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SURAT KETERANGAN

No : /Lab Bahan Teknik/DTMI/UGM/2017

Kami selaku pengelola Laboratorium Bahan Teknik Departemen Teknik Mesin dan Industri Universitas Gadjah Mada menerangkan bahwa mahasiswa tersebut di bawah ini :

Nama	**: Lutfi Nafian Lunawan**
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Fakultas	**:Program Vokasi, Universitas Muhammadiyah Yogyakarta**

Telah bebas dari segala tanggungan di laboratorium kami, dan telah selesai melakukan penelitian dengan judul :

"Analisis Kekuatan Tarik Komposit Hybrid Lamina Serat Anyam Rami dan Gelas diperkuat Polyester "

Demikian surat keterangan ini dibuat dengan sebenar – benarnya, untuk dimanfaatkan sebagaimana mestinya.

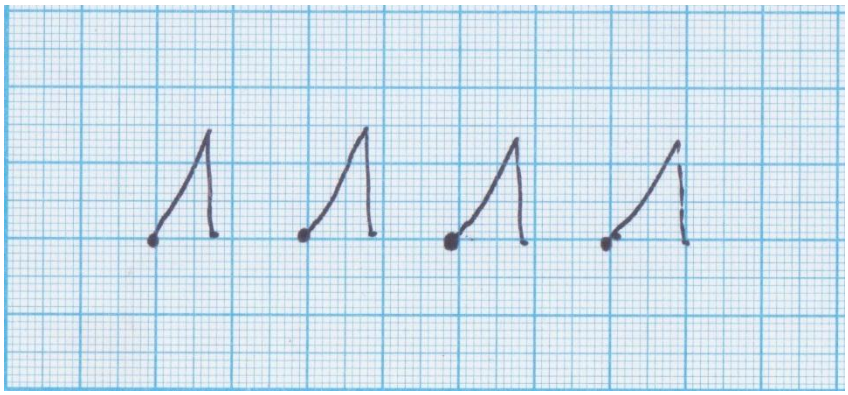
Yogyakarta, 10 Juli 2017
Teknisi Laboratorium
Bahan Teknik UGM

Sunhaji
196506041986121001

LAMPIRAN II

Hasil perhitungan Uji Tarik pada keempat variasi.

Perhitungan pengujian tarik pada spesimen komposit *hybrid* berserat anyam rami dan gelas acak (A).



1. Spesimen A1

   Diketahui :

   Tebal spesimen (t) = 2,83 mm F = 1850 N

   Lebar spesimen (L) = 13,43 mm Panjang akhir (L_1) = 167 mm

   Panjang awal (Lo) = 166 mm Beban = 2 ton

   a. Luas penampang spesimen A1

      A = t x L

      = 2,83 x 13,43

      = 38,0065 mm^2

b. Regangan spesimen A1

$$\varepsilon = \frac{\Delta L}{Lo} \text{ x } 100$$

$$\varepsilon = \frac{L1 - Lo}{Lo} \text{ x } 100$$

$$\varepsilon = \frac{1}{166} \text{ x } 100 = 0{,}602\ \%$$

c. Tegangan spesimen A1

F = 1850 N

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

$$= \frac{1850}{38{,}0065} = 48{,}675\ Mpa$$

d. Modulus elastisitas spesimen A1

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

$$= \frac{48{,}675}{0{,}00602}$$

$$= 8085{,}548\ Mpa$$

$$= 8{,}086\ Gpa$$

2. Spesimen A2

Diketahui :

Tebal spesimen (t) = 2,75 mm

Lebar spesimen (L) = 14,12 mm

Panjang awal (Lo) = 165 mm

F = 2020 N

Panjang akhir (L_1) = 166 mm

Beban = 2 ton

a. Luas penampang spesimen A2

A = t x L

= 2,75 x 14,12

= 38,83 mm^2

b. Regangan spesimen A2

$$\varepsilon = \frac{\Delta L}{Lo} \text{ x } 100$$

$$\varepsilon = \frac{L1 - Lo}{Lo} \text{ x } 100$$

$$\varepsilon = \frac{1}{165} \text{ x } 100 = 0{,}606\ \%$$

d. Tegangan spesimen A2

F = 2,02 KN

= 2020 N

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

$$= \frac{2020}{38{,}83} = 52{,}021\ Mpa$$

e. Modulus elastisitas spesimen A2

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

$$= \frac{52{,}021}{0{,}00606}$$

$$= 8584{,}323\ Mpa$$

$$= 8{,}584\ \text{Gpa}$$

3. Spesimen A3

Diketahui :

Tebal spesimen (t) = 2,78 mm

Lebar spesimen (L) = 13,25 mm

Panjang awal (Lo) = 167 mm

F = 1740 N

Panjang akhir (L_1) = 168 mm

Beban = 2 ton

a. Luas penampang spesimen A3

A = t x L

= 2,78 x 13,25

= 36,825 mm^2

b. Regangan spesimen A3

$$\varepsilon = \frac{\Delta L}{Lo} \text{ x } 100$$

$$\varepsilon = \frac{L1 - Lo}{Lo} \text{ x } 100$$

$$\varepsilon = \frac{1}{167} \text{ x } 100 = 0{,}598\ \%$$

c. Tegangan spesimen A3

F = 1,74 KN

= 1740 N

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

$$= \frac{1740}{36{,}825} = 47{,}250\ Mpa$$

d. Modulus elastisitas spesimen A3

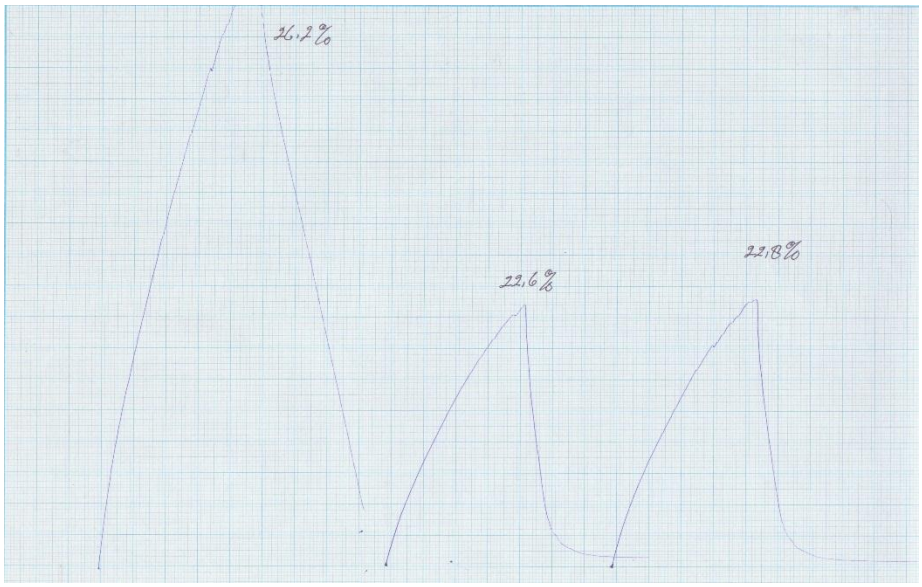
$$E = \frac{\sigma}{\varepsilon}$$

$$= \frac{47{,}250}{0{,}00598}$$

$= 7901{,}337\ Mpa$

$= 7{,}901\ Gpa$

Perhitungan pengujian tarik pada spesimen komposit *hybrid* berserat anyam rami dan gelas anyam (B).



1. Spesimen B1

Diketahui :

Tebal spesimen (t) = 2,90 mm

Lebar spesimen (L) = 15,80 mm

Panjang awal (Lo) = 163 mm

F = 5135,2 N

Panjang akhir (L_1) = 164 mm

Beban = 2 ton

a. Luas penampang spesimen B1

A = t x L

= 2,90 x 15,80

= 45,82 mm^2

b. Regangan spesimen B1

$$\varepsilon = \frac{\Delta L}{Lo} \text{ x } 100$$

$$\varepsilon = \frac{L1 - Lo}{Lo} \text{ x } 100$$

$$\varepsilon = \frac{1}{163} \text{ x } 100 = 0{,}613\ \%$$

c. Tegangan spesimen B1

F = 5135,2 N

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

$$= \frac{5135{,}2}{45{,}82} = 112{,}073\ Mpa$$

d. Modulus elastisitas spesimen B1

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

$$= \frac{112{,}073}{0{,}00613}$$

$$= 18282{,}707\ Mpa$$

$$= 18{,}282\ Gpa$$

2. Spesimen B2

Diketahui :

Tebal spesimen (t) = 2,85 mm

Lebar spesimen (L) = 15,15 mm

Panjang awal (Lo) = 166 mm

F = 4429,6 N

Panjang akhir (L_1) = 167 mm

Beban = 2 ton

a. Luas penampang spesimen B2

A = t x L

= 2,85 x 15,15

= 43,176 mm^2

b. Regangan spesimen B2

$$\varepsilon = \frac{\Delta L}{Lo} \text{ x } 100$$

$$\varepsilon = \frac{L1 - Lo}{Lo} \text{ x } 100$$

$$\varepsilon = \frac{1}{166} \text{ x } 100 = 0{,}602\ \%$$

c. Tegangan spesimen B2

F = 4429,6 N

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

$$= \frac{4429{,}6}{43{,}176} = 102{,}5904\ Mpa$$

d. Modulus elastisitas spesimen B2

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

$$= \frac{102{,}5904}{0{,}00602}$$

$$= 17041{,}594\ Mpa$$

$$= 17{,}042\ Gpa$$

3. Spesimen B3

Diketahui :

Tebal spesimen (t) = 2,90 mm

Lebar spesimen (L) = 15,50 mm

Panjang awal (Lo) = 162 mm

F = 4468,8 N

Panjang akhir (L_1) = 163 mm

Beban = 2 ton

a. Luas penampang spesimen B3

A = t x L

= 2,90 x 15,4

= 44,66 mm^2

b. Regangan spesimen B3

$$\varepsilon = \frac{\Delta L}{Lo} \text{ x } 100$$

$$\varepsilon = \frac{L1 - Lo}{Lo} \text{ x } 100$$

$$\varepsilon = \frac{1}{162} \text{ x } 100 = 0{,}617\ \%$$

c. Tegangan spesimen B3

F = 4468,8 N

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

$$= \frac{4468{,}8}{44{,}66} = 100{,}063\ Mpa$$

d. Modulus elastisitas spesimen B3

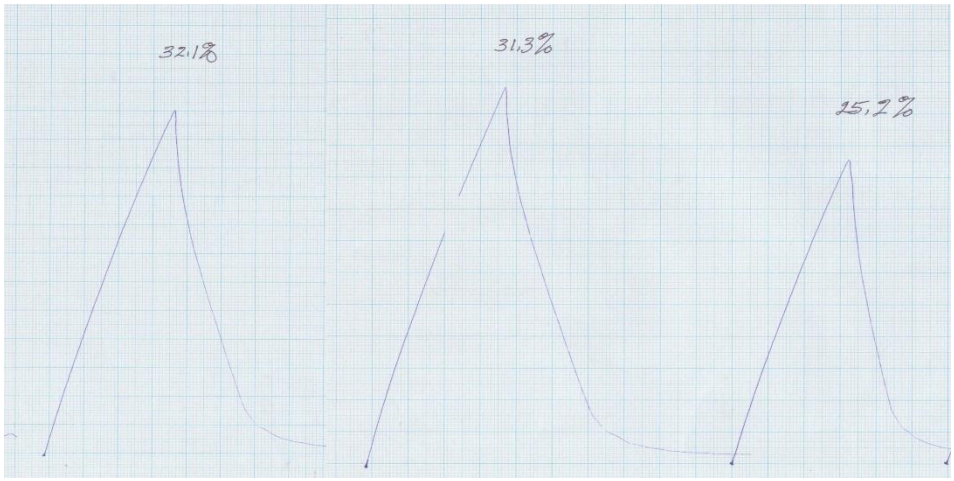
$$E = \frac{\sigma}{\varepsilon}$$

$$= \frac{100{,}063}{0{,}00617}$$

$$= 16217{,}617\ Mpa$$

$= 16{,}217\ Gpa$

Perhitungan pengujian tarik pada spesimen komposit *hybrid* berserat anyam rami dan gelas longitudinal (C).



1. Spesimen C1

Diketahui :

Tebal spesimen (t) = 2,73 mm

Lebar spesimen (L) = 14,74 mm

Panjang awal (Lo) = 162 mm

F = 6291,6 N

Panjang akhir (L_1) = 163 mm

Beban = 2 ton

a. Luas penampang spesimen C1

A = t x L

= 2,73 x 14,74

= 40,2402 mm^2

b. Regangan spesimen C1

$$\varepsilon = \frac{\Delta L}{Lo} \text{ x } 100$$

$$\varepsilon = \frac{L1 - Lo}{Lo} \text{ x } 100$$

$$\varepsilon = \frac{1}{162} \text{ x } 100 = 0{,}617\ \%$$

c. Tegangan spesimen C1

F = 4468,8 N

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

$$= \frac{6291{,}6}{40{,}2402} = 156{,}351\ Mpa$$

d. Modulus elastisitas spesimen C1

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

$$= \frac{156{,}351}{0{,}00617}$$

$$= 25340{,}518\ Mpa$$

$$= 25{,}340\ Gpa$$

2. Spesimen C2

Diketahui :

Tebal spesimen (t) = 2,63 mm

Lebar spesimen (L) = 14,91 mm

Panjang awal (Lo) = 166 mm

F = 6134,8 N

Panjang akhir (L_1) = 167 mm

Beban = 2 ton

a. Luas penampang spesimen C2

A = t x L

= 2,63 x 14,91

= 39,213 mm^2

b. Regangan spesimen C2

$$\varepsilon = \frac{\Delta L}{Lo} \times 100$$

$$\varepsilon = \frac{L1 - Lo}{Lo} \times 100$$

$$\varepsilon = \frac{1}{166} \times 100 = 0{,}602\ \%$$

c. Tegangan spesimen C2

F = 6134,8 N

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

$$= \frac{6134{,}8}{39{,}213} = 156{,}446\ Mpa$$

d. Modulus elastisitas spesimen C2

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

$$= \frac{156{,}446}{0{,}00602}$$

$$= 25987{,}707\ Mpa$$

$$= 25{,}987\ Gpa$$

3. Spesimen C3

Diketahui :

Tebal spesimen (t) = 2,70 mm Panjang awal (Lo) = 162 mm

Lebar spesimen (L) = 14,54 mm F = 4939,2 N

Panjang akhir (L_1) = 163 mm Beban = 2 ton

a. Luas penampang spesimen C3

A = t x L

= 2,70 x 14,54

= 39,258 mm^2

b. Regangan spesimen C3

$$\varepsilon = \frac{\Delta L}{Lo} \text{ x } 100$$

$$\varepsilon = \frac{L1 - Lo}{Lo} \text{ x } 100$$

$$\varepsilon = \frac{1}{162} \text{ x } 100 = 0{,}617\ \%$$

c. Tegangan spesimen C3

F = 4939,2 N

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

$$= \frac{4939{,}2}{39{,}258} = 125{,}813\ Mpa$$

d. Modulus elastisitas spesimen C3

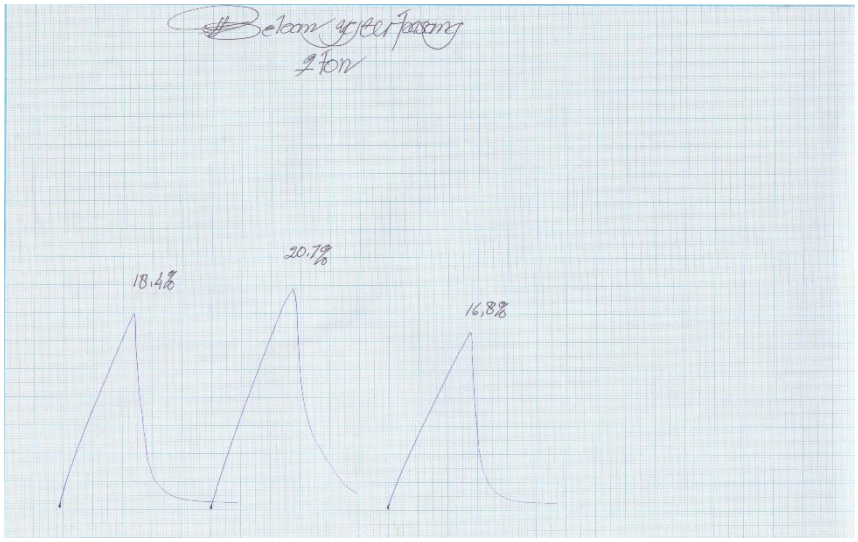
$$E = \frac{\sigma}{\varepsilon}$$

$$= \frac{125{,}813}{0{,}00617}$$

$$= 20391{,}223\ Mpa$$

$$= 20{,}391 Gpa$$

Perhitungan pengujian tarik pada spesimen komposit *hybrid* berserat anyam rami dan gelas longitudinal + acak (D).



1. Spesimen D1

Diketahui :

Tebal spesimen (t) = 2,66 mm

Lebar spesimen (L) = 15,86 mm

Panjang awal (Lo) = 161 mm

F = 3606,4 N

Panjang akhir (L_1) = 162 mm

Beban = 2 ton

a. Luas penampang spesimen D1

A = t x L

= 2,66 x 15,86

= 42,1876 mm^2

b. Regangan spesimen D1

$$\varepsilon = \frac{\Delta L}{Lo} \text{ x } 100$$

$$\varepsilon = \frac{L1 - Lo}{Lo} \text{ x } 100$$

$$\varepsilon = \frac{1}{161} \text{ x } 100 = 0{,}621\ \%$$

c. Tegangan spesimen D1

F = 3606,4 N

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

$$= \frac{3606{,}4}{42{,}1876} = 85{,}484\ Mpa$$

d. Modulus elastisitas spesimen D1

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

$$= \frac{85{,}484}{0{,}00621}$$

$$= 13765{,}539\ Mpa$$

$$= 13{,}765\ Gpa$$

2. Spesimen D2

Diketahui :

Tebal spesimen (t) = 2,71 mm

Lebar spesimen (L) = 15,32 mm

Panjang awal (Lo) = 161 mm

F = 4057,2 N

Panjang akhir (L_1) = 162 mm

Beban = 2 ton

a. Luas penampang spesimen D2

A = t x L

= 2,71 x 15,32

= 41,5172 mm^2

b. Regangan spesimen D2

$$\varepsilon = \frac{\Delta L}{Lo} \text{ x } 100$$

$$\varepsilon = \frac{L1 - Lo}{Lo} \text{ x } 100$$

$$\varepsilon = \frac{1}{161} \text{ x } 100 = 0{,}621\ \%$$

c. Tegangan spesimen D2

F = 4057,2 N

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

$$= \frac{4057{,}2}{41{,}5172} = 97{,}723\ Mpa$$

d. Modulus elastisitas spesimen D2

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

$$= \frac{97{,}723}{0{,}00621}$$

$$= 15736{,}392\ Mpa$$

$$= 15{,}736\ Gpa$$

3. Spesimen D3

Diketahui :

Tebal spesimen (t) = 2,63 mm Panjang awal (Lo) = 161 mm

Lebar spesimen (L) = 14,08 mm F = 3292,8 N

Panjang akhir (L_1) = 162 mm Beban = 2 ton

a. Luas penampang spesimen D3

A = t x L

= 2,63 x 14,08

= 37,0304 mm^2

b. Regangan spesimen D3

$$\varepsilon = \frac{\Delta L}{Lo} \text{ x } 100$$

$$\varepsilon = \frac{L1 - Lo}{Lo} \text{ x } 100$$

$$\varepsilon = \frac{1}{161} \text{ x } 100 = 0{,}621\ \%$$

c. Tegangan spesimen D3

F = 3292,8 N

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

$$= \frac{3292{,}8}{37{,}0304} = 88{,}921\ Mpa$$

d. Modulus elastisitas spesimen D3

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

$$= \frac{88{,}921}{0{,}00621}$$

$$= 14319{,}001\ Mpa$$

$$= 14{,}319\ Gpa$$

LAMPIRAN III

Perhitungan *moisture content*

Perhitungan *moisture content* pada serat anyam rami (A).

1. $\text{Mc (A)} = \frac{\text{Ma}-\text{Mb}}{\text{Ma}} \text{ x } 100\ \%$

$= \frac{16{,}05 - 14{,}56}{16{,}65} x100$

= 9,28 %

Perhitungan *moisture content* pada serat anyam rami (B).

2. $\text{Mc (B)} = \frac{\text{Ma}-\text{Mb}}{\text{Ma}} \text{ x } 100\ \%$

$= \frac{17{,}22 - 15{,}89}{17{,}22} x100$

$= 7{,}72\ \%$

Perhitungan *moisture content* pada serat anyam rami (C).

3. $\text{Mc (C)} = \frac{\text{Ma}-\text{Mb}}{\text{Ma}} \text{ x } 100\ \%$

$= \frac{16{,}72 - 15{,}59}{15{,}72} x100$

$= 6{,}75\ \%$

Perhitungan *moisture content* pada serat anyam rami (D).

4. $\text{Mc (D)} = \frac{\text{Ma}-\text{Mb}}{\text{Ma}} \text{ x } 100\ \%$

$= \frac{16{,}20 - 14{,}22}{16{,}22} x100$

$= 8{,}51\ \%$

LAMPIRAN IV

Perhitungan densitas bahan, fraksi void , fraksi volume serat dan fraksi volume matrik.

Keterangan :

a. *wf* = Berat Serat (gr)
b. wc = Berat Komposit (gr)
c. *wm* = Berat Matrik (gr)
d. ρf = Massa Jenis Serat (gr/cm³)
   Massa Jenis serat rami 1,6 gr/cm
e. ρc = Massa Jenis Komposit (gr/cm³)
f. ρm = Massa Jenis Matrik (gr/cm³)
   Massa jenis matrik polyester = 1,2 gr/cm^3
g. Vc = Volume Komposit (cm³)
h. Vf = Fraksi Volume Serat (%)
i. Vm = Fraksi Volume Matrik (%)
j. Vv = Fraksi Volume Void (%)

Perhitungan Fraksi Volume

diketahui :

Diket wc = 116,10 gr

V_c = 19,5 x 15,5 x 0,29 = 90,68 cm^3

Ditanya : ρ_c .....?

Jawab : $\rho_c = \frac{ma}{Va}$

$= \frac{116,10}{90,68}$

$= 1{,}28 \text{ gr/cm}^3$

1. Nilai Fraksi Void

$$V_V = 1 - \left[\frac{(wf/ef)+(Wc-Wf)/Pm}{(Wc/\rho c)}\right]$$

$$= 1 - \left[\frac{(32{,}56/1{,}6)+(116{,}10-32{,}56)/1{,}2}{(116{,}10/1{,}28)}\right]$$

$$= 1 - \left[\frac{(20{,}35)+(69{,}62)}{(90{,}68)}\right]$$

$$V_v = 1-0{,}9919 = 0{,}0081 = 0{,}81\ \%$$

2. Nilai Fraksi Volume Serat

Persamaan V_m = 0,9919 - V_f ke dalam persamaan :

$\rho c = \rho f \,.Vf + \rho m.Vm$

$1{,}28 = 1{,}6.V_f + 1{,}2\ (0{,}9919 - V_f)$

Sehingga nilai fraksi volume serat :

$1{,}28 = 1{,}6.V_f + 1{,}19028 - 1{,}2\ V_f$

$0{,}08972 = 1{,}6\ V_f - 1{,}2\ V_f$

$0{,}08972 = 0{,}4\ V_f$

$V_f = 0{,}2243 = 22{,}43\ \%$

3. Nilai Fraksi volume matriks

$$V_m = 1 - Vf - Vv$$

$$= 1 - 0{,}2243 - 0{,}0081$$

$$V_m = 0{,}7676 = 76{,}76\ \%$$

Perhitungan Densitas

A. Densitas bahan variasi A

1. Densitas Bahan

Diket m_a = 116,10 gr

$V_a = 19{,}5 \times 15{,}5 \times 0{,}29 = 90{,}68 \text{ cm}^3$

Ditanya : ρ_a .....?

Jawab : $\rho_a = \frac{ma}{Va}$

$= \frac{116,10}{90,68}$

$= 1,28 \text{ gr/cm}^3$

Keterangan :

m_a : Berat Komposit (gr)

V_a : Volume Komposit (cm^3)

ρ_a : Massa Jenis ($gram/cm^3$)

B. Densitas bahan variasi B

1. Diket $m_b = 119,32$ gr

$V_b = 19,5 \times 15,5 \times 0,285 = 86,141 \text{ cm}^3$

Ditanya : ρ_b .....?

Jawab : $\rho_b = \frac{mb}{Vb}$

$= \frac{119,32}{86,141}$

$= 1,38 \text{ gr/cm}^3$

Keterangan :

m_a : Berat Komposit (gr)

V_a : Volume Komposit (cm^3)

ρ_a : Massa Jenis ($gram/cm^3$)

C. Densitas bahan variasi C

1. Diket $m_c = 116,84$ gr

V_c = 19,5 x 15,5 x 0,27 = 81,61 cm^3

Ditanya : ρ_c .....?

Jawab : $\rho_c = \frac{mc}{Vc}$

$= \frac{116,84}{81,61}$

= 1,43 gr/cm^3

Keterangan :

m_a : Berat Komposit (gr)

V_a : Volume Komposit (cm^3)

ρ_a : Massa Jenis ($gram/cm^3$)

D. Densitas bahan variasi D

1. Diket m_d = 115,04 gr

V_d = 19,5 x 15,5 x 0,27 = 81,61 cm^3

Ditanya : ρ_d .....?

Jawab : $\rho_d = \frac{md}{Vd}$

$= \frac{115,04}{81,61}$

= 1,39 gr/cm^3

Keterangan :

m_a : Berat Komposit (gr)

V_a : Volume Komposit (cm^3)

ρ_a : Massa Jenis ($gram/cm^3$)

LAMPIRAN V

Berat molekul = 60,25 (60 gr/mol)

Konsentrasi = 5%

Densitas = 1,6 gr/cm3

Kemurnian larutan 48,24%

$$M2 \text{ 5\% NaOH} = \frac{10 \times 1{,}6 \times 5}{60}$$

$$M2 = 1{,}3$$

$$\text{M1 48,24 \%} = \frac{10 \times 48{,}24 \times 1{,}6}{60}$$

$$M1 = 12{,}864$$

$$\boldsymbol{M1.V1 = M2.V2}$$

$$12{,}864 \text{ .v1} = 1{,}3 \text{ . } 5000$$

$$\text{V1} = \frac{14480}{34{,}97}$$

$$\text{V1} = 505{,}3 \text{ (} 505 \textit{ ml} \text{)}$$

LAMPIRAN VI

Proses penenunan serat rami yang dilakukan di Desa wisata Gamplong, Godean, Wates, Yogyakarta.

Alat Penenun

Proses Penenunan Serat Rami

Hasil Tenunan Sebelum dipotong