

## LAMPIRAN

### Menentukan Fraksi Volume

Berat komposit ( $W_c$ ) : 80,67 g/cm<sup>3</sup>

Berat serat ( $W_f$ ) : 23,22 g/cm<sup>3</sup>

Volume : 20 x 20 g/cm<sup>3</sup>

Tebal : 0,17 mm

Berat matriks : 1,2 g/cm<sup>3</sup>

P fiber : 1,4 g/cm<sup>3</sup>

$$V_c = 20 \times 20 \times 0,17$$

$$= 68 \text{ g/cm}^3$$

$$\rho_c = \frac{W_c}{V_c} = \frac{80,67}{68} = 1,18 \text{ g/cm}^3$$

$$V_v = 1 - \left\{ \frac{(23,22 \div 1,4) + (80,67 - 23,22) \div 1,2}{(80,67 \div 1,18)} \right\}$$

$$V_v = 1 - \left\{ \frac{(16,58) + (47,87)}{(68,36)} \right\}$$

$$V_v = 1 - \left\{ \frac{(64,45)}{68,36} \right\} = 1 - (0,942)$$

$$V_v = 0,058 \times 100\%$$

$$V_v = 5,8\% \text{ (Porous/Void)}$$

$$V_v + V_m + V_f = 1$$

$$0,058 + V_m + V_f = 1$$

$$V_m = (1 - 0,058) - V_f$$

$$V_m = 0,942 - V_f$$

$$e_c = e_f \times V_f + e_m \times V_m$$

$$1,18 = 1,4 \times V_f + 1,2 (0,942 - V_f)$$

$$1,18 = 1,4 V_f - 1,2 V_f + 1,130$$

$$1,18 - 1,13 = 0,2 V_f$$

$$0,005 = 0,2 V_f$$

$$V_f = \frac{0,05}{0,2} = 0,25 \times 100\% = 25 \%$$

$$V_v + V_m + V_f = 100$$

$$5,8\% + V_m + V_f = 100$$

$$V_m + 25 + 5,8 = 100$$

$$V_m + 30,8 = 100$$

$$V_m = 69,2$$

### Raw Material

No	Kode Spesimen	Kekuatan tarik (Mpa)	Regangan (%)	Modulus Elastis (Gpa)
1	C1	13,23	0,23	5,75
2	C2	18,42	0,35	5,26
3	C3	14,89	0,41	3,62
4	C4	14,11	0,47	3,00

### Alkali Material

No	Kode Spesimen	Kekuatan tarik (Mpa)	Regangan (%)	Modulus Elastis (Gpa)
1	B1	30,24	1,13	2,67
2	B2	23,81	0,77	3,09
3	B3	30,96	0,65	4,76
4	B4	31,94	0,59	5,41

### Bleaching Material

No	Kode Spesimen	Kekuatan tarik (Mpa)	Regangan (%)	Modulus Elastis (Gpa)
1	A1	15,19	0,47	3,23
2	A2	21,85	0,70	3,12
3	A3	29,30	0,71	4,12
4	A4	23,81	0,53	4,49

### Bleaching pH 10

No	Kode Spesimen	Kekuatan tarik (Mpa)	Regangan (%)	Modulus Elastis (Gpa)
1	X1	28,50	0,54	5,27
2	X2	33,40	0,66	5,06
3	X3	37	0,78	4,74
4	X4	28,50	0,60	4,75

## Perhitungan uji tarik raw material

### C1

$$A = t \times L$$

$$= 3,0 \times 15,8$$

$$= 47,4 \text{ mm}^2$$

Tegangan

$$F = \frac{3,2}{100} \times 2000 = 64 \text{ kg}$$

$$\sigma = \frac{F}{A} = \frac{64}{47,4} = 1,35 \text{ kg/mm}^2$$

$$= 1,35 \times 9,8 \text{ m/s}^2$$

$$= 13,23 \text{ MPa}$$

### C2

$$A = t \times L$$

$$= 2,90 \times 15,00$$

$$= 43,5 \text{ mm}^2$$

Tegangan

$$F = \frac{4,1}{100} \times 2000 = 82 \text{ kg}$$

$$\sigma = \frac{F}{A} = \frac{82}{43,5} = 1,88 \text{ kg/mm}^2$$

$$= 1,88 \times 9,8 \text{ m/s}^2$$

$$= 18,42 \text{ MPa}$$

### C3

$$A = t \times L$$

$$= 2,90 \times 16,30$$

$$= 47,27 \text{ mm}^2$$

Regangan

$$e = \frac{\Delta l}{l_0} = \frac{l_i - l_0}{l_0} \times 100 \%$$

$$= \frac{168,2 - 167,8}{167,8} \times 100 \%$$

$$= \frac{0,4}{167,8} \times 100 \%$$

$$= 0,23 \%$$

Modulus elastis

$$E = \frac{\sigma}{e} = \frac{13,23}{0,23\%}$$

$$= 5,75 \text{ GPa}$$

Regangan

$$e = \frac{\Delta l}{l_0} = \frac{l_i - l_0}{l_0} \times 100 \%$$

$$= \frac{168,1 - 167,5}{167,5} \times 100 \%$$

$$= 0,35 \%$$

Modulus elastis

$$E = \frac{\sigma}{e} = \frac{18,42}{0,35\%}$$

$$= 5,26 \text{ GPa}$$

Regangan

$$e = \frac{\Delta l}{l_0} = \frac{l_i - l_0}{l_0} \times 100 \%$$

$$= \frac{169,3 - 168,6}{168,6} \times 100 \%$$

$$= 0,41 \%$$

Tegangan

$$F = \frac{3,6}{100} \times 2000 = 72 \text{ kg}$$

$$\sigma = \frac{F}{A} = \frac{72}{47,27} = 1,52 \text{ kg/mm}^2$$

$$= 1,52 \times 9,8 \text{ m/s}^2$$

$$= 14,89 \text{ MPa}$$

Modulus elastis

$$E \frac{\sigma}{e} = \frac{14,89}{0,41 \%$$

$$= 3,63$$

**C4**

$$A = t \times L$$

$$= 2,95 \times 15,9$$

$$= 46,9 \text{ mm}^2$$

Regangan

$$e = \frac{\Delta l}{l_0} = \frac{l_i - l_0}{l_0} \times 100 \%$$

$$= \frac{168,8 - 168}{168} \times 100\%$$

$$= 0,47 \%$$

Tegangan

$$F = \frac{3,4}{100} \times 2000 = 68 \text{ kg}$$

$$\sigma = \frac{F}{A} = \frac{68}{46,9} = 1,44 \text{ kg/mm}^2$$

$$= 1,44 \times 9,8 \text{ m/s}^2$$

$$= 14,11 \text{ MPa}$$

Modulus elastis

$$E \frac{\sigma}{e} = \frac{14,11}{0,47\%$$

$$= 3,00 \text{ GPa}$$

**Perhitungan uji tarik alkali komposit**

**B1**

$$A = t \times L$$

$$= 2,65 \times 15,65$$

$$= 41,47$$

Regangan

$$e = \frac{\Delta l}{l_0} = \frac{l_i - l_0}{l_0} \times 100 \%$$

$$= \frac{168,9 - 167}{167} \times 100\%$$

$$= 1,13 \%$$

Tegangan

$$F = \frac{6,4}{100} \times 2000 = 128 \text{ kg}$$

$$\sigma = \frac{F}{A} = \frac{128}{41,47} = 3,08 \text{ kg/mm}^2$$

$$= 3,08 \times 9,8 \text{ m/s}^2$$

Modulus elastis

$$E \frac{\sigma}{e} = \frac{30,24}{1,13\%$$

$$= 2,67 \text{ GPa}$$

$$= 30,24 \text{ MPa}$$

## B2

$$A = t \times L$$

$$= 2,9 \times 14,7$$

$$= 42,63 \text{ mm}^2$$

Tegangan

$$F = \frac{5,2}{100} \times 2000 = 104 \text{ kg}$$

$$\sigma = \frac{F}{A} = \frac{104}{42,63} = 2,43 \text{ kg/mm}^2$$

$$= 2,43 \times 9,8 \text{ m/s}^2$$

$$= 23,81 \text{ MPa}$$

## B3

$$A = t \times L$$

$$= 2,5 \times 14,9$$

$$= 37,25 \text{ mm}^2$$

Tegangan

$$F = \frac{5,9}{100} \times 2000 = 118 \text{ kg}$$

$$\sigma = \frac{F}{A} = \frac{118}{37,25} = 3,16 \text{ kg/mm}^2$$

$$= 3,16 \times 9,8 \text{ m/s}^2$$

$$= 30,96 \text{ MPa}$$

## B4

$$A = t \times L$$

$$= 2,7 \times 14,5$$

$$= 39,15 \text{ mm}^2$$

Regangan

$$e = \frac{\Delta l}{l_0} = \frac{l_i - l_0}{l_0} \times 100 \%$$

$$= \frac{168,7 - 167,4}{167,4} \times 100\%$$

$$= 0,77 \%$$

Modulus elastis

$$E \frac{\sigma}{e} = \frac{23,81}{0,77\%}$$

$$= 3,09$$

Regangan

$$e = \frac{\Delta l}{l_0} = \frac{l_i - l_0}{l_0} \times 100 \%$$

$$= \frac{169,1 - 168}{168} \times 100\%$$

$$= 0,65 \%$$

Modulus elastis

$$E \frac{\sigma}{e} = \frac{30,96}{0,65\%}$$

$$= 4,76 \text{ GPa}$$

Regangan

$$e = \frac{\Delta l}{l_0} = \frac{l_i - l_0}{l_0} \times 100 \%$$

$$= \frac{169,9 - 168,9}{168,9} \times 100\%$$

$$= 0,59 \%$$

Tegangan

$$F = \frac{6,4}{100} \times 2000 = 128 \text{ kg}$$

$$\sigma = \frac{F}{A} = \frac{128}{39,15} = 3,26 \text{ kg/mm}^2$$

$$= 3,26 \times 9,8 \text{ m/s}^2$$

$$= 31,94 \text{ MPa}$$

Modulus elastis

$$E \frac{\sigma}{e} = \frac{31,94}{0,59\%}$$

$$= 5,41 \text{ GPa}$$

### Perhitungan uji tarik *alkali bleaching* komposit

#### A1

$$A = t \times L$$

$$= 2,6 \times 16,85$$

$$= 43,81 \text{ mm}^2$$

Regangan

$$e = \frac{\Delta l}{l_0} = \frac{l_i - l_0}{l_0} \times 100 \%$$

$$= \frac{170 - 169,2}{169,2} \times 100\%$$

$$= 0,47 \%$$

Tegangan

$$F = \frac{3,4}{100} \times 2000 = 68 \text{ kg}$$

$$\sigma = \frac{F}{A} = \frac{68}{43,81} = 1,55 \text{ kg/mm}^2$$

$$= 1,55 \times 9,8 \text{ m/s}^2$$

$$= 15,19 \text{ MPa}$$

Modulus elastis

$$E \frac{\sigma}{e} = \frac{15,19}{0,47\%}$$

$$= 3,23, \text{ GPa}$$

#### A2

$$A = t \times L$$

$$= 2,6 \times 16,20$$

$$= 42,12 \text{ mm}^2$$

Regangan

$$e = \frac{\Delta l}{l_0} = \frac{l_i - l_0}{l_0} \times 100 \%$$

$$= \frac{171,1 - 169,9}{169,9} \times 100\%$$

$$= 0,70 \%$$

Tegangan

$$F = \frac{4,7}{100} \times 2000 = 94 \text{ kg}$$

$$\sigma = \frac{F}{A} = \frac{94}{42,12} = 2,23 \text{ kg/mm}^2$$

$$= 2,23 \times 9,8 \text{ m/s}^2$$

$$= 21,85 \text{ MPa}$$

Modulus elastis

$$E \frac{\sigma}{e} = \frac{21,85}{0,70\%}$$

$$= 3,12 \text{ GPa}$$

### A3

$$A = t \times L$$

$$= 2,5 \times 16,85$$

$$= 42,12 \text{ mm}^2$$

Tegangan

$$F = \frac{6,3}{100} \times 2000 = 126 \text{ kg}$$

$$\sigma = \frac{F}{A} = \frac{126}{42,12} = 2,99 \text{ kg/mm}^2$$

$$= 2,99 \times 9,8 \text{ m/s}^2$$

$$= 29,30 \text{ MPa}$$

### A4

$$A = t \times L$$

$$= 2,6 \times 16,10$$

$$= 41,86 \text{ mm}^2$$

Tegangan

$$F = \frac{5,1}{100} \times 2000 = 102 \text{ kg}$$

$$\sigma = \frac{F}{A} = \frac{102}{41,86} = 2,43 \text{ kg/mm}^2$$

$$= 2,43 \times 9,8 \text{ m/s}^2$$

$$= 23,81 \text{ MPa}$$

### Perhitungan uji tarik *bleaching* pH 10

#### X1

$$A = t \times L$$

$$= 2,6 \times 12,73$$

$$= 33 \text{ mm}^2$$

Regangan

$$e = \frac{\Delta l}{l_0} = \frac{l_i - l_0}{l_0} \times 100 \%$$

$$= \frac{169,5 - 168,3}{168,3} \times 100\%$$

$$= 0,71 \%$$

Modulus elastis

$$E \frac{\sigma}{e} = \frac{29,30}{0,71\%}$$

$$= 4,12 \text{ GPa}$$

Regangan

$$e = \frac{\Delta l}{l_0} = \frac{l_i - l_0}{l_0} \times 100 \%$$

$$= \frac{169,2 - 168,3}{168,3} \times 100\%$$

$$= 0,53 \%$$

Modulus elastis

$$E \frac{\sigma}{e} = \frac{23,81}{0,53\%}$$

$$= 4,49 \text{ GPa}$$

Regangan

$$e = \frac{\Delta l}{l_0} = \frac{l_i - l_0}{l_0} \times 100 \%$$

$$= \frac{166,4 - 165,5}{165,5} \times 100\%$$

$$= 0,54 \%$$

Tegangan

$$F = \frac{4,8}{100} \times 2000 = 96 \text{ kg} \times 9,8 = 940,8 \text{ kg/mm}^2$$

$$\sigma = \frac{F}{A} = \frac{940,8}{33} = 28,50 \text{ MPa}$$

Modulus elastis

$$E \frac{\sigma}{e} = \frac{28,50}{0,54\%}$$
$$= 5,27 \text{ Gpa}$$

**X2**

$$A = t \times L$$

$$= 2,65 \times 13,30$$

$$= 35,2 \text{ mm}^2$$

Regangan

$$e = \frac{\Delta l}{l_0} = \frac{l_i - l_0}{l_0} \times 100 \%$$

$$= \frac{166,7 - 165,6}{165,5} \times 100\%$$

$$= 0,66 \%$$

Tegangan

$$F = \frac{6}{100} \times 2000 = 120 \text{ kg} \times 9,8 = 1176 \text{ kg/mm}^2$$

$$\sigma = \frac{F}{A} = \frac{1176}{35,2} = 33,40 \text{ MPa}$$

Modulus elastis

$$E \frac{\sigma}{e} = \frac{33,40}{0,66\%}$$
$$= 5,06 \text{ Gpa}$$

**X3**

$$A = t \times L$$

$$= 2,60 \times 12,80$$

$$= 33,3 \text{ mm}^2$$

Regangan

$$e = \frac{\Delta l}{l_0} = \frac{l_i - l_0}{l_0} \times 100 \%$$

$$= \frac{167,1 - 165,8}{165,8} \times 100\%$$

$$= 0,78 \%$$

Tegangan

$$F = \frac{6,3}{100} \times 2000 = 126 \text{ kg} \times 9,8 = 1234 \text{ kg/mm}^2$$

$$\sigma = \frac{F}{A} = \frac{1234}{33,3} = 37 \text{ MPa}$$



Modulus elastis

$$E \frac{\sigma}{e} = \frac{37}{0,78 \%}$$
$$= 4,74 \text{ Gpa}$$

**X4**

$$A = t \times L$$

$$= 2,62 \times 12,60$$

$$= 33 \text{ mm}^2$$

Regangan

$$e = \frac{\Delta l}{l_0} = \frac{l_i - l_0}{l_0} \times 100 \%$$

$$= \frac{166,75 - 165,8}{165,8} \times 100\%$$

$$= 0,60 \%$$

Tegangan

$$F = \frac{4,8}{100} \times 2000 = 96 \text{ kg} \times 9,8 = 940,8 \text{ kg/mm}^2$$

$$\sigma = \frac{F}{A} = \frac{940,8}{33} = 28,50 \text{ MPa}$$

Modulus elastis

$$E \frac{\sigma}{e} = \frac{28,50}{0,60 \%}$$

$$= 4,75 \text{ Gpa}$$

### Menentukan densitas komposit

$$\rho = \frac{m}{v}$$

### Bleaching

$$A1 \frac{1,04}{4,9} = 0,21 \quad A2 \frac{1,01}{5} = 0,20 \quad A3 \frac{1,01}{4,9} = 0,21 \quad A4 \frac{1,16}{4,88} = 0,21$$

### Alkali

$$B1 \frac{1,16}{5,3} = 0,21 \quad B2 \frac{1,08}{5,8} = 0,18 \quad B3 \frac{1,03}{5} = 0,20 \quad B4 \frac{1,00}{5,4} = 0,18$$

### Raw

$$C1 \frac{0,81}{6} = 0,13 \quad C2 \frac{0,89}{5,8} = 0,15 \quad C3 \frac{0,82}{5,8} = 0,14 \quad C4 \frac{0,78}{5,9} = 0,13$$

### Perhitungan proses alkali (NaOH)

Konsentrasi NaOH 5 %

Berat Molekul = 20,34 (20 gr/mol)

Densitas = 1,45 gr/cm<sup>3</sup>

Kemurnian larutan 48,24 %

$$M2 \text{ 5 NaOH} = \frac{10 \times 1,45 \times 5}{20}, M2 = 3,62$$

$$M1 \text{ 48,24 \%} = \frac{10 \times 48,24 \times 1,45}{20}, M1 = 34,97$$

$$M1 \cdot V1 = M2 \cdot V2$$

$$34,97 \cdot V1 = 3,62 \cdot 4000$$

$$V1 = \frac{14480}{34,97} = 414,06 \text{ (207 ml)}$$

### Perhitungan proses bleaching

NaOH = 0,25 %

Kemurnian = 48,24 %

$$M2 = \frac{10 \times 0,25 \times 1,45}{20}, M2 = 0,18$$

$$M1 = \frac{10 \times 48,24 \times 1,45}{20}, M1 = 34,97$$

$$M1 \cdot V1 = M2 \cdot V2$$

$$34,97 \cdot V1 = 0,18 \cdot 4000$$

$$V1 = \frac{720}{34,97} = 20,58 \text{ ml}$$

V1 = 20,58 ml NaOH : 4000 ml air



Konsentrasi  $\text{H}_2\text{O}_2 = 3 \%$

Densitas =  $1,45 \text{ gr/cm}^3$

Berat molekul =  $34 \text{ gr/mol}$

$$M1 = \frac{10 \times 50 \times 1,45}{34}, M1 = 21,32$$

$$M2 = \frac{10 \times 3 \times 1,45}{34}, M2 = 1,27$$

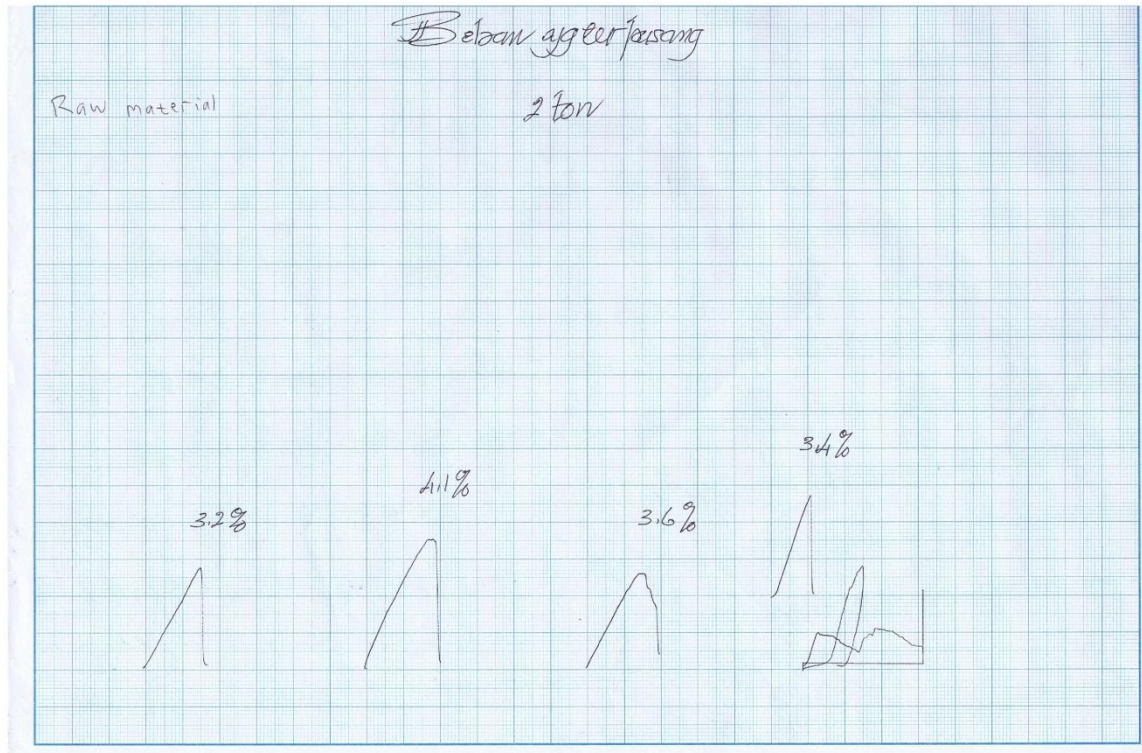
$$M1 \cdot V1 = M2 \cdot V2$$

$$21,32 \cdot V1 = 1,27 \cdot 4000$$

$$V1 = \frac{5080}{21,32}, V1 = 238,27 \text{ ml}$$

230,27 ml  $\text{H}_2\text{O}_2$  : 4000 ml air

Tabel Data Hasil Pengujian Tarik Dari Laboratorium Bahan Teknik,  
Universitas Gadjah Mada



Alkali Bleaching

