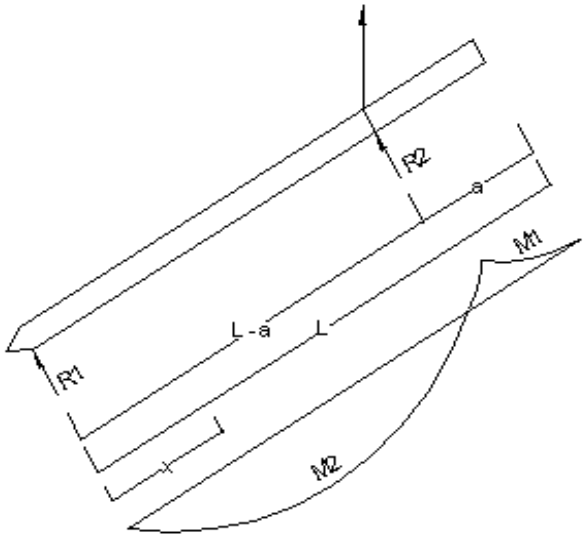
5.4 Tiang Pancang

5.4.1 Momen akibat pengangkatan satu titik



Gambar 5.79 Pengangkatan dengan 1 titik

$$M_1 = \frac{1}{2} \times q \times a^2$$

$$R_1 = \frac{1}{2} q \left(L - a \right) - \frac{1}{2} \times q a^2 \frac{1}{L - a} = \frac{q\,(L - a)}{2} - \frac{q a^2}{2(L - a)} = \frac{q L^2 - 2aq}{2\left(L - a \right)}$$

$$Mx = R_1 x - \frac{1}{2} q x^2$$

Syarat Maksimum $\frac{dMx}{dx} = 0$

$$R_1 - qx = 0$$

$$x = \frac{R_1}{q} = \frac{(L^2 - 2aL)}{\{2(L - a)\}}$$

$$M \max = R_1 \frac{L^2 - 2aL}{2(L - a)} - \frac{1}{2} q \left(\frac{L^2 - 2aL}{2(L - a)} \right)^2$$

$$M \max = \frac{1}{2} q \left(\frac{L^2 - 2aL}{2(L - a)} \right)^2$$

$M_1 = M_2$

$$\frac{1}{2}qa^2 = \frac{1}{2}q\left(\frac{L^2 - 2aL}{2(L-a)}\right)^2$$

$$a = \frac{L^2 - 2aL}{2\,(L - a)}$$

$$a^2 - 4\,aL + L^2 = 0 \rightarrow L = 25\ m$$

$$a^2 - 100a + 625 = 0$$

$$a_{1,2} = \frac{100 \pm \sqrt{(-100)^2 - 4.1.625}}{2.1}$$

$a_1 = 6{,}69m$(memenuhi)

$a_2 = 93{,}3m$(tidakmemenuhi)

$a = 0{,}297 \times L = 0{,}297 \text{ x } 25 = 7{,}245\ m$

$$WD = \frac{1}{4} \times \pi \times d^2 \times \gamma_{beton} = \frac{1}{4} \times 3{,}14 \times 0{,}4^2 \times 2400 = 301{,}44\ kg/m$$

$WL = 40\ kg/m$

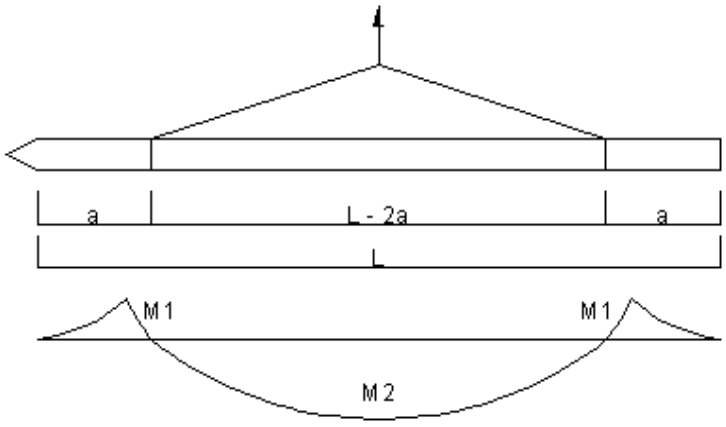
$q_{tot} = 1{,}2\ WD + 1{,}6\ WL = (1{,}2 \times 301{,}44) + (1{,}6 \times 40) = 425{,}728\ kg$

$$M_1 = M_2 = M_{max}$$

$$= \frac{1}{2} \times q \times a^2 = \frac{1}{2} \times 301{,}44 \times 6{,}69^2$$

$= 9526{,}96\ kgm = 9{,}527.10^4\ Nm$

5.4.2 Momen akibat pengangkatan dengan dua titik



Gambar 5.80 Pengangkatan dengan dua titik

$$M_1 = \frac{1}{2} \times q \times a^2$$

$$M_2 = \frac{1}{8} q \left(L - 2a\right)^2 - \frac{1}{2} qa^2$$

$$M_1 = M_2$$

$$\frac{1}{2} qa^2 = \frac{1}{8} q \left(L - 2a\right)^2 - \frac{1}{2} qa^2$$

$$a = 0{,}209 \times L$$

$$a = 0{,}209 \text{ x } 25 = 5{,}125$$

$$M_1 = M_2 = M_{max} = \frac{1}{2} \times q \times a^2 = \frac{1}{2} \times 425{,}728 \times 5{,}125 = 5811{,}32 \text{ kgm} = 5{,}811.10^4 \text{Nm}$$

Pada perhitungan tulangan didasarkan pada momen pengangkatan dengan 1 titik karena momen yang didapat dari 2 titik pengangkatan lebih kecil daripada momen pengangkatan akibat 1 titik. Pada perhitungan tulangan didasarkan pada momen pengangkatan dengan 1 titik.

$M_{design} = 1{,}5 \times M_{Max} = 1{,}5 \times 9526{,}96 = 14290{,}44 \text{ kgm} = 1{,}43 .10^5 \text{ Nm}$

Direncanakan ;

f'c = 45 Mpa

fy = 240 Mpa

Diameter pancang (h) = 400 mm

Tebal selimut (p) = 50 mm

Diameter efektif (d) = 400 – 50 – 0,5 × 14 – 8 = 335 mm

<u>Tulangan</u>

Untuk K – 450 (fc'= 37,5 Mpa) dan BJTP 24 (fy = 240 Mpa)

$$\rho min = \frac{1{,}4}{fy} = \frac{1{,}4}{240} = 0{,}00583$$

$$\rho max = 0{,}75 x \beta 1 x \left[\frac{0{,}85 x fc'}{fy} x \frac{600}{600 + fy} \right] dim ana \beta 1 = 0{,}85$$

$$\rho max = 0{,}75 x 0{,}85 x \left[\frac{0{,}85 x 45}{240} x \frac{600}{600 + 240} \right] = 0{,}0726$$

Tiang pancang berbentuk bulat, sehingga perhitungannya dikonfirmasikan ke dalam bentuk bujur sangkar dengan b = 0,88D = 0,88. 0,4 = 0,352 m

$$\frac{Mu}{bxd^2} = \rho.\varphi.fy\left[1 - 0{,}588\rho x\frac{fy}{fc'}\right]$$

$$\frac{Mu}{bxd^2} = \rho x 0{,}8 x 240\left[1 - 0{,}588\rho x\frac{240}{45}\right]$$

$$\frac{1{,}43.10^8}{352 \times 352^2} = 192\rho - 602{,}112\rho^2$$

$$602{,}112\rho^2 - 192\rho + 3{,}278 = 0$$

$$\rho = 0{,}0181$$

$$\left.\begin{array}{l}\rho min = 0{,}00583\\ \rho maks = 0{,}0726\end{array}\right] \quad \rho\ min < \rho < \rho\ max$$

- **Tulangan utama**

  Ast = $\rho.b.d.10^6$ = 0,0181x 352x352 = 2242,66 mm^2

  Dipakai tulangan 10D19 (Ast = 2835 mm^2)

- **Kontrol terhadap Tumbukan Hammer**

  Jenis Hammer yang akan digunakan adalah tipe K –35 dengan berat hammer 3,5 ton.

  Daya dukung satu tiang pancang = $7{,}17.10^5$ N

  Rumus Tumbukan :

  $$R = \frac{Wr\ .H}{\Phi\left(s + c\right)}$$

  Dimana :

  R = Kemampuan dukung tiang akibat tumbukan

  Wr = Berat Hammer = 3,5 T = 35 kN

  H = Tinggi jatuh Hammer = 1,5 m

  S = final settlement rata-rata = 2,5 cm

  C = Koefisien untuk double acting system Hammer = 0,1

Maka :

$$R = \frac{Wr \,.H}{\Phi\left(s + c\right)}$$

$$R = \frac{35\ x1{,}5}{0{,}2\left(0{,}025\ + 0{,}1\right)} = 210 \text{ kN}$$

$2{,}1.10^5$ N < P_{tiang} = $7{,}17.10^5$ N ….. (Aman)

- **Penulangan Akibat Tumbukan**

  Dipakai rumus New Engineering Formula :

$$P_U = \frac{eh.Wr \,.H}{s + c}$$

  Dimana :

  P_U = Daya Dukung Tiang tunggal

  eh = efisiensi Hammer = 0,8

  H = Tinggi jatuh Hammer = 1,5 m

  S = final settlement rata-rata = 2,5 cm

  Maka :

$$P_U = \frac{eh.Wr \,.H}{s + c} = \frac{0{,}8\,x35\ x1{,}5}{0{,}025\ + 0{,}1} = 336 \text{ kN}$$

  Menurut SKSNI – T – 03 – 1991 Pasal 3.3.3.5

  Kuat Tekan Struktur :

  Pmak = 0,8 (0,85 f'c (Ag – Agt) + fy.Ast)

  $336000 = 0{,}8 (0{,}85.45 (3{,}14.200^2 - Agt) + 45.Ast)$

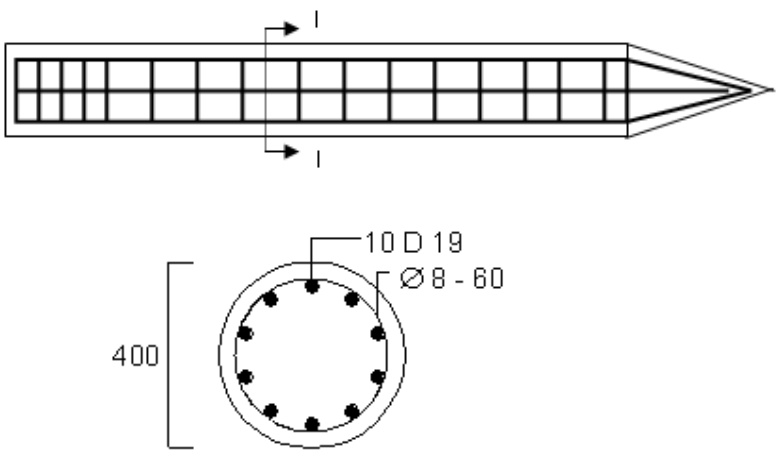
  Ast = - 830746

  Karena hasil negatif, maka digunakan :

  Ast = 1 % x 3,14 x 200^2

  Ast = 1256 mm^2

  Dipakai tulangan 10 D 19 (Ast = 2835 mm^2)



POT 1 -1

- **Kontrol geser**

$$\tau_b = \frac{D\,max}{0{,}9x1/4\pi.d^2} = \frac{(-q.a)+(1/2.q.L)}{0{,}9x1/4\pi.d^2}$$

$$\tau_b = \frac{(425{,}728x6{,}69)+(1/2x425{,}728x25)}{0{,}9x1/4x3{,}14x0{,}4^2}$$

$$= 72272{,}826\ kg/m^2 = 7{,}227\ kg/cm^2$$

$$\tau_b = 0{,}53\sigma \rightarrow \sigma = 1600 kg/cm^2$$

$$= 0{,}53\ .\ 1600 = 848\ kg/cm^2$$

karena $\tau_b < \tau_b$ijin maka tidak perlu tulangan geser,maka digunakan tulangan sengkang praktis yaitu tulangan spiral.

5.4.3 Perhitungan Tulangan Spiral

Rasio penulangan spiral :

$$\rho_s = 0{,}45\left(\frac{Ag}{Ac} - 1\right)x\frac{fc}{fy}$$

$$\rho_s = 0{,}45\left(\frac{1/4.\pi.40^2}{1/4.\pi.30^2} - 1\right)x\frac{450}{2400} = 0{,}0656$$

As = 2 x ρs x Ac

= 2 x 0,0656 x ¼.π 40^2 = 164,85 cm^2

s = 2 x π x Dc x Asp/s

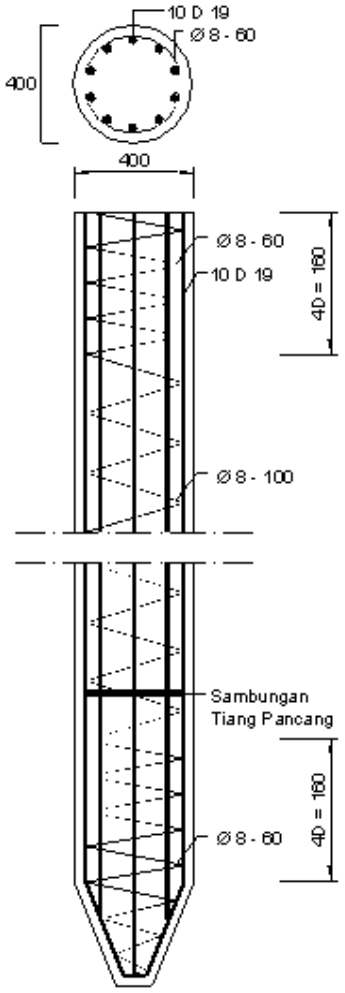
= 2 x 3,14 x 40 x ¼ .3,14.0,8^2/164,85

= 0,76 cm→ 6 cm

sehingga dipakai tulangan Ø8-60

sengkang pada ujung tiang dipakai Ø8-60

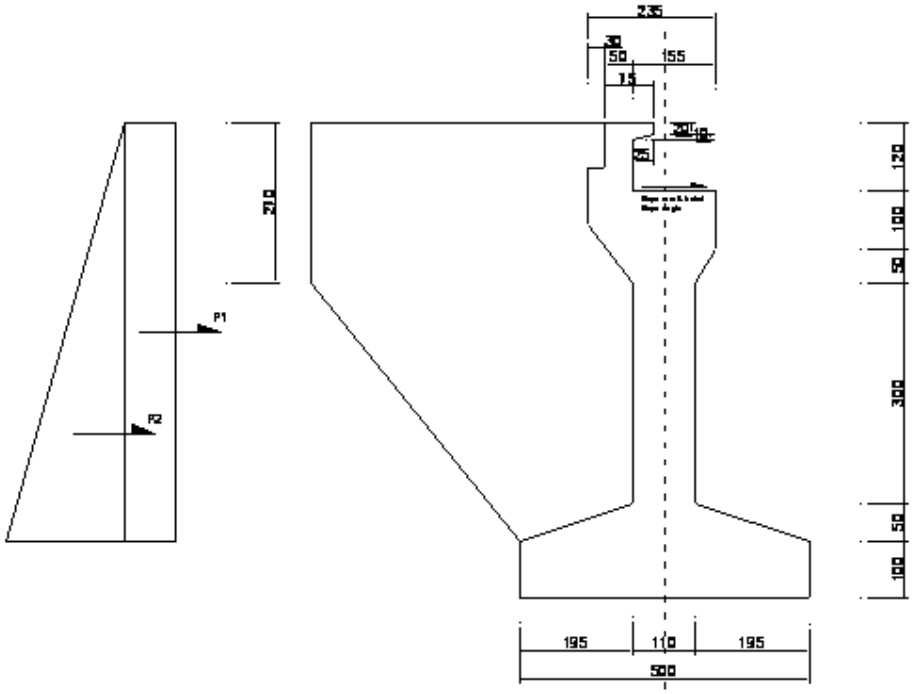
sengkang pada tengah tiang dipakai Ø8-100



Gambar 5.81 Penulangan Tiang Pancang

5.5 Perencanaan Wing Wall

Perencanaan wing wall bertujuan untuk menahan stabilisasi tanah urugan dibelakang abutmen.



Gambar 5.82 Pembebanan untuk Wing Wall

Tanah merupakan tanah urugan, diambil tanah dengan data sebagai berikut :

$\gamma t = 1{,}75\ t/m^3$.
$\varnothing = 25^0$.
$C = 0{,}12\ kg/cm^2$.

$Ka = tg^2 (45 - \frac{\varphi}{2}) = tg^2 (45 - \frac{\varphi}{2}) = 0{,}41$

Tegangan – tegangan yang terjadi :

$\sigma 1 = (q * Ka)$

$= (1{,}050 * 0{,}41) = 0{,}431\ t/m^2$.

$\sigma 2 = (\gamma * Ka * h)$

$= (1{,}75 * 0{,}41 * 6{,}20) = 4{,}448\ t/m^2$

Tekanan tanah aktif :

P1 = 0,431 * 6,20 * 5 = 13,361 ton

P2 = 4,090 * 6,20 * 5 = 137,888 ton

Momen yang terjadi :

MP1 = 13,361 * 3,10 = 41,419 ton.m

MP2 = 137,888 * 2,067 = 285,014 ton.m

Mtotal = 41,419 + 285,014 = 326,433 ton.m

Penulangan Wing Wall :

Tebal plat 250 mm

d diambil 210 mm

$$\frac{Mu}{bd^2} = \frac{32643300}{100 * 21^2} = 740{,}210\ kg/cm^2$$

ρ = 0,0023

syarat ρ min ≤ ρ ≤ ρ max

ρ min = 0,0035

ρ max = 0,028

Maka, digunakan ρ min = 0,0035

As = ρ * b * d

= 0,0035 * 1000 * 210 = 735 mm^2.

Digunakan tulangan D16 – 200 (As = 1005 mm^2)

Checking :

ρ = As terpasang / (b*d)

= 1005 / (1000 * 210)

= 0,00478 < ρ max (Ok)

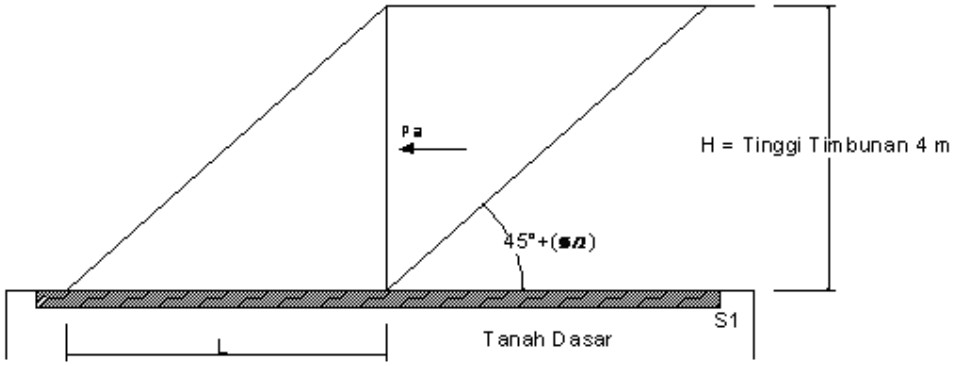
Tulangan Pembagi

= 0,0025 * b * d

= 0,0025 * 1000 * 210 = 525 mm^2.

digunakan tulangan D12 – 200 (As = 566 mm^2)

5.6 Stabilitas Timbunan Optrit



γt	$= 1{,}75$ t/m^3.	γt	$= 1{,}63$ t/m^3.
$\varnothing$	$= 25^0$.	$\varnothing$	$= 10^0$.
C	$= 0{,}12$ kg/cm^2 $= 1{,}2$ t/m^2	C	$= 0{,}13$ kg/cm^2 $= 1{,}3$ t/m^2
σ	$= 0{,}68$ kg/m^2		

$$Ka = tg^2 (45 - \frac{\varphi}{2})$$

$$= tg^2 (45 - \frac{25^o}{2}) = 0{,}41$$

tegangan tanah yang terjadi

$$Pa = \tfrac{1}{2} (\gamma * Ka * H^2)$$

$$= \tfrac{1}{2} (1{,}75 * 0{,}41 * 4^2) = 5{,}74 \text{ t/m}^2$$

Besarnya gaya internal lapisan tanah :

$$S_1 = H * Cu * \tan \varnothing$$

$$= 4 * 1{,}2 * \tan 25^o = 2{,}238 \text{ t/m}$$

Untuk stabilitas timbunan terhadap keruntuhan / kelongsoran permukaan, maka ; $\mathbf{S_1 > Pa}$, dengan catatan mengambil faktor keamanan sebesar 3 , sehingga diperoleh :

$$S_{1\,Min} > \frac{Pa}{3} = \frac{5{,}74}{3} = 1{,}913 \text{ t/m}$$

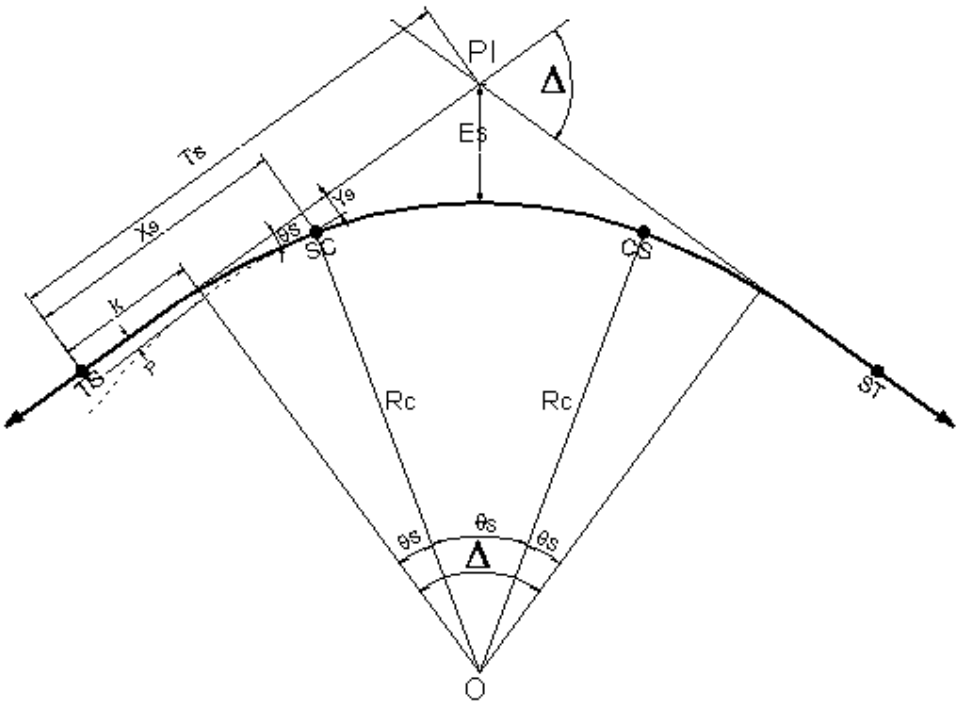
maka ; $S_{1\,Min} = 2{,}238$ t/m $>$ 1,913 t/m ……..ok

5.7 PERHITUNGAN JALAN PENDEKAT *(Oprit)*

5.7.1 PERENCANAAN GEOMETRIK JALAN

- **ALINYEMEN HORIZONTAL**

Dalam perencanaan jembatan Air Tiris ini digunakan tikungan Spiral – Circle – Spiral. Seperti tergambar sebagai berikut :



Gambar 5.83 Lengkung S-C-S

Keterangan :

PI = Point of Intersection, titik perpotongan garis tangent utama.
TS = Tangent Spiral, titik awal spiral (dari Tangent ke Spiral).
SC = Spiral Circle, titik perubahan dari Spiral ke Circle.
CS =. Circle Spiral, titik perubahan dari Circle ke Spiral.
ST = Spiral Tangent, titik perubahan dari Spiral ke Tangent.
Xs = Absis titik SC pada garis tangen, jarak dari titik TS ke SC (jarak lurus lengkung peralihan).
Ys = Ordinat titik SC pada garis tegak lurus garis tangen, jarak tegak lurus

ke titik SC pada lengkung.

Ls = Panjang busur lingkaran (panjang dari titik SC ke CS).

Ts = Panajang tangen dari titik PI ke titik TS atau ke titik ST.

Es = Jarak dari PI ke busur lingkaran.

Δ = Sudut pertemuan antara tangent utama.

θs = Sudut lengkung spiral.

Rc = Jari-jari lingkaran

p = Pergeseran tangen terhadap spiral

k = Absis dari p pada garis tangen spiral

Data dan Ketentuan :

- V_R = 60 – 80 km/jam , diambil V_R = 70 km/jam
- $R_{MIN} = \dfrac{(V_R)^2}{127 * (e_{MAK} - f_{MAK})}$
- e_{mak} = 10 % ; maka f_{mak} = 0,24
- maka ; $R_{MIN} = \dfrac{(70)^2}{127 * (0{,}10 - 0{,}24)} = 11{,}5\ m$, diambil R = 12 m

Menentukan Nilai L_s :

a) Berdasarkan Waktu Tempuh Maksimum (3 detik)

$$L_S = \frac{V_R}{3{,}6} * T = \frac{70}{3{,}6} * 3 = 58{,}34\ m$$

b) Berdasarkan Antisipasi Gaya Sentrifugal

$$L_S = 0{,}022 \frac{(V_R)^3}{R_C * C} - 2{,}727 \frac{V_R * e}{C}$$

$$L_S = 0{,}022 \frac{(70)^3}{150 * 1} - 2{,}727 \frac{70 * 0{,}1}{1} = 30{,}95\ m$$

c) Berdasarkan Tingkat Pencapaian Perubahan Kelandaian

$$L_S = \frac{(e_m - e_n)}{3{,}6 * \Gamma e} * V_R = \frac{(0{,}10 - 0{,}02)}{3{,}6 * 0{,}035} * 70 = 44{,}45\ m$$

Besar nilai L_S diambil nilai terbesar yakni L_S = 58,34 m ≈ 60,0 m

- **PI-1**

1) Menghitung Komponen Tikungan

R = 12 m ; $\Delta = 3{,}27^{O}$; L_S = 60,0 m

$$X_S = L_S\left(1 - \frac{(L_S)^2}{40*(R_C)^2}\right) = 60*\left(1 - \frac{(60)^2}{40*(12)^2}\right) = 22{,}5\ m$$

$$Y_S = \frac{(L_S)^2}{6*(R_C)} = \frac{(60)^2}{6*(12)} = 50\ m$$

$$\theta_S = \frac{90*L_S}{\pi*R_C} = \frac{90*60}{\pi*12} = 11{,}465^{O}$$

$$P = \frac{(L_S)^2}{6*(R_C)} - R_C(1-\cos\theta_S) = \frac{(60)^2}{6*(12)} - 12*(1-\cos 11{,}465^{O}) = 1{,}010\ m$$

$$K = L_S - \frac{(L_S)^3}{40*(R_C)^2} - R_C\sin\theta_S = 20 - \frac{(60)^3}{40*(12)^2} - 12\sin 11{,}465^{O} = 19{,}945\ m$$

$$T_S = (R_C + P)\tan ½\nabla + K$$
$$= (12 + 1{,}010)\tan ½\ 3{,}27^{O} + 19{,}945 = 12{,}088\ m$$
$$E_S = (R_C + P)\sec ½\nabla - R_C$$
$$= (12 + 1{,}010)\sec ½\ 3{,}27^{O} - 12 = 5{,}033\ m$$
$$L_C = \frac{(\nabla - 2\theta_S)}{180}*\pi*R_C = \frac{(3{,}27^{O} - 2*11{,}465^{O})}{180}*\pi*12 = 18{,}397\ m$$

2) Mencari Posisi titik-titik Tikungan

STA A = 0+360

STA PI-1 = (0+360) + 12 = 0+372 m

STA TS = (0+372) – T_S = (0+372) – 12,088 = 0+356,912 m

STA SC = STA TS + Ls = (0+356,912) + 60,0 = 0+419,912 m

STA CS = STA SC + Lc = (0+419,912) + 18,397 = 0+438,309 m

STA ST = STA CS + Ls = (0+438,309) + 60,0 = 0+498,309 m

STA B = STA ST – Ts + 12

= (0+480) – 12,088 + 12 = 0+455,912 m

- **PI-2**

1) Menghitung Komponen Tikungan

R = 12 m ; $\Delta = 3{,}27^O$; L_S = 60,0 m

$$X_S = L_S\left(1-\frac{(L_S)^2}{40*(R_C)^2}\right) = 60*\left(1-\frac{(60)^2}{40*(150)^2}\right) = 59{,}76\ m$$

$$Y_S = \frac{(L_S)^2}{6*(R_C)} = \frac{(60)^2}{6*(150)} = 4{,}00\ m$$

$$\theta_S = \frac{90*L_S}{\pi*R_C} = \frac{90*60}{\pi*150} = 11{,}465^O$$

$$P = \frac{(L_S)^2}{6*(R_C)} - R_C(1-\cos\theta_S) = \frac{(60)^2}{6*(150)} - 150*(1-\cos 11{,}465^O) = 1{,}010\ m$$

$$K = L_S - \frac{(L_S)^3}{40*(R_C)^2} - R_C\ \sin\theta_S = 20 - \frac{(60)^3}{40*(150)^2} - 150\sin 11{,}465^O = 29{,}945\ m$$

$$T_S = (R_C+P)\tan ½\nabla + K$$
$$= (150+1{,}010)\tan ½\,8^O + 29{,}945 = 40{,}505\ m$$
$$E_S = (R_C+P)\sec ½\nabla - R_C$$
$$= (150+1{,}010)\sec ½\,8^O - 150 = 0{,}64\ m$$

$$L_C = \frac{(\nabla-2\theta_S)}{180}*\pi*R_C = \frac{(8^O-2*11{,}465^O)}{180}*\pi*150 = 39{,}067\ m$$

2) Mencari Posisi titik-titik Tikungan

STA A = 0+275

STA PI-2 = (0+275) + 50 = 0+325 m

STA TS = (0+325) – T_S = (0+325) – 40,505 = 0+284,495 m

STA SC = STA TS + Ls = (0+284,495) + 60,0 = 0+344,495 m

STA CS = STA SC + Lc = (0+344,495) + 39,067 = 0+383,562 m

STA ST = STA CS + Ls = (0+383,562) + 60,0 = 0+443,562 m

STA B = STA ST – Ts + 50

= (0+443,562) – 40,505 + 50 = 0+453,057 m

- **PI-3**

1) Menghitung Komponen Tikungan

R = 12 m ; $\Delta = 3{,}27^{O}$; L_S = 60,0 m

$$X_S = L_S\left(1 - \frac{(L_S)^2}{40*(R_C)^2}\right) = 60*\left(1 - \frac{(60)^2}{40*(12)^2}\right) = 22{,}5\ m$$

$$Y_S = \frac{(L_S)^2}{6*(R_C)} = \frac{(60)^2}{6*(12)} = 50\ m$$

$$\theta_S = \frac{90*L_S}{\pi*R_C} = \frac{90*60}{\pi*12} = 11{,}465^{O}$$

$$P = \frac{(L_S)^2}{6*(R_C)} - R_C(1-\cos\theta_S) = \frac{(60)^2}{6*(12)} - 12*(1-\cos 11{,}465^{O}) = 1{,}010\ m$$

$$K = L_S - \frac{(L_S)^3}{40*(R_C)^2} - R_C\sin\theta_S = 20 - \frac{(60)^3}{40*(12)^2} - 150\sin 11{,}465^{O} = 19{,}945\ m$$

$$T_S = (R_C + P)\tan ½\,\nabla + K$$
$$= (12 + 1{,}010)\tan ½\,3.27^{O} + 19{,}945 = 12.088\ m$$
$$E_S = (R_C + P)\sec ½\,\nabla - R_C$$
$$= (12 + 1{,}010)\sec ½\,8^{O} - 12 = 5.033\ m$$

$$L_C = \frac{(\nabla - 2\theta_S)}{180}*\pi*R_C = \frac{(8^{O} - 2*11{,}465^{O})}{180}*\pi*12 = 18.397\ m$$

3) Mencari Posisi titik-titik Tikungan

STA A = 0+480

STA PI-2 = (0+480) + 12 = 0+492 m

STA TS = (0+492) – T_S = (0+492) – 12.088 = 0+479.912 m

STA SC = STA TS + Ls = (0+479.912) + 18.397= 0+498.309 m

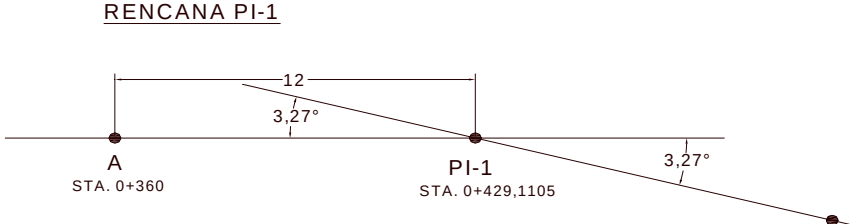
STA CS = STA SC + Lc = (0+498.309) + 18.397 = 0+516,706 m

STA ST = STA CS + Ls = (0+516,706) + 60,0 = 0+576.706 m

STA B = STA ST – Ts + 50

= (0+576.706) – 12.088 + 12 = 0+552.612 m

- **Gambar Sket Alinyemen Horisontal**



- **ALINYEMEN VERTIKAL**

A) Perhitungan Alinyemen Vertikal pada section A (STA 0 +200)

Perhitungan Stasioning (lengkung vertikal cekung)

Direncanakan dengan V_R = 70 km/jam

Dari tabel didapat Data dan Ketentuan :

Kelandain maksimum (i) = 3 ,27 % (datar)

Jarak Pandang Henti Minimum (Jh) = 100 m

Jarak Pandang Mendahului Minimum (Jd) = 450 m

Perencanaan Lengkung Vertikal

1) Menghitung kelandaian rancana

g_1 = 0 % (awal) ; g_2 = 3,27 %

A = $g_1 + g_2$ = 0 + 3,27 = 3,27 %

2) Mencari Panjang L

Berdasarkan Jarak Pandang Henti (Jh)

$$Jh < L \Rightarrow L = \frac{A * Jh^2}{120 + (3{,}5\ Jh)} = \frac{3{,}27 * 100^2}{120 + (3{,}5 * 100)} = 69{,}57\ m\ .....tdk\ memenuhi$$

$$\text{Jh} > \text{L} \Rightarrow L = 2\ Jh - \frac{120 + (3{,}5\ Jh)}{A}$$

$$L = 2 * 100 - \frac{120 + (3{,}5 * 100)}{3{,}27} = 56{,}26m\ .....memenuhi$$

Jadi panjang L :

Berdasarkan jarak pandang henti = 56,26 m

Dengan pertimbangan ekonomis maka : diambil Lv = 50 m

Dari rumus ; $Ev = \frac{A * L}{800} = \frac{3{,}27 * 50}{800} = 0{,}2$

STA. PV1

Lv = 50 m

STA. PLV = STA. PPV – (½ * Lv)

= 0+200 – (½ * 50) = 0+175 m

Elevasi = Elv. PPV – (½ * g_1 * Lv)

= + 5,00 – (½ * 0,0% * 50) = + 5,00 m

Titik ½ lengkung

STA 0+200

Elevasi = Elv. PPV + E

= + 5,00 + 0,2 = + 5,2 m

Titik akhir lengkung

STA akhir = STA.PPV + (½ * Lv)

= 0+200 + (½ * 50) = 0+225

Elevasi = Elv. PPV + ½ . g_2 . Lv

= + 5,00 + (½ * 3,27% * 50)

= + 5,8 m

B) Perhitungan Alinyemen Vertikal pada section B (STA +320)

Perhitungan Stasioning (lengkung vertikal cembung)

Direncanakan dengan V_R = 70 km/jam

Dari tabel didapat Data dan Ketentuan :

Kelandain maksimum (i) = 3,27 %

Jarak Pandang Henti Minimum (Jh) = 100 m

Jarak Pandang Mendahului Minimum (Jd) = 450 m

Perencanaan Lengkung Vertikal

1) Mencari Panjang L

Berdasarkan Jarak Pandang Henti (Jh)

$$Jh < L \Rightarrow L = \frac{A * Jh^2}{399} = \frac{3{,}27 * 100^2}{399} = 81{,}95\ m \text{ ..... } tdk\ memenuhi$$

$$\text{Jh} > \text{L} \Rightarrow L = 2\ Jh - \frac{399}{A} = 2 * 100 - \frac{399}{3{,}27} = 77{,}9m \text{ ..... } memenuhi$$

Berdasarkan Jarak Pandang Mendahului (Jd)

$$Jd < L \Rightarrow L = \frac{A * Jd^2}{840} = \frac{3{,}27 * 450^2}{840} = 788{,}30\ m \text{ ..... } memenuhi$$

$$\text{Jh} > \text{L} \Rightarrow L = 2\ Jh - \frac{840}{A} = 2 * 75 - \frac{840}{3{,}27} = 256{,}88\ m \text{ ..... } tdk\ memenuhi$$

Jadi panjang L :

Berdasarkan jarak pandanag henti = 77,9 m

Berdasarkan jarak pandanag mendahului = 788,30 m

Dengan pertimbangan ekonomis maka : diambil L = 50 m

Dari rumus ; $Ev = \frac{A * L}{800} = \frac{3{,}27 * 50}{800} = 0{,}204$

STA. PV1

Lv = 50 m

STA. PLV = STA. PPV – (½ * Lv)

= 0+320 – (½ * 50) = 0+295 m

Elevasi = Elv. PPV – (½ * g_1 * Lv)

= + 9,00 – (½ * 3,27% * 50) = + 5,2 m

Titik ½ lengkung

STA 0+325

Elevasi = Elv. PPV – E

= + 9,00 – 0,204 = + 8,79 m

Titik akhir lengkung

STA akhir = STA.PPV + (½ * Lv)

= 0+320 + (½ * 50) = 0+345

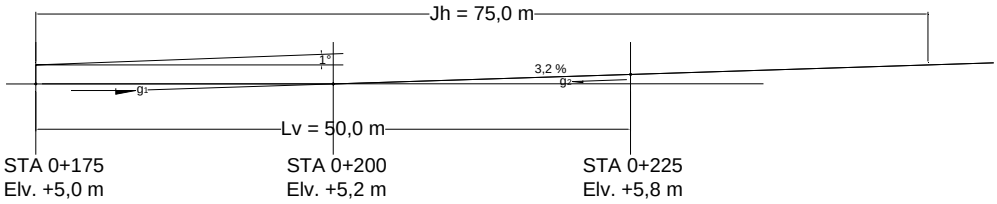
Elevasi = Elv. PPV + ½ . g_2 . Lv

= + 9,00 + (½ * 3,27% * 50) = + 9,081 m

- **Gambar Sket Alinyemen Vertikal**

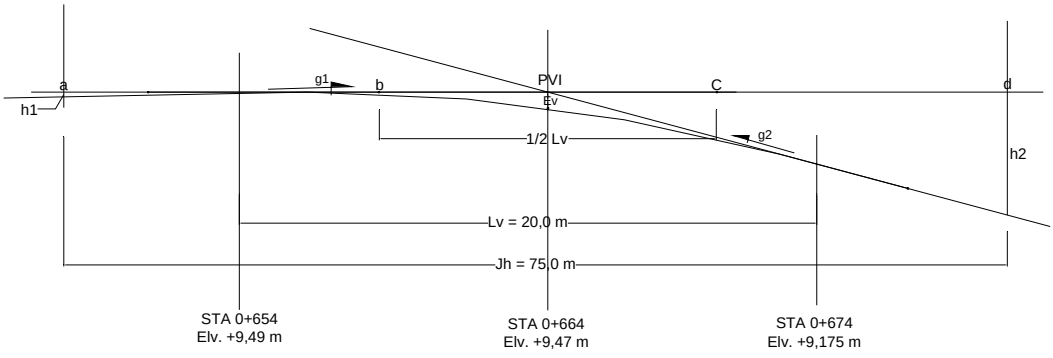
C) LENGKUNG VERTIKAL CEMBUNG

1. SECTION A (STA 0+200)



2. SECTION B (STA 0+320)

F) LENGKUNG VERTIKAL CEMBUNG



5.7.2 PERENCANAAN TEBAL PERKERASAN

- **Data LHR awal umur rencana (tahun 2005)**

MC	= 7771	kendaraan
LV	= 3813	kendaraan
MHV	= 5020	kendaraan
LT	= 2171	kendaraan
Total	= 18775	kendaraan

- **Faktor Regional**

Prosentase kendaraan berat $= \frac{(2171 + 5020)\ x\ 100\%}{18775} = 38{,}30\ \% > 30\%$

Iklim II curah hujan > 900 mm/th

Kelandaian I < 6 %

Faktor Regional (FR) = 2,0

- **Koefisien Distribusi Kendaraan**

Harga C untuk : Kendaraan ringan C = 0,5

Kendaraan berat C = 0,5

- **Angka Ekivalen (E)**

MC	= 0,6
LV	= 1
MHV	= 2,4
LT	= 5

- **LHR pada akhir umur rencana**

$LHR_{2018} = LHR_{2008} (1 + i)^{n}$

Dimana : i = 2,82 %

n = 10 tahun

$LHR_{2018} = 21424{,}93 (1 + 0{,}0282)^{10} = 28294{,}06$ SMP / hari

- **Lintas Ekivalen Permulaan (LEP)**

$$\boxed{\text{LEP} = \sum \text{LHR x C x E}}$$

LEP =19710 SMP/Hari x 0,5 = 9855 SMP / hari

Lintas Ekivalen Akhir (LEA)

$$\boxed{\text{LEA} = \sum \text{LHR x C x E}}$$

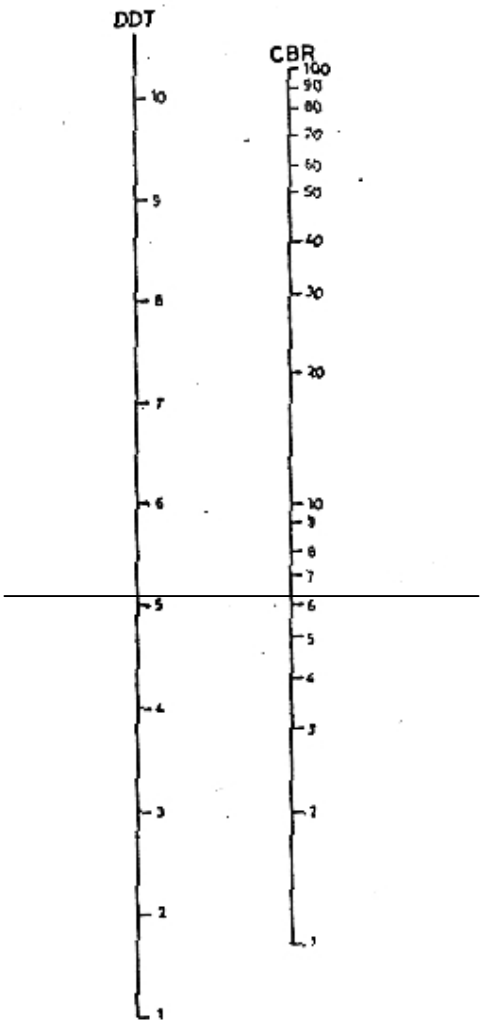
LEA = 28294,06 SMP / hari x 0,5 = 14147 SMP / hari

- **Lintas Ekivalen Tengah (LET)**

$$\text{LET} = \frac{LEP + LEA}{2} = \frac{9855 + 14147}{2} = 12001$$

- **Lintas Ekivalen Rencana (LER)**

$$\text{LER} = LET + \frac{UR}{10}(0{,}5) = 12001 + \frac{10}{10}(0{,}5) = 6000{,}5$$



Gambar 1
KORELASI DDT DAN CBR

Catatan : Hubungan nilai CBR dengan garis mendatar kesebelah kiri diperoleh nilai DDT.

Indeks Perkerasan (IP) = 2,0

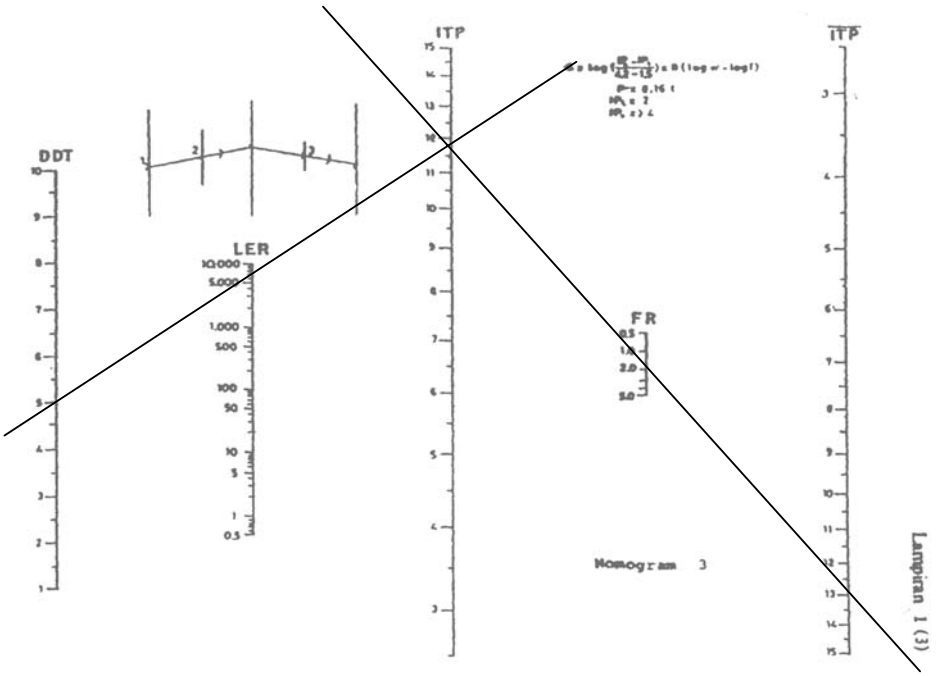
CBR tanah dasar = 6,0 %,

maka ; DDT = 5,0

FR = 2,0

LER = 6586

Dari nomogram 3 diperoleh : ITP = 13



Menentukan Tebal Lapisan

* Lapis Permukaan (a1) = Laston = 0,40

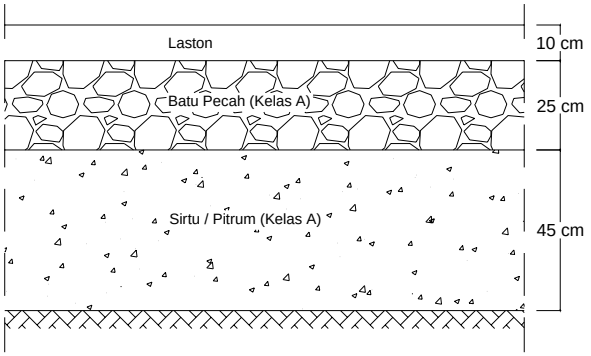
* Lapis Pondasi Atas (a1) = Batu Pecah Kelas A (CBR 100 %) = 0,14

* Lapis Pondasi Bawah (a3) = Sirtu (Kelas A) = 0,13

Maka ; ITP = a1.D1 + a2.D2 + a3.D3

13 = 0,40*10 + 0,14*25 + 0,13*D3

$$D3 = \frac{5,5}{0,13} = 42,307\ cm \approx 45\ cm$$



Gambar 5.84 Susunan perkerasan