LAMPIRAN 1 – Perhitungan Momen Inersia dan
Modulus Elastisitas Penampang Komposit

DATA PERENCANAAN :

Kuat tekan balok,f'$_c$ = 20,722 Mpa

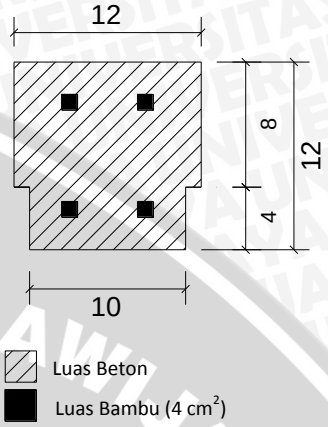
Selimut Beton = 2 cm

As (Luas tulangan tarik) = 2 cm$^2$

$E_{bambu}$ = 166703 kg/cm$^2$

$E_{beton} = 4700\sqrt{f'_c} = 4700\sqrt{20{,}722}$

= 21395,0691 Mpa = 209819,954 kg/cm$^2$




PERHITUNGAN :

$$n = \frac{E_{bambu}}{E_{beton}} = \frac{166703}{209819{,}954} = 0{,}7945$$

$$\bar{y} = \frac{10 \times 12 \times {}^{12}/_{2} + 0{,}7945 \times 2 \times 10 + 2 \times 1 \times 8 \times {}^{8}/_{2}}{10 \times 12 + 0{,}7945 \times 2 + 2 \times 1 \times 8}$$

$$\bar{y} = \frac{720 + 15{,}89 + 64}{120 + 1{,}589 + 16} = \frac{799{,}89}{137{,}589} = 5{,}814\ cm$$

$$I_{gt\ transformasi} = \frac{10 \times 12^3}{12} + 10 \times 12 \times (6 - 5{,}814)^2 + 0{,}7945 \times 2 \times (10 - 5{,}814)^2 + \frac{1 \times 8^3}{12} + 1 \times 8 \times (5{,}814 - 4)^2$$

$$I_{gt\ transformasi} = 1440 + 4{,}1515 + 27{,}8434 + 42{,}6667 + 26{,}3248$$

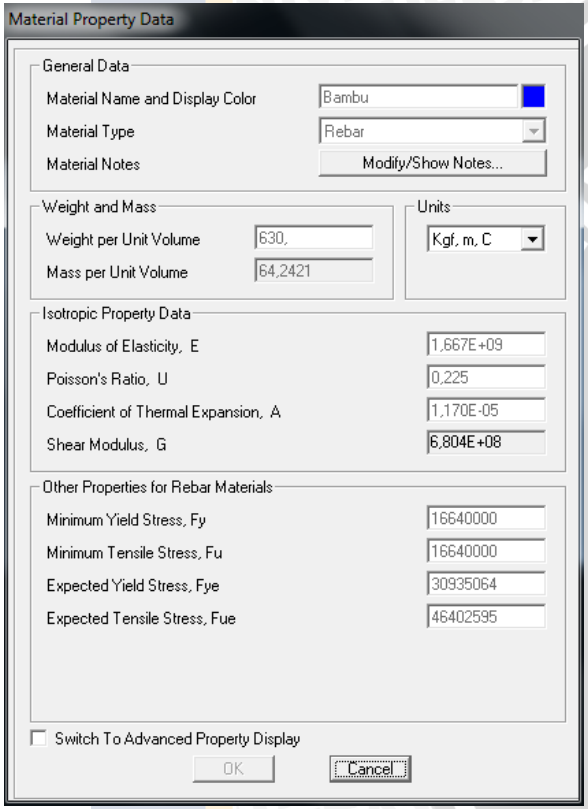
$$I_{gt\ transformasi} = 1540{,}9864\ cm^4$$

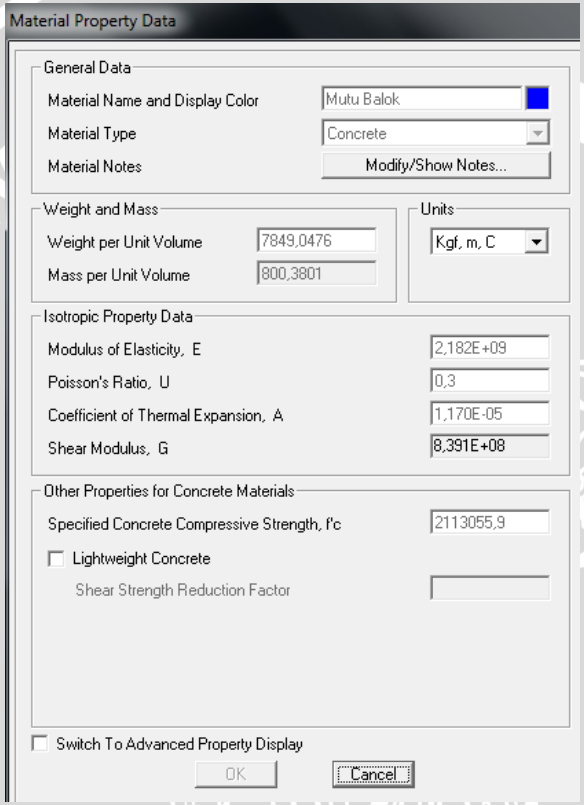
$$A_{komp} \times E_{komp} = A_{bambu} \times E_{bambu} + A_{beton} \times E_{beton}$$

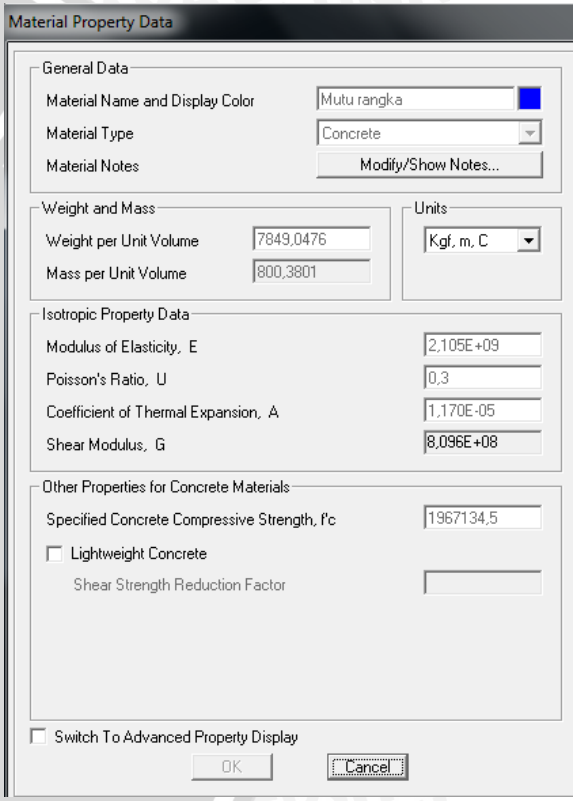
$$(12 \times 8 + 10 \times 4) \times E_{komp} = 4 \times 166703 + (12 \times 8 + 10 \times 4 - 4) \times 209819{,}954$$

$$E_{komp} = \frac{666812 + 27696233{,}93}{136} = 208551{,}808\ kg/cm^2$$

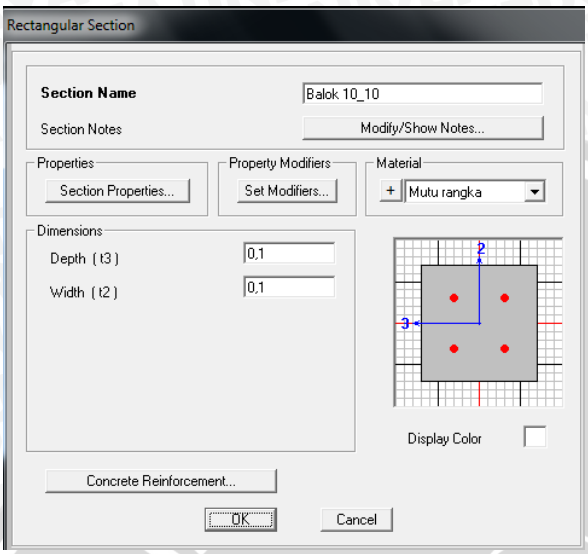
LAMPIRAN 2 - Spesifikasi Material pada Program SAP2000 v14.2.2

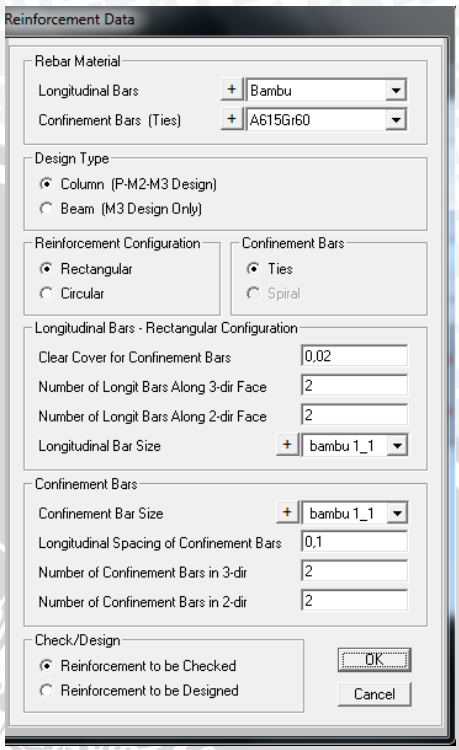


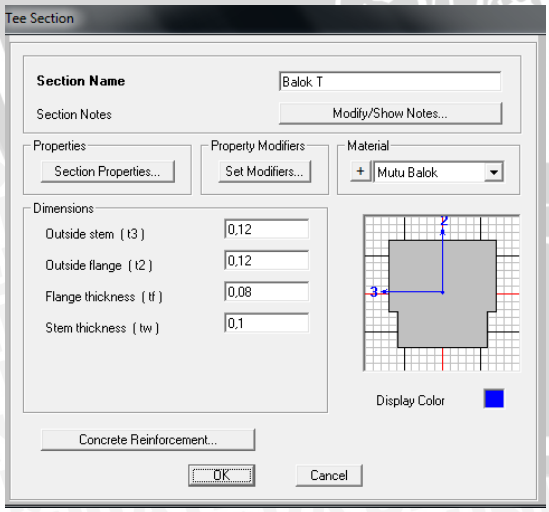



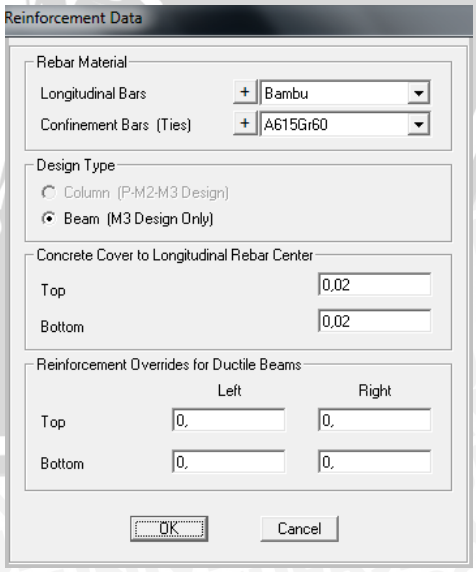



# LAMPIRAN 3 - Spesifikasi Penampang Pada SAP2000 v14.2.2

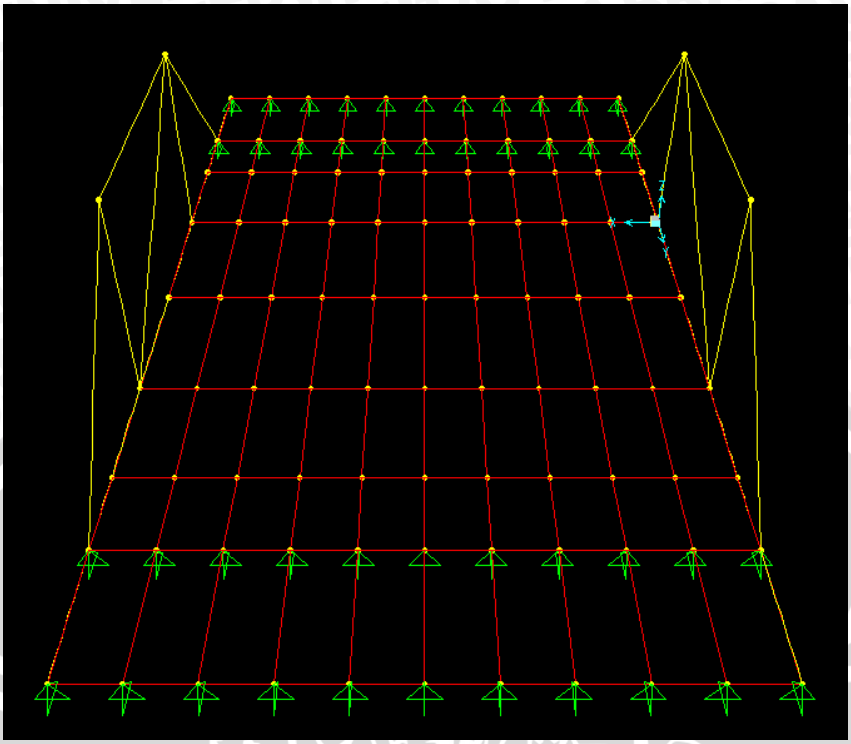


LAMPIRAN 4 – Hasil Momen, Regangan, dan Defleksi SAP2000 v14.2.2



- Akibat Beban 50 kg

| Posisi (cm) | Momen (kgm) | | Defleksi $10^{-3}$ (mm) | | Regangan $10^{-6}$ (m/m) | |
|---|---|---|---|---|---|---|
| | Balok A | Balok B | Balok A | Balok B | Balok A | Balok B |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 40 | -0,189 | -0,0602 | 0,58 | 0,19 | -0,4 | -0,1 |
| 80 | -0,4467 | -0,4534 | 1,34 | 1,36 | -1,0 | -1,0 |
| 120 | -0,0592 | -0,1906 | 0,18 | 0,58 | -0,1 | -0,4 |
| 160 | 0 | 0 | 0 | 0 | 0 | 0 |

- Akibat Beban 100 kg

| Posisi (cm) | Momen (kgm) | | Defleksi $10^{-3}$ (mm) | | Regangan $10^{-6}$ (m/m) | |
|---|---|---|---|---|---|---|
| | Balok A | Balok B | Balok A | Balok B | Balok A | Balok B |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 40 | -0,378 | -0,1205 | 1,16 | 0, 37 | -0,9 | -0,3 |
| 80 | -0,8932 | -0,9066 | 2,68 | 2,72 | -2,0 | -2,1 |
| 120 | -0,1183 | -0,3812 | 0,37 | 1,17 | -0,3 | -0,9 |
| 160 | 0 | 0 | 0 | 0 | 0 | 0 |

- Akibat Beban 150 kg

| Posisi (cm) | Momen (kgm) | | Defleksi $10^{-3}$ (mm) | | Regangan $10^{-6}$ (m/m) | |
|---|---|---|---|---|---|---|
| | Balok A | Balok B | Balok A | Balok B | Balok A | Balok B |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 40 | -0,5671 | -0,1807 | 1,75 | 0,56 | -1,3 | -0,4 |
| 80 | -1,34 | -1,3601 | 4,03 | 4,08 | -3,0 | -3,1 |
| 120 | -0,1775 | -0,5718 | 0,55 | 1,75 | -0,4 | -1,3 |
| 160 | 0 | 0 | 0 | 0 | 0 | 0 |

- Akibat Beban 290 kg

| Posisi (cm) | Momen (kgm) | | Defleksi $10^{-3}$ (mm) | | Regangan $10^{-6}$ (m/m) | |
|---|---|---|---|---|---|---|
| | Balok A | Balok B | Balok A | Balok B | Balok A | Balok B |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 40 | -1,0963 | -0,3494 | 3,38 | 1,08 | -2,5 | -0,8 |
| 80 | -2,5906 | -2,6295 | 7,79 | 7,88 | -5,9 | -6,0 |
| 120 | -0,3431 | -1,1056 | 1,06 | 3,39 | -0,8 | -2,5 |
| 160 | 0 | 0 | 0 | 0 | 0 | 0 |

LAMPIRAN 5 – Hasil Pengujian Regangan Pada Balok Melintang A dan B Pada Jembatan Komposit Bambu

A. Pembacaan Regangan Balok A

A.1 Pembacaan Akibat Beban 50 kg (permbacaan pertama)

| Posisi | Pemb. Awal | Pemb. Akhir | Regangan $10^{-6}$ (m/m) |
|---|---|---|---|
| 0 | 8572 | 8576 | 4 |
| 40 | 8584 | 8587 | 3 |
| 80 | 8584 | 8590 | 6 |
| 120 | 8595 | 8592 | -3 |
| 160 | 8593 | 8593 | 0 |

A.2 Pembacaan Akibat Beban 50 kg (permbacaan kedua)

| Posisi | Pemb. Awal | Pemb. Akhir | Regangan $10^{-6}$ (m/m) |
|---|---|---|---|
| 0 | 8599 | 8598 | - 1 |
| 40 | 8599 | 8601 | 2 |
| 80 | 8599 | 8597 | -2 |
| 120 | 8599 | 8598 | -1 |
| 160 | 8601 | 8602 | 1 |

A.3 Pembacaan Akibat Beban 50 kg (permbacaan ketiga)

| Posisi | Pemb. Awal | Pemb. Akhir | Regangan $10^{-6}$ (m/m) |
|---|---|---|---|
| 0 | 8585 | 8586 | 1 |
| 40 | 8585 | 8587 | 2 |
| 80 | 8602 | 8606 | 4 |
| 120 | 8596 | 8598 | 2 |
| 160 | 8589 | 8592 | 3 |

A.4 Pembacaan Akibat Beban 100 kg (permbacaan pertama)

| Posisi | Pemb. Awal | Pemb. Akhir | Regangan $10^{-6}$ (m/m) |
|---|---|---|---|
| 0 | 8516 | 8518 | 2 |
| 40 | 8520 | 8523 | 3 |
| 80 | 8519 | 8522 | 3 |
| 120 | 8522 | 8525 | 3 |
| 160 | 8526 | 8525 | -1 |

A.5 Pembacaan Akibat Beban 100 kg (permbacaan kedua)

| Posisi | Pemb. Awal | Pemb. Akhir | Regangan $10^{-6}$ (m/m) |
|---|---|---|---|
| 0 | 8613 | 8612 | -1 |
| 40 | 8595 | 8593 | -2 |
| 80 | 8594 | 8590 | -4 |
| 120 | 8585 | 8581 | -4 |
| 160 | 8589 | 8592 | 3 |

A.6 Pembacaan Akibat Beban 100 kg (permbacaan ketiga)

| Posisi | Pemb. Awal | Pemb. Akhir | Regangan $10^{-6}$ (m/m) |
|---|---|---|---|
| 0 | 8602 | 8604 | 2 |
| 40 | 8605 | 8604 | -1 |
| 80 | 8602 | 8598 | -4 |
| 120 | 8605 | 8602 | -3 |
| 160 | 8605 | 8602 | -3 |

A.7 Pembacaan Akibat Beban 150 kg (permbacaan pertama)

| Posisi | Pemb. Awal | Pemb. Akhir | Regangan $10^{-6}$ (m/m) |
|---|---|---|---|
| 0 | 8552 | 8556 | 4 |
| 40 | 8560 | 8555 | -5 |
| 80 | 8555 | 8553 | -2 |
| 120 | 8561 | 8559 | -2 |
| 160 | 8558 | 8557 | -1 |

A.8 Pembacaan Akibat Beban 150 kg (permbacaan kedua)

| Posisi | Pemb. Awal | Pemb. Akhir | Regangan $10^{-6}$ (m/m) |
|---|---|---|---|
| 0 | 8613 | 8608 | -5 |
| 40 | 8604 | 8601 | -3 |
| 80 | 8613 | 8605 | -8 |
| 120 | 8607 | 8604 | -3 |
| 160 | 8611 | 8608 | -3 |

A.9 Pembacaan Akibat Beban 150 kg (permbacaan ketiga)

| Posisi | Pemb. Awal | Pemb. Akhir | Regangan $10^{-6}$ (m/m) |
|---|---|---|---|
| 0 | 8610 | 8612 | 2 |
| 40 | 8616 | 8613 | -3 |
| 80 | 8627 | 8623 | -4 |
| 120 | 8626 | 8622 | -4 |
| 160 | 8628 | 8626 | -2 |

B. Pembacaan Regangan Balok B

B.1 Pembacaan Akibat Beban 50 kg (permbacaan pertama)

| Posisi | Pemb. Awal | Pemb. Akhir | Regangan $10^{-6}$ (m/m) |
|---|---|---|---|
| 0 | 7563 | 7564 | 1 |
| 40 | 7566 | 7568 | 2 |
| 80 | 7582 | 7583 | 1 |
| 120 | 7571 | 7573 | 2 |
| 160 | 7570 | 7572 | 2 |

B.2 Pembacaan Akibat Beban 50 kg (permbacaan kedua)

| Posisi | Pemb. Awal | Pemb. Akhir | Regangan $10^{-6}$ (m/m) |
|---|---|---|---|
| 0 | 7491 | 7492 | 1 |
| 40 | 7505 | 7507 | 2 |
| 80 | 7513 | 7516 | 3 |
| 120 | 7518 | 7516 | -2 |
| 160 | 7515 | 7513 | -2 |

B.3 Pembacaan Akibat Beban 50 kg (permbacaan ketiga)

| Posisi | Pemb. Awal | Pemb. Akhir | Regangan $10^{-6}$ (m/m) |
|---|---|---|---|
| 0 | 7507 | 7506 | -1 |
| 40 | 7507 | 7509 | 2 |
| 80 | 7507 | 7510 | 3 |
| 120 | 7507 | 7504 | -3 |
| 160 | 7508 | 7507 | -1 |

B.4 Pembacaan Akibat Beban 100 kg (permbacaan pertama)

| Posisi | Pemb. Awal | Pemb. Akhir | Regangan $10^{-6}$ (m/m) |
|---|---|---|---|
| 0 | 7421 | 7422 | 1 |
| 40 | 7425 | 7426 | 1 |
| 80 | 7421 | 7423 | 2 |
| 120 | 7420 | 7421 | 1 |
| 160 | 7423 | 7425 | 2 |

B.5 Pembacaan Akibat Beban 100 kg (permbacaan kedua)

| Posisi | Pemb. Awal | Pemb. Akhir | Regangan $10^{-6}$ (m/m) |
|---|---|---|---|
| 0 | 7526 | 7524 | -2 |
| 40 | 7526 | 7522 | -4 |
| 80 | 7521 | 7515 | -6 |
| 120 | 7523 | 7518 | -5 |
| 160 | 7523 | 7517 | -6 |

B.6 Pembacaan Akibat Beban 100 kg (permbacaan ketiga)

| Posisi | Pemb. Awal | Pemb. Akhir | Regangan $10^{-6}$ (m/m) |
|---|---|---|---|
| 0 | 7530 | 7533 | 3 |
| 40 | 7535 | 7532 | -3 |
| 80 | 7558 | 7553 | -5 |
| 120 | 7550 | 7547 | -3 |
| 160 | 7547 | 7545 | -2 |

B.7 Pembacaan Akibat Beban 150 kg (permbacaan pertama)

| Posisi | Pemb. Awal | Pemb. Akhir | Regangan $10^{-6}$ (m/m) |
|---|---|---|---|
| 0 | 7533 | 7530 | -3 |
| 40 | 7521 | 7525 | 4 |
| 80 | 7532 | 7529 | -3 |
| 120 | 7533 | 7526 | -7 |
| 160 | 7532 | 7529 | -3 |

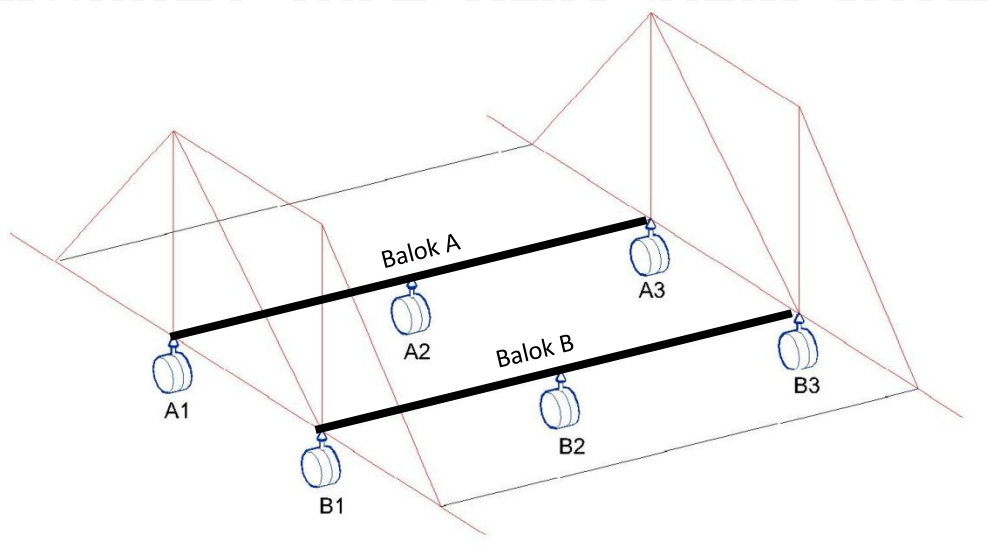
B.8 Pembacaan Akibat Beban 150 kg (permbacaan kedua)

| Posisi | Pemb. Awal | Pemb. Akhir | Regangan $10^{-6}$ (m/m) |
|---|---|---|---|
| 0 | 7528 | 7531 | 3 |
| 40 | 7538 | 7536 | -2 |
| 80 | 7541 | 7540 | -1 |
| 120 | 7542 | 7540 | -2 |
| 160 | 7546 | 7543 | -3 |

B.9 Pembacaan Akibat Beban 150 kg (permbacaan ketiga)

| Posisi | Pemb. Awal | Pemb. Akhir | Regangan $10^{-6}$ (m/m) |
|---|---|---|---|
| 0 | 7424 | 7426 | 2 |
| 40 | 7429 | 7428 | -1 |
| 80 | 7426 | 7425 | -1 |
| 120 | 7424 | 7423 | -1 |
| 160 | 7424 | 7426 | 2 |

LAMPIRAN 6 – Hasil Pengujian Defleksi (Beban 290 kg) Pada Balok Melintang A dan B Pada Jembatan Komposit Bambu



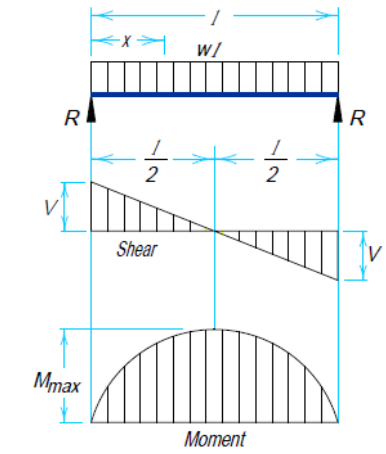

| Jarak (cm) | Defleksi (mm) | | | | | |
|---|---|---|---|---|---|---|
| | A1 | A2 | A3 | B1 | B2 | B3 |
| 0 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 |
| 40 | 0,002 | 0,007 | 0,002 | 0,000 | 0,000 | 0,000 |
| 80 | 0,002 | 0,011 | 0,002 | 0,000 | 0,003 | 0,000 |
| 120 | 0,002 | 0,005 | 0,002 | 0,000 | 0,000 | 0,000 |
| 160 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 |

| Jarak (cm) | Defleksi Aktual (mm) | |
|---|---|---|
| | $A2_{aktual}$ | $B2_{aktual}$ |
| 0 | 0,000 | 0,000 |
| 40 | 0,005 | 0,000 |
| 80 | 0,009 | 0,003 |
| 120 | 0,003 | 0,000 |
| 160 | 0,000 | 0,000 |

Defleksi aktual pada A2 = Defleksi pada A2 – Defleksi rata-rata A1 dan A3

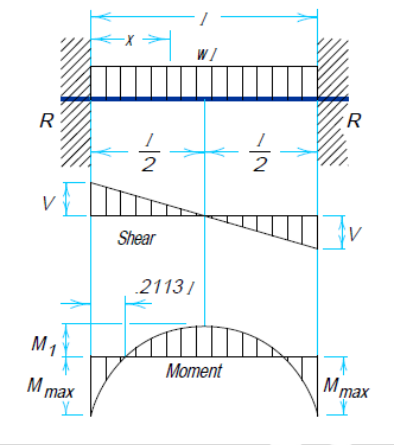
Defleksi aktual pada B2 = Defleksi pada B2 – Defleksi rata-rata B1 dan B3

LAMPIRAN 7 – Perhitungan Pemodelan Tumpuan Pada Balok Melintang Pada Jembatan Komposit Bambu




tumpuan sendi-sendi

$$M_{max}\ (at\ center) = \frac{1}{8}\ ql^2$$




tumpuan jepit-jepit

$$M_{max}\ (at\ center) = \frac{1}{24}\ ql^2$$

| Balok A | | | | | |
|---|---|---|---|---|---|
| Pembacaan | Momen Lapangan Eksperimen (kgm) | Momen Lapangan Teoritis (kgm) | | Pemodelan tumpuan (%) | |
| | | sendi-sendi | Jepit-jepit | | |
| (a) | (b) | (c) | (d) | Sendi-sendi $\frac{(c)-\lvert(b)\rvert}{(c)} \times 100\%$ | Jepit-jepit $\frac{(d)-\lvert(b)\rvert}{(d)} \times 100\%$ |
| 1 | -2,2110 | **12,5** | **4,167** | | |
| 2 | -3,3166 | | | | |
| 3 | -2,7638 | | | | |
| Rata-rata | **-2,764** | | | **77,890** | **33,669** |

| Balok B | | | | | |
|---|---|---|---|---|---|
| Pembacaan | Momen Lapangan Eksperimen (kgm) | Momen Lapangan Teoritis (kgm) | | Pemodelan tumpuan (%) | |
| | | sendi-sendi | Jepit-jepit | | |
| (a) | (b) | (c) | (d) | Sendi-sendi $\frac{(c)-\lvert(b)\rvert}{(c)} \times 100\%$ | Jepit-jepit $\frac{(d)-\lvert(b)\rvert}{(d)} \times 100\%$ |
| 1 | -1,6583 | **12,5** | **4,167** | | |
| 2 | -2,7638 | | | | |
| 3 | -2,2110 | | | | |
| Rata-rata | **-2,211** | | | **82,312** | **46,935** |
| **Analisis tumpuan** | | | | **80,101** | **40,302** |

LAMPIRAN 8 – Pengujian Tekan Beton



Komposisi benda uji : 1:2:2

Elemen Uji : Rangka

Ukuran benda uji : Kubus 15x15x15 cm

Umur benda uji : 7 hari dan 28 hari

| Benda Uji | Luas penampang ($cm^2$) | Berat (kg) | Umur (hari) | Beban Maksimum | | Kuat Tekan (28 hari) | |
|---|---|---|---|---|---|---|---|
| | | | | (kN) | (kg) | ($kg/cm^2$) | MPa |
| A1 | 225 | 7,48 | 7 | 362 | 36913,727 | 209,493 | 20,544 |
| A2 | 225 | 7,34 | 7 | 348 | 35486,124 | 201,391 | 19,750 |
| A3 | 225 | 7,42 | 7 | 361 | 36811,755 | 208,915 | 20,488 |
| A4 | 225 | 7,6 | 28 | 513 | 52311,442 | 192,971 | 18,924 |
| A5 | 225 | 7,24 | 28 | 502 | 51189,754 | 188,833 | 18,518 |
| A6 | 225 | 7,24 | 28 | 475 | 48436,520 | 178,677 | 17,522 |
| Kuat Tekan Beton Rata-rata | | | | | | 197,779 | 19,396 |

Kuat tekan beton rata-rata (f'c)

$$f'c = \frac{(209{,}493 + 201{,}391 + 208{,}915 + 199{,}366 + 188{,}833 + 178{,}677)}{6}$$

= 197,779 $kg/cm^2$ = 19,396 MPa

Komposisi benda uji : 1:2:2

Elemen Uji : Balok dan pelat

| Benda Uji | Luas penampang ($cm^2$) | Berat (kg) | Umur (hari) | Beban Maksimum | | Kuat Tekan (28 hari) | |
|---|---|---|---|---|---|---|---|
| | | | | (kN) | (kg) | ($kg/cm^2$) | MPa |
| A1 | 225 | 7,1 | 7 | 421 | 42930,053 | 243,637 | 23,893 |
| A2 | 225 | 7,26 | 7 | 409 | 41706,393 | 236,693 | 23,212 |
| A3 | 225 | 7,22 | 7 | 363 | 37015,699 | 210,072 | 20,601 |
| A4 | 225 | 7,04 | 28 | 536 | 54656,789 | 201,623 | 19,772 |
| A5 | 225 | 7,4 | 28 | 524 | 53433,130 | 197,109 | 19,330 |
| A6 | 225 | 7,12 | 28 | 475 | 48436,520 | 178,677 | 17,522 |
| Kuat Tekan Beton Rata-rata | | | | | | 211,302 | 20,722 |

Kuat tekan beton rata-rata (f'c)

$$f'c = \frac{(243,637 + 236,693 + 210,072 + 201,623 + 197,109 + 178.677)}{6}$$

= 211,302 $kg/cm^2$ = 20,722 MPa

Komposisi benda uji : 1:2:2

Elemen Uji : Abutment

| Benda Uji | Luas penampang ($cm^2$) | Berat (kg) | Umur (hari) | Beban Maksimum | | Kuat Tekan (28 hari) | |
|---|---|---|---|---|---|---|---|
| | | | | (kN) | (kg) | ($kg/cm^2$) | MPa |
| A1 | 225 | 7,7 | 7 | 451 | 45989,201 | 260,999 | 25,595 |
| A2 | 225 | 7,94 | 7 | 399 | 40686,677 | 230,906 | 22,644 |
| A3 | 225 | 7,58 | 7 | 348 | 35486,124 | 201,391 | 19,750 |
| A4 | 225 | 8,06 | 28 | 476 | 48538,492 | 179,053 | 17,559 |
| A5 | 225 | 8,08 | 28 | 637 | 64955,923 | 239,615 | 23,498 |
| A6 | 225 | 8,06 | 28 | 626 | 63834,235 | 235,477 | 23,092 |
| Kuat Tekan Beton Rata-rata | | | | | | 224,574 | 22,023 |

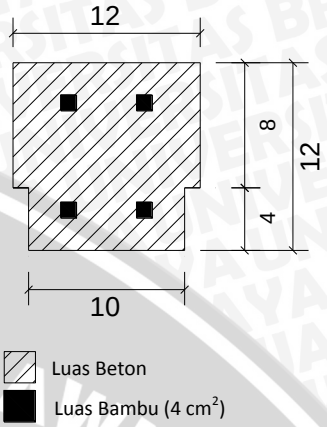
Kuat tekan beton rata-rata (f'c)

$$f'c = \frac{(260,999 + 230,906 + 201,391 + 179,053 + 239,615 + 235,574)}{6}$$

= 224,574 $kg/cm^2$ = 22,023 MPa

LAMPIRAN 9 – Perhitungan Pmax

DATA PERENCANAAN :




Kuat tekan balok,f'$_c$ = 20,722 Mpa = 3005,366 Psi

Selimut Beton = 2 cm

As (Luas tulangan tarik) = 2 cm$^2$

$E_{bambu}$ = 166703 kg/cm$^2$

$E_{beton} = 4700\sqrt{f'_c} = 4700\sqrt{20{,}722}$

= 21395,0691 Mpa = 209819,954 kg/cm$^2$

PERHITUNGAN :

$$n = \frac{E_{bambu}}{E_{beton}} = \frac{166703}{209819{,}954} = 0{,}7945$$

$$\bar{y} = \frac{10 \times 12 \times {}^{12}/_{2} + 0{,}7945 \times 2 \times 10 + 2 \times 1 \times 8 \times {}^{8}/_{2}}{10 \times 12 + 0{,}7945 \times 2 + 2 \times 1 \times 8}$$

$$\bar{y} = \frac{720 + 15{,}89 + 64}{120 + 1{,}589 + 16} = \frac{799{,}89}{137{,}589} = 5{,}814\ cm$$

$$I_{gt\ transformasi} = \frac{10 \times 12^3}{12} + 10 \times 12 \times (6 - 5{,}814)^2 + 0{,}7945 \times 2 \times (10 - 5{,}814)^2 + \frac{1 \times 8^3}{12} + 1 \times 8 \times (5{,}814 - 4)^2$$

$$I_{gt\ transformasi} = 1440 + 4{,}1515 + 27{,}8434 + 42{,}6667 + 26{,}3248$$

$$I_{gt\ transformasi} = 1540{,}9864\ cm^4$$

yt = 12 cm – 5,814 cm = 6,186 cm

$$fr = 7{,}5\sqrt{f'c} = 7{,}5\sqrt{3005{,}366\ \text{Psi}} = 411{,}159\text{Psi} = 2{,}8349\ \text{MPa} = 27{,}8013\ \text{kg/cm}^2$$

$$M_{cr} = \frac{I_{gt} \times fr}{yt} = \frac{1540{,}9864\ cm^4 \times 27{,}8013\ kg/cm^2}{6{,}186\ cm} = 6925{,}5456\ kgcm$$

$$Mcr = \frac{1}{8} \times q \times l^2$$

$$q = \frac{Mcr \times 8}{l^2} = \frac{6925{,}5456 \times 8}{100^2} = 5{,}540436\ kg/cm = 554{,}0436 kg/m$$

LAMPIRAN 10 – Dokumentasi