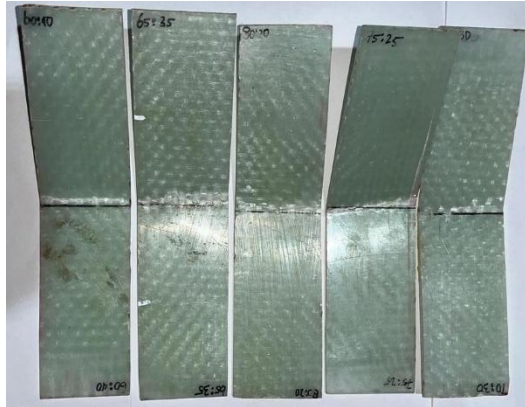


LAMPIRAN

1. Spesimen Setelah Uji Bending



2. Spesimen Setelah Uji Tarik



3. Perhitungan Tegangan Bending

Perbandingan Rasio 60 : 40

Spesimen 1

$$P = \text{Beban maksimum (kg)} \times \text{gravitasi (m/s}^2\text{)}$$

$$P = 77,80 \text{ kg} \times 9,81 \text{ m/s}^2$$

$$P = 763,22 \text{ N}$$

$$\begin{aligned}\sigma &= \frac{3PL}{2bd^2} \\ \sigma &= \frac{3 \times 763,22 \text{ N} \times 96 \text{ mm}}{2 \times 50 \text{ mm} \times (3 \text{ mm})^2} \\ \sigma &= \frac{219.807,36 \text{ N}}{900 \text{ mm}^2} \\ \sigma &= 244,23 \text{ N/mm}^2 \\ \sigma &= 244,23 \text{ MPa}\end{aligned}$$

Spesimen 2

$$\begin{aligned}P &= \text{Beban maksimum (kg)} \times \text{gravitasi (m/s}^2\text{)} \\ P &= 86,6 \text{ kg} \times 9,81 \text{ m/s}^2 \\ P &= 849,55 \text{ N}\end{aligned}$$

$$\begin{aligned}\sigma &= \frac{3PL}{2bd^2} \\ \sigma &= \frac{3 \times 849,55 \text{ N} \times 96 \text{ mm}}{2 \times 50 \text{ mm} \times (3 \text{ mm})^2} \\ \sigma &= \frac{244.670,4 \text{ N}}{900 \text{ mm}^2} \\ \sigma &= 271,85 \text{ N/mm}^2 \\ \sigma &= 271,85 \text{ MPa}\end{aligned}$$

Spesimen 3

$$\begin{aligned}P &= \text{Beban maksimum (kg)} \times \text{gravitasi (m/s}^2\text{)} \\ P &= 90,4 \text{ kg} \times 9,81 \text{ m/s}^2 \\ P &= 886,82 \text{ N}\end{aligned}$$

$$\begin{aligned}\sigma &= \frac{3PL}{2bd^2} \\ \sigma &= \frac{3 \times 886,82 \text{ N} \times 96 \text{ mm}}{2 \times 50 \text{ mm} \times (3 \text{ mm})^2} \\ \sigma &= \frac{255.404,16 \text{ N}}{900 \text{ mm}^2} \\ \sigma &= 283,78 \text{ N/mm}^2 \\ \sigma &= 283,78 \text{ MPa}\end{aligned}$$

Perbandingan Rasio 65:35

Spesimen 1

$$P = \text{Beban maksimum (kg)} \times \text{gravitasi (m/s}^2\text{)}$$

$$P = 76,8 \text{ kg} \times 9,81 \text{ m/s}^2$$

$$P = 753,41 \text{ N}$$

$$\sigma = \frac{3PL}{2bd^2}$$

$$\sigma = \frac{3 \times 753,41 \text{ N} \times 96 \text{ mm}}{2 \times 50 \text{ mm} \times (3 \text{ mm})^2}$$

$$\sigma = \frac{216.982,08 \text{ N}}{900 \text{ mm}^2}$$

$$\sigma = 241,09 \text{ N/mm}^2$$

$$\sigma = 241,09 \text{ MPa}$$

Spesimen 2

$$P = \text{Beban maksimum (kg)} \times \text{gravitasi (m/s}^2\text{)}$$

$$P = 89,4 \text{ kg} \times 9,81 \text{ m/s}^2$$

$$P = 877,01 \text{ N}$$

$$\sigma = \frac{3PL}{2bd^2}$$

$$\sigma = \frac{3 \times 877,01 \text{ N} \times 96 \text{ mm}}{2 \times 50 \text{ mm} \times (3 \text{ mm})^2}$$

$$\sigma = \frac{252.580,03 \text{ N}}{900 \text{ mm}^2}$$

$$\sigma = 280,64 \text{ N/mm}^2$$

$$\sigma = 280,64 \text{ MPa}$$

Spesimen 3

$$P = \text{Beban maksimum (kg)} \times \text{gravitasi (m/s}^2\text{)}$$

$$P = 86,6 \text{ kg} \times 9,81 \text{ m/s}^2$$

$$P = 849,55 \text{ N}$$

$$\sigma = \frac{3PL}{2bd^2}$$

$$\sigma = \frac{3 \times 849,55 \text{ N} \times 96 \text{ mm}}{2 \times 50 \text{ mm} \times (3 \text{ mm})^2}$$

$$\begin{aligned}\sigma &= \frac{244.669,24\text{N}}{900\text{ mm}^2} \\ \sigma &= 271,85\text{N/mm}^2 \\ \sigma &= 271,85\text{ MPa}\end{aligned}$$

Perbandingan Rasio 70:30

Spesimen 1

$$\begin{aligned}P &= \text{Beban maksimum (kg)} \times \text{gravitasi (m/s}^2\text{)} \\ P &= 100,2\text{ kg} \times 9,81\text{ m/s}^2 \\ P &= 982,96\text{N}\end{aligned}$$

$$\begin{aligned}\sigma &= \frac{3PL}{2bd^2} \\ \sigma &= \frac{3 \times 982,96\text{ N} \times 96\text{ mm}}{2 \times 50\text{ mm} \times (3\text{ mm})^2} \\ \sigma &= \frac{283.092,48\text{N}}{900\text{ mm}^2} \\ \sigma &= 314,55\text{N/mm}^2 \\ \sigma &= 314,55\text{ MPa}\end{aligned}$$

Spesimen 2

$$\begin{aligned}P &= \text{Beban maksimum (kg)} \times \text{gravitasi (m/s}^2\text{)} \\ P &= 115,2\text{kg} \times 9,81\text{ m/s}^2 \\ P &= 1130,11\text{N}\end{aligned}$$

$$\begin{aligned}\sigma &= \frac{3PL}{2bd^2} \\ \sigma &= \frac{3 \times 1130,11\text{ N} \times 96\text{ mm}}{2 \times 50\text{ mm} \times (3\text{ mm})^2} \\ \sigma &= \frac{325.471,68\text{N}}{900\text{ mm}^2} \\ \sigma &= 361,63\text{N/mm}^2 \\ \sigma &= 361,63\text{ MPa}\end{aligned}$$

Spesimen 3

$$\begin{aligned}P &= \text{Beban maksimum (kg)} \times \text{gravitasi (m/s}^2\text{)} \\ P &= 104,8\text{kg} \times 9,81\text{ m/s}^2 \\ P &= 1028,09\text{N}\end{aligned}$$

$$\begin{aligned}\sigma &= \frac{3PL}{2bd^2} \\ \sigma &= \frac{3 \times 1028,09 \text{ N} \times 96 \text{ mm}}{2 \times 50 \text{ mm} \times (3 \text{ mm})^2} \\ \sigma &= \frac{296.089,92\text{N}}{900 \text{ mm}^2} \\ \sigma &= 328,99\text{N/mm}^2 \\ \sigma &= 328,99 \text{ MPa}\end{aligned}$$

Perbandingan Rasio 75 : 25

Spesimen 1

$$\begin{aligned}P &= \text{Beban maksimum (kg)} \times \text{gravitasi (m/s}^2\text{)} \\ P &= 82,4 \text{ kg} \times 9,81 \text{ m/s}^2 \\ P &= 808,34\text{N}\end{aligned}$$

$$\begin{aligned}\sigma &= \frac{3PL}{2bd^2} \\ \sigma &= \frac{3 \times 808,34 \text{ N} \times 96 \text{ mm}}{2 \times 50 \text{ mm} \times (3 \text{ mm})^2} \\ \sigma &= \frac{232.801,92\text{N}}{900 \text{ mm}^2} \\ \sigma &= 258,67 \text{ N/mm}^2 \\ \sigma &= 258,67 \text{ MPa}\end{aligned}$$

Spesimen 2

$$\begin{aligned}P &= \text{Beban maksimum (kg)} \times \text{gravitasi (m/s}^2\text{)} \\ P &= 96,2 \text{ kg} \times 9,81 \text{ m/s}^2 \\ P &= 943,72\text{N}\end{aligned}$$

$$\begin{aligned}\sigma &= \frac{3PL}{2bd^2} \\ \sigma &= \frac{3 \times 943,72 \text{ N} \times 96 \text{ mm}}{2 \times 50 \text{ mm} \times (3 \text{ mm})^2} \\ \sigma &= \frac{271.791,36\text{N}}{900 \text{ mm}^2} \\ \sigma &= 301,99 \text{ N/mm}^2 \\ \sigma &= 301,99 \text{ MPa}\end{aligned}$$

Spesimen 3

$$P = \text{Beban maksimum (kg)} \times \text{gravitasi (m/s}^2\text{)}$$

$$P = 82,6 \text{ kg} \times 9,81 \text{ m/s}^2$$

$$P = 810,31\text{N}$$

$$\sigma = \frac{3PL}{2bd^2}$$

$$\sigma = \frac{3 \times 810,31 \text{ N} \times 96 \text{ mm}}{2 \times 50 \text{ mm} \times (3 \text{ mm})^2}$$

$$\sigma = \frac{233.369,28\text{N}}{900 \text{ mm}^2}$$

$$\sigma = 259,30 \text{ N/mm}^2$$

$$\sigma = 259,30 \text{ MPa}$$

Perbandingan Rasio 80:20

Spesimen 1

$$P = \text{Beban maksimum (kg)} \times \text{gravitasi (m/s}^2\text{)}$$

$$P = 81,2 \text{ kg} \times 9,81 \text{ m/s}^2$$

$$P = 796,57\text{N}$$

$$\sigma = \frac{3PL}{2bd^2}$$

$$\sigma = \frac{3 \times 796,57 \text{ N} \times 96 \text{ mm}}{2 \times 50 \text{ mm} \times (3 \text{ mm})^2}$$

$$\sigma = \frac{229.412,16\text{N}}{900 \text{ mm}^2}$$

$$\sigma = 254,90 \text{ N/mm}^2$$

$$\sigma = 254,90 \text{ MPa}$$

Spesimen 2

$$P = \text{Beban maksimum (kg)} \times \text{gravitasi (m/s}^2\text{)}$$

$$P = 74,2 \text{ kg} \times 9,81 \text{ m/s}^2$$

$$P = 727,90\text{N}$$

$$\sigma = \frac{3PL}{2bd^2}$$

$$\sigma = \frac{3 \times 727,90 \text{ N} \times 96 \text{ mm}}{2 \times 50 \text{ mm} \times (3 \text{ mm})^2}$$

$$\sigma = \frac{209.635,2\text{N}}{900 \text{ mm}^2}$$

$$\sigma = 232,93 \text{ N/mm}^2$$

$$\sigma = 232,93 \text{ MPa}$$

Spesimen 3

$$P = \text{Beban maksimum (kg)} \times \text{gravitasi (m/s}^2\text{)}$$

$$P = 76,4 \text{ kg} \times 9,81 \text{ m/s}^2$$

$$P = 749,48\text{N}$$

$$\sigma = \frac{3PL}{2bd^2}$$

$$\sigma = \frac{3 \times 749,48 \text{ N} \times 96 \text{ mm}}{2 \times 50 \text{ mm} \times (3 \text{ mm})^2}$$

$$\sigma = \frac{215.850,24 \text{ N}}{900 \text{ mm}^2}$$

$$\sigma = 239,83 \text{ N/mm}^2$$

$$\sigma = 239,83 \text{ MPa}$$

4. Perhitungan Nilai Kekuatan Tarik

Perbandingan Rasio 60:40

Spesimen 1

$$P = \text{Beban maksimum (kg)} \times \text{gravitasi (m/s}^2\text{)}$$

$$P = 1724,2\text{kg} \times 9,81 \text{ m/s}^2$$

$$P = 16.914,40 \text{ N}$$

$$A = \text{lebar} \times \text{tebal}$$

$$A = 25 \text{ mm} \times 3 \text{ mm}$$

$$A = 75 \text{ mm}^2$$

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

$$\sigma = \frac{16.914,40 \text{ N}}{75 \text{ mm}^2}$$

$$\sigma = 225,53\text{N/mm}^2$$

$$\sigma = 225,53 \text{ MPa}$$

$$\varepsilon = \frac{\Delta L}{L_0}$$

$$\varepsilon = \frac{8,12 \text{ mm}}{110 \text{ mm}^2} \times 100\%$$
$$\varepsilon = 7,38 \%$$

Tegangan, Regangan, dan Modulus Elastisitas Yield

$$P = \text{Beban Yield (kg)} \times \text{gravitasi (m/s}^2\text{)}$$
$$P = 1.186,6 \text{ kg} \times 9,81 \text{ m/s}^2$$
$$P = 11.640,55 \text{ N}$$

$$\sigma = \frac{P}{A}$$
$$\sigma = \frac{11.640,55 \text{ N}}{75 \text{ mm}^2}$$
$$\sigma = 155,21 \text{ N/mm}^2$$
$$\sigma = 155,21 \text{ MPa}$$

$$\varepsilon = \frac{\Delta L}{L_0}$$
$$\varepsilon = \frac{4,47 \text{ mm}}{110 \text{ mm}^2} \times 100\%$$
$$\varepsilon = 4,06 \%$$

$$E = \frac{\sigma}{\varepsilon}$$
$$E = \frac{155,21 \text{ MPa}}{0,0406}$$
$$E = 3.822,91 \text{ MPa}$$

Spesimen 2

$$P = \text{Beban maksimum (kg)} \times \text{gravitasi (m/s}^2\text{)}$$
$$P = 1.823,4 \text{ kg} \times 9,81 \text{ m/s}^2$$
$$P = 17.887,55 \text{ N}$$

$$A = \text{lebar} \times \text{tebal}$$
$$A = 25 \text{ mm} \times 3 \text{ mm}$$
$$A = 75 \text{ mm}^2$$

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

$$\begin{aligned}\sigma &= \frac{17.887,55 \text{ N}}{75 \text{ mm}^2} \\ \sigma &= 238,50 \text{ N/mm}^2 \\ \sigma &= 238,50 \text{ MPa}\end{aligned}$$

$$\begin{aligned}\varepsilon &= \frac{\Delta L}{L_0} \\ \varepsilon &= \frac{18,59 \text{ mm}}{110 \text{ mm}^2} \times 100\% \\ \varepsilon &= 16,90 \%\end{aligned}$$

Tegangan, Regangan, dan Modulus Elastisitas Yield

$$\begin{aligned}P &= \text{Beban Yield (kg)} \times \text{gravitasi (m/s}^2\text{)} \\ P &= 1.262,6 \text{ kg} \times 9,81 \text{ m/s}^2 \\ P &= 12.386,11 \text{ N}\end{aligned}$$

$$\begin{aligned}\sigma &= \frac{P}{A} \\ \sigma &= \frac{12.386,11 \text{ N}}{75 \text{ mm}^2} \\ \sigma &= 165,14 \text{ N/mm}^2 \\ \sigma &= 165,14 \text{ MPa}\end{aligned}$$

$$\begin{aligned}\varepsilon &= \frac{\Delta L}{L_0} \\ \varepsilon &= \frac{10,24 \text{ mm}}{110 \text{ mm}^2} \times 100\% \\ \varepsilon &= 9,30 \%\end{aligned}$$

$$\begin{aligned}E &= \frac{\sigma}{\varepsilon} \\ E &= \frac{165,14 \text{ MPa}}{0,0930} \\ E &= 1.775,70 \text{ MPa}\end{aligned}$$

Spesimen 3

$$P = \text{Beban maksimum (kg)} \times \text{gravitasi (m/s}^2\text{)}$$

$$P = 1.711,2 \text{ kg} \times 9,81 \text{ m/s}^2$$

$$P = 16.786,87 \text{ N}$$

$$A = \text{lebar} \times \text{tebal}$$

$$A = 25 \text{ mm} \times 3 \text{ mm}$$

$$A = 75 \text{ mm}^2$$

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

$$\sigma = \frac{16.786,87 \text{ N}}{75 \text{ mm}^2}$$

$$\sigma = 223,82 \text{ N/mm}^2$$

$$\sigma = 223,82 \text{ MPa}$$

$$\varepsilon = \frac{\Delta L}{L_0}$$

$$\varepsilon = \frac{10,47 \text{ mm}}{110 \text{ mm}^2} \times 100\%$$

$$\varepsilon = 9,52\%$$

Tegangan, Regangan, dan Modulus Elastisitas Yield

$$P = \text{Beban Yield (kg)} \times \text{gravitasi (m/s}^2)$$

$$P = 1.580,60 \text{ kg} \times 9,81 \text{ m/s}^2$$

$$P = 15.505,69 \text{ N}$$

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

$$\sigma = \frac{15.505,69 \text{ N}}{75 \text{ mm}^2}$$

$$\sigma = 206,74 \text{ N/mm}^2$$

$$\sigma = 206,74 \text{ MPa}$$

$$\varepsilon = \frac{\Delta L}{L_0}$$

$$\varepsilon = \frac{4,94 \text{ mm}}{110 \text{ mm}^2} \times 100\%$$

$$\varepsilon = 4,49 \%$$

$$E = \frac{\sigma}{\varepsilon}$$

$$E = \frac{206,74 \text{ MPa}}{0,0449}$$
$$E = 4.604,45 \text{ MPa}$$

Perbandingan Rasio 65:35

Spesimen 1

$$P = \text{Beban maksimum (kg)} \times \text{gravitasi (m/s}^2\text{)}$$
$$P = 1.871,4 \text{ kg} \times 9,81 \text{ m/s}^2$$
$$P = 18.358,43 \text{ N}$$

$$A = \text{lebar} \times \text{tebal}$$
$$A = 25 \text{ mm} \times 3 \text{ mm}$$
$$A = 75 \text{ mm}^2$$

$$\sigma = \frac{P}{A}$$
$$\sigma = \frac{18.358,43 \text{ N}}{75 \text{ mm}^2}$$
$$\sigma = 244,78 \text{ N/mm}^2$$
$$\sigma = 244,78 \text{ MPa}$$

$$\varepsilon = \frac{\Delta L}{L_0}$$
$$\varepsilon = \frac{18,47 \text{ mm}}{110 \text{ mm}^2} \times 100\%$$
$$\varepsilon = 16,79 \%$$

Tegangan, Regangan, dan Modulus Elastisitas Yield

$$P = \text{Beban Yield (kg)} \times \text{gravitasi (m/s}^2\text{)}$$
$$P = 1.031,4 \text{ kg} \times 9,81 \text{ m/s}^2$$
$$P = 10.118,03 \text{ N}$$

$$\sigma = \frac{P}{A}$$
$$\sigma = \frac{10.118,03 \text{ N}}{75 \text{ mm}^2}$$
$$\sigma = 134,91 \text{ N/mm}^2$$
$$\sigma = 134,91 \text{ MPa}$$

$$\begin{aligned}\varepsilon &= \frac{\Delta L}{L_0} \\ \varepsilon &= \frac{8,35 \text{ mm}}{110 \text{ mm}^2} \times 100\% \\ \varepsilon &= 7,59 \%\end{aligned}$$

$$\begin{aligned}E &= \frac{\sigma}{\varepsilon} \\ E &= \frac{134,91 \text{ MPa}}{0,0759} \\ E &= 1.777,47 \text{ MPa}\end{aligned}$$

Spesimen 2

$$\begin{aligned}P &= \text{Beban maksimum (kg)} \times \text{gravitasi (m/s}^2\text{)} \\ P &= 1.764,2 \text{ kg} \times 9,81 \text{ m/s}^2 \\ P &= 17.306,80 \text{ N}\end{aligned}$$

$$\begin{aligned}A &= \text{lebar} \times \text{tebal} \\ A &= 25 \text{ mm} \times 3 \text{ mm} \\ A &= 75 \text{ mm}^2\end{aligned}$$

$$\begin{aligned}\sigma &= \frac{P}{A} \\ \sigma &= \frac{17.306,80 \text{ N}}{75 \text{ mm}^2} \\ \sigma &= 230,76 \text{ N/mm}^2 \\ \sigma &= 230,76 \text{ MPa}\end{aligned}$$

$$\begin{aligned}\varepsilon &= \frac{\Delta L}{L_0} \\ \varepsilon &= \frac{15,65 \text{ mm}}{110 \text{ mm}^2} \times 100\% \\ \varepsilon &= 14,23 \%\end{aligned}$$

Tegangan, Regangan, dan Modulus Elastisitas Yield

$$\begin{aligned}P &= \text{Beban Yield (kg)} \times \text{gravitasi (m/s}^2\text{)} \\ P &= 870,8 \text{ kg} \times 9,81 \text{ m/s}^2 \\ P &= 8.542,55 \text{ N}\end{aligned}$$

$$\begin{aligned}\sigma &= \frac{P}{A} \\ \sigma &= \frac{8.542,55 \text{ N}}{75 \text{ mm}^2} \\ \sigma &= 113,90 \text{ N/mm}^2 \\ \sigma &= 113,90 \text{ MPa}\end{aligned}$$

$$\begin{aligned}\varepsilon &= \frac{\Delta L}{L_0} \\ \varepsilon &= \frac{7,3 \text{ mm}}{110 \text{ mm}^2} \times 100\% \\ \varepsilon &= 6,63 \%\end{aligned}$$

$$\begin{aligned}E &= \frac{\sigma}{\varepsilon} \\ E &= \frac{113,90 \text{ MPa}}{0,0663} \\ E &= 1.717,95 \text{ MPa}\end{aligned}$$

Spesimen 3

$$\begin{aligned}P &= \text{Beban maksimum (kg)} \times \text{gravitasi (m/s}^2\text{)} \\ P &= 1.805,4 \text{ kg} \times 9,81 \text{ m/s}^2 \\ P &= 17.710,97 \text{ N}\end{aligned}$$

$$\begin{aligned}A &= \text{lebar} \times \text{tebal} \\ A &= 25 \text{ mm} \times 3 \text{ mm} \\ A &= 75 \text{ mm}^2\end{aligned}$$

$$\begin{aligned}\sigma &= \frac{P}{A} \\ \sigma &= \frac{17.710,97 \text{ N}}{75 \text{ mm}^2} \\ \sigma &= 236,15 \text{ N/mm}^2 \\ \sigma &= 236,15 \text{ MPa}\end{aligned}$$

$$\varepsilon = \frac{\Delta L}{L_0}$$

$$\varepsilon = \frac{16,59 \text{ mm}}{110 \text{ mm}^2} \times 100\%$$
$$\varepsilon = 15,08\%$$

Tegangan, Regangan, dan Modulus Elastisitas Yield

$$P = \text{Beban Yield (kg)} \times \text{gravitasi (m/s}^2\text{)}$$
$$P = 721,4 \text{ kg} \times 9,81 \text{ m/s}^2$$
$$P = 7.076,93 \text{ N}$$

$$\sigma = \frac{P}{A}$$
$$\sigma = \frac{7.076,93 \text{ N}}{75 \text{ mm}^2}$$
$$\sigma = 94,36 \text{ N/mm}^2$$
$$\sigma = 94,36 \text{ MPa}$$

$$\varepsilon = \frac{\Delta L}{L_0}$$
$$\varepsilon = \frac{6,12 \text{ mm}}{110 \text{ mm}^2} \times 100\%$$
$$\varepsilon = 5,56 \%$$

$$E = \frac{\sigma}{\varepsilon}$$
$$E = \frac{94,36 \text{ MPa}}{0,0556}$$
$$E = 1.697,12 \text{ MPa}$$

Perbandingan Rasio 70:30

Spesimen 1

$$P = \text{Beban maksimum (kg)} \times \text{gravitasi (m/s}^2\text{)}$$
$$P = 1.468,8 \text{ kg} \times 9,81 \text{ m/s}^2$$
$$P = 14.408,93 \text{ N}$$

$$A = \text{lebar} \times \text{tebal}$$
$$A = 25 \text{ mm} \times 3 \text{ mm}$$
$$A = 75 \text{ mm}^2$$

$$\begin{aligned}\sigma &= \frac{P}{A} \\ \sigma &= \frac{14.408,93 \text{ N}}{75 \text{ mm}^2} \\ \sigma &= 192,12 \text{ N/mm}^2 \\ \sigma &= 192,12 \text{ MPa}\end{aligned}$$

$$\begin{aligned}\varepsilon &= \frac{\Delta L}{L_0} \\ \varepsilon &= \frac{9,53 \text{ mm}}{110 \text{ mm}^2} \times 100\% \\ \varepsilon &= 8,66 \%\end{aligned}$$

Tegangan, Regangan, dan Modulus Elastisitas Yield

$$\begin{aligned}P &= \text{Beban Yield (kg)} \times \text{gravitasi (m/s}^2\text{)} \\ P &= 484,4 \text{ kg} \times 9,81 \text{ m/s}^2 \\ P &= 4.751,96 \text{ N}\end{aligned}$$

$$\begin{aligned}\sigma &= \frac{P}{A} \\ \sigma &= \frac{4.751,96 \text{ N}}{75 \text{ mm}^2} \\ \sigma &= 63,35 \text{ N/mm}^2 \\ \sigma &= 63,35 \text{ MPa}\end{aligned}$$

$$\begin{aligned}\varepsilon &= \frac{\Delta L}{L_0} \\ \varepsilon &= \frac{1,17 \text{ mm}}{110 \text{ mm}^2} \times 100\% \\ \varepsilon &= 1,06 \%\end{aligned}$$

$$\begin{aligned}E &= \frac{\sigma}{\varepsilon} \\ E &= \frac{63,35 \text{ MPa}}{0,0105} \\ E &= 5.976,42 \text{ MPa}\end{aligned}$$

Spesimen 2

$$P = \text{Beban maksimum (kg)} \times \text{gravitasi (m/s}^2\text{)}$$

$$P = 1.787,6 \text{ kg} \times 9,81 \text{ m/s}^2$$

$$P = 17.536,36 \text{ N}$$

$$A = \text{lebar} \times \text{tebal}$$

$$A = 25 \text{ mm} \times 3 \text{ mm}$$

$$A = 75 \text{ mm}^2$$

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

$$\sigma = \frac{17.536,36 \text{ N}}{75 \text{ mm}^2}$$

$$\sigma = 233,82 \text{ N/mm}^2$$

$$\sigma = 233,82 \text{ MPa}$$

$$\varepsilon = \frac{\Delta L}{L_0}$$

$$\varepsilon = \frac{4 \text{ mm}}{110 \text{ mm}^2} \times 100\%$$

$$\varepsilon = 3,64 \%$$

Tegangan, Regangan, dan Modulus Elastisitas Yield

$$P = \text{Beban Yield (kg)} \times \text{gravitasi (m/s}^2\text{)}$$

$$P = 495,6 \text{ kg} \times 9,81 \text{ m/s}^2$$

$$P = 4.861,84 \text{ N}$$

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

$$\sigma = \frac{4.861,84 \text{ N}}{75 \text{ mm}^2}$$

$$\sigma = 64,82 \text{ N/mm}^2$$

$$\sigma = 64,82 \text{ MPa}$$

$$\varepsilon = \frac{\Delta L}{L_0}$$

$$\varepsilon = \frac{3,17 \text{ mm}}{110 \text{ mm}^2} \times 100\%$$

$$\varepsilon = 2,88 \%$$

$$E = \frac{\sigma}{\varepsilon}$$
$$E = \frac{64,82 \text{ MPa}}{0,0288}$$
$$E = 2.250,69 \text{ MPa}$$

Spesimen 3

$$P = \text{Beban maksimum (kg)} \times \text{gravitasi (m/s}^2\text{)}$$
$$P = 1.664,6 \text{ kg} \times 9,81 \text{ m/s}^2$$
$$P = 16.329,73 \text{ N}$$

$$A = \text{lebar} \times \text{tebal}$$
$$A = 25 \text{ mm} \times 3 \text{ mm}$$
$$A = 75 \text{ mm}^2$$

$$\sigma = \frac{P}{A}$$
$$\sigma = \frac{16.329,73 \text{ N}}{75 \text{ mm}^2}$$
$$\sigma = 217,73 \text{ N/mm}^2$$
$$\sigma = 217,73 \text{ MPa}$$

$$\varepsilon = \frac{\Delta L}{L_0}$$
$$\varepsilon = \frac{17,64 \text{ mm}}{110 \text{ mm}^2} \times 100\%$$
$$\varepsilon = 16,04 \%$$

Tegangan, Regangan, dan Modulus Elastisitas Yield

$$P = \text{Beban Yield (kg)} \times \text{gravitasi (m/s}^2\text{)}$$
$$P = 678,2 \text{ kg} \times 9,81 \text{ m/s}^2$$
$$P = 6.653,14 \text{ N}$$

$$\sigma = \frac{P}{A}$$
$$\sigma = \frac{6.653,14 \text{ N}}{75 \text{ mm}^2}$$
$$\sigma = 88,71 \text{ N/mm}^2$$
$$\sigma = 88,71 \text{ MPa}$$

$$\begin{aligned}\varepsilon &= \frac{\Delta L}{L_0} \\ \varepsilon &= \frac{6,58 \text{ mm}}{110 \text{ mm}^2} \times 100\% \\ \varepsilon &= 5,98 \%\end{aligned}$$

$$\begin{aligned}E &= \frac{\sigma}{\varepsilon} \\ E &= \frac{88,71 \text{ MPa}}{0,0598} \\ E &= 1.483,44 \text{ MPa}\end{aligned}$$

Perbandingan Rasio 75:25

Spesimen 1

$$\begin{aligned}P &= \text{Beban maksimum (kg)} \times \text{gravitasi (m/s}^2\text{)} \\ P &= 1.165,80 \text{ kg} \times 9,81 \text{ m/s}^2 \\ P &= 11.436,50 \text{ N}\end{aligned}$$

$$\begin{aligned}A &= \text{lebar} \times \text{tebal} \\ A &= 25 \text{ mm} \times 3 \text{ mm} \\ A &= 75 \text{ mm}^2\end{aligned}$$

$$\begin{aligned}\sigma &= \frac{P}{A} \\ \sigma &= \frac{11.436,50 \text{ N}}{75 \text{ mm}^2} \\ \sigma &= 152,49 \text{ N/mm}^2 \\ \sigma &= 152,49 \text{ MPa}\end{aligned}$$

$$\begin{aligned}\varepsilon &= \frac{\Delta L}{L_0} \\ \varepsilon &= \frac{9,18 \text{ mm}}{110 \text{ mm}^2} \times 100\% \\ \varepsilon &= 8,35 \%\end{aligned}$$

Tegangan, Regangan, dan Modulus Elastisitas Yield

$$P = \text{Beban Yield (kg)} \times \text{gravitasi (m/s}^2\text{)}$$

$$P = 608,4 \text{ kg} \times 9,81 \text{ m/s}^2$$
$$P = 5.968,40 \text{ N}$$

$$\sigma = \frac{P}{A}$$
$$\sigma = \frac{5.968,40 \text{ N}}{75 \text{ mm}^2}$$
$$\sigma = 79,57 \text{ N/mm}^2$$
$$\sigma = 79,57 \text{ MPa}$$

$$\varepsilon = \frac{\Delta L}{L_0}$$
$$\varepsilon = \frac{4,71 \text{ mm}}{110 \text{ mm}^2} \times 100\%$$
$$\varepsilon = 4,28\%$$

$$E = \frac{\sigma}{\varepsilon}$$
$$E = \frac{35,26 \text{ MPa}}{0,0428}$$
$$E = 1.859,11 \text{ MPa}$$

Spesimen 2

$$P = \text{Beban maksimum (kg)} \times \text{gravitasi (m/s}^2\text{)}$$
$$P = 1.619,8 \text{ kg} \times 9,81 \text{ m/s}^2$$
$$P = 15.890,24 \text{ N}$$

$$A = \text{lebar} \times \text{tebal}$$
$$A = 25 \text{ mm} \times 3 \text{ mm}$$
$$A = 75 \text{ mm}^2$$

$$\sigma = \frac{P}{A}$$
$$\sigma = \frac{15.890,24 \text{ N}}{75 \text{ mm}^2}$$
$$\sigma = 211,87 \text{ N/mm}^2$$
$$\sigma = 211,87 \text{ MPa}$$

$$\begin{aligned}\varepsilon &= \frac{\Delta L}{L_0} \\ \varepsilon &= \frac{14,83 \text{ mm}}{110 \text{ mm}^2} \times 100\% \\ \varepsilon &= 13,48 \%\end{aligned}$$

Tegangan, Regangan, dan Modulus Elastisitas Yield

$$\begin{aligned}P &= \text{Beban Yield (kg)} \times \text{gravitasi (m/s}^2\text{)} \\ P &= 748,40 \text{ kg} \times 9,81 \text{ m/s}^2 \\ P &= 7.341,80 \text{ N} \\ \sigma &= \frac{P}{A} \\ \sigma &= \frac{7.341,80 \text{ N}}{75 \text{ mm}^2} \\ \sigma &= 97,89 \text{ N/mm}^2 \\ \sigma &= 97,89 \text{ MPa}\end{aligned}$$

$$\begin{aligned}\varepsilon &= \frac{\Delta L}{L_0} \\ \varepsilon &= \frac{5,77 \text{ mm}}{110 \text{ mm}^2} \times 100\% \\ \varepsilon &= 5,24 \%\end{aligned}$$

$$\begin{aligned}E &= \frac{\sigma}{\varepsilon} \\ E &= \frac{97,89 \text{ MPa}}{0,0524} \\ E &= 1.868,13 \text{ MPa}\end{aligned}$$

Spesimen 3

$$\begin{aligned}P &= \text{Beban maksimum (kg)} \times \text{gravitasi (m/s}^2\text{)} \\ P &= 1.404,8 \text{ kg} \times 9,81 \text{ m/s}^2 \\ P &= 13.781,09 \text{ N}\end{aligned}$$

$$\begin{aligned}A &= \text{lebar} \times \text{tebal} \\ A &= 25 \text{ mm} \times 3 \text{ mm} \\ A &= 75 \text{ mm}^2\end{aligned}$$

$$\begin{aligned}\sigma &= \frac{P}{A} \\ \sigma &= \frac{13.781,09 \text{ N}}{75 \text{ mm}^2} \\ \sigma &= 183,75 \text{ N/mm}^2 \\ \sigma &= 183,75 \text{ MPa}\end{aligned}$$

$$\begin{aligned}\varepsilon &= \frac{\Delta L}{L_0} \\ \varepsilon &= \frac{15.06 \text{ mm}}{110 \text{ mm}^2} \times 100\% \\ \varepsilon &= 13,69 \%\end{aligned}$$

Tegangan, Regangan, dan Modulus Elastisitas Yield

$$\begin{aligned}P &= \text{Beban Yield (kg)} \times \text{gravitasi (m/s}^2\text{)} \\ P &= 698,20 \text{ kg} \times 9,81 \text{ m/s}^2 \\ P &= 6.849,34 \text{ N}\end{aligned}$$

$$\begin{aligned}\sigma &= \frac{P}{A} \\ \sigma &= \frac{6.849,34 \text{ N}}{75 \text{ mm}^2} \\ \sigma &= 91,32 \text{ N/mm}^2 \\ \sigma &= 91,32 \text{ MPa}\end{aligned}$$

$$\begin{aligned}\varepsilon &= \frac{\Delta L}{L_0} \\ \varepsilon &= \frac{6,48 \text{ mm}}{110 \text{ mm}^2} \times 100\% \\ \varepsilon &= 5,89 \%\end{aligned}$$

$$\begin{aligned}E &= \frac{\sigma}{\varepsilon} \\ E &= \frac{91,32 \text{ MPa}}{0,0589} \\ E &= 1.550,42 \text{ MPa}\end{aligned}$$

Perbandingan Rasio 80:20

Spesimen 1

$$P = \text{Beban maksimum (kg)} \times \text{gravitasi (m/s}^2\text{)}$$

$$P = 1.397,6 \text{ kg} \times 9,81 \text{ m/s}^2$$

$$P = 13.710,46 \text{ N}$$

$$A = \text{lebar} \times \text{tebal}$$

$$A = 25 \text{ mm} \times 3 \text{ mm}$$

$$A = 75 \text{ mm}^2$$

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

$$\sigma = \frac{13.710,46 \text{ N}}{75 \text{ mm}^2}$$

$$\sigma = 182,81 \text{ N/mm}^2$$

$$\sigma = 182,81 \text{ MPa}$$

$$\varepsilon = \frac{\Delta L}{L_0}$$

$$\varepsilon = \frac{13.65 \text{ mm}}{110 \text{ mm}^2} \times 100\%$$

$$\varepsilon = 12,41 \%$$

Tegangan, Regangan, dan Modulus Elastisitas Yield

$$P = \text{Beban Yield (kg)} \times \text{gravitasi (m/s}^2\text{)}$$

$$P = 1.1441,40 \text{ kg} \times 9,81 \text{ m/s}^2$$

$$P = 11.197,13 \text{ N}$$

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

$$\sigma = \frac{11.197,13 \text{ N}}{75 \text{ mm}^2}$$

$$\sigma = 149,30 \text{ N/mm}^2$$

$$\sigma = 149,30 \text{ MPa}$$

$$\begin{aligned}\varepsilon &= \frac{\Delta L}{L_0} \\ \varepsilon &= \frac{8,24 \text{ mm}}{110 \text{ mm}^2} \times 100\% \\ \varepsilon &= 7,49 \%\end{aligned}$$

$$\begin{aligned}E &= \frac{\sigma}{\varepsilon} \\ E &= \frac{149,30 \text{ MPa}}{0,0749} \\ E &= 1.993,32 \text{ MPa}\end{aligned}$$

Spesimen 2

$$\begin{aligned}P &= \text{Beban maksimum (kg)} \times \text{gravitasi (m/s}^2\text{)} \\ P &= 1.773,80 \text{ kg} \times 9,81 \text{ m/s}^2 \\ P &= 17.400,98 \text{ N}\end{aligned}$$

$$\begin{aligned}A &= \text{lebar} \times \text{tebal} \\ A &= 25 \text{ mm} \times 3 \text{ mm} \\ A &= 75 \text{ mm}^2 \\ \sigma &= \frac{P}{A} \\ \sigma &= \frac{17.400,98 \text{ N}}{75 \text{ mm}^2} \\ \sigma &= 232,01 \text{ N/mm}^2 \\ \sigma &= 232,01 \text{ MPa}\end{aligned}$$

$$\begin{aligned}\varepsilon &= \frac{\Delta L}{L_0} \\ \varepsilon &= \frac{9,06 \text{ mm}}{110 \text{ mm}^2} \times 100\% \\ \varepsilon &= 8,24 \%\end{aligned}$$

Tegangan, Regangan, dan Modulus Elastisitas Yield

$$\begin{aligned}P &= \text{Beban Yield (kg)} \times \text{gravitasi (m/s}^2\text{)} \\ P &= 490,20 \text{ kg} \times 9,81 \text{ m/s}^2 \\ P &= 4.808,86 \text{ N}\end{aligned}$$

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

$$\sigma = \frac{4.808,86 \text{ N}}{75 \text{ mm}^2}$$

$$\sigma = 64,50 \text{ N/mm}^2$$

$$\sigma = 64,50 \text{ MPa}$$

$$\varepsilon = \frac{\Delta L}{L_0}$$

$$\varepsilon = \frac{1,18 \text{ mm}}{110 \text{ mm}^2} \times 100\%$$

$$\varepsilon = 1,07 \%$$

$$E = \frac{\sigma}{\varepsilon}$$

$$E = \frac{64,50 \text{ MPa}}{0,0170}$$

$$E = 6.028,04 \text{ MPa}$$

Spesimen 3

$$P = \text{Beban maksimum (kg)} \times \text{gravitasi (m/s}^2\text{)}$$

$$P = 1.597,20 \text{ kg} \times 9,81 \text{ m/s}^2$$

$$P = 15.668,53 \text{ N}$$

$$A = \text{lebar} \times \text{tebal}$$

$$A = 25 \text{ mm} \times 3 \text{ mm}$$

$$A = 75 \text{ mm}^2$$

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

$$\sigma = \frac{15.668,53 \text{ N}}{75 \text{ mm}^2}$$

$$\sigma = 208,91 \text{ N/mm}^2$$

$$\sigma = 208,91 \text{ MPa}$$

$$\begin{aligned}\varepsilon &= \frac{\Delta L}{L_0} \\ \varepsilon &= \frac{19.53 \text{ mm}}{110 \text{ mm}^2} \times 100\% \\ \varepsilon &= 17,75 \%\end{aligned}$$

Tegangan, Regangan, dan Modulus Elastisitas Yield

$$\begin{aligned}P &= \text{Beban Yield (kg)} \times \text{gravitasi (m/s}^2\text{)} \\ P &= 510,60 \text{ kg} \times 9,81 \text{ m/s}^2 \\ P &= 5.008,99 \text{ N}\end{aligned}$$

$$\begin{aligned}\sigma &= \frac{P}{A} \\ \sigma &= \frac{5.008,99 \text{ N}}{75 \text{ mm}^2} \\ \sigma &= 66,79 \text{ N/mm}^2 \\ \sigma &= 66,79 \text{ MPa}\end{aligned}$$

$$\begin{aligned}\varepsilon &= \frac{\Delta L}{L_0} \\ \varepsilon &= \frac{6,24 \text{ mm}}{110 \text{ mm}^2} \times 100\% \\ \varepsilon &= 5,67 \%\end{aligned}$$

$$\begin{aligned}E &= \frac{\sigma}{\varepsilon} \\ E &= \frac{66,79 \text{ MPa}}{0,0567} \\ E &= 1.177,95 \text{ MPa}\end{aligned}$$

5. Perhitungan Nilai Kekuatan Tarik Spesimen Tanpa Sera
Perbandingan Rasio 70:30

Spesimen 1

$$\begin{aligned}P &= \text{Beban maksimum (kg)} \times \text{gravitasi (m/s}^2\text{)} \\ P &= 135,2 \text{ kg} \times 9,81 \text{ m/s}^2 \\ P &= 1.326,31 \text{ N}\end{aligned}$$

$$\begin{aligned}A &= \text{lebar} \times \text{tebal} \\ A &= 25 \text{ mm} \times 3 \text{ mm} \\ A &= 75 \text{ mm}^2\end{aligned}$$

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

$$\sigma = \frac{1.326,31 \text{ N}}{75 \text{ mm}^2}$$

$$\sigma = 17,68 \text{ N/mm}^2$$

$$\sigma = 17,68 \text{ MPa}$$

$$\varepsilon = \frac{\Delta L}{L_0}$$

$$\varepsilon = \frac{1,53 \text{ mm}}{110 \text{ mm}^2} \times 100\%$$

$$\varepsilon = 1,39 \%$$

Tegangan, Regangan, dan Modulus Elastisitas Yield

$$P = \text{Beban Yield (kg)} \times \text{gravitasi (m/s}^2\text{)}$$

$$P = 52,6 \text{ kg} \times 9,81 \text{ m/s}^2$$

$$P = 516,01 \text{ N}$$

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

$$\sigma = \frac{516,01 \text{ N}}{75 \text{ mm}^2}$$

$$\sigma = 6,88 \text{ N/mm}^2$$

$$\sigma = 6,88 \text{ MPa}$$

$$\varepsilon = \frac{\Delta L}{L_0}$$

$$\varepsilon = \frac{0,83 \text{ mm}}{110 \text{ mm}^2} \times 100\%$$

$$\varepsilon = 0,75 \%$$

$$E = \frac{\sigma}{\varepsilon}$$

$$E = \frac{6,88 \text{ MPa}}{0,0075}$$

$$E = 911,82 \text{ MPa}$$

Spesimen 2

$$\begin{aligned}P &= \text{Beban maksimum (kg)} \times \text{gravitasi (m/s}^2\text{)} \\P &= 361,6 \text{ kg} \times 9,81 \text{ m/s}^2 \\P &= 3.547,30 \text{ N}\end{aligned}$$

$$\begin{aligned}A &= \text{lebar} \times \text{tebal} \\A &= 25 \text{ mm} \times 3 \text{ mm} \\A &= 75 \text{ mm}^2\end{aligned}$$

$$\begin{aligned}\sigma &= \frac{P}{A} \\ \sigma &= \frac{3.547,30 \text{ N}}{75 \text{ mm}^2} \\ \sigma &= 47,30 \text{ N/mm}^2 \\ \sigma &= 47,30 \text{ MPa}\end{aligned}$$

$$\begin{aligned}\varepsilon &= \frac{\Delta L}{L_0} \\ \varepsilon &= \frac{3,27 \text{ mm}}{110 \text{ mm}^2} \times 100\% \\ \varepsilon &= 2,97 \%\end{aligned}$$

Tegangan, Regangan, dan Modulus Elastisitas Yield

$$\begin{aligned}P &= \text{Beban Yield (kg)} \times \text{gravitasi (m/s}^2\text{)} \\P &= 79,4 \text{ kg} \times 9,81 \text{ m/s}^2 \\P &= 778,91 \text{ N}\end{aligned}$$

$$\begin{aligned}\sigma &= \frac{P}{A} \\ \sigma &= \frac{778,91 \text{ N}}{75 \text{ mm}^2} \\ \sigma &= 10,39 \text{ N/mm}^2 \\ \sigma &= 10,39 \text{ MPa}\end{aligned}$$

$$\begin{aligned}\varepsilon &= \frac{\Delta L}{L_0} \\ \varepsilon &= \frac{2,5 \text{ mm}}{110 \text{ mm}^2} \times 100\% \\ \varepsilon &= 2,27 \%\end{aligned}$$

$$E = \frac{\sigma}{\varepsilon}$$
$$E = \frac{10,39 \text{ MPa}}{0,0227}$$
$$E = 456,96 \text{ MPa}$$

Spesimen 3

$$P = \text{Beban maksimum (kg)} \times \text{gravitasi (m/s}^2\text{)}$$
$$P = 69,4 \text{ kg} \times 9,81 \text{ m/s}^2$$
$$P = 680,81 \text{ N}$$

$$A = \text{lebar} \times \text{tebal}$$
$$A = 25 \text{ mm} \times 3 \text{ mm}$$
$$A = 75 \text{ mm}^2$$

$$\sigma = \frac{P}{A}$$
$$\sigma = \frac{680,81 \text{ N}}{75 \text{ mm}^2}$$
$$\sigma = 9,08 \text{ N/mm}^2$$
$$\sigma = 9,08 \text{ MPa}$$

$$\varepsilon = \frac{\Delta L}{L_0}$$
$$\varepsilon = \frac{0,93 \text{ mm}}{110 \text{ mm}^2} \times 100\%$$
$$\varepsilon = 0,85 \%$$

Tegangan, Regangan, dan Modulus Elastisitas Yield

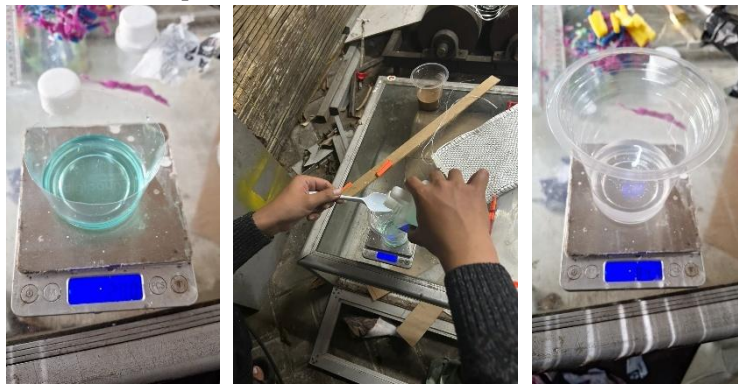
$$P = \text{Beban Yield (kg)} \times \text{gravitasi (m/s}^2\text{)}$$
$$P = 79,4 \text{ kg} \times 9,81 \text{ m/s}^2$$
$$P = 778,91 \text{ N}$$

$$\sigma = \frac{P}{A}$$
$$\sigma = \frac{778,91 \text{ N}}{75 \text{ mm}^2}$$
$$\sigma = 10,39 \text{ N/mm}^2$$
$$\sigma = 10,39 \text{ MPa}$$

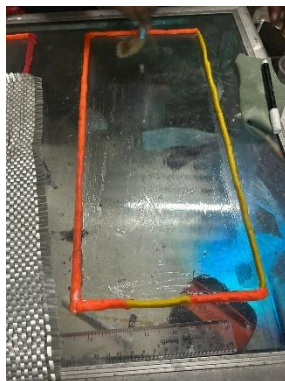
$$\begin{aligned}\varepsilon &= \frac{\Delta L}{L_0} \\ \varepsilon &= \frac{1,16 \text{ mm}}{110 \text{ mm}^2} \times 100\% \\ \varepsilon &= 1,05 \%\end{aligned}$$

$$\begin{aligned}E &= \frac{\sigma}{\varepsilon} \\ E &= \frac{10,39 \text{ MPa}}{0,0105} \\ E &= 984,83 \text{ MPa}\end{aligned}$$

6. Proses Pembuatan Komposit



Penimbangan resin dan hardener



Penataan cetakan dan pelapisan wax



Penataan serat fiberglass ke dalam cetakan



Pengolesan resin dan hardener pada komposit



Komposit setelah dilakukan proses hand lay up



Pemotongan spesimen



Spesimen uji bending dan uji tarik