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LAMPIRAN

Lampiran 1. Perhitungan Hasil Pengujian

1. Uji tarik

a) Spesimen uji tarik raw material ke-1

$$\begin{aligned} P_{\max} &= 39,14 \text{ KN} \\ &= 39,14 \times 1000 \\ &= 39140 \text{ N} \end{aligned}$$

$$\text{Lebar} = 10,29 \text{ mm}$$

$$\text{Tebal} = 7,87 \text{ mm}$$

$$\begin{aligned} A_0 &= \text{Tebal} \times \text{Lebar} \\ &= 7,87 \times 10,29 \\ &= 80,98 \text{ mm}^2 \end{aligned}$$

$$\begin{aligned} \sigma &= \frac{P_{\max}}{A_0} \\ &= \frac{39140 \text{ N}}{80,98 \text{ mm}^2} \\ &= 483,32 \text{ N/mm}^2 \end{aligned}$$

b) Spesimen uji tarik raw material ke-2

$$\begin{aligned} P_{\max} &= 48,02 \text{ KN} \\ &= 48,02 \times 1000 \\ &= 48030 \text{ N} \end{aligned}$$

$$\text{Lebar} = 10,24 \text{ mm}$$

$$\text{Tebal} = 8,00 \text{ mm}$$

$$\begin{aligned} A_0 &= \text{Tebal} \times \text{Lebar} \\ &= 80,00 \times 10,24 \end{aligned}$$

$$\begin{aligned}
 &= 81,92 \text{ mm}^2 \\
 \sigma &= \frac{P_{\max}}{A_0} \\
 &= \frac{48020 \text{ N}}{81,92 \text{ mm}^2} \\
 &= 586,18 \text{ N/mm}^2
 \end{aligned}$$

c) Spesimen uji tarik raw matrial ke-3

$$\begin{aligned}
 P_{\max} &= 49,37 \text{ KN} \\
 &= 49,37 \times 1000 \\
 &= 49370 \text{ N}
 \end{aligned}$$

$$\text{Lebar} = 10,16 \text{ mm}$$

$$\text{Tebal} = 8,00 \text{ mm}$$

$$\begin{aligned}
 A_0 &= \text{Tebal} \times \text{Lebar} \\
 &= 8,00 \times 10,16 \\
 &= 81,28 \text{ mm}^2
 \end{aligned}$$

$$\begin{aligned}
 \sigma &= \frac{P_{\max}}{A_0} \\
 &= \frac{49370 \text{ N}}{81,28 \text{ mm}^2} \\
 &= 607,41 \text{ N/mm}^2
 \end{aligned}$$

Nilai tegangan tarik rata - rata tarik variasi raw matrial dari sampel 1-3

$$\begin{aligned}
 \text{Rata - rata} &= \frac{\text{Jumlah nilai}}{\text{Banyak data}} \\
 &= \frac{483,32+586,18+607,41}{3} \\
 &= 599,0 \text{ Mpa}
 \end{aligned}$$

a) Spesimen uji tarik variasi arus 70A ke-1

$$\begin{aligned}
 P_{\max} &= 44,64 \text{ KN} \\
 &= 44,64 \times 1000
 \end{aligned}$$

$$\begin{aligned}
 &= 44.640 \text{ N} \\
 \text{Lebar} &= 10,10 \text{ mm} \\
 \text{Tebal} &= 9,50 \text{ mm} \\
 A_0 &= \text{Tebal} \times \text{Lebar} \\
 &= 9,50 \times 10,10 \\
 &= 95,95 \text{ mm}^2 \\
 \sigma &= \frac{P_{\max}}{A_0} \\
 &= \frac{44640 \text{ N}}{95,95 \text{ mm}^2} \\
 &= 465,24 \text{ N/mm}^2
 \end{aligned}$$

b) Spesimen uji tarik variasi arus 70A ke-2

$$\begin{aligned}
 P_{\max} &= 44,23 \text{ KN} \\
 &= 44,23 \times 1000 \\
 &= 44230 \text{ N} \\
 \text{Lebar} &= 10,34 \text{ mm} \\
 \text{Tebal} &= 9,77 \text{ mm} \\
 A_0 &= \text{Tebal} \times \text{Lebar} \\
 &= 9,77 \times 10,34 \\
 &= 101,02 \text{ mm}^2 \\
 \sigma &= \frac{P_{\max}}{A_0} \\
 &= \frac{44230 \text{ N}}{101,02 \text{ mm}^2} \\
 &= 437,83 \text{ N/mm}^2
 \end{aligned}$$

c) Spesimen uji tarik variasi arus 70A ke-3

$$\begin{aligned}
 P_{\max} &= 45,29 \text{ KN} \\
 &= 45,29 \times 1000
 \end{aligned}$$

$$\begin{aligned}
 &= 45290 \text{ N} \\
 \text{Lebar} &= 10,27 \text{ mm} \\
 \text{Tebal} &= 9,48 \text{ mm} \\
 A_0 &= \text{Tebal} \times \text{Lebar} \\
 &= 9,48 \times 10,27 \\
 &= 97,3596 \text{ mm}^2 \\
 \sigma &= \frac{P_{\max}}{A_0} \\
 &= \frac{45290 \text{ N}}{97,3596 \text{ mm}^2} \\
 &= 465,18 \text{ N/mm}^2
 \end{aligned}$$

Nilai tegangan rata – rata tarik variasi arus 70A dari sampel 1-3

$$\begin{aligned}
 \text{Rata – rata} &= \frac{\text{Jumlah nilai}}{\text{Banyaknya data}} \\
 &= \frac{465,24+437,83+465,18}{3} \\
 &= 456,1 \text{ Mpa}
 \end{aligned}$$

a) Spesimen uji tarik variasi arus 80A ke-1

$$\begin{aligned}
 P_{\max} &= 44,92 \text{ KN} \\
 &= 44,92 \times 1000 \\
 &= 44920 \text{ N} \\
 \text{Lebar} &= 10,13 \text{ mm} \\
 \text{Tebal} &= 9,38 \text{ mm} \\
 A_0 &= \text{Tebal} \times \text{Lebar} \\
 &= 9,38 \times 10,13 \\
 &= 95,0194 \text{ mm}^2 \\
 \sigma &= \frac{P_{\max}}{A_0}
 \end{aligned}$$

$$= \frac{44920 \text{ N}}{95,0194 \text{ mm}^2}$$

$$= 472,75 \text{ N/mm}^2$$

b) Spesimen uji tarik variasi arus 80A ke-2

$$P_{\max} = 45,09 \text{ KN}$$

$$= 45,09 \times 1000$$

$$= 45090 \text{ N}$$

$$\text{Lebar} = 10,19 \text{ mm}$$

$$\text{Tebal} = 10,25 \text{ mm}$$

$$A_0 = \text{Tebal} \times \text{Lebar}$$

$$= 10,25 \times 10,19$$

$$= 104,4475 \text{ mm}^2$$

$$\sigma = \frac{P_{\max}}{A_0}$$

$$= \frac{45090 \text{ N}}{104,4475 \text{ mm}^2}$$

$$= 431,70 \text{ N/mm}^2$$

c) Spesimen uji tarik variasi arus 80A ke-3

$$P_{\max} = 44,57 \text{ KN}$$

$$= 44,57 \times 1000$$

$$= 44570 \text{ N}$$

$$\text{Lebar} = 9,87 \text{ mm}$$

$$\text{Tebal} = 9,71 \text{ mm}$$

$$A_0 = \text{Tebal} \times \text{Lebar}$$

$$= 9,71 \times 9,87$$

$$= 95,837 \text{ mm}^2$$

$$\sigma = \frac{P_{\max}}{A_0}$$

$$= \frac{44570 \text{ N}}{95,837 \text{ mm}^2}$$

$$= 465,06 \text{ N/mm}^2$$

Nilai tegangan rata – rata tarik variasi arus 80A dari sampel 1-3

$$\text{Rata – rata} = \frac{\text{Jumlah nilai}}{\text{Banyak data}}$$

$$= \frac{472,75+431,70+465,06}{3}$$

$$= 456,5 \text{ Mpa}$$

a) Spesimen uji tarik variasi arus 90A ke-1

$$P_{\max} = 42,93 \text{ KN}$$

$$= 42,93 \times 1000$$

$$= 42930 \text{ N}$$

$$\text{Lebar} = 9,90 \text{ mm}$$

$$\text{Tebal} = 9,68 \text{ mm}$$

$$A_0 = \text{Tebal} \times \text{Lebar}$$

$$= 9,68 \times 9,90$$

$$= 95,832 \text{ mm}^2$$

$$\sigma = \frac{P_{\max}}{A_0}$$

$$= \frac{42930 \text{ N}}{95,832 \text{ mm}^2}$$

$$= 447,97 \text{ N/mm}^2$$

b) Spesimen uji tarik variasi arus 90A ke-2

$$P_{\max} = 45,50 \text{ KN}$$

$$= 45,50 \times 1000$$

$$= 45500 \text{ N}$$

$$\text{Lebar} = 10,25 \text{ mm}$$

$$\begin{aligned}
 \text{Tebal} &= 10,07 \text{ mm} \\
 A_0 &= \text{Tebal} \times \text{Lebar} \\
 &= 10,07 \times 10,25 \\
 &= 103,2175 \text{ mm}^2 \\
 \sigma &= \frac{P_{\max}}{A_0} \\
 &= \frac{45500 \text{ N}}{103,2175 \text{ mm}^2} \\
 &= 440,82 \text{ N/mm}^2
 \end{aligned}$$

c) Spesimen uji tarik variasi arus 90A ke-3

$$\begin{aligned}
 P_{\max} &= 44,84 \text{ KN} \\
 &= 44,84 \times 1000 \\
 &= 44840 \text{ N} \\
 \text{Lebar} &= 10,03 \text{ mm} \\
 \text{Tebal} &= 10,72 \text{ mm} \\
 A_0 &= \text{Tebal} \times \text{Lebar} \\
 &= 10,72 \times 10,03 \\
 &= 107,5216 \text{ mm}^2 \\
 \sigma &= \frac{P_{\max}}{A_0} \\
 &= \frac{44840 \text{ N}}{107,5216 \text{ mm}^2} \\
 &= 417,03 \text{ N/mm}^2
 \end{aligned}$$

Nilai tegangan rata – rata tarik variasi arus 90A dari sampel 1-3

$$\begin{aligned}
 \text{Rata – rata} &= \frac{\text{Jumlah nilai}}{\text{Banyak data}} \\
 &= \frac{447,97+440,82+417,03}{3} \\
 &= 435,3 \text{ Mpa}
 \end{aligned}$$

2. Uji Bending

a) Spesimen uji *bending* raw matrial ke-1

$$\begin{aligned} P_{\max} &= 18,03 \text{ KN} \\ &= 18,03 \times 1000 \\ &= 18030 \text{ N} \end{aligned}$$

$$\text{Lebar (b)} = 21,46 \text{ mm}$$

$$\text{Tebal (d)} = 7,82 \text{ mm}$$

$$\text{Jarak tumpul (L)} = 40 \text{ mm}$$

$$\begin{aligned} \sigma_b &= \frac{3 \times P_{\max} \times L}{2 \times b \times d^2} \\ &= \frac{3 \times 18030 \times 40}{2 \times 21,46 \times 7,82^2} \\ &= 824,34 \text{ N/mm}^2 \end{aligned}$$

b) Spesimen uji *bending* raw matrial ke-2

$$\begin{aligned} P_{\max} &= 18,01 \text{ KN} \\ &= 18,0 \times 1000 \\ &= 18010 \text{ N} \end{aligned}$$

$$\text{Lebar (b)} = 10,83 \text{ mm}$$

$$\text{Tebal (d)} = 7,92 \text{ mm}$$

$$\text{Jarak tumpul (L)} = 40 \text{ mm}$$

$$\begin{aligned} \sigma_b &= \frac{3 \times P_{\max} \times L}{2 \times b \times d^2} \\ &= \frac{3 \times 18010 \times 40}{2 \times 10,83 \times 7,92^2} \\ &= 1590,69 \text{ N/mm}^2 \end{aligned}$$

c) Spesimen uji *bending* raw matrial ke-3

$$\begin{aligned} P_{\max} &= 17,78 \text{ KN} \\ &= 17,78 \times 1000 \\ &= 17780 \text{ N} \end{aligned}$$

$$\text{Lebar (b)} = 10,92 \text{ mm}$$

$$\text{Tebal (d)} = 9,94 \text{ mm}$$

$$\text{Jarak tumpil (L)} = 40 \text{ mm}$$

$$\begin{aligned} \sigma_b &= \frac{3 \times P_{\max} \times L}{2 \times b \times d^2} \\ &= \frac{3 \times 17780 \times 40}{2 \times 10,92 \times 9,94^2} \\ &= 988,75 \text{ N/mm}^2 \end{aligned}$$

Nilai tegangan rata – rata *bending* variasi raw matrial dari sampel 1-3

$$\begin{aligned} \text{Rata – rata} &= \frac{\text{jumlah nilai}}{\text{banyak data}} \\ &= \frac{824,34 + 1590,69 + 988,75}{3} \\ &= 1134,59 \text{ Mpa} \end{aligned}$$

a) Spesimen uji *bending* variasi arus 70A ke-1

$$\begin{aligned} P_{\max} &= 15,96 \text{ KN} \\ &= 15,96 \times 1000 \\ &= 15960 \text{ N} \end{aligned}$$

$$\text{Lebar (b)} = 10,03 \text{ mm}$$

$$\text{Tebal (d)} = 10,51 \text{ mm}$$

$$\text{Jarak Tumpul (L)} = 40 \text{ mm}$$

$$\begin{aligned}\sigma_b &= \frac{3 \times P_{\max} \times L}{2 \times b \times d^2} \\ &= \frac{3 \times 15960 \times 40}{2 \times 10,03 \times 10,51^2} \\ &= 864,33 \text{ N/mm}^2\end{aligned}$$

b) Spesimen uji *bending* variasi arus 70A ke-2

$$\begin{aligned}P_{\max} &= 16,76 \text{ KN} \\ &= 16,76 \times 1000 \\ &= 16760 \text{ N}\end{aligned}$$

$$\text{Lebar (b)} = 10,85 \text{ mm}$$

$$\text{Tebal (d)} = 9,93 \text{ mm}$$

$$\text{Jarak tumpul (L)} = 40 \text{ mm}$$

$$\begin{aligned}\sigma_b &= \frac{3 \times P_{\max} \times L}{2 \times b \times d^2} \\ &= \frac{3 \times 16760 \times 40}{2 \times 10,85 \times 9,93^2} \\ &= 939,93 \text{ N/mm}^2\end{aligned}$$

c) Spesimen uji *bending* variasi arus 70A ke-3

$$\begin{aligned}P_{\max} &= 17,56 \text{ KN} \\ &= 17,56 \times 1000 \\ &= 17560 \text{ N}\end{aligned}$$

$$\text{Lebar (b)} = 10,18 \text{ mm}$$

$$\text{Tebal (d)} = 10,26 \text{ mm}$$

$$\text{Jarak tumpul (L)} = 40 \text{ mm}$$

$$\sigma_b = \frac{3 \times P_{\max} \times L}{2 \times b \times d^2}$$

$$= \frac{3 \times 17560 \times 40}{2 \times 10,18 \times 10,26^2}$$

$$= 983,18 \text{ N/mm}^2$$

Nilai tegangan rata – rata *bending* variasi arus 70A dari sampel 1-3

$$\text{Rata – rata} = \frac{\text{jumlah nilai}}{\text{Banyak data}}$$

$$= \frac{864,33 + 939,93 + 983,18}{3}$$

$$= 929,15 \text{ Mpa}$$

a) Spesimen uji *bending* variasi arus 80A ke-1

$$P_{\max} = 16,26 \text{ KN}$$

$$= 16,26 \times 1000$$

$$= 16260 \text{ N}$$

$$\text{Lebar (b)} = 10,45 \text{ mm}$$

$$\text{Tebal (d)} = 9,42 \text{ mm}$$

$$\text{Jarak tumpul (L)} = 40 \text{ mm}$$

$$\sigma_b = \frac{3 \times P_{\max} \times L}{2 \times b \times d^2}$$

$$= \frac{3 \times 16260 \times 40}{2 \times 10,45 \times 9,42^2}$$

$$= 1048,08 \text{ N/mm}^2$$

b) Spesimen uji *bending* variasi arus 80A ke-2

$$P_{\max} = 16,67 \text{ KN}$$

$$= 16,67 \times 1000$$

$$= 16670 \text{ N}$$

$$\text{Lebar (b)} = 10,21 \text{ mm}$$

$$\text{Tebal (d)} = 9,36 \text{ mm}$$

$$\text{Jarak tumpul (L)} = 40 \text{ mm}$$

$$\begin{aligned}\sigma_b &= \frac{3 \times P_{\max} \times L}{2 \times b \times d^2} \\ &= \frac{3 \times 16670 \times 40}{2 \times 10,21 \times 9,36^2} \\ &= 1118,17 \text{ N/mm}^2\end{aligned}$$

c) Spesimen uji *bending* variasi arus 80A ke-3

$$\begin{aligned}P_{\max} &= 16,84 \text{ KN} \\ &= 16,84 \times 1000 \\ &= 16840 \text{ N}\end{aligned}$$

$$\text{Lebar (b)} = 10,40 \text{ mm}$$

$$\text{Tebal (d)} = 9,27 \text{ mm}$$

$$\text{Jarak tumpul (L)} = 40 \text{ mm}$$

$$\begin{aligned}\sigma_b &= \frac{3 \times P_{\max} \times L}{2 \times b \times d^2} \\ &= \frac{3 \times 16840 \times 40}{2 \times 10,40 \times 9,27^2} \\ &= 1130,58 \text{ N/mm}^2\end{aligned}$$

Nilai tegangan rata – rata *bending* variasi arus 80A dari sampel 1-3

$$\begin{aligned}\text{Rata – rata} &= \frac{\text{Jumlah nilai}}{\text{Banyak data}} \\ &= \frac{1048,08 + 1118,17 + 1130,58}{3} \\ &= 1098,94 \text{ Mpa}\end{aligned}$$

a) Spesimen uji *bending* variasi arus 90A ke-1

$$\begin{aligned}P_{\max} &= 17,58 \text{ KN} \\ &= 17,58 \times 1000 \\ &= 17580 \text{ N}\end{aligned}$$

$$\text{Lebar (b)} = 10,54 \text{ mm}$$

$$\text{Tebal (d)} = 9,90 \text{ mm}$$

$$\text{Jarak tumpul (L)} = 40 \text{ mm}$$

$$\begin{aligned}\sigma_b &= \frac{3 \times P_{\max} \times L}{2 \times b \times d^2} \\ &= \frac{3 \times 17580 \times 40}{2 \times 10,54 \times 9,90^2} \\ &= 1021,08 \text{ N/mm}^2\end{aligned}$$

b) Spesimen uji bending variasi arus 90A ke-2

$$\begin{aligned}P_{\max} &= 16,91 \text{ KN} \\ &= 16,91 \times 1000 \\ &= 16910 \text{ N}\end{aligned}$$

$$\text{Lebar (b)} = 10,66 \text{ mm}$$

$$\text{Tebal (d)} = 9,45 \text{ mm}$$

$$\text{Jarak tumpul (L)} = 40 \text{ mm}$$

$$\begin{aligned}\sigma_b &= \frac{3 \times P_{\max} \times L}{2 \times b \times d^2} \\ &= \frac{3 \times 16910 \times 40}{2 \times 10,66 \times 9,45^2} \\ &= 1065,80 \text{ N/mm}^2\end{aligned}$$

c) Spesimen uji bending variasi arus 90A ke-3

$$\begin{aligned}P_{\max} &= 16,94 \text{ KN} \\ &= 16,94 \times 1000 \\ &= 16940 \text{ N}\end{aligned}$$

$$\text{Lebar (b)} = 10,34 \text{ mm}$$

$$\text{Tebal (d)} = 9,75 \text{ mm}$$

$$\text{Jarak tumpul (L)} = 40 \text{ mm}$$

$$\begin{aligned}\sigma_b &= \frac{3 \times P_{\max} \times L}{2 \times b \times d^2} \\ &= \frac{3 \times 16940 \times 40}{2 \times 10,34 \times 9,75^2}\end{aligned}$$

$$= 1034,03 \text{ N/mm}^2$$

Nilai tegangan rata – rata *bending* variasi arus 90A dari sampel 1-3

$$\begin{aligned} \text{Rata – rata} &= \frac{\text{Jumlah nilai}}{\text{Banyak data}} \\ &= \frac{1021,08 + 1065,80 + 1034,03}{3} \\ &= 1040,30 \text{ Mpa} \end{aligned}$$

3. Uji Impak

a) Spesimen uji impak raw material ke-1

Lebar spesimen (l) : 7,87 mm

Tinggi spesimen (t) : 8,40 mm

Luas (A_0) : 66,11 mm²

Sudut α : 151°

Sudut β : 51°

Panjang lengan (r) : 0,8 m

Percepatan gravitasi (g) : 9,81 m/s² = 10 m/s²

Berat pendulum (m) : 20 Kg

$$\begin{aligned} 1) \text{ Energi Terserap} &= m \times g \times r (\cos \beta - \cos \alpha) \\ &= 20 \text{ kg} \times 10 \text{ m/s}^2 \times 0,8 \text{ m} (\cos 51 - \cos 151) \\ &= 160 \text{ Kg.m}^2/\text{s}^2 (0,62932 - (-0,87461)) \\ &= 160 \times 1,50393 \\ &= 240,6288 \text{ Kg.m}^2/\text{s}^2 = 240,6 \text{ J} \end{aligned}$$

$$\begin{aligned} 2) \text{ Harga Impak} &= \frac{\text{Energi terserap}}{A_0} \\ &= \frac{240,6 \text{ J}}{66,11 \text{ mm}^2} \end{aligned}$$

$$= 3,640 \text{ J/mm}^2$$

b) Spesimen uji impak raw material ke-2

Lebar spesimen (l) : 7,84 mm

Tinggi spesimen (t) : 9,64 mm

Luas (A_0) : 75,6 mm²

Sudut α : 151°

Sudut β : 45°

Panjang lengan (r) : 0,8 m

Percepatan gravitasi (g) : 9,81 m/s² = 10 m/s²

Berat pendulum (m) : 20 Kg

$$\begin{aligned} 1) \text{ Energi Terserap} &= m \times g \times r (\cos \beta - \cos \alpha) \\ &= 20 \text{ kg} \times 10 \text{ m/s}^2 \times 0,8 \text{ m} (\cos 45 - \cos 151) \\ &= 160 \text{ Kg.m}^2/\text{s}^2 (0,70710 - (-0,87461)) \\ &= 160 \times 1,58171 \\ &= 253,0736 \text{ Kg.m}^2/\text{s}^2 = 253,1 \text{ J} \end{aligned}$$

$$\begin{aligned} 2) \text{ Harga Impak} &= \frac{\text{Energi terserap}}{A_0} \\ &= \frac{253,1 \text{ J}}{75,6 \text{ mm}^2} \\ &= 3,349 \text{ J/mm}^2 \end{aligned}$$

c) Spesimen uji impak raw material ke-3

Lebar spesimen (l) : 7,85 mm

Tinggi spesimen (t) : 8,26 mm

Luas (A_0) : 64,84 mm²

Sudut α : 151°

Sudut β : 45°

Panjang lengan (r) : 0,8 m

Percepatan gravitasi (g) : $9,81 \text{ m/s}^2 = 10 \text{ m/s}^2$

Berat pendulum (m) : 20 Kg

$$\begin{aligned}
 1) \text{ Energi Terserap} &= m \times g \times r (\cos \beta - \cos \alpha) \\
 &= 20 \text{ kg} \times 10 \text{ m/s}^2 \times 0,8 \text{ m} (\cos 45 - \cos 151) \\
 &= 160 \text{ Kg.m}^2 / \text{s}^2 (0,70710 - (-0,87461)) \\
 &= 160 \times 1,58171 \\
 &= 253,0736 \text{ Kg.m}^2 / \text{s}^2 = 253,1 \text{ J}
 \end{aligned}$$

$$\begin{aligned}
 2) \text{ Harga Impak} &= \frac{\text{Energi terserap}}{A_0} \\
 &= \frac{253,1 \text{ J}}{64,84 \text{ mm}^2} \\
 &= 3,903 \text{ J/mm}^2
 \end{aligned}$$

Nilai rata – rata harga impact variasi raw material dari sampel 1-3

$$\begin{aligned}
 \text{Rata – rata} &= \frac{\text{jumlah nilai}}{\text{banyak data}} \\
 &= \frac{3,640 + 3,349 + 3,903}{3} \\
 &= 3,631 \text{ J/mm}^2
 \end{aligned}$$

a) Spesimen uji impact variasi arus 70A ke-1

Lebar spesimen (l) : 9,15 mm

Tinggi spesimen (t) : 9,20 mm

Luas (A_0) : $84,2 \text{ mm}^2$

Sudut α : 151°

Sudut β : 106°

Panjang lengan (r) : 0,8 m

Percepatan gravitasi (g) : $9,81 \text{ m/s}^2 = 10 \text{ m/s}^2$

Berat pendulum (m) : 20 Kg

$$\begin{aligned}
 1) \text{ Energi Terserap} &= m \times g \times r (\cos \beta - \cos \alpha) \\
 &= 20 \text{ kg} \times 10 \text{ m/s}^2 \times 0,8 \text{ m} (\cos 106 - \cos 151) \\
 &= 160 \text{ Kg.m}^2 / \text{s}^2 (-0,27563 - (-0,87461)) \\
 &= 160 \times 0,59898 \\
 &= 95,8368 \text{ Kg.m}^2 / \text{s}^2 = 95,8 \text{ J}
 \end{aligned}$$

$$\begin{aligned}
 2) \text{ Harga Impak} &= \frac{\text{Energi terserap}}{A_0} \\
 &= \frac{95,8 \text{ J}}{84,2 \text{ mm}^2} \\
 &= 1,138 \text{ J/mm}^2
 \end{aligned}$$

b) Spesimen uji impact variasi arus 70A ke-2

Lebar spesimen (l) : 9,52 mm

Tinggi spesimen (t) : 9,29 mm

Luas (A_0) : $88,4 \text{ mm}^2$

Sudut α : 151°

Sudut β : 103°

Panjang lengan (r) : 0,8 m

Percepatan gravitasi (g) : $9,81 \text{ m/s}^2 = 10 \text{ m/s}^2$

Berat pendulum (m) : 20 Kg

$$\begin{aligned}
 1) \text{ Energi Terserap} &= m \times g \times r (\cos \beta - \cos \alpha) \\
 &= 20 \text{ kg} \times 10 \text{ m/s}^2 \times 0,8 \text{ m} (\cos 103 - \cos 151) \\
 &= 160 \text{ Kg.m}^2 / \text{s}^2 (-0,22495 - (-0,87461))
 \end{aligned}$$

$$= 160 \times 0,64966$$

$$= 103,9456 \text{ Kg.m}^2/\text{s}^2 = 103,9 \text{ J}$$

$$2) \text{ Harga Impak} = \frac{\text{Energi terserap}}{A_o}$$

$$= \frac{103,9 \text{ J}}{88,4 \text{ mm}^2}$$

$$= 1,175 \text{ J/mm}^2$$

c) Spesimen uji impact variasi arus 70A ke-3

Lebar spesimen (l) : 9,35 mm

Tinggi spesimen (t) : 8,85 mm

Luas (A_o) : 82,7 mm²

Sudut α : 151°

Sudut β : 104°

Panjang lengan (r) : 0,8 m

Percepatan gravitasi (g) : 9,81 m/s² = 10 m/s²

Berat pendulum (m) : 20 Kg

$$1) \text{ Energi Terserap} = m \times g \times r (\cos \beta - \cos \alpha)$$

$$= 20 \text{ kg} \times 10 \text{ m/s}^2 \times 0,8 \text{ m} (\cos 104 - \cos 151)$$

$$= 160 \text{ Kg.m}^2/\text{s}^2 (-0,24192 - (-0,87461))$$

$$= 160 \times 0,63269$$

$$= 101,2304 \text{ Kg.m}^2/\text{s}^2 = 101,2 \text{ J}$$

$$2) \text{ Harga Impak} = \frac{\text{Energi terserap}}{A_o}$$

$$= \frac{101,2 \text{ J}}{82,7 \text{ mm}^2}$$

$$= 1,223 \text{ J/mm}^2$$

Nilai rata – rata harga Impak variasi arus 70A dari sampel 1-3

$$\begin{aligned} \text{Rata – rata} &= \frac{\text{jumlah nilai}}{\text{banyak data}} \\ &= \frac{1,138 + 1,175 + 1,223}{3} \\ &= 1,179 \text{ J/mm}^2 \end{aligned}$$

a) Spesimen uji Impak variasi arus 80A ke-1

Lebar spesimen (l) : 9,60 mm

Tinggi spesimen (t) : 9,11 mm

Luas (A_0) : 87,5 mm²

Sudut α : 151°

Sudut β : 100°

Panjang lengan (r) : 0,8 m

Percepatan gravitasi (g) : 9,81 m/s² = 10 m/s²

Berat pendulum (m) : 20 Kg

$$\begin{aligned} 1) \text{ Energi Terserap} &= m \times g \times r (\cos \beta - \cos \alpha) \\ &= 20 \text{ kg} \times 10 \text{ m/s}^2 \times 0,8 \text{ m} (\cos 100 - \cos 151) \\ &= 160 \text{ Kg m}^2 / \text{s}^2 (-0,17364 - (-0,87461)) \\ &= 160 \times 0,70097 \\ &= 112,1552 \text{ Kg.m}^2 / \text{s}^2 = 112,2 \text{ J} \end{aligned}$$

$$\begin{aligned} 2) \text{ Harga Impak} &= \frac{\text{Energi terserap}}{A_0} \\ &= \frac{112,2 \text{ J}}{87,5 \text{ mm}^2} \\ &= 1,282 \text{ J/mm}^2 \end{aligned}$$

b) Spesimen uji Impak variasi arus 80A ke-2

Lebar spesimen (l)	: 9,44 mm
Tinggi spesimen (t)	: 9,01 mm
Luas (A_0)	: 85,05 mm ²
Sudut α	: 151°
Sudut β	: 115°
Panjang lengan (r)	: 0,8 m
Percepatan gravitasi (g)	: 9,81 m/s ² = 10 m/s ²
Berat pendulum (m)	: 20 Kg

$$\begin{aligned}
 1) \text{ Energi Terserap} &= m \times g \times r (\cos \beta - \cos \alpha) \\
 &= 20 \text{ kg} \times 10 \text{ m/s}^2 \times 0,8 \text{ m} (\cos 115 - \cos 151) \\
 &= 160 \text{ Kg.m}^2 / \text{s}^2 (-0,42261 - (-0,87461)) \\
 &= 160 \times 0,452 \\
 &= 72,32 \text{ Kg.m}^2 / \text{s}^2 = 72,3 \text{ J}
 \end{aligned}$$

$$\begin{aligned}
 2) \text{ Harga Impak} &= \frac{\text{Energi terserap}}{A_0} \\
 &= \frac{72,3 \text{ J}}{85,05 \text{ mm}^2} \\
 &= 0,850 \text{ J/mm}^2
 \end{aligned}$$

c) Spesimen uji Impak variasi arus 80A ke-3

Lebar spesimen (l)	: 9,65 mm
Tinggi spesimen (t)	: 8,86 mm
Luas (A_0)	: 85,5 mm ²
Sudut α	: 151°
Sudut β	: 103°

Panjang lengan (r) : 0,8 m

Percepatan gravitasi (g) : $9,81 \text{ m/s}^2 = 10 \text{ m/s}^2$

Berat pendulum (m) : 20 Kg

$$\begin{aligned}
 1) \text{ Energi Terserap} &= m \times g \times r (\cos \beta - \cos \alpha) \\
 &= 20 \text{ kg} \times 10 \text{ m/s}^2 \times 0,8 \text{ m} (\cos 103 - \cos 151) \\
 &= 160 \text{ Kg.m}^2 / \text{s}^2 (-0,22495 - (-0,87461)) \\
 &= 160 \times 0,64966 \\
 &= 103,9456 \text{ Kg.m}^2 / \text{s}^2 = 103,9 \text{ J}
 \end{aligned}$$

$$\begin{aligned}
 2) \text{ Harga Impak} &= \frac{\text{Energi terserap}}{A_0} \\
 &= \frac{103,9 \text{ J}}{85,5 \text{ mm}^2} \\
 &= 1,216 \text{ J/mm}^2
 \end{aligned}$$

Nilai rata – rata harga Impak variasi arus 80A dari sampel 1-3

$$\begin{aligned}
 \text{Rata – rata} &= \frac{\text{jumlah nilai}}{\text{banyak data}} \\
 &= \frac{1,282 + 0,850 + 1,216}{3} \\
 &= 1,116 \text{ J/mm}^2
 \end{aligned}$$

a) Spesimen uji Impak variasi arus 90A ke-1

Lebar spesimen (l) : 10,05 mm

Tinggi spesimen (t) : 8,76 mm

Luas (A_0) : $88,0 \text{ mm}^2$

Sudut α : 151°

Sudut β : 102°

Panjang lengan (r) : 0,8 m

Percepatan gravitasi (g) : $9,81 \text{ m/s}^2 = 10 \text{ m/s}^2$

Berat pendulum (m) : 20 Kg

$$\begin{aligned}
 1) \text{ Energi Terserap} &= m \times g \times r (\cos \beta - \cos \alpha) \\
 &= 20 \text{ kg} \times 10 \text{ m/s}^2 \times 0,8 \text{ m} (\cos 102 - \cos 151) \\
 &= 160 \text{ Kg m}^2 / \text{s}^2 (-0,20791 - (-0,87461)) \\
 &= 160 \times 0,6667 \\
 &= 106,672 \text{ Kg.m}^2 / \text{s}^2 = 106,7 \text{ J}
 \end{aligned}$$

$$\begin{aligned}
 2) \text{ Harga Impak} &= \frac{\text{Energi terserap}}{A_0} \\
 &= \frac{106,7 \text{ J}}{88,0 \text{ mm}^2} \\
 &= 1,212 \text{ J/mm}^2
 \end{aligned}$$

b) Spesimen uji Impak variasi arus 90A ke-2

Lebar spesimen (l) : 10,12 mm

Tinggi spesimen (t) : 8,96 mm

Luas (A_0) : $90,7 \text{ mm}^2$

Sudut α : 151°

Sudut β : 105°

Panjang lengan (r) : 0,8 m

Percepatan gravitasi (g) : $9,81 \text{ m/s}^2 = 10 \text{ m/s}^2$

Berat pendulum (m) : 20 Kg

$$\begin{aligned}
 1) \text{ Energi Terserap} &= m \times g \times r (\cos \beta - \cos \alpha) \\
 &= 20 \text{ kg} \times 10 \text{ m/s}^2 \times 0,8 \text{ m} (\cos 105 - \cos 151) \\
 &= 160 \text{ Kg m}^2 / \text{s}^2 (-0,25881 - (-0,87461)) \\
 &= 160 \times 0,6158
 \end{aligned}$$

$$= 98,528 \text{ Kg.m}^2/\text{s}^2 = 98,5 \text{ J}$$

$$\begin{aligned} 2) \text{ Harga Impak} &= \frac{\text{Energi terserap}}{A_0} \\ &= \frac{98,5 \text{ J}}{90,7 \text{ mm}^2} \\ &= 1,087 \text{ J/mm}^2 \end{aligned}$$

c) Spesimen uji Impak variasi arus 90A ke-3

Lebar spesimen (l) : 9,48 mm

Tinggi spesimen (t) : 9,01 mm

Luas (A_0) : 85,4 mm²

Sudut α : 151°

Sudut β : 97°

Panjang lengan (r) : 0,8 m

Percepatan gravitasi (g) : 9,81 m/s² = 10 m/s²

Berat pendulum (m) : 20 Kg

$$\begin{aligned} 1) \text{ Energi Terserap} &= m \times g \times r (\cos \beta - \cos \alpha) \\ &= 20 \text{ kg} \times 10 \text{ m/s}^2 \times 0,8 \text{ m} (\cos 97 - \cos 151) \\ &= 160 \text{ Kg.m}^2 / \text{s}^2 (-0,12186 - (-0,87461)) \\ &= 160 \times 0,75275 \\ &= 120,44 \text{ Kg.m}^2/\text{s}^2 = 120,4 \text{ J} \end{aligned}$$

$$\begin{aligned} 2) \text{ Harga Impak} &= \frac{\text{Energi terserap}}{A_0} \\ &= \frac{120,4 \text{ J}}{85,4 \text{ mm}^2} \\ &= 1,410 \text{ J/mm}^2 \end{aligned}$$

Nilai rata – rata harga Impak variasi arus 90A dari sampel 1-3

$$\begin{aligned}\text{Rata – rata} &= \frac{\text{jumlah nilai}}{\text{banyak data}} \\ &= \frac{1,212 + 1,087 + 1,410}{3} \\ &= 1,236 \text{ J/mm}^2\end{aligned}$$

Lampiran 2. Proses pembuatan spesimen









Lampiran 3. Proses pengujian spesimen



Pengujian tarik



Pengujian impak




Pengujian bending

Lampiran 4. Gambar alat



Lampiran 5. Hasil uji tarik



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HASIL PENGUJIAN TARIK

No.	Variasi Spesimen	Tebal (mm)	Lebar (mm)	Pmax (KN)	ΔL (mm)	Tegangan (MPa)	Regangan (%)
1	Raw_A	7.87	10.29	39.14	12.45	483.32	24.90
2	Raw_B	8.00	10.24	48.02	11.02	586.18	22.04
3	Raw_C	8.00	10.16	49.37	9.62	607.41	19.24
4	70A_A	9.50	10.10	44.64	6.27	465.24	12.54
5	70A_B	9.77	10.34	44.23	5.32	437.83	10.64
6	70A_C	9.48	10.27	45.29	0.07	465.18	0.14
7	80A_A	9.38	10.13	44.92	9.14	472.75	18.28
8	80A_B	10.25	10.19	45.09	12.18	431.70	24.36
9	80A_C	9.71	9.87	44.57	9.77	465.06	19.54
10	90A_A	9.68	9.90	42.93	11.66	447.97	23.32
11	90A_B	10.07	10.25	45.50	10.27	440.82	20.54
12	90A_C	10.72	10.03	44.84	8.97	417.03	17.94

Lembar asli, tidak untuk digandakan

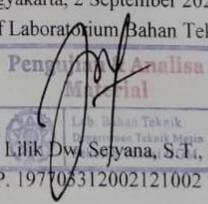
Keterangan:

- Pengujian dilakukan tanggal 2 September 2024
- Pengujian menggunakan Universal Testing Machine
- Standar spesimen menggunakan ASTM E8

Identitas Penguji :

Nama : Moh. Fariz Pratama Putra
NPM : 6420600018
Institusi : Universitas Pancasakti Tegal

Yogyakarta, 2 September 2024
Staf Laboratorium Bahan Teknik



Dr. Lilik Dwi Setyana, S.Ti, M.T
NIP. 197706312002121002

Kampus : Jl. Grafika 2A Yogyakarta 55281

Lampiran 6. Hasil pengujian bending



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HASIL PENGUJIAN BENDING

No.	Variasi Spesimen	Tebal	Lebar	Pmax	Defleksi	Tegangan
		(mm)	(mm)	(KN)	(mm)	Bending (MPa)
1	Raw_A	7.82	21.46	18.03	29.06	824.34
2	Raw_B	7.92	10.83	18.01	29.85	1590.69
3	Raw_C	9.94	10.92	17.78	28.33	988.75
4	70A_A	10.51	10.03	15.96	19.21	864.33
5	70A_B	9.93	10.85	16.76	20.58	939.93
6	70A_C	10.26	10.18	17.56	19.82	983.18
7	80A_A	9.42	10.49	16.26	19.50	1048.08
8	80A_B	9.36	10.21	16.67	29.42	1118.17
9	80A_C	9.27	10.40	16.84	29.07	1130.58
10	90A_A	9.90	10.54	17.58	21.67	1021.08
11	90A_B	9.45	10.66	16.91	24.04	1065.80
12	90A_C	9.75	10.34	16.94	22.64	1034.03

Keterangan:

1. Pengujian dilakukan tanggal 2 September 2024
2. Pengujian menggunakan Universal Testing Machine
3. Standar spesimen menggunakan ASTM E-190

Identitas Penguji :

Nama : Moh. Fariz Pratama Putra
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Institusi : Universitas Pancasakti Tegal

Yogyakarta, 2 September 2024
Staf Laboratorium Bahan Teknik



Dr. Lilik Dwi Setyana, S.T., M.T
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Lampiran 7. Hasil pengujian Impak



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HASIL PENGUJIAN IMPACT

No.	Variasi Spesimen	Sudut α (°)	Energi (J)	Sudut β (°)	Energi Terserap (J)	Luas (mm ²)	Harga Impact (J/mm ²)
1	Raw_A	151	300	51.00	240.6	66.1	3.640
2	Raw_B	151	300	45.00	253.1	75.6	3.349
3	Raw_C	151	300	45.00	253.1	64.8	3.903
4	70A_A	151	300	106.00	95.8	84.2	1.138
5	70A_B	151	300	103.00	103.9	88.4	1.175
6	70A_C	151	300	104.00	101.2	82.7	1.223
7	80A_A	151	300	100.00	112.2	87.5	1.282
8	80A_B	151	300	115.00	72.3	85.1	0.850
9	80A_C	151	300	103.00	103.9	85.5	1.216
10	90A_A	151	300	102.00	106.7	88.0	1.212
11	90A_B	151	300	105.00	98.5	90.7	1.087
12	90A_C	151	300	97.00	120.4	85.4	1.410

Keterangan :

1. Menggunakan metode Charpy
2. Standar Spesimen menggunakan ASTM E23
3. Panjang lengan 0,8 meter
4. Berat palu 20 kilogram

Identitas Penguji :

Nama : Moh. Fariz Pratama Putra
 NPM : 6420600018
 Institusi : Universitas Pancasakti Tegal

Yogyakarta, 2 September 2024
 Staf Laboratorium Bahan Teknik




Pengujian & Analisa
 Lab. Bahan Teknik
 Departemen Teknik Mesin
 Dr. Lilik Dwi Setyana, S.T., M.T
 NIP. 197703312002121002

Kampus : Jl. Grafika 2A Yogyakarta 55281

Lembar asli, tidak untuk digandakan

Lampiran 8. Sertifikat Baja ST 37



SeAH Besteel Corp.
1-6, SORYONG-DONG, KUNSAN,
CHEONGJU, KOREA(573-711)

MILL CERTIFICATE

TEL : +82-(0)63-460-8572, 8318(QA)
+82-(0)63-460-8114(Repres.)
FAX : +82-(0)63-460-8423 Page(0/0)

Date : 2018-03-11	Steel Grade : AISI 1037/ST37	Size (mm) : 8 X 1200
Cert. No. : 201803-019834	Shape of Product : PLATE BAR	Length (mm) : 2400
Customer : +	Delivery Condition : FOUR SQUARE PLATE	Weight (kg) : 230
Heat No. : 300046		Quantity(pcs) : 1,000

Inspection Items	Chemical Composition (wt. %)				
	C	SI	MN	P	S
	x 100	x 100	x 100	x 1000	x 1000
Spec.	Min.	17	0.7	40	35
	Max.	40	1		
	Result	37	37	0.8	MAX

Inspection Items	Product Hardness (HB)		
	SURFACE	100-120 HB	10-30 HRC

Mechanical Properties AISI 1037/ST37

Mechanical Properties	Symbol	Steel
Young's modulus (GPa)	E	190
Poisson's ratio	v	0,29
Density(Kg/m ³)	P	7,740
Yield strength (MPa)	Sy	540
Shear strength (MPa)	Ss	340
Extension ratio (%)		14 - 20
Area reduction (Psi)		40 - 45
Hardness (Hb)	Hb	100 - 120

<<Remarks>>

B/DS : 4

----- End of report -----

We hereby certify that the material described herein has been made in accordance with the rules of the contract.

Certified by *O. Y. Cho*