BAB V

ANALISA PERHITUNGAN

5.1   Data Peninjauan Konstruksi

Data perencanaan kerja proyek pada P.203 Jalan Tol Jakarta–Cikampek II *Elevated*

ini meliputi data konstruksi dan data tanah. Data tersebut adalah sebagai berikut:

5.1.1 Data Konstruksi

1.   Data Struktur Atas

Bentang antar pilar   : 60 m

Lebar *Pier head*   : 18,05 m

Panjang *Steel Box Girder*   : 60 m

Lalu lintas jalan   : 2 Jalur 4 lajur

Tinggi pilar   : beton prategang

Tinggi pilar   : 10,414 m

2.   Data Struktur Bawah

Panjang *Bore Pile*   : 40,5 m

Diameter *Bore Pile*   : 1,2 m

Jenis konstruksi   : beton bertulang

Berat jenis beton bertulang (γ)   : 2,5 t/m^2

Mutu beton borepile (fc')   : 30 Mpa
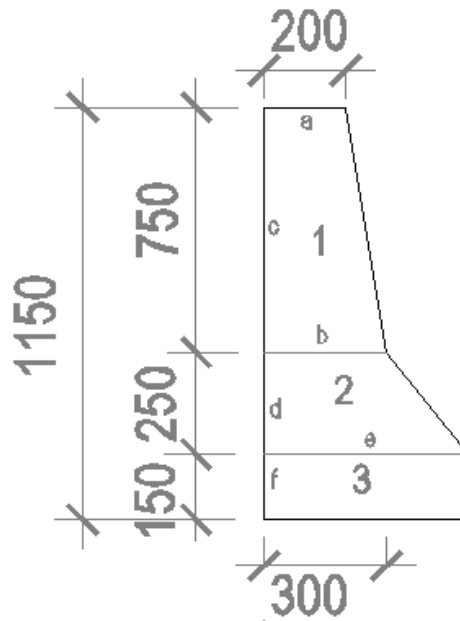
Mutu baja tulangan (fy)   : 392 Mpa

3.   Data Tanah

Standart Penetration Test (SPT)   : Terlampir

5.2   Perhitungan Beban Konstruksi

5.2.1   Beban Mati

1. Berat Barier

Gambar 5.1 Barier

Bentang   = 60 m

Berat jenis beton (γ)   = 2,5 t/m³

Jumlah Barier   = 4 buah

Luas 1 $= \frac{1}{2} \, x \, (\, a + b \,) \, x \, c$

$= \frac{1}{2} \, x \, (\, 0,2 + 0,3 \,) \, x \, 0,75$

$= 0,188 \text{ m}^2$

Luas 2 $= \frac{1}{2} \, x \, (\, b + d \,) \, x \, e$

$$= \frac{1}{2} \; x \; (\; 0,3 + 0,5 \;) \; x \; 0,25$$

$$= 0,1 \text{ m}^2$$

Luas 3   = d x f

$$= 0,5 \text{ x } 0,15$$

$$= 0,075 \text{ m}^2$$

Volume   = (Luas 1 + Luas 2 + Luas 3) x Bentang

$$= (\; 0,188 + 0,1 + 0,075 \;) \text{ x } 60$$

$$= 0,363 \text{ x } 60$$

$$= 21,78 \text{ m}^2$$

Berat   = Volume x γ x Jumlah Barier

$$= 21,78 \text{ x } 2,5 \text{ x } 4$$

$$= 217,8 \text{ t}$$

2. Berat Aspal
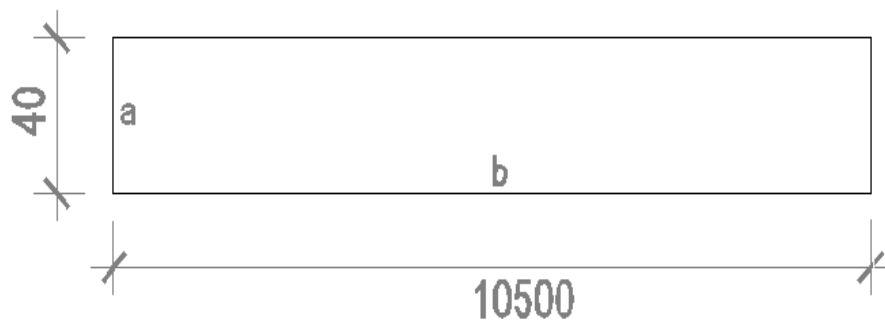
Gambar 5.2 Aspal

Bentang   = 60 m

Berat Jenis Aspal (γ)   = 2,3 t/m^3

Luas   = a x b

$$= 0,04 \text{ x } 10,5$$

$$= 0{,}42 \text{ m}^2$$

Volume $= \text{Luas x bentang}$

$$= 0{,}42 \text{ x } 60$$

$$= 25{,}2 \text{ m}^3$$

Berat $= \text{Volume x } \gamma$
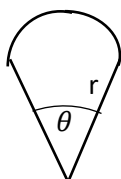
$$= 25{,}2 \text{ x } 2{,}3$$

$$= 57{,}96 \text{ t}$$

3. Berat Slab
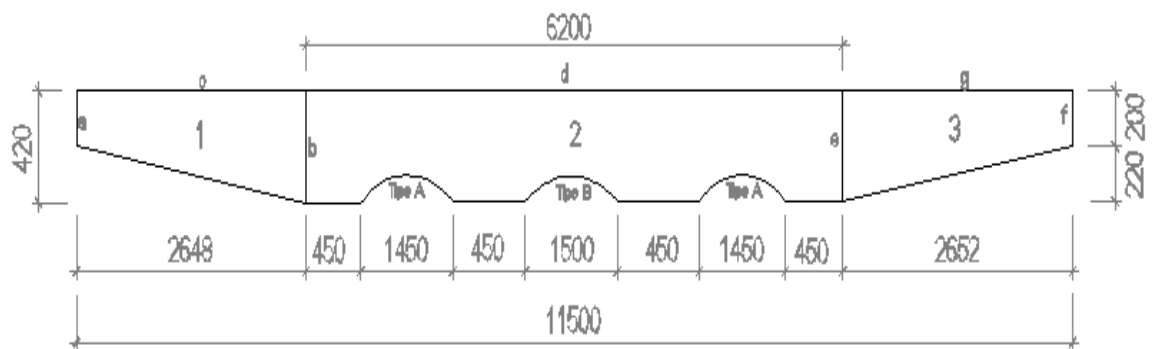
Gambar 5.3 Slab

Tipe A

r $= 1{,}6995 \text{ m}$

busur $= 1{,}7285 \text{ m}$

Tipe B
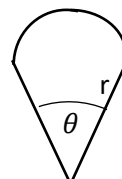
r $= 1{,}8003 \text{ m}$

busur $= 1{,}7781 \text{ m}$

Bentang $= 60 \text{ m}$

Berat jenis beton (γ) $= 2{,}5 \text{ t/m}^3$

Luas $1 = \frac{1}{2} \; x \; (\, a + b \,) \; x \; c$

$$= \frac{1}{2} \; x \; (\, 0{,}2 + 0{,}42 \,) \; x \; 2{,}648$$

$$= 0{,}820 \ \text{m}^2$$

Luas 2 = Luas persegi panjang – (2x luas Tembereng Tipe A) – Luas Tembereng

      Tipe B

- Luas Persegi Panjang   = b x d

$$= 0{,}4 \ \text{x} \ 6{,}2$$

$$= 2{,}48 \ \text{m}^2$$

- Luas Tembereng Tipe A:

$$\text{Busur} \ = \frac{\theta}{360^0} \ x \ 2 \ \pi \ r$$

$$\theta \ = \frac{Busur \ x \ 360^o}{2 \ \pi \ r}$$

$$\theta \ = \frac{1{,}7285 \ x \ 360}{2 \ x \ 3{,}14 \ x \ 1{,}6995}$$

$$\theta \ = 58{,}303^o$$

- Luas Juring $\ = \frac{\theta}{360^o} \ x \ \pi \ x \ r^2$

$$= \frac{58{,}303}{360^o} \ x \ 3{,}14 \ x \ 1{,}6995^2$$

$$= 1{,}469 \ \text{m}^2$$

- Luas segitiga $= \frac{1}{2} \ x \ r^2 \ x \sin \theta$

$$= \frac{1}{2} \ x \ 1{,}6995^2 \ x sin \ 58{,}303^o$$

$$= 1{,}229 \ \text{m}^2$$

- Luas Tembereng Tipe A   = Luas juring – luas segitiga

$$= 1{,}469 - 1{,}229$$

$$= 0{,}24 \ \text{m}^2$$

- Luas Tembereng Tipe B:

$$\text{Busur} = \frac{\theta}{360^o} \; x \; 2 \, \pi \, r$$

$$\theta = \frac{busur \; x \; 360}{2 \, \pi \, r}$$

$$\theta = \frac{1,7781 \; x \; 360}{2 \; x \; 3,14 \; x \; 1,8003}$$

$$\theta = 56,618^o$$

$$\text{Luas Juring} = \frac{\theta}{360^o} \; x \; \pi \; x \; r^2$$

$$= \frac{56,618}{360^o} \; x \; 3,14 \; x \; 1,8003^2$$

$$= 1,601 \; m^2$$

$$\text{Luas segitiga} = \frac{1}{2} \; x \; r^2 \; x \sin\theta$$

$$= \frac{1}{2} \; x \; 1,8003^2 \; x \sin 56,618^o$$

$$= 1,353 \; m^2$$

Luas Tembereng Tipe B = Luas juring – luas segitiga

$$= 1,601 - 1,353$$

$$= 0,248 \; m^2$$

Luas 2 = Luas persegi – (2 x Luas Tembereng Tipe A) – Luas Tembereng Tipe B

$$= 2,48 - (2 \; x \; 0,24) - 0,248$$

$$= 1,752 \; m^2$$

$$\text{Luas 3} = \frac{1}{2} \; x \; (e + f) \; x \; g$$

$$= \frac{1}{2} \; x \; (0,2 + 0,4) \; x \; 2,652$$

$$= 0,796 \; m^2$$

Luas Total = luas 1 + luas 2 + luas 3

$$= 0,820 + 1,752 + 0,796$$

$$= 3{,}368 \text{ m}^2$$

Volume = luas total x bentang

= 3,368 x 60

$$= 202{,}08 \text{ m}^3$$

Berat Slab = Volume x δ x jumlah slab

= 202,08 x 2,5 x 2

= 1.010,4 t

4. Berat *Steel Box Girder*
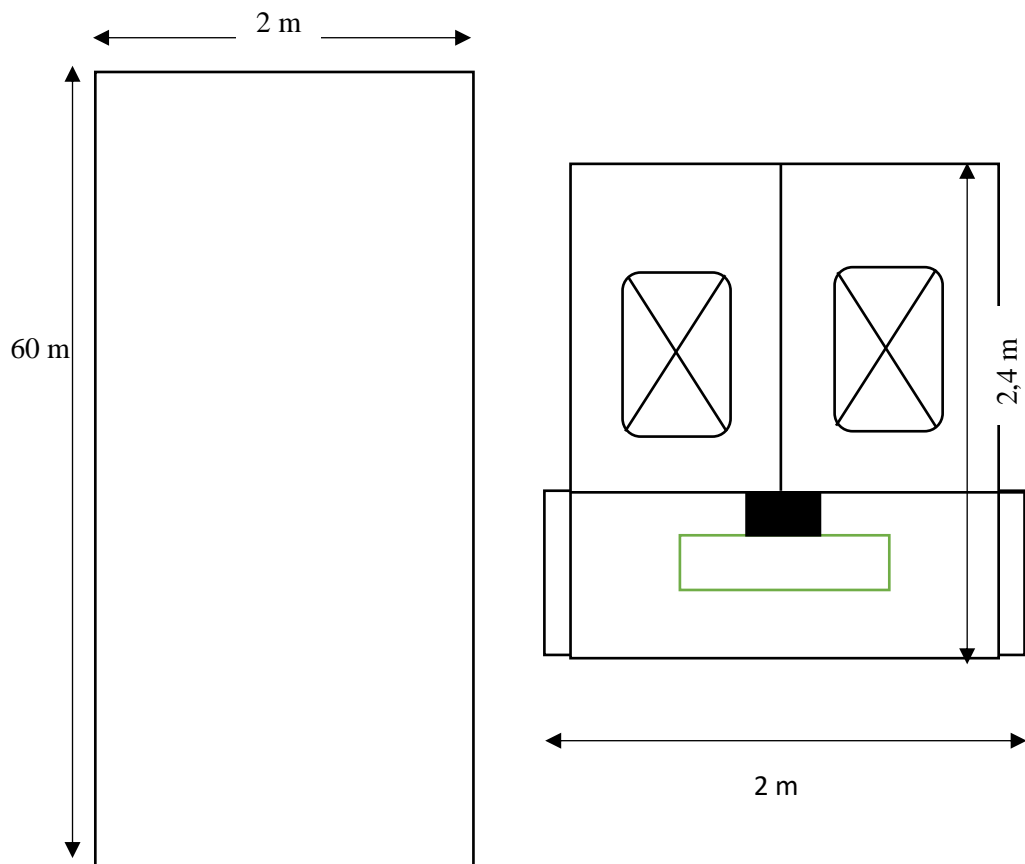
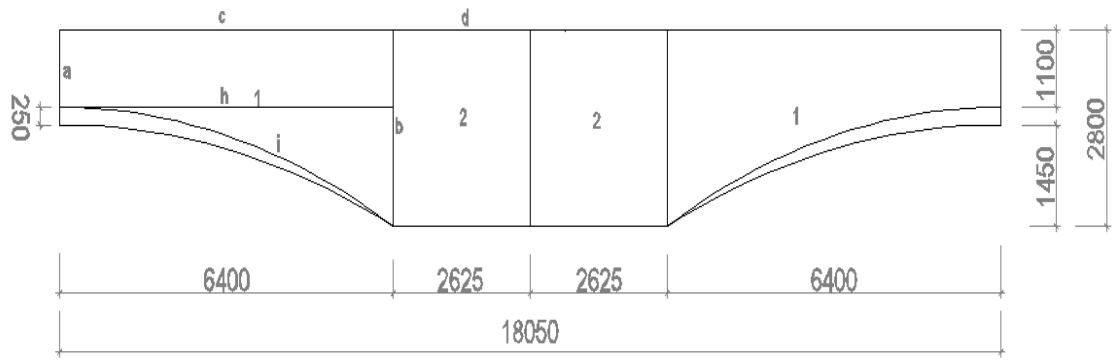**Gambar 5.4** *Steel Box Girder*

Jumlah *Girder* = 4 buah

Berat 1 *Girder* = 75.911,29 kg

$\qquad$ = 75,911 t

Berat 2 *Girder* = 2 x 75,911

$\qquad$ = 151,822 t

5. Berat *Pier Head*

Gambar 5.5 *Pier Head*
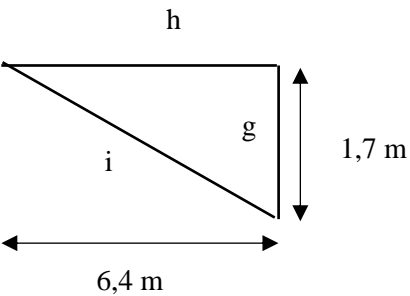
Bentang $\qquad$ = 3 m

Berat Jenis Beton (γ) = 2,5 t/m^3

Volume 1 $\qquad = (\frac{1}{2} \, x \, (\, a + b \,) \, x \, c \,) \, x$ Bentang

$\qquad = (\frac{1}{2} \, x \, (\, 1,35 + 2,8 \,) \, x \, 6,4 \,) \, x \, 3$

$\qquad = 39,84$ m^3

Volume 2 $\qquad$ = b x d x Bentang

$\qquad$ = 2,8 x 2,625 x 3

$\qquad$ = 22,05 m^3

Panjang i   =

$i \quad = \sqrt{g^2 + h^2}$

$\quad\quad = \sqrt{1,7^2 + 6,4^2}$

$\quad\quad = \sqrt{43,85}$

$\quad\quad = 6,62 \text{ m}$

Volume 3 $= \left(\frac{1}{2} x\, e\, x\, f \right) x\, i$

$\quad\quad\quad = \left(\frac{1}{2} x\, 0,25\, x\, 1 \right) x\, 6,62$

$\quad\quad\quad = 0,828 \text{ m}^2$

Volume Total $= (2 \text{ x } (\text{volume 1} + \text{volume 2})) - (4 \text{ x volume 3})$

$\quad\quad\quad = (2 \text{ x } (39,84 + 22,05)) - (4 \text{ x } 0,828)$

$\quad\quad\quad = (2 \text{ x } 61,89) - (3,312)$

$\quad\quad\quad = 123,78 - 3,312$

$\quad\quad\quad = 120,468 \text{ m}^3$

Berat $= \text{Volume Total x } \gamma$

$\quad\quad\quad = 120,468 \text{ x } 2,5$

$\quad\quad\quad = 301,17 \text{ t}$

6. Berat Kolom/*Pier*
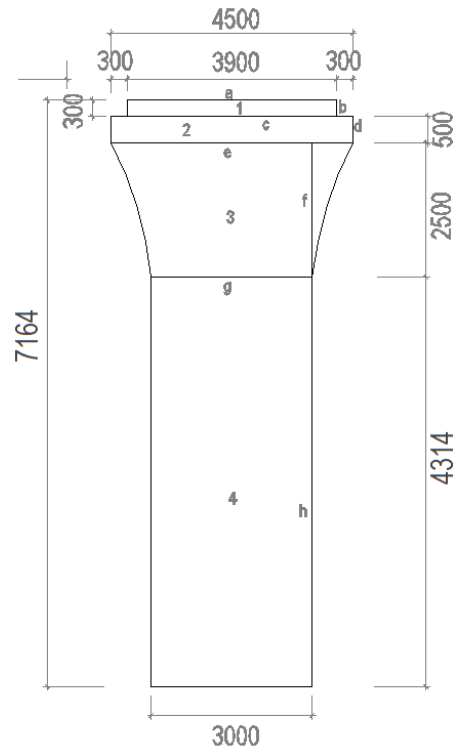
Gambar 5.6 Kolom

Bentang 1 $= 2,5$ m

Bentang 2 $= 3$ m

Berat Jenis Beton (γ) $= 2,5$ t/m^3

Volume 1 $= (a \times b) \times$ Bentang 1

               $= (3,9 \times 0,3) \times 2,5$

               $= 2,925$ m^3

Volume 2 $= (c \times d) \times$ Bentang 2

               $= (4,5 \times 0,5) \times 3$

               $= 6,75$ m^3

Volume 3 $= \left(\frac{1}{2} x (e + g) x f \right) \times$ Bentang 1

$$= \left(\frac{1}{2} \, x \, (4,5 + 3) \, x \, 2.5 \right) x \, 2,5$$

$$= 23,438 \text{ m}^3$$

Volume 4 $\quad$ = (g x h) x Bentang 1

$\qquad = (3 \text{ x } 4,314) \text{ x } 2,5$

$\qquad = 32, 355 \text{ m}^3$

Volume Total = Volume 1 + Volume 2 + Volume 3 + Volume 4

$\qquad = 2,925 + 6,75 + 23,438 + 23,438 + 13,605 + 32,355$

$\qquad = 65,468 \text{ m}^3$

Berat Kolom $\quad$ = Volume Total x γ

$\qquad = 65,468 \text{ x } 2,5$

$\qquad = 163,67 \text{ t}$

7. Berat *Pile Cap*
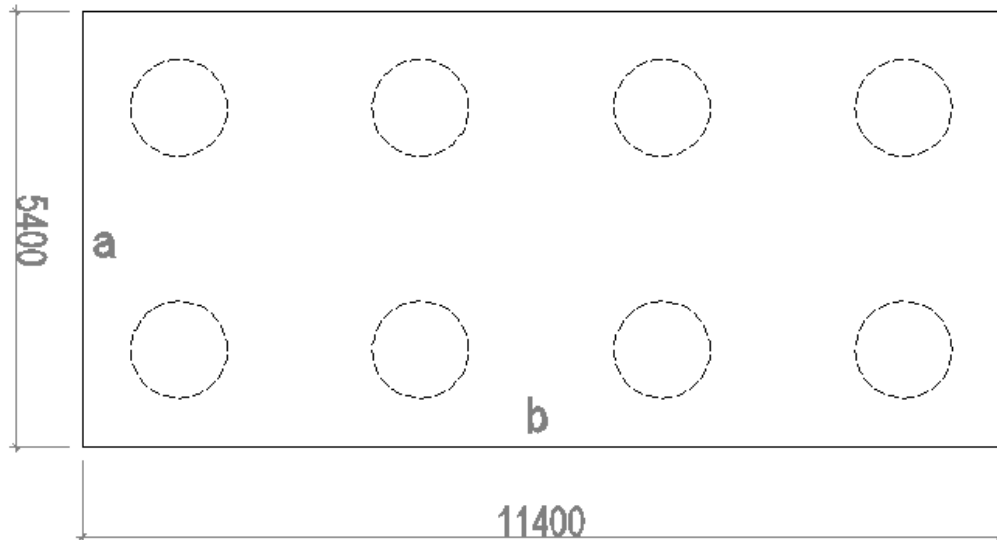
Gambar 5.7 *Pile Cap*

Tinggi *Pile Cap*   = 2,5 m

Berat Jenis Beton (γ) = 2,5 t/m^3

Volume Pile Cap   = a x b x bentang *pile cap*

                                = 5,4 x 11,4 x 2,5

                                = 153,9 m^3

Berat Pile Cap   = Volume x γ

                                = 153,9 x 2,5

                                = 384,75 t

Σ Beban Mati:

• Berat *Barier*	= 217,8 t
• Berat Aspal	= 57,96 t
• Berat Slab	= 1.010,4 t
• Berat *Steel Box Girder*	= 2 x 151,822 t
• Berat *Pier Head*	= 301,17 t
• Berat Kolom	= 163,67 t
• Berat *Pile Cap*	= <u>384,75 t +</u>
	= 2.439,394 t

5.2.2   Beban Hidup

a) Beban " D "

Menghitung menggunakan bentang gelagar

Bentang gelagar (L) = 60 m

Untuk bentang 60 m digunakan rumus :

$$q = 2,2 - \frac{1,1}{60} \; x \; (L - 30)$$

maka besar nya q adalahh :

$q = 2,2 - \frac{1,1}{60} \; x \; (L - 30)$

$q = 2,2 - \frac{1,1}{60} \; x \; (60 - 30)$

$q = 2,2 - \frac{1,1}{60} \; x \; 30$

$q = 2,2 - 0,55$

$q = 1,65 \; t$

Beban hidup parameter lebar jembatan, dengan rumus:

$$\text{Beban terbagi rata (Q)} \quad = \frac{q}{2{,}75}$$

$$\text{Beban garis (P)} \quad = \frac{p}{2{,}75}$$

Untuk beban garis digunakan nilai P = 12 (menurut PPPJJR tahun 1987)

$$Q \quad = \frac{q}{2{,}75} \quad = \frac{1{,}65}{2{,}75} = 0{,}6 \text{ t}$$

$$P \quad = \frac{p}{2{,}75} \quad = \frac{12}{2{,}75} = 4{,}364 \text{ t}$$

Muatan merata diperhitungkan berdasarkan lebar lantai kendaraan.

Lebar lantai jembatan = 11,50 m

Ketentuan PPPJJR 1987:

" Untuk jembatan dengan lebar lantai kendaraan lebih besar dari 5,50 m, beban "D"

sepenuhnya (100%) dibebankan pada lebar jalur 5,50m. Sedangkan lebar

selebihnya dibebani hanya separuh beban "D" (50%)

Sehingga besarnya muatan merata adalah:

$$q = (\ 100\% \ x \ q \ x \ 5{,}50 \ ) + 2 \ (\ 50\% \ x \ q \ x \ 3{,}0)$$

$$p = (\ 100\% \ x \ p \ x \ 5{,}50 \ ) + 2 \ (\ 50\% \ x \ p \ x \ 3{,}0 \ )$$

dengan berat Q = 0,6 t dan P = 4,364 T

q   = (100% x 0,6 x 5,50) +2 (50% x 0,6 x 3,0)

    = 3,3 + 2 (0,9)

    = 3,3 + 1,8

    = 5,1 t

p   = (100% x 4,364 x 5,50) + 2 (50% x 4,364 x 3,0)

    = 24,002 + 2 (6,546)

$$= 24{,}002 + 13{,}092$$

$$= 37{,}094 \text{ t}$$

Q = q x L

= 5,1 x 60

= 306 t

b) Beban Kejut

Untuk memperhitungkan beban kejut digunakan beban "P" dan "Q". Untuk beban

"P" dikalikan dengan koefisien kejut.

Koefisien kejut dirumuskan:

$$K = 1 + \frac{20}{50 + L}$$

dimana:

K = koefisien kejut

L = Panjang bentang

Nilai koefisien kejut sebesar:

$$K = 1 + \frac{20}{50 + 60}$$

$$= 1 + \frac{20}{110}$$

$$= 1 + 0{,}182$$

$$= 1{,}182$$

Untuk beban "P" (beban garis):

P = K x P

= 1,182 x 37,094

= 43,845 t
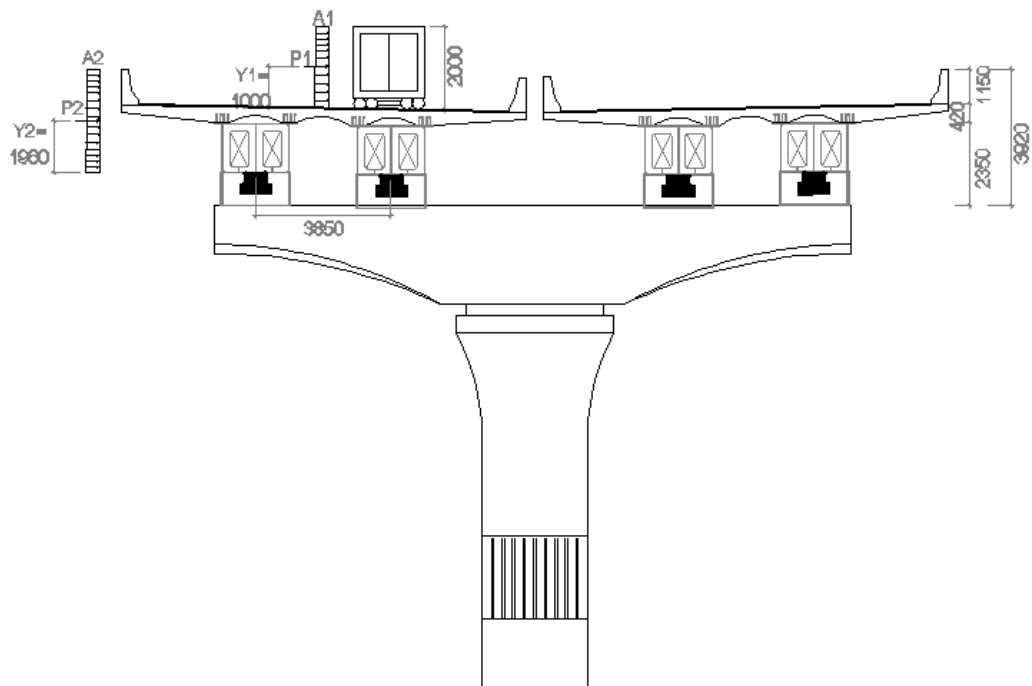
c) Beban Angin

Pengaruh beban angin sebesar 150 kg/m^2 pada jembatan

W = 150 kg/m^2

W = 0,15 t/m^2

Bentang = 60 m

Gambar 5.8 Beban Angin

$P_1 \quad = A_1 \text{ x W x } 100\%$

$\quad = (2 \text{ x } 60) \text{ x } 0,15 \text{ x } 100\%$

$\quad = 120 \text{ x } 0,15 \text{ x } 100\%$

$\quad = 18 \text{ ton}$
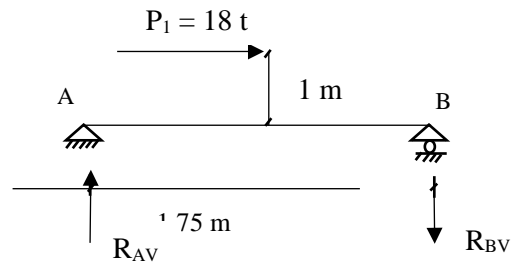
$\Sigma M_B \quad = 0$

$R_{AV} . 1,75 - P_1 . Y_1 \quad = 0$

$R_{AV} . 1,75 - 18 . 1 \quad = 0$

$R_{AV} . 1,75 - 18 \quad = 0$

$\qquad R_{AV} \qquad = \dfrac{18}{1,75} = 10,286 \text{ ton}$

$P_2 \quad = A_2 \text{ x W x } 50\%$

$\quad = (3,92 \text{ x } 60) \text{ x } 0,15 \text{ x } 50\%$

$\quad = 17,64 \text{ t}$
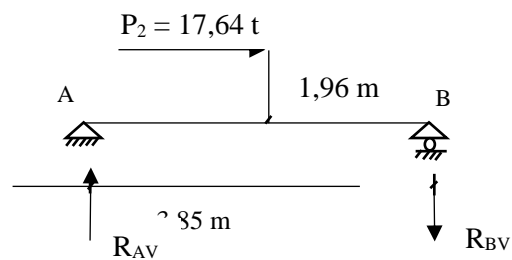
$\Sigma M_B \quad = 0$

$R_{AV} . 3,85 - P_2 . Y_2 \qquad = 0$

$R_{AV} . 3,85 - 17,64 . 1,96 \quad = 0$

$R_{AV} . 1,75 - 34,574 \qquad = 0$

$$R_{AV} = \frac{34,574}{3,85}$$

$$R_{AV} = 8,98 \text{ ton}$$

Σ = 10,286 t + 8,98 t

= 19,266 t

Σ Beban Hidup:

Beban D = 306 T

Beban P = 43,845 T

Beban Angin = 19,266 T   +

= 369,111 T

Σ Beban Vertikal:

Beban Mati = 2.439,394 T

Beban Hidup = 369,111 T   +

= 2.808,503 T