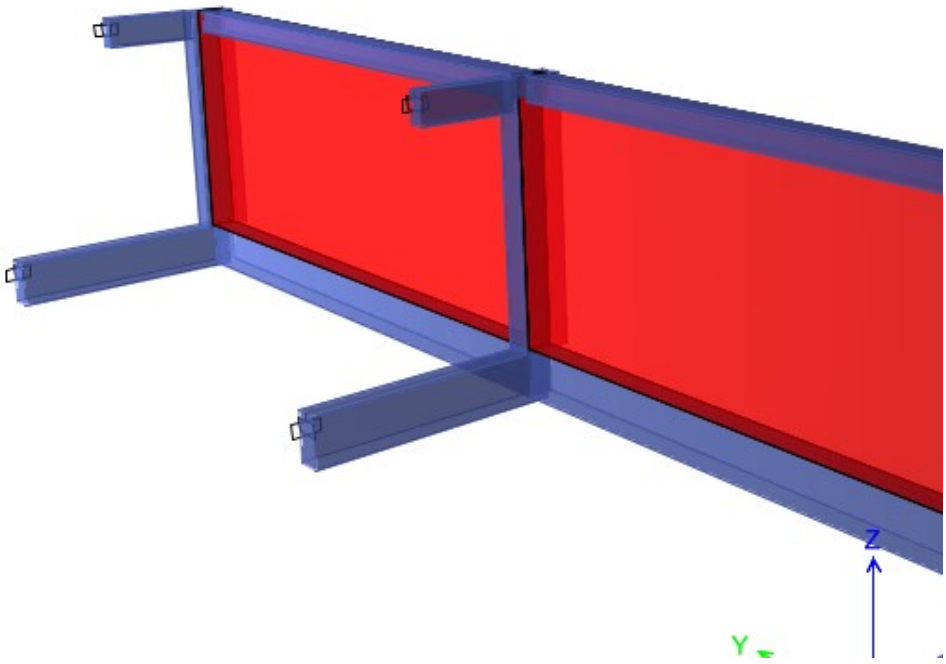
PROYEK
RUKO SOUTH CITY SQUARE LOT 1
TANGERANG SELATAN - BANTEN

LAPORAN PERBAIKAN STRUKTUR

PENAHAN TANAH



JAKARTA, FEBRUARI 2020

I. DESAIN KRITERIA

KRITERIA PERANCANGAN STRUKTUR

A. KETERANGAN UMUM

1. **Nama Proyek** : Desain Perbaikan Struktur Penahan Tanah
   Ruko South City Square Lot 1
2. **Lokasi** : Jl. Southcity Raya, Tangerang Selatan-Banten
3. **Deskripsi Pekerjaan** :

   Proyek Ruko South City Square Lot 1 merupakan bangunan yang sudah berdiri. Namun kondisi existing struktur penahan tanah menunjukkan bahwa adanya area yang membutuhkan perbaikan struktur dikarenakan adanya struktur penahan tanah gagal di lapangan.

B. SPESIFIKASI BAHAN

1. Beton

Mutu beton ditentukan berdasarkan kekuatan karakteristik beton f'_c dengan benda uji silinder pada umur beton 28 hari.

Mutu beton yang digunakan adalah sebagai berikut

- Tie Beam : f'_c= 25 MPa
- Kolom : f'_c= 25 MPa
- Dinding : f'_c= 25 MPa

Parameter sifat mekanis beton:

- Modulus elastisitas Ec = 4700√f'c (MPa).
- Untuk pembebanan sesaat, modulus elastisitas dapat ditingkatkan sampai 1.3 kali.
- *Poisson Ratio* beton = 0.2.

2. Baja tulangan

Jenis baja tulangan yang digunakan adalah sebagai berikut:

- ASTM A-615M Grade 280, fy = 280 MPa digunakan untuk baja tulangan polos diameter Ø < 10 mm.
- ASTM A-615M Grade 420, fy = 420 MPa digunakan untuk baja tulangan ulir diameter D ≥ 10 mm.

Parameter sifat mekanis baja tulangan:

- Modulus elastisitas E_s = 200000 MPa

C. PEMBEBANAN

Pembebanan didasarkan pada peraturan SNI-1727:2013 (Beban Minimum untuk Perancangan Bangunan Gedung dan Struktur Lain).

Beban yang ditinjau terdiri dari beban mati dan beban hidup.

Kombinasi Pembebanan yang digunakan dalam analisis ini adalah kombinasi beban tetap, antara lain:

U = 1,4 DL

U = 1,2 DL + 1,6 LL

D. PERHITUNGAN STRUKTUR

1. Penulangan Dinding Penahan Tanah

Penulangan pelat lantai dihitung berdasarkan pembebanan U = 1,2 DL + 1,6 LL_R

2. Penulangan Lentur dan Gaya Lintang Tie Beam

Penulangan lentur dan gaya lintang pada daerah tumpuan dan lapangan tie beam dihitung berdasarkan pembebanan:

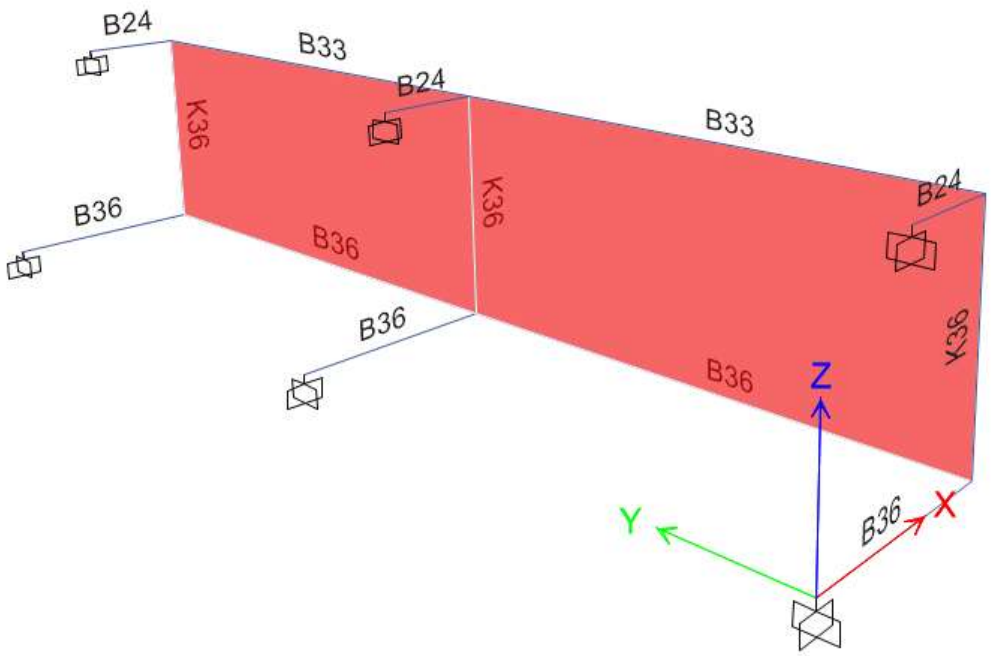
U = 1,4 DL

U = 1,2 DL + 1,6 LL

ANALISIS STRUKTUR

Terdapat 2 kondisi perkuatan struktur penahan tanah Ruko South City Lot 1, antara lain:

1. Perkuatan dinding sheet pile eksisting dengan ditambahkan balok strutting pada elevasi pondasi dan elevasi lantai 1.
2. Perbaikan dinding sheet pile yang rubuh dengan cara pembongkaran dinding existing yang sudah retak diganti dengan dinding baru yang duduk di atas tie beam yang terhubung ke struktur utama. Dalam tahap pelaksanaannya akan dilakukan galian opencut terlebih dahulu pada sisi lahan tetangga dan akan dilakukan pengurugan kembali setelah dinding penahan tanah sudah terlaksana di lapangan.



Gambar 1 : Pemodelan Dinding dengan ETABS

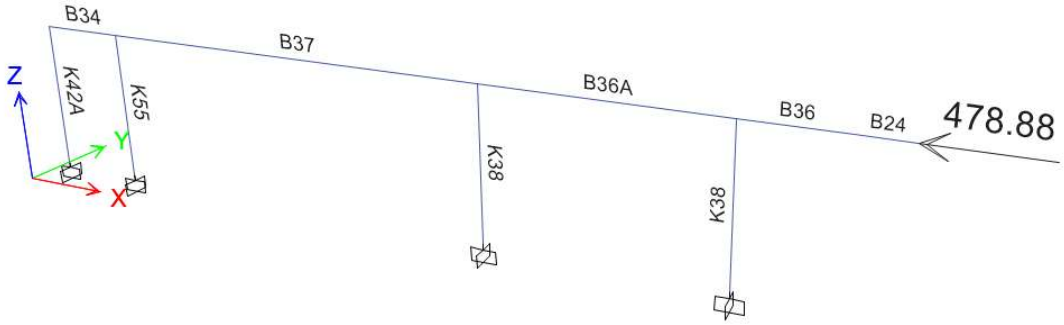
Pemodelan dinding penahan tanah, balok, *tie beam* dan kolom menggunakan ETABS. Dinding dimodelkan setinggi 3.6 meter dengan panjang bentang 8.2 meter dan tebal 300 mm.

Dimensi yang digunakan adalah :

- Balok strutting lantai 1 = 200 x 400 mm dengan panjang bentang 1.5 meter.

- *Tie beam* = 300 x 600 mm dengan panjang bentang 3 meter menghubungkan *pilecap* dan dinding.
- *Tie beam* = 300 x 600 mm dengan panjang bentang 8.2 meter sepanjang dinding penahan tanah.
- Kolom dinding = 300 x 600 mm.

Beban lateral tanah yang digunakan pada permukaan dinding adalah sebesar 6.48 ton/m^2.

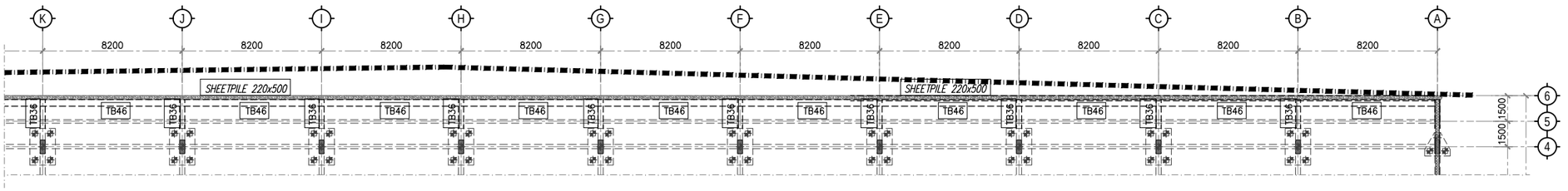


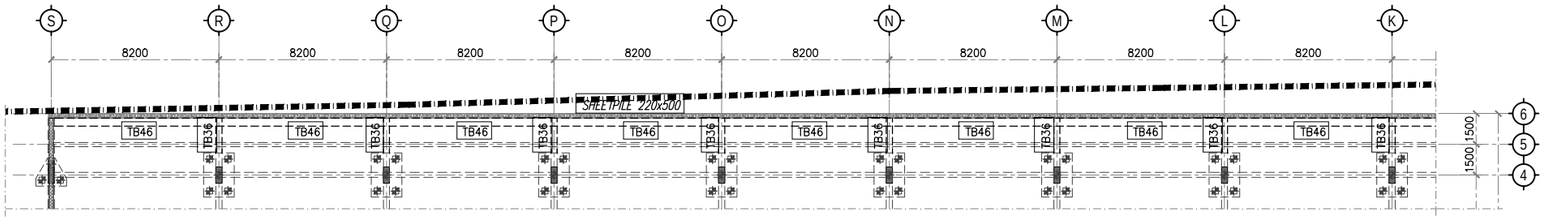
Gambar 2 : Pemodelan Portal Sederhana Gaya strutting dinding ke Bangunan Utama

Model sederhana dibuat dengan program ETABS berdasarkan gambar perkuatan yang diajukan oleh pihak perencana sebelumnya. Hasil analisis menunjukan bahwa bangunan utama akan mengalami defleksi maksimum bangunan sebesar 7.024 mm. Gaya lateral yang diterima oleh balok 200 x 400 mm tegak lurus dinding adalah sebesar 478.88 KN untuk dinding per 8.2 m.

Terlampir perhitungan pembesian untuk dinding, kolom, dan balok.

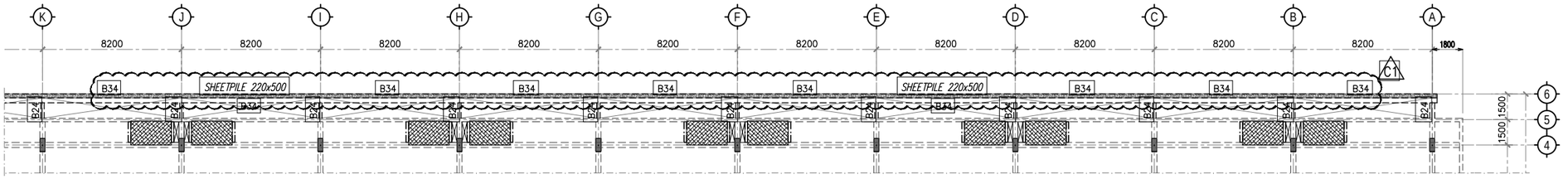
II. DENAH, POTONGAN DAN DETAIL STRUKTUR PENAHAN TANAH

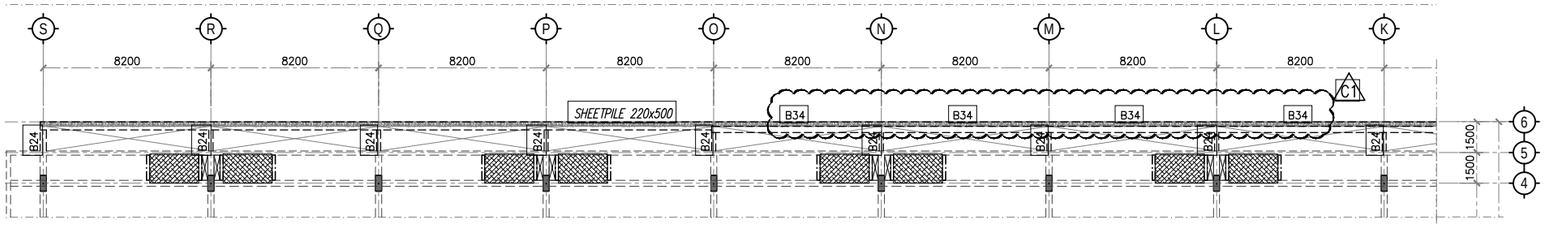




DENAH PERKUATAN SHEET PILE LANTAI BASEMENT

SKALA 1 : 150



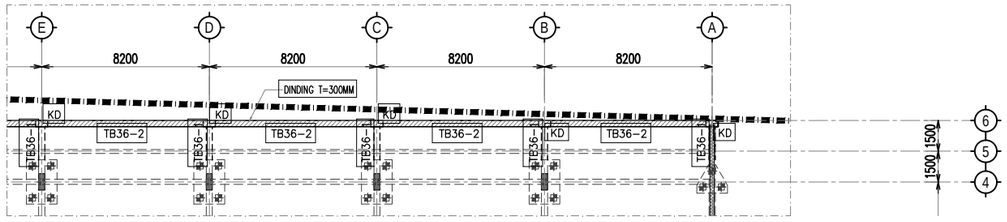


DENAH PERKUATAN SHEET PILE LANTAI 1

C1

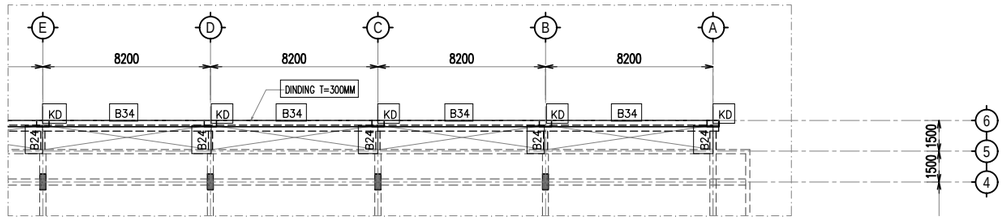
SKALA 1 : 150

CATATAN =
- B34 DARI AS A S/D AS O (SELEVEL CAPPING BEAM EXISTING)
- TB36-2 DARI AS A S/D AS E (POSISI DI BAWAH DINDING T=300MM)



DENAH PERBAIKAN STRUKTUR PENAHAN TANAH LANTAI BASEMENT

SKALA 1 : 150



DENAH PERBAIKAN STRUKTUR PENAHAN TANAH LANTAI 1

SKALA 1 : 150

PROYEK

RUKO SOUTH CITY SQUARE LOT. 1

OWNER / DEVELOPER

KONSULTAN PERENCANA

KONSULTAN STRUKTUR

KONSULTAN M&E

MANAJEMEN KONSTRUKSI

Catatan:

NO.	KETERANGAN	TANGGAL
C1	POSISI WALLER BEAM	

NOTE:
MUTU BETON = f'c 25 MPa

MUTU BESI TULANGAN = U-40

MUTU BAJA SS400
MUTU LAS E-70XX
MUTU BAUT A325M

JUDUL GAMBAR

DENAH STRUTTING SHEET PILE EKSISTING & DENAH PERBAIKAN STRUKTUR PENAHAN TANAH

STATUS : FOR CONSTRUCTION

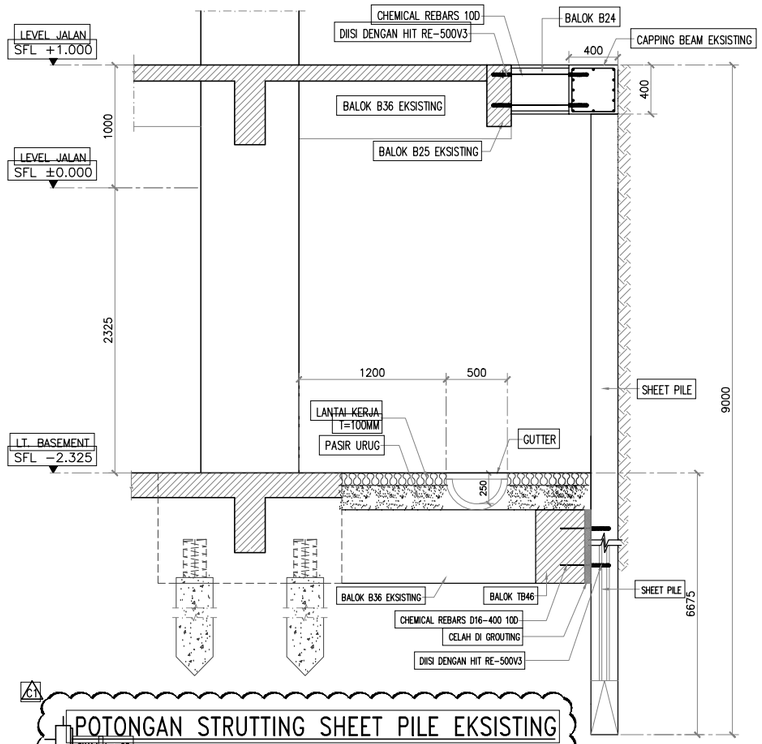
DIGAMBAR	DIPERIKSA	DISETUJUI

SKALA	TANGGAL
(A1) -	
(A3) 1 : 150	

KODE GAMBAR	NO. REVISI
SA-01	C1

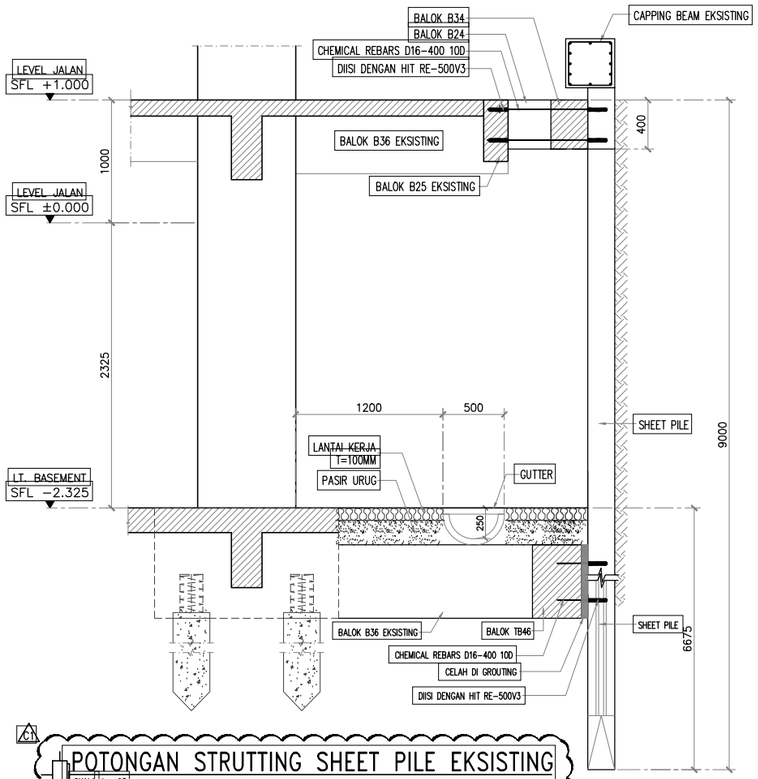
DIKELUARKAN UNTUK

CONSTRUCTION



POTONGAN STRUTTING SHEET PILE EKSISTING

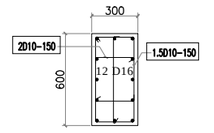
SKALA 1 : 25



POTONGAN STRUTTING SHEET PILE EKSISTING

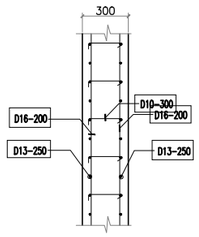
SKALA 1 : 25

(KONDISI CAPPING BEAM TIDAK SELEVEL DENGAN BALOK EKSISTING)



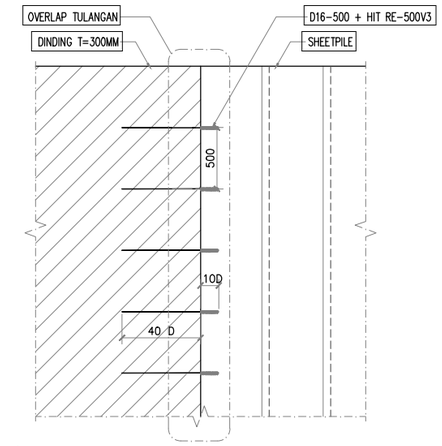
DETAIL KOLOM KD

SKALA 1 : 20



DETAIL DINDING

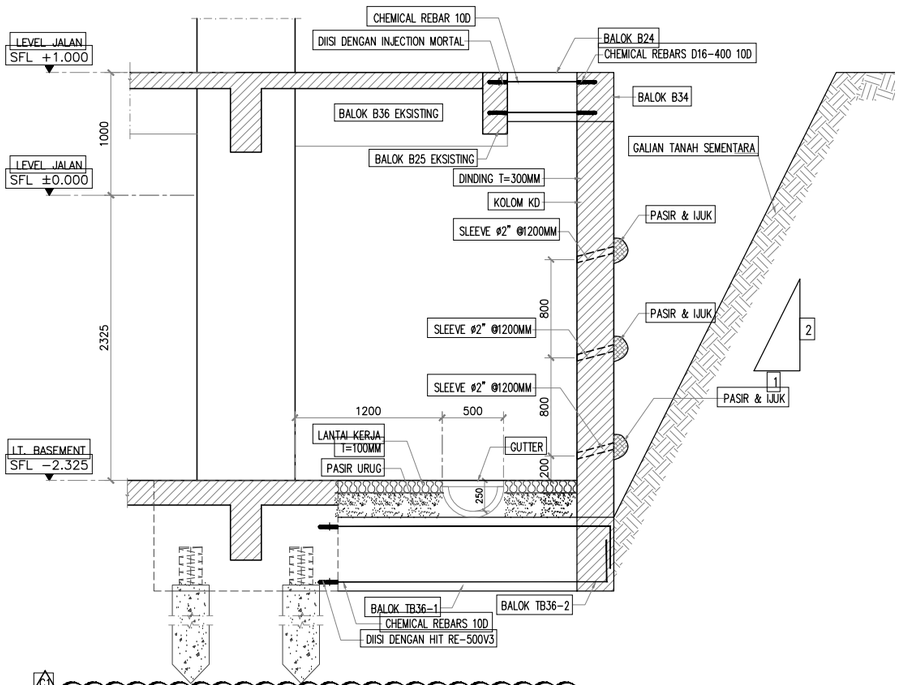
SKALA 1 : 20



DETAIL PRINSIP SAMBUNGAN

SKALA 1 : 25

(DINDING BETON BARU KE SHEETPILE)



POTONGAN STRUKTUR PENAHAN TANAH BARU

SKALA 1 : 25

TABEL PENULANGAN BALOK

TIPE	TB36-1		TB36-2		TB46	
	TUMPUAN	LAPANGAN	TUMPUAN	LAPANGAN	TUMPUAN	LAPANGAN
POTONGAN	600 / 300	600 / 300	600 / 300	600 / 300	600 / 400	600 / 400
UKURAN	300X600		300X600		400X600	
TULANGAN ATAS	4D22	3D22	5D22	3D22	5D19	5D19
TULANGAN BAWAH	3D22	3D22	3D22	6D22	5D19	5D19
SENGKANG	1.5D10-150	1.5D10-150	1.5D10-150	1.5D10-150	1.5D10-150	1.5D10-150
TUL.PINGGANG	2D10	2D10	2D10	2D10	2D19	2D19

TIPE	B24		B34	
	TUMPUAN	LAPANGAN	TUMPUAN	LAPANGAN
POTONGAN	400 / 200	400 / 200	400 / 300	400 / 300
UKURAN	200X400		300X400	
TULANGAN ATAS	5D16	4D16	3D16	3D16
TULANGAN BAWAH	3D16	3D16	3D16	3D16
SENGKANG	1D10-150	1D10-150	1D10-150	1D10-150
TUL.PINGGANG	–	–	2D13	2D13

PROYEK

RUKO SOUTH CITY SQUARE LOT. 1

OWNER / DEVELOPER

KONSULTAN PERENCANA

KONSULTAN STRUKTUR

KONSULTAN M&E

MANAJEMEN KONSTRUKSI

Catatan:

NO.	KETERANGAN	TANGGAL
2	UPDATE POTONGAN & PENAMBAHAN DETAIL	

NOTE:
MUTU BETON = f'c 25 MPa

MUTU BESI TULANGAN = U-40

MUTU BAJA SS400
MUTU LAS E-70XX
MUTU BAUT A325M

JUDUL GAMBAR

POTONGAN & DETAIL

STATUS : FOR CONSTRUCTION

DIGAMBAR	DIPERIKSA	DISETUJUI

SKALA	TANGGAL
(A1) –	
(A3) 1 : 150	

KODE GAMBAR	NO. REVISI
SA-02	C1

DIKELUARKAN UNTUK

CONSTRUCTION

III. ANALISIS PERHITUNGAN

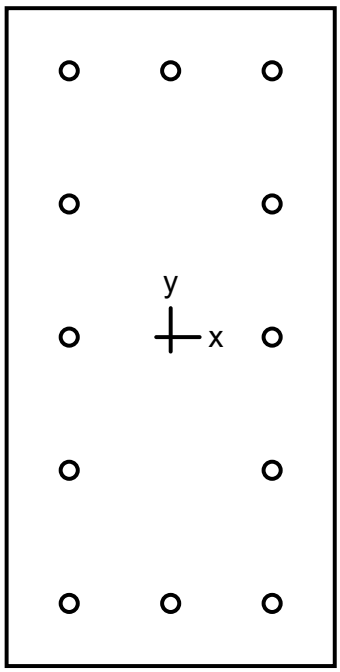
Perhitungan Dinding Penahan Tanah Ruko South City Square Lot. 1

Tulangan Longitudinal

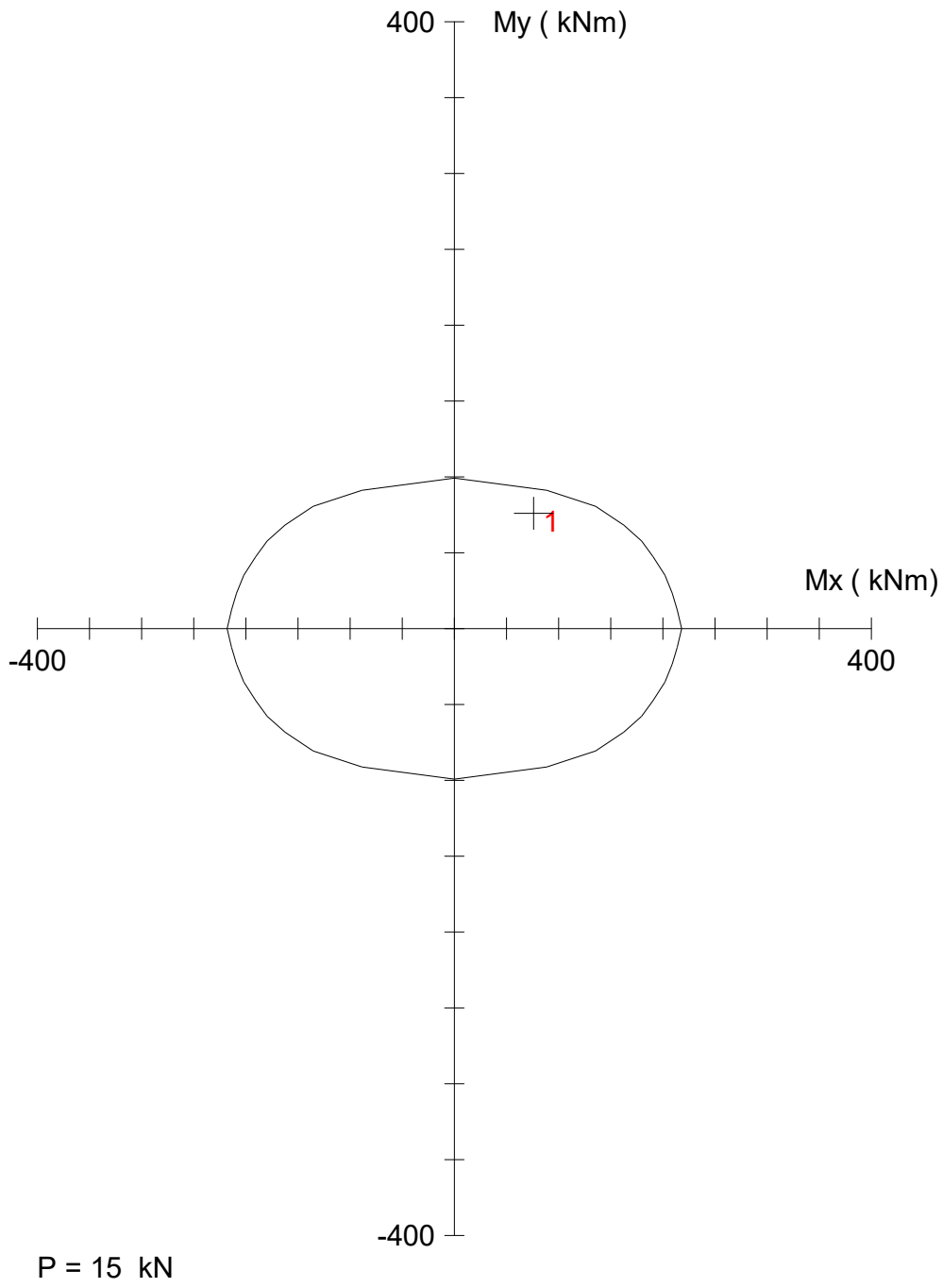
Tinggi	=	3600	mm		
Tebal	=	**300**	**mm**	(minimum H/25)	
Selimut	=	75	mm		
D sengkang	=	10	mm		
d	=	215	mm		
f'c	=	25	MPa	β	0.85
Fy	=	400	MPa		
$M_{u\ (factored)}$	=	84.3961	KNm		
ø	=	0.9			
R_n	=	$\frac{M_u}{\phi b d^2}$			
	=	2.0286			
m	=	$\frac{fy}{0.85\,fc}$			
	=	18.8235			
$\rho_{\ min}$	=	0.0035			
$\rho_{\ max}$	=	0.0135			
$\rho_{\ syarat\ vertikal}$	=	0.0015			
$\rho_{\ syarat\ horizontal}$	=	0.0025			
ρ	=	0.0053			
$\rho_{\ used}$	=	0.0053			
A_s	=	1148.0900	mm^2		
Main Reinf.	=	D	16	-	200
Horizontal Reinf.	=	D	13	-	250

Sengkang dan Ties

$V_{u\ (factored)}$	=	140.9474	KN		
ø	=	0.75			
ϕVc	=	134.375	kN		
Vs	=	6.5724	kN		
Shear Reinf.	=	D	10	-	300



300 x 600 mm



P = 15 kN

Code: ACI 318-11

Units: Metric

Run axis: Biaxial

Run option: Investigation

Slenderness: Not considered

Column type: Structural

Bars: ASTM A615M

spColumn v4.81. Licensed to: user, user. License ID:

Project:

Column:

Engineer:

f'c = 25 MPa	fy = 400 MPa	Ag = 180000 mm^2	12 #16 bars
Ec = 23500 MPa	Es = 200000 MPa	As = 2388 mm^2	rho = 1.33%
fc = 21.25 MPa		Xo = 0 mm	Ix = 5.4e+009 mm^4
e_u = 0.003 mm/mm		Yo = 0 mm	Iy = 1.35e+009 mm^4
Beta1 = 0.85		Min clear spacing = 77 mm	Clear cover = 49 mm

Confinement: Tied

phi(a) = 0.8, phi(b) = 0.9, phi(c) = 0.65

Perhitungan Balok B24

Data :

Ukuran Balok $b := 200mm$ $h := 400mm$ $ds := 40mm$

Material $fc := 25MPa$ $E_s := 29725.41MPa$

Spesifikasi Tulangan $fy := 400MPa$ $D := 16mm$ $D_s := 10mm$

Momen dan Geser

Tumpuan	Lapangan
$Mu_{1a} := 96kN\cdot m$	$Mu_{2a} := 62kN\cdot m$
$Mu_{1b} := 48kN\cdot m$	$Mu_{2b} := 24kN\cdot m$
$Vu_1 := 73kN$	$Vu_2 := 74kN$

Perhitungan :

Tulangan Lentur

*) Tumpuan atas

$d := h - ds = 360\cdot mm$

Faktor reduksi kuat lentur $\phi := 0.9$

$$m := \frac{fy}{0.85\cdot fc} = 18.824$$

$$R_n := \frac{Mu_{1a}}{\phi\cdot b\cdot d^2} = 4.115\cdot MPa$$

$$\beta := 0.85 - \left[\frac{0.05\cdot(fc - 28MPa)}{7MPa}\right] = 0.871$$

$$\rho_{min} := 0.0035$$

$$\rho_{max} := 0.75\cdot\frac{0.75\cdot fc\cdot\beta}{fy}\cdot\left(\frac{0.003E_s}{0.003\cdot E_s + fy}\right) = 5.585\times 10^{-3}$$

$$\rho := \frac{1}{m}\cdot\left(1 - \sqrt{1 - \frac{2\cdot m\cdot R_n}{fy}}\right) = 0.01154$$

$$\rho_{pakai} := \begin{cases} \rho_{min} & \text{if } \rho < \rho_{min} \\ \rho & \text{if } \rho > \rho_{max} \\ \rho & \text{otherwise} \end{cases} \qquad \rho_{pakai} = 0.01154$$

Minimum area of rebar $A_s := \rho_{pakai}\cdot b\cdot d = 831.013\cdot mm^2$

Min. number of rebar $n := Ceil\left(\frac{A_s}{0.25\cdot\pi\cdot D^2}, 1\right) = 5$

Number of rebar use $n_b := 5$

$$TumpuanAtas := \begin{cases} \text{"Ok"} & \text{if } n \le n_b \\ \text{"Not Ok"} & \text{otherwise} \end{cases}$$

TumpuanAtas = "Ok"

5D16

*) Tumpuan bawah

$$R_n := \frac{Mu_{1b}}{\phi \cdot b \cdot d^2} = 2.058 \cdot MPa$$

$$\rho := \frac{1}{m} \cdot \left(1 - \sqrt{1 - \frac{2 \cdot m \cdot R_n}{fy}} \right) = 0.00542$$

$$\rho_{pakai} := \begin{cases} \rho_{min} & \text{if } \rho < \rho_{min} \\ \rho & \text{if } \rho > \rho_{max} \\ \rho & \text{otherwise} \end{cases} \qquad \rho_{pakai} = 0.00542$$

Minimum area of rebar $A_s := \rho_{pakai} \cdot b \cdot d = 390.281 \cdot mm^2$

Min. number of rebar $n := Ceil\left(\frac{A_s}{0.25 \cdot \pi \cdot D^2}, 1 \right) = 2$

Number of rebar use $n_b := 3$

$$TumpuanBawah := \begin{cases} \text{"Ok"} & \text{if } n \le n_b \\ \text{"Not Ok"} & \text{otherwise} \end{cases}$$

TumpuanBawah = "Ok"

3D16

*) Lapangan atas

$$R_n := \frac{Mu_{2a}}{\phi \cdot b \cdot d^2} = 2.658 \cdot MPa$$

$$\rho := \frac{1}{m} \cdot \left(1 - \sqrt{1 - \frac{2 \cdot m \cdot R_n}{fy}} \right) = 0.00712$$

$$\rho_{pakai} := \begin{cases} \rho_{min} & \text{if } \rho < \rho_{min} \\ \rho & \text{if } \rho > \rho_{max} \\ \rho & \text{otherwise} \end{cases} \qquad \rho_{pakai} = 0.00712$$

Minimum area of rebar $A_s := \rho_{pakai} \cdot b \cdot d = 512.765 \cdot mm^2$

Min. number of rebar $n := Ceil\left(\frac{A_s}{0.25 \cdot \pi \cdot D^2}, 1 \right) = 3$

Number of rebar use $n_b := 3$

$$LapanganAtas := \begin{cases} \text{"Ok"} & \text{if } n \le n_b \\ \text{"Not Ok"} & \text{otherwise} \end{cases}$$

LapanganAtas = "Ok"

4D16

*) Lapangan bawah

$$R_n := \frac{Mu_{2b}}{\phi \cdot b \cdot d^2} = 1.029 \cdot MPa$$

$$\rho := \frac{1}{m} \cdot \left(1 - \sqrt{1 - \frac{2 \cdot m \cdot R_n}{fy}} \right) = 0.00264$$

$$\rho_{pakai} := \begin{cases} \rho_{min} & \text{if } \rho < \rho_{min} \\ \rho & \text{if } \rho > \rho_{max} \\ \rho & \text{otherwise} \end{cases} \qquad \rho_{pakai} = 0.0035$$

Minimum area of rebar $A_s := \rho_{pakai} \cdot b \cdot d = 252 \cdot mm^2$

Min. number of rebar $n := Ceil\left(\frac{A_s}{0.25 \cdot \pi \cdot D^2}, 1\right) = 2$

Number of rebar use $n_b := 3$

$$LapanganBawah := \begin{cases} \text{"Ok"} & \text{if } n \le n_b \\ \text{"Not Ok"} & \text{otherwise} \end{cases}$$

LapanganBawah = "Ok"

3D16

Perhitungan Sengkang

Faktor reduksi kuat geser $\phi := 0.6$

*) Tumpuan

Jarak antar sengkang $s_s := 150mm$

Luas tulangan minimum $A_v := \frac{s_s \cdot Vu_1}{fy \cdot d} = 76.042 \cdot mm^2$

Jumlah minimum sengkang $n_s := Ceil\left(\frac{A_v}{0.25 \cdot \pi \cdot D_s^2}, 1\right) = 1$

Jumlah sengkang dipakai $n_{bs} := 2$

$$Sengkang := \begin{cases} \text{"Ok"} & \text{if } n_s \le n_{bs} \\ \text{"Not Ok"} & \text{otherwise} \end{cases}$$

Sengkang = "Ok"

1D10-150

*) Lapangan

Jarak antar sengkang $s_s := 150mm$

Luas tulangan minimum $A_v := \frac{s_s \cdot Vu_2}{fy \cdot d} = 77.083 \cdot mm^2$

Jumlah minimum sengkang $n_s := Ceil\left(\frac{A_v}{0.25 \cdot \pi \cdot D_s^2}, 1\right) = 1$

Jumlah sengkang dipakai $n_{bs} := 2$

$$ShearReinforcing := \begin{cases} \text{"Ok"} & \text{if } n_s \le n_{bs} \\ \text{"Not Ok"} & \text{otherwise} \end{cases}$$

ShearReinforcing = "Ok"

1D10-150

Perhitungan Balok B34

Data :

Ukuran Balok $b := 400mm$ $h := 300mm$ $ds := 40mm$

Material $fc := 25MPa$ $E_s := 29725.41MPa$

Spesifikasi Tulangan $fy := 400MPa$ $D := 16mm$ $D_s := 10mm$

Momen dan Geser

	Tumpuan	Lapangan
	$Mu_{1a} := 25kN\cdot m$	$Mu_{2a} := 34kN\cdot m$
	$Mu_{1b} := 25kN\cdot m$	$Mu_{2b} := 34kN\cdot m$
	$Vu_1 := 5kN$	$Vu_2 := 7kN$

Perhitungan :

Tulangan Lentur

$d := h - ds = 260\cdot mm$

Faktor reduksi kuat lentur $\phi := 0.9$

$$m := \frac{fy}{0.85\cdot fc} = 18.824$$

$$R_n := \frac{Mu_{1a}}{\phi\cdot b\cdot d^2} = 1.027\cdot MPa$$

$$\beta := 0.85 - \left[\frac{0.05\cdot(fc - 28MPa)}{7MPa}\right] = 0.871$$

$$\rho_{min} := 0.0035$$

$$\rho_{max} := 0.75\cdot\frac{0.75\cdot fc\cdot\beta}{fy}\cdot\left(\frac{0.003E_s}{0.003\cdot E_s + fy}\right) = 5.585\times 10^{-3}$$

$$\rho := \frac{1}{m}\cdot\left(1 - \sqrt{1 - \frac{2\cdot m\cdot R_n}{fy}}\right) = 0.00263$$

$$\rho_{pakai} := \begin{cases} \rho_{min} & \text{if } \rho < \rho_{min} \\ \rho & \text{if } \rho > \rho_{max} \\ \rho & \text{otherwise} \end{cases} \qquad \rho_{pakai} = 0.0035$$

Minimum area of rebar $A_s := \rho_{pakai}\cdot b\cdot d = 364\cdot mm^2$

Min. number of rebar $n := Ceil\left(\frac{A_s}{0.25\cdot\pi\cdot D^2}, 1\right) = 2$

Number of rebar use $n_b := 3$

$$TulanganUtama := \begin{cases} \text{"Ok"} & \text{if } n \le n_b \\ \text{"Not Ok"} & \text{otherwise} \end{cases}$$

TulanganUtama = "Ok"

3D16

Perhitungan Sengkang

Faktor reduksi kuat geser $\phi := 0.6$

*) Tumpuan

Jarak antar sengkang $s_s := 200mm$

Luas tulangan minimum $A_v := \frac{s_s \cdot Vu_1}{fy \cdot d} = 9.615 \cdot mm^2$

Jumlah minimum sengkang $n_s := Ceil\left(\frac{A_v}{0.25 \cdot \pi \cdot D_s^{\,2}}, 1\right) = 1$

Jumlah sengkang dipakai $n_{bs} := 2$

$$Sengkang := \begin{cases} \text{"Ok"} & \text{if } n_s \le n_{bs} \\ \text{"Not Ok"} & \text{otherwise} \end{cases}$$

Sengkang = "Ok"

1D10-200

Perhitungan Balok B36-1

Data :

Ukuran Balok $b := 300mm$ $h := 600mm$ $ds := 50mm$

Material $fc := 25MPa$ $E_s := 29725.41MPa$

Spesifikasi Tulangan $fy := 400MPa$ $D := 22mm$ $D_s := 10mm$

Momen dan Geser

Tumpuan	Lapangan
$Mu_{1a} := 244kN\cdot m$	$Mu_{2a} := 203kN\cdot m$
$Mu_{1b} := 122kN\cdot m$	$Mu_{2b} := 68kN\cdot m$
$Vu_1 := 206kN$	$Vu_2 := 233kN$

Perhitungan :

Tulangan Lentur

*) Tumpuan atas

$d := h - ds = 550\cdot mm$

Faktor reduksi kuat lentur $\phi := 0.9$

$$m := \frac{fy}{0.85\cdot fc} = 18.824$$

$$R_n := \frac{Mu_{1a}}{\phi\cdot b\cdot d^2} = 2.987\cdot MPa$$

$$\beta := 0.85 - \left[\frac{0.05\cdot(fc - 28MPa)}{7MPa}\right] = 0.871$$

$$\rho_{min} := 0.0035$$

$$\rho_{max} := 0.75\cdot\frac{0.75\cdot fc\cdot\beta}{fy}\cdot\left(\frac{0.003E_s}{0.003\cdot E_s + fy}\right) = 5.585\times 10^{-3}$$

$$\rho := \frac{1}{m}\cdot\left(1 - \sqrt{1 - \frac{2\cdot m\cdot R_n}{fy}}\right) = 0.00808$$

$$\rho_{pakai} := \begin{cases} \rho_{min} & \text{if } \rho < \rho_{min} \\ \rho & \text{if } \rho > \rho_{max} \\ \rho & \text{otherwise} \end{cases} \qquad \rho_{pakai} = 0.00808$$

Minimum area of rebar $A_s := \rho_{pakai}\cdot b\cdot d = 1333.801\cdot mm^2$

Min. number of rebar $n := Ceil\left(\frac{A_s}{0.25\cdot\pi\cdot D^2}, 1\right) = 4$

Number of rebar use $n_b := 4$

$$TumpuanAtas := \begin{cases} \text{"Ok"} & \text{if } n \le n_b \\ \text{"Not Ok"} & \text{otherwise} \end{cases}$$

TumpuanAtas = "Ok"

4D22

*) Tumpuan bawah

$$R_n := \frac{Mu_{1b}}{\phi \cdot b \cdot d^2} = 1.494 \cdot MPa$$

$$\rho := \frac{1}{m} \cdot \left(1 - \sqrt{1 - \frac{2 \cdot m \cdot R_n}{fy}}\right) = 0.00388$$

$$\rho_{pakai} := \begin{cases} \rho_{min} & \text{if } \rho < \rho_{min} \\ \rho & \text{if } \rho > \rho_{max} \\ \rho & \text{otherwise} \end{cases} \qquad \rho_{pakai} = 0.00388$$

Minimum area of rebar $A_s := \rho_{pakai} \cdot b \cdot d = 639.488 \cdot mm^2$

Min. number of rebar $n := Ceil\left(\frac{A_s}{0.25 \cdot \pi \cdot D^2}, 1\right) = 2$

Number of rebar use $n_b := 3$

$$TumpuanBawah := \begin{cases} \text{"Ok"} & \text{if } n \le n_b \\ \text{"Not Ok"} & \text{otherwise} \end{cases}$$

TumpuanBawah = "Ok"

3D22

*) Lapangan atas

$$R_n := \frac{Mu_{2a}}{\phi \cdot b \cdot d^2} = 2.485 \cdot MPa$$

$$\rho := \frac{1}{m} \cdot \left(1 - \sqrt{1 - \frac{2 \cdot m \cdot R_n}{fy}}\right) = 0.00663$$

$$\rho_{pakai} := \begin{cases} \rho_{min} & \text{if } \rho < \rho_{min} \\ \rho & \text{if } \rho > \rho_{max} \\ \rho & \text{otherwise} \end{cases} \qquad \rho_{pakai} = 0.00663$$

Minimum area of rebar $A_s := \rho_{pakai} \cdot b \cdot d = 1093.453 \cdot mm^2$

Min. number of rebar $n := Ceil\left(\frac{A_s}{0.25 \cdot \pi \cdot D^2}, 1\right) = 3$

Number of rebar use $n_b := 3$

$$LapanganAtas := \begin{cases} \text{"Ok"} & \text{if } n \le n_b \\ \text{"Not Ok"} & \text{otherwise} \end{cases}$$

LapanganAtas = "Ok"

3D22

*) Lapangan bawah

$$R_n := \frac{Mu_{2b}}{\phi \cdot b \cdot d^2} = 0.833 \cdot MPa$$

$$\rho := \frac{1}{m} \cdot \left(1 - \sqrt{1 - \frac{2 \cdot m \cdot R_n}{fy}}\right) = 0.00212$$

$$\rho_{pakai} := \begin{cases} \rho_{min} & \text{if } \rho < \rho_{min} \\ \rho & \text{if } \rho > \rho_{max} \\ \rho & \text{otherwise} \end{cases} \qquad \rho_{pakai} = 0.0035$$

Minimum area of rebar $A_s := \rho_{pakai} \cdot b \cdot d = 577.5 \cdot mm^2$

Min. number of rebar $n := Ceil\left(\frac{A_s}{0.25 \cdot \pi \cdot D^2}, 1\right) = 2$

Number of rebar use $n_b := 3$

$$LapanganBawah := \begin{cases} \text{"Ok"} & \text{if } n \le n_b \\ \text{"Not Ok"} & \text{otherwise} \end{cases}$$

LapanganBawah = "Ok"

3D22

Perhitungan Sengkang

Faktor reduksi kuat geser $\phi := 0.6$

*) Tumpuan

Jarak antar sengkang $s_s := 150mm$

Luas tulangan minimum $A_v := \frac{s_s \cdot Vu_1}{fy \cdot d} = 140.455 \cdot mm^2$

Jumlah minimum sengkang $n_s := Ceil\left(\frac{A_v}{0.25 \cdot \pi \cdot D_s^2}, 1\right) = 2$

Jumlah sengkang dipakai $n_{bs} := 3$

$$Sengkang := \begin{cases} \text{"Ok"} & \text{if } n_s \le n_{bs} \\ \text{"Not Ok"} & \text{otherwise} \end{cases}$$

Sengkang = "Ok"

1.5D10-150

*) Lapangan

Jarak antar sengkang $s_s := 150mm$

Luas tulangan minimum $A_v := \frac{s_s \cdot Vu_2}{fy \cdot d} = 158.864 \cdot mm^2$

Jumlah minimum sengkang $n_s := Ceil\left(\frac{A_v}{0.25 \cdot \pi \cdot D_s^2}, 1\right) = 3$

Jumlah sengkang dipakai $n_{bs} := 3$

$$ShearReinforcing := \begin{cases} \text{"Ok"} & \text{if } n_s \le n_{bs} \\ \text{"Not Ok"} & \text{otherwise} \end{cases}$$

ShearReinforcing = "Ok"

1.5D10-150

Perhitungan Balok B36-2

Data :

Ukuran Balok $b := 300mm$ $h := 600mm$ $ds := 50mm$

Material $fc := 25MPa$ $E_s := 29725.41MPa$

Spesifikasi Tulangan $fy := 400MPa$ $D := 22mm$ $D_s := 10mm$

Momen dan Geser

Tumpuan	Lapangan
$Mu_{1a} := 285kN\cdot m$	$Mu_{2a} := 33kN\cdot m$
$Mu_{1b} := 27kN\cdot m$	$Mu_{2b} := 356kN\cdot m$
$Vu_1 := 174kN$	$Vu_2 := 174kN$

Perhitungan :

Tulangan Lentur

*) Tumpuan atas

$d := h - ds = 550\cdot mm$

Faktor reduksi kuat lentur $\phi := 0.9$

$$m := \frac{fy}{0.85\cdot fc} = 18.824$$

$$R_n := \frac{Mu_{1a}}{\phi\cdot b\cdot d^2} = 3.489\cdot MPa$$

$$\beta := 0.85 - \left[\frac{0.05\cdot(fc - 28MPa)}{7MPa}\right] = 0.871$$

$$\rho_{min} := 0.0035$$

$$\rho_{max} := 0.75\cdot\frac{0.75\cdot fc\cdot\beta}{fy}\cdot\left(\frac{0.003E_s}{0.003\cdot E_s + fy}\right) = 5.585\times 10^{-3}$$

$$\rho := \frac{1}{m}\cdot\left(1 - \sqrt{1 - \frac{2\cdot m\cdot R_n}{fy}}\right) = 0.00959$$

$$\rho_{pakai} := \begin{cases} \rho_{min} & \text{if } \rho < \rho_{min} \\ \rho & \text{if } \rho > \rho_{max} \\ \rho & \text{otherwise} \end{cases} \qquad \rho_{pakai} = 0.00959$$

Minimum area of rebar $A_s := \rho_{pakai}\cdot b\cdot d = 1582.185\cdot mm^2$

Min. number of rebar $n := Ceil\left(\frac{A_s}{0.25\cdot\pi\cdot D^2}, 1\right) = 5$

Number of rebar use $n_b := 5$

$$TumpuanAtas := \begin{cases} \text{"Ok"} & \text{if } n \le n_b \\ \text{"Not Ok"} & \text{otherwise} \end{cases}$$

TumpuanAtas = "Ok"

5D22

*) Tumpuan bawah

$$R_n := \frac{Mu_{1b}}{\phi \cdot b \cdot d^2} = 0.331 \cdot MPa$$

$$\rho := \frac{1}{m} \cdot \left(1 - \sqrt{1 - \frac{2 \cdot m \cdot R_n}{fy}} \right) = 0.00083$$

$$\rho_{pakai} := \begin{cases} \rho_{min} & \text{if } \rho < \rho_{min} \\ \rho & \text{if } \rho > \rho_{max} \\ \rho & \text{otherwise} \end{cases} \qquad \rho_{pakai} = 0.0035$$

Minimum area of rebar $A_s := \rho_{pakai} \cdot b \cdot d = 577.5 \cdot mm^2$

Min. number of rebar $n := Ceil\left(\frac{A_s}{0.25 \cdot \pi \cdot D^2}, 1 \right) = 2$

Number of rebar use $n_b := 3$

$$TumpuanBawah := \begin{cases} \text{"Ok"} & \text{if } n \le n_b \\ \text{"Not Ok"} & \text{otherwise} \end{cases}$$

TumpuanBawah = "Ok"

3D22

*) Lapangan atas

$$R_n := \frac{Mu_{2a}}{\phi \cdot b \cdot d^2} = 0.404 \cdot MPa$$

$$\rho := \frac{1}{m} \cdot \left(1 - \sqrt{1 - \frac{2 \cdot m \cdot R_n}{fy}} \right) = 0.00102$$

$$\rho_{pakai} := \begin{cases} \rho_{min} & \text{if } \rho < \rho_{min} \\ \rho & \text{if } \rho > \rho_{max} \\ \rho & \text{otherwise} \end{cases} \qquad \rho_{pakai} = 0.0035$$

Minimum area of rebar $A_s := \rho_{pakai} \cdot b \cdot d = 577.5 \cdot mm^2$

Min. number of rebar $n := Ceil\left(\frac{A_s}{0.25 \cdot \pi \cdot D^2}, 1 \right) = 2$

Number of rebar use $n_b := 3$

$$LapanganAtas := \begin{cases} \text{"Ok"} & \text{if } n \le n_b \\ \text{"Not Ok"} & \text{otherwise} \end{cases}$$

LapanganAtas = "Ok"

3D22

*) Lapangan bawah

$$R_n := \frac{Mu_{2b}}{\phi \cdot b \cdot d^2} = 4.359 \cdot MPa$$

$$\rho := \frac{1}{m} \cdot \left(1 - \sqrt{1 - \frac{2 \cdot m \cdot R_n}{fy}} \right) = 0.01233$$

$\rho_{pakai} := \begin{cases} \rho_{min} & \text{if } \rho < \rho_{min} \\ \rho & \text{if } \rho > \rho_{max} \\ \rho & \text{otherwise} \end{cases}$ $\rho_{pakai} = 0.01233$

Minimum area of rebar $A_s := \rho_{pakai} \cdot b \cdot d = 2033.957 \cdot mm^2$

Min. number of rebar $n := Ceil\left(\frac{A_s}{0.25 \cdot \pi \cdot D^2}, 1\right) = 6$

Number of rebar use $n_b := 6$

$LapanganBawah := \begin{cases} \text{"Ok"} & \text{if } n \le n_b \\ \text{"Not Ok"} & \text{otherwise} \end{cases}$ LapanganBawah = "Ok"

6D22

Perhitungan Sengkang

Faktor reduksi kuat geser $\phi := 0.6$

*) Tumpuan

Jarak antar sengkang $s_s := 150mm$

Luas tulangan minimum $A_v := \frac{s_s \cdot Vu_1}{fy \cdot d} = 118.636 \cdot mm^2$

Jumlah minimum sengkang $n_s := Ceil\left(\frac{A_v}{0.25 \cdot \pi \cdot D_s^2}, 1\right) = 2$

Jumlah sengkang dipakai $n_{bs} := 3$

$Sengkang := \begin{cases} \text{"Ok"} & \text{if } n_s \le n_{bs} \\ \text{"Not Ok"} & \text{otherwise} \end{cases}$ Sengkang = "Ok"

1.5D10-150

*) Lapangan

Jarak antar sengkang $s_s := 150mm$

Luas tulangan minimum $A_v := \frac{s_s \cdot Vu_2}{fy \cdot d} = 118.636 \cdot mm^2$

Jumlah minimum sengkang $n_s := Ceil\left(\frac{A_v}{0.25 \cdot \pi \cdot D_s^2}, 1\right) = 2$

Jumlah sengkang dipakai $n_{bs} := 3$

$ShearReinforcing := \begin{cases} \text{"Ok"} & \text{if } n_s \le n_{bs} \\ \text{"Not Ok"} & \text{otherwise} \end{cases}$ ShearReinforcing = "Ok"

1.5D10-150

Perhitungan Balok B46

Data :

Ukuran Balok $b := 400mm$ $h := 600mm$ $ds := 50mm$

Material $fc := 25MPa$ $E_s := 29725.41MPa$

Spesifikasi Tulangan $fy := 400MPa$ $D := 19mm$ $D_s := 10mm$

Momen dan Geser

Tumpuan	Lapangan
$Mu_{1a} := 224kN\cdot m$	$Mu_{2a} := 33kN\cdot m$
$Mu_{1b} := 27kN\cdot m$	$Mu_{2b} := 160kN\cdot m$
$Vu_1 := 110kN$	$Vu_2 := 110kN$

Perhitungan :

Tulangan Lentur

$d := h - ds = 550\cdot mm$

Faktor reduksi kuat lentur $\phi := 0.9$

$$m := \frac{fy}{0.85\cdot fc} = 18.824$$

$$R_n := \frac{Mu_{1a}}{\phi\cdot b\cdot d^2} = 2.057\cdot MPa$$

$$\beta := 0.85 - \left[\frac{0.05\cdot(fc - 28MPa)}{7MPa}\right] = 0.871$$

$$\rho_{min} := 0.0035$$

$$\rho_{max} := 0.75\cdot\frac{0.75\cdot fc\cdot\beta}{fy}\cdot\left(\frac{0.003E_s}{0.003\cdot E_s + fy}\right) = 5.585\times 10^{-3}$$

$$\rho := \frac{1}{m}\cdot\left(1 - \sqrt{1 - \frac{2\cdot m\cdot R_n}{fy}}\right) = 0.00542$$

$$\rho_{pakai} := \begin{cases} \rho_{min} & \text{if } \rho < \rho_{min} \\ \rho & \text{if } \rho > \rho_{max} \\ \rho & \text{otherwise} \end{cases} \qquad \rho_{pakai} = 0.00542$$

Minimum area of rebar $A_s := \rho_{pakai}\cdot b\cdot d = 1192.11\cdot mm^2$

Min. number of rebar $n := Ceil\left(\frac{A_s}{0.25\cdot\pi\cdot D^2}, 1\right) = 5$

Number of rebar use $n_b := 5$

$$TulanganUtama := \begin{cases} \text{"Ok"} & \text{if } n \le n_b \\ \text{"Not Ok"} & \text{otherwise} \end{cases}$$

TulanganUtama = "Ok"

5D19

Perhitungan Sengkang

Faktor reduksi kuat geser $\phi := 0.6$

*) Tumpuan

Jarak antar sengkang $s_s := 200mm$

Luas tulangan minimum $A_v := \frac{s_s \cdot Vu_1}{fy \cdot d} = 100 \cdot mm^2$

Jumlah minimum sengkang $n_s := Ceil\left(\frac{A_v}{0.25 \cdot \pi \cdot D_s^{\,2}}, 1\right) = 2$

Jumlah sengkang dipakai $n_{bs} := 3$

$$Sengkang := \begin{cases} \text{"Ok"} & \text{if } n_s \le n_{bs} \\ \text{"Not Ok"} & \text{otherwise} \end{cases}$$

Sengkang = "Ok"

1.5D10-150