7.4.2 PIER CIREBON AND SEMARANG SIDE

1.1. DATA

4.1.1.EXISTING SUPERTRUCTURES

	LEFT SIDE	RIGHT SIDE
- Type	Truss	Truss
- Total Weight	67.00 ton-f	67.00 ton-f
- Effective Span (c.t.c.)	31.20 m	31.20 m
- Total Length of Stringer or Truss Girder	32.16 m	32.16 m
- Center to center of Main Girder	4.60 m	4.60 m
- Construction Depth	1.33 m	1.33 m
- Height of Shoe	0.32 m	0.32 m
- Distance between top of rail up to top of concrete bearing	1.65 m	1.65 m
- Distance between top of rail up to elevation of HWL	2.33 m	2.33 m

4.1.2.TRACK

- Track Plan : straight
- Track Elevation : Level

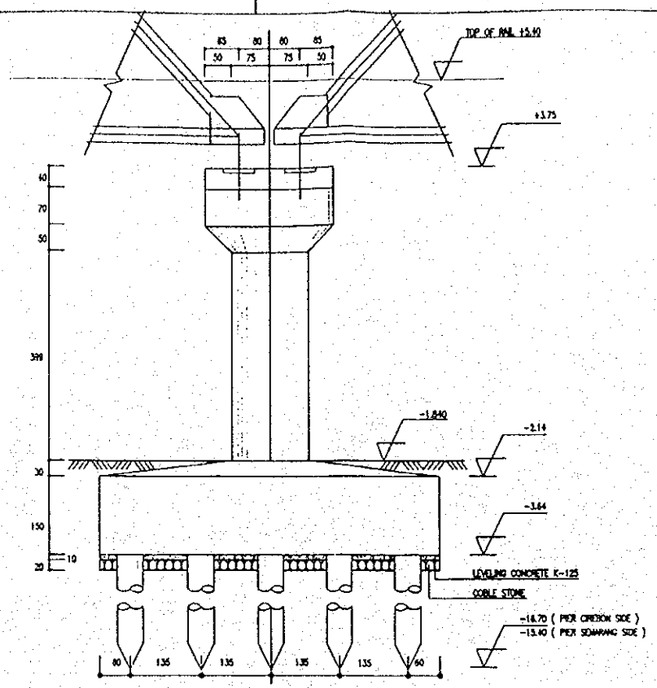
4.1.3.LOADINGS

- Train Load (Live Load) : based on 100 % Load Scheme 1921.
- Impact : { 0.2 + 25 / (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 x Train Load
- Wind Load : 0.10 t f /m2.
- Earth Pressure : based on Coulomb's Theory
- Stream Flow : based on the velocity of stream on HWL Condition
- Seismic Load : based on the equivalent static force and design seismic intensity expressed as followings :

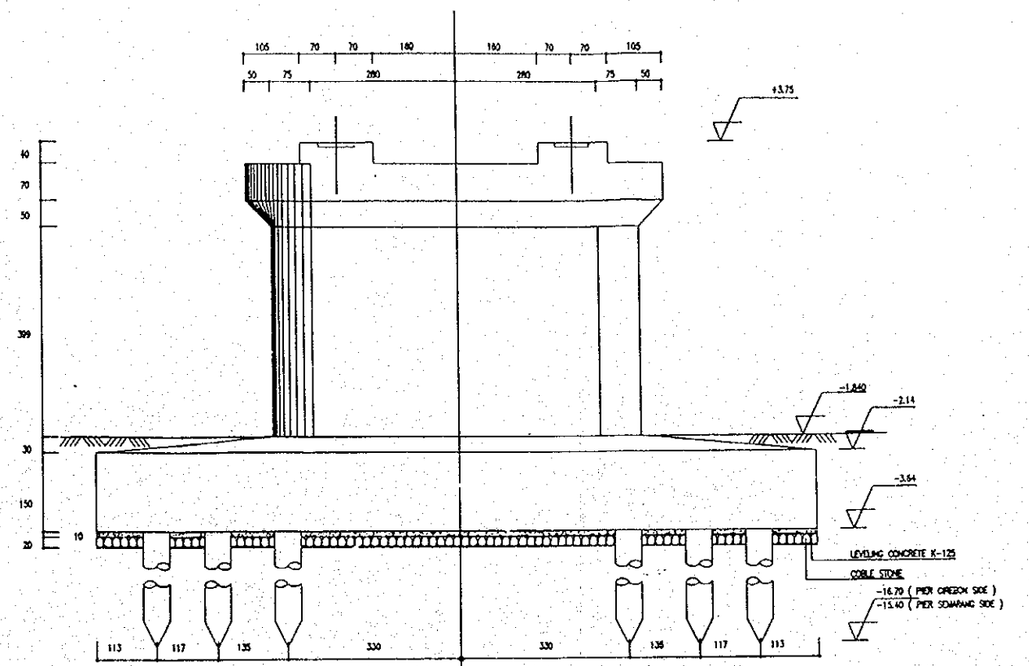
  KH = 0.18

  KV = 0.00

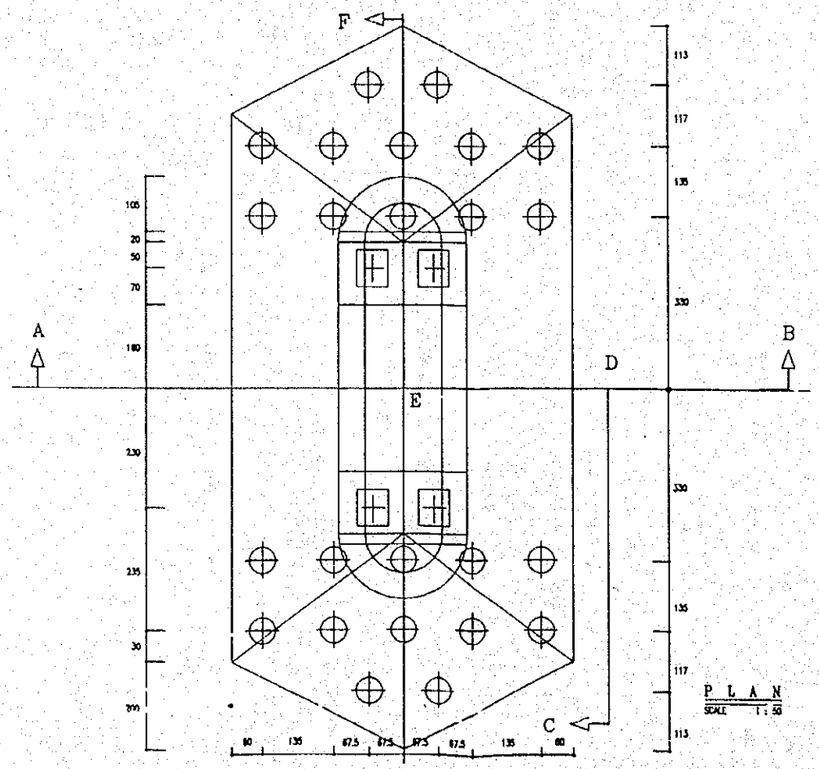
4.2. DIMENSION OF PIER.



SECTION A - B
SCALE 1 : 50



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



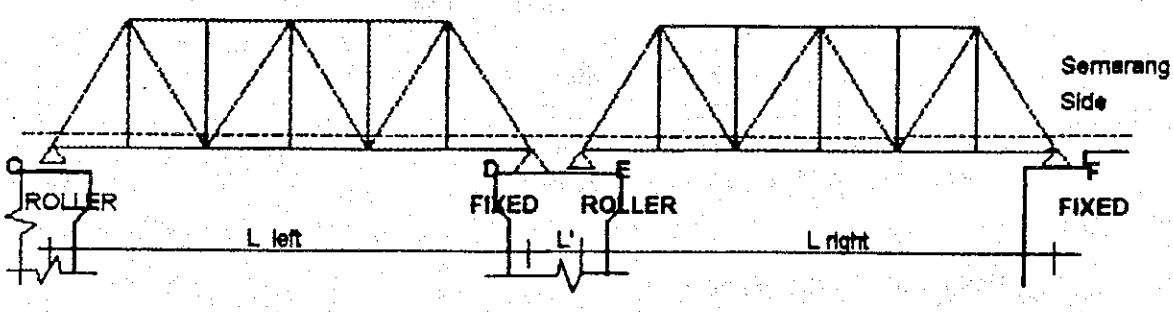
P L A N
SCALE 1 : 50

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

GENERAL DRAWING OF PIER
CIREBON / SEMARANG SIDE

4.3. LOADINGS

4.3.1. TRAIN ON BOTH SIDE OF PIER .



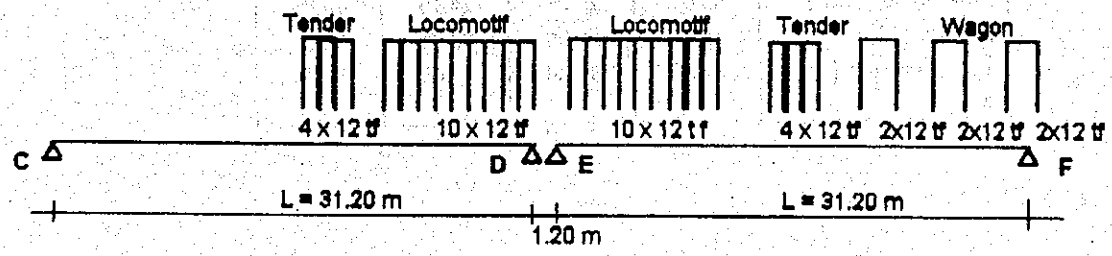
L left = 31.20 m
L right = 31.20 m
L' = 1.20 m

a) VERTICAL FORCE.

1). DEAD LOAD

Vc = 33.50 tf.
Vd = 33.50 tf.
Ve = 33.50 tf.
Vf = 33.50 tf.

2). TRIAN LOAD (LIVE LOAD)



Vc = 98.04 tf.
Vd = 129.96 tf.
Ve = 124.16 tf.
Vf = 43.85 tf.

3). IMPACT LOAD

Impact Coefficient

L left = 31.20 m

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

L right = 31.20 m

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

Vc	=	98.04	x	0.5079	= 49.79 tf.
Vd	=	129.96	x	0.5079	= 66.00 tf.
Ve	=	124.15	x	0.5079	= 63.05 tf.
Vf	=	43.85	x	0.5079	= 22.27 tf.

4). TRAIN LOAD FOR SEISMIC

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

Vc	=	5.00 (	31.20 +	1.20) x	0.5	=	81 tf.
Vd	=	5.00 (	31.20 +	1.20) x	0.5	=	81 tf.
Ve	=	5.00 (	31.20 +	1.20) x	0.5	=	81.00 tf.
Vf	=	5.00 (	31.20 +	1.20) x	0.5	=	81.00 tf.

SUMMARY DUE TO VERTICAL FORCE.

ITEMS	Vc [ton-f]	Vd [ton-f]	Ve [ton-f]	Vf [ton-f]
Dead Load [DL]	33.50	33.50	33.50	33.50
Train Load [LL]	98.04	129.96	124.15	43.85
Impact [I]	49.79	66.00	63.05	22.27
Train Seismic [LL]	81.00	81.00	81.00	81.00

b) LONGITUDINAL HORIZONTAL FORCE

1). DEAD LOAD + LONG RAIL LOAD

1) SPAN C - D

TOTAL HORIZONTAL FORCE

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

HORIZONTAL FORCE ON SUPPORTING D

$Hd = \Sigma H - 1/2 \times \mu \times Vc$

$= 32.16 - 0.5 \times 0.10 \times 33.50$

$= 30.49$ tf $>$ $1/2 \times 32.16 = 16.08$ tf

therefore

$Hd = 30.49$ tf

VERTICAL FORCE ON SUPPORTING D

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

2) SPAN E - F

TOTAL HORIZONTAL FORCE

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

HORIZONTAL FORCE ON SUPPORTING E

$He = \mu \times Ve$

$= 0.10 \times 33.50$

$= 3.35$ tf $<$ $1/2 \times 32.16 = 16.08$ tf

therefore

$He = 3.35$ tf

VERTICAL FORCE ON SUPPORTING E

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

2). LONG RAIL LOAD + BRAKE LOAD

1) SPAN C - D

TOTAL HORIZONTAL FORCE

$\Sigma H = 5 \times 12.00 \times 0.1000 + 14 \times 12.00 \times 0.1667 + 32.16$

$= 66.16$ tf

HORIZONTAL FORCE ON SUPPORTING D

$Hd = \Sigma H - 1/2 \times \mu \times Vc$

$= 66.16 - 0.5 \times 0.10 \times (33.50 + 98.04)$

$= 59.58$ tf $>$ $1/2 \times 66.16 = 33.08$ tf

therefore

$Hd = 59.583$ tf

VERTICAL FORCE ON SUPPORTING D.

$$Vd = \frac{-66.16 \times 1.65}{31.20} = -3.50 \text{ tf}$$

2) SPAN E - F

TOTAL HORIZONTAL FORCE

$$\Sigma H = 14 \times 12.00 \times 0.1667 + 32.16 = 60.16 \text{ tf}$$

HORIZONTAL FORCE ON SUPPORTING E

$$He = \mu \times Ve$$
$$= 0.10 \times (33.50 + 124.15)$$
$$15.77 \text{ tf} < 1/2 \times 60.16 = 30.08 \text{ tf}$$

therefore

$$He = 15.77 \text{ tf}$$

VERTICAL FORCE ON SUPPORTING E

$$Ve = \frac{60.16 \times 1.65}{31.20} = 3.17 \text{ tf}$$

3). TRAIN LOAD + LONG RAIL LOAD

1) SPAN C - D

TOTAL HORIZONTAL FORCE

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

HORIZONTAL FORCE ON SUPPORTING D

$$Hd = \Sigma H - 1/2 \times \mu \times Vc$$
$$= 32.16 - 0.5 \times 0.10 \times (33.50 + 98.04)$$
$$25.58 \text{ tf} > 1/2 \times 32.16 = 16.08 \text{ tf}$$

therefore

$$Hd = 25.58 \text{ tf}$$

VERTICAL FORCE ON SUPPORTING D

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

2) SPAN E - F

TOTAL HORIZONTAL FORCE

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

HORIZONTAL FORCE ON SUPPORTING E

$$He = \mu \times Ve$$
$$= 0.10 \times (33.50 + 124.15)$$
$$15.77 \text{ tf} < 1/2 \times 32.16 = 16.08 \text{ tf}$$

therefore

$$He = 15.77 \text{ tf}$$

VERTICAL FORCE ON SUPPORTING E

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

4). DEAD LOAD FOR SEISMIC LOAD

1) SPAN C - D

TOTAL HORIZONTAL FORCE

$$\Sigma H = 33.50 \times 2 \times 0.18 = 12.06 \text{ tf}$$

HORIZONTAL FORCE ON SUPPORTING D

$$Hd = \Sigma H - 1/2 \times \mu \times Vc$$
$$= 12.06 - 0.5 \times 0.10 \times 33.50$$
$$= 10.39 \text{ tf} > 1/2 \times 12.06 = 6.03 \text{ tf}$$

therefore

$$Hd = 10.39 \text{ tf}$$

VERTICAL FORCE ON SUPPORTING D

$$Vd = \frac{-12.06 \times 1.65}{31.20} = -0.64 \text{ tf}$$

2) SPAN E - F

TOTAL HORIZONTAL FORCE

$$\Sigma H = 33.50 \times 2 \times 0.18 = 12.06 \text{ tf}$$

HORIZONTAL FORCE ON SUPPORTING E

$$He = \mu \times Ve$$
$$= 0.10 \times 33.50$$
$$= 3.35 \text{ tf} < 1/2 \times 12.06 = 6.03 \text{ tf}$$

therefore

$$Hb\ e = 3.35 \text{ tf}$$

VERTICAL FORCE ON SUPPORTING E

$$Ve = \frac{12.06 \times 1.65}{31.20} = 0.64 \text{ tf}$$

5). DEAD LOAD + TRAIN LOAD FOR SEISMIC LOAD

1) SPAN C - D

TOTAL HORIZONTAL FORCE

$$\Sigma H = (33.50 + 81) \times 2 \times 0.18 = 41.22 \text{ tf}$$

HORIZONTAL FORCE ON SUPPORTING D

$$Hd = \Sigma H - 1/2 \times \mu \times Vc$$
$$= 41.22 - 0.5 \times 0.10 \times (33.50 + 81)$$
$$= 35.50 \text{ tf} > 1/2 \times 41.22 = 20.61 \text{ tf}$$

therefore

$$Hb\ d = 35.50 \text{ tf}$$

VERTICAL FORCE ON SUPPORTING D

$$Vd = \frac{-41.22 \times 1.65}{31.20} = -2.18 \text{ tf}$$

2) SPAN E - F

TOTAL HORIZONTAL FORCE

$$\Sigma H = (33.50 + 81.00) \times 2 \times 0.18 = 41.22 \text{ tf}$$

HORIZONTAL FORCE ON SUPPORTING E

$$He = \mu \times Ve$$
$$= 0.10 \times (33.50 + 81.00)$$
$$= 11.45 \text{ tf} < 1/2 \times 41.22 = 20.61 \text{ tf}$$

therefore

$$He = 11.45 \text{ tf}$$

VERTICAL FORCE ON SUPPORTING E

$$Ve = \frac{41.22 \times 1.65}{31.20} = 2.17 \text{ tf}$$

SUMMARY DUE TO LONGITUDINAL HORIZONTAL FORCE

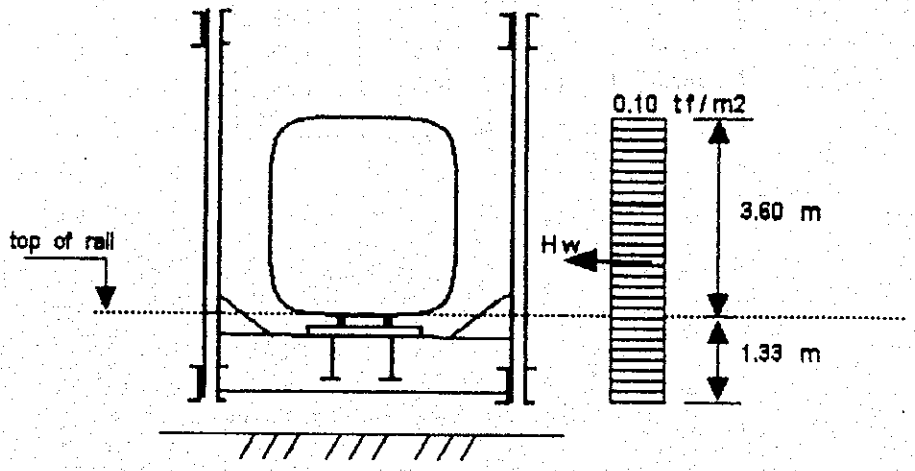
ITEMS	Support D		Support E	
	H [ton-f]	V [ton-f]	H [ton-f]	V [ton-f]
Long Rail [DL]	30.49	-1.70	3.35	1.70
Long [DL] + Brake [B]	59.68	-3.50	16.77	3.17
Long Rail [LL]	25.58	-1.70	15.77	1.70
Seismic [DL]	10.39	-0.64	3.35	0.64
Seismic [DL + LL]	35.50	-2.18	11.45	2.17

c) TRANSVERSAL HORIZONTAL FORCE

1). LATERAL LOAD

Hd	=	0.5 x	0.10 x	19 x	12.00 =	11.40	tf.
He	=	0.5 x	0.10 x	14 x	12.00 =	8.40	tf.

2). WIND LOAD



Hd	=	0.10 x	4.93 x (	31.20 +	0.60) x	0.50 =	7.84	tf
He	=	0.10 x	4.93 x (	31.20 +	0.60) x	0.50 =	7.84	tf

3). DEAD LOAD FOR SEISMIC LOAD

Hd	=	33.50 x	0.18 =	6.03 tf
He	=	33.50 x	0.18 =	6.03 tf

4). TRAIN LOAD FOR SEISMIC LOAD

Hd	=	81 x	0.18 =	14.58 tf
He	=	81 x	0.18 =	14.58 tf

5). FLOWING WATER PRESSURE (Wp)

- IN HWL CONDITION

Velocity of Water in HWL = 2.00 m/sec.

Flowing of Water Pressure.

K	=	0.04					
A	=	1.80 x	4.34 =	7.812	m		
Pw	=	KAV^2 =	0.04 x	7.812 x	4.00 =	1.25	tf.
Y	=	4.91 x	0.60 +	1.80	=	4.75	m

- IN LWL CONDITION

Velocity of Water in HWL = 1.00 m/sec.

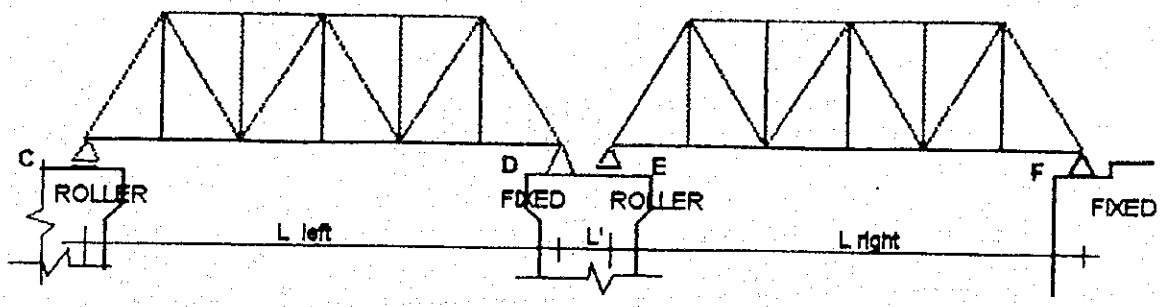
Flowing of Water Pressure.

K	=	0.04					
A	=	1.80 x	1.00 =	1.800	m		
Pw	=	KAV^2 =	0.04 x	1.8 x	1.00 =	0.07	tf.
Y	=	1 x	0.60 +	1.80	=	2.40	m

SUMMARY DUE TO TRANSVERSAL HORIZONTAL FORCE

ITEMS	Support D		Support E	
	H	y	H	y
	[ton-f]	[m]	[ton-f]	[m]
Lateral Load [Lf]	11.40	1.65	8.40	1.65
Wind Load [W]	7.84	2.79	7.84	2.79
Seismic [DL]	6.03	1.65	6.03	1.65
Seismic [LL]	14.58	1.65	14.58	1.65

4.3.2. TRAIN ON THE LEFT SIDE OF PIER



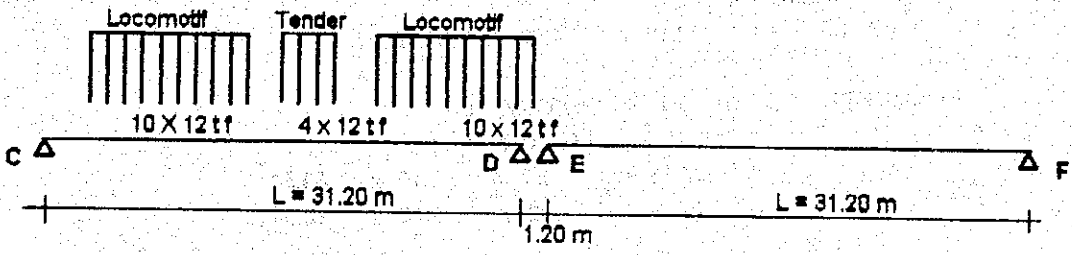
L 1 = 31.20 m
L 2 = 31.20 m
L' = 1.20 m

a) VERTICAL FORCE.

1). DEAD LOAD

Rc = 33.50 tf.
Rd = 33.60 tf.
Re = 33.50 tf.
Rf = 33.60 tf.

2). TRIAN LOAD



Rc = 135.85 tf.
Rd = 152.15 tf.
Re = 0.00 tf.
Rf = 0.00 tf.

3). IMPACT LOAD

Impac Coefficient

L = 31.20 m

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

Rc = 135.85 x 0.5079 = 69.00 tf.
Rd = 152.15 x 0.5079 = 77.27 tf.

4). TRAIN LOAD FOR SEISMIC

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

Ra = 5.00 (31.20 + 1.2) x 0.5 = 81 tf.
Rb = 5.00 (31.20 + 1.2) x 0.5 = 81 tf.

SUMMARY DUE TO VERTICAL FORCE.

ITEMS	Vc [ton-f]	Vd [ton-f]	Ve [ton-f]	Vf [ton-f]
Dead Load [DL]	33.50	33.50	33.50	33.50
Train Load [LL]	135.85	152.15	0.00	0.00
Impact [I]	69.00	77.27	0.00	0.00
Train Seismic [LL]	81.00	81.00	0.00	0.00

b). LONGITUDINAL HORIZONTAL FORCE

1). DEAD LOAD + LONG RAIL LOAD

*) SPAN C - D

TOTAL HORIZONTAL FORCE

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

HORIZONTAL FORCE ON SUPPORTING D

$Hd = \Sigma H - 1/2 \times \mu \times Rc$
$= 32.16 - 0.5 \times 0.10 \times 33.50$
$= 30.49$ tf > $1/2 \times 32.16 = 16.08$ tf

therefore

$Hd = 30.49$ tf

VERTICAL FORCE ON SUPPORTING D

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

*) SPAN E - F

TOTAL HORIZONTAL FORCE

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

HORIZONTAL FORCE ON SUPPORTING E

$He = \mu \times Re$
$= 0.10 \times 33.50 = 3.35$ tf < $1/2 \times 32.16 = 16.08$ tf

therefore

$He = 3.35$ tf

VERTICAL FORCE ON SUPPORTING E

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

2). LONG RAIL LOAD + BRAKE LOAD

*) SPAN C - D

TOTAL HORIZONTAL FORCE

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

HORIZONTAL FORCE ON SUPPORTING D

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

therefore

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

VERTICAL FORCE ON SUPPORTING D

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

*) SPAN E - F

TOTAL HORIZONTAL FORCE

$$\Sigma H = 0.00 \times 0.00 \times 0.1667 + 32.16 = 32.16 \text{ tf}$$

HORIZONTAL FORCE ON SUPPORTING E

$$He = \mu \times Re$$
$$= 0.10 \times (33.50 + 0.00)$$
$$3.35 \text{ tf} < 1/2 \times 32.16 = 16.08 \text{ tf}$$

therefore

$$He = 3.35 \text{ tf}$$

VERTICAL FORCE ON SUPPORTING E

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

3). TRAIN LOAD + LONG RAIL LOAD

*) SPAN C - D

TOTAL HORIZONTAL FORCE

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

HORIZONTAL FORCE ON SUPPORTING D

$$Hd = \Sigma H - 1/2 \times \mu \times Rc$$
$$= 32.16 - 0.5 \times 0.10 \times (33.50 + 135.85)$$
$$= 23.69 \text{ tf} > 1/2 \times 32.16 = 16.08 \text{ tf}$$

therefore

$$Hd = 23.69 \text{ tf}$$

VERTICAL FORCE ON SUPPORTING D

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

*) SPAN E - F

TOTAL HORIZONTAL FORCE

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

HORIZONTAL FORCE ON SUPPORTING E

$He = \mu \times Re$

$= 0.10 \times (33.60 + 0.00)$

$= 3.35$ tf $<$ $1/2 \times 32.16 = 16.08$ tf

therefore

$He = 3.35$ tf

VERTICAL FORCE ON SUPPORTING E

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

4). DEAD LOAD FOR SEISMIC LOAD

*) SPAN C - D

TOTAL HORIZONTAL FORCE

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

HORIZONTAL FORCE ON SUPPORTING D

$Hd = \Sigma H - 1/2 \times \mu \times Rc$

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

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

therefore

$Hd = 10.39$ tf

VERTICAL FORCE ON SUPPORTING D

$$Vd = \frac{-12.06 \times 1.65}{31.20} = -0.64 \text{ tf}$$

*) SPAN E - F

TOTAL HORIZONTAL FORCE

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

HORIZONTAL FORCE ON SUPPORTING E

$He = \mu \times Re$

$= 0.10 \times 33.50$

$= 3.35$ tf $<$ $1/2 \times 12.06 = 6.03$ tf

therefore

$He = 3.35$ tf

VERTICAL FORCE ON SUPPORTING E

$$Ve = \frac{12.06 \times 1.65}{31.20} = 0.64 \text{ tf}$$

5). DEAD LOAD + TRAIN LOAD FOR SEISMIC LOAD

*) SPAN C - D

TOTAL HORIZONTAL FORCE

$$\Sigma H = (33.50 + 81) \times 2 \times 0.18 = 41.22 \text{ tf}$$

HORIZONTAL FORCE ON SUPPORTING D

$$Hd = \Sigma H - 1/2 \times \mu \times Rc$$
$$= 41.22 - 0.5 \times 0.10 \times (33.50 + 81)$$
$$= 35.50 \text{ tf} > 1/2 \times 41.22 = 20.61 \text{ tf}$$

therefore

$$Hd = 35.50 \text{ tf}$$

VERTICAL FORCE ON SUPPORTING D

$$Vd = \frac{-41.22 \times 1.65}{31.20} = -2.18 \text{ tf}$$

*) SPAN E - F

TOTAL HORIZONTAL FORCE

$$\Sigma H = (33.50 + 0.00) \times 2 \times 0.18 = 12.06 \text{ tf}$$

HORIZONTAL FORCE ON SUPPORTING E

$$He = \mu \times Re$$
$$= 0.10 \times (33.50 + 0.00)$$
$$= 3.35 \text{ tf} < 1/2 \times 12.06 = 6.03 \text{ tf}$$

therefore

$$He = 3.35 \text{ tf}$$

VERTICAL FORCE ON SUPPORTING E

$$Ve = \frac{12.06 \times 1.65}{31.20} = 0.64 \text{ tf}$$

SUMMARY DUE TO LONGITUDINAL HORIZONTAL FORCE

ITEMS	Support D		Support E	
	H [ton-f]	V [ton-f]	H [ton-f]	V [ton-f]
Long Rail [DL]	30.49	-1.70	3.35	1.70
Long [DL] + Brake [B]	71.69	-4.24	3.35	1.70
Long Rail [LL]	23.69	-1.70	3.35	1.70
Seismic [DL]	10.39	-0.64	3.35	0.64
Seismic [DL + LL]	35.50	-2.18	3.35	0.64

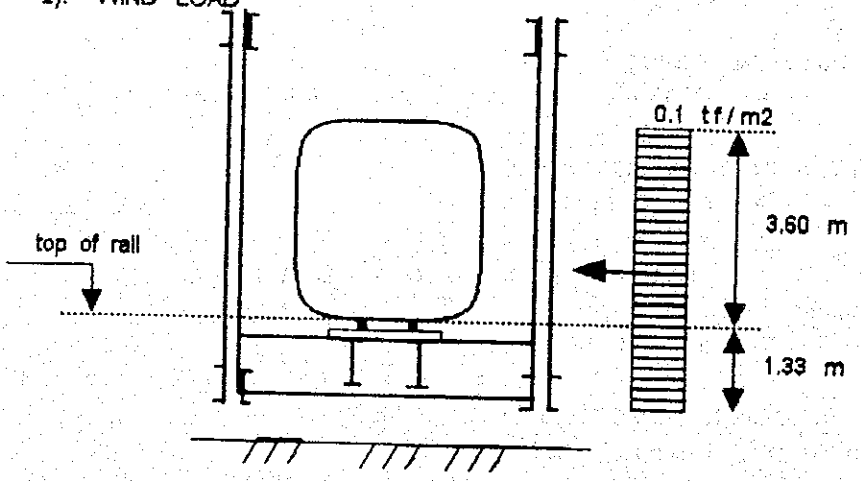
c) TRANSVERSAL HORIZONTAL FORCE

1). LATERAL LOAD

Hb = 0.6 x 0.10 x 24 x 12 = 14.40 tf.

Hc = 0.00 tf.

2). WIND LOAD



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

He = 0.00 tf

3). DEAD LOAD FOR SEISMIC LOAD

Hd = 33.50 x 0.18 = 6.03 tf

He = 33.50 x 0.18 = 6.03 tf

4). TRAIN LOAD FOR SEISMIC LOAD

Hd = 81 x 0.18 = 14.58 tf

He = 0.00 x 0.18 = 0.00 tf

5). FLOWING WATER PRESSURE (Wp)

- IN HWL CONDITION

Velocity of Water in HWL = 2.00 m / sec.

Flowing of Water Pressure.

K = 0.04

A = 1.80 x 4.34 = 7.812 m

Pw = KAV^2 = 0.04 x 7.812 x 4.00 = 1.25 tf.

Y = 4.91 x 0.60 + 1.80 = 4.75 m

- IN LWL CONDITION

Velocity of Water in HWL = 1.00 m / sec.

Flowing of Water Pressure.

K = 0.04

A = 1.80 x 1.00 = 1.800 m

Pw = KAV^2 = 0.04 x 1.8 x 1.00 = 0.07 tf.

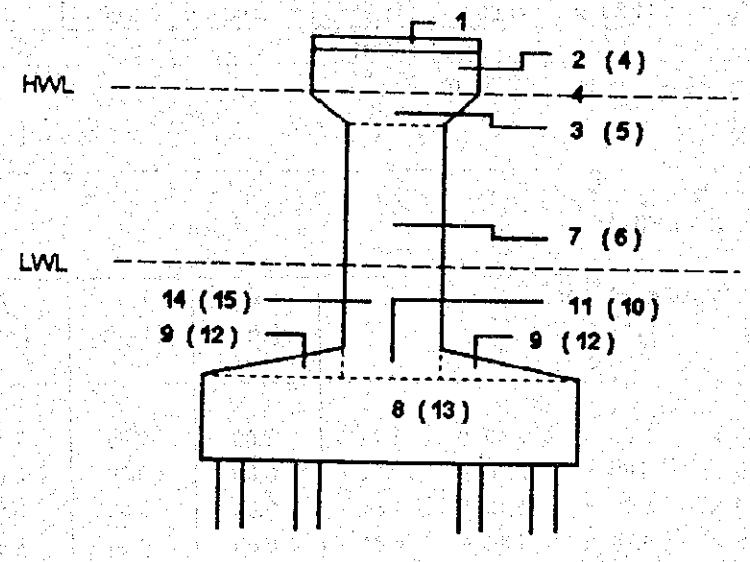
Y = 1 x 0.60 + 1.80 = 2.40 m

SUMMARY DUE TO TRANSVERSAL HORIZONTAL FORCE

ITEMS	Support D		Support E	
	H	y	H	y
	[ton-f]	[m]	[ton-f]	[m]
Lateral Load [Lf]	14.40	1.65	0.00	1.65
Wind Load [W]	7.69	2.79	0.00	2.79
Seismic [DL]	6.03	1.65	6.03	1.65
Seismic [LL]	14.58	1.65	0.00	1.65

4.4. STABILITY CALCULATION.

4.4.1. SKETCH



4.4.1. WEIGHT OF PIER IN LWL CONDITION

Item	Weight of Pier [tf]					x [m]	Mx [tf-m]	y [m]	My [tf-m]
	Concrete								
1	2.50 x	0.40 x	2.80 x	2.40 =	6.72	0.00	0.00	7.19	48.32
2	2.50 x	0.70 x	5.60 x	2.40 =	23.52	0.00	0.00	6.64	156.17
3	2.00 x	0.50 x	5.60 x	2.40 =	13.44	0.00	0.00	6.04	81.18
4	0.79 x	6.25 x	0.70 x	2.40 =	8.25	0.00	0.00	6.64	54.78
5	0.79 x	4.00 x	0.50 x	2.40 =	3.77	0.00	0.00	6.04	22.78
6	0.79 x	2.25 x	4.29 x	2.40 =	18.20	0.00	0.00	3.65	66.35
7	1.50 x	4.29 x	5.60 x	2.40 =	86.49	0.00	0.00	4.65	401.73
8	6.60 x	1.50 x	11.30 x	2.40 =	268.49	0.00	0.00	0.75	201.37
9	2.55 x	0.30 x	8.25 x	2.40 =	15.15	0.00	0.00	1.65	24.99
10	6.60 x	0.30 x	3.35 x	2.40 =	15.92	0.00	0.00	1.65	26.27
	Load caused by buoyancy								
11	6.60 x	0.30 x	3.35 x	-1.00	-6.63	0.00	0.00	1.65	-10.94
12	2.55 x	0.30 x	8.25 x	-1.00	-6.31	0.00	0.00	1.65	-10.41
13	1.50 x	1.30 x	5.60 x	-1.00	-10.92	0.00	0.00	2.15	-23.48
14	0.79 x	1.30 x	2.25 x	-1.00	-2.30	0.00	0.00	2.15	-4.94
15	6.60 x	1.60 x	11.30 x	-1.00	-111.87	0.00	0.00	0.75	-83.90
	Total				321.91		0.00		950.25
			x =	0.00 m					
			y =	2.95 m					

4.4.2. WEIGHT OF PIER IN HWL CONDITION

Item	Weight of Pier [tf]					x [m]	Mx [tf-m]	y [m]	My [tf-m]
1	2.50 x	0.40 x	2.80 x	2.40 =	6.72	0.00	0.00	7.19	48.32
2	2.50 x	0.70 x	5.60 x	2.40 =	23.52	0.00	0.00	6.64	156.17
3	2.00 x	0.50 x	5.60 x	1.40 =	7.84	0.00	0.00	6.04	47.35
4	0.79 x	6.25 x	0.70 x	1.40 =	4.81	0.00	0.00	6.64	31.96
5	0.79 x	4.00 x	0.50 x	1.40 =	2.20	0.00	0.00	6.04	13.29
6	0.79 x	2.25 x	4.29 x	1.40 =	10.62	0.00	0.00	3.65	38.70
7	1.50 x	4.29 x	5.60 x	1.40 =	50.45	0.00	0.00	4.65	234.34
8	6.60 x	1.50 x	11.30 x	1.40 =	156.62	0.00	0.00	0.75	117.46
9	2.55 x	0.30 x	8.25 x	1.40 =	8.84	0.00	0.00	1.65	14.58
10	6.60 x	0.30 x	3.35 x	1.40 =	9.29	0.00	0.00	1.65	15.32
	Total				280.90		0.00		717.49
			x =	0.00 m					
			y =	2.55 m					

4.4.3. LOAD COMBINATION

A. IN LWL CONDITION

A.1. TRAIN ON BOTH SIDE OF PIER

a). IN LONGITUDINAL DIRECTION

1) Dead Load + Train Load + Earth Pressure

ITEMS	V [tf]	x [m]	M [tf-m]	H [t]	y [m]	M [tf-m]
Vd [DL]	33.50	0.60	20.10			
Vd [LL]	129.96	0.60	77.98			
Ve [DL]	33.50	-0.60	-20.10			
Ve [LL]	124.15	-0.60	-74.49			
Hd				0.00	7.39	0.00
He				0.00	7.39	0.00
Sub- total	321.11		3.49	0.00		0.00
W [pier]	321.91	0.00	0.00			
TOTAL	643.02		3.49			

$\Sigma M = 3.49$ tf-m
$\Sigma V = 643.02$ tf
$\Sigma H = 0.00$ tf
$e = M / N = 0.01$ m

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

ITEMS	V [tf]	x [m]	M [tf-m]	H [t]	y [m]	M [tf-m]
Vd [DL]	33.50	0.60	20.10			
Vd [LL]	129.96	0.60	77.98			
Vd [I]	66.00	0.60	39.60			
Ve [DL]	33.50	-0.60	-20.10			
Ve [LL]	124.15	-0.60	-74.49			
Ve [I]	63.05	-0.60	-37.83			
Hd				0.00	7.39	0.00
He				0.00	7.39	0.00
Sub-total	450.17		5.26	0.00		0.00
W [pier]	321.91	0.00	0.00			
Total	772.08		5.26			

$\Sigma M = 5.26$ tf-m
$\Sigma V = 772.08$ tf
$\Sigma H = 0.00$ tf
$e = M / N = 0.01$ m

3) Dead Load + Earth Pressure + Long Rail Load [DL]

ITEMS	V [tf]	x [m]	M [tf-m]	H [t]	y [m]	M [tf-m]
Vd [DL]	33.50	0.60	20.10			
Vd [LL]	0.00	0.60	0.00			
Ve [DL]	33.50	-0.60	-20.10			
Ve [LL]	0.00	-0.60	0.00			
Vd [Lr]	-1.70	0.60	-1.02			
Ve [Lr]	1.70	-0.60	-1.02			
Hd [Lr]				30.49	7.39	225.28
He [Lr]				3.35	7.39	24.76
Sub- total	66.99		-2.04	33.84		250.04
W [pier]	321.91	0.00	0.00			
TOTAL	388.91		-2.04			

$\Sigma M = 248.00$ tf-m
$\Sigma V = 388.91$ tf
$\Sigma H = 33.84$ tf

$e = M / N = 0.64$ m

4) Dead Load + Train Load + Earth Pressure + Long Rail Load [LL]

ITEMS	V [tf]	x [m]	M [tf-m]	H [t]	y [m]	M [tf-m]
Vd [DL]	33.50	0.60	20.10			
Vd [LL]	129.96	0.60	77.98			
Ve [DL]	33.50	-0.60	-20.10			
Ve [LL]	124.15	-0.60	-74.49			
Vd [Lr]	-1.70	0.60	-1.02			
Ve [Lr]	1.70	-0.60	-1.02			
Hd [Lr]				26.58	7.39	189.06
He [Lr]				15.77	7.39	116.50
Sub- total	321.10		1.45	41.35		305.56
W [pier]	321.91	0.00	0.00			
TOTAL	643.02		1.45			

$\Sigma M = 307.01$ tf-m
$\Sigma V = 643.02$ tf
$\Sigma H = 41.35$ tf

$e = M / N = 0.48$ m

5) Dead Load + Train Load + Impact + Earth Pressure + Long Rail Load [LL]

ITEMS	V [tf]	x [m]	M [tf-m]	H [t]	y [m]	M [tf-m]
Vd [DL]	33.50	0.60	20.10			
Vd [LL]	129.96	0.60	77.98			
Vd [I]	66.00	0.60	39.60			
Ve [DL]	33.50	-0.60	-20.10			
Ve [LL]	124.15	-0.60	-74.49			
Ve [I]	63.05	-0.60	-37.83			
Vd [Lr]	-1.70	0.60	-1.02			
Ve [Lr]	1.70	-0.60	-1.02			
Hd [Lr]				25.58	7.39	189.06
He [Lr]				15.77	7.39	116.50
Sub- total	450.16		3.22	41.35		305.56
W [pier]	321.91	0.00	0.00			
TOTAL	772.07		3.22			

$\Sigma M = 308.78$ tf-m
$\Sigma V = 772.07$ tf
$\Sigma H = 41.35$ tf

$e = M / N = 0.40$ m

6) 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]
Vd [DL]	33.50	0.60	20.10			
Vd [LL]	129.96	0.60	77.98			
Ve [DL]	33.50	-0.60	-20.10			
Ve [LL]	124.15	-0.60	-74.49			
Vd [Lr + B]	-3.50	0.60	-2.10			
Ve [Lr + B]	3.17	-0.60	-1.90			
Hd [Lr + B]				59.58	7.39	440.32
He [Lr + B]				15.77	7.39	116.50
Sub- total	320.78		-0.52	75.35		556.82
W [pier]	321.91	0.00	0.00			
TOTAL	642.69		-0.52			

$\Sigma M = 556.31$ tf-m
$\Sigma V = 642.69$ tf
$\Sigma H = 75.35$ tf

$e = M / N = 0.87$ m

7) 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]
Vd [DL]	33.50	0.60	20.10			
Vd [LL]	129.96	0.60	77.98			
Vd [I]	66.00	0.60	39.60			
Ve [DL]	33.50	-0.60	-20.10			
Ve [LL]	124.15	-0.60	-74.49			
Ve [I]	63.05	-0.60	-37.83			
Vd [Lr + B]	-3.50	0.60	-2.10			
Ve [Lr + B]	3.17	-0.60	-1.90			
Hd [Lr + B]				59.58	7.39	440.32
He [Lr + B]				15.77	7.39	116.50
Sub- total	448.84		1.25	75.35		556.82
W [pier]	321.91	0.00	0.00			
TOTAL	771.75		1.25			

$\Sigma M = 558.08$ tf-m
$\Sigma V = 771.75$ tf
$\Sigma H = 75.35$ tf

$e = M / N = 0.72$ m

8) Dead Load + Earth Pressure + Seismic [DL]

ITEMS	V [tf]	x [m]	M [tf-m]	H [t]	y [m]	M [tf-m]
Vd [DL]	33.50	0.60	20.10			
Vd [LL]	0.00	0.60	0.00			
Ve [DL]	33.50	-0.60	-20.10			
Ve [LL]	0.00	-0.60	0.00			
Vd [Eq]	-0.64	0.60	-0.38			
Ve [Eq]	0.64	-0.60	-0.38			
Hd [Eq]				10.39	7.39	76.75
He [Eq]				3.35	7.39	24.76
Sub- total	67.00		-0.76	13.74		101.50
W [pier]	321.91	0.00	0.00	57.94	2.95	171.04
TOTAL	388.91		-0.76	71.68		272.55

$\Sigma M = 271.78$ tf-m
$\Sigma V = 388.91$ tf
$\Sigma H = 71.68$ tf

$e = M / N = 0.70$ m

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

ITEMS	V [tf]	x [m]	M [tf-m]	H [t]	y [m]	M [tf-m]
Vd [DL]	33.50	0.60	20.10			
Vd [LL]	81.00	0.60	48.60			
Ve [DL]	33.50	-0.60	-20.10			
Ve [LL]	81.00	-0.60	-48.60			
Vd [Eq]	-2.18	0.60	-1.31			
Ve [Eq]	2.17	-0.60	-1.30			
Hd [Eq]				35.50	7.39	262.31
He [Eq]				11.45	7.39	84.62
Sub- total	228.99		-2.61	46.95		346.92
W [pier]	321.91	0.00	0.00	57.94	2.95	171.04
TOTAL	550.90		-2.61	104.89		517.97

$\Sigma M = 515.36$ tf-m
$\Sigma V = 550.90$ tf
$\Sigma H = 104.89$ tf

$e = M / N = 0.94$ m

b). IN TRANVERSAL 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]
Vd [DL]	33.50	2.30	77.05			
Vd [LL]	129.96	2.30	298.91			
Vd [I]	66.00	2.30	151.81			
Ve [DL]	33.50	-2.30	-77.05			
Ve [LL]	124.15	-2.30	-285.55			
Ve [I]	63.05	-2.30	-145.02			
H [Lr]				11.40	9.04	103.06
				8.40	9.04	75.94
H [W]				7.84	10.18	79.80
				7.84	10.18	79.80
Sub- total	450.17		20.15	35.48		338.59
W [pier]	321.91	0.00	0.00			
TOTAL	772.08		20.15	35.48		338.59

$\Sigma M = 368.74$ tf-m
$\Sigma V = 772.08$ tf
$\Sigma H = 35.48$ tf
$e = M / N = 0.46$ m

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

ITEMS	V [tf]	x [m]	M [tf-m]	H [t]	y [m]	M [tf-m]
Vd [DL]	33.50	2.30	77.05			
Vd [LL]	81.00	2.30	186.30			
Ve [DL]	33.50	-2.30	-77.05			
Ve [LL]	81.00	-2.30	-186.30			
H [Eq]				14.58	9.04	131.80
H [Eq]				14.58	9.04	
Sub- total	229.00		0.00	29.16		131.80
W [pier]	321.91	0.00	0.00	57.94	2.95	171.04
TOTAL	550.91		0.00	87.10		302.85

$\Sigma M = 302.85$ tf-m
$\Sigma V = 550.91$ tf
$\Sigma H = 87.10$ tf

$e = M / N = 0.55$ m

3) Dead Load + Earth Pressure + Seismic + Flowing Water

ITEMS	V [tf]	x [m]	M [tf-m]	H [t]	y [m]	M [tf-m]
Vd [DL]	33.50	2.30	77.05			
Vd [LL]	81.00	2.30	186.30			
Ve [DL]	33.50	-2.30	-77.05			
Ve [LL]	81.00	-2.30	-186.30			
H [Eq]				14.58	9.04	131.80
H [Eq]				14.58	9.04	131.80
H [Wp]				0.07	2.40	0.17
Sub- total	229.00		0.00	29.23		263.78
W [pier]	321.91	0.00	0.00	57.94	2.95	171.04
TOTAL	550.91		0.00	87.18		434.82

$\Sigma M = 434.82$ tf-m
$\Sigma V = 550.91$ tf
$\Sigma H = 87.18$ tf

$e = M / N = 0.79$ m

A.2. TRAIN ON THE LEFT SIDE OF PIER

a). IN LONGITUDINAL DIRECTION

1) Dead Load + Train Load + Earth Pressure

ITEMS	V [tf]	x [m]	M [tf-m]	H [t]	y [m]	M [tf-m]
Vd [DL]	33.50	0.60	20.10			
Vd [LL]	152.15	0.60	91.29			
Ve [DL]	33.50	-0.60	-20.10			
Ve [LL]	0.00	-0.60	0.00			
Hd				0.00	7.39	0.00
He				0.00	7.39	0.00
Sub- total	219.15		91.29	0.00		0.00
W [pier]	321.91	0.00	0.00			
TOTAL	541.06		91.29			

$\Sigma M = 91.29$ tf-m

$\Sigma V = 541.06$ tf

$\Sigma H = 0.00$ tf

$e = M / N = 0.17$ m

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

ITEMS	V [tf]	x [m]	M [tf-m]	H [t]	y [m]	M [tf-m]
Vd [DL]	33.50	0.60	20.10			
Vd [LL]	152.15	0.60	91.29			
Vd [I]	77.27	0.60	46.36			
Ve [DL]	33.50	-0.60	-20.10			
Ve [LL]	0.00	-0.60	0.00			
Ve [I]	0.00	-0.60	0.00			
Hd				0.00	7.39	0.00
He				0.00	7.39	0.00
Sub-total	296.42		137.65	0.00		0.00
W [pier]	321.91	0.00	0.00			
Total	618.34		137.65			

$\Sigma M = 137.65$ tf-m

$\Sigma V = 618.34$ tf

$\Sigma H = 0.00$ tf

$e = M / N = 0.22$ m

3) Dead Load + Earth Pressure + Long Rail Load [DL]

ITEMS	V [tf]	x [m]	M [tf-m]	H [t]	y [m]	M [tf-m]
Vd [DL]	33.50	0.60	20.10			
Vd [LL]	0.00	0.60	0.00			
Ve [DL]	33.50	-0.60	-20.10			
Ve [LL]	0.00	-0.60	0.00			
Vd [Lr]	-1.70	0.60	-1.02			
Ve [Lr]	1.70	-0.60	-1.02			
Hd [Lr]				30.49	7.39	225.28
He [Lr]				3.35	7.39	24.76
Sub- total	66.99		-2.04	33.84		250.04
W [pier]	321.91	0.00	0.00			
TOTAL	388.91		-2.04			

$\Sigma M = 248.00$ tf-m
$\Sigma V = 388.91$ tf
$\Sigma H = 33.84$ tf

$e = M / N = 0.64$ m

4) Dead Load + Train Load + Earth Pressure + Long Rail Load [LL]

ITEMS	V [tf]	x [m]	M [tf-m]	H [t]	y [m]	M [tf-m]
Vd [DL]	33.50	0.60	20.10			
Vd [LL]	152.15	0.60	91.29			
Ve [DL]	33.50	-0.60	-20.10			
Ve [LL]	0.00	-0.60	0.00			
Vd [Lr]	-4.24	0.60	-2.54			
Ve [Lr]	1.70	-0.60	-1.02			
Hd [Lr]				71.69	7.39	529.81
He [Lr]				3.35	7.39	24.76
Sub- total	216.61		87.73	75.04		554.56
W [pier]	321.91	0.00	0.00			
TOTAL	538.52		87.73			

$\Sigma M = 642.29$ tf-m
$\Sigma V = 538.52$ tf
$\Sigma H = 75.04$ tf

$e = M / N = 1.19$ m

6) Dead Load + Train Load + Impact + Earth Pressure + Long Rail Load [LL]

ITEMS	V [tf]	x [m]	M [tf-m]	H [t]	y [m]	M [tf-m]
Vd [DL]	33.60	0.60	20.10			
Vd [LL]	152.15	0.60	91.29			
Vd [I]	77.27	0.60	46.36			
Ve [DL]	33.60	-0.60	-20.10			
Ve [LL]	0.00	-0.60	0.00			
Ve [I]	0.00	-0.60	0.00			
Vd [Lr]	-1.70	0.60	-1.02			
Ve [Lr]	1.70	-0.60	-1.02			
Hd [Lr]				23.69	7.39	175.09
He [Lr]				3.35	7.39	24.76
Sub- total	296.42		135.62	27.04		199.84
W [pier]	321.91	0.00	0.00			
TOTAL	618.33		135.62			

$\Sigma M = 335.46$ tf-m
$\Sigma V = 618.33$ tf
$\Sigma H = 27.04$ tf

$e = M / N = 0.54$ m

6) 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]
Vd [DL]	33.50	0.60	20.10			
Vd [LL]	152.15	0.60	91.29			
Ve [DL]	33.50	-0.60	-20.10			
Ve [LL]	0.00	-0.60	0.00			
Vd [Lr + B]	-4.24	0.60	-2.54			
Ve [Lr + B]	1.70	-0.60	-1.02			
Hd [Lr + B]				71.69	7.39	529.81
He [Lr + B]				3.35	7.39	24.76
Sub- total	216.61		87.73	75.04		554.56
W [pier]	321.91	0.00	0.00			
TOTAL	538.52		87.73			

$\Sigma M = 642.29$ tf-m
$\Sigma V = 538.52$ tf
$\Sigma H = 75.04$ tf

$e = M / N = 1.19$ m

7) 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]
Vd [DL]	33.50	0.60	20.10			
Vd [LL]	152.15	0.60	91.29			
Vd [I]	77.27	0.60	46.36			
Ve [DL]	33.50	-0.60	-20.10			
Ve [LL]	0.00	-0.60	0.00			
Ve [I]	0.00	-0.60	0.00			
Vd [Lr + B]	-4.24	0.60	-2.54			
Ve [Lr + B]	1.70	-0.60	-1.02			
Hd [Lr + B]				71.69	7.39	529.81
He [Lr + B]				3.35	7.39	24.76
Sub- total	293.88		134.09	75.04		554.56
W [pier]	321.91	0.00	0.00			
TOTAL	615.79		134.09			

$\Sigma M = 688.66$ tf-m
$\Sigma V = 615.79$ tf
$\Sigma H = 75.04$ tf

$e = M / N = 1.12$ m

8) Dead Load + Earth Pressure + Seismic [DL]

ITEMS	V [tf]	x [m]	M [tf-m]	H [t]	y [m]	M [tf-m]
Vd [DL]	33.50	0.60	20.10			
Vd [LL]	152.15	0.60	91.29			
Ve [DL]	33.50	-0.60	-20.10			
Ve [LL]	0.00	-0.60	0.00			
Vd [Eq]	-0.64	0.60	-0.38			
Ve [Eq]	0.64	-0.60	-0.38			
Hd [Eq]				10.39	7.39	76.75
He [Eq]				3.35	7.39	24.76
Sub- total	219.15		90.53	13.74		101.50
W [pier]	321.91	0.00	0.00	57.94	2.95	171.04
TOTAL	541.06		90.53	71.68		272.55

$\Sigma M = 363.07$ tf-m
$\Sigma V = 541.06$ tf
$\Sigma H = 71.68$ tf

$e = M / N = 0.67$ m

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

ITEMS	V [tf]	x [m]	M [tf-m]	H [t]	y [m]	M [tf-m]
Vd [DL]	33.50	0.60	20.10			
Vd [LL]	152.15	0.60	91.29			
Ve [DL]	33.50	-0.60	-20.10			
Ve [LL]	0.00	-0.60	0.00			
Vd [Eq]	-2.18	0.60	-1.31			
Ve [Eq]	0.64	-0.60	-0.38			
Hd [Eq]				35.50	7.39	262.31
He [Eq]				3.35	7.39	24.76
Sub- total	217.61		89.60	38.85		287.06
W [pier]	321.91	0.00	0.00	57.94	2.95	171.04
TOTAL	539.52		89.60	96.79		458.11

$\Sigma M = 547.71$ tf-m
$\Sigma V = 539.52$ tf
$\Sigma H = 96.79$ tf

$e = M / N = 1.02$ m

b). IN TRANVERSAL 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]
Vd [DL]	33.50	2.30	77.05			
Vd [LL]	152.15	2.30	349.95			
Vd [I]	77.27	2.30	177.73			
Ve [DL]	33.50	-2.30	-77.05			
Ve [LL]	0.00	-2.30	0.00			
Ve [I]	0.00	-2.30	0.00			
H [Lr]				14.40	9.04	130.16
				0.00	9.04	0.00
H [W]				7.69	10.18	78.29
				0.00	10.18	0.00
Sub- total	296.42		527.68	22.09		208.47
W [pier]	321.91	0.00	0.00			
TOTAL	618.34		527.68	22.09		208.47

$\Sigma M = 736.14$ tf-m
$\Sigma V = 618.34$ tf
$\Sigma H = 22.09$ tf
$e = M / N = 1.19$ m

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

ITEMS	V [tf]	x [m]	M [tf-m]	H [t]	y [m]	M [tf-m]
Vd [DL]	33.50	2.30	77.05			
Vd [LL]	152.15	2.30	349.95			
Ve [DL]	33.50	-2.30	-77.05			
Ve [LL]	0.00	-2.30	0.00			
H [Eq]				14.58	9.04	131.80
H [Eq]				0.00	9.04	
Sub- total	219.15		349.95	14.58		131.80
W [pier]	321.91	0.00	0.00	57.94	2.95	171.04
TOTAL	541.06		349.95	72.52		302.85

$\Sigma M = 652.79$ tf-m
$\Sigma V = 541.06$ tf
$\Sigma H = 72.52$ tf

$e = M / N = 1.21$ m

3) Dead Load + Earth Pressure + Seismic + Flowing Water

ITEMS	V [tf]	x [m]	M [tf-m]	H [t]	y [m]	M [tf-m]
Vd [DL]	33.50	2.30	77.05			
Vd [LL]	152.15	2.30	349.95			
Ve [DL]	33.50	-2.30	-77.05			
Ve [LL]	0.00	-2.30	0.00			
H [Eq]				14.58	9.04	131.80
H [Eq]				0.00	9.04	0.00
H [Wp]				0.07	2.40	0.17
Sub- total	219.15		349.95	14.65		131.98
W [pier]	321.91	0.00	0.00	0.00	2.95	0.00
TOTAL	541.06		349.95	14.65		131.98

$\Sigma M = 481.92$ tf-m
$\Sigma V = 541.06$ tf
$\Sigma H = 14.65$ tf

$e = M / N = 0.89$ m

B. IN HWL CONDITION

B.1. TRAIN ON BOTH SIDE OF PIER ,

a). IN LONGITUDINAL DIRECTION

1) Dead Load + Train Load + Earth Pressure

ITEMS	V [tf]	x [m]	M [tf-m]	H [t]	y [m]	M [tf-m]
Vd [DL]	33.50	0.60	20.10			
Vd [LL]	129.96	0.60	77.98			
Ve [DL]	33.50	-0.60	-20.10			
Ve [LL]	124.15	-0.60	-74.49			
Hd				0.00	7.39	0.00
He				0.00	7.39	0.00
Sub- total	321.11		3.49	0.00		0.00
W [pier]	280.90	0.00	0.00			
TOTAL	602.01		3.49			

$\Sigma M = 3.49$ tf-m
$\Sigma V = 602.01$ tf
$\Sigma H = 0.00$ tf

$e = M / N = 0.01$ m

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

ITEMS	V [tf]	x [m]	M [tf-m]	H [t]	y [m]	M [tf-m]
Vd [DL]	33.50	0.60	20.10			
Vd [LL]	129.96	0.60	77.98			
Vd [I]	66.00	0.60	39.60			
Ve [DL]	33.50	-0.60	-20.10			
Ve [LL]	124.15	-0.60	-74.49			
Ve [I]	63.05	-0.60	-37.83			
Hd				0.00	7.39	0.00
He				0.00	7.39	0.00
Sub-total	450.17		5.26	0.00		0.00
W [pier]	280.90	0.00	0.00			
Total	731.07		5.26			

$\Sigma M = 5.26$ tf-m
$\Sigma V = 731.07$ tf
$\Sigma H = 0.00$ tf

$e = M / N = 0.01$ m

3) Dead Load + Earth Pressure + Long Rail Load [DL]

ITEMS	V [tf]	x [m]	M [tf-m]	H [t]	y [m]	M [tf-m]
Vd [DL]	33.50	0.60	20.10			
Vd [LL]	0.00	0.60	0.00			
Ve [DL]	33.50	-0.60	-20.10			
Ve [LL]	0.00	-0.60	0.00			
Vd [Lr]	-1.70	0.60	-1.02			
Ve [Lr]	1.70	-0.60	-1.02			
Hd [Lr]				30.49	7.39	225.28
He [Lr]				59.58	7.39	440.32
Sub- total	66.99		-2.04	90.07		665.60
W [pier]	280.90	0.00	0.00			
TOTAL	347.90		-2.04			

$\Sigma M = 663.56$ tf-m
$\Sigma V = 347.90$ tf
$\Sigma H = 90.07$ tf

$e = M / N = 1.91$ m

4) Dead Load + Train Load + Earth Pressure + Long Rail Load [LL]

ITEMS	V [tf]	x [m]	M [tf-m]	H [t]	y [m]	M [tf-m]
Vd [DL]	33.50	0.60	20.10			
Vd [LL]	129.96	0.60	77.98			
Ve [DL]	33.50	-0.60	-20.10			
Ve [LL]	124.15	-0.60	-74.49			
Vd [Lr]	-1.70	0.60	-1.02			
Ve [Lr]	1.70	-0.60	-1.02			
Hd [Lr]				25.58	7.39	189.06
He [Lr]				15.77	7.39	116.50
Sub- total	321.10		1.45	41.35		305.56
W [pier]	280.90	0.00	0.00			
TOTAL	602.01		1.45			

$\Sigma M = 307.01$ tf-m
$\Sigma V = 602.01$ tf
$\Sigma H = 41.35$ tf

$e = M / N = 0.51$ m

5) Dead Load + Train Load + Impact + Earth Pressure + Long Rail Load [LL]

ITEMS	V [tf]	x [m]	M [tf-m]	H [t]	y [m]	M [tf-m]
Vd [DL]	33.50	0.60	20.10			
Vd [LL]	129.96	0.60	77.98			
Vd [I]	66.00	0.60	39.60			
Ve [DL]	33.50	-0.60	-20.10			
Ve [LL]	124.15	-0.60	-74.49			
Ve [I]	63.06	-0.60	-37.83			
Vd [Lr]	-1.70	0.60	-1.02			
Ve [Lr]	1.70	-0.60	-1.02			
Hd [Lr]				25.58	7.39	189.06
He [Lr]				15.77	7.39	116.50
Sub- total	450.16		3.22	41.35		305.56
W [pier]	280.90	0.00	0.00			
TOTAL	731.06		3.22			

$\Sigma M = 308.78$ tf-m
$\Sigma V = 731.06$ tf
$\Sigma H = 41.35$ tf

$e = M / N = 0.42$ m

6) 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]
Vd [DL]	33.50	0.60	20.10			
Vd [LL]	129.96	0.60	77.98			
Ve [DL]	33.50	-0.60	-20.10			
Ve [LL]	124.15	-0.60	-74.49			
Vd [Lr + B]	-3.50	0.60	-2.10			
Ve [Lr + B]	3.17	-0.60	-1.90			
Hd [Lr + B]				59.58	7.39	440.32
He [Lr + B]				15.77	7.39	116.50
Sub- total	320.78		-0.52	75.35		556.82
W [pier]	280.90	0.00	0.00			
TOTAL	601.68		-0.52			

$\Sigma M = 556.31$ tf-m
$\Sigma V = 601.68$ tf
$\Sigma H = 75.35$ tf

$e = M / N = 0.92$ m

7) 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]
Vd [DL]	33.60	0.60	20.10			
Vd [LL]	129.96	0.60	77.98			
Vd [I]	66.00	0.60	39.60			
Ve [DL]	33.50	-0.60	-20.10			
Ve [LL]	124.15	-0.60	-74.49			
Ve [I]	63.05	-0.60	-37.83			
Vd [Lr + B]	-3.50	0.60	-2.10			
Ve [Lr + B]	3.17	-0.60	-1.90			
Hd [Lr + B]				59.58	7.39	440.32
He [Lr + B]				15.77	7.39	116.50
Sub- total	449.84		1.25	75.35		556.82
W [pier]	280.90	0.00	0.00			
TOTAL	730.74		1.25			

$\Sigma M = 558.08$ tf-m
$\Sigma V = 730.74$ tf
$\Sigma H = 75.35$ tf

$e = M / N = 0.76$ m

8) Dead Load + Earth Pressure + Seismic (DL)

ITEMS	V [tf]	x [m]	M [tf-m]	H [t]	y [m]	M [tf-m]
Vd [DL]	33.50	0.60	20.10			
Vd [LL]	0.00	0.60	0.00			
Ve [DL]	33.50	-0.60	-20.10			
Ve [LL]	0.00	-0.60	0.00			
Vd [Eq]	-0.64	0.60	-0.38			
Ve [Eq]	0.64	-0.60	-0.38			
Hd [Eq]				10.39	7.39	76.75
He [Eq]				3.35	7.39	24.76
Sub- total	67.00		-0.76	13.74		101.50
W [pier]	280.90	0.00	0.00	50.56	2.55	129.15
TOTAL	347.90		-0.76	64.30		230.65

$\Sigma M = 229.89$ tf-m
$\Sigma V = 347.90$ tf
$\Sigma H = 64.30$ tf

$e = M / N = 0.66$ m

9) Dead Load + Earth Pressure + Seismic (LL)

ITEMS	V [tf]	x [m]	M [tf-m]	H [t]	y [m]	M [tf-m]
Vd [DL]	33.60	0.60	20.10			
Vd [LL]	81.00	0.60	48.60			
Ve [DL]	33.50	-0.60	-20.10			
Ve [LL]	81.00	-0.60	-48.60			
Vd [Eq]	-2.18	0.60	-1.31			
Ve [Eq]	2.17	-0.60	-1.30			
Hd [Eq]				35.50	7.39	262.31
He [Eq]				11.45	7.39	84.62
Sub- total	228.99		-2.61	46.95		346.92
W [pier]	280.90	0.00	0.00	50.56	2.55	129.15
TOTAL	509.89		-2.61	97.51		476.07

$\Sigma M = 473.46$ tf-m
$\Sigma V = 509.89$ tf
$\Sigma H = 97.51$ tf

$e = M / N = 0.93$ m

b). IN TRANVERSAL 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]
Vd [DL]	33.60	2.30	77.05			
Vd [LL]	129.96	2.30	298.91			
Vd [I]	66.00	2.30	151.81			
Ve [DL]	33.50	-2.30	-77.05			
Ve [LL]	124.15	-2.30	-285.55			
Ve [I]	63.05	-2.30	-145.02			
H [Lr]				11.40	9.04	103.06
				8.40	9.04	75.94
H [W]				7.84	10.18	79.80
				7.84	10.18	79.80
Sub- total	450.17		20.15	35.48		338.59
W [pier]	280.90	0.00	0.00			
TOTAL	731.07		20.15	35.48		338.59

$\Sigma M = 358.74$ tf-m
$\Sigma V = 731.07$ tf
$\Sigma H = 35.48$ tf
$e = M / N = 0.49$ m

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

ITEMS	V [tf]	X [m]	M [tf-m]	H [t]	y [m]	M [tf-m]
Vd [DL]	33.50	2.30	77.05			
Vd [LL]	81.00	2.30	186.30			
Ve [DL]	33.50	-2.30	-77.05			
Ve [LL]	81.00	-2.30	-186.30			
H [Eq]				14.58	9.04	131.80
H [Eq]				14.58	9.04	
Sub- total	229.00		0.00	29.16		131.80
W [pier]	280.90	0.00	0.00	50.56	2.55	129.15
TOTAL	509.90		0.00	79.72		260.95

$\Sigma M = 260.95$ tf-m
$\Sigma V = 509.90$ tf
$\Sigma H = 79.72$ tf

$e = M / N = 0.51$ m

3) Dead Load + Earth Pressure + Seismic + Flowing Water

ITEMS	V [tf]	X [m]	M [tf-m]	H [t]	y [m]	M [tf-m]
Vd [DL]	33.50	2.30	77.05			
Vd [LL]	81.00	2.30	186.30			
Ve [DL]	33.50	-2.30	-77.05			
Ve [LL]	81.00	-2.30	-186.30			
H [Eq]				14.58	9.04	131.80
H [Eq]				14.58	9.04	131.80
H [Wp]				1.25	4.75	5.93
Sub- total	229.00		0.00	30.41		269.54
W [pier]	280.90	0.00	0.00	50.56	2.55	129.15
TOTAL	509.90		0.00	80.97		398.69

$\Sigma M = 398.69$ tf-m
$\Sigma V = 509.90$ tf
$\Sigma H = 80.97$ tf

$e = M / N = 0.78$ m

B.2. TRAIN ON THE LEFT SIDE OF PIER

a) IN LONGITUDINAL DIRECTION

1) Dead Load + Train Load + Earth Pressure

ITEMS	V [tf]	x [m]	M [tf-m]	H [t]	y [m]	M [tf-m]
Vd [DL]	33.50	0.60	20.10			
Vd [LL]	152.15	0.60	91.29			
Ve [DL]	33.50	-0.60	-20.10			
Ve [LL]	0.00	-0.60	0.00			
Hd				0.00	7.39	0.00
He				0.00	7.39	0.00
Sub- total	219.15		91.29	0.00		0.00
W [pier]	280.90	0.00	0.00			
TOTAL	500.05		91.29			

$\Sigma M = 91.29$ tf-m

$\Sigma V = 500.05$ tf

$\Sigma H = 0.00$ tf

$e = M / N = 0.18$ m

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

ITEMS	V [tf]	x [m]	M [tf-m]	H [t]	y [m]	M [tf-m]
Vd [DL]	33.50	0.60	20.10			
Vd [LL]	152.15	0.60	91.29			
Vd [I]	77.27	0.60	46.36			
Ve [DL]	33.50	-0.60	-20.10			
Ve [LL]	0.00	-0.60	0.00			
Ve [I]	0.00	-0.60	0.00			
Hd				0.00	7.39	0.00
He				0.00	7.39	0.00
Sub-total	296.42		137.65	0.00		0.00
W [pier]	280.90	0.00	0.00			
Total	577.32		137.65			

$\Sigma M = 137.65$ tf-m

$\Sigma V = 577.32$ tf

$\Sigma H = 0.00$ tf

$e = M / N = 0.24$ m

3) Dead Load + Earth Pressure + Long Rail Load [DL]

ITEMS	V [tf]	x [m]	M [tf-m]	H [t]	y [m]	M [tf-m]
Vd [DL]	33.50	0.60	20.10			
Vd [LL]	0.00	0.60	0.00			
Ve [DL]	33.50	-0.60	-20.10			
Ve [LL]	0.00	-0.60	0.00			
Vd [Lr]	-1.70	0.60	-1.02			
Ve [Lr]	1.70	-0.60	-1.02			
Hd [Lr]				30.49	7.39	225.28
He [Lr]				3.35	7.39	24.76
Sub- total	66.99		-2.04	33.84		250.04
W [pier]	280.90	0.00	0.00			
TOTAL	347.90		-2.04			

$\Sigma M = 248.00$ tf-m
$\Sigma V = 347.90$ tf
$\Sigma H = 33.84$ tf

$e = M / N = 0.71$ m

4) Dead Load + Train Load + Earth Pressure + Long Rail Load [LL]

ITEMS	V [tf]	x [m]	M [tf-m]	H [t]	y [m]	M [tf-m]
Vd [DL]	33.50	0.60	20.10			
Vd [LL]	152.15	0.60	91.29			
Ve [DL]	33.50	-0.60	-20.10			
Ve [LL]	0.00	-0.60	0.00			
Vd [Lr]	-4.24	0.60	-2.54			
Ve [Lr]	1.70	-0.60	-1.02			
Hd [Lr]				71.69	7.39	529.81
He [Lr]				3.35	7.39	24.76
Sub- total	216.61		87.73	75.04		554.56
W [pier]	280.90	0.00	0.00			
TOTAL	497.51		87.73			

$\Sigma M = 642.29$ tf-m
$\Sigma V = 497.51$ tf
$\Sigma H = 75.04$ tf

$e = M / N = 1.29$ m

6) Dead Load + Train Load + Impact + Earth Pressure + Long Rail Load [LL]

ITEMS	V [tf]	x [m]	M [tf-m]	H [t]	y [m]	M [tf-m]
Vd [DL]	33.50	0.60	20.10			
Vd [LL]	152.15	0.60	91.29			
Vd [I]	77.27	0.60	46.36			
Ve [DL]	33.50	-0.60	-20.10			
Ve [LL]	0.00	-0.60	0.00			
Ve [I]	0.00	-0.60	0.00			
Vd [Lr]	-1.70	0.60	-1.02			
Ve [Lr]	1.70	-0.60	-1.02			
Hd [Lr]				23.69	7.39	175.09
He [Lr]				3.35	7.39	24.76
Sub- total	296.42		135.62	27.04		199.84
W [pier]	280.90	0.00	0.00			
TOTAL	577.32		135.62			

$\Sigma M = 335.46$ tf-m
$\Sigma V = 577.32$ tf
$\Sigma H = 27.04$ tf

$e = M / N = 0.58$ m

6) 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]
Vd [DL]	33.50	0.60	20.10			
Vd [LL]	152.15	0.60	91.29			
Ve [DL]	33.50	-0.60	-20.10			
Ve [LL]	0.00	-0.60	0.00			
Vd [Lr + B]	-4.24	0.60	-2.54			
Ve [Lr + B]	1.70	-0.60	-1.02			
Hd [Lr + B]				71.69	7.39	529.81
He [Lr + B]				3.36	7.39	24.76
Sub- total	216.61		87.73	75.04		554.56
W [pier]	280.90	0.00	0.00			
TOTAL	497.51		87.73			

$\Sigma M = 642.29$ tf-m
$\Sigma V = 497.51$ tf
$\Sigma H = 75.04$ tf

$e = M / N = 1.29$ m

7) 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]
Vd [DL]	33.50	0.60	20.10			
Vd [LL]	152.15	0.60	91.29			
Vd [I]	77.27	0.60	46.36			
Ve [DL]	33.50	-0.60	-20.10			
Ve [LL]	0.00	-0.60	0.00			
Ve [I]	0.00	-0.60	0.00			
Vd [Lr + B]	-4.24	0.60	-2.54			
Ve [Lr + B]	1.70	-0.60	-1.02			
Hd [Lr + B]				71.69	7.39	529.81
He [Lr + B]				3.35	7.39	24.76
Sub- total	293.88		134.09	75.04		554.56
W [pier]	280.90	0.00	0.00			
TOTAL	574.78		134.09			

$\Sigma M = 688.66$ tf-m
$\Sigma V = 574.78$ tf
$\Sigma H = 75.04$ tf

$e = M / N = 1.20$ m

8) Dead Load + Earth Pressure + Seismic [DL]

ITEMS	V [tf]	x [m]	M [tf-m]	H [t]	y [m]	M [tf-m]
Vd [DL]	33.50	0.60	20.10			
Vd [LL]	152.15	0.60	91.29			
Ve [DL]	33.50	-0.60	-20.10			
Ve [LL]	0.00	-0.60	0.00			
Vd [Eq]	-0.64	0.60	-0.38			
Ve [Eq]	0.64	-0.60	-0.38			
Hd [Eq]				10.39	7.39	76.75
He [Eq]				3.35	7.39	24.76
Sub- total	219.15		90.53	13.74		101.50
W [pier]	280.90	0.00	0.00	50.56	2.55	129.15
TOTAL	500.05		90.53	64.30		230.65

$\Sigma M = 321.16$ tf-m
$\Sigma V = 500.05$ tf
$\Sigma H = 64.30$ tf

$e = M / N = 0.64$ m

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

ITEMS	V [tf]	x [m]	M [tf-m]	H [t]	y [m]	M [tf-m]
Vd [DL]	33.50	0.60	20.10			
Vd [LL]	152.15	0.60	91.29			
Ve [DL]	33.50	-0.60	-20.10			
Ve [LL]	0.00	-0.60	0.00			
Vd [Eq]	-2.18	0.60	-1.31			
Ve [Eq]	0.64	-0.60	-0.38			
Hd [Eq]				35.50	7.39	262.31
He [Eq]				3.35	7.39	24.76
Sub- total	217.61		89.60	38.85		287.06
W [pier]	280.90	0.00	0.00	50.56	2.55	129.15
TOTAL	498.51		89.60	89.41		416.21

$\Sigma M = 505.81$ tf-m
$\Sigma V = 498.51$ tf
$\Sigma H = 89.41$ tf

$e = M / N = 1.01$ m

b) IN TRANVERSAL 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]
Vd [DL]	33.50	2.30	77.05			
Vd [LL]	152.15	2.30	349.95			
Vd [I]	77.27	2.30	177.73			
Ve [DL]	33.50	-2.30	-77.05			
Ve [LL]	0.00	-2.30	0.00			
Ve [I]	0.00	-2.30	0.00			
H [Lr]				14.40	9.04	130.18
				0.00	9.04	0.00
H [W]				7.69	10.18	78.29
				0.00	10.18	0.00
Sub- total	296.42		527.68	22.09		208.47
W [pier]	280.90	0.00	0.00			
TOTAL	577.32		527.68	22.09		208.47

$\Sigma M = 736.14$ tf-m
$\Sigma V = 577.32$ tf
$\Sigma H = 22.09$ tf
$e = M / N = 1.28$ m

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

ITEMS	V [tf]	X [m]	M [tf-m]	H [t]	y [m]	M [tf-m]
Vd [DL]	33.50	2.30	77.05			
Vd [LL]	152.15	2.30	349.95			
Ve [DL]	33.50	-2.30	-77.05			
Ve [LL]	0.00	-2.30	0.00			
H [Eq]				14.58	9.04	131.80
H [Eq]				0.00	9.04	
Sub- total	219.15		349.95	14.58		131.80
W [pier]	280.90	0.00	0.00	50.56	2.55	129.15
TOTAL	500.05		349.95	65.14		260.95

$\Sigma M = 610.90$ tf-m
$\Sigma V = 500.05$ tf
$\Sigma H = 65.14$ tf

$e = M / N = 1.22$ m

3) Dead Load + Earth Pressure + Seismic + Flowing Water

ITEMS	V [tf]	X [m]	M [tf-m]	H [t]	y [m]	M [tf-m]
Vd [DL]	33.50	2.30	77.05			
Vd [LL]	152.16	2.30	349.95			
Ve [DL]	33.50	-2.30	-77.05			
Ve [LL]	0.00	-2.30	0.00			
H [Eq]				14.58	9.04	131.80
H [Eq]				0.00	9.04	0.00
H [Wp]				1.25	4.75	5.93
Sub- total	219.16		349.95	15.83		137.74
W [pier]	280.90	0.00	0.00	50.56	2.55	129.15
TOTAL	500.05		349.95	66.39		266.88

$\Sigma M = 616.83$ tf-m
$\Sigma V = 500.05$ tf
$\Sigma H = 66.39$ tf

$e = M / N = 1.23$ m

4.5. PILE CALCULATION

4.5.1. CAPACITY OF PILE

a). ALLOWABLE CAPACITY OF PILE

1) MATERIAL

PRESTRESS CONCRETE PILE.

Quality		K - 500
Diameter	=	0.45 m
g	=	0.23 tf / m
Area	=	0.159 m2 (End Pile)
Area	=	0.0515 m2 (Body of Pile)
E	=	1400000 t-f / m2
I	=	0.002 m4
Pn	=	130 tf.

2) BEARING CAPACITY OF PILE AT PIER CIREBON SIDE

Elevation bottom of pier = -3.64 m+

Refer to Boring Log R-51

Elevation of ground surface = -2.62 m+

a) End Bearing

N 1 = 45

N 2 = 0.5 (36 + 50 + 45)= 65.5

Nr = 0.5 (45 + 65.5)= 55.25 > 40

therefore

Nr = 40

Le = 1.90 m

$$\frac{Le}{D} = 4.22$$

qd = 18.44 x Nr

= 18.44 x 40

= 737.78 tf

Pb = 737.78 x 0.159 = 117.34 tf

b) Friction

Elevtion [m+]	Soil Describtion	Thickness [m]	Nr	fi	Li x fi [t-f / m]
-3.64 - 4.62	sand	0.98	1	1	0.98
-4.62 - 5.17	silty sand	0.55	1	1	0.55
-5.17 - 12.62	sandy clay	7.45	1	1	7.45
-12.62 - 14.17	sandy clay	1.55	6	3	4.65
-14.17 - 16.62	clay	2.45	60	12	29.40
		12.98		total	43.03

Efficiency Group of Pile,

$$Eg = 1 - \tan^{-1}\left(\frac{0.45}{1.35}\right) \times \frac{8 + 5}{90 \times 5 \times 2}$$

$$= 0.73$$

$$Pf = 0.73 \times 43.03 \times 1.4137 = 44.408 \text{ tf}$$

c) Allowable bearing capacity of pile.

- Normal Condition

Condition : DL + LL + I + E, $\alpha = 1$

DL + LL + I + E + Lr, $\alpha = 1.15$

DL + LL + I + E + Lr + B, $\alpha = 1.25$

Coefficient Factor

$$\alpha = 1 \quad Pa = \frac{117.34}{3} + \frac{44.41}{4} = 50.21 \text{ tf}$$

$\alpha = 1.15$ Pa = 1.15 x 50.21 = 57.76 tf

$\alpha = 1.25$ Pa = 1.25 x 50.21 = 62.77 tf

- Earthquake Condition

$\alpha = 1.5$ Pa = 1.50 x 50.21 = 75.32 tf

$$Pa = \frac{117.34}{2} + \frac{44.408}{3} = 73.47 \text{ tf}$$

therefore :

Pa = 75.322 tf

d) Allowable Pull-Out capacity of pile.

- Normal Condition

Pu = 43.03 x 1.4137 = 60.832 tf

W pile = 12.98 x 0.23 = 2.9854 tf

$$P = \frac{60.832}{6} + 2.9854 = 13.124 \text{ tf}$$

- Earthquake Condition

$$P = \frac{60.832}{3} + 2.9854 = 23.263 \text{ tf}$$

3) BEARING CAPACITY OF PILE AT PIER SEMARANG SIDE

Elevation bottom of pier = -3.64 m+

Refer to Boring Log R-18

Elevation of ground surface = 1.60 m+

a) End Bearing

N1 = 45

N2 = 0.50 (30 + 45)= 37.50

Nr = 0.5 (45 + 37.50)= 41.25 > 40

therefore

Nr = 40

Le = 0.66 m

$$\frac{Le}{D} = 1.47$$

qd = 12.93 x Nr

= 12.93 x 40

= 517.33 tf

Pb = 517.33 x 0.159 = 82.28 tf

b) Friction

Elevtion [m+]	Soil Description	Thickness [m]	Nr	fi	Li x fi [t-f/m]
-3.64 - 4.00	silty sand	0.36	3	0.6	0.22
-4.00 - 13.4	silty clay	9.40	3	3	28.20
-13.4 - 14.6	clay	1.20	30	12	14.40
-14.6 - 15.40	silty sand	0.80	30	12	9.60
		11.76		total	52.42

Efficiency Group of Pile.

$$Eg = 1 - \tan^{-1}\left(\frac{0.45}{1.35}\right) \times \frac{8 \times 5}{90 \times 5 \times 2}$$

= 0.73

Pf = 0.73 x 52.42 x 1.4137 = 54.09 tf

c) Allowable bearing capacity of pile.

- Normal Condition

Condition : DL + LL + I + E α = 1

DL + LL + I + E + Lr α = 1.15

DL + LL + I + E + Lr + B α = 1.25

Coefficient Factor

$$\alpha = 1 \qquad Pa = \frac{82.28}{3} + \frac{54.09}{4} = 40.95 \text{ tf}$$

$$\alpha = 1.15 \qquad Pa = 1.15 \times 40.95 = 47.09 \text{ tf}$$

$$\alpha = 1.25 \qquad Pa = 1.25 \times 40.95 = 51.19 \text{ tf}$$

- Earthquake Condition

$$Pa = \frac{82.278}{2} + \frac{54.094}{3} = 59.17 \text{ tf}$$

d) Allowable Pull-Out capacity of pile.

- Normal Condition

$$Pu = 52.416 \times 1.4137 = 74.101 \text{ tf}$$

$$W\,pile = 11.76 \times 0.23 = 2.7048 \text{ tf}$$

$$P = \frac{74.101}{6} + 2.7048 = 15.055 \text{ tf}$$

- Earthquake Condition

$$P = \frac{74.101}{3} + 2.7048 = 27.405 \text{ tf}$$

4.5.2. REACTION ON PILE