## 7.4.6 BOX CULVERT (LOCATION 2 + 331M)

| Name of Structure | | Category of calculation | | Page | |
|---|---|---|---|---|---|

## RESULT OF DESIGN CALCULATION

### 1. Existing Abutment

Stability Analisys of bearing Capacity

a. At normal condition qu = 58.599 t/m2

q max = 14.016 t/m2
SF = 4.181 > 3

b. At Seismic condition qu = 58.424 t/m2

q max = 18.119 t/m2
SF = 3.224 > 2

### 2. Raising Abutment

Stability Analisys of bearing Capacity

a. At normal condition qu = 58.364 t/m2

q max = 15.897 t/m2
SF = 3.661 > 3

b. At Seismic condition qu = 58.205 t/m2

q max = 20.350 t/m2
SF = 2.860 > 2

### 3. Reinforcing Bar

From existing concrete

- on body/wall = D22 – 150
- on footing = D22 – 150

### 4. From Calculation of raising abutment

- on joint of concrete to new concrete necessary D19 – 150
- on footing = D22 – 150

The existing reinforcing bar is all right

# DESIGN CALCULATION REPORT

## RAILWAY BRIDGE BH - 13

## PART 1

## STABILITY ANALISYS OF EXISTING ABUTMENT

# CALCULATION REPORT

## PART-1

## ( STABILITY ANALYSIS FOR EXISTING ABUTMENT )

RAILWAY BRIDGE BH. 13 ( STEEL BRIDGE 8.00 M )

**Table content**

# 1. DESIGN CONDITION

## 1,1 EXISTING CONDITION

**a. Superstructure**

- Type : Girder
- Total weight : 10,03 tf
- Effective Span ( c . t . c ) : 8,80 m
- Total Lenght of girder : 9,60 m
- Center to center of main Girder : 3,00 m
- Distance between top of rail up to top of Concrete Bearing : 0,90 m
- Material of Bearing Shoe : Steel Bearing

**b. Substructure**

- Material : concrete K 225
- Type : cantilever
- Visual Condition : good
- Crack on Structure : nothing
- Displesement : nothing
- Fondation : concrete slab

## 1,2 TRACK CONDITION

- Track Plan : Straigt
- Track Elevation : 0,0044 gradien

## 1,3 REGULATION REFERENCE

- Spesifikation of Perumka Railway Bridge Design ( AVBP 1932 )
- PD-10
- Indonesian Concrete Code
- Elastic Analysis of concrete section ( Departement PU )

## 1,4 MATERIAL QUALITY

- Concrete K - 225
- Plain / Lean Concrete K-125
- Reinforced Steel bar U-39 ( Deform steel )

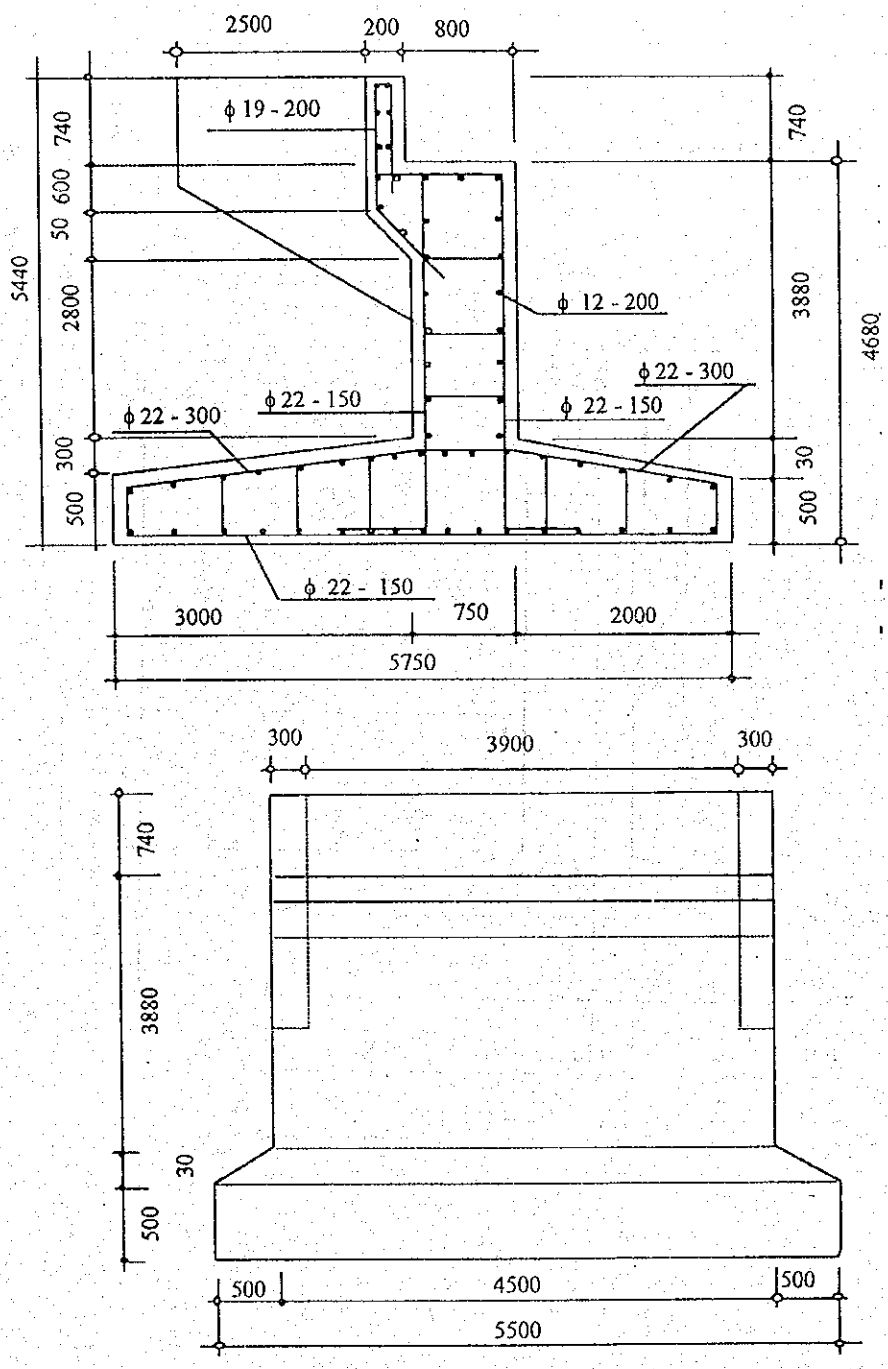
| Name of Structure | Railway Bridge BH - 13 | Category of Calculation | Structure Calculation | Page | 3/22 |
|---|---|---|---|---|---|

## 1,5 LOADINGS

| | |
|---|---|
| - Train 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 ) max. 200 tf |
| - Break Load (Brake) | : 1/6 Locomotive + 1/10 Wagon |
| - Lateral Load | : 1/10 train Load |
| - Wind Load | : 0.10 $tf/m^2$ |
| - Eart Pressure | : bassed on Collomb teory |
| - Stream Flow | : based on the equivalent static force and design |
| - Seismic Load | : bassed on the equivalent static force and design seismic intensity expressed as followings : KH = 0.18 KV = 0.00 |

| Name of Structure | Railway Bridge BH - 13 | Category of Calculation | Structure Calculation | Page | 4/22 |
|---|---|---|---|---|---|

## 2 DIMENSION OF EXISTING ABUTMENT

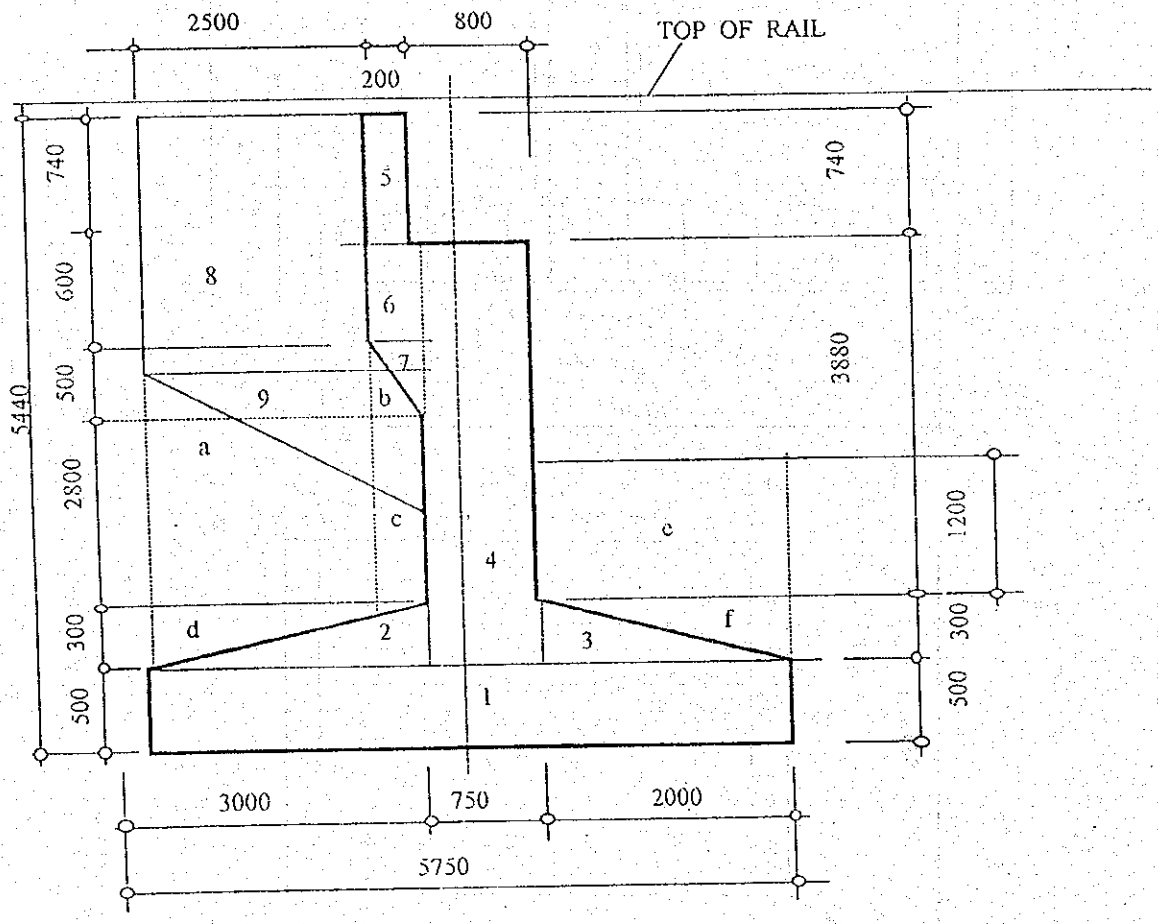



This data from SUDP Kodia Dati II Semarang 1994/1995

| Name of Structure | Railway Bridge BH - 13 | Category of Calculation | Structure Calculation | Page | 5/22 |
|---|---|---|---|---|---|

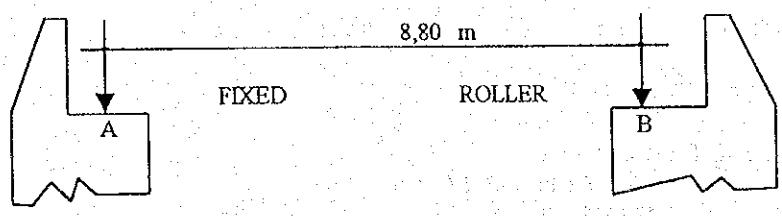
# 3 ABUTMENT

## 3.1 DIMENSION OF ABUTMENT



3,2 LOADING

3.2.1 VERTICAL FORCE




a. Dead Load

Vb = Va = 5,015 tf

b. Train Load ( Live Load )

q tr : 7 x 15.00 x 0.5 = 52,500 tf

Vb = Va = 52,500 tf

c. Impact Load

Impact Coefficient

I = 0.200 + 25/(8.00 + 50.00 ) = 0,631

Va = Vb = 52.50 x 0.631 = 33,128 tf

d. Train Load for Seismic

q = 15.00 / 2.4 = 6,250 tf / m

Va = 6.250 x 8.8 x 0.5 = 27,500 tf

Vb = 6.250 x 8.8 x 0.5 = 27,500 tf

SUMMARY OF VERTICAL FORCE

| ITEM | Support A ( ton - f ) | Support B ( ton - f ) |
|---|---|---|
| Dead load ( DL ) | 5,015 | 5,015 |
| Train Load ( LL ) | 52,500 | 52,500 |
| Impact Load ( I ) | 33,128 | 33,128 |
| Train for Seismic ( LL ) | 27,500 | 27,500 |

3.2.2. LONGITUDINAL HORIZONTAL FORCE

a. DEAD LOAD + LONG RAIL LOAD

TOTAL HORIZONTAL FORCE

$\Sigma H = 9.6 \times 1.00 =$ 9,600 tf

HORIZONTAL FORCE ON SUPPORT

$Ha = \Sigma H - 1/2 \times \mu \times Vb$

$= 9.60 - 0.5 \times 0.10 \times 9.60$

= 9,120 tf > 1/2 x 9.6 = 4.8 tf

therefore
Ha = 9,12 tf

VERTICAL FORCE

Va = 9.6 x 0.9 / 8.8 = 0,982 tf

b. LONG RAIL LOAD + BRAKE LOAD

TOTAL HORIZONTAL FORCE
ΣH = 0 x 15.00 x 0.100 + 7 x 15 x 0.1667 + 9.6
= 27,1035 tf

HORIZONTAL FORCE ON SUPPORT
Ha = ΣH - 1/2 x μ x Vb
= 27.1035 - 0.5 x 0.10 x ( 10.03+52.50 )
= 23,977 tf > 1/2 x 27.1035 = 13.5518 tf
therefore
Ha = 23.977 tf

VERTICAL FORCE
Va = 23.977 x 0.9 / 8.8 = 2,452 tf

c. TRAIN LOAD + LONG RAIL LOAD

TOTAL HORIZONTAL FORCE
ΣH = 9.6 x 1.00 = 9,600 tf

HORIZONTAL FORCE ON SUPPORT
Ha = ΣH - 1/2 x μ x Vb
= 9.6 - 0.5 x 0.10 x ( 10.03+52.50 )
= 6,474 tf > 1/2 x 9.600 = 4.80 tf
therefore
Ha = 6.474 tf

VERTICAL FORCE
Va = 9.6 x 0.9 / 8.8 = 0,982 tf

d. DEAD LOAD FOR SEISMICC

TOTAL HORIZONTAL FORCE
ΣH = 10.03 x 2 x 0.18 = 3,611 tf

HORIZONTAL FORCE ON SUPPORT
Ha = ΣH - 1/2 x μ x Vb
= 3.611 - 0.5 x 0.10 x 10.03
= 3,110 tf > 1/2 x 3.611 = 1.805 tf

therefore
Ha = 3.110 tf

VERTICAL FORCE
Va = 3.110 x 0.9 / 8.8 = 0,318 tf

e. TRAIN LOAD FOR SEISMICC

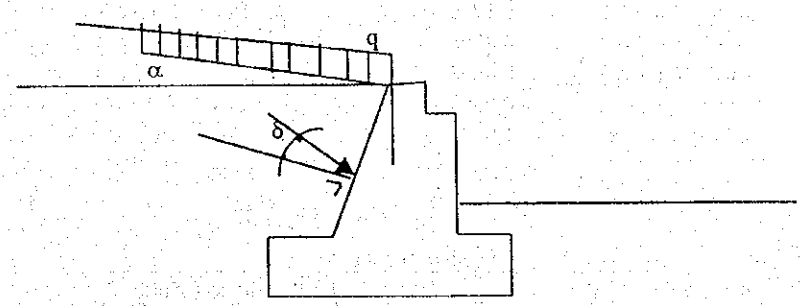
TOTAL HORIZONTAL FORCE
ΣH = ( 10.03 + 27.50 ) x 2 x 0.18 = 13,511 tf

HORIZONTAL FORCE ON SUPPORT
Ha = ΣH - 1/2 x μ x Vb
= 13.511 - 0.5 x 0.10 x ( 10.03 + 27.500 )
= 11,635 tf > 1/2 x 13.511 = 6.755 tf

therefore
Ha = 11.635 tf

VERTICAL FORCE
Va = 11.635 x 0.9 / 8.8 = 1,190 tf

f. EART 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 ( Assumsion same with BH 10 ) | |
|---|---|---|---|
| θ = | 0 | θ = | 0 |
| ϕ = | 30 | ϕ = | 3 |
| δ = | 20 | δ = | 2 |
| α = | 0 | α = | 0 |

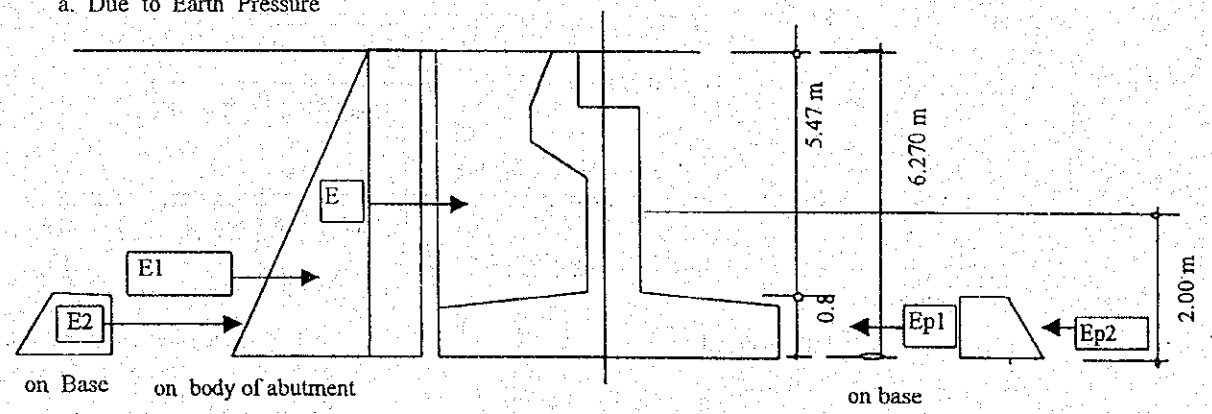
| | | | | | |
|---|---|---|---|---|---|
| Cos | $(\phi-\theta)$ | = | 0,8662 | 0,9986 | |
| Cos | $(\phi+\theta)$ | = | 0,8662 | 0,9986 | |
| Cos | $\theta$ | = | 1,0000 | 1,0000 | |
| Cos | $(\theta+\delta)$ | = | 0,9398 | 0,9994 | |
| Sin | $(\phi+\delta)$ | = | 0,7658 | 0,0871 | |
| Sin | $(\phi-\delta)$ | = | 0,1736 | 0,0174 | |
| Sin | $(\phi-\alpha)$ | = | 0,4998 | 0,0523 | |
| Sin | $(\phi+\alpha)$ | = | 0,4998 | 0,0523 | |
| Cos | $(\theta+\delta)$ | = | 0,9398 | 0,9994 | |
| Cos | $(\theta-\alpha)$ | = | 1,0000 | 1,0000 | |

Active Earth Pressure

$$Ka = \frac{0.8660 \times 0.8660}{1.000 \times 0.9398 \times \left[1+\sqrt{\frac{0.7660 \times 0.5000}{0.9397 \times 1.000}}\right]^2}$$

$$= 0,2973$$

a. Due to Earth Pressure




Active Earth Pressure

| | | | |
|---|---|---|---|
| E1 = 0.5 x 2.00x 5.440 x 5.440 x 0.2973 = | 8,798 | tf/m | |
| E2 = 0.8 x 2.00 x 5.440 x 0.2973 = | 2,588 | tf/m | |
| E1 h = E1 Cos $\delta$ = 8.798 x 0.9397 = | 8,268 | tf/m | |
| E2 h = E2 Cos $\delta$ = 2.588 x 0.9397 = | 2,432 | tf/m | |
| E1 v = E1 Sin $\delta$ = 8.798 x 0.342 = | 3,009 | tf/m | |
| E2 v = E2 Sin $\delta$ = 2.588 x 0.342 = | 0,885 | tf/m | |

Total force per abutment

| | | | | |
|---|---|---|---|---|
| E1h = 8.268 x 4.5 = | 37,204 tf | y1 = | 2,093 | m |
| E2h = 2.588 x 4.5 = | 10,942 tf | y2 = | 0,400 | m |
| | 48,147 tf | y = | 1,247 | m |
| E1v = 3.009 x 4.50 = | 13,540 tf | x1 = | 2,875 | m |
| E2v = 0.885 x 4.50 = | 3,982 tf | x2 = | 2,875 | m |
| | 17,523 tf | x = | 2,875 | m |

Passive Earth Pressure

$$Ka = \frac{0.9986 \times 0.9986}{1.000 \times 0.9994 \times \left[1 + \sqrt{\frac{0.0672 \times 0.0523}{0.9994 \times 1.000}}\right]^2}$$

$$= 1,1477$$

Ep1 = 2.00 x 1.60 x 1.1477 = 3,673 tf/m²
Ep2 = 2.80 x 1.60 x 1.1477 = 5,142 tf/m²

Ep1 = 0.80 x 3.673 = 2,938 tf/m
Ep2 = 0.5 x 0.8 x 5.142 = 2,057 tf/m

Ep1 h = E1 Cos δ = 2.938 x 0.9994 = 2,936 tf/m
Ep2 h = E2 Cos δ = 2.057 x 0.9994 = 2,056 tf/m
Ep1 v = E1 Sin δ = 2.938 x 0.0349 = 0,103 tf/m
Ep2 v = E1 Sin δ = 2.057 x 0.0349 = 0,072 tf/m

Total force per abutment

| | | | | | |
|---|---|---|---|---|---|
| Ep1h = 2.936 x 4.50 = | 13,212 tf | y1 = | 0,400 | m |
| Ep2h = 2.056 x 4.50 = | 9,252 tf | y2 = | 0,267 | m |
| | 22,464 tf | y = | 0,333 | m |
| Ep1v = 0.103 x 4.50 = | 0,464 tf | x1 = | 2,875 | m |
| Ep2v = 0.072 x 4.50 = | 0,324 tf | x2 = | 2,875 | m |
| | 0,788 tf | x = | 2,875 | m |

b). Do to live Load

Total force per Abutment

E = 8.75 x 0.2973 x 5.440 = 14,151 tf
Eh = E Cos δ = 14.151 x 0.9397 = 13,298 tf-m
Ev = E Sin δ = 14.151 x 0.3420 = 4,840 tf-m

2). EARTQUAKE CONDITION

COEFFICIENT OF EARTH PRESSURE

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

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

Fill material

θo = 10,20
θ = 0,00
ϕ = 30,00
δ = 0,00
α = 0,00

Soil ( Assumsion same with BH 10 )

θo = 10,20
θ = 0,00
ϕ = 3,00
δ = 0,00
α = 0,00

| | | | |
|---|---|---|---|
| Cos ( ϕ – θo –θ ) | = 0,9408 | Cos ( ϕ – θo –θ ) | = 0,9921 |
| Cos ( ϕ – θo +θ ) | = 0,9408 | Cos ( ϕ – θo +θ ) | = 0,9921 |
| Cos θo | = 0,9842 | Cos θo | = 0,9842 |
| Cos θ | = 1,0000 | Cos θ | = 1,0000 |
| Cos ( θ +θo+ δ ) | = 0,9842 | Cos ( θ +θo+ δ ) | = 0,9842 |
| Cos ( θ +θo+ δ ) | = 0,9842 | Cos ( θ +θo+ δ ) | = 0,9842 |
| Sin ( ϕ + δ ) | = 0,5002 | Sin ( ϕ + δ ) | = 0,0524 |
| Sin ( ϕ +δ– θo ) | = 0,3389 | Sin ( ϕ +δ– θo ) | = -0,1254 |
| Sin ( ϕ – δ ) | = 0,5002 | Sin ( ϕ – δ ) | = 0,0524 |
| Sin ( ϕ +α– θo ) | = 0,3386 | Sin ( ϕ +α– θo ) | = -0,1253 |
| Cos ( θ – α ) | = 1,0000 | Cos ( θ – α ) | = 1,0000 |

Active Earth pressure

$$Kea = \frac{0{,}9842 \times 0{,}9408}{0.9842 \times 1.000 \times 1.000 + 0.9842 \left[ 1 + \sqrt{\frac{0.5000 \times 0.3387}{0.9842 \times 1.000}} \right]^2}$$

= 0,4566

a). Due to Earth Pressure

| | | | | | |
|---|---|---|---|---|---|
| E1 | = 0.500 x 1.90 x 5.440 x 5.440 x 0.4566 | = | 12,837 | tf / m | |
| E2 | = 0.800 x 1.90 x 5.440 x 0.4566 | = | 3,776 | tf / m | |
| E1h | = E Cos δ = | 12.837 x 1.000 | = | 12,837 | tf / m |
| E2h | = E Cos δ = | 3.776 x 1.000 | = | 3,776 | tf / m |
| E1v | = E Sin δ = | 12.837 x 0.000 | = | 0,000 | tf / m |
| E2v | = E Sin δ = | 3.776 x 0.000 | = | 0,000 | tf / m |

Total force per abutment

| | | | | | |
|---|---|---|---|---|---|
| E1h | = 12.837 x 4.50 = | 57,766 tf | y1 = | 2,090 | m |
| E2h | = 3.776 x 4.50 = | 16,990 tf | y2 = | 0,400 | m |
| | | 74,756 tf | y = | 1,245 | m |
| E1v | = 0.000 x 4.50 = | 0,000 tf | x1 = | 2,875 | m |
| E2v | = 0.000 x 4.50 = | 0,000 tf | x2 = | 2,875 | m |
| | | 0,000 tf | x = | 2,875 | m |

Passive Earth pressure

$$Kep = \frac{0{,}9408 \times 0{,}9408}{0.9842 \times 1.000 \times 1.000 + 0.9842 \left[ 1 - \sqrt{\frac{0.0523 \times -0.1253}{0.9842 \times 1.000}} \right]^2}$$

= not possible

SUMMARY DUE TO LONGITUDINAL HORIZONTAL FORCE

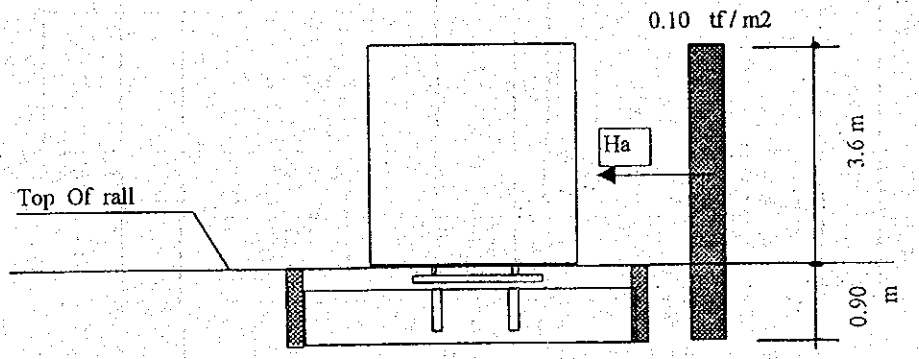
| ITEM | FORCE ON SUPPORT | |
|---|---|---|
| | Ha | Va |
| Long Rail ( DL ) | 9,120 | 0,982 |
| Long ( DL ) + Brake ( B ) | 23,977 | 2,452 |
| Long Rail ( LL ) | 6,474 | 0,982 |
| Seismic ( DL ) | 3,110 | 0,318 |
| Seismic ( LL ) | 11,635 | 1,190 |

3.3.3. TRANVERSAL HORIZONTAL FORCE

a. LATERAL LOAD

Ha = 0.5 x 0.1 x 7 x 15 = 5,25 tf

b. WIND LOAD




Ha = 0.10 x 4.50 x 8.8 x 0.50 1,98 tf

c. DEAD LOAD FOR SEISMIC LOAD

Ea = 10.03 x 0.18 = 1,8054 tf

d. LIVE LOAD FOR SEISMIC LOAD

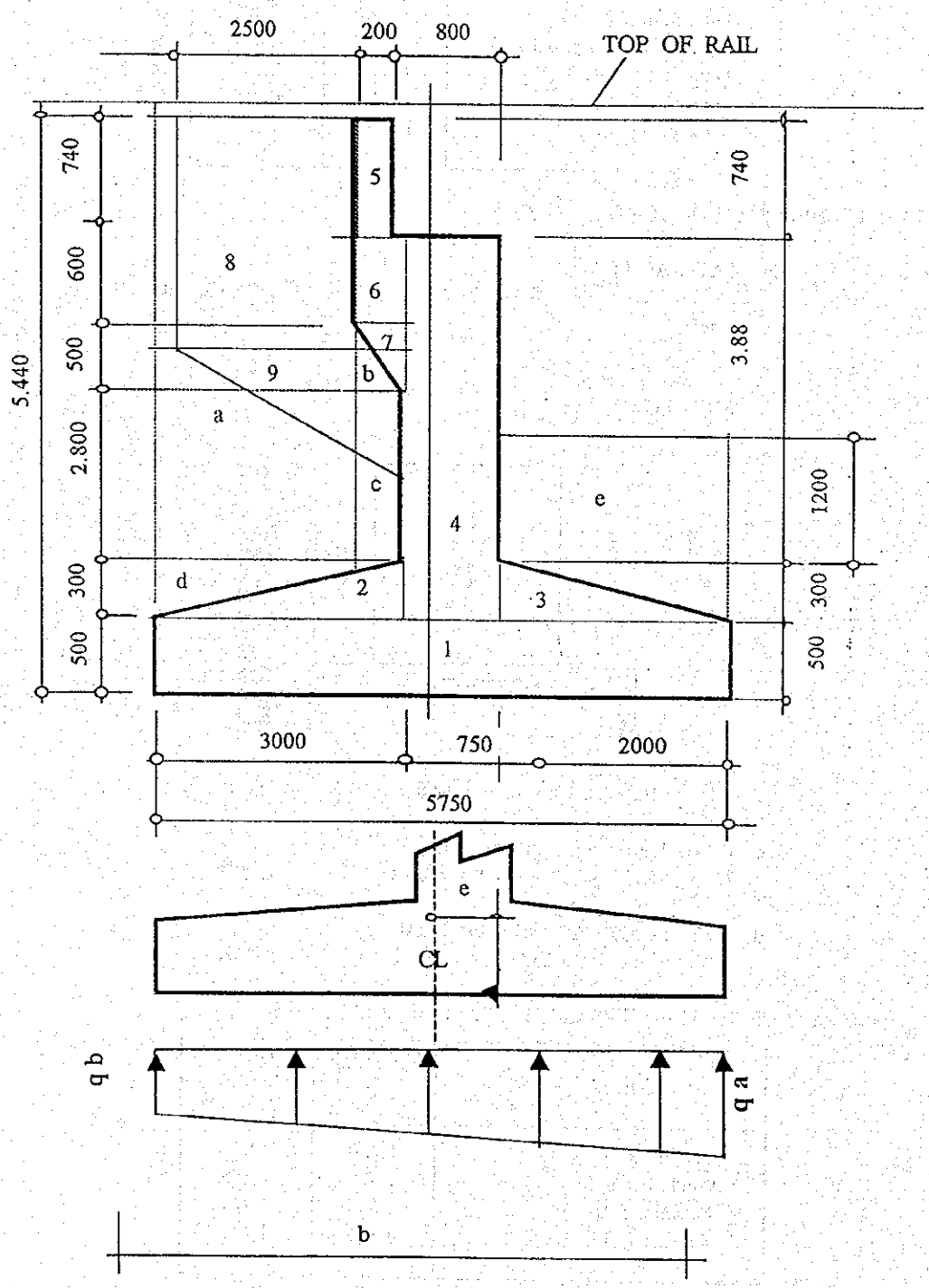
Ea = 23.977 x 0.18 = 4,31586 tf

SUMMARY DUE TO TRANVERSAL HORIZONTAL FORCE

| ITEM | FORCE ON SUPPORT | |
|---|---|---|
| | H ( ton - f ) | Y ( m ) |
| Lateral Load ( Lr ) | 5,250 | 1,225 |
| Wind Load ( W ) | 1,980 | 2,575 |
| Seismic ( DL ) | 1,805 | 1,225 |
| Seismic ( LL ) | 4,316 | 1,225 |

## 3.3 EXTERNAL STABILITY CALCULATION

### 3.3.1 WEIGHT OF ABUTMENT



| Name of Structure | Railway Bridge BH - 13 | Category of Calculation | Structure Calculation | Page | 14/22 |
|---|---|---|---|---|---|

| ITEM | WIGHT OF ABUTMENT | | ( tf ) | X | Mx ( tf-m ) | Y ( m ) | My ( tf - m ) |
|---|---|---|---|---|---|---|---|
| | CONCRETE | | | | | | |
| 1 | 5.750 x 0.500 x 5.500 x | 2.400 = | 37,950 | - | - | 0,250 | 9,488 |
| 2 | 0.50 x 3.000 x 0.500 x 5.000 x | 2.400 = | 9,000 | (0,875) | (7,875) | 0,600 | 5,400 |
| 3 | 0.50 x 2.000 x 0.500 x 5.000 x | 2.400 = | 6,000 | 1,542 | 9,250 | 0,600 | 3,600 |
| 4 | 0.750 x 3.88 x 4.500 x | 2.400 = | 31,428 | 0,500 | 15,714 | 3,165 | 99,470 |
| 5 | 0.200 x 0.740 x 4.000 x | 2.400 = | 1,421 | (0,075) | (0,107) | 5,900 | 8,383 |
| 6 | 0.500 x 0.600 x 4.000 x | 2.400 = | 2,880 | (0,125) | (0,360) | 5,230 | 15,062 |
| 7 | 0.50 x 0.500 x 0.500 x 4.000 x | 2.400 = | 1,200 | (0,042) | (0,050) | 4,763 | 5,716 |
| 8 | 2.900 x 1.570 x 0.250 x 2.0 x | 2.400 = | 5,464 | (1,475) | (8,059) | 5,485 | 29,968 |
| 9 | 0.50 x 2.700 x 2.00 x 0.25 x 2.0 | 2.400 = | 3,240 | (0,875) | (2,835) | 4,033 | 13,068 |
| | SOIL | | | | | | |
| a | 2.500 x 4.64 x 5.500 x | 1.800 = | 114,840 | (1,625) | (186,615) | 3,535 | 405,959 |
| b | 0.50 x 0.500 x 0.500 x 0.500 x | 1.800 = | 0,113 | (0,208) | (0,023) | 4,597 | 0,517 |
| c | 0.500 x 3.380 x 5.000 x | 1.800 = | 15,210 | (0,125) | (1,901) | 2,615 | 39,774 |
| d | 0.50 x 3.000 x 0.300 x 5.000 x | 1.800 = | 4,050 | (1,875) | (7,594) | 0,700 | 2,835 |
| e | 2.000 x 1.200 x 5.000 x | 1.800 = | 21,600 | 1,875 | 40,500 | 2,300 | 49,680 |
| f | 0.50 x 2.000 x 0.300 x 5.000 x | 1.800 = | 2,700 | 2,208 | 5,963 | 0,700 | 1,890 |
| | | | | | | | |
| | | | 257,095 | | (143,992) | | 690,810 |
| | X = -0,56007 | | | | | | |
| | Y = 2,686984 | | | | | | |

3.3.2. LOAD COMBINATION

a. In Longitudinal Direction

1) Dead Load + Earth Pressuse

| ITEM | V (tf) | x (m) | M (tf - m) | H (tf) | y (m) | M (tf - m) |
|---|---|---|---|---|---|---|
| Va ( DL ) | 5,015 | 0,475 | 2,382 | | | |
| Va ( LL ) | - | 0,475 | - | | | |
| Eh | | | | 48,147 | 1,247 | 60,023 |
| | | | | (22,464) | 0,333 | (7,488) |
| Ev | 17,523 | (2,875) | (50,378) | | | |
| | (0,788) | 2,875 | (2,264) | | | |
| Ha | | | | - | 5,530 | - |
| Sub Total | 21,750 | | (50,260) | 25,683 | | 52,535 |
| W( Abutment) | 257,095 | (0,560) | (143,992) | | | |
| Total | 278,845 | | (194,252) | | | |

ΣM = (141,717) q = V/b x ( 1 +- 6e/b )

ΣV = 278,845 qa = 4.143 tf/m²

ΣH = 25,683 qb = 13.491 tf/m²

e = M/N = -0,508229396

2) Dead Load + Earth Pressuse ( LL )

| ITEM | V (tf) | x (m) | M (tf - m) | H (tf) | y (m) | M (tf - m) |
|---|---|---|---|---|---|---|
| Va ( DL ) | 5,015 | 0,475 | 2,382 | | | |
| Va ( LL ) | - | 0,475 | - | | | |
| Eh | | | | 48,147 | 1,247 | 60,023 |
| | | | | 13,298 | 3,315 | 44,083 |
| | | | | (22,464) | 0,333 | (7,488) |
| Ev | 17,523 | (2,875) | (50,378) | | | |
| | (0,788) | 2,875 | (2,264) | | | |
| | 4,840 | (2,875) | (13,914) | | | |
| Ha | | | | - | 5,530 | - |
| Sub Total | 26,590 | | (66,557) | 38,981 | | 96,618 |
| W( Abutment) | 257,095 | (0,560) | (143,992) | | | |
| Total | 283,685 | | (210,549) | | | |

ΣM = (113,931) q = V/b x ( 1 +- 6e/b )

ΣV = 283,685 qa = 5.211 tf/m²

ΣH = 38,981 qb = 12.730 tf/m²

e = M/N = -0,401609343

3 ) Dead Load + Train load + Earth Pressusc

| ITEM | V ( tf ) | x ( m ) | M ( tf - m ) | H ( tf ) | y ( m ) | M ( tf - m ) |
|---|---|---|---|---|---|---|
| Va ( DL ) | 5,015 | 0,475 | 2,382 | | | |
| Va ( LL ) | 52,500 | 0,475 | 24,938 | | | |
| Eh | | | | 48,147 | 1,247 | 60,023 |
| | | | | 13,298 | 3,315 | 44,083 |
| | | | | (22,464) | 0,333 | (7,488) |
| Ev | 17,523 | (2,875) | (50,378) | | | |
| | (0,788) | 2,875 | (2,264) | | | |
| | 4,840 | (2,875) | (13,914) | | | |
| Ha | | | | - | 5,530 | - |
| Sub Total | 79,090 | | (39,237) | 38,981 | | 96,618 |
| W( Abutment) | 257,095 | (0,560) | (143,992) | | | |
| Total | 336,185 | | (183,229) | | | |

ΣM = (86,611) q = V/b x ( 1 +- 6e/b )

ΣV = 336,185 qa = 7.772 tf/m²

ΣH = 38,981 qb = 13.487 tf/m²

e = M/N = -0,257628781

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

| ITEM | V ( tf ) | x ( m ) | M ( tf - m ) | H ( tf ) | y ( m ) | M ( tf - m ) |
|---|---|---|---|---|---|---|
| Va ( DL ) | 5,015 | 0,475 | 2,382 | | | |
| Va ( LL ) | 52,500 | 0,475 | 24,938 | | | |
| Va [ I ] | 33,128 | 0,475 | 15,736 | | | |
| Eh | | | | 48,147 | 1,247 | 60,023 |
| | | | | 13,298 | 3,315 | 44,083 |
| | | | | (22,464) | 0,333 | (7,488) |
| Ev | 17,523 | (2,875) | (50,378) | | | |
| | (0,788) | 2,875 | (2,264) | | | |
| | 4,840 | (2,875) | (13,914) | | | |
| Ha | | | | - | 5,530 | - |
| Sub Total | 112,218 | | (23,501) | 38,981 | | 96,618 |
| W( Abutment) | 257,095 | (0,560) | (143,992) | | | |
| Total | 369,313 | | (167,494) | | | |

ΣM = (70,875) q = V/b x ( 1 +- 6e/b )

ΣV = 369,313 qa = 9.929 tf/m²

ΣH = 38,981 qb = 14.016 tf/m²

e = M/N = -0,191910754

5) Dead Load + Earth Pressuse + Long Rail Load

| ITEM | V (tf) | x (m) | M (tf-m) | H (tf) | y (m) | M (tf-m) |
|---|---|---|---|---|---|---|
| Va (DL) | 5,015 | 0,475 | 2,382 | | 0,03112791 | |
| Va (LL) | - | 0,475 | - | | 0,00558706 | |
| Va [Ir] | 0,982 | 0,475 | 0,466 | | | |
| Eh | | | | 48,147 | 1,247 | 60,023 |
| | | | | (22,464) | 0,333 | (7,488) |
| Ev | 17,523 | (2,875) | (50,378) | | | |
| | (0,788) | 2,875 | (2,264) | | | |
| Ha | | | | 9,120 | 5,530 | 50,434 |
| Sub Total | 22,732 | | (49,794) | 25,683 | | 102,969 |
| W(Abutment) | 257,095 | (0,560) | (143,992) | | | |
| Total | 279,827 | | (193,786) | | | |

ΣM = (90,817) q = V/b x (1 +- 6e/b)

ΣV = 279,827 qa = 5.852 tf/m²

ΣH = 25,683 qb = 11.845 tf/m²

e = M/N = -0,324547754

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

| ITEM | V (tf) | x (m) | M (tf-m) | H (tf) | y (m) | M (tf-m) |
|---|---|---|---|---|---|---|
| Va (DL) | 5,015 | 0,475 | 2,382 | | | |
| Va (LL) | 52,500 | 0,475 | 24,938 | | | |
| Va [Ir] | 0,982 | 0,475 | 0,466 | | | |
| Eh | | | | 48,147 | 1,247 | 60,023 |
| | | | | 13,298 | 3,315 | 44,083 |
| | | | | (22,464) | 0,333 | (7,488) |
| Ev | 17,523 | (2,875) | (50,378) | | | |
| | 4,840 | 2,875 | 13,914 | | | |
| | (0,788) | 2,875 | (2,264) | | | |
| Ha | | | | 9,120 | 5,530 | 50,434 |
| Sub Total | 80,072 | | (10,942) | 38,981 | | 147,052 |
| W(Abutment) | 257,095 | (0,560) | (143,992) | | | |
| Total | 337,167 | | (154,934) | | | |

ΣM = (7,882) q = V/b x (1 +- 6e/b)

ΣV = 337,167 qa = 10.401 tf/m²

ΣH = 38,981 qb = 10.922 tf/m²

e = M/N = -0,023377177

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

| ITEM | V ( tf ) | x ( m ) | M ( tf - m ) | H ( tf ) | y ( m ) | M ( tf - m ) |
|---|---|---|---|---|---|---|
| Va ( DL ) | 5,015 | 0,475 | 2,382 | | | |
| Va ( LL ) | 52,500 | 0,475 | 24,938 | | | |
| Va ( I ) | 33,128 | 0,475 | 15,736 | | | |
| Va [ Ir ] | 0,982 | 0,475 | 0,466 | | | |
| Eh | | | | 48,147 | 1,247 | 60,023 |
| | | | | 13,298 | 3,315 | 44,083 |
| | | | | (22,464) | 0,333 | (7,488) |
| Ev | 17,523 | (2,875) | (50,378) | | | |
| | 4,840 | (2,875) | (13,914) | | | |
| | (0,788) | 2,875 | (2,264) | | | |
| Ha | | | | 9,120 | 5,530 | 50,434 |
| Sub Total | 113,200 | | (25,417) | 38,981 | | 147,052 |
| W( Abutment) | 257,095 | (0,560) | (143,992) | | | |
| Total | 370,295 | | (169,409) | | | |

ΣM = (22,357) q = V/b x ( 1 +- 6e/b )

ΣV = 370,295 qa = 10.971 tf/m²

ΣH = 38,981 qb = 12.447 tf/m²

e = M/N = -0,060376782

8) Dead Load + Train Load + Break Load + Earth Pressuse + Long Rail Load

| ITEM | V ( tf ) | x ( m ) | M ( tf - m ) | H ( tf ) | y ( m ) | M ( tf - m ) |
|---|---|---|---|---|---|---|
| Va ( DL ) | 5,015 | 0,475 | 2,382 | | | |
| Va ( LL ) | 52,500 | 0,475 | 24,938 | | | |
| Va [ Ir ] | 2,107 | 0,475 | 1,001 | | | |
| Eh | | | | 48,147 | 1,247 | 60,023 |
| | | | | 13,298 | 3,315 | 44,083 |
| | | | | (22,464) | 0,333 | (7,488) |
| Ev | 17,523 | (2,875) | (50,378) | | | |
| | 4,840 | (0,875) | (4,235) | | | |
| | (0,788) | 2,875 | (2,264) | | | |
| Ha | | | | 23,977 | 5,530 | 132,593 |
| Sub Total | 81,197 | | (28,557) | 38,981 | | 229,211 |
| W( Abutment) | 257,095 | (0,560) | (143,992) | | | |
| Total | 338,292 | | (172,549) | | | |

ΣM = 56,662 q = V/b x ( 1 +- 6e/b )

ΣV = 338,292 qa = 12.566 tf/m²

ΣH = 38,981 qb = 8.827 tf/m²

e = M/N = 0,167495199

9) Dead Load + Train Load + Impact + Break Load + Long rail Load + Earth Pressuse

| ITEM | V (tf) | x (m) | M (tf-m) | H (tf) | y (m) | M (tf-m) |
|---|---|---|---|---|---|---|
| Va (DL) | 5,015 | 0,475 | 2,382 | | | |
| Va (LL) | 52,500 | 0,475 | 24,938 | | | |
| Va (I) | 33,128 | 0,475 | 15,736 | | | |
| Va [Ir] | 0,982 | 0,475 | 0,466 | | | |
| Eh | | | | 48,147 | 1,247 | 60,023 |
| | | | | 13,298 | 3,315 | 44,083 |
| | | | | (22,464) | 0,333 | (7,481) |
| Ev | 17,523 | (2,875) | (50,378) | | | |
| | 4,840 | (2,875) | (13,914) | | | |
| | (0,788) | 2,875 | (2,266) | | | |
| Ha | | | | 23,977 | 5,530 | 132,593 |
| Sub Total | 113,200 | | (23,036) | 38,981 | | 229,219 |
| W(Abutment) | 257,095 | (0,560) | (143,992) | | | |
| Total | 370,295 | | (167,029) | | | |

ΣH = 62,190 q = V/b x (1 +- 6e/b)
ΣV = 370,295 qa = 13.761 tf/m²
ΣH = 38,981 qb = 9.659 tf/m²
e = M/N = 0,167947807

10) Dead Load + Earth Pressuse + Seismic

| ITEM | V (tf) | x (m) | M (tf-m) | H (tf) | y (m) | M (tf-m) |
|---|---|---|---|---|---|---|
| Va (DL) | 5,015 | 0,475 | 2,382 | | | |
| Va (LL) | - | 0,475 | - | | | |
| Va [Eq] | 0,318 | 0,475 | 0,151 | | | |
| Eh | | | | 48,147 | 1,247 | 60,039 |
| | | | | (22,464) | 0,333 | (7,481) |
| Ev | 17,523 | (2,875) | (50,378) | | | |
| | (0,788) | 2,875 | (2,266) | | | |
| Ha | | | | 23,977 | 5,630 | 134,991 |
| Sub Total | 22,068 | | (50,111) | 25,683 | | 187,549 |
| W(Abutment) | 257,095 | (0,560) | (143,992) | | | |
| Total | 279,163 | | (194,103) | | | |

ΣM = (6,554) q = V/b x (1 +- 6e/b)
ΣV = 279,163 qa = 8.611 tf/m²
ΣH = 25,683 qb = 9.043 tf/m²
e = M/N = -0,023476271

II ) Dead Load + Earth Pressuse + Seismic ( LL )

| ITEM | V ( tf ) | x ( m ) | M ( tf - m ) | H ( tf ) | y ( m ) | M ( tf - m ) |
|---|---|---|---|---|---|---|
| Va ( DL ) | 5,015 | 0,475 | 2,382 | | | |
| Va ( LL ) | 22,000 | 0,475 | 10,450 | | | |
| Va [ Eq ] | 1,711 | 0,475 | 0,813 | | | |
| Eh | | | | 63,824 | 1,263 | 80,610 |
| | | | | (22,464) | 0,333 | (7,481) |
| Ev | 27,500 | (2,875) | (79,063) | | | |
| | 4,840 | (2,875) | (13,914) | | | |
| | (0,788) | 2,875 | (2,266) | | | |
| Ha | | | | 23,977 | 5,630 | 134,991 |
| Sub Total | 60,278 | | (81,598) | 41,360 | | 208,120 |
| W( Abutment) | 257,095 | (0,560) | (143,992) | | | |
| Total | 317,373 | | (225,590) | | | |

ΣH = (17,470) q = V/b x ( 1 +- 6e/b )

ΣV = 317,373 qa = 9.459 tf/m²

ΣH = 41,360 qb = 10.612 tf/m²

e = M/N = -0,0550416291

b. IN TRANVERSAL DIRECTION

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

| ITEM | V ( tf ) | x ( m ) | M ( tf - m ) | H ( tf ) | y ( m ) | M ( tf - m ) |
|---|---|---|---|---|---|---|
| Va ( DL ) | 5,015 | 0,475 | 2,382 | | | |
| Va ( LL ) | 52,500 | 0,475 | 24,938 | | | |
| Va [ Lr ] | 0,982 | 0,475 | 0,466 | | | |
| Eh | | | | 48,147 | 1,247 | 60,039 |
| | | | | 13,298 | 3,315 | 44,083 |
| | | | | (22,464) | 0,333 | (7,481) |
| Ev | 17,523 | (2,875) | (50,378) | | | |
| | 4,840 | (2,875) | (13,914) | | | |
| | (0,788) | 2,875 | (2,266) | | | |
| Sub Total | 80,072 | | (38,772) | 38,981 | | 96,642 |
| W( Abutment) | 257,095 | (0,560) | (143,992) | - | 2,770 | - |
| Total | 337,167 | | (182,764) | 38,981 | | 96,642 |
| H [ Lr ] | | | | 5,250 | 5,640 | 29,610 |
| H ( W ) | | | | 1,980 | 5,640 | 11,167 |
| Total | | | | 7,230 | | 40,777 |

$\Sigma M$ = (163,764) ( longitudinal )
$\Sigma M$ = 40,777 ( Tranversal )
$\Sigma V$ = 337,167
$\Sigma H$ = 38,981 ( Longitudinal )
$\Sigma H$ = 7,230 ( transversal )

e = M/N = (0,486) ( Longitudinal )
e = M/N = 0,121 ( Transversal )

qmax = 16.065 tf/m2 ( longitudinal)
qmax = 12.006 tf/m2 ( tranfersal )

2 ) Dead Load + Earth Pressuse + Seisanic

| ITEM | V ( tf ) | x ( m ) | M ( tf - m ) | H ( tf ) | y ( m ) | M ( tf - m ) |
|---|---|---|---|---|---|---|
| Va ( DL ) | 5,015 | 0,475 | 2,382 | | | |
| Va ( LL ) | 22,000 | 0,475 | 10,450 | | | |
| Va [ Eq ] | 0,318 | 0,475 | 0,151 | | | |
| Eh | | | | 48,147 | 1,247 | 60,039 |
| | | | | (22,464) | 0,333 | (7,481) |
| Ev | 17,523 | (2,875) | (50,378) | | | |
| | (0,788) | 2,875 | (2,264) | | | |
| Eq ( DL ) | | | | 4,316 | 5,640 | 24,341 |
| Sub Total | 44,068 | | (39,659) | 29,999 | | 76,900 |
| W( Abutment) | 257,095 | (0,560) | (143,992) | 46,277 | 2,687 | 124,346 |
| Total | 301,163 | | (183,651) | 76,276 | | 201,246 |
| Eq [ LL ] | | | | 46,277 | 5,630 | 260,540 |

$\Sigma M$ = (164,651) ( longitudinal )
$\Sigma M$ = 260,540 ( Tranversal )
$\Sigma V$ = 301,163
$\Sigma H$ = 76,276 ( Longitudinal )
$\Sigma H$ = 46,277 ( transversal )

e = M/N = (0,547) ( Longitudinal )
e = M/N = 0,865 ( Transversal )

qmax = 14.956 tf/m2 ( longitudinal)
qmax = 18.119 tf/m2 ( tranfersal )

| Name of Structure | Railway Bridge BH - 13 | Category of Calculation | Structure Calculation | Page | 22/22 |
|---|---|---|---|---|---|

## 3.3.3 STABILITY ANALISYS OF BEARING CAPACITY

### BEARING CAPACITY ANALYSIS AT NORMAL CONDITION

In This Location is no Soil investigation, from Design Criteria Report can be estimed by N value .

$Qu = A' ( \alpha . k . c . Nc + k . q . Nq + 1/2 . \gamma 1 . \beta . B' . N\gamma )$

$A' = B' \times L'$

$B' = B - 2\ eB = 4,779$ m

$L' = L - 2\ eL = 5,258$ m

$A' = 25,126$ m²

$\alpha = 1,3$

$\beta = 0,6$

$k = 1+0.3 \times Df/B' = 1,126$ ; $Df = 2,000$ m

$q = g . Df = 3,4$ ; $g1 = 1,7$ t/m

$C = N/1 = 5/11 = 0,455$ ( for soft clay, N < 10 )

$\phi = 15 + (15*N)^{0.5} = 23,660$ degree

$Nc = 18,000$

$Nq = 9,000$

$N\gamma = 5,000$

$Qu = 1.472,390$ ton

TheUltimate Bearing capacity $qu = Qu/A' = 58,599$ ton/m2

From the stability analisis qa max = 14.016 t/m2

The safety factor $SF = qu / qa\ max = 4.181 > 3$

The Bearing Capacity its all right.

### BEARING CAPACITY ANALYSIS AT SEISMIC CONDITION

$Qa = Qu/Sf$

$Qu = A' ( \alpha . k . c . Nc + k . q . Nq + 1/2 . \gamma 1 . \beta . B' . N\gamma )$

$A' = B' \times L'$

$B' = B - 2\ eB = 4,657$ m

$L' = L - 2\ eL = 3,770$ m

$A' = 17,554$ m²

$\alpha = 1,3$

$\beta = 0,6$

$k = 1+0.3 \times Df/B' = 1,129$ ; $Df = 2,000$ m

$q = g . Df = 3,4$ ; $g1 = 1,7$ t/m

$C = N/1\ \ 5/11 = 0,455$ ( for soft clay, N < 10 )

$\phi = 15 + (15*N)^{0.5} = 23,660$ degree

$Nc = 18,000$

$Nq = 9,000$

$N\gamma = 5,000$

$Qu = 1.025,585$

TheUltimate Bearing capacity $qu = Qu/A' = 58,424$ ton/m2

From the stability analisis qa max = 18.119 t/m2

The safety factor $SF = qu / qa\ max = 3.224 > 2$

The Bearing Capacity its all right.

# DESIGN CALCULATION REPORT

## RAILWAY BRIDGE BH - 13

## PART 2

## STABILITY ANALISYS OF RAISING ABUTMENT

# PART 2

## STABILITY ANALISIS OF RAISING ABUTMENT
## RAILWAY BRIDGE BH. 13 ( STEEL BRIDGE 8.00 M )

Table content

# 1. DESIGN CONDITION

## 1,1 EXISTING CONDITION

**a. Superstructure**

- Type : Steel Girder
- Total weight : 10,03 tf
- Effective Span ( c . t . c ) : 8,80 m
- Total Lenght of girder : 9,60 m
- Center to center of main Girder : 3,00 m
- Distance between top of rail up to top of Concrete Bearing : 0,90 m
- Material of Bearing Shoe : Steel Bearing

**b. Substructure**

- Material : concrete K 225
- Type : cantilever
- Visual Condition : good
- Crack on Structure : nothing
- Displesement : nothing
- Fondation : concrete slab

## 1,2 TRACK CONDITION

- Track Plan : Straigt
- Track Elevation : 0,0044 gradien

## 1,3 REGULATION REFERENCE

- Spesifikation of Perumka Railway Bridge Design ( AVBP 1932 )
- PD-10
- Indonesian Concrete Code
- Elastic Analysis of concrete section ( Departement PU )

## 1,4 MATERIAL QUALITY

- Concrete K - 225
- Plain / Lean Concrete K-125
- Reinforced Steel bar U-32 ( Deform steel )

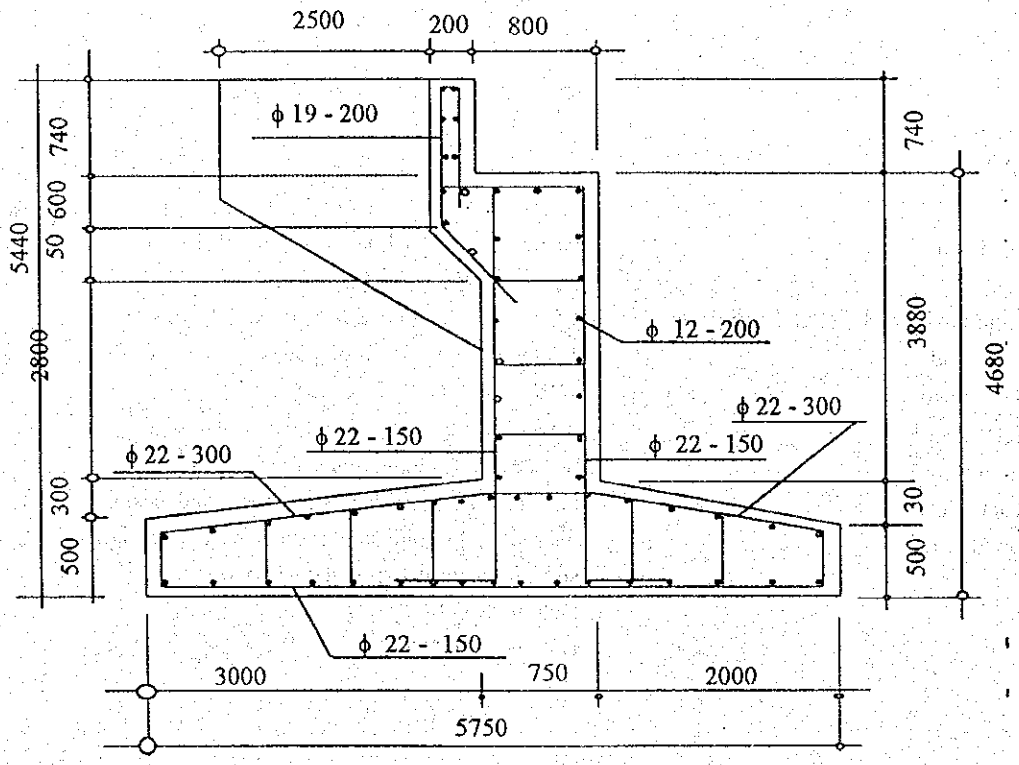
## 1,5 LOADINGS

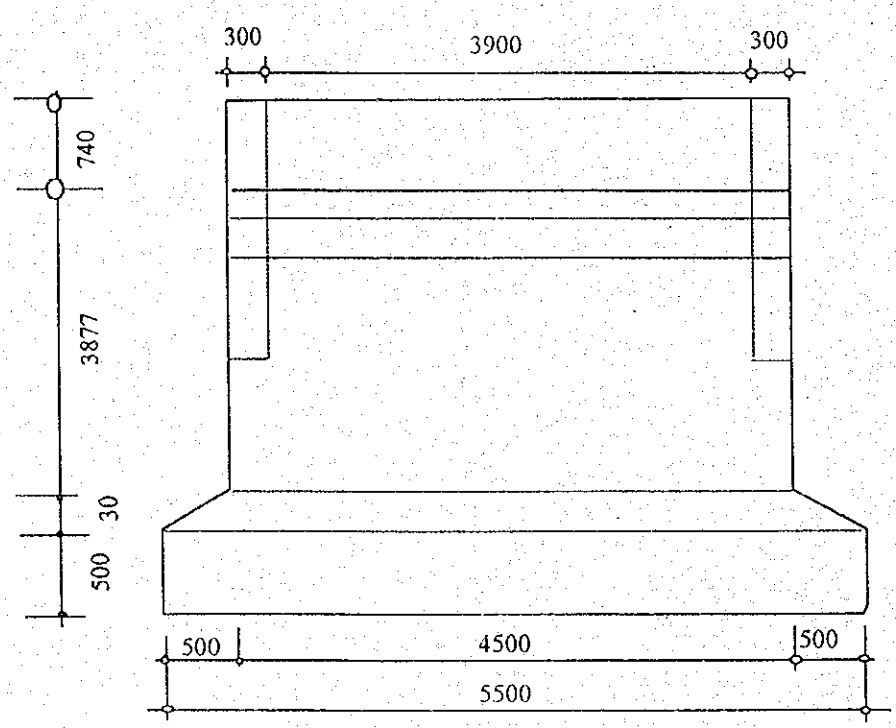
## 1,5 LOADINGS

| | |
|---|---|
| - Train 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 ) max. 200 tf |
| - Break Load | : 1/6 Locomotive + 1/10 Wagon |
| - Lateral Load | : 1/10 train Load |
| - Wind Load | : 0.10 $tf/m^2$ |
| - Eart Pressure | : bassed on Collomb teory |
| - Stream Flow | : based on the equivalent static force and design |
| - Seismic Load | : bassed on the equivalent static force and design seismic intensity expressed as followings : KH = 0.18 KV = 0.00 |

| Name of Structure | Railway Bridge BH - 13 | Category of Calculation | Structure Calculation | Page | |
|---|---|---|---|---|---|

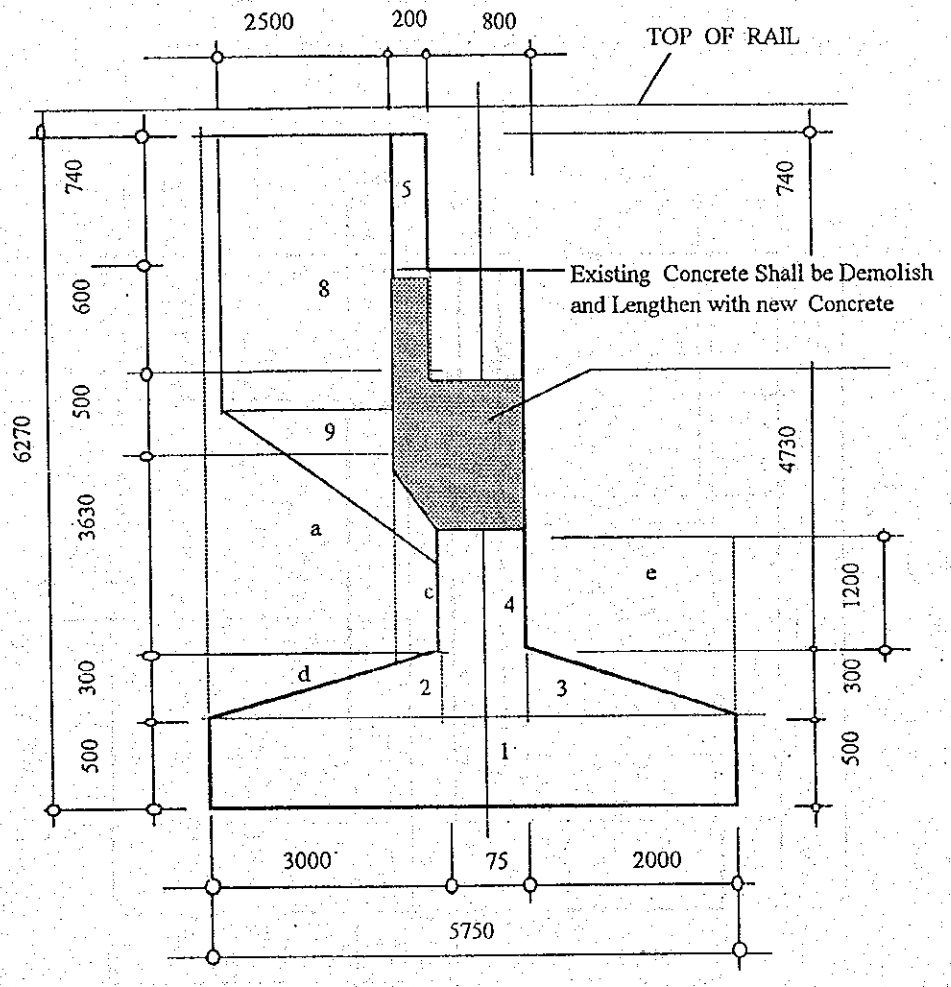
## 2. DIMENSION OF EXISTING ABUTMENT



| Name of Structure | Railway Bridge BH - 13 | Category of Calculation | Structure Calculation | Page | |
|---|---|---|---|---|---|

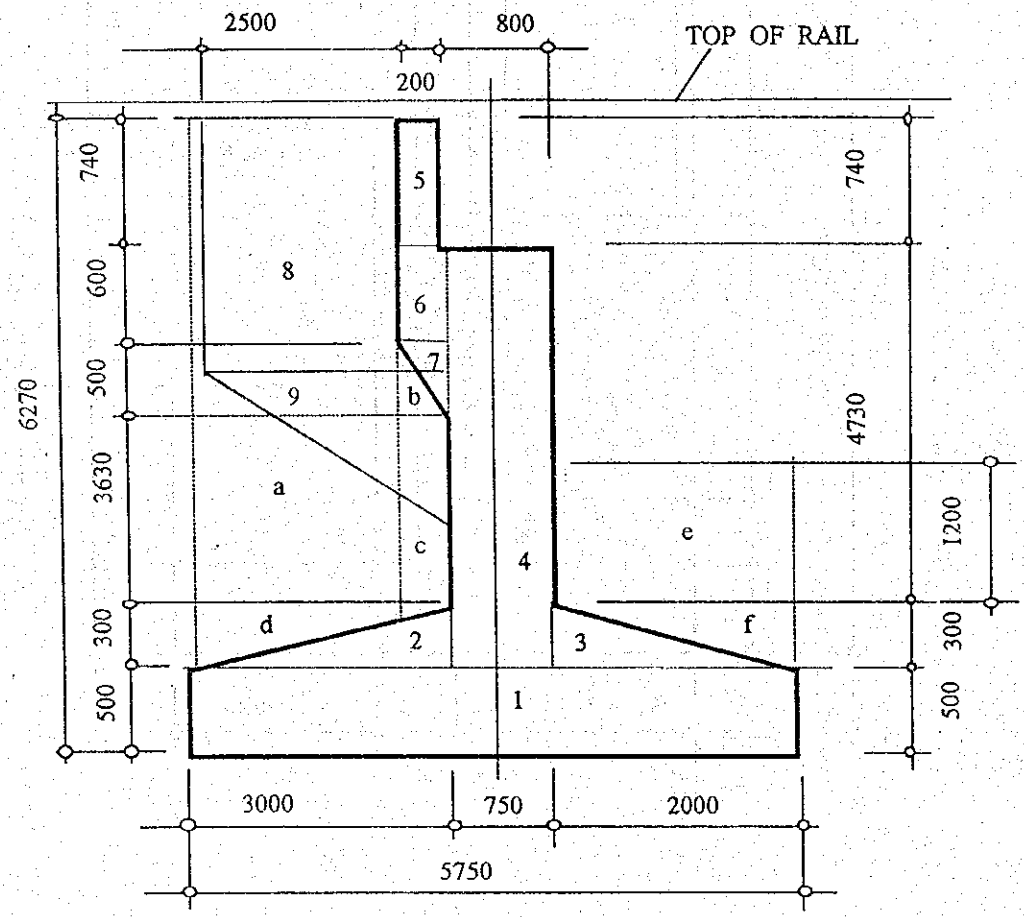
## BASIC CONCEP OF RAISING ABUTMENT



| Name Of Structure | Railwy Bridge BH - 13 | Category of Calculation | Structure Calculation | Page | 6/51 |
|---|---|---|---|---|---|

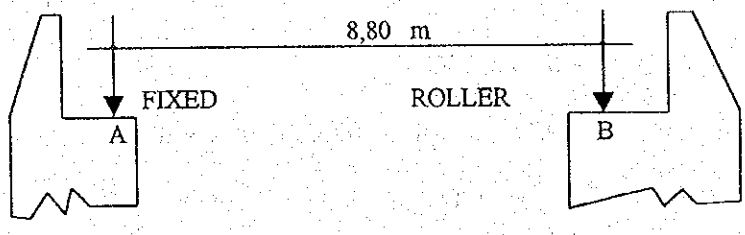
# 3. STABILITY ANALYSIS OF RAISING ABUTMENT

## 3,1 DIMENSION OF NEW ABUTMENT( AFTER RAISSING )



## 3,2 LOADING

### 3.2.1 VERTICAL FORCE




a. Dead Load

Vb = Va = 5,015 V tf

b. Train Load ( Live Load )

q tr 7 x 15.00 x 0.5 = 52,500 tf

Vb = Va = 52,500 tf

c. Impact Load

Impact Coefficient

I = 0.200 + 25/(8.00 + 50.00 ) = 0,631

Va = V 52.50 x 0.631 = 33,128 tf

d. Train Load for Seismic

q = 15.00 / 2.4 = 6,250 tf / m

Va = 6.250 x 8.8 x 0.5 = 27,500 tf

Vb = 6.250 x 8.8 x 0.5 = 27,500 tf

SUMMARY OF VERTICAL FORCE

| ITEM | Support A ( ton - f ) | Support B ( ton - f ) |
|---|---|---|
| Dead load ( DL ) | 5,015 | 5,015 |
| Train Load ( LL ) | 52,500 | 52,500 |
| Impact Load ( I ) | 33,128 | 33,128 |
| Train for Seismic ( LL ) | 27,500 | 27,500 |

### 3.2.2. LONGITUDINAL HORIZONTAL FORCE

a. DEAD LOAD + LONG RAIL LOAD

TOTAL HORIZONTAL FORCE

$\Sigma H = 9.6 \times 1.00 = 9,600$ tf

HORIZONTAL FORCE ON SUPPORT

$Ha = \Sigma H - 1/2 \times \mu \times Vb$

$= 9.60 - 0.5 \times 0.10 \times 9.60$

$= 9,120$ tf $> 1/2 \times 9.6 = 4.8$ tf

therefore

$Ha = 9,12$ tf

VERTICAL FORCE

$Va = 9.6 \times 0.9 / 8.8 = 0,982$ tf

b. LONG RAIL LOAD + BRAKE LOAD

TOTAL HORIZONTAL FORCE

$\Sigma H = 0 \times 15.00 \times 0.100 + 7 \times 15 \times 0.1667 + 9.6$

$= 27,1035$ tf

HORIZONTAL FORCE ON SUPPORT

$Ha = \Sigma H - 1/2 \times \mu \times Vb$

$= 27.1035 - 0.5 \times 0.10 \times (10.03+52.50)$

$= 23,977$ tf $> 1/2 \times 27.1035 = 13.5518$ tf

therefore

$Ha = 23.977$ tf

VERTICAL FORCE

$Va = 23.977 \times 0.9 / 8.8 = 2,452$ tf

c. TRAIN LOAD + LONG RAIL LOAD

TOTAL HORIZONTAL FORCE

$\Sigma H = 9.6 \times 1.00 = 9,600$ tf

HORIZONTAL FORCE ON SUPPORT

$Ha = \Sigma H - 1/2 \times \mu \times Vb$

$= 9.6 - 0.5 \times 0.10 \times (10.03+52.50)$

$= 6,474$ tf $> 1/2 \times 9.600 = 4.80$ tf

therefore

$Ha = 6.474$ tf

VERTICAL FORCE

$Va = 9.6 \times 0.9 / 8.8 = 0,982$ tf

d. DEAD LOAD FOR SEISMICC

TOTAL HORIZONTAL FORCE

$\Sigma H = 10.03 \times 2 \times 0.18 = 3,611$ tf

HORIZONTAL FORCE ON SUPPORT

$Ha = \Sigma H - 1/2 \times \mu \times Vb$

$= 3.611 - 0.5 \times 0.10 \times 10.03$

$= 3,110$ tf $> 1/2 \times 3.611 = 1.805$ tf

therefore

$Ha = 3.110$ tf

VERTICAL FORCE

$Va = 3.110 \times 0.9 / 8.8 = 0,318$ tf

e. TRAIN LOAD FOR SEISMICC

TOTAL HORIZONTAL FORCE

$\Sigma H = ( 10.03 + 27.50 ) \times 2 \times 0.18$ 13,511 tf

HORIZONTAL FORCE ON SUPPORT

$Ha = \Sigma H - 1/2 \times \mu \times Vb$

$= 13.511 - 0.5 \times 0.10 \times ( 10.03 + 27.500 )$

$= 11,635$ tf $> 1/2 \times 13.511 = 6.755$ tf

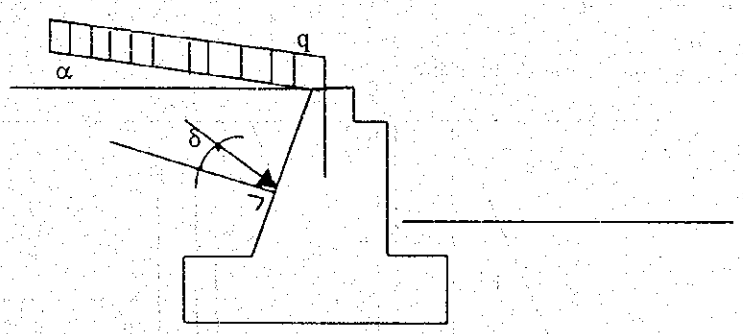
therefore

$Ha = 11.635$ tf

VERTICAL FORCE

$Va = 11.635 \times 0.9 / 8.8 = 1,190$ tf

f. EART PRESSURE




1) NORMAL CONDITION

COEFFICIENT OF EARTH PRESSURE

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

$$\cos^2 ( \phi + \theta )$$

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

Fill material

| | | |
|---|---|---|
| θ | = | 0 |
| ϕ | = | 30 |
| δ | = | 20 |
| α | = | 0 |
| Cos (ϕ − θ) | = | 0,8662 |
| Cos (ϕ + θ) | = | 0,8662 |
| Cos θ | = | 1,0000 |
| Cos (θ + δ) | = | 0,9398 |
| Sin (ϕ + δ) | = | 0,7658 |
| Sin (ϕ − δ) | = | 0,1736 |
| Sin (ϕ − α) | = | 0,4998 |
| Sin (ϕ + α) | = | 0,4998 |
| Cos (θ + δ) | = | 0,9398 |
| Cos (θ − α) | = | 1,0000 |

Soil ( Assumsion same with BH 10 )

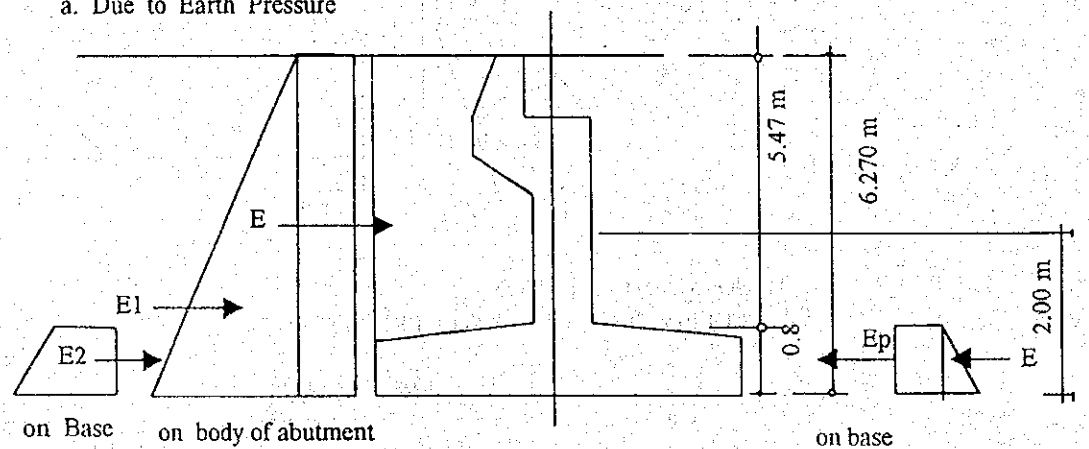
| | | |
|---|---|---|
| θ | = | 0 |
| ϕ | = | 3 |
| δ | = | 2 |
| α | = | 0 |
| Cos (ϕ − θ) | = | 0,9986 |
| Cos (ϕ + θ) | = | 0,9986 |
| Cos θ | = | 1,0000 |
| Cos (θ + δ) | = | 0,9994 |
| Sin (ϕ + δ) | = | 0,0871 |
| Sin (ϕ − δ) | = | 0,0174 |
| Sin (ϕ − α) | = | 0,0523 |
| Sin (ϕ + α) | = | 0,0523 |
| Cos (θ + δ) | = | 0,9994 |
| Cos (θ − α) | = | 1,0000 |

Active Earth Pressure

$$Ka = \frac{0.8660 \times 0.8660}{1.000 \times 0.9398 \times \left[1+\sqrt{\frac{0.7660 \times 0.5000}{0.9397 \times 1.000}}\right]^2}$$

$$= 0,2973$$

a. Due to Earth Pressure




Active Earth Pressure

| | | | | |
|---|---|---|---|---|
| E1 | = | 0.5 x 2.00x 6.270 x 6.270 x 0.2973 | 11,688 | tf/m |
| E2 | = | 0.8 x 2.00 x 6.270 x 0.2973 | 2,983 | tf/m |

E1 h = E1 Cos δ = 11.688 x 0.9397 = 10,983 tf/m
E2 h = E2 Cos δ = 2.983 x 0.9397 = 2,803 tf/m
E1 v = E1 Sin δ = 111.688 x 0.342 = 3,997 tf/m
E2 v = E2 Sin δ = 2.983 x 0.342 = 1,020 tf/m

Total force per abutment

| | | | | | |
|---|---|---|---|---|---|
| E1h = 10.983 x 4.5 | = | 49,423 tf | y1 = | 2,093 | m |
| E2h = 2.803 x 4.5 | = | 12,612 tf | y2 = | 0,400 | m |
| | ✓ | 62,035 tf | y = | 1,247 | m |
| E1v = 3.997 x 4.50 | = | 17,987 tf | x1 | 2,875 | m |
| E2v = 1.02 x 4.50 | = | 4,590 tf | x2 | 2,875 | m |
| | ✓ | 22,577 tf | x | 2,875 | m |

Passive Earth Pressure

$$Ka = \frac{0.9986 \times 0.9986}{1.000 \times 0.9994 \times \left[1 + \sqrt{\frac{0.0672 \times 0.0523}{0.9994 \times 1.000}}\right]^2}$$

$$= 1,1477$$

Ep1 = 2.00 x 1.60 x 1.1477 = 3,673 tf/m²
Ep2 = 2.80 x 1.60 x 1.1477 = 5,142 tf/m²

Ep1 = 0.80 x 3.673 = 2,938 tf/m
Ep2 = 0.5 x 0.8 x 5.142 = 2,057 tf/m

Ep1 h = E1 Cos δ = 2.938 x 0.9994 = 2,936 tf/m
Ep2 h = E2 Cos δ = 2.057 x 0.9994 = 2,056 tf/m
Ep1 v = E1 Sin δ = 2.938 x 0.0349 = 0,103 tf/m
Ep2 v = E1 Sin δ = 2.057 x 0.0349 = 0,072 tf/m

Total force per abutment

| | | | | | |
|---|---|---|---|---|---|
| Ep1h = 2.936 x 4.50 | = | 13,212 tf | y1 = | 0,400 | m |
| Ep2h = 2.056 x 4.50 | = | 9,252 tf | y2 = | 0,267 | m |
| | ✓ | 22,464 tf | y = | 0,333 | m |
| Ep1v = 0.103 x 4.50 | = | 0,464 tf | x1 | 2,875 | m |
| Ep2v = 0.072 x 4.50 | = | 0,324 tf | x2 | 2,875 | m |
| | | 0,788 tf | x | 2,875 | m |

b). Do to live Load

Total force per Abutment
E = 8.75 x 0.2973 x 6.27 = 16,311 tf
Eh = E Cos δ 16.311 x 0.9397 = 15,327 tf-m
Ev = E Sin δ 16.311 x 0.3420 = 5,578 tf-m

2). EARTQUAKE CONDITION

COEFFICIENT OF EARTH PRESSURE

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

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

| Fill material | | | Soil ( Assumsion same with BH 10 ) | | |
|---|---|---|---|---|---|
| θo | = | 10,20 | θo | = | 10,20 |
| θ | = | 0,00 | θ | = | 0,00 |
| ϕ | = | 30,00 | ϕ | = | 3,00 |
| δ | = | 0,00 | δ | = | 0,00 |
| α | = | 0,00 | α | = | 0,00 |
| Cos ( ϕ – θo –θ ) | = | 0,9408 | Cos ( ϕ – θo –θ ) | = | 0,9921 |
| Cos ( ϕ – θo +θ ) | = | 0,9408 | Cos ( ϕ – θo +θ ) | = | 0,9921 |
| Cos θo | = | 0,9842 | Cos θo | = | 0,9842 |
| Cos θ | = | 1,0000 | Cos θ | = | 1,0000 |
| Cos ( θ +θo+ δ ) | = | 0,9842 | Cos ( θ +θo+ δ ) | = | 0,9842 |
| Cos ( θ +θo+ δ ) | = | 0,9842 | Cos ( θ +θo+ δ ) | = | 0,9842 |
| Sin ( ϕ + δ ) | = | 0,5002 | Sin ( ϕ + δ ) | = | 0,0524 |
| Sin ( ϕ +δ– θo ) | = | 0,3389 | Sin ( ϕ +δ– θo ) | = | -0,1254 |
| Sin ( ϕ – δ ) | = | 0,5002 | Sin ( ϕ – δ ) | = | 0,0524 |
| Sin ( ϕ +α– θo ) | = | 0,3386 | Sin ( ϕ +α– θo ) | = | -0,1253 |
| Cos ( θ – α ) | = | 1,0000 | Cos ( θ – α ) | = | 1,0000 |

Active Earth pressure

$$Kea = \frac{0{,}9842 \times 0{,}9408}{0.9842 \times 1.000 \times 1.000 + 0.9842\left[1 + \sqrt{\frac{0.5000 \times 0.3387}{0.9842 \times 1.000}}\right]^2}$$

$$= 0{,}4566$$

a). Due to Earth Pressure

| | | | | | | |
|---|---|---|---|---|---|---|
| E1 | = | 0.500 x 1.90 x 6.270 x 6.270 x 0.4566 | = | 17,080 | tf / m |
| E2 | = | 0.800 x 1.90 x 6.270 x 0.4566 | = | 4,352 | tf / m |
| E1h | = | E Cos δ | = | 17.080 x 1.000 | = | 17,080 | tf / m |
| E2h | = | E Cos δ | = | 4.352 x 1.000 | = | 4,352 | tf / m |

E1v = E Sin δ = 17.080 x 0.000 = 0,000 tf / m
E2v = E Sin δ = 4.352 x 0.000 = 0,000 tf / m

Total force per abutment

| | | | | | |
|---|---|---|---|---|---|
| E1h = 17.080 x 4.50 = | 76,860 tf | y1 = | 2,090 | m |
| E2h = 4.351 x 4.50 = | 19,582 tf | y2 = | 0,400 | m |
| | 96,442 tf | y = | 1,245 | m |
| E1v = 0.000 x 4.50 = | 0,000 tf | x1 = | 2,875 | m |
| E2v = 0.000 x 4.50 = | 0,000 tf | x2 = | 2,875 | m |
| | 0,000 tf | x = | 2,875 | m |

Passive Earth pressure

$$Kep = \frac{0,9408 \quad x \quad 0,9408}{0.9842 \times 1.000 \times 1.000 + 0.9842 \left[ 1 + \sqrt{\frac{0.0523 \times -0.1253}{0.9842 \times 1.000}} \right]^2}$$

= not possible

SUMMARY DUE TO LONGITUDINAL HORIZONTAL FORCE

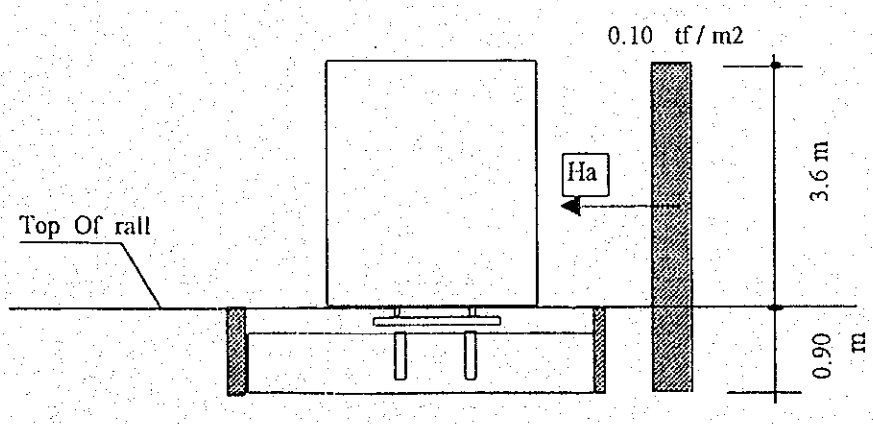
| ITEM | FORCE ON SUPPORT | |
|---|---|---|
| | Ha | Va |
| Long Rail ( D L ) | 9,120 | 0,982 |
| Long ( DL ) + Brake ( B ) | 23,977 | 2,452 |
| Long Rail ( LL ) | 6,474 | 0,982 |
| Seismic ( DL ) | 3,110 | 0,318 |
| Seismic ( LL ) | 11,635 | 1,190 |

### 3.3.3. TRANVERSAL HORIZONTAL FORCE

a. LATERAL LOAD

Ha = 0.5 x 0.1 x 7 x 15 = 5,25 tf

b. WIND LOAD



Ha = 0.10 x 4.50 x 8.8 x 0.50 1,98 tf

c. DEAD LOAD FOR SEISMIC LOAD

Ea = 10.03 x 0.18 1,8054 tf

d. LIVE LOAD FOR SEISMIC LOAD

Ea = 23.977 x 0.18 = 4,31586 tf

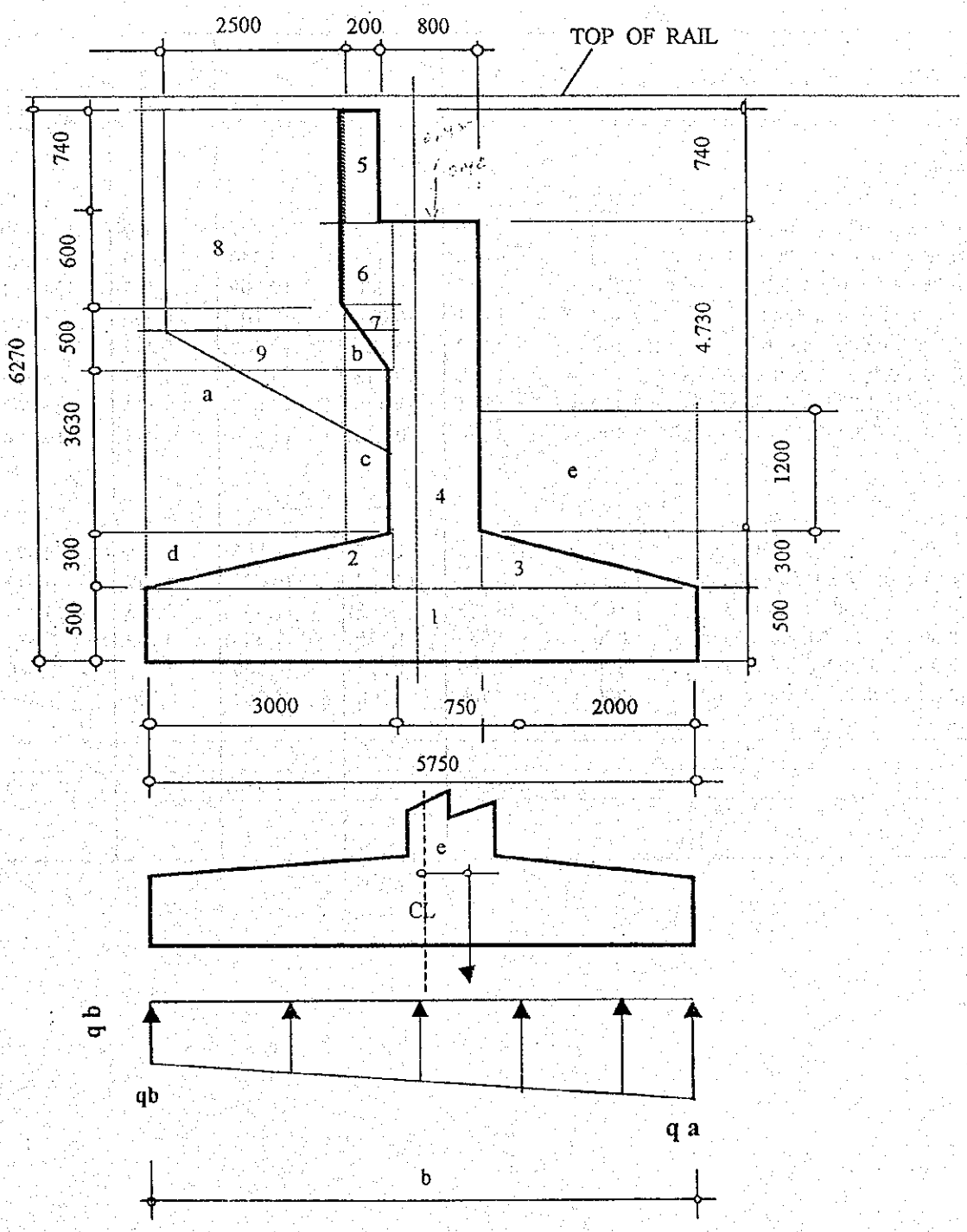
SUMMARY DUE TO TRANVERSAL HORIZONTAL FORCE

| ITEM | FORCE ON SUPPORT | |
|---|---|---|
| | H ( ton - f ) | Y ( m ) |
| Lateral Load ( Lr ) | 5,250 | 1,225 |
| Wind Load ( W ) | 1,980 | 2,575 |
| Seismic ( DL ) | 1,805 | 1,225 |
| Seismic ( LL ) | 4,316 | 1,225 |

| Name Of Structure | Railway Bridge BH - 13 | Category of Calculation | Structure Calculation | Page | 15/51 |
|---|---|---|---|---|---|

## 3.3 STABILITY ANALYSIS

### 3.3.1 WEIGHT OF ABUTMENT



| Name Of Structure | Railway Bridge BH - 13 | Category of Calculation | Structure Calculation | Page | 16/51 |
|---|---|---|---|---|---|

| ITEM | WIGHT OF ABUTMENT | | ( tf ) | X | Mx ( tf-m ) | Y ( m ) | My ( tf - m ) |
|---|---|---|---|---|---|---|---|
| | CONCRETE | | | | | | |
| 1 | 5.750 x 0.500 x 5.500 x | 2.400 = | 37,950 | - | - | 0,250 | 9,488 |
| 2 | 0.50 x 3.000 x 0.500 x 5.000 x | 2.400 = | 9,000 | (0,875) | (7,875) | 0,600 | 5,400 |
| 3 | 0.50 x 2.000 x 0.500 x 5.000 x | 2.400 = | 6,000 | 1,542 | 9,250 | 0,600 | 3,600 |
| 4 | 0.750 x 4.730 x 4.500 x | 2.400 = | 38,418 | 0,500 | 19,209 | 3,165 | 121,594 |
| 5 | 0.200 x 0.740 x 4.000 x | 2.400 = | 1,421 | (0,075) | (0,107) | 5,900 | 8,383 |
| 6 | 0.500 x 0.600 x 4.000 x | 2.400 = | 2,880 | (0,125) | (0,360) | 5,230 | 15,062 |
| 7 | 0.50 x 0.500 x 0.500 x 4.000 x | 2.400 = | 1,200 | (0,042) | (0,050) | 4,763 | 5,716 |
| 8 | 2.900 x 1.570 x 0.250 x 2.0 x | 2.400 = | 5,464 | (1,475) | (8,059) | 5,485 | 29,968 |
| 9 | 0.50 x 2.700 x 2.00 x 0.25 x 2.0 | 2.400 = | 3,240 | (0,875) | (2,835) | 4,033 | 13,068 |
| | SOIL | | | | | | |
| a | 2.500 x 5.470 x 5.500 x | 1.800 = | 135,383 | (1,625) | (219,997) | 3,535 | 478,577 |
| b | 0.50 x 0.500 x 0.500 x 0.500 x | 1.800 = | 0,113 | (0,208) | (0,023) | 4,597 | 0,517 |
| c | 0.500 x 2.80 x 5.000 x | 1.800 = | 16,785 | (0,175) | (2,937) | 2,615 | 43,893 |
| d | 0.50 x 3.000 x 0.300 x 5.000 x | 1.800 = | 4,050 | (1,875) | (7,594) | 0,700 | 2,835 |
| e | 2.000 x 1.200 x 5.000 x | 1.800 = | 21,600 | 1,875 | 40,500 | 2,300 | 49,680 |
| f | 0.50 x 2.000 x 0.300 x 5.000 x | 1.800 = | 2,700 | 2,208 | 5,963 | 0,700 | 1,890 |
| | | | | | | | |
| | | | 286,203 | | (174,915) | | 789,670 |
| | X = (0,611) | | | | | | |
| | Y = 2,759 | | | | | | |