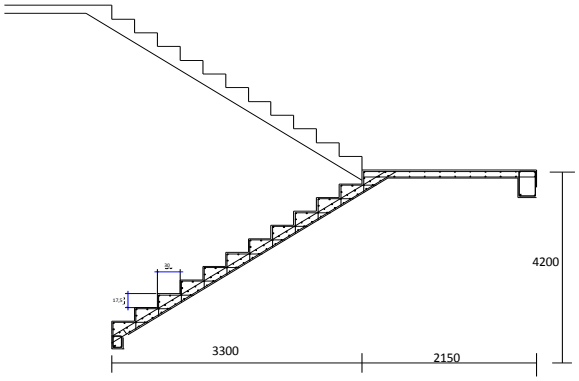
3.3 Perhitungan Tangga

3.3.1 Perencanaan Ukuran

Lantai Dasar ± 0,00

Lantai 1 ± 4,20



Gambar 3.3.1 Gambar Perencanaan Tangga Tampak Samping

Maka tinggi bordes = $\frac{4{,}20}{2}$ = 2,10

Ukuran optrede = 17,5 cm

Jumlah optrede = $\frac{210\ cm}{17{,}5\ \text{cm}}$ = 12 bh

Ukuran antrede = 2 optrede + 1antrede = 65

A = 65-2(17,5)

A = 30 cm

Syarat tangga

Antrede + 2 Optrede = ln
30 + 2 (17,5) = 65
65 = 65 (oke)

1. Sudut kemiringan tangga < 45˚

   Tg $\dot{\alpha}$ = $\frac{17{,}5\ cm}{30\ \text{cm}}$ = 0,58

   $\dot{\alpha}$ = 30,11 ˚
2. Lebar tangga = 190 cm
3. Panjang bordes = ln + 1,5 @ x a

   = 65 cm + 1,5 x 30cm

   = 110 cm ~ 150 cm

Lebar bordes = 2 x 150cm = 300cm

3.3.2 Pembenanan dan Perhitungan Tangga

Tebal pelat = 150mm = 0,15m

Beban mati (WD)

- Berat pelat tangga = 0,15m x 1,00m x 2400kg/m^3 = 360kg/m
- Berat anak tangga = $\frac{0{,}175 \text{ x } 0{,}30}{2}$ x 1,00m x $\frac{12\ \text{bh}}{3{,}00\ \text{m}}$ x 0,86 x 2400kg/m^3 = 216,72kg/m
- Berat penutup lantai = 24kg/m^2 x 1,00m x 0,86 = 20,64 kg/m
- Berat adukan = 21kg/m^2 x 1,00m x 0,86 = 18,06 kg/m
- Berat sandaran = 20kg/m^2 x 1,00m x 0,86 = 17,2 kg/m

  WD = 632,62 kg/m

Beban hidup (WL)

- WL = 300kg/m^2 x 1,00m x 0,86 = 258 kg/m
- Beban tefaktor (WU)

WU = 1,2 WD + 1,6 WL = 1,2x632,62kg/m + 1,6x258kg/m

= 1171,944 kg/m

3.3.3 Pembebanan bordes

Beban mati (WD)

- Berat pelat tangga = 0,15m x 1,00m x 2400kg/m^3 = 360kg/m
- Berat penutup lantai = 24kg/m^2 x 1,00m = 24kg/m
- Berat adukan = 21kg/m^2 x 1,00m = 21kg/m

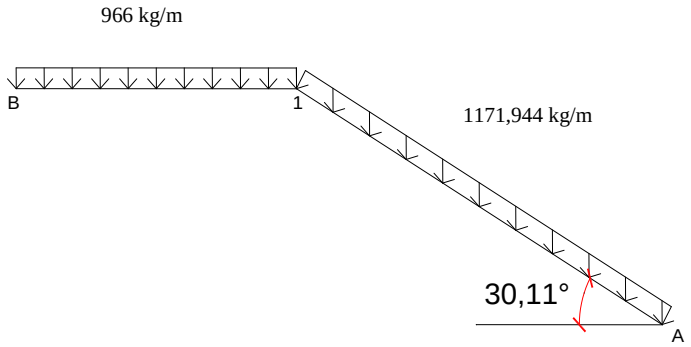
WD = 405 kg/m

Beban hidup (WL)

- WL = 300kg/m^2 x 1,00m = 300kg/m
- Beban terfaktor (WU)

WU =1,2 WD + 1,6 WL = 1,2x405kg/m + 1,6x300kg/m = 966kg/m

3.3.4 Perhitungan struktur



Gambar 3.3.2 Pembebanan Tangga

a. Momen inersia

$I_{1A} = \frac{1}{12}$ x b x $h^3 = \frac{1}{12}$ x 100 x 15^3 = 28125cm^4 ……. I

$I_{1B} = \frac{1}{12}$ x b x $h^3 = \frac{1}{12}$ x 100 x 15^3 = 28125cm^4 ……. I

b. Factor keamanan

$K_{1A} = \frac{4EI}{L} = \frac{4EI}{3,912}$ = 1,02EI

$K_{1B} = \frac{4EI}{L} = \frac{4EI}{2,150}$ = 1,86EI

c. Factor distribusi

$\mu_{1A} = \frac{1,02}{1,02+1,86}$ = 0,36

$\mu_{1B} = \frac{1,86}{1,02+1,86}$ = 0,65

d. Momen primer

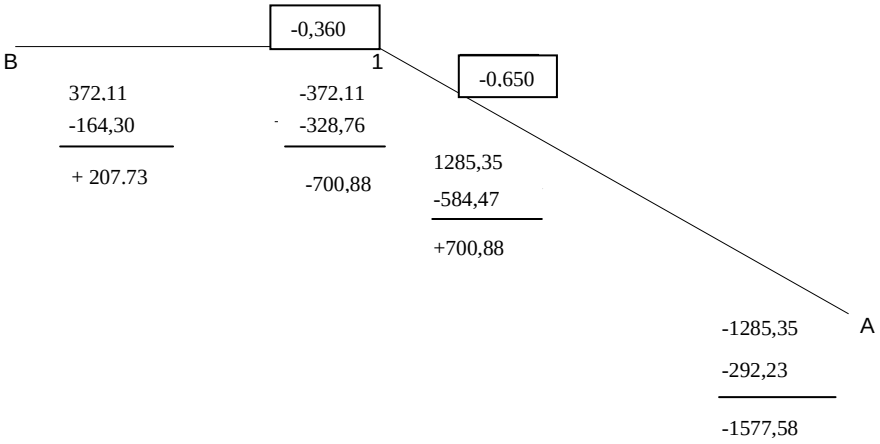
$$M\ 1A = -\frac{q \times \cos\dot{\alpha} \times l^2}{12} = -\frac{1171{,}944 \times 0{,}86 \times 3{,}912^2}{12} = -\ 1285{,}35\text{kgm}$$

$$M\ A1 = +\frac{q \times \cos\dot{\alpha} \times l^2}{12} = +\frac{1171{,}944 \times 0{,}86 \times 3{,}912^2}{12} = +\ 1285{,}35\text{kgm}$$

$$M\ 1B = -\frac{q \times l^2}{12} = -\frac{966 \times 2{,}150^2}{12} = -\ 372{,}11\text{kgm}$$

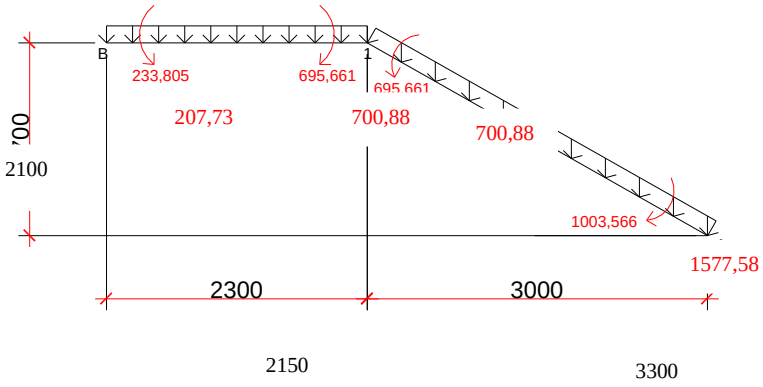
$$M\ B1 = +\frac{q \times l^2}{12} = +\frac{966 \times 2{,}150^2}{12} = +\ 372{,}11\text{kgm}$$

Perataan momen



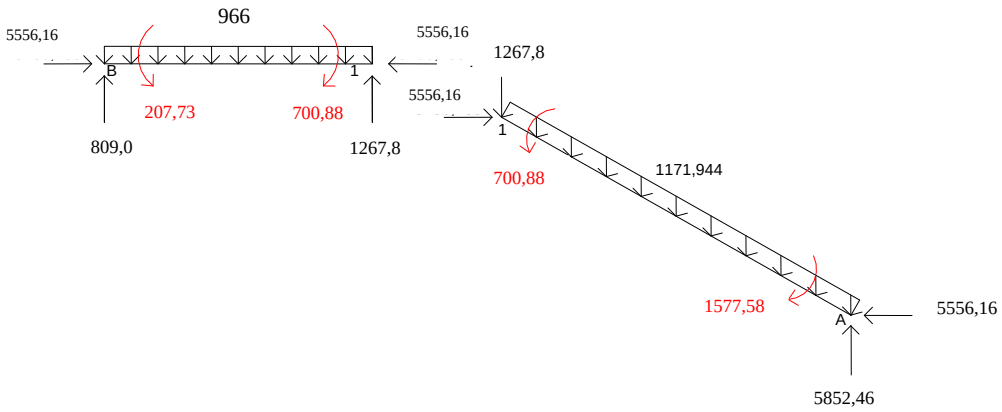
Gambar 3.3.3 Perataan Momen

Momen design



Gambar 3.3.4 Momen Design

Freebody



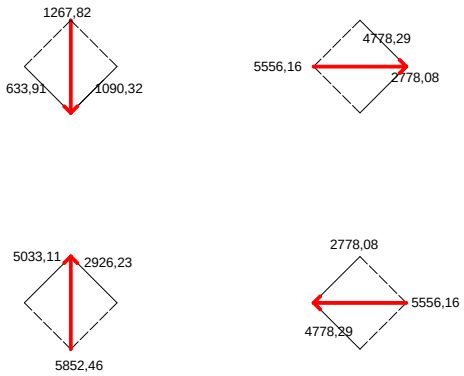
Gambar 3.3.5 Freebody

$$\sum M1 = 0$$

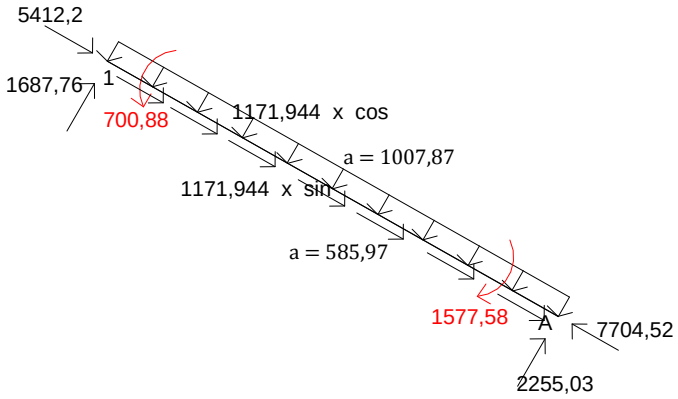
= (5852,467 x 3,3) – (AH x 2,1) – 1577,58 + 1267,8 – (1171,944 x 3,912 x 1,6)

= 5556,16

Uraian gaya

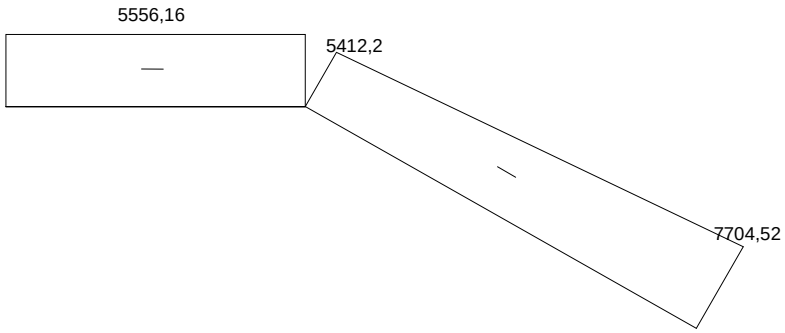


Gambar 3.3.6 Uraian Gaya



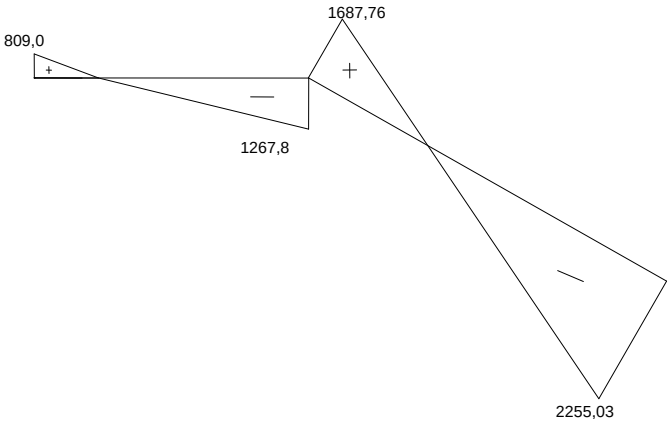
Gambar 3.3.7 Beban Pada Tangga

Bidang normal



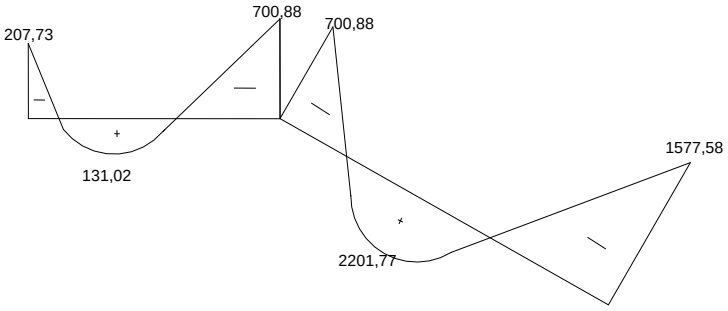
Gambar 3.3.8 Diagram Bidang N

Bidang lintang



Gambar 3.3.9 Diagram Bidang D

Bidang momen



Gambar 3.3.10 Diagram Bidang M

3.3.5 Perhitungan tulangan

1. Penulangan tangga
   - Tebal pelat tangga (h) = 15cm = 150mm
   - Selimut beton (p) = 20mm (terlindung dari cuaca)
   - Fc' = 25mpa
   - Fy = 400mpa
   - Direncanakan menggunakan tulangan ⌀10
   - d= h-p- $\frac{1}{2}$ Ø = 150-20-$\frac{1}{2}$10 = 125mm

   a. Tulangan tumpuan

   Mu = 1577,58 kgm

   $K = \frac{Mu}{Ø \text{ x } b \text{ x } d^2} = \frac{1577{,}58 \text{ x } 10^4}{0{,}8 \text{ x } 1000 \text{ x } 125^2} = 1{,}262$

   ρ = 0,0035

   As = ρ x b xd = 0,0035 x 1000 x 125 = 437,5mm^2

   $n = \frac{As}{\frac{1}{4} \text{ x } \pi \text{ x } d^2} = \frac{437{,}5}{\frac{1}{4} \text{ x } \pi \text{ x } 10^2} = 5{,}5 \sim 6 \text{ bh}$

   $s = \frac{1000 \text{ mm}}{6 \text{ bh}} = 166{,}67\text{mm} \sim 200 \text{ mm}$

   as pakai = 6 bh x $\frac{1}{4}$ x π x 10^2 = 471,23mm^2 ~471mm^2

   tulangan yang digunakan Ø10 – 200mm

   b. Tulangan lapangan

Mu = 2201,77 kgm

K = $\frac{\text{Mu}}{\text{Ø x b x } d^2} = \frac{2201{,}77\text{x } 10^4}{0{,}8 \text{ x } 1000 \text{ x } 125^2}$ = 1,76

ρ = 0,0035

As = ρ x b xd = 0,0035 x 1000 x 125 = 437,5 mm^2

n = $\frac{\text{As}}{\frac{1}{4} \text{ x } \pi \text{ x } d^2} = \frac{437{,}5}{\frac{1}{4} \text{ x } \pi \text{ x } 10^2}$ = 5,57 ~6 bh

s = $\frac{1000 \text{ mm}}{6 \text{ bh}}$ = 166,67mm ~ 200 mm

as pakai = 6 bh x $\frac{1}{4}$ x π x 10^2 = 471,23 mm^2 ~471mm^2

tulangan yang digunakan = Ø10 – 200mm

c. Tulangan pembagi

Menggunakan tulangan Ø 8

As = 0,0020 x b xd = 0,0020 x 1000 x 150 = 300mm^2

n = $\frac{\text{As}}{\frac{1}{4} \text{ x } \pi \text{ x } d^2} = \frac{300}{\frac{1}{4} \text{ x } \pi \text{ x } 8^2}$ = 5,9 ~6 bh

s = $\frac{1000 \text{ mm}}{6 \text{ bh}}$ = 166,66 mm ~ 200 mm

as pakai = 6 bh x $\frac{1}{4}$ x π x 8^2 = 301,59 mm^2 ~301 mm^2

tulangan yang digunakan = Ø8 – 200mm

2. Penulangan bordes

- Tebal pelat tangga (h) = 300mm
- Dimensi balok bordes =250 x 400
- Selimut beton (p) = 20mm (terlindung dari cuaca)
- Fc’ = 25mpa
- Fy = 400mpa
- Direncanakan menggunakan tulangan utama Ø12
- Direncanakan menggunakan tulangan sengkang Ø8
- d= h-p- Øsengkang - $\frac{1}{2}$ Ø = 300-20 – 8 - $\frac{1}{2}$12 = 266mm

Pembebanan balok bordes

- Beban mati (WD)

Berat balok = 0,250 x 0,400 x 2400kg/m^3 = 240 kg/m

Berat pelat bordes = 966 kg/m

WD = 1206 kg/m

- Beban hidup (WL)

WL = 300kg/m^2 x 1m = 300 kg/m

- Beban terfaktor (WU)

WU = (1,2 x WD) + (1,6 X WL)

= (1,2 x 1206 kg/m)+ (1,6 x 300kg/m)

=1927,2kg/m

a. Tulangan tumpuan

Mu = $\frac{1}{12}$ x WU x l^2 = $\frac{1}{12}$ x 1927,2 kg/m x2,150^2

= 742,373 kg/m

K = $\frac{\text{Mu}}{\text{Ø x b x } d^2}$ = $\frac{742{,}373 \text{ x } 10^4}{0{,}8 \text{ x } 1000 \text{ x } 266^2}$ = 0,131 < k_{min}

ρ_{min} = 0,0035

As = ρ x b x d = 0,0035 x 250 x 266

= 232,75 mm^2

n = $\frac{\text{As}}{\frac{1}{4} \text{ x } \pi \text{ x } d^2}$ = $\frac{232{,}75}{\frac{1}{4} \text{ x } \pi \text{ x } 12^2}$ = 2,05 ~3bh

as pakai = 3 bh x $\frac{1}{4}$ x π x 12^2

= 339,29mm^2~ 339mm^2

s = $\frac{1000 \text{ mm}}{3\text{bh}}$ = 333,33 mm ~ 300 mm

tulangan yang digunakan = Ø12 – 300mm

b. Tulangan lapangan

Mu = $\frac{1}{24}$ x WU x l^2 = $\frac{1}{24}$ x 1927,2 kg/m x2,150^2

= 371,186 kg/m

K = $\frac{\text{Mu}}{\text{Ø x b x } d^2}$ = $\frac{371{,}186 \text{ x } 10^4}{0{,}8 \text{ x } 1000 \text{ x } 266^2}$

= 0,065 < k_{min} 1,3537

ρ_{min} = 0,0035

As = ρ x b x d = 0,0035 x 250 x 266

= 232,75 mm^2

n = $\frac{\text{As}}{\frac{1}{4} \text{ x } \pi \text{ x } d^2}$ = $\frac{232{,}75}{\frac{1}{4} \text{ x } \pi \text{ x } 12^2}$ = 2,05 ~3 bh

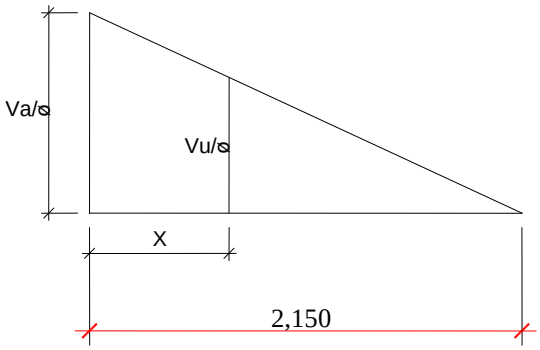
as pakai = 3 bh x $\frac{1}{4}$ x π x 12^2

= 339,29 mm^2 ~339 mm^2

s = $\frac{1000\ mm}{3bh}$ = 333,33 mm ~ 300 mm

tulangan yang digunakan = Ø12-300

c. Tulangan geser



- Deff =266mm
- Ø = 0,75
- VA = $\frac{1}{2}$ x WU x l = $\frac{1}{2}$ x 1927,2 x 2,150
  = 2071,74 kgm
- $\frac{VA}{Ø}$ = $\frac{2071,74}{0,75}$ = 2762,32
- Jarak $\frac{VU}{Ø}$ (x) = $\frac{1}{2}$ b + deff = $\frac{1}{2}$ x250 + 266
  = 391 mm
- $\frac{VA}{Ø}$: $\frac{VU}{Ø}$ = 1,075 : (1,075 – x)

2762,32 : $\frac{VU}{Ø}$ = 1,075 : (1,075 – 0,391)

2762,32 : $\frac{VU}{Ø}$ = 1,075 : 0,684

$\frac{VU}{Ø}$ = $\frac{0,684\ x\ 2762,32}{1,075}$

$\frac{VU}{Ø}$ = 1757,606 = 17576,06 N

- Vc = $\frac{1}{6}$ x $\sqrt{f c'}$ x b x deff

  = $\frac{1}{6}$ x $\sqrt{35}$ x 250 x 266

  = 65569,88

- Vs = $\frac{VU}{\varnothing}$ - Vc = 17576,06 – 65569,88
  = -47993,82N
- Av = 2 x $\frac{1}{4}$ x π x d^2 = 2 x $\frac{1}{4}$ x π x 8^2
  = 100,53 mm^2
- S_{max} = d/2 = 266/2 = 133 mm
- S = $\frac{Av \text{ x } fy \text{ x } deff}{Vs}$ = $\frac{100,53 \text{ x } 240 \text{ x } 266}{47993,82}$
  = 133,722 mm > S_{max}

Jadi dipakai sengkang Ø8-150

Tabel 3.4 Penulangan Pelat Tangga

Posisi	Momen (Nmm)	D (mm)	K	ρ	As (mm^2)	Tulangan	As terpasang (mm^2)
Tumpuan	$1577,58 \text{ x } 10^4$	125	1,15	0,0035	437,5	Ø10 – 200	471
Lapangan	$240,79 \text{ x } 10^4$	125	0,32	0,0035	437,5	Ø10 – 200	471
Pembagi					300	Ø8- 200	301

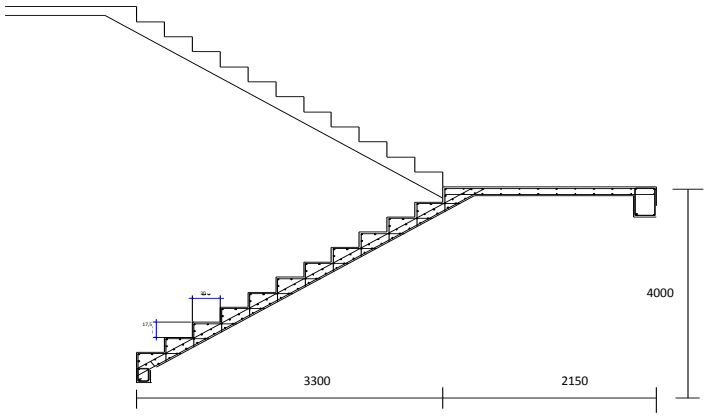
Table 3.5 Penulangan Pelat Bodes

Posisi	Momen (Nmm)	D (mm)	K	ρ	As (mm^2)	Tulangan	As terpasang (mm^2)
Tumpuan	742×10^4	266	0,131	0,0035	232,7	Ø12-300	339
Lapangan	$371{,}186 \times 10^4$	266	0,065	0,0035	232,7	Ø12-300	339
Pembagi					300	Ø8- 200	301

3.3.6 Perencanaan Ukuran

Lantai 1 ± 4,20

Lantai 2 ± 8,20



Gambar 3.3.11 Gambar Perencanaan Tangga Tampak Samping

Maka tinggi bordes = $\frac{4{,}0}{2}$ = 2

Ukuran optrede = 17,5 cm

Jumlah optrede = $\frac{200\ cm}{17{,}5\ \text{cm}}$ = 11,42 bh ~ 12 bh

Ukuran antrede = 2 optrede + 1antrede = 65

A = 65-2(17,5)

A = 30 cm

Syarat tangga

Antrede + 2 Optrede = ln
30 + 2 (17,5) = 65
65 = 65 (oke)

1. Sudut kemiringan tangga < 45˚
   Tg $\dot{\alpha}$ = $\frac{20\ cm}{30\ \text{cm}}$ = 0,66
   $\dot{\alpha}$ = 33,69 ˚
2. Lebar tangga = 190 cm
3. Panjang bordes = ln + 1,5 @ x a
   = 65 cm + 1,5 x 30cm
   = 110 cm ~ 150 cm

Lebar bordes = 2 x 150cm = 300cm

3.3.7 Pembenanan dan Perhitungan Tangga

Tebal pelat = 150mm = 0,15m

Beban mati (WD)

- Berat pelat tangga = 0,15m x 1,00m x 2400kg/m^3 = 360kg/m
- Berat anak tangga = $\frac{0{,}175 \text{ x } 0{,}30}{2}$ x 1,00m x $\frac{12\ \text{bh}}{3{,}00\ \text{m}}$ x 0,83 x 2400kg/m^3 = 209,16 kg/m
- Berat penutup lantai = 24kg/m^2 x 1,00m x 0,83 = 19,92 kg/m
- Berat adukan = 21kg/m^2 x 1,00m x 0,83 = 17,43 kg/m
- Berat sandaran = 20kg/m^2 x 1,00m x 0,83 = 16,6 kg/m
  WD = 623,11 kg/m

Beban hidup (WL)

- WL = 300kg/m^2 x 1,00m x 0,83 = 249 kg/m

- Beban tefaktor (WU)

WU = 1,2 WD + 1,6 WL = 1,2x623,11kg/m + 1,6x249kg/m
= 1146,132 kg/m

3.3.8 Pembebanan bordes

Beban mati (WD)

- Berat pelat tangga = 0,15m x 1,00m x 2400kg/m^3 = 360kg/m
- Berat penutup lantai = 24kg/m^2 x 1,00m = 24kg/m
- Berat adukan = 21kg/m^2 x 1,00m = 21kg/m

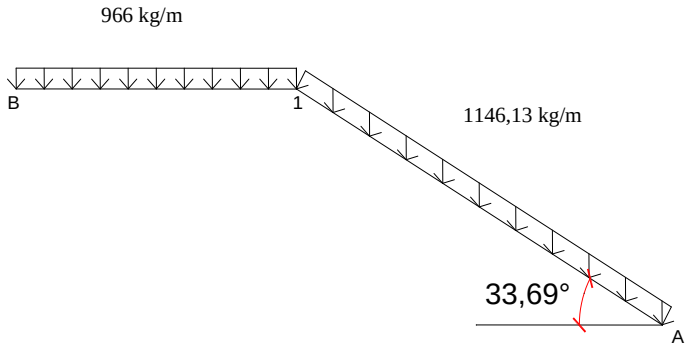
WD = 405 kg/m

Beban hidup (WL)

- WL = 300kg/m^2 x 1,00m = 300kg/m
- Beban terfaktor (WU)

WU =1,2 WD + 1,6 WL = 1,2x405kg/m + 1,6x300kg/m = 966kg/m

3.3.9 Perhitungan struktur



Gambar 3.3.12 Pembebanan Tangga

e. Momen inersia

$I_{1A} = \frac{1}{12}$ x b x $h^3 = \frac{1}{12}$ x 100 x 15^3 = 28125cm^4 I

$I_{1B} = \frac{1}{12}$ x b x $h^3 = \frac{1}{12}$ x 100 x 15^3 = 28125cm^4 I

f. Factor keamanan

$K_{1A} = \frac{4EI}{L} = \frac{4EI}{3,858} = 1,03EI$

$K_{1B} = \frac{4EI}{L} = \frac{4EI}{2,150} = 1,86EI$

g. Factor distribusi

$\mu_{1A} = \frac{1,03}{1,03+1,86} = 0,36$

$\mu_{1B} = \frac{1,86}{1,03+1,86} = 0,64$

h. Momen primer

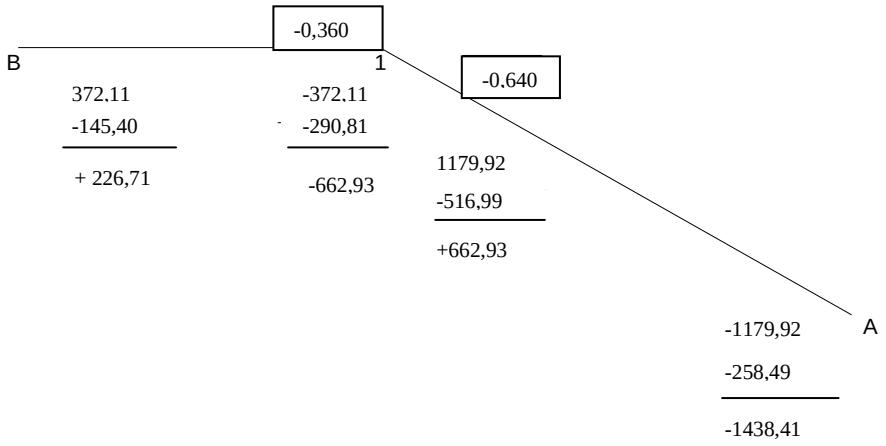
$M\ 1A = -\frac{q \times \cos\dot{\alpha} \times l^2}{12} = -\frac{1146,13 \times 0,83 \times 3,858^2}{12} = -1179,92kgm$

$M\ A1 = +\frac{q \times \cos\dot{\alpha} \times l^2}{12} = +\frac{1146,13 \times 0,83 \times 3,858^2}{12} = +1179,92kgm$

$M\ 1B = -\frac{q \times l^2}{12} = -\frac{966 \times 2,150^2}{12} = -372,11kgm$

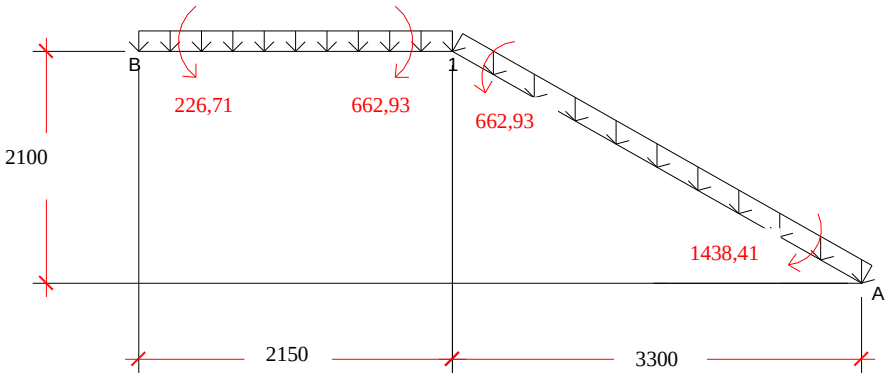
$M\ B1 = +\frac{q \times l^2}{12} = +\frac{966 \times 2,150^2}{12} = +372,11kgm$

Perataan momen



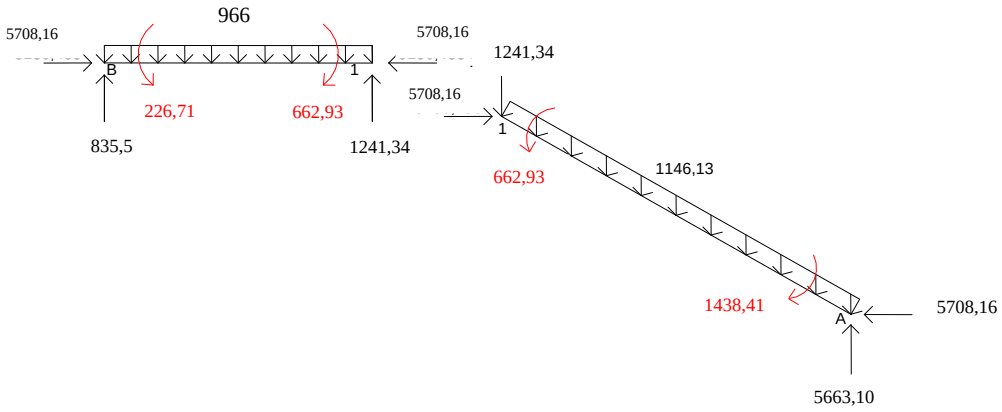
Gambar 3.3.13 Perataan Momen

Momen design



Gambar 3.3.14 Momen Design

Freebody



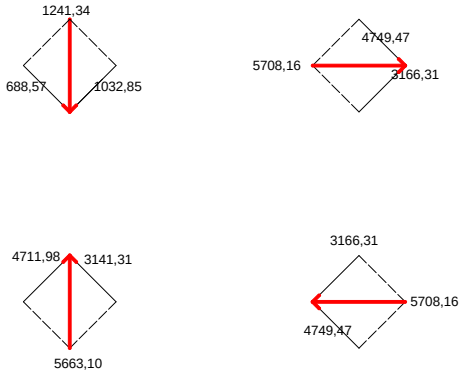
Gambar 3.3.15 Freebody

$$\sum M1 = 0$$

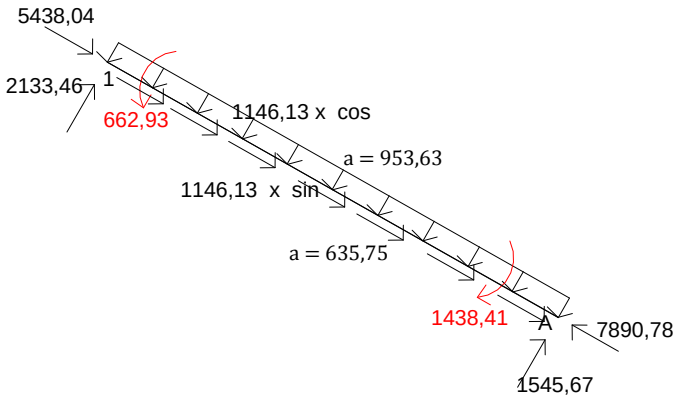
= (5663,10x 3,3) – (AH x 2,0) – 1438,41 + 1241,34 – (1146,13 x 3,858x 1,6)

= 5708,16

Uraian gaya

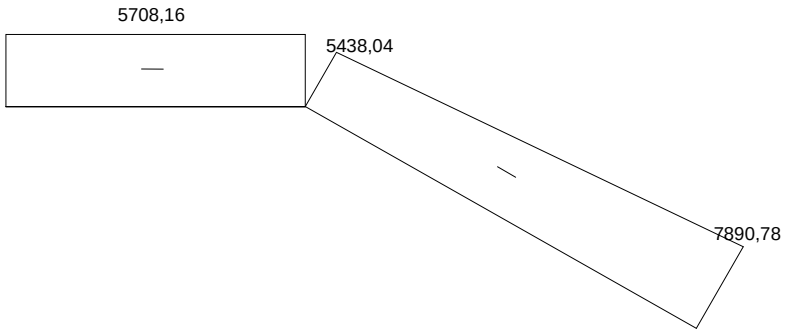


Gambar 3.3.16 Uraian Gaya



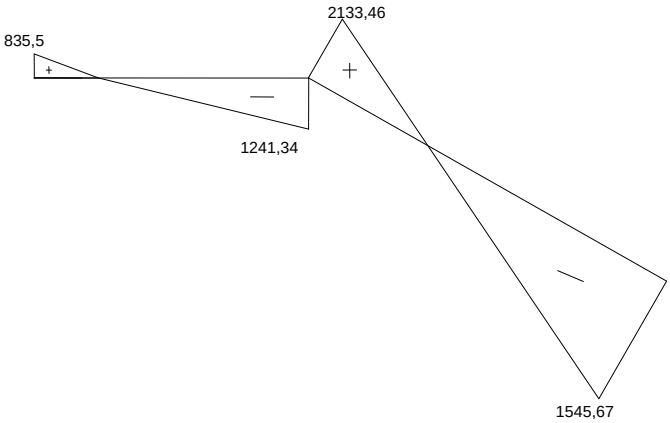
Gambar 3.3.17 Beban Pada Tangga

Bidang normal



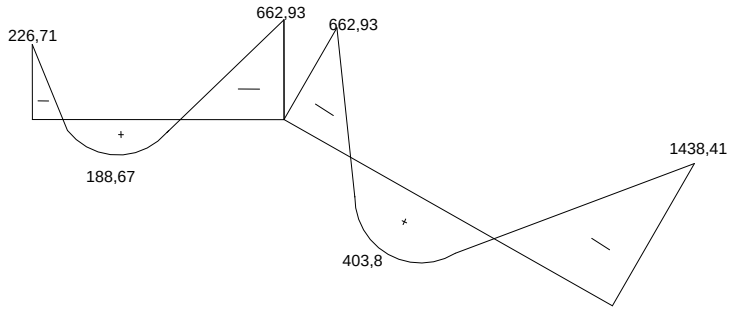
Gambar 3.3.18 Diagram Bidang N

Bidang lintang



Gambar 3.3.19 Diagram Bidang D

Bidang momen



Gambar 3.3.20 Diagram Bidang M

3.3.10 Perhitungan tulangan

1. Penulangan tangga
   - Tebal pelat tangga (h) = 15cm = 150mm
   - Selimut beton (p) = 20mm (terlindung dari cuaca)
   - Fc' = 25mpa
   - Fy = 400mpa
   - Direncanakan menggunakan tulangan ⌀10
   - d= h-p- $\frac{1}{2}$ Ø = 150-20-$\frac{1}{2}$10 = 125mm

   a. Tulangan tumpuan

   Mu = 1438,41 kgm

   K = $\frac{\text{Mu}}{\text{Ø x b x } d^2}$ = $\frac{1438{,}41 \text{ x } 10^4}{0{,}8 \text{ x } 1000 \text{ x } 125^2}$ = 1,15

   ρ = 0,0035

   As = ρ x b xd = 0,0035 x 1000 x 125 = 437,5mm^2

   n = $\frac{\text{As}}{\frac{1}{4} \text{ x } \pi \text{ x } d^2}$ = $\frac{437{,}5}{\frac{1}{4} \text{ x } \pi \text{ x } 10^2}$ = 5,5 ~6 bh

   s = $\frac{1000 \text{ mm}}{6 \text{ bh}}$ = 166,67mm ~ 200 mm

   as pakai = 6 bh x $\frac{1}{4}$ x π x 10^2 = 471,23mm^2 ~471mm^2

tulangan yang digunakan Ø10 – 200mm

b. Tulangan lapangan

Mu = 403,8 kgm

$K = \frac{Mu}{\emptyset \times b \times d^2} = \frac{403{,}8 \times 10^4}{0{,}8 \times 1000 \times 125^2} = 0{,}32$

$\rho = 0{,}0035$

$As = \rho \times b \times d = 0{,}0035 \times 1000 \times 125 = 437{,}5\ mm^2$

$n = \frac{As}{\frac{1}{4} \times \pi \times d^2} = \frac{437{,}5}{\frac{1}{4} \times \pi \times 10^2} = 5{,}57 \sim 6\ bh$

$s = \frac{1000\ mm}{6\ bh} = 166{,}67mm \sim 200\ mm$

$as\ pakai = 6\ bh \times \frac{1}{4} \times \pi \times 10^2 = 471{,}23\ mm^2 \sim 471mm^2$

tulangan yang digunakan = Ø10 – 200mm

c. Tulangan pembagi

Menggunakan tulangan Ø 8

$As = 0{,}0020 \times b \times d = 0{,}0020 \times 1000 \times 150 = 300mm^2$

$n = \frac{As}{\frac{1}{4} \times \pi \times d^2} = \frac{300}{\frac{1}{4} \times \pi \times 8^2} = 5{,}9 \sim 6\ bh$

$s = \frac{1000\ mm}{6\ bh} = 166{,}66\ mm \sim 200\ mm$

$as\ pakai = 6\ bh \times \frac{1}{4} \times \pi \times 8^2 = 301{,}59\ mm^2 \sim 301\ mm^2$

tulangan yang digunakan = Ø8 – 200mm

2. Penulangan bordes

- Tebal pelat tangga (h) = 300mm
- Dimensi balok bordes =250 x 400
- Selimut beton (p) = 20mm (terlindung dari cuaca)
- Fc' = 25mpa
- Fy = 400mpa
- Direncanakan menggunakan tulangan utama Ø12
- Direncanakan menggunakan tulangan sengkang Ø8
- $d = h - p - Øsengkang - \frac{1}{2}Ø = 300 - 20 - 8 - \frac{1}{2}12 = 266mm$

Pembebanan balok bordes

- Beban mati (WD)

Berat balok = 0,250 x 0,400 x 2400kg/m^3 = 240 kg/m

Berat pelat bordes = 966 kg/m

WD = 1206 kg/m

- Beban hidup (WL)

WL = 300kg/m^2 x 1m = 300 kg/m

- Beban terfaktor (WU)

WU = (1,2 x WD) + (1,6 X WL)

= (1,2 x 1206 kg/m)+ (1,6 x 300kg/m)

=1927,2kg/m

a. Tulangan tumpuan

Mu = $\frac{1}{12}$ x WU x l^2 = $\frac{1}{12}$ x 1927,2 kg/m x2,150^2

= 742,373 kg/m

K = $\frac{\text{Mu}}{\text{Ø x b x } d^2}$ = $\frac{742{,}373 \text{ x } 10^4}{0{,}8 \text{ x } 1000 \text{ x } 266^2}$ = 0,131 < k_{min}

ρ_{min} = 0,0035

As = ρ x b x d = 0,0035 x 250 x 266

= 232,75 mm^2

n = $\frac{\text{As}}{\frac{1}{4} \text{ x } \pi \text{ x } d^2}$ = $\frac{232{,}75}{\frac{1}{4} \text{ x } \pi \text{ x } 12^2}$ = 2,05 ~3bh

as pakai = 3 bh x $\frac{1}{4}$ x π x 12^2

= 339,29mm^2~ 339mm^2

s = $\frac{1000 \text{ mm}}{3\text{bh}}$ = 333,33 mm ~ 300 mm

tulangan yang digunakan = Ø12 – 300mm

b. Tulangan lapangan

Mu = $\frac{1}{24}$ x WU x l^2 = $\frac{1}{24}$ x 1927,2 kg/m x2,150^2

= 371,186 kg/m

K = $\frac{\text{Mu}}{\text{Ø x b x } d^2}$ = $\frac{371{,}186 \text{ x } 10^4}{0{,}8 \text{ x } 1000 \text{ x } 266^2}$

= 0,065 < k_{min} 1,3537

ρ_{min} = 0,0035

As = ρ x b x d = 0,0035 x 250 x 266

= 232,75 mm^2

$$n = \frac{As}{\frac{1}{4} \times \pi \times d^2} = \frac{232,75}{\frac{1}{4} \times \pi \times 12^2} = 2,05 \sim 3 \text{ bh}$$

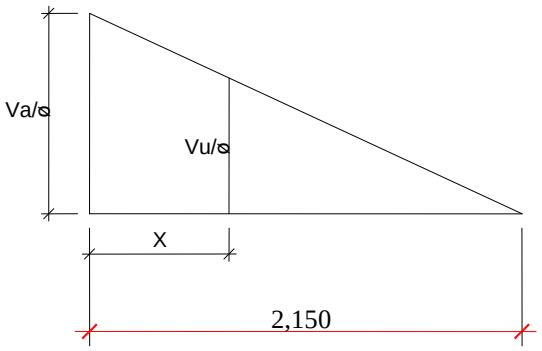
as pakai = 3 bh x $\frac{1}{4}$ x π x 12^2

= 339,29 mm^2 ~339 mm^2

$$s = \frac{1000 \text{ mm}}{3bh} = 333,33 \text{ mm} \sim 300 \text{ mm}$$

tulangan yang digunakan = Ø12-300

c. Tulangan geser



- Deff =266mm
- Ø = 0,75
- VA = $\frac{1}{2}$ x WU x l = $\frac{1}{2}$ x 1927,2 x 2,150
  = 2071,74 kgm
- $\frac{VA}{Ø}$ = $\frac{2071,74}{0,75}$ = 2762,32
- Jarak $\frac{VU}{Ø}$ (x) = $\frac{1}{2}$ b + deff = $\frac{1}{2}$ x250 + 266
  = 391 mm
- $\frac{VA}{Ø}$: $\frac{VU}{Ø}$ = 1,075 : (1,075 – x)

2762,32 : $\frac{VU}{Ø}$ = 1,075 : (1,075 – 0,391)

$$2762{,}32 : \frac{VU}{\emptyset} = 1{,}075 : 0{,}684$$

$$\frac{VU}{\emptyset} = \frac{0{,}684 \text{ x } 2762{,}32}{1{,}075}$$

$$\frac{VU}{\emptyset} = 1757{,}606 = 17576{,}06 \text{ N}$$

- $Vc = \frac{1}{6} \text{ x } \sqrt{f c'} \text{ x b x deff}$

$$= \frac{1}{6} \text{ x } \sqrt{35} \text{ x } 250 \text{ x } 266$$

$$= 65569{,}88$$

- $Vs = \frac{VU}{\emptyset} - Vc = 17576{,}06 - 65569{,}88$
  $= -47993{,}82 \text{N}$
- $Av = 2 \text{ x } \frac{1}{4} \text{ x } \pi \text{ x } d^2 = 2 \text{ x } \frac{1}{4} \text{ x } \pi \text{ x } 8^2$
  $= 100{,}53 \text{ mm}^2$
- $S_{max} = d/2 = 266/2 = 133 \text{ mm}$
- $S = \frac{Av \text{ x } fy \text{ x } deff}{Vs} = \frac{100{,}53 \text{ x } 240 \text{ x } 266}{47993{,}82}$
  $= 133{,}722 \text{ mm} > S_{max}$

Jadi dipakai sengkang Ø8-150

Tabel 3.6 Penulangan Pelat Tangga

Posisi	Momen (Nmm)	D (mm)	K	ρ	As (mm^2)	Tulangan	As terpasang (mm^2)
Tumpuan	$1438{,}41 \text{ x } 10^4$	125	1,15	0,0035	437,5	Ø10 – 200	471
Lapangan	$403{,}8 \text{ x } 10^4$	125	0,32	0,0035	437,5	Ø10 – 200	471
Pembagi					300	Ø8- 200	301

Table 3.7 Penulangan Pelat Bodes

Posisi	Momen (Nmm)	D (mm)	K	ρ	As (mm^2)	Tulangan	As terpasang (mm^2)
Tumpuan	742×10^4	266	0,131	0,0035	232,7	Ø12-300	339
Lapangan	$371{,}186 \times 10^4$	266	0,065	0,0035	232,7	Ø12-300	339
Pembagi					300	Ø8- 200	301