## DAFTAR PUSTAKA

Ã, Mazharul Islam, David S Ting, and Amir Fartaj. 2008. “Aerodynamic Models for Darrieus-Type Straight-Bladed Vertical Axis Wind Turbines” 12: 1087– 1109. https://doi.org/10.1016/j.rser.2006.10.023.

Adlie, Taufan Arif, and Teuku Azuar Rizal. 2015. “Perancangan Turbin Angin Sumbu Horizontal 3 Sudu Dengan Daya Output 1 KW.”

Aji, Wahyono. 2018. “Analisa Kekuata Tekan Dan Pengaruh Ketebalan Pada Profil ‘I’ Bhan Material Komposit Yang Di Perkuat Serat Eceng Gondok.”

Ajithram, A A, J T Winowlin Jappes A, and N C Brintha B. 2020. “Materi Hari Ini : Prosiding Eceng Gondok ( Eichhornia Crassipes ) Metode Dan Sifat Ekstraksi Komposit Alami – Tinjauan,” no. xxxx. https://doi.org/10.1016/j.matpr.2020.08.472.

Aswan, Din, and Amran Ritonga. 2020. “Analisa Sifat Mekanik Komposit Uji Bending” 8 (2): 100–104.

Dewi, Marizka Lustia. 2010. “Analisis Kinerja Turbin Angin Poros Vertikal Dengan Modifikasi Rotor Savonius L Untuk.”

Diana, Lohdy, Arrad Ghani Safitra, and Muhammad Nabiel Ariansyah. 2020. “Analisis Kekuatan Tarik Pada Material Komposit Dengan Serat Penguat Polimer” 4 (2): 59–67.

Idris, Ahmad Rosyid, Fischer Siampa, Nirwan A Noor, and Sarma Thaha. n.d. “Rancang Bangun Pembangkit Listrik Tenaga Bayu Sumbu Vertikal,” 28– 34.

Inovasi, Jurnal, Sains Dan, Teknologi Kelautan, and Bahan Pembuatan Kapal.

2021. “Zona Laut” 2 (2): 26–32.

Jureczko, Mariola, and Maciej Mrówka. 2022. “Multiobjective Optimization of Composite Wind Turbine Blade.” *Materials* 15 (13). https://doi.org/10.3390/ma15134649.

Khotimah, Fia Khusnul. 2018. *Analisis Serat Eceng Gondok Dan HDPE ( High Density Polyetylene ) Sebagai Material Alternatif Pada Lambung Kapal*.

Nayiroh, Nurun. 2013. “Teknologi Matrial Komposit.”

Nugroho, M I Putra G. 2021. “Pengaruh Curing Time Terhadap Sifat Mekanis Komposit Epoxy / Carbon Fiber Dan Epoxy / Glass Fiber Dengan Metode Manufaktur Bladder Compression Moulding” 3 (1): 20–28.

Rusnoto. 2020. “PEMANFAATAN SERBUK POHON TEBU PADA MATERIAL” 1 (1): 8–14.

Rusnoto Mesin, Prodi Teknik, Fakultas Teknik, and Universitas Pancasakti. 2018. “Studi Pengaruh Panjang Serat Bambu Pada Kekuatan Impak Komposit Matrik Polyester.”

Ruzuqi, Rezza. 2021. “ANALISIS KEKUATAN TARIK DAN IMPAK MATERIAL KOMPOSIT POLIMER DALAM APLIKASI FIBERBOAT,” 121–26.

Sampurna, Agrippina Faiz, Fery Setiawan, Edi Sofyan, Sekolah Tinggi, and Teknologi Kedirgantaraan. n.d. “Pengujian Karakteristik Uji Impact Material Komposit Matriks Resin Polyester Campur Serat Pisang Dan Pasir” 8 (2): 274–80.

Sulardjaka, S A, N A Iskandar, Sri Nugroho A, A A Alamsyah, and A Prasetyaku. 2022. “Heliyon Karakterisasi Serat Eceng Gondok Searah Dan Anyaman Yang Diperkuat Dengan Komposit Resin Epoksi” 8. https://doi.org/10.1016/j.heliyon.2022.e10484.

## LAMPIRAN

### Lampiran 1. Perhitungan Hasil Pengujian

1. Pengujina Tarik

𝑆𝑝𝑒𝑠𝑖𝑚𝑒𝑛 𝑢𝑗𝑖 𝑡𝑎𝑟𝑖𝑘 𝑠𝑒𝑟𝑎𝑡 0,5% 𝑘𝑒 1

𝑃𝑚𝑎𝑥 = 1,90 𝐾𝑁

= 1,90 × 1000

= 1900𝑁

𝐿𝑒𝑏𝑎𝑟 = 14,84 𝑚𝑚

𝑃𝑎𝑛𝑗𝑎𝑛𝑔 = 5,58

A0 = Panjang × Lebar

= 5,58 × 14,84

= 82,8072 mm2

𝑃𝑚𝑎𝑥

σ = A0

1900 𝑀𝑝𝑎

= 82,8072

= 22,94 𝑀𝑝𝑎/𝑚𝑚²

𝑆𝑝𝑒𝑠𝑖𝑚𝑒𝑛 𝑢𝑗𝑖 𝑡𝑎𝑟𝑖𝑘 𝑠𝑒𝑟𝑎𝑡 0,5% 𝑘𝑒 2

𝑃𝑚𝑎𝑥 = 2,09 𝐾𝑁

= 2,09 × 1000

= 2.090𝑁

𝐿𝑒𝑏𝑎𝑟 = 14,46 𝑚𝑚

𝑃𝑎𝑛𝑗𝑎𝑛𝑔 = 5,67

A0 = Tebal × Lebar

= 5,67 × 14,46

= 81,9882mm2

𝑃𝑚𝑎𝑥

σ = A0

2.090 𝑀𝑝𝑎

= 81,9882

= 25,49𝑀𝑝𝑎/𝑚𝑚²

𝑆𝑝𝑒𝑠𝑖𝑚𝑒𝑛 𝑢𝑗𝑖 𝑡𝑎𝑟𝑖𝑘 𝑠𝑒𝑟𝑎𝑡 0,5% 𝑘𝑒 3

𝑃𝑚𝑎𝑥 = 1,52 𝐾𝑁

= 1,52 × 1000

= 1.520𝑁

𝐿𝑒𝑏𝑎𝑟 = 14,75 𝑚𝑚

𝑃𝑎𝑛𝑗𝑎𝑛𝑔 = 5,08 𝑚𝑚

A0 = Panjang × Lebar

= 5,08 × 14,75

= 74,93 mm2

𝑃𝑚𝑎𝑥

σ = A0

1.520 𝑀𝑝𝑎

= 74,93

= 20,29𝑀𝑝𝑎/𝑚𝑚²

𝑁𝑖𝑙𝑎𝑖 𝑡𝑒𝑔𝑎𝑛𝑔𝑎𝑛 𝑟𝑎𝑡𝑎 − 𝑟𝑎𝑡𝑎 𝑡𝑎𝑟𝑖𝑘 𝑣𝑎𝑘𝑠𝑖 𝑠𝑒𝑟𝑎𝑡 0,5 % 𝑑𝑎𝑟𝑖 𝑠𝑎𝑚𝑝𝑒𝑙 1 − 3

Rata-rata = 𝑗𝑢𝑚𝑙𝑎ℎ 𝑛𝑖𝑙𝑎𝑖

𝐵𝑎𝑚𝑦𝑎𝑘𝑛𝑦𝑎 𝑑𝑎𝑡𝑎

22,94 + 25,49 + 20,29

= 3

= 22,9 𝑀𝑝𝑎/𝑚𝑚²

𝑆𝑝𝑒𝑠𝑖𝑚𝑒𝑛 𝑢𝑗𝑖 𝑡𝑎𝑟𝑖𝑘 𝑠𝑒𝑟𝑎𝑡 1% 𝑘𝑒 1

𝑃𝑚𝑎𝑥 = 1𝐾𝑁

= 1 × 1000

= 1000𝑁

𝐿𝑒𝑏𝑎𝑟 = 15,04 𝑚𝑚

𝑃𝑎𝑛𝑗𝑎𝑛𝑔 = 4,2 𝑚𝑚

A0 = Tebal × Lebar

= 4,2 × 15,04

= 63,168 mm2

𝑃𝑚𝑎𝑥

σ = A0

1000 𝑀𝑝𝑎

= 63,168

= 15,83 𝑀𝑝𝑎/𝑚𝑚²

𝑆𝑝𝑒𝑠𝑖𝑚𝑒𝑛 𝑢𝑗𝑖 𝑡𝑎𝑟𝑖𝑘 𝑠𝑒𝑟𝑎𝑡 1% 𝑘𝑒 2

𝑃𝑚𝑎𝑥 = 0,84𝐾𝑁

= 0,84 × 1000

= 840𝑁

𝐿𝑒𝑏𝑎𝑟 = 15,76 𝑚𝑚

𝑃𝑎𝑛𝑗𝑎𝑛𝑔 = 4,25𝑚𝑚

A0 = Panjang × Lebar

= 4,25 × 15,76

= 66,98 mm2

𝑃𝑚𝑎𝑥

σ = A0

840 𝑀𝑝𝑎

= 66,98

= 12,54 𝑀𝑝𝑎/𝑚𝑚²

𝑆𝑝𝑒𝑠𝑖𝑚𝑒𝑛 𝑢𝑗𝑖 𝑡𝑎𝑟𝑖𝑘 𝑠𝑒𝑟𝑎𝑡 1% 𝑘𝑒 3

𝑃𝑚𝑎𝑥 = 0,92𝐾𝑁

= 0,92 × 1000

= 920𝑁

𝐿𝑒𝑏𝑎𝑟 = 13,26 𝑚𝑚

𝑃𝑎𝑛𝑗𝑎𝑛𝑔 = 4,35𝑚𝑚

A0 = Tebal × Lebar

= 5,58 × 14,84

= 57,681 mm2

𝑃𝑚𝑎𝑥

σ = A0

920 𝑀𝑝𝑎

= 57,681

= 15,94 𝑀𝑝𝑎/𝑚𝑚²

Nilai tegangan rata − rata tarik vaksi serat 1% dari sampel 1 − 3

Rata-rata = 𝑗𝑢𝑚𝑙𝑎ℎ 𝑛𝑖𝑙𝑎𝑖

𝐵𝑎𝑚𝑦𝑎𝑘𝑛𝑦𝑎 𝑑𝑎𝑡𝑎

15,83 + 12,54 + 15,94

= 3

= 14,8 𝑀𝑝𝑎/𝑚𝑚²

𝑆𝑝𝑒𝑠𝑖𝑚𝑒𝑛 𝑢𝑗𝑖 𝑡𝑎𝑟𝑖𝑘 𝑠𝑒𝑟𝑎𝑡 1,5% 𝑘𝑒 1

𝑃𝑚𝑎𝑥 = 0,85𝐾𝑁

= 0,85 × 1000

= 850𝑁

𝐿𝑒𝑏𝑎𝑟 = 14,14 𝑚𝑚

𝑃𝑎𝑛𝑗𝑎𝑛𝑔 = 4,47 𝑚𝑚

A0 = Panjang × Lebar

= 4,47 × 14,14

= 63,2058 mm2

𝑃𝑚𝑎𝑥

σ = A0

850𝑀𝑝𝑎

= 63,2058

= 13,45 𝑀𝑝𝑎/𝑚𝑚²

𝑆𝑝𝑒𝑠𝑖𝑚𝑒𝑛 𝑢𝑗𝑖 𝑡𝑎𝑟𝑖𝑘 𝑠𝑒𝑟𝑎𝑡 1,5% 𝑘𝑒 2

𝑃𝑚𝑎𝑥 = 1,06𝐾𝑁

= 1,06 × 1000

= 1.060𝑁

𝐿𝑒𝑏𝑎𝑟 = 16,11𝑚𝑚

𝑃𝑎𝑛𝑗𝑎𝑛𝑔 = 5,13𝑚𝑚

A0 = Tebal × Lebar

= 5,13 × 14,84

= 76,1292 mm2

𝑃𝑚𝑎𝑥

σ = A0

1.060 𝑀𝑝𝑎

= 82,8072

= 12,83𝑀𝑝𝑎/𝑚𝑚²

𝑆𝑝𝑒𝑠𝑖𝑚𝑒𝑛 𝑢𝑗𝑖 𝑡𝑎𝑟𝑖𝑘 𝑠𝑒𝑟𝑎𝑡 1,5% 𝑘𝑒 3

𝑃𝑚𝑎𝑥 = 0,69 𝐾𝑁

= 0,69 × 1000

= 690𝑁

𝐿𝑒𝑏𝑎𝑟 = 14,08 𝑚𝑚

𝑃𝑎𝑛𝑗𝑎𝑛𝑔 = 4,71𝑚𝑚

A0 = Panjang × Lebar

= 4,71 × 14,08

= 66,3168 mm2

𝑃𝑚𝑎𝑥

σ = A0

690𝑀𝑝𝑎

= 66,3168

= 10,40 𝑀𝑝𝑎/𝑚𝑚²

𝑁𝑖𝑙𝑎𝑖 𝑡𝑒𝑔𝑎𝑛𝑔𝑎𝑛 𝑟𝑎𝑡𝑎 − 𝑟𝑎𝑡𝑎 𝑡𝑎𝑟𝑖𝑘 𝑣𝑎𝑘𝑠𝑖 𝑠𝑒𝑟𝑎𝑡 1,5 % 𝑑𝑎𝑟𝑖 𝑠𝑎𝑚𝑝𝑒𝑙 1 − 3

Rata-rata = 𝑗𝑢𝑚𝑙𝑎ℎ 𝑛𝑖𝑙𝑎𝑖

𝐵𝑎𝑚𝑦𝑎𝑘𝑛𝑦𝑎 𝑑𝑎𝑡𝑎

13,45 + 12,83 + 10,40

= 3

1. Pengujian Bending

= 12,2 𝑀𝑝𝑎/𝑚𝑚²

𝑆𝑝𝑒𝑠𝑖𝑚𝑒𝑛 𝑢𝑗𝑖 𝑏𝑒𝑛𝑑𝑖𝑛𝑔 𝑣𝑎𝑟𝑖𝑎𝑠𝑖 𝑠𝑒𝑟𝑎𝑡 0,5% 𝑘𝑒 1

𝐷𝑖𝑘𝑒𝑡𝑎ℎ𝑢𝑖: 𝑃𝑎𝑛𝑗𝑎𝑛𝑔 (𝐿) = 90𝑚𝑚

𝐿𝑒𝑏𝑎𝑟 (𝑏) = 14,50 𝑚𝑚

𝑃𝑎𝑛𝑗𝑎𝑛𝑔 (𝑑) = 4,70 𝑚𝑚

𝑃𝑚𝑎𝑥 (𝑝) = 0,09 𝐾𝑁

# σь =

= 0,09 × 1000

= 90 𝑁

3 × Pmax × L

2 × b × d ²

3 × 90 × 90

= 2 × 14,5 × 4,702

24,300

=

640,41

# = 37,93 𝑀𝑝𝑎/𝑚𝑚

𝑆𝑝𝑒𝑠𝑖𝑚𝑒𝑛 𝑢𝑗𝑖 𝑏𝑒𝑛𝑑𝑖𝑛𝑔 𝑣𝑎𝑟𝑖𝑎𝑠𝑖 𝑠𝑒𝑟𝑎𝑡 0,5% 𝑘𝑒 2

𝐷𝑖𝑘𝑒𝑡𝑎ℎ𝑢𝑖: 𝑃𝑎𝑛𝑗𝑎𝑛𝑔 (𝐿) = 90𝑚𝑚

𝐿𝑒𝑏𝑎𝑟 (𝑏) = 17,22 𝑚𝑚

𝑃𝑎𝑛𝑗𝑎𝑛𝑔 (𝑑) = 5,12 𝑚𝑚

𝑃𝑚𝑎𝑥 (𝑝) = 0,18 𝐾𝑁

= 0,18 × 1000

= 180𝑁

3 × Pmax × L

# σь =

2 × b × d ²

3 × 180 × 90

= 2 × 17,22 × 5,122

# 48.600

=

902,8

# = 53,83 𝑀𝑝𝑎/𝑚𝑚

𝑆𝑝𝑒𝑠𝑖𝑚𝑒𝑛 𝑢𝑗𝑖 𝑏𝑒𝑛𝑑𝑖𝑛𝑔 𝑣𝑎𝑟𝑖𝑎𝑠𝑖 𝑠𝑒𝑟𝑎𝑡 0,5% 𝑘𝑒 3

𝐷𝑖𝑘𝑒𝑡𝑎ℎ𝑢𝑖: 𝑃𝑎𝑛𝑗𝑎𝑛𝑔 (𝐿) = 90𝑚𝑚

𝐿𝑒𝑏𝑎𝑟 (𝑏) = 15,08𝑚𝑚

𝑃𝑎𝑛𝑗𝑎𝑛𝑔 (𝑑) = 4,38 𝑚𝑚

𝑃𝑚𝑎𝑥 (𝑝) = 0,08 𝐾𝑁

= 0,08 × 1000

= 80 𝑁

# σь =

3 × Pmax × L

2 × b × d ²

3 × 80 × 90

= 2 × 15,08 × 4,38 2

21.600

=

578,60

# = 37,33𝑀𝑝𝑎/𝑚𝑚

Nilai tegangan rata − rata bending variasi serat 0,5 % dari sampel 1 − 3

𝑗𝑢𝑚𝑙𝑎ℎ 𝑛𝑖𝑙𝑎𝑖 Rata − rata = 𝐵𝑎𝑚𝑦𝑎𝑘𝑛𝑦𝑎 𝑑𝑎𝑡𝑎

37,93 + 53,83 + 37,33

=

3

= 43,03 𝑁/𝑚𝑚

𝑆𝑝𝑒𝑠𝑖𝑚𝑒𝑛 𝑢𝑗𝑖 𝑏𝑒𝑛𝑑𝑖𝑛𝑔 𝑣𝑎𝑟𝑖𝑎𝑠𝑖 𝑠𝑒𝑟𝑎𝑡 1% 𝑘𝑒 1

𝐷𝑖𝑘𝑒𝑡𝑎ℎ𝑢𝑖: 𝑃𝑎𝑛𝑗𝑎𝑛𝑔 (𝐿) = 90𝑚𝑚

𝐿𝑒𝑏𝑎𝑟 (𝑏) = 15,87 𝑚𝑚

𝑃𝑎𝑛𝑗𝑎𝑛𝑔 (𝑑) = 4,44 𝑚𝑚

𝑃𝑚𝑎𝑥 (𝑝) = 0,09 𝐾𝑁

= 0,09 × 1000

= 90 𝑁

3 × Pmax × L

# σь =

2 × b × d ²

3 × 90 × 90

= 2 × 15,87 × 4,442

24,300

=

625,70

# = 38,84 𝑀𝑝𝑎/𝑚𝑚

𝑆𝑝𝑒𝑠𝑖𝑚𝑒𝑛 𝑢𝑗𝑖 𝑏𝑒𝑛𝑑𝑖𝑛𝑔 𝑣𝑎𝑟𝑖𝑎𝑠𝑖 𝑠𝑒𝑟𝑎𝑡 1% 𝑘𝑒 2

𝐷𝑖𝑘𝑒𝑡𝑎ℎ𝑢𝑖: 𝑃𝑎𝑛𝑗𝑎𝑛𝑔 (𝐿) = 90𝑚𝑚

𝐿𝑒𝑏𝑎𝑟 (𝑏) = 14,08 𝑚𝑚

𝑃𝑎𝑛𝑗𝑎𝑛𝑔 (𝑑) = 4,73 𝑚𝑚

𝑃𝑚𝑎𝑥 (𝑝) = 0,10 𝐾𝑁

= 0,10 × 1000

= 100 𝑁

3 × Pmax × L

# σь =

2 × b × d ²

3 × 100 × 90

= 2 × 14,08 × 4,732

27,000

=

630,02

# = 42,86 𝑀𝑝𝑎/𝑚𝑚

𝑆𝑝𝑒𝑠𝑖𝑚𝑒𝑛 𝑢𝑗𝑖 𝑏𝑒𝑛𝑑𝑖𝑛𝑔 𝑣𝑎𝑟𝑖𝑎𝑠𝑖 𝑠𝑒𝑟𝑎𝑡 1% 𝑘𝑒 3

𝐷𝑖𝑘𝑒𝑡𝑎ℎ𝑢𝑖: 𝑃𝑎𝑛𝑗𝑎𝑛𝑔 (𝐿) = 90𝑚𝑚

𝐿𝑒𝑏𝑎𝑟 (𝑏) = 14,50𝑚𝑚

𝑃𝑎𝑛𝑗𝑎𝑛𝑔(𝑑) = 3,79 𝑚𝑚

𝑃𝑚𝑎𝑥 (𝑝) = 0,03𝐾𝑁

= 0,03 × 1000

= 30 𝑁

3 × Pmax × L

# σь =

2 × b × d ²

3 × 30 × 90

= 2 × 14,50 × 3,792

8.100

=

416,55

# = 19,45𝑀𝑝𝑎/𝑚𝑚

Nilai tegangan rata − rata bending variasi serat 1% dari sampel 1 − 3

𝑗𝑢𝑚𝑙𝑎ℎ 𝑛𝑖𝑙𝑎𝑖 Rata − rata = 𝐵𝑎𝑚𝑦𝑎𝑘𝑛𝑦𝑎 𝑑𝑎𝑡𝑎

38,84 + 42,86 + 19,45

= 3

= 33,71 𝑁/𝑚𝑚

𝑆𝑝𝑒𝑠𝑖𝑚𝑒𝑛 𝑢𝑗𝑖 𝑏𝑒𝑛𝑑𝑖𝑛𝑔 𝑣𝑎𝑟𝑖𝑎𝑠𝑖 𝑠𝑒𝑟𝑎𝑡 1,5% 𝑘𝑒 1

𝐷𝑖𝑘𝑒𝑡𝑎ℎ𝑢𝑖: 𝑃𝑎𝑛𝑗𝑎𝑛𝑔 (𝐿) = 90𝑚𝑚

𝐿𝑒𝑏𝑎𝑟 (𝑏) = 14,14𝑚𝑚

𝑃𝑎𝑛𝑗𝑎𝑛𝑔 (𝑑) = 4,5𝑚𝑚

𝑃𝑚𝑎𝑥 (𝑝) = 0,06 𝐾𝑁

= 0,06 × 1000

= 60 𝑁

3 × Pmax × L

# σь =

=

2 × b × d ²

3 × 60 × 90

2 × 14,14 × 4,5²

16.200

=

572,67

= 28,29 𝑀𝑝𝑎/𝑚𝑚

𝑆𝑝𝑒𝑠𝑖𝑚𝑒𝑛 𝑢𝑗𝑖 𝑏𝑒𝑛𝑑𝑖𝑛𝑔 𝑣𝑎𝑟𝑖𝑎𝑠𝑖 𝑠𝑒𝑟𝑎𝑡 1,5% 𝑘𝑒 2

𝐷𝑖𝑘𝑒𝑡𝑎ℎ𝑢𝑖: 𝑃𝑎𝑛𝑗𝑎𝑛𝑔 (𝐿) = 90𝑚𝑚

𝐿𝑒𝑏𝑎𝑟 (𝑏) = 13,46𝑚𝑚

𝑃𝑎𝑛𝑗𝑎𝑛𝑔 (𝑑) = 3,70 𝑚𝑚

𝑃𝑚𝑎𝑥 (𝑝) = 0,05 𝐾𝑁

= 0,05 × 1000

= 50 𝑁

3 × Pmax × L

# σь =

2 × b × d ²

3 × 50 × 90

= 2 × 13,46 × 3,702

13.500

= 368,53

# = 36,63 𝑀𝑝𝑎/𝑚𝑚

𝑆𝑝𝑒𝑠𝑖𝑚𝑒𝑛 𝑢𝑗𝑖 𝑏𝑒𝑛𝑑𝑖𝑛𝑔 𝑣𝑎𝑟𝑖𝑎𝑠𝑖 𝑠𝑒𝑟𝑎𝑡 1,5% 𝑘𝑒 3

𝐷𝑖𝑘𝑒𝑡𝑎ℎ𝑢𝑖: 𝑃𝑎𝑛𝑗𝑎𝑛𝑔 (𝐿) = 90𝑚𝑚

𝐿𝑒𝑏𝑎𝑟 (𝑏) = 14,35𝑚𝑚

𝑃𝑎𝑛𝑗𝑎𝑛𝑔(𝑑) = 4,6 𝑚𝑚

𝑃𝑚𝑎𝑥 (𝑝) = 0,03𝐾𝑁

= 0,03 × 1000

= 30 𝑁

3 × Pmax × L

# σь =

=

2 × b × d ²

3 × 30 × 90

2 × 14,35 × 4,6 ²

8.100

=

607,29

# = 13,34 𝑀𝑝𝑎/𝑚𝑚

Nilai tegangan rata − rata bending variasi serat 0,5 % dari sampel 1 − 3

𝑗𝑢𝑚𝑙𝑎ℎ 𝑛𝑖𝑙𝑎𝑖 Rata − rata = 𝐵𝑎𝑚𝑦𝑎𝑘𝑛𝑦𝑎 𝑑𝑎𝑡𝑎

28,29 + 36,63 + 13,34

= 3

1. Pengujian Impak

= 43,03 𝑁/𝑚𝑚

Spesimen uji impak variasi serat 0,5% ke 1

Diketahui :

Lebar bahan uji ( Ɩ ) = 11,85 mm Panjang bahan uji ( t ) = 9,42 mm

Panjang pendulum ( R ) = jarak titik putar = 80 cm

Ke titik berat pendulum = 0,8 m Berat pendulum ( G ) = 20 kg x 9,81 = 196,2 N

Cos α = 300

Cos β = 29,000

Rumus luas penampang

Ao = l × t

= 11,85 × 9,24

= 111,62 𝑚𝑚²

Rumus energi yang diserap benda uji / tenaga patah

G × R = 196,2N × 0,8m = 156,96 J

𝐶𝑜𝑠 α = cos 300 = −0,8660 Cos β = cos 29,000 = −0,8746

𝑊 = 𝐺 × 𝑅 (cos β − cos α)

= 156,96 × (0,8746 − 0,8660)

= 156,96 × 0,0086

= 1,4 𝑗𝑜𝑢𝑙𝑒

Rumus harga *impack* (HI) :

σb = 𝑊

𝑏ˡ𝑥 ℎˡ

= 𝑊

𝐴𝑜

𝑊 = 𝐸𝑛𝑒𝑟𝑔𝑖 𝑡𝑒𝑟𝑠𝑒𝑟𝑎𝑝 𝑏𝑒𝑛𝑑𝑎 𝑢𝑗𝑖 (𝑗)

= 1,4 𝑗𝑜𝑢𝑙𝑒

𝐴𝑜 = 𝐿𝑢𝑎𝑠 𝑝𝑒𝑛𝑎𝑚𝑝𝑎𝑛𝑔 (𝑚𝑚2)

= 111,627 𝑚𝑚² σb = 𝑊

𝐴𝑜

= 1,4 𝑗𝑜𝑢𝑙𝑒

111,627 𝑚𝑚²

= 0,0 12 joule / mm²

𝑆𝑝𝑒𝑠𝑖𝑚𝑒𝑛 𝑢𝑗𝑖 𝑖𝑚𝑝𝑎𝑘 𝑣𝑎𝑟𝑖𝑎𝑠𝑖 𝑠𝑒𝑟𝑎𝑡 0,5% 𝑘𝑒 2

Diketahui :

Lebar bahan uji ( Ɩ ) = 12,28 mm Panjang bahan uji ( t ) = 9,98 mm

Panjang pendulum ( R ) = jarak titik putar = 80 cm

Ke titik berat pendulum = 0,8 m Berat pendulum ( G ) = 20 kg x 9,81 = 196,2 N

Cos α = 300

Cos β = 29,000

Rumus luas penampang

Ao = l × t

= 12,28 × 9,98

= 122,55 𝑚𝑚²

Rumus energi yang diserap benda uji / tenaga patah

G × R = 196,13N × 0,8m = 15.690 J

𝐶𝑜𝑠 α = cos 300 = −0,8660

Cos β = cos 29,000 = −0,8746

𝑊 = 𝐺 × 𝑅 (cos β − cos α)

= 15.690 × (0,8746 − 0,8660)

= 15.690 − (0,0086)

= 1,4 𝑗𝑜𝑢𝑙𝑒

Rumus harga *impack* (HI) :

σb = 𝑊

𝑏ˡ𝑥 ℎˡ

= 𝑊

𝐴𝑜

𝑊 = 𝐸𝑛𝑒𝑟𝑔𝑖 𝑡𝑒𝑟𝑠𝑒𝑟𝑎𝑝 𝑏𝑒𝑛𝑑𝑎 𝑢𝑗𝑖 (𝑗)

= 1,4 𝑗𝑜𝑢𝑙𝑒

𝐴𝑜 = 𝐿𝑢𝑎𝑠 𝑝𝑒𝑛𝑎𝑚𝑝𝑎𝑛𝑔 (𝑚𝑚2)

= 122,55 𝑚𝑚² σb = 𝑊

𝐴𝑜

= 1,4 𝑗𝑜𝑢𝑙𝑒

122,55 𝑚𝑚²

= 0,0 11 joule / mm²

𝑆𝑝𝑒𝑠𝑖𝑚𝑒𝑛 𝑢𝑗𝑖 𝑖𝑚𝑝𝑎𝑘 𝑣𝑎𝑟𝑖𝑎𝑠𝑖 𝑠𝑒𝑟𝑎𝑡 0,5% 𝑘𝑒 3

Diketahui :

Lebar bahan uji ( Ɩ ) = 11,61 mm Panjang bahan uji ( t ) = 10,67 mm

Panjang pendulum ( R ) = jarak titik putar = 80 cm

Ke titik berat pendulum = 0,8 m Berat pendulum ( G ) = 20 kg x 9,81 = 196,2 N

Cos α = 300

Cos β = 29,000

Rumus luas penampang

Ao = l × t

= 11,61 × 10,67

= 123,87 𝑚𝑚²

Rumus energi yang diserap benda uji / tenaga patah

G × R = 196,2N × 0,8m = 156,96 J

𝐶𝑜𝑠 α = cos 300 = −0,8660 Cos β = cos 29,000 = −0,8746

𝑊 = 𝐺 × 𝑅 (cos β − cos α)

= 156,96 × (0,8746 − 0,8660)

= 156,96 × 0,0086

= 1,4 𝑗𝑜𝑢𝑙𝑒

Rumus harga *impack* (HI) :

σb = 𝑊

𝑏ˡ𝑥 ℎˡ

= 𝑊

𝐴𝑜

𝑊 = 𝐸𝑛𝑒𝑟𝑔𝑖 𝑡𝑒𝑟𝑠𝑒𝑟𝑎𝑝 𝑏𝑒𝑛𝑑𝑎 𝑢𝑗𝑖 (𝑗)

= 1,4 𝑗𝑜𝑢𝑙𝑒

= 123,87 𝑚𝑚² σb = 𝑊

𝐴𝑜

= 1,4 𝑗𝑜𝑢𝑙𝑒

123,87 𝑚𝑚²

= 0,011 joule / mm²

Nilai tegangan rata − rata impak variasi serat 0,5 % dari sampel 1 − 3

𝑗𝑢𝑚𝑙𝑎ℎ 𝑛𝑖𝑙𝑎𝑖 Rata − rata = 𝐵𝑎𝑚𝑦𝑎𝑘𝑛𝑦𝑎 𝑑𝑎𝑡𝑎

0,012 + 0,011 + 0,011

= 3

= 0,012 𝐽𝑜𝑢𝑒𝑙/𝑚𝑚² Spesimen uji impak variasi serat 1% ke 1

Diketahui :

Lebar bahan uji ( Ɩ ) = 12,05 mm Panjang bahan uji ( t ) = 8,81 mm

Panjang pendulum ( R ) = jarak titik putar = 80 cm

Ke titik berat pendulum = 0,8 m Berat pendulum ( G ) = 20 kg x 9,81 = 196,2 N

Cos α = 300

Cos β = 28,500

Rumus luas penampang

Ao = l × t

= 12,05 × 8,81

= 106,16 mm²

Rumus energi yang diserap benda uji / tenaga patah

G × R = 196,2N × 0,8m = 156,96 J

𝐶𝑜𝑠 α = cos 300 = 0,8660 Cos β = cos 28,500 = 0,8788

𝑊 = 𝐺 × 𝑅 (cos β − cos α)

= 156,96 × (0,8788 − 0,8660)

= 156,96 × 0,0128

= 2,0 𝑗𝑜𝑢𝑙𝑒

Rumus harga *impack* (HI) :

σb = 𝑊

𝑏ˡ𝑥 ℎˡ

= 𝑊

𝐴𝑜

𝑊 = 𝐸𝑛𝑒𝑟𝑔𝑖 𝑡𝑒𝑟𝑠𝑒𝑟𝑎𝑝 𝑏𝑒𝑛𝑑𝑎 𝑢𝑗𝑖 (𝑗)

𝐴𝑜 = 𝐿𝑢𝑎𝑠 𝑝𝑒𝑛𝑎𝑚𝑝𝑎𝑛𝑔 (𝑚𝑚2)

= 106,16 mm² σb = 𝑊

𝐴𝑜

= 2,0 𝑗𝑜𝑢𝑙𝑒

106,16 𝑚𝑚²

= 0,018 𝑗𝑜𝑢𝑙/𝑚𝑚²

Spesimen uji impak variasi serat 1% ke 2

Diketahui :

Lebar bahan uji ( Ɩ ) = 13,08 mm Panjang bahan uji ( t ) = 11,24 mm

Panjang pendulum ( R ) = jarak titik putar = 80 cm

Ke titik berat pendulum = 0,8 m Berat pendulum ( G ) = 20 kg x 9,81 = 196,2 N

Cos α = 300

Cos β = 28,500

Rumus luas penampang

Ao = l × t

= 13,08 × 11,24

= 146,56 mm²

Rumus energi yang diserap benda uji / tenaga patah

G × R = 196,2N × 0,8m = 156,96 J

𝐶𝑜𝑠 α = cos 300 = 0,8660 Cos β = cos 28,500 = 0,8788

𝑊 = 𝐺 × 𝑅 (cos β − cos α)

= 156,96 × (0,8788 − 0,8660)

= 156,96 × 0,0128

= 2,0 𝑗𝑜𝑢𝑙𝑒

Rumus harga *impack* (HI) :

σb = 𝑊

𝑏ˡ𝑥 ℎˡ

= 𝑊

𝐴𝑜

𝑊 = 𝐸𝑛𝑒𝑟𝑔𝑖 𝑡𝑒𝑟𝑠𝑒𝑟𝑎𝑝 𝑏𝑒𝑛𝑑𝑎 𝑢𝑗𝑖 (𝑗)

= 2,0 𝑗𝑜𝑢𝑙𝑒

𝐴𝑜 = 𝐿𝑢𝑎𝑠 𝑝𝑒𝑛𝑎𝑚𝑝𝑎𝑛𝑔 (𝑚𝑚2)

= 146,56 mm² σb = 𝑊

𝐴𝑜

2,0 𝑗𝑜𝑢𝑙𝑒

=

146,56 𝑚𝑚²

= 0,013 𝑗𝑜𝑢𝑙/𝑚𝑚²

Spesimen uji impak variasi serat 1% ke 3

Diketahui :

Lebar bahan uji ( Ɩ ) = 12,07 mm Panjang bahan uji ( t ) = 8,4 mm

Panjang pendulum ( R ) = jarak titik putar = 80 cm

Ke titik berat pendulum = 0,8 m Berat pendulum ( G ) = 20 kg x 9,81 = 196,2 N

Cos α = 300

Cos β = 28,500

Rumus luas penampang

Ao = l × t

= 12,07 × 8,4

= 101,388 mm²

Rumus energi yang diserap benda uji / tenaga patah

G × R = 196,2N × 0,8m = 156,96 J

𝐶𝑜𝑠 α = cos 300 = 0,8660 Cos β = cos 28,500 = 0,8788

𝑊 = 𝐺 × 𝑅 (cos β − cos α)

= 156,96 × (0,8788 − 0,8660)

= 156,96 × 0,0128

= 2,0 𝑗𝑜𝑢𝑙𝑒

Rumus harga *impack* (HI) :

σb = 𝑊

𝑏ˡ𝑥 ℎˡ

= 𝑊

𝐴𝑜

𝑊 = 𝐸𝑛𝑒𝑟𝑔𝑖 𝑡𝑒𝑟𝑠𝑒𝑟𝑎𝑝 𝑏𝑒𝑛𝑑𝑎 𝑢𝑗𝑖 (𝑗)

= 2,0 𝑗𝑜𝑢𝑙𝑒

𝐴𝑜 = 𝐿𝑢𝑎𝑠 𝑝𝑒𝑛𝑎𝑚𝑝𝑎𝑛𝑔 (𝑚𝑚2)

= 101,388 mm²

σb = 𝑊

𝐴𝑜

= 2,0𝑗𝑜𝑢𝑙𝑒

101,388 mm²

= 0,019 joule / mm²

Nilai tegangan rata − rata impak variasi serat 1 % dari sampel 1 − 3

𝑗𝑢𝑚𝑙𝑎ℎ 𝑛𝑖𝑙𝑎𝑖 Rata − rata = 𝐵𝑎𝑚𝑦𝑎𝑘𝑛𝑦𝑎 𝑑𝑎𝑡𝑎

0,018 + 0,013 + 0,019

= 3

= 0,018 𝐽𝑜𝑢𝑒𝑙/𝑚𝑚²

Spesimen uji impak variasi serat 1,5% ke 1

Diketahui :

Lebar bahan uji ( Ɩ ) = 12,38 mm Panjang bahan uji ( t ) = 9,73 mm

Panjang pendulum ( R ) = jarak titik putar = 80 cm

Ke titik berat pendulum = 0,8 m Berat pendulum ( G ) = 20 kg x 9,81 = 196,2 N

Cos α = 300

Cos β = 29,000

Rumus luas penampang

Ao = l × t

= 12,38 × 9,73

= 120,45 mm²

Rumus energi yang diserap benda uji / tenaga patah

G × R = 196,2N × 0,8m = 156,96 J

𝐶𝑜𝑠 α = cos 300 = 0,8660 Cos β = cos 28,250 = 0,8808

𝑊 = 𝐺 × 𝑅 (cos β − cos α)

= 156,96 × (0,8808 − 0,8660)

= 156,96 × 0,0148

= 2,3 𝑗𝑜𝑢𝑙𝑒

Rumus harga *impack* (HI) :

σb = 𝑊

𝑏ˡ𝑥 ℎˡ

= 𝑊

𝐴𝑜

𝑊 = 𝐸𝑛𝑒𝑟𝑔𝑖 𝑡𝑒𝑟𝑠𝑒𝑟𝑎𝑝 𝑏𝑒𝑛𝑑𝑎 𝑢𝑗𝑖 (𝑗)

= 2,3 𝑗𝑜𝑢𝑙𝑒

𝐴𝑜 = 𝐿𝑢𝑎𝑠 𝑝𝑒𝑛𝑎𝑚𝑝𝑎𝑛𝑔 (𝑚𝑚2)

= 120,45 mm² σb = 𝑊

𝐴𝑜

= 2,3 𝑗𝑜𝑢𝑙𝑒

120,45 mm²

= 0,019 𝑗𝑜𝑢𝑙/𝑚𝑚²

Spesimen uji impak variasi serat 1,5% ke 2

Diketahui :

Lebar bahan uji ( Ɩ ) = 12,90 mm Panjang bahan uji ( t ) = 9,42 mm

Panjang pendulum ( R ) = jarak titik putar = 80 cm

Ke titik berat pendulum = 0,8 m Berat pendulum ( G ) = 20 kg x 9,81 = 196,2 N

Cos α = 300

Cos β = 28,250

Rumus luas penampang

Ao = l × t

= 12,90 × 8,88

= 114,55 mm²

Rumus energi yang diserap benda uji / tenaga patah

G × R = 196,2N × 0,8m = 156,96 J

𝐶𝑜𝑠 α = cos 300 = 0,8660 Cos β = cos 28,250 = 0,8808

𝑊 = 𝐺 × 𝑅 (cos β − cos α)

= 156,96 × (0,8808 − 0,8660)

= 156,96 × 0,0148

= 2,3𝑗𝑜𝑢𝑙𝑒

Rumus harga *impack* (HI) :

σb = 𝑊

𝑏ˡ𝑥 ℎˡ

= 𝑊

𝐴𝑜

𝑊 = 𝐸𝑛𝑒𝑟𝑔𝑖 𝑡𝑒𝑟𝑠𝑒𝑟𝑎𝑝 𝑏𝑒𝑛𝑑𝑎 𝑢𝑗𝑖 (𝑗)

= 2,3 𝑗𝑜𝑢𝑙𝑒

𝐴𝑜 = 𝐿𝑢𝑎𝑠 𝑝𝑒𝑛𝑎𝑚𝑝𝑎𝑛𝑔 (𝑚𝑚2)

= 114,55 mm² σb = 𝑊

𝐴𝑜

= 2,3 𝑗𝑜𝑢𝑙𝑒

114,55 mm²

= 0,020 𝑗𝑜𝑢𝑙𝑒/𝑚𝑚²

Spesimen uji impak variasi serat 1,5% ke 3

Diketahui :

Lebar bahan uji ( Ɩ ) = 13,36 mm Panjang bahan uji ( t ) = 8,7 mm

Panjang pendulum ( R ) = jarak titik putar = 80 cm

Ke titik berat pendulum = 0,8 m Berat pendulum ( G ) = 20 kg x 9,81 = 196,2 N

Cos α = 300

Cos β = 28,000

Rumus luas penampang

Ao = l × t

= 13,36 × 8,70

= 116,23 mm²

Rumus energi yang diserap benda uji / tenaga patah

G × R = 196,2N × 0,8m = 156,96 J

𝐶𝑜𝑠 α = cos 300 = 0,8660 Cos β = cos 28,000 = 0,8829

𝑊 = 𝐺 × 𝑅 (cos β − cos α)

= 156,96 × (0,88,29 − 0,8660)

= 156,96 × 0,016

= 2,5 𝑗𝑜𝑢𝑙𝑒

Rumus harga *impack* (HI) :

σb = 𝑊

𝑏ˡ𝑥 ℎˡ

= 𝑊

𝐴𝑜

𝑊 = 𝐸𝑛𝑒𝑟𝑔𝑖 𝑡𝑒𝑟𝑠𝑒𝑟𝑎𝑝 𝑏𝑒𝑛𝑑𝑎 𝑢𝑗𝑖 (𝑗)

= 2,5 𝑗𝑜𝑢𝑙𝑒

𝐴𝑜 = 𝐿𝑢𝑎𝑠 𝑝𝑒𝑛𝑎𝑚𝑝𝑎𝑛𝑔 (𝑚𝑚2)

= 116,23 𝑚𝑚² σb = 𝑊

𝐴𝑜

2,5 𝑗𝑜𝑢𝑙𝑒

=

116,23 𝑚𝑚²

= 0,021 𝑗𝑜𝑢𝑙𝑒/𝑚𝑚²

Nilai tegangan rata − rata impak variasi serat 1,5 % dari sampel 1 − 3

𝑗𝑢𝑚𝑙𝑎ℎ 𝑛𝑖𝑙𝑎𝑖 Rata − rata = 𝐵𝑎𝑚𝑦𝑎𝑘𝑛𝑦𝑎 𝑑𝑎𝑡𝑎

0,019 + 0,020 + 0,021

= 3

= 0,021 𝐽𝑜𝑢𝑒𝑙/𝑚𝑚²



50

40

30

20

10

0

Hubungan Varibel Bebas dan Terikat Hasil

Pengujian Bending Komposit Eceng Gondok

43,03

34,79

33,71

26,09

0 2,25 4,5 6,75

Penambahan Serat (Gram)



Hubungan Varibel Bebas dan Terikat Hasil

Pengujian Impak Komposit Eceng Gondok

0,025

0,02

0,015

0,01

0,005

0

0,021

0,018

0,012

0,008

0 2,25 4,5 6,75

Penambahan Serat (Gram)

Nilai Harga Impak

Nilai Tegangan Bending

**Lampiran 2. Grafik Hubungan Variabel Bebas dan Terikat**



60

50

40

30

20

10

0

Hubungan Varibel Bebas dan Terikat Hasil

Pengujian Tarik Komposit Eceng Gondok

53,83

22,9

14,8

12,2

0

2,25

4,5

6,75

Penambahan Serat (Gram)

Nilai Tegangan Tarik

**Lampiran 3. Pembuatan Blade**



**Lampiran 4. Hasil Pengujian Material**