7.4.3 ABUTMENT SEMARANG SIDE

5 ABUTMENT SEMARANG SIDE

5.1. DATA

5.1.1. EXISTING SUPERSTRUCTURE

- Type	Through Truss Girder
- Total Weight	67.00 ton-f
- Effective Span (c.t.c.)	31.20 m
- Total Length of Stringer or truss girder	32.16 m
- Center to center of Main Girder	4.60 m
- Construction Depth	1.33 m
- Distance between top of rail up to top of concrete bearing	1.65 m
- Distance between top of rail up to elevation of HWL	2.33 m

5.1.2. TRACK CONDITION

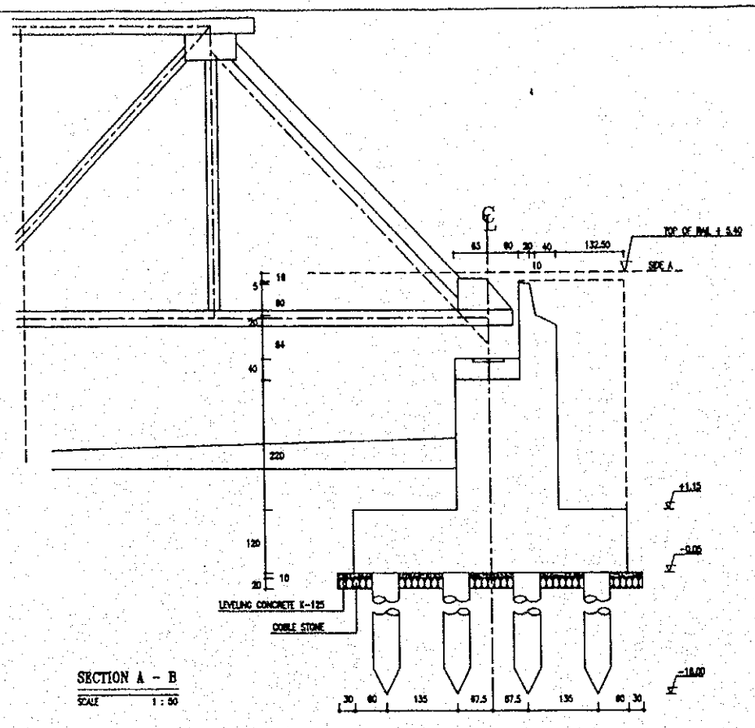
- Track Plan : straight
- Track Elevation : Level

5.1.3. LOADINGS

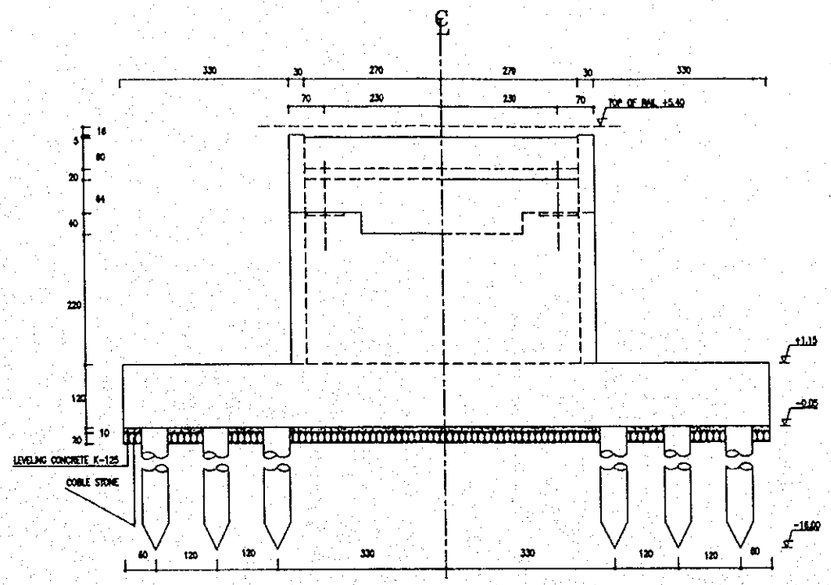
- Train Load : based on 100 % Load Scheme 1921.
- Impact : { 0.2 + 26 / (L + 50) } x Train Load
- Longitudinal Load due to Long Rails : 1.00 tf / m' (per one track) , but max. 200 t f.
- Brake Load : 1 / 6 Locomotive + 1 / 10 Wagon
- Lateral Load : 1 / 10 Train Load
- Wind Load : 0.10 t f /m2.
- Earth Pressure : based on Coulomb's Theory
- Seismic Load : based on the equivalent static force and design seismic intensity expressed as followings :

  KH = 0.18

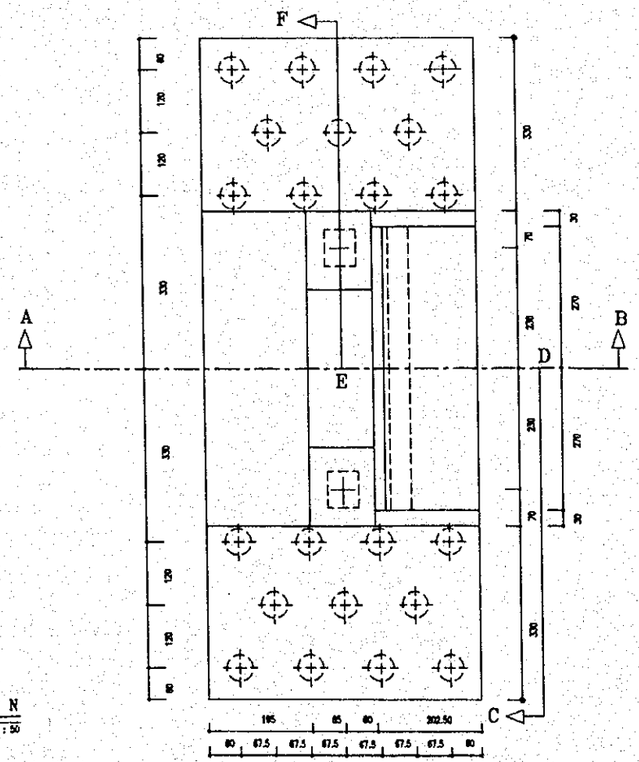
  KV = 0.00



SECTION A - B
SCALE 1 : 50

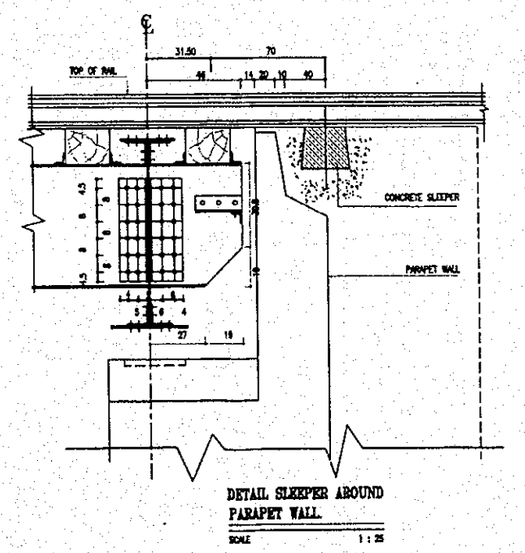


SECTION C-D-E-F
SCALE 1 : 50



P L A N
SCALE 1 : 50

NOTES :
- CONCRETE QUALITY K - 225
- REINFORCED BAR U -39

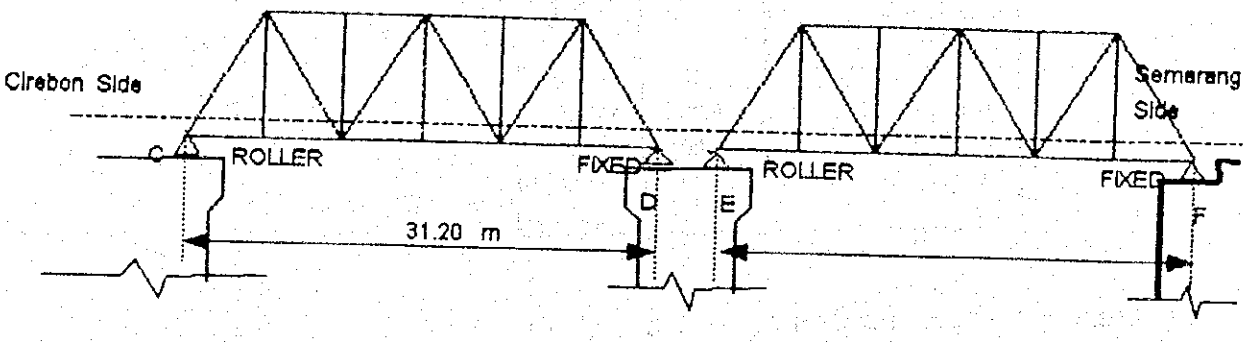


DETAIL SLEEPER AROUND PARAPET WALL.
SCALE 1 : 25

GENERAL DRAWING OF ABUTMENT SEMARANG SIDE

5.3. LOADINGS

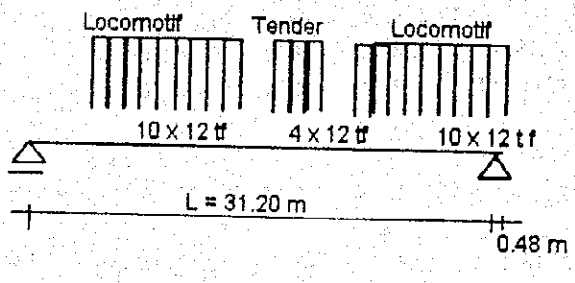
5.3.1. VERTICAL FORCE



a. DEAD LOAD

Ve = 33.50 t f.
Vf = 33.50 t f.

b. TRAIN LOAD (LIVE LOAD)



Ve = 135.85 t f.
Vf = 162.15 t f.

c. IMPACT LOAD

Impact Coefficient

$$I = 0.2 + \frac{25}{50 + 31.20} = 0.5079$$

Ve = 135.85 x 0.5079 = 69.00 t f.
Vf = 162.15 x 0.5079 = 77.27 t f.

d. TRAIN LOAD FOR SEISMIC

$$q = \frac{12.00}{2.40} = 5.00 \text{ tf/m'}$$

Ve = 5.00 x 31.20 x 0.5 = 78 t f.
Vf = 5.00 x 31.20 x 0.6 = 78 t f.

SUMMARY OF VERTICAL FORCE

ITEMS	Support E [ton-f]	Support F [ton-f]
Dead Load [DL]	33.50	33.50
Train Load [LL]	135.85	162.16
Impact [I]	69.00	77.27
Train for Seismic [LL]	78.00	78.00

5.3.2. LONGITUDINAL HORIZONTAL FORCE

a. DEAD LOAD + LONG RAIL LOAD

TOTAL HORIZONTAL FORCE

$$\Sigma H = 32.16 \times 1.00 = 32.16 \text{ tf}$$

HORIZONTAL FORCE ON SUPPORTING

$$Hf = \Sigma H - 1/2 \times \mu \times Ve$$
$$= 32.16 - 0.5 \times 0.10 \times 33.50$$
$$= 30.49 \text{ tf} > 1/2 \times 32.16 = 16.08 \text{ tf}$$

therefore

$$Hf = 30.49 \text{ tf}$$

VERTICAL FORCE

$$Vf = \frac{32.16 \times 1.65}{31.20} = 1.70 \text{ tf}$$

b. LONG RAIL LOAD + BRAKE LOAD

TOTAL HORIZONTAL FORCE

$$\Sigma H = 0 \times 12.00 \times 0.1000 + 24 \times 12 \times 0.1667 + 32.16$$
$$= 80.16 \text{ tf}$$

HORIZONTAL FORCE ON SUPPORTING

$$Hf = \Sigma H - 1/2 \times \mu \times Ve$$
$$= 80.16 - 0.5 \times 0.10 \times (33.50 + 135.85)$$
$$= 71.69 \text{ tf} > 1/2 \times 80.16 = 40.08 \text{ tf}$$

therefore

$$Hf = 71.693 \text{ tf}$$

VERTICAL FORCE

$$Vf = \frac{80.16 \times 1.65}{31.20} = 4.24 \text{ tf}$$

c. TRAIN LOAD + LONG RAIL LOAD

TOTAL HORIZONTAL FORCE

$\Sigma H = 32.16 \times 1.00 = 32.16$ tf

HORIZONTAL FORCE ON SUPPORTING

$Hf = \Sigma H - 1/2 \times \mu \times Ve$

$= 32.16 - 0.5 \times 0.10 \times (33.50 + 135.65)$

$= 23.69$ tf > $1/2 \times 32.16 = 16.08$ tf

therefore

$Hf = 23.69$ tf

VERTICAL FORCE

$$Vf = \frac{32.16 \times 1.65}{31.20} = 1.70 \text{ tf}$$

d. DEAD LOAD FOR SEISMIC

TOTAL HORIZONTAL FORCE

$\Sigma H = 33.50 \times 2 \times 0.18 = 12.06$ tf

HORIZONTAL FORCE ON SUPPORTING

$Hf = \Sigma H - 1/2 \times \mu \times Vf$

$= 12.06 - 0.5 \times 0.10 \times 33.50$

$= 10.39$ tf > $1/2 \times 12.06 = 6.03$ tf

therefore

$Hf = 10.39$ tf

VERTICAL FORCE

$$Vf = \frac{12.06 \times 1.65}{31.2} = 0.64 \text{ tf}$$

e. TRAIN LOAD FOR SEISMIC

TOTAL HORIZONTAL FORCE

$\Sigma H = (33.50 + 78) \times 2 \times 0.18 = 40.14$ tf

HORIZONTAL FORCE ON SUPPORTING

$Hf = \Sigma H - 1/2 \times \mu \times Ve$

$= 40.14 - 0.5 \times 0.10 \times (33.50 + 78)$

$= 34.57$ tf > $1/2 \times 40.14 = 20.07$ tf

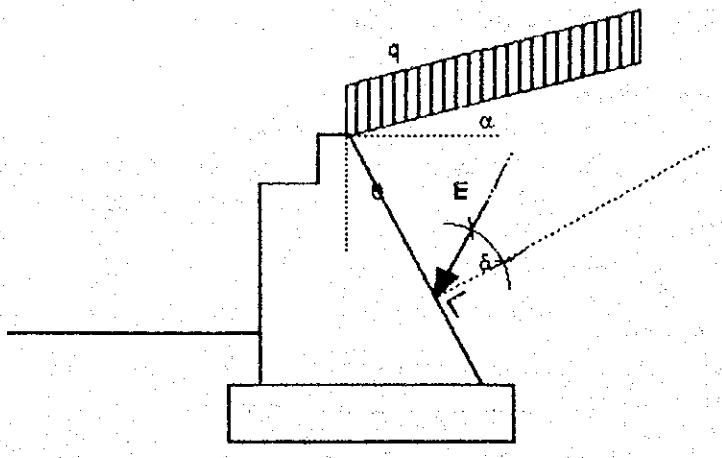
therefore

$Hf = 34.57$ tf

VERTICAL FORCE

$$Vf = \frac{40.14 \times 1.65}{31.20} = 2.12 \text{ tf}$$

f. EARTH PRESSURE



1) NORMAL CONDITION

COEFFICIENT OF EARTH PRESSURE :

$$Ka = \frac{\cos^2(\phi - \theta)}{\cos^2\theta \cos(\theta + \delta)\left[1 + \sqrt{\frac{\sin(\phi + \delta)\sin(\phi - \alpha)}{\cos(\theta + \delta)\cos(\theta - \alpha)}}\right]^2}$$

$$Kp = \frac{\cos^2(\phi + \theta)}{\cos^2\theta \cos(\theta + \delta)\left[1 - \sqrt{\frac{\sin(\phi - \delta)\sin(\phi + \alpha)}{\cos(\theta + \delta)\cos(\theta - \alpha)}}\right]^2}$$

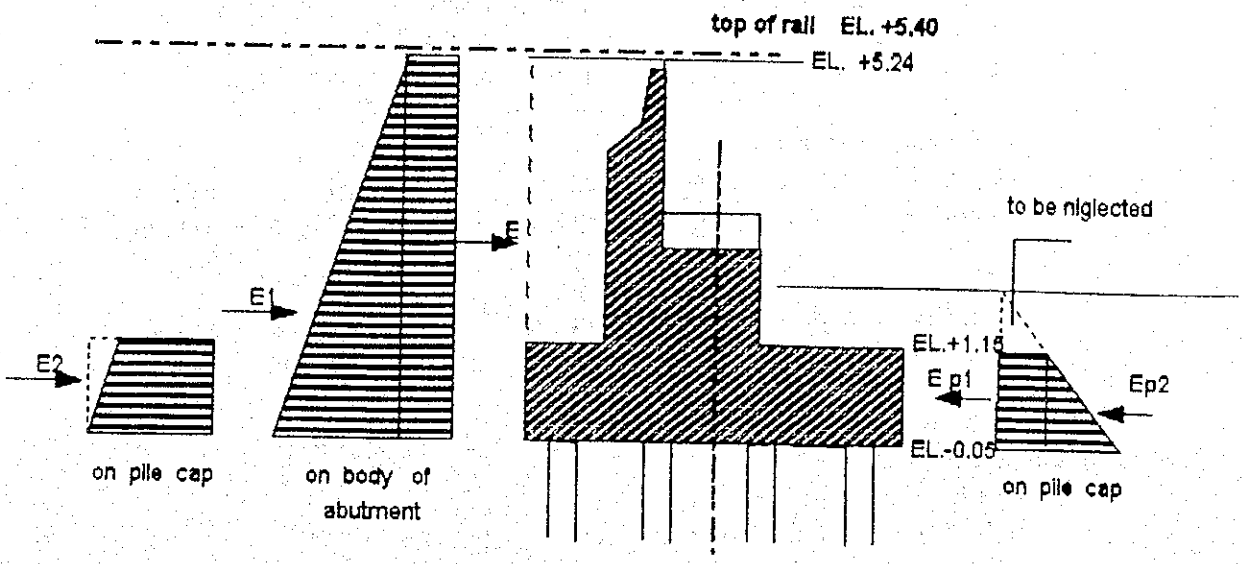
Fill Material		Soil	
θ =	0.00	θ =	0.00
φ =	30.00	φ =	3.00
δ =	20.00	δ =	2.00
α =	0.00	α =	0.00
Cos (φ − θ) =	0.8660	Cos (φ − θ) =	0.9986
Cos (φ + θ) =	0.8660	Cos (φ + θ) =	0.9986
Cos θ =	1.0000	Cos θ =	1.0000
Cos (θ + δ) =	0.9397	Cos (θ + δ) =	0.9994
Sin (φ + δ) =	0.7660	Sin (φ + δ) =	0.0872
Sin (φ − δ) =	0.7660	Sin (φ − δ) =	0.0872
Sin (φ − α =	0.5000	Sin (φ − α =	0.0523
Sin (φ + α =	0.5000	Sin (φ + α =	0.0523
Cos (θ + δ) =	0.9397	Cos (θ + δ) =	0.9994
Cos (θ − α =	1.0000	Cos (θ − α =	1.0000

Active Earth Pressure

$$Ka = \frac{0.8660 \times 0.8660}{1.0000 \times 0.9397 \times \left[1 + \sqrt{\frac{0.7660 \times 0.5000}{0.9397 \times 1.0000}}\right]^2}$$

$$= 0.2973$$

a). Due to Earth Pressure



Active Earth Pressure

E 1 = 0.5 x 2.00 x 5.29 x 5.29 x 0.2973 = 8.32 tf/m
E 2 = 1.2 x 2.00 x 6.29 x 0.2973 = 3.77 tf/m

E 1h = E1 cos δ = 8.32 x 0.9397 = 7.82 tf/m
E 2h = E2 cos δ = 3.77 x 0.9397 = 3.55 tf/m
E 1v = E1 sin δ = 8.32 x 0.3420 = 2.86 tf/m
E 2v = E2 sin δ = 3.77 x 0.3420 = 1.29 tf/m

Total force per abutment

E 1h = 7.82 x 6.00 = 46.91 tf
E 2h = 3.55 x 6.60 = 23.41 tf
70.32 tf

y 1 = 1.76 m
y 2 = 0.60 m
y = 1.38 m

E 1v = 2.85 x 6.00 = 17.07 tf
E 2v = 1.29 x 6.60 = 8.52 tf
25.59 tf

x 1 = 2.63 m
x 2 = 2.63 m
x = 2.63 m

Passive Earth Pressure

$$Kp = \frac{0.9986 \times 0.9986}{1.0000 \times 0.9994 \times \left[1 - \sqrt{\frac{0.0872 \times 0.0523}{0.9994 \times 1.0000}}\right]^2}$$

$$= 1.1477$$

E p1 = 0.50 x 1.60 x 1.1477 = 0.918 tf/m2
E p2 = 1.70 x 1.60 x 1.1477 = 3.122 tf/m2

E p1 = 1.20 x 0.92 = 1.102 tf/m
E p2 = 0.50 x 1.20 x 2.204 = 1.322 tf/m

Ep1h	= Ep1 cos δ	=	1.10 x	0.9994 =	1.10 tf/m
Ep2h	= Ep2 cos δ	=	1.32 x	0.9994 =	1.32 tf/m
Ep1v	= Ep1 sin δ	=	1.10 x	0.0349 =	0.04 tf/m
Ep2v	= Ep2 sin δ	=	1.32 x	0.0349 =	0.05 tf/m

Total force per abutment

Ep1h	=	1.10 x	12.60 =	13.87 tf	y1	=	0.60 m
Ep2h	=	1.32 x	12.60 =	16.65 tf	y2	=	0.40 m
				30.52	y	=	0.49 m
Ep1v	=	0.04 x	12.60 =	0.48 tf	x1	=	2.63 m
Ep2v	=	0.06 x	12.60 =	0.58 tf	x2	=	2.63 m
				1.07 tf	x	=	2.63 m

b). Due to Live Load

Total force per abutment

E	=	8.75 x	0.2973 x	4.09 =	10.64 tf	
Eh	= E cos δ	=	10.64 x	0.9397	=	10.00 tf-m
Ev	= E sin δ	=	10.64 x	0.3420	=	3.64 tf-m

2) EARTHQUAKE CONDITION

COEFFICIENT OF EARTH PRESSURE :

$$Kea = \frac{\text{Cos}^2(\phi - \theta_o - \theta)}{\text{Cos}\ \theta_o\ \text{Cos}^2\theta\ \text{Cos}(\theta_o+\theta+\delta)\left[1+\sqrt{\frac{\text{Sin}(\phi+\delta)\ \ \text{Sin}(\phi-\alpha-\theta_o)}{\text{Cos}(\theta+\theta_o+\delta)\ \ \text{Cos}(\theta-\alpha)}}\right]^2}$$

$$Kep = \frac{\text{Cos}^2(\phi - \theta_o + \theta)}{\text{Cos}\ \theta_o\ \text{Cos}^2\theta\ \text{Cos}(\theta-\theta_o+\delta)\left[1-\sqrt{\frac{\text{Sin}(\phi-\delta)\ \ \text{Sin}(\phi+\alpha-\theta_o)}{\text{Cos}(\theta-\theta_o+\delta)\ \ \text{Cos}(\theta-\alpha)}}\right]^2}$$

Fill Material

θo	=	10.20
θ	=	0.00
φ	=	30.00
δ	=	0.00
α	=	0.00
Cos (φ - θo - θ	=	0.9409
Cos (φ - θo + θ)	=	0.9409
Cos θo	=	0.9842
Cos θ	=	1.0000
Cos (θ + θo + δ)	=	0.9842
Cos (θ - θo + δ)	=	0.9842
Sin (φ + δ	=	0.5000
Sin (φ + δ - θo	=	0.3387
Sin (φ - δ)	=	0.5000
Sin (φ + α - θo	=	0.3387
Cos (θ - α	=	1.0000

Soil

θo	=	10.20
θ	=	0.00
φ	=	3.00
δ	=	0.00
α	=	0.00
Cos (φ - θo - θ	=	0.9921
Cos (φ + θo + θ)	=	0.9921
Cos θo	=	0.9842
Cos θ	=	1.0000
Cos (θ + θo + δ)	=	0.9842
Cos (θ - θo + δ)	=	0.9842
Sin (φ + δ	=	0.0523
Sin (φ - δ - θo	=	-0.1253
Sin (φ - δ)	=	0.0523
Sin (φ + α - θo	=	-0.1253
Cos (θ - α	=	1.0000

Active Earth Pressure

$$Kea = \frac{0.9409 \times 0.9409}{0.9842 \times 1.0000 \times 0.9842 \times \left[1 + \sqrt{\frac{0.5000 \times 0.3387}{0.9842 \times 1.0000}}\right]^2}$$

$$= 0.4566$$

a). Due to Earth Pressure

E 1 = 0.5 x 2.00 x 5.29 x 5.29 x 0.4566 = 12.78 tf/m
E 2 = 1.2 x 2.00 x 5.29 x 0.4566 = 5.80 tf/m

E 1h = E cos δ = 12.78 x 1.0000 = 12.78 tf/m
E 2h = E cos δ = 5.80 x 1.0000 = 5.80 tf/m
E 1v = E sin δ = 12.78 x 0.0000 = 0.00 tf/m
E 2v = E sin δ = 5.80 x 0.0000 = 0.00 tf/m

Total force per abutment

E 1h = 12.78 x 6.00 = 76.66 tf
E 2h = 5.80 x 6.60 = 38.26 tf
114.91 tf

y 1 = 1.76 m
y 2 = 0.60 m
y = 1.38 m

E 1v = 0.00 x 6.00 = 0.00 tf
E 2v = 0.00 x 6.60 = 0.00 tf
0.00 tf

x 1 = 2.63 m
x 2 = 2.63 m
x = 2.63 m

Passive Earth Pressure

$$Kep = \frac{0.9409 \times 0.9409}{0.9842 \times 1.0000 \times 0.9842 \times \left[1 - \sqrt{\frac{0.0523 \times -0.1253}{0.9842 \times 1.0000}}\right]^2}$$

= not possible

SUMMARY DUE TO LONGITUDINAL HORIZONTAL FORCE

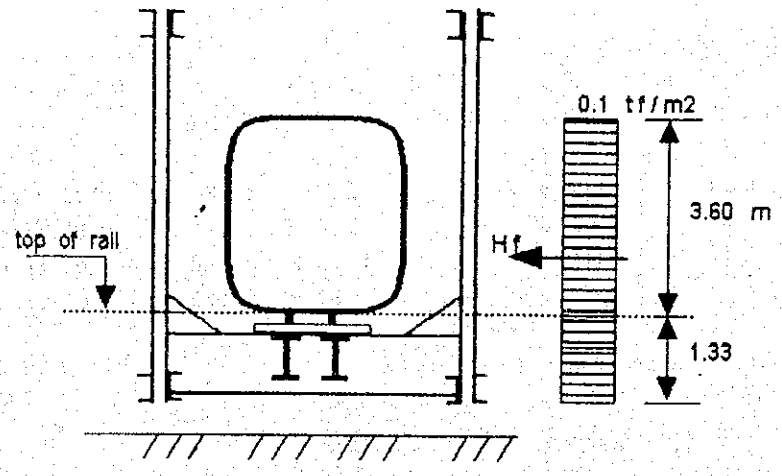
ITEMS	Support F	
	Hf [ton-f]	Vf [ton-f]
Long Rail [DL]	30.49	1.70
Long [DL]+ Brake [B]	71.69	4.24
Long Rail [LL]	23.69	1.70
Seismic [DL]	10.39	0.64
Seismic [LL]	34.57	2.12

5.3.3. TRANSVERSAL HORIZONTAL FORCE

a. LATERAL LOAD

Hf = 0.5 x 0.10 x 24 x 12.00 = 14.40 tf.

b. WIND LOAD



Hf = 0.1 x 4.93 x 31.20 x 0.50 = 7.69 tf

c. DEAD LOAD FOR SEISMIIC LOAD

Ef = 33.50 x 0.18 = 6.03 tf

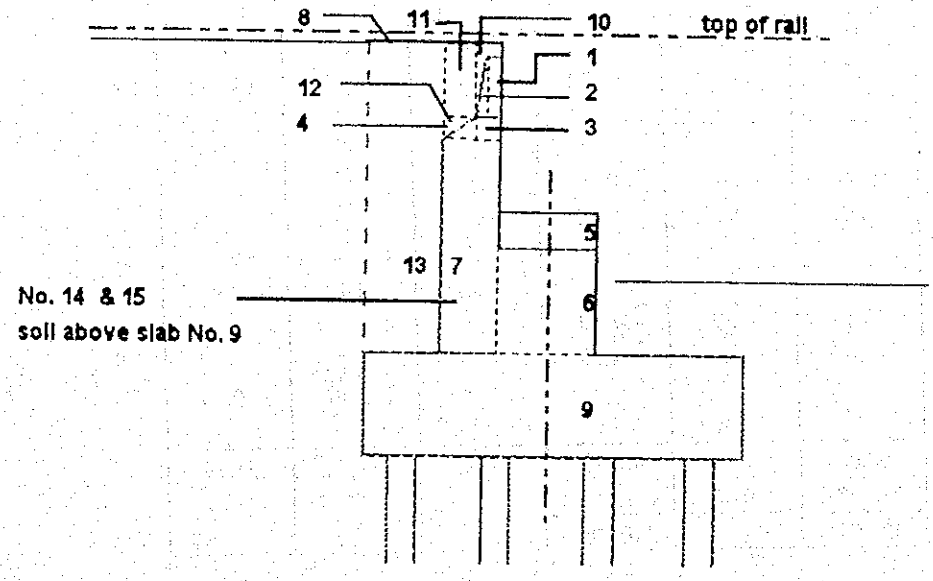
d. LIVE LOAD FOR SEISMIIC LOAD

Ef = 78 x 0.18 = 14.04 tf

SUMMARY DUE TO TRANSVERSAL HORIZONTAL FORCE

ITEMS	Support F	
	H	Y
	[ton-f]	[m]
Lateral Load [Lr]	14.40	1.65
Wind Load [W]	7.69	2.79
Seismic [DL]	6.03	1.65
Seismic [LL]	14.04	1.65

5.4. EXTERNAL STABILITY CALCULATION.



5.4.1. WEIGHT OF ABUTMENT

Item	Weight of Abutment [tf]					x [m]	Mx [tf-m]	y [m]	My [tf-m]
1	0.200	x 0.600	x 5.400	x 2.400	= 1.555	-0.700	-1.089	4.940	7.683
2	0.050	x 0.600	x 5.400	x 2.400	= 0.389	-0.833	-0.324	4.840	1.882
3	0.300	x 0.200	x 5.400	x 2.400	= 0.778	-0.750	-0.583	4.540	3.530
4	0.200	x 0.200	x 5.400	x 2.400	= 0.518	-0.933	-0.484	4.507	2.336
5	1.250	x 0.400	x 2.800	x 2.400	= 3.360	0.025	0.084	3.600	12.096
6	1.250	x 2.200	x 6.000	x 2.400	= 39.600	0.025	0.990	2.300	91.080
7	0.700	x 3.240	x 5.400	x 2.400	= 29.393	-0.950	-27.924	2.820	82.889
8	2.025	x 4.090	x 0.600	x 2.400	= 11.926	-1.613	-19.231	3.245	38.701
9	5.250	x 1.200	x 12.600	x 2.400	= 190.512	0.000	0.000	0.600	114.307
10	0.060	x 0.650	x 5.400	x 2.000	= 0.351	-0.867	-0.304	5.070	1.780
11	0.400	x 0.650	x 5.400	x 2.000	= 2.808	-1.000	-2.808	4.965	13.942
12	0.200	x 0.200	x 5.400	x 2.000	= 0.432	-1.067	-0.461	4.573	1.976
13	1.325	x 2.890	x 5.400	x 2.000	= 41.356	-1.963	-81.161	3.245	134.200
14	1.313	x 1.406	x 6.600	x 1.600	= 19.487	-1.750	-34.103	2.182	42.521
15	5.250	x 0.514	x 6.600	x 1.600	= 28.496	0.000	0.000	1.457	41.519
	Total				370.962		-167.397		590.441

x = -0.45 m
y = 1.59 m

5.4.2. LOAD COMBINATIONS

a. IN LONGITUDINAL DIRECTION

1) Dead Load + Earth Pressure

ITEMS	V [tf]	x [m]	M [tf-m]	H [t]	y [m]	M [tf-m]
Vf [DL]	33.50	0.00	0.00			
Vf [LL]	0.00	0.00	0.00			
Eh				70.32	1.38	96.76
				-30.52	0.49	-14.98
Ev	25.59	-2.63	-67.19			
	-1.07	2.63	-2.80			
Hf				0.00	3.80	0.00
Sub- total	58.03		-69.98	39.80		81.78
W [abutment]	370.96	-0.45	-167.40			
Total	428.99		-237.38			

ΣM = -155.60 tf-m
ΣV = 428.99 tf
ΣH = 39.80 tf
e = M / N = -0.363 m

2) Dead Load + Earth Pressure [LL]

ITEMS	V [tf]	x [m]	M [tf-m]	H [t]	y [m]	M [tf-m]
Vf [DL]	33.50	0.00	0.00			
Vf [LL]	0.00	0.00	0.00			
Eh				70.32	1.38	96.76
				10.00	2.65	26.45
				-30.52	0.49	-14.98
Ev	25.59	-2.63	-67.19			
	3.64	-2.63	-9.55			
	-1.07	2.63	-2.80			
Hf				0.00	3.80	0.00
Sub- total	61.67		-79.54	49.80		108.23
W [abutment]	370.96	-0.45	-167.40			
Total	432.63		-246.93			

ΣM = -138.71 tf-m
ΣV = 432.63 tf
ΣH = 49.80 tf
e = M / N = -0.32 m

3) Dead Load + Train Load + Earth Pressure

ITEMS	V [tf]	X [m]	M [tf-m]	H [t]	Y [m]	M [tf-m]
Vf [DL]	33.50	0.00	0.00			
Vf [LL]	152.15	0.00	0.00			
Eh				70.32	1.38	96.76
				10.00	2.65	26.45
				-30.52	0.49	-14.98
Ev	25.59	-2.63	-67.19			
	3.64	-2.63	-9.55			
	-1.07	2.63	-2.80			
Hf				0.00	3.80	0.00
Sub- total	213.82		-79.54	49.80		108.23
W [abutment]	370.96	-0.45	-167.40			
Total	584.78		-246.93			

ΣM = -138.71 tf-m
ΣV = 584.78 tf
ΣH = 49.80 tf
e = M / N = -0.24 m

4) Dead Load + Train Load + Impact + Earth Pressure

ITEMS	V [tf]	X [m]	M [tf-m]	H [t]	Y [m]	M [tf-m]
Vf [DL]	33.50	0.00	0.00			
Vf [LL]	152.15	0.00	0.00			
Vf [I]	77.27	0.00	0.00			
Eh				70.32	1.38	96.76
				10.00	2.65	26.45
				-30.52	0.49	-14.98
Ev	25.59	-2.63	-67.19			
	3.64	-2.63	-9.55			
	-1.07	2.63	-2.80			
Hf				0.00	3.80	0.00
Sub- total	291.09		-79.54	49.80		108.23
W [abutment]	370.96	-0.45	-167.40			
Total	662.05		-246.93			

ΣM = -138.71 tf-m
ΣV = 662.05 tf
ΣH = 49.80 tf
e = M / N = -0.21 m

5) Dead Load + Earth Pressure + Long Rail Load

ITEMS	V [tf]	x [m]	M [tf-m]	H [t]	y [m]	M [tf-m]
Vf [DL]	33.50	0.00	0.00			
Vf [LL]	0.00	0.00	0.00			
Vf [Lr]	1.70	0.00	0.00			
Eh				70.32	1.38	96.76
				-30.52	0.49	-14.98
Ev	25.59	-2.63	-67.19			
	-1.07	2.63	-2.80			
Hf				30.49	3.80	115.84
Sub- total	59.73		-69.98	70.28		197.62
W [abutment]	370.96	-0.45	-167.40			
Total	430.69		-237.38			

Σ M = -39.76 tf-m
Σ V = 430.69 tf
Σ H = 70.28 tf
e = M / N = -0.09 m

6) Dead Load + Train Load + Earth Pressure + Long Rail Load

ITEMS	V [tf]	x [m]	M [tf-m]	H [t]	y [m]	M [tf-m]
Vf [DL]	33.50	0.00	0.00			
Vf [LL]	152.15	0.00	0.00			
Vf [Lr]	1.70	0.00	0.00			
Eh				70.32	1.38	96.76
				10.00	2.65	26.45
				-30.52	0.49	-14.98
Ev	25.59	-2.63	-67.19			
	3.64	-2.63	-9.55			
	-1.07	2.63	-2.80			
Hf				30.49	3.80	115.84
Sub- total	215.52		-79.54	80.28		224.07
W [abutment]	370.96	-0.45	-167.40			
Total	586.48		-246.93			

Σ M = -22.86 tf-m
Σ V = 586.48 tf
Σ H = 80.28 tf
e = M / N = -0.04 m

7) Dead Load + Train Load + Impact + Earth Pressure + Long Rail Load

ITEMS	V [tf]	x [m]	M [tf-m]	H [t]	y [m]	M [tf-m]
Vf [DL]	33.50	0.00	0.00			
Vf [LL]	152.15	0.00	0.00			
Vf [I]	77.27	0.00	0.00			
Vf [Lr]	1.70	0.00	0.00			
Eh				70.32	1.38	96.76
				10.00	2.65	26.45
				-30.52	0.49	-14.98
Ev	25.59	-2.63	-67.19			
	3.64	-2.63	-9.55			
	-1.07	2.63	-2.80			
Hf				23.69	3.80	90.03
Sub- total	292.79		-79.54	73.49		198.26
W [abutment]	370.96	-0.45	-167.40			
Total	663.75		-246.93			

ΣM = -48.68 tf-m
ΣV = 663.75 tf
ΣH = 73.49 tf
e = M / N = -0.07 m

8) Dead Load + Train Load + Brake Load + Long Rail Load + Earth Pressure

ITEMS	V [tf]	x [m]	M [tf-m]	H [t]	y [m]	M [tf-m]
Vf [DL]	33.50	0.00	0.00			
Vf [LL]	152.15	0.00	0.00			
Vf [Lr]	4.24	0.00	0.00			
Eh				70.32	1.38	96.76
				10.00	2.65	26.45
				-30.52	0.49	-14.98
Ev	25.59	-2.63	-67.19			
	3.64	-2.63	-9.55			
	-1.07	2.63	-2.80			
Hf				71.69	3.80	272.43
Sub- total	218.06		-79.54	121.49		380.66
W [abutment]	370.96	-0.45	-167.40			
Total	589.02		-246.93			

ΣM = 133.72 tf-m
ΣV = 589.02 tf
ΣH = 121.49 tf
e = M / N = 0.23 m

9) Dead Load + Train Load + Impact + Brake Load + Long Rail Load + Earth Pressure

ITEMS	V [tf]	x [m]	M [tf-m]	H [t]	y [m]	M [tf-m]
Vf [DL]	33.50	0.00	0.00			
Vf [LL]	152.15	0.00	0.00			
Vf [I]	77.27	0.00	0.00			
Vf [Lr]	1.70	0.00	0.00			
Eh				70.32	1.38	96.76
				10.00	2.65	26.45
				-30.52	0.49	-14.98
Ev	25.59	-2.63	-67.19			
	3.64	-2.63	-9.55			
	-1.07	2.63	-2.80			
Hf				71.69	3.80	272.43
Sub- total	292.79		-79.54	121.49		380.66
W [abutment]	370.96	-0.45	-167.40			
Total	663.75		-246.93			

ΣM = 133.72 tf-m
ΣV = 663.75 tf
ΣH = 121.49 tf
e = M / N = 0.20 m

10) Dead Load + Earth Pressure + Seismic

ITEMS	V [tf]	x [m]	M [tf-m]	H [t]	y [m]	M [tf-m]
Vf [DL]	33.50	0.00	0.00			
Vf [LL]	0.00	0.00	0.00			
Vf [Eq]	0.64	0.00	0.00			
Eh				70.32	1.38	96.76
				-30.52	0.49	-14.98
Ev	25.59	-2.63	-67.19			
	-1.07	2.63	-2.80			
Hf				10.39	3.80	39.46
Sub- total	58.67		-69.98	50.18		121.24
W [abutment]	370.96	-0.45	-167.40	66.77	1.59	106.28
Total	429.63		-237.38	116.96		227.52

ΣM = -9.86 tf-m
ΣV = 429.63 tf
ΣH = 116.96 tf
e = M / N = -0.02 m

11) Dead Load + Earth Pressure + Seismic [LL]

ITEMS	V [tf]	x [m]	M [tf-m]	H [t]	y [m]	M [tf-m]
Vf [DL]	33.50	0.00	0.00			
Vf [LL]	78.00	0.00	0.00			
Vf [Eq]	2.12	0.00	0.00			
Eh				70.32	1.38	96.76
				10.00	2.65	26.45
				-30.52	0.49	-14.98
Ev	25.59	-2.63	-67.19			
	3.64	-2.63	-9.55			
	-1.07	2.63	-2.80			
Hf				34.57	3.80	131.35
Sub- total	141.79		-79.54	84.36		239.57
W [abutment]	370.96	-0.45	-167.40	66.77	1.59	106.28
Total	512.75		-246.93	151.13		345.85

ΣM = 98.92 tf-m
ΣV = 512.75 tf
ΣH = 151.13 tf
e = M / N = 0.19 m

b. IN TRANSVERSAL DIRECTION

1) Dead Load + Train Load + Impact + Lateral Load + Wind Load + Earth Pressure

ITEMS	V [tf]	x [m]	M [tf-m]	H [t]	y [m]	M [tf-m]
Vf [DL]	33.50	0.00	0.00			
Vf [LL]	152.15	0.00	0.00			
Vf [Lr]	1.70	0.00	0.00			
Eh				70.32	1.38	96.76
				10.00	2.65	26.45
				-30.52	0.49	-14.98
Ev	25.59	-2.63	-67.19			
	3.64	-2.63	-9.55			
	-1.07	2.63	-2.80			
Sub- total	215.52		-79.54	49.80		108.23
W [abutment]	370.96	-0.45	-167.40	0.00	0.00	0.00
Total	586.48		-246.93	49.80		108.23
H [Lr]				14.40	3.80	54.72
H [W]				7.69	3.80	29.23
Total				22.09		83.95

Σ M	=	-138.71	tf- m	(longitudinal)
Σ M	=	83.95	tf- m	(transversal)
Σ V	=	586.48	tf	
Σ H	=	49.80	tf	(longitudinal)
Σ H	=	22.09	tf	(transversal)
e	= M / N =	-0.24	m	(longitudinal)
e	= M / N =	0.14	m	(transversal)

2) Dead Load + Earth Pressure + Seismic

ITEMS	V [tf]	X [m]	M [tf-m]	H [t]	y [m]	M [tf-m]
Vf [DL]	33.50	0.00	0.00			
Vf [LL]	78.00	0.00	0.00			
Vf [Eq]	0.64	0.00	0.00			
Eh				70.32	1.38	96.76
				-30.52	0.49	-14.98
Ev	25.69	-2.63	-67.19			
	-1.07	2.63	-2.80			
Eq [DL]				14.04	2.60	36.50
Sub- total	136.67		-69.98	53.84		118.28
W [abutment]	370.96	-0.45	-167.40	66.77	1.59	106.28
Total	507.63		-237.38	120.61		224.56
Eq [LL]				66.77	1.59	106.28

Σ M	=	-12.82	tf-m	(longitudinal)
Σ M	=	106.28	tf-m	(transversal)
Σ V	=	507.63	tf	
Σ H	=	120.61	tf	(longitudinal)
Σ H	=	66.77	tf	(transversal)
e	= M / N =	-0.03	m	(longitudinal)
e	= M / N =	0.21	m	(transversal)

5.4.3. CAPACITY OF PILE

ALLOWABLE CAPACITY OF PILE

1) MATERIAL

PRESTRESS CONCRETE PILE.

Quality		K - 500	
Diameter	=	0.45	m
g	=	0.23	t f / m
Area	=	0.159	m2 (End Pile)
Area	=	0.093	m2 (Body of Pile)
E	=	1400000	t-f / m2
I	=	0.002	m4
Pn	=	130	t f.

2) BEARING CAPACITY OF PILE

Elevation bottom of abutment = -0.05 m+
Refer to Boring Log R-52
Elevation of ground surface = 1.95 m+

a) End Bearing

N 1 = 47.00

N 2 = 0.50 (47.00 + 27.00)= 37.00

N r = 0.50 (47.00 + 37.00)= 42.00 > 40.00

therefore

N r = 40.00

L e = 0.70 m

$\frac{L e}{D}$ = 1.56

q d = 13.11 x Nr
= 13.11 x 40.00
= 524.44 t f

P b = 524.44 x 0.159 = 83.41 t f

b) Friction

Elevtion [m+]	Soil Describtion	Thickness [m]	N r	f i	L i x f i [t-f / m]
-0.05 - 7.15	clayey silt	7.10	3	3	21.30
-7.15 - 13.35	sandy clay	6.20	3	3	18.60
-13.35 - 16.05	silty sand	2.70	27	8	21.60
		16		total	61.50

Efficiency Group of Pile.

$$Eg = 1 - \tan^{-1}\left(\frac{0.45}{1.20}\right) \times \frac{9 + 8}{90 \times 4 \times 3}$$

$$= 0.68$$

$$Pf = 0.68 \times 61.50 \times 1.4137 = 59.12 \text{ tf}$$

c) Allowable bearing capacity of pile.

- Normal Condition

Condition :

DL + LL + I + E ----------> α = 1.00

DL + LL + I + E + Lr ----------> α = 1.15

DL + LL + I + E + Lr + B----------> α = 1.25

Coefficient Factor

α = 1.00 ----------> $Pa = \frac{83.41}{3} + \frac{59.12}{4} =$ 42.58 tf

α = 1.15 ----------> Pa = 1.15 x 42.58 = 48.97 tf

α = 1.25 ----------> Pa = 1.25 x 42.58 = 53.23 tf

- Earthquake Condition

$$Pa = \frac{83.409}{2} + \frac{59.122}{3} = 61.41 \text{ tf}$$

d) Allowable Pull Out Capacity of Pile.

- Normal Condition

Pu = 61.5 x 1.4137 = 86.944 tf

W pile = 16 x 0.23 = 3.68 tf

$$Pa = \frac{86.944}{6} + 3.68 = 18.171 \text{ tf}$$

- Earthquake Condition

$$Pa = \frac{86.944}{3} + 3.68 = 32.661 \text{ tf}$$

5.4.4. PILE CALCULATION.

CONCRETE PILE CALCULATION
No : 1

BH. 10 - 183

PROJECT : RAILWAY BRIDGE ACROSS WEST FLOODWAY
LOCATION : BH. 10 ,SEMARANG SIDE (DL+LL+I+E)

DISPLACEMENT METHOD

DATA OF FILE :

- NUMBER OF PILE	:	22
- LENGTH	:	15.95 m.
- DIAMETER	:	0.45 m.
- AREA	:	0.0930 m2.
- INERSIA	:	0.002000 m4
- MODULUS ELASTICITY [E]	:	1400000.00 tf/m2.

ANGLE AND COORDINATE OF PILE :

No. PILE	ANGLE TO THE VERTICAL AXIS [°]	DISTANCE TO THE POER AXIS [m]
1	0.00	-2.03
2	0.00	-2.03
3	0.00	-2.03
4	0.00	-2.03
5	0.00	-1.35
6	0.00	-1.35
7	0.00	-0.68
8	0.00	-0.68
9	0.00	-0.68
10	0.00	-0.68
11	0.00	0.00
12	0.00	0.00
13	0.00	0.68
14	0.00	0.68
15	0.00	0.68
16	0.00	0.68
17	0.00	1.35
18	0.00	1.35
19	0.00	2.03
20	0.00	2.03
21	0.00	2.03
22	0.00	2.03

EXTERNAL FORCE :

- MOMENT	:	-138.71 tf m.
- VERTICAL FORCE	:	662.05 tf.
- HORIZONTAL FORCE	:	49.80 tf.

N VALUE : 4

COEFFICIENT OF HORIZONTAL SUBGRADE REACTION :
Ko : 1.29 kg-f/cm3.
k : 4.08 kg-f/cm3 = 4076.98 t-f/m3.

CHRACTERISTIC VALUE OF PILE :
β : 0.63618 1/m.
Γ : 1.57 m.

SPRING CONSTANTS OF PILE :

k1	:	2883.82 tf/m.			
k2 = k3	:	2266.49 tf/rad.			
k4	:	3562.63 tm-f/rad.			
a	:	1.18 ---->	kv :	9658.65	t/m.

DISPLACEMENT EQUATIONS :

(6.3E+04) δx+(0.0E+00) δy+(-5.0E+04) α = 49.80
(0.0E+00) δx+(2.1E+05) δy+(-6.0E-08) α = 662.05
(-5.0E+04) δx+(-6.0E-08) δy+(5.0E+05) α = -138.71

DISPLACEMENT AT CENTERLINE OF PILECAP :

δx : 0.06 cm
δy : 0.31 cm
α : -0.00022 rad

DISPLACEMENT AND AXIAL/ORTHOGONAL FORCE :

No. PILE	δ'x [cm]	δ'y [cm]	PH [tf]	PN [tf]
1	0.06	0.36	2.26	34.31
2	0.06	0.36	2.26	34.31
3	0.06	0.36	2.26	34.31
4	0.06	0.36	2.26	34.31
5	0.06	0.34	2.26	32.91
6	0.06	0.34	2.26	32.91
7	0.06	0.33	2.26	31.50
8	0.06	0.33	2.26	31.50
9	0.06	0.33	2.26	31.50
10	0.06	0.33	2.26	31.50
11	0.06	0.31	2.26	30.09
12	0.06	0.31	2.26	30.09
13	0.06	0.30	2.26	28.69
14	0.06	0.30	2.26	28.69
15	0.06	0.30	2.26	28.69
16	0.06	0.30	2.26	28.69
17	0.06	0.28	2.26	27.28
18	0.06	0.28	2.26	27.28
19	0.06	0.27	2.26	25.87
20	0.06	0.27	2.26	25.87
21	0.06	0.27	2.26	25.87
22	0.06	0.27	2.26	25.87

REACTION ON HEAD OF PILE :

No. PILE	H [tf]	N [tf]	Mt [tf-m]
1	2.26	34.31	-2.16
2	2.26	34.31	-2.16
3	2.26	34.31	-2.16
4	2.26	34.31	-2.16
5	2.26	32.91	-2.16
6	2.26	32.91	-2.16
7	2.26	31.50	-2.16
8	2.26	31.50	-2.16
9	2.26	31.50	-2.16
10	2.26	31.50	-2.16
11	2.26	30.09	-2.16
12	2.26	30.09	-2.16
13	2.26	28.69	-2.16
14	2.26	28.69	-2.16

15	2.26	28.69	-2.16
16	2.26	28.69	-2.16
17	2.26	27.28	-2.16
18	2.26	27.28	-2.16
19	2.26	25.87	-2.16
20	2.26	25.87	-2.16
21	2.26	25.87	-2.16
22	2.26	25.87	-2.16

ALLOWABLE HORZONTAL FORCE

δ = 1 cm (Normal Condition)
H all = 28.84 tf

CONCRETE PILE CALCULATION
No : 1

PROJECT : RAILWAY BRIDGE ACROSS FLOODWAY
LOCATION : BH. 10 ,SEMARANG SIDE (DL+LL+I+E+Lr)

DISPLACEMENT METHOD

DATA OF PILE :

- NUMBER OF PILE	:	22
- LENGTH	:	15.95 m.
- DIAMETER	:	0.45 m.
- AREA	:	0.0930 m2.
- INERSIA	:	0.002000 m4
- MODULUS ELASTICITY [E]	:	1400000.00 tf/m2.

ANGLE AND COORDINATE OF PILE :

No. PILE	ANGLE TO THE VERTICAL AXIS [°]	DISTANCE TO THE POER AXIS [m]
1	0.00	-2.03
2	0.00	-2.03
3	0.00	-2.03
4	0.00	-2.03
5	0.00	-1.35
6	0.00	-1.35
7	0.00	-0.68
8	0.00	-0.68
9	0.00	-0.68
10	0.00	-0.68
11	0.00	0.00
12	0.00	0.00
13	0.00	0.68
14	0.00	0.68
15	0.00	0.68
16	0.00	0.68
17	0.00	1.35
18	0.00	1.35
19	0.00	2.03
20	0.00	2.03
21	0.00	2.03
22	0.00	2.03

EXTERNAL FORCE :

- MOMENT	:	-48.68 tf m.
- VERTICAL FORCE	:	663.75 tf.
- HORIZONTAL FORCE	:	73.49 tf.

N VALUE : 4

COEFFICIENT OF HORIZONTAL SUBGRADE REACTION :
Ko : 1.29 kg-f/cm3.
k : 4.08 kg-f/cm3 = 4076.98 t-f/m3.

CHRACTERISTIC VALUE OF PILE :
β : 0.63618 1/m.
Γ : 1.57 m.

SPRING CONSTANTS OF PILE :

k1	:	2883.82 tf/m.			
k2 = k3	:	2266.49 tf/rad.			
k4	:	3562.63 tm-f/rad.			
a	:	1.18 ---->	kv :	9658.65 t/m.	

DISPLACEMENT EQUATIONS :

(6.3E+04) δx+(0.0E+00) δy+(-5.0E+04) α = 73.49
(0.0E+00) δx+(2.1E+05) δy+(-6.0E-08) α = 663.75
(-5.0E+04) δx+(-6.0E-08) δy+(5.0E+05) α = -48.68

DISPLACEMENT AT CENTERLINE OF PILECAP :

δx : 0.12 cm
δy : 0.31 cm
α : 0.00002 rad

DISPLACEMENT AND AXIAL/ORTHOGONAL FORCE :

No. PILE	δ'x [cm]	δ'y [cm]	PH [tf]	PN [tf]
1	0.12	0.31	3.34	29.79
2	0.12	0.31	3.34	29.79
3	0.12	0.31	3.34	29.79
4	0.12	0.31	3.34	29.79
5	0.12	0.31	3.34	29.91
6	0.12	0.31	3.34	29.91
7	0.12	0.31	3.34	30.04
8	0.12	0.31	3.34	30.04
9	0.12	0.31	3.34	30.04
10	0.12	0.31	3.34	30.04
11	0.12	0.31	3.34	30.17
12	0.12	0.31	3.34	30.17
13	0.12	0.31	3.34	30.30
14	0.12	0.31	3.34	30.30
15	0.12	0.31	3.34	30.30
16	0.12	0.31	3.34	30.30
17	0.12	0.32	3.34	30.43
18	0.12	0.32	3.34	30.43
19	0.12	0.32	3.34	30.56
20	0.12	0.32	3.34	30.56
21	0.12	0.32	3.34	30.56
22	0.12	0.32	3.34	30.56

REACTION ON HEAD OF PILE :

No. PILE	H [tf]	N [tf]	Mt [tf-m]
1	3.34	29.79	-2.59
2	3.34	29.79	-2.59
3	3.34	29.79	-2.59
4	3.34	29.79	-2.59
5	3.34	29.91	-2.59
6	3.34	29.91	-2.59
7	3.34	30.04	-2.59
8	3.34	30.04	-2.59
9	3.34	30.04	-2.59
10	3.34	30.04	-2.59
11	3.34	30.17	-2.59
12	3.34	30.17	-2.59
13	3.34	30.30	-2.59

14	3.34	30.30	-2.59
15	3.34	30.30	-2.59
16	3.34	30.30	-2.59
17	3.34	30.43	-2.59
18	3.34	30.43	-2.59
19	3.34	30.56	-2.59
20	3.34	30.56	-2.59
21	3.34	30.56	-2.59
22	3.34	30.56	-2.59

ALLOWABLE HORZONTAL FORCE

δ = 1 cm (Normal Condition)
H all = 28.84 tf

CONCRETE PILE CALCULATION BH. 10 - 169
No : 1

PROJECT : RAILWAY BRIDGE ACROSS FLOODWAY
LOCATION : BH. 10 ,SEMARANG SIDE (DL+LL+I+E+Lr+B)

DISPLACEMENT METHOD

DATA OF PILE :

- NUMBER OF PILE	:	22
- LENGTH	:	15.95 m.
- DIAMETER	:	0.45 m.
- AREA	:	0.0930 m2.
- INERSIA	:	0.002000 m4
- MODULUS ELASTICITY [E]	:	1400000.00 tf/m2.

ANGLE AND COORDINATE OF PILE :

No. PILE	ANGLE TO THE VERTICAL AXIS [°]	DISTANCE TO THE POER AXIS [m]
1	0.00	-2.03
2	0.00	-2.03
3	0.00	-2.03
4	0.00	-2.03
5	0.00	-1.35
6	0.00	-1.35
7	0.00	-0.68
8	0.00	-0.68
9	0.00	-0.68
10	0.00	-0.68
11	0.00	0.00
12	0.00	0.00
13	0.00	0.68
14	0.00	0.68
15	0.00	0.68
16	0.00	0.68
17	0.00	1.35
18	0.00	1.35
19	0.00	2.03
20	0.00	2.03
21	0.00	2.03
22	0.00	2.03

EXTERNAL FORCE :

- MOMENT	:	133.72 tf m.
- VERTICAL FORCE	:	663.75 tf.
- HORIZONTAL FORCE	:	121.49 tf.

N VALUE : 4

COEFFICIENT OF HORIZONTAL SUBGRADE REACTION :
Ko : 1.29 kg-f/cm3.
k : 2.88 kg-f/cm3 = 2882.86 t-f/m3.

CHRACTERISTIC VALUE OF PILE :
β : 0.58338 1/m.
Γ : 1.71 m.

SPRING CONSTANTS OF PILE :

k1	:	2223.73 tf/m.			
k2 = k3	:	1905.89 tf/rad.			
k4	:	3266.95 tm-f/rad.			
a	:	1.18	----->	kv :	9658.65 t/m.

DISPLACEMENT EQUATIONS :

(4.9E+04) δx+(0.0E+00) δy+(-4.2E+04) α =	121.49
(0.0E+00) δx+(2.1E+05) δy+(-6.0E-08) α =	663.75
(-4.2E+04) δx+(-6.0E-08) δy+(4.9E+05) α =	133.72

DISPLACEMENT AT CENTERLINE OF PILECAP :

δx	:	0.29 cm
δy	:	0.31 cm
α	:	0.00052 rad

DISPLACEMENT AND AXIAL/ORTHOGONAL FORCE :

No. PILE	δ'x [cm]	δ'y [cm]	PH [tf]	PN [tf]
1	0.29	0.21	5.52	20.02
2	0.29	0.21	5.52	20.02
3	0.29	0.21	5.52	20.02
4	0.29	0.21	5.52	20.02
5	0.29	0.24	5.52	23.41
6	0.29	0.24	5.52	23.41
7	0.29	0.28	5.52	26.79
8	0.29	0.28	5.52	26.79
9	0.29	0.28	5.52	26.79
10	0.29	0.28	5.52	26.79
11	0.29	0.31	5.52	30.17
12	0.29	0.31	5.52	30.17
13	0.29	0.35	5.52	33.55
14	0.29	0.35	5.52	33.55
15	0.29	0.35	5.52	33.55
16	0.29	0.35	5.52	33.55
17	0.29	0.38	5.52	36.94
18	0.29	0.38	5.52	36.94
19	0.29	0.42	5.52	40.32
20	0.29	0.42	5.52	40.32
21	0.29	0.42	5.52	40.32
22	0.29	0.42	5.52	40.32

REACTION ON HEAD OF PILE :

No. PILE	H [tf]	N [tf]	Mt [tf-m]
1	5.52	20.02	-3.89
2	5.52	20.02	-3.89
3	5.52	20.02	-3.89
4	5.52	20.02	-3.89
5	5.52	23.41	-3.89
6	5.52	23.41	-3.89
7	5.52	26.79	-3.89
8	5.52	26.79	-3.89
9	5.52	26.79	-3.89
10	5.52	26.79	-3.89
11	5.52	30.17	-3.89
12	5.52	30.17	-3.89
13	5.52	33.55	-3.89

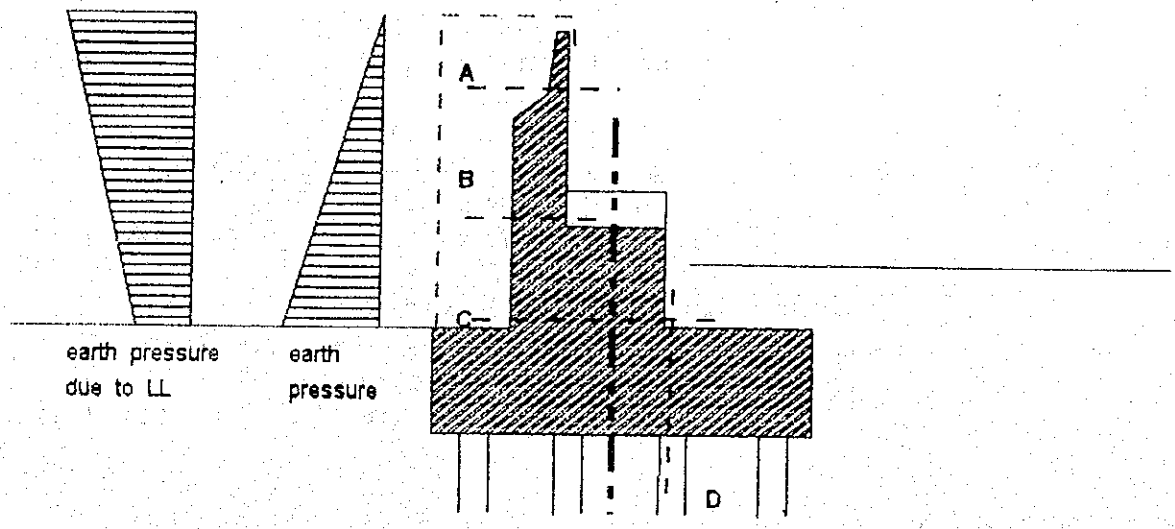
14	5.52	33.55	-3.89
15	5.52	33.55	-3.89
16	5.52	33.55	-3.89
17	5.52	36.94	-3.89
18	5.52	36.94	-3.89
19	5.52	40.32	-3.89
20	5.52	40.32	-3.89
21	5.52	40.32	-3.89
22	5.52	40.32	-3.89

ALLOWABLE HORZONTAL FORCE

δ = 1 cm (Normal Condition)
H all = 22.24 tf

5.5. REINFORCED CALCULATION

5.5.1. SKETCH

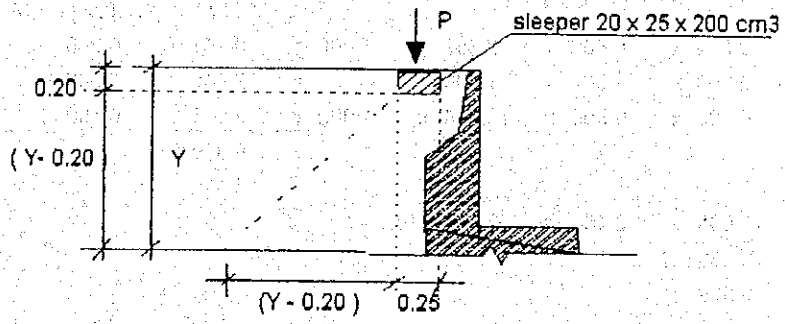


5.5.2. PARAPET WALL

a) EARTH PRESSURE

Y	=	0.00 m	ph	=	0.00 t/m2				
Y	=	0.60 m	ph	=	0.60 x	2.00 x	0.2973 =	0.357	t/m2
Y	=	1.84 m	ph	=	1.84 x	2.00 x	0.2973 =	1.094	t/m2
Y	=	4.04 m	ph	=	4.04 x	2.00 x	0.2973 =	2.402	t/m2

EARTH PRESSURE DUE TO LIVE LOAD



P = 20.00 tf

I = 1.50

PI = 1.50 x 20.00 = 30.00 tf

Y = 0.00 m

$$q = \frac{30.00}{2.00 \times 0.25} = 60.00 \text{ tf/m2}$$

ph = 0.2973 x 60.00 = 17.839 t/m2

Y = 0.60 m q = 30.00 / (0.65 x 2.80) = 16.48 tf/m2

ph = 0.2973 x 16.48 = 4.901 t/m2

Y = 1.84 m q = 30.00 / (1.89 x 5.28) = 3.01 tf/m2

ph = 0.2973 x 3.01 = 0.894 t/m2

Y = 4.04 m q = 30.00 / (1.95 x 5.40) = 2.85 tf/m2

ph = 0.2973 x 2.85 = 0.847 t/m2

b) SECTION A - A

- Vertical Dead Load (concrete)

					V [tf]	X [m]	M [tf-m]
0.200 x	0.600 x	1.000 x	2.400	=	0.288	0.050	0.014
0.050 x	0.600 x	1.000 x	2.400	=	0.072	-0.083	-0.006
					0.360		0.008

- Horizontal Load

					V [tf]	X [m]	M [tf-m]
0.500 x	0.600 x	0.357 x	1.000	=	0.107	0.200	0.021
0.600 x	4.901 x	1.000		=	2.940	0.300	0.882
0.500 x	0.600 x	12.938 x	1.000	=	3.881	0.400	1.553
					6.929		2.456

M = 0.008 + 2.456 = 2.465 tf-m

V = 0.360 tf

H = 6.929 tf

h = 24 cm

b = 100 cm

$\phi o = \frac{2250}{21 \times 75} = 1.4286$

Ca = 5.0041

δ = 0.400

ϕ = 3.000

ϕ i = 5.000

ζ = 0.915

nw = 0.056 ----> A = 6.40 cm2

A' = 2.56 cm2

A min = 7.5 cm2 D 13 - 10.00 cm

D 13 - 20.00 cm

$$\tau = \frac{6.9283 \times 1000}{0.875 \times 100 \times 24} = 3.30 \text{ kg f/cm2}$$

b) SECTION B - B

- Vertical Dead Load (concrete)

					V [t f]	X [m]	M [t f-m]
0.200 x	0.600 x	1.000 x	2.400	=	0.288	0.250	0.072
0.050 x	0.600 x	1.000 x	2.400	=	0.072	0.117	0.008
0.300 x	0.200 x	1.000 x	2.400	=	0.144	0.200	0.029
0.200 x	0.200 x	1.000 x	2.400	=	0.096	-0.083	-0.008
0.700 x	1.040 x	1.000 x	2.400	=	1.747	0.000	0.000
					2.347		0.101

- Horizontal Load

				V [t f]	X [m]	M [t f-m]
0.500 x	1.840 x	1.094 x	1.000	= 1.007	0.613	0.617
1.840 x	0.894 x	1.000 x	0.000	= 1.645	0.920	1.513
0.500 x	1.840 x	16.945 x	1.000	= 15.589	1.227	19.123
				18.241		21.253

M = 0.1013 + 21.253 = 21.355 t f-m
V = 2.3472 t f
H = 18.241 t f

h = 64 cm
b = 100 cm

$$\phi o = \frac{2250}{21 \times 75} = 1.4286$$

Ca = 4.5333
δ = 0.40
ϕ = 2.704
ϕ l = 4.294
ζ = 0.909
mw = 0.055 ——> A = 16.76 cm2 D 16 - 12.50 cm
A' = 6.70 cm2 D 13 - 20.00 cm
A min = 7.5 cm2

$$\tau = \frac{18.241 \times 1000}{0.875 \times 100 \times 64} = 3.26 \text{ kg f/cm2}$$

5.5.3. BODY

SECTION C - C

- Vertical Dead Load (concrete)

					V [tf]	X [m]	M [tf-m]
0.200 x	0.600 x	6.000 x	2.400	=	1.728	-0.375	-0.648
0.050 x	0.600 x	6.000 x	2.400	=	0.432	-0.508	-0.219
0.300 x	0.200 x	6.000 x	2.400	=	0.864	-0.425	-0.367
0.200 x	0.200 x	6.000 x	2.400	=	0.576	-0.708	-0.408
1.250 x	0.400 x	6.000 x	2.400	=	7.200	0.350	2.520
1.250 x	2.200 x	6.000 x	2.400	=	39.600	0.350	13.860
0.700 x	3.240 x	6.000 x	2.400	=	32.659	-0.625	-20.412
					83.059	-0.068	-5.674

- Horizontal Load

				V [tf]	X [m]	M [tf-m]
0.500 x	4.040 x	2.402 x	6.000	= 29.116	1.347	39.209
4.040 x	0.847 x	6.000 x	0.000	= 20.532	2.020	41.476
0.500 x	4.040 x	16.992 x	6.000	= 205.940	2.693	554.666
				255.589	2.486	635.351

a) Dead Load + Earth Pressure [LL]

ITEMS	V [tf]	x [m]	M [tf-m]	H [t]	y [m]	M [tf-m]
Va [DL]	33.50	0.325	10.89			
Va [LL]	0.00	0.325	0.00			
Eh				255.59	2.49	635.35
Ha				0.00	2.60	0.00
Sub- total	33.50		10.89	255.59		635.35
W	83.06	-0.07	-5.67			
Total	116.56		5.21			

M = 640.56 x 0.1667 = 106.76 tf-m / m

V = 116.56 x 0.1667 = 19.427 tf / m

H = 255.59 x 0.1667 = 42.598 tf / m

b) Dead Load + Train Load + Impact + Earth Pressure

ITEMS	V [tf]	x [m]	M [tf-m]	H [t]	y [m]	M [tf-m]
Va [DL]	33.50	0.325	10.89			
Va [LL]	152.15	0.325	49.45			
Va [I]	77.27	0.325	25.11			
Eh				255.59	2.49	635.35
Ha				0.00	2.60	0.00
Sub- total	262.92		85.45	255.59		635.35
W	83.06	-0.07	-5.67			
Total	345.98		79.78			

M = 715.13 x 0.1667 = 119.19 tf-m
V = 345.98 x 0.1667 = 57.664 tf
H = 255.59 x 0.1667 = 42.598 tf

c) Dead Load + Earth Pressure + Long Rail Load

ITEMS	V [tf]	x [m]	M [tf-m]	H [t]	y [m]	M [tf-m]
Va [DL]	33.50	0.325	10.89			
Va [LL]	0.00	0.325	0.00			
Va [Lr]	1.70	0.325	0.55			
Eh				255.59	2.49	635.35
Ha				30.49	2.60	79.26
Sub- total	35.20		11.44	286.07		714.61
W	83.06	-0.07	-5.67			
Total	118.26		5.77			

M = 720.38 x 0.1667 = 120.06 tf-m
V = 118.26 x 0.1667 = 19.71 tf
H = 286.07 x 0.1667 = 47.679 tf

d) Dead Load + Train Load + Impact + Earth Pressure + Long Rail Load

ITEMS	V [tf]	x [m]	M [tf-m]	H [t]	y [m]	M [tf-m]
Va [DL]	33.50	0.325	10.89			
Va [LL]	152.15	0.325	49.45			
Va [I]	77.27	0.325	25.11			
Va [Lr]	1.70	0.325	0.55			
Eh				255.59	2.49	635.35
Ha				23.69	2.60	61.60
Sub- total	264.62		86.00	279.28		696.95
W	83.06	-0.07	-5.67			
Total	347.68		80.33			

M = 777.28 x 0.1667 = 129.55 tf-m
V = 347.68 x 0.1667 = 57.947 tf
H = 279.28 x 0.1667 = 46.547 tf

e) Dead Load + Train Load + Brake Load + Long Rail Load + Earth Pressure

ITEMS	V [tf]	x [m]	M [tf-m]	H [t]	y [m]	M [tf-m]
Va [DL]	33.50	0.325	10.89			
Va [LL]	152.15	0.325	49.45			
Va [Lr]	4.24	0.325	1.38			
Eh				255.59	2.49	635.35
Ha				71.69	2.60	186.40
Sub- total	189.89		61.71	327.28		821.75
W	83.06	-0.07	-5.67			
Total	272.95		56.04			

M = 877.79 x 0.1667 = 146.3 tf-m
V = 272.95 x 0.1667 = 45.491 tf
H = 327.28 x 0.1667 = 54.547 tf

f) Dead Load + Train Load + Impact + Brake Load + Long Rail Load + Earth Pressure

ITEMS	V [tf]	x [m]	M [tf-m]	H [t]	y [m]	M [tf-m]
Va [DL]	33.50	0.325	10.89			
Va [LL]	152.15	0.325	49.45			
Va [I]	77.27	0.325	25.11			
Va [Lr]	1.70	0.325	0.55			
Eh				255.59	2.49	635.35
Ha				71.69	2.60	186.40
Sub- total	264.62		86.00	327.28		821.75
W	83.06	-0.07	-5.67			
Total	347.68		80.33			

M = 902.08 x 0.1667 = 150.35 tf-m
V = 347.68 x 0.1667 = 57.947 tf
H = 327.28 x 0.1667 = 54.547 tf

g) Dead Load + Earth Pressure + Seismic [LL]

ITEMS	V [tf]	x [m]	M [tf-m]	H [t]	y [m]	M [tf-m]
Va [DL]	33.50	0.325	10.89			
Va [LL]	78.00	0.325	25.35			
Va [Eq]	2.12	0.325	0.69			
Eh				255.59	2.49	635.35
Ha				34.57	2.60	89.87
Sub- total	113.62		36.93	290.15		725.22
W	83.06	-0.07	-5.67			
Total	196.68		31.25			

M = 756.47 x 0.1667 = 126.08 tf-m
V = 196.68 x 0.1667 = 32.78 tf
H = 290.15 x 0.1667 = 48.359 tf

REINFORCEMENT ANALYSIS

ITEMS	CASE						
	A	B	C	D	E	F	G
Internal Force							
M [tf m]	106.76	119.19	120.06	129.55	146.30	150.35	126.08
V [tf]	19.43	57.66	19.71	57.95	45.49	57.95	32.78
Q [tf]	42.60	42.60	47.68	46.66	54.55	54.55	48.36
b [m]	1.00	1.00	1.00	1.00	1.00	1.00	1.00
h [m]	1.95	1.95	1.95	1.95	1.95	1.95	1.95
d [m]	1.88	1.88	1.88	1.88	1.88	1.88	1.88
d' [m]	0.07	0.07	0.07	0.07	0.07	0.07	0.07
n	21	21	21	21	21	21	21
ϕ o	1.4286	1.4286	1.4286	1.4286	1.2190	1.2190	1.2190
e o1 [m]	5.50	2.07	6.09	2.24	3.22	2.59	3.85
e o2 [m]	0.07	0.07	0.07	0.07	0.07	0.07	0.07
e o [m]	5.56	2.13	6.16	2.30	3.28	2.66	3.91
e o / h	2.85	1.09	3.16	1.18	1.68	1.36	2.01
C	7.00	7.00	7.00	7.00	7.00	7.70	7.70
lk [m]	2.60	2.60	2.60	2.60	2.60	2.60	2.60
e 1 [m]	0.00	0.00	0.00	0.00	0.00	0.00	0.00
e 2 [m]	0.29	0.29	0.29	0.29	0.29	0.29	0.29
e [m]	5.85	2.42	6.45	2.59	3.57	2.95	4.20
e a [m]	6.76	3.33	7.35	3.50	4.48	3.86	5.11
N ea [tf m]	131.29	191.99	144.95	202.71	203.73	223.51	167.46
C a	5.371	4.681	5.388	4.556	5.142	4.909	5.671
δ	0.400	0.400	0.400	0.400	0.400	0.400	0.400
ϕ	3.255	2.846	3.255	2.704	3.082	3.000	3.444
ϕ !	5.667	4.625	5.667	4.294	5.207	5.000	6.200
ζ	0.235	0.260	0.235	0.270	0.245	0.250	0.225
ζ	0.920	0.912	0.920	0.909	0.917	0.915	0.923
C b	2.812	2.651	2.812	2.592	2.745	2.713	2.884
nw	0.039	0.050	0.039	0.055	0.043	0.045	0.035
Reinforcement							
i	1.344	2.062	1.308	1.955	1.626	1.805	1.514
A [cm]	25.98	21.71	26.70	25.18	23.68	22.32	20.69
A' [cm]	13.97	17.90	13.97	19.70	15.40	16.11	12.53
A min [cm2]	47.00	47.00	47.00	47.00	47.00	47.00	47.00
Therefore							
A [cm]	47.00	47.00	47.00	47.00	47.00	47.00	47.00
Rebar diameter	25	25	25	25	25	25	25
Distance [cm]	10	10	10	10	10	10	10
A' [cm2]	18.80	18.80	18.80	18.80	22.20	18.80	18.80
Rebar diameter	25	25	25	25	25	25	25
Distance [cm]	25	25	25	25	20	25	25
Checking Shear Stress							
τ [kg f/cm2]	2.59	2.59	2.90	2.83	3.32	3.32	2.94

5.5.4 FOOTING / PILE CAP.

Pararel with Track

SECTION D - D

a) Dead Load + Train Load + Impact + Earth Pressure

Vertical Force

Vd	=	1.975	x	1.20	x	3.00	x -2.40 =	-17.06 tf	(concrete)
Vp	=					25.87	x 2 =	51.74 tf	(reaction of pile)
						27.28	x 1 =	27.28 tf	(reaction of pile)
						28.69	x 2 =	67.38 tf	(reaction of pile)
							total =	119.34 tf	

Moment

Mvd	=	-17.06	x	0.9875		=	-16.85	tf m
Mp	=	25.87	x	1.375	x 2 =		71.143	tf m
		27.28	x	0.70	x 1 =		19.096	tf m
		28.69	x	0.025	x 2 =		1.4345	tf m
					total =		74.822	tf m

therefore per m' .

Vd	=	119.34	x	0.3333	=	39.779 tf / m'
Md	=	74.822	x	0.3333	=	24.941 t-f m / m'

h = 104 cm

b = 100 cm

$$\phi o = \frac{2250}{21 \times 75} = 1.4286$$

Ca	=	6.8165					
δ	=	0.4					
ϕ	=	4.263					
ϕ 1	=	9.000					
ζ	=	0.935					
rw	=	0.023	---->	A	=	11.39	cm2
				A'	=	4.56	cm2
				A min	=	24.00	cm2 D 19 - 10.00 cm

$$\tau = \frac{39.779 \times 1000}{0.875 \times 100 \times 104} = 4.37 \text{ kg f/cm2}$$

Check Punch

P = 28.69 tf

$$\tau = \frac{28.69 \times 1000}{3.14 \times (45 + 104) \times 104} = 0.59 \text{ kg f/cm2}$$

b) Dead Load + Train Load + Impact + Earth Pressure + Long rail

Vertical Force

Vd	=	1.975	x	1.20	x	3.00	x -2.40 =	-17.06 tf	(concrete)
Vp	=					30.56	x 2 =	61.12 tf	(reaction of pile)
						30.43	x 1 =	30.43 tf	(reaction of pile)
						30.30	x 2 =	60.60 tf	(reaction of pile)
							total =	135.09 tf	

Moment

Mvd	=	-17.06	x	0.9875	=	-16.85	tf m
Mp	=	30.56	x	1.375	x 2 =	84.04	tf m
		30.43	x	0.70	x 1 =	21.301	tf m
		30.30	x	0.025	x 2 =	1.515	tf m
					total =	90.005	tf m

therefore per m' .

Vd	=	135.09	x 0.3333	=	45.029 tf / m'
Md	=	90.005	x 0.3333	=	30.002 t-f m / m'

h = 104 cm

b = 100 cm

$$\phi o = \frac{3200}{21 \times 125} = 1.219$$

Ca	=	7.4118					
δ	=	0.4					
ϕ	=	4.714					
ϕ l	=	11.00					
ζ	=	0.94					
rw	=	0.019	---->	A	=	9.41	cm2
				A'	=	3.76	cm2
				A min	=	24.00	cm2

D 19 - 10.00 cm

$$\tau = \frac{45.029 \times 1000}{0.875 \times 100 \times 104} = 4.95 \text{ kg f /cm2}$$

Check Punch

P = 30.3 tf

$$\tau = \frac{30.3 \times 1000}{3.14 \times (45 + 104) \times 104} = 0.62 \text{ kg f /cm2}$$

c) Dead Load + Train Load + Impact + Earth Pressure + Long rail + Brake

Vertical Force

Vd	=	1.975	x	1.20	x	3.00	x -2.40 =	-17.06 tf	(concrete)
Vp	=					40.32	x 2 =	80.64 tf	(reaction of pile)
						36.94	x 1 =	36.94 tf	(reaction of pile)
						33.55	x 2 =	67.10 tf	(reaction of pile)
							total =	167.62 tf	

Moment

Mvd	=	-17.06	x	0.9875		=	-16.85 tf m
Mp	=	40.32	x	1.375	x 2	=	110.88 tf m
		36.94	x	0.70	x 1	=	25.858 tf m
		33.55	x	0.025	x 2	=	1.6775 tf m
					total	=	121.56 tf m

therefore per m' .

Vd	=	167.62	x 0.3333	=	55.872 tf / m'
Md	=	121.56	x 0.3333	=	40.522 t-f m / m'

h = 104 cm

b = 100 cm

$$\phi o = \frac{3200}{21 \times 125} = 1.219$$

Ca	=	6.3776				
δ	=	0.4				
ϕ	=	3.878				
ϕ 1	=	7.571				
ζ	=	0.93				
nw	=	0.028	—>	A	=	13.87 cm2
				A'	=	5.55 cm2
				A min	=	24.00 cm2 D 19 - 10.00 cm

$$\tau = \frac{55.872 \times 1000}{0.875 \times 100 \times 104} = 6.14 \text{ kg f/cm2}$$

use stirrup D 13 -250

$$\tau = \frac{5.2 \times 2250}{25 \times 100} = 4.68 \text{ kg f/cm2} > 6.22 - 6.00 = 0.22 \text{ kg f/cm2}$$

Check Punch

P = 40.32 tf

$$\tau = \frac{40.32 \times 1000}{3.14 \times (45 + 104) \times 104} = 0.83 \text{ kg f/cm2}$$

Perpendicular with Track

- Vertical Dead Load

0.200	0.600	x 5.400	x 2.400	=	1.555	tf
0.050	0.600	x 5.400	x 2.400	=	0.389	tf
0.300	0.200	x 5.400	x 2.400	=	0.778	tf
0.200	0.200	x 5.400	x 2.400	=	0.518	tf
1.250	0.400	x 2.800	x 2.400	=	3.360	tf
1.250	2.200	x 6.000	x 2.400	=	39.600	tf
0.700	3.240	x 5.400	x 2.400	=	29.393	tf
2.025	4.090	x 0.600	x 2.400	=	11.926	tf
0.050	0.650	x 5.400	x 2.000	=	0.351	tf
0.400	0.650	x 5.400	x 2.000	=	2.808	tf
0.200	0.200	x 5.400	x 2.000	=	0.432	tf
1.325	2.890	x 5.400	x 2.000	=	41.356	tf
			Total	=	132.467	tf

$$q1 = \frac{132.467}{5.25 \times 6.000} = 4.205 \text{ tf/m'}$$

$$q2 = 1.200 \times 2.400 = 2.880 \text{ tf/m'}$$

1.3125	x 1.406	x 6.6	x 1.6	=	19.487	tf
5.25	x 0.514	x 6.6	x 1.6	=	28.496	tf
			total	=	47.983	tf

$$q3 = \frac{47.983}{5.25 \times 6.600} = 1.385 \text{ tf/m'}$$

$$q\,dl = \frac{33.5}{5.25 \times 6} = 1.063 \text{ tf/m'}$$

- Vertical Live Load + Impact

$$q\,ll = \frac{152.15 + 77.274}{5.25 \times 6} = 7.283 \text{ tf}$$

Field Moment

M =	12.552	x 3	x 3		=	112.97	tf m/m'
	0.125	x 2.88	x 8.4	x 4.2	=	12.701	tf m/m'
	1.3848	x 1.2	x 0.6		=	0.9971	tf m/m'
				M	=	126.67	tf m/m'

Shear Force

Q = 12.552 x 3 + 2.88 x 4.2 + 1.3848 x 1.2

= 51.414 tf

therefore per m' .

Vd = 51.414 tf / m'

Md = 126.67 t-f m / m'

h = 104 cm

b = 100 cm

$$\phi o = \frac{2250}{21 \times 75} = 1.4286$$

Ca = 3.0247

δ = 0.4

ϕ = 1.740

ϕ 1 = 2.396

ζ = 0.882

mw = 0.126 ——> A = 62.40 cm2 D 29 - 10.00 cm

A' = 24.96 cm2 D 19 - 10.00 cm

A min = 30.00 cm2

$$\tau = \frac{51.414 \times 1000}{0.875 \times 100 \times 104} = 5.65 \text{ kg f/cm2} < \tau a$$

3.5.5. CHECKING STRESS ON PILE.

Data of pile

D = 45 cm

d = 29 cm

A = 930 cm2

W = 7403 cm3

σ ce = 82.9 kg / cm2

σ ce = 6030.9 kg / cm2

n = Ea / Eb = 15

Stress of Pile

1) Dead Load + Train Load + Impact + Earth Pressure ——> permanent load

α = 1.00

Force on head pile

M = 2.16 tf m

N = 34.31 tf

H = 2.26 tf

Compressive stress of concrete

$$\sigma c = \sigma ce + \frac{M}{W} + \frac{N}{A}$$

$$= 82.90 + 29.18 + 36.89$$

$$= 148.97 \text{ kg f / cm2} < 166 \text{ kg f / cm2}$$

Tensile stress of concrete

$$\sigma c' = \sigma ce - \frac{M}{W} + \frac{N}{A}$$

$$= 82.90 + 29.18 + 36.89$$

$$= 90.615 \text{ kg f / cm2} > 0 \text{ kg f / cm2}$$

Tensile stress of PC cable

$$\sigma p = \sigma pe + \frac{n \times M}{W} + \frac{n \times N}{A}$$

$$= 8030.94 + 437.66 - 553.39$$

$$= 7915.2 \text{ kg f / cm2} < 8700 \text{ kg f / cm2}$$

Stress on joint between pile and footing

Compressive stress

N = 34.31 tf

H = 2.26 tf

l = 10 cm

$$\sigma v = \frac{N}{0.25 \times 22/7 \times (D^2-d^2)} = \frac{34.31 \times 1000}{930} = 36.88 \text{ kg f / cm2} < 75 \text{ kgf /cm2}$$

$$\sigma h = \frac{H}{D.l} = \frac{2.26 \times 1000}{45 \times 10} = 5.02 \text{ kg f / cm2} < 76 \text{ kgf /cm2}$$

Shear stress

h 1 = 110 cm (= distance between pile top and footing)

$$\tau = \frac{N}{22/7 \times (D \times h1)} = \frac{34.31 \times 1000}{15557} = 2.21 \text{ kg f / cm2} < 7.5 \text{ kgf/cm2}$$

2) Dead Load + Train Load + Impact + Earth Pressure + Long rail ——> temporary load

$\alpha = 1.15$

Force on head pile

M = 2.59 tf m

N = 29.79 tf

H = 3.34 tf

Compressive stress of concrete

$$\sigma c = \sigma ce + \frac{M}{W} + \frac{N}{A}$$

$$= 82.90 + 34.99 + 32.03$$

$$= 149.92 \text{ kg f / cm2} < 1.15 \times 166 \text{ kg f / cm2}$$

$$= 190.9 \text{ kg f / cm2}$$

Tensile stress of concrete

$$\sigma c' = \sigma ce - \frac{M}{W} + \frac{N}{A}$$

$$= 82.90 + 34.99 + 32.03$$

$$= 79.95 \text{ kg f / cm2} > 0 \text{ kg f / cm2}$$

Tensile stress of PC cable

$$\sigma p = \sigma pe + \frac{n \times M}{W} + \frac{n \times N}{A}$$

$$= 8030.94 + 524.79 - 480.48$$

$$= 8075.2 \text{ kg f / cm2} < 8700 \text{ kg f / cm2}$$

Stress on joint between pile and footing

Compressive stress

N = 29.79 t f

H = 3.34 t f

l = 10 cm

$$\sigma v = \frac{N}{0.25 \times 22/7 \times (D^2 - d^2)}$$

$$= \frac{29.79 \times 1000}{930.29} = 32.02 \text{ kg f / cm2} < 1.15 \times 75 \text{ kgf /cm2}$$

$$= 86.25 \text{ kgf /cm2}$$

$$\sigma h = \frac{H}{D.l}$$

$$= \frac{3.34 \times 1000}{45 \times 10} = 7.42 \text{ kg f / cm2} < 1.15 \times 75 \text{ kgf /cm2}$$

$$= 86.25 \text{ kgf /cm2}$$

Shear stress

h 1 = 110 cm (= distance between pile top and footing)

$$\tau = \frac{N}{22/7 \times (D \times h1)} = \frac{29.79 \times 1000}{15557} = 1.91 \text{ kg f / cm2} < 7.5 \text{ kgf/cm2}$$

c) Dead Load + Train Load + Impact + Earth Pressure + Long rail + Brake ——> temporary load

$\alpha = 1.25$

Force on head pile

M = 3.89 t f m

N = 40.32 t f

H = 5.52 t f

Compressive stress of concrete

$$\sigma c = \sigma ce + \frac{M}{W} + \frac{N}{A}$$

$$= 82.90 + 52.55 + 43.35$$

$$= 178.80 \text{ kgf/cm2} < 1.25 \times 166 \text{ kgf/cm2}$$

$$= 207.5 \text{ kgf/cm2}$$

Tensile stress of concrete

$$\sigma c' = \sigma ce - \frac{M}{W} + \frac{N}{A}$$

$$= 82.90 + 52.55 + 43.35$$

$$= 73.71 \text{ kgf/cm2} > 0 \text{ kgf/cm2}$$

Tensile stress of PC cable

$$\sigma p = \sigma pe + \frac{n \times M}{W} + \frac{n \times N}{A}$$

$$= 8030.94 + 788.19 - 650.32$$

$$= 8168.8 \text{ kgf/cm2} < 8700 \text{ kgf/cm2}$$

Stress on joint between pile and footing

Compressive stress

N = 40.32 tf

H = 5.52 tf

l = 10 cm

$$\sigma v = \frac{N}{0.25 \times 22/7 \times (D^2 - d^2)}$$

$$= \frac{40.32 \times 1000}{930.29} = 43.34 \text{ kgf/cm2} < 1.25 \times 75 \text{ kgf/cm2}$$

$$= 93.75 \text{ kgf/cm2}$$

$$\sigma h = \frac{H}{D.l}$$

$$= \frac{5.52 \times 1000}{45 \times 10} = 12.27 \text{ kgf/cm2} < 1.25 \times 75 \text{ kgf/cm2}$$

$$= 93.75 \text{ kgf/cm2}$$

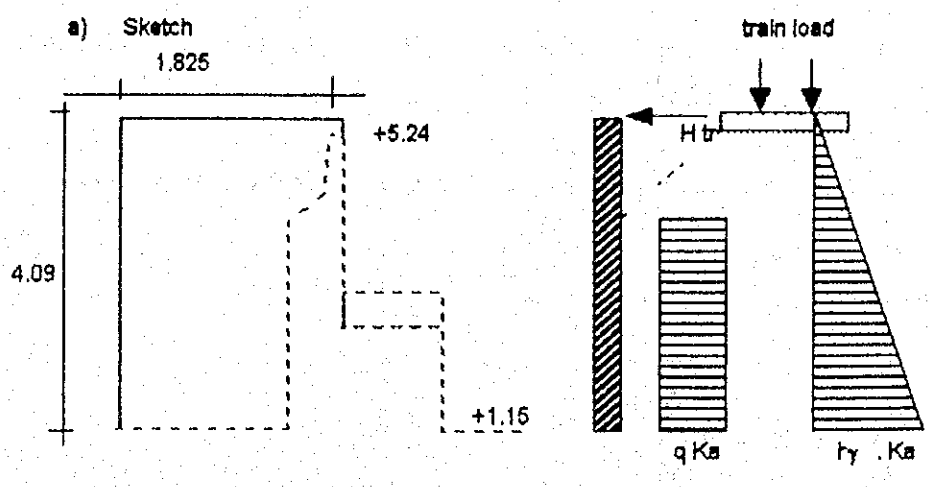
Shear stress

h1 = 110 cm (= distance between pile top and footing)

$$\tau = \frac{N}{22/7 \times (D \times h1)} = \frac{40.32 \times 1000}{16567} = 2.59 \text{ kgf/cm2} < 7.5 \text{ kgf/cm2}$$

5.5.6 WING WALL .

a) Sketch



b) Lateral earth pressure

- data of soil

γ = 2.000 tf/m3
ϕ = 30.00 degree
Ko = 0.2973

- earth pressure

p1 = 2 x 2.89 x 0.2973 = 1.72 tf/m2

Force.					P [tf]			x [m]	Mx [t-f m]
P1	=	0.50 x	4.09 x	1.72 x	1.825	=	6.41	0.9125	5.85

- earth pressure caused by train load

$$q\,Ka = \frac{8.75}{5.40} \times 0.2973 = 0.48 \text{ tf/m2}$$

Force.				P [tf]			x [m]	Mx [t-f m]
P1	=	0.48 x	4.09 x	1.825	=	3.60	0.9125	3.28

- Caused by Transversal Load.

Htr = 12.00 x 0.10 = 1.20 t-f / sleeper

friction coeficient between ballast and bottom of sleeper = 0.05

H'tr = 1.20 - 0.05 x 12.00 = 0.60 t-f / sleeper

for 1 m length of side wall

$$H'tr = \frac{0.60}{1.20} = 0.50 \text{ t-f/m}$$

		P [tf]				x [m]	Mx [t-f m]
P	=	0.5 x	1.825	=	0.9125	0.9125	0.83

Total Force

$$M = \frac{1}{4.09}(5.85 + 3.28 + 0.83) = 2.44 \text{ t-f m / m'}$$

$$Q = \frac{1}{4.09}(6.41 + 3.60 + 0.91 = 2.67 \text{ t-f / m'}$$

c) Reinforcement

h	=	0.23 m					
b	=	1.00 m					
Ca	=	4.823					
δ	=	0.40					
ϕ	=	2.922					
ζ	=	0.914					
nw	=	0.0476					
A	=	$\frac{0.0476}{21}$ x	23 x	100 =	5.21 cm2		
As	=	0.0025 x	29 x	100 =	7.25 cm2	use	D 16 - 260
τ	=	$\frac{2.670 \times 1000}{0.875 \times 23 \times 100}$ =			1.33 kg / cm2	ok.	