \\ &= \frac{0,7317 + 0,7317 + 0,6504}{3} \end{aligned}$$

$$= 0,7046 \text{ joule}$$

5. Rata-rata kekuatan impact ketiga spesimen

$$\begin{aligned} \text{Rata-rata} &= \frac{Aiu 1 + Aiu 2 + Aiu 3}{3} \\ &= \frac{0,037 + 0,035 + 0,033}{3} \end{aligned}$$

$$= 0,035 \text{ joule/mm}^2$$