CONCRETE PILE CALCULATION
No : 1

PROJECT : RAILWAY BRIDGE ACROSS FLOODWAY
LOCATION : BH. 10 , PIER (DL+LL+I+E), LWL CONDITION

DISPLACEMENT METHOD

DATA OF PILE :

- NUMBER OF PILE	:	24
- LENGTH	:	13.06 m.
- DIAMETER	:	0.45 m.
- AREA	:	0.0930 m2.
- INERSIA	:	0.002000 m4
- MODULUS ELASTICITY [E]	:	1400000.00 tf/m2.

ANGLE AND COORDINATE OF PILE :

No. PILE	ANGLE TO THE VERTICAL AXIS [°]	DISTANCE TO THE POER AXIS [m]
1	0.00	-2.70
2	0.00	-2.70
3	0.00	-2.70
4	0.00	-2.70
5	0.00	-1.35
6	0.00	-1.35
7	0.00	-1.35
8	0.00	-1.35
9	0.00	-0.68
10	0.00	-0.68
11	0.00	0.00
12	0.00	0.00
13	0.00	0.00
14	0.00	0.00
15	0.00	0.68
16	0.00	0.68
17	0.00	1.35
18	0.00	1.35
19	0.00	1.35
20	0.00	1.35
21	0.00	2.70
22	0.00	2.70
23	0.00	2.70
24	0.00	2.70

EXTERNAL FORCE :

- MOMENT	:	5.26 tf m.
- VERTICAL FORCE	:	772.08 tf.
- HORIZONTAL FORCE	:	0.00 tf.

N VALUE : 3

COEFFICIENT OF HORIZONTAL SUBGRADE REACTION :
Ko : 0.97 kg-f/cm3.
k : 3.06 kg-f/cm3 = 3057.74 t-f/m3.

CHRACTERISTIC VALUE OF PILE :
β : 0.59204 1/m.
Γ : 1.69 m.

SPRING CONSTANTS OF PILE :

k1	:	2324.15 tf/m.			
k2 = k3	:	1962.84 tf/rad.			
k4	:	3315.41 tm-f/rad.			
a	:	0.92	----->	kv :	9170.94 t/m.

DISPLACEMENT EQUATIONS :

(5.6E+04)	δx+(0.0E+00)	δy+(-4.7E+04)	α =	0.00
(0.0E+00)	δx+(2.2E+05)	δy+(-3.6E-07)	α =	772.08
(-4.7E+04)	δx+(-3.6E-07)	δy+(7.6E+05)	α =	5.26

DISPLACEMENT AT CENTERLINE OF PILECAP :

δx	:	0.00 cm
δy	:	0.35 cm
α	:	0.00001 rad

DISPLACEMENT AND AXIAL/ORTHOGONAL FORCE :

No. PILE	δ'x [cm]	δ'y [cm]	PH [tf]	PN [tf]
1	0.00	0.35	0.00	31.99
2	0.00	0.35	0.00	31.99
3	0.00	0.35	0.00	31.99
4	0.00	0.35	0.00	31.99
5	0.00	0.35	0.00	32.08
6	0.00	0.35	0.00	32.08
7	0.00	0.35	0.00	32.08
8	0.00	0.35	0.00	32.08
9	0.00	0.35	0.00	32.13
10	0.00	0.35	0.00	32.13
11	0.00	0.35	0.00	32.17
12	0.00	0.35	0.00	32.17
13	0.00	0.35	0.00	32.17
14	0.00	0.35	0.00	32.17
15	0.00	0.35	0.00	32.21
16	0.00	0.35	0.00	32.21
17	0.00	0.35	0.00	32.26
18	0.00	0.35	0.00	32.26
19	0.00	0.35	0.00	32.26
20	0.00	0.35	0.00	32.26
21	0.00	0.35	0.00	32.35
22	0.00	0.35	0.00	32.35
23	0.00	0.35	0.00	32.35
24	0.00	0.35	0.00	32.35

REACTION ON HEAD OF PILE :

No. PILE	H [tf]	N [tf]	Mt [tf-m]
1	0.00	31.99	0.01
2	0.00	31.99	0.01
3	0.00	31.99	0.01
4	0.00	31.99	0.01
5	0.00	32.08	0.01
6	0.00	32.08	0.01
7	0.00	32.08	0.01
8	0.00	32.08	0.01
9	0.00	32.13	0.01
10	0.00	32.13	0.01
11	0.00	32.17	0.01

12	0.00	32.17	0.01
13	0.00	32.17	0.01
14	0.00	32.17	0.01
15	0.00	32.21	0.01
16	0.00	32.21	0.01
17	0.00	32.26	0.01
18	0.00	32.26	0.01
19	0.00	32.26	0.01
20	0.00	32.26	0.01
21	0.00	32.35	0.01
22	0.00	32.35	0.01
23	0.00	32.35	0.01
24	0.00	32.35	0.01

ALLOWABLE HORZONTAL FORCE

δ = 1 cm (Normal Condition)
H all = 23.24 tf

CONCRETE PILE CALCULATION
No : 1

BH.10-114

PROJECT : RAILWAY BRIDGE ACROSS FLOODWAY
LOCATION : BH. 10 , PIER (DL+LL+I+E+Lr) , LWL CONDITION

DISPLACEMENT METHOD

DATA OF PILE :

- NUMBER OF PILE	:	24
- LENGTH	:	13.06 m.
- DIAMETER	:	0.45 m.
- AREA	:	0.0930 m2.
- INERSIA	:	0.002000 m4
- MODULUS ELASTICITY [E]	:	1400000.00 tf/m2.

ANGLE AND COORDINATE OF PILE :

No. PILE	ANGLE TO THE VERTICAL AXIS [°]	DISTANCE TO THE POER AXIS [m]
1	0.00	-2.70
2	0.00	-2.70
3	0.00	-2.70
4	0.00	-2.70
5	0.00	-1.35
6	0.00	-1.35
7	0.00	-1.35
8	0.00	-1.35
9	0.00	-0.68
10	0.00	-0.68
11	0.00	0.00
12	0.00	0.00
13	0.00	0.00
14	0.00	0.00
15	0.00	0.68
16	0.00	0.68
17	0.00	1.35
18	0.00	1.35
19	0.00	1.35
20	0.00	1.35
21	0.00	2.70
22	0.00	2.70
23	0.00	2.70
24	0.00	2.70

EXTERNAL FORCE :

- MOMENT	:	308.78 tf m.
- VERTICAL FORCE	:	772.07 tf.
- HORIZONTAL FORCE	:	41.35 tf.

N VALUE : 3

COEFFICIENT OF HORIZONTAL SUBGRADE REACTION :
Ko : 0.97 kg-f/cm3.
k : 2.16 kg-f/cm3 = 2162.15 t-f/m3.

CHRACTERISTIC VALUE OF PILE :
β : 0.54290 1/m.
I : 1.84 m.

SPRING CONSTANTS OF PILE :

k1	:	1792.16 tf/m.			
k2 = k3	:	1650.55 tf/rad.			
k4	:	3040.24 tm-f/rad.			
a	:	0.92	---->	kv :	9170.94 t/m.

DISPLACEMENT EQUATIONS :

(4.3E+04) δx+(0.0E+00) δy+(-4.0E+04) α = 41.35
(0.0E+00) δx+(2.2E+05) δy+(-3.6E-07) α = 772.07
(-4.0E+04) δx+(-3.6E-07) δy+(7.6E+05) α = 308.78

DISPLACEMENT AT CENTERLINE OF PILECAP :

δx	:	0.14 cm
δy	:	0.35 cm
α	:	0.00048 rad

DISPLACEMENT AND AXIAL/ORTHOGONAL FORCE :

No. PILE	δ'x [cm]	δ'y [cm]	PH [tf]	PN [tf]
1	0.14	0.22	1.72	20.27
2	0.14	0.22	1.72	20.27
3	0.14	0.22	1.72	20.27
4	0.14	0.22	1.72	20.27
5	0.14	0.29	1.72	26.22
6	0.14	0.29	1.72	26.22
7	0.14	0.29	1.72	26.22
8	0.14	0.29	1.72	26.22
9	0.14	0.32	1.72	29.19
10	0.14	0.32	1.72	29.19
11	0.14	0.35	1.72	32.17
12	0.14	0.35	1.72	32.17
13	0.14	0.35	1.72	32.17
14	0.14	0.35	1.72	32.17
15	0.14	0.38	1.72	35.14
16	0.14	0.38	1.72	35.14
17	0.14	0.42	1.72	38.12
18	0.14	0.42	1.72	38.12
19	0.14	0.42	1.72	38.12
20	0.14	0.42	1.72	38.12
21	0.14	0.48	1.72	44.07
22	0.14	0.48	1.72	44.07
23	0.14	0.48	1.72	44.07
24	0.14	0.48	1.72	44.07

REACTION ON HEAD OF PILE :

No. PILE	H [tf]	N [tf]	Mt [tf-m]
1	1.72	20.27	-0.86
2	1.72	20.27	-0.86
3	1.72	20.27	-0.86
4	1.72	20.27	-0.86
5	1.72	26.22	-0.86
6	1.72	26.22	-0.86
7	1.72	26.22	-0.86
8	1.72	26.22	-0.86
9	1.72	29.19	-0.86
10	1.72	29.19	-0.86
11	1.72	32.17	-0.86

12	1.72	32.17	-0.86
13	1.72	32.17	-0.86
14	1.72	32.17	-0.86
15	1.72	35.14	-0.86
16	1.72	35.14	-0.86
17	1.72	38.12	-0.86
18	1.72	38.12	-0.86
19	1.72	38.12	-0.86
20	1.72	38.12	-0.86
21	1.72	44.07	-0.86
22	1.72	44.07	-0.86
23	1.72	44.07	-0.86
24	1.72	44.07	-0.86

ALLOWABLE HORZONTAL FORCE

δ = 1 cm (Normal Condition)
H all = 17.92 tf

CONCRETE PILE CALCULATION
No : 1

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

DISPLACEMENT METHOD

DATA OF PILE :

- NUMBER OF PILE	:	24
- LENGTH	:	13.06 m.
- DIAMETER	:	0.45 m.
- AREA	:	0.0930 m2.
- INERSIA	:	0.002000 m4
- MODULUS ELASTICITY [E]	:	1400000.00 tf/m2.

ANGLE AND COORDINATE OF PILE :

No. PILE	ANGLE TO THE VERTICAL AXIS [°]	DISTANCE TO THE POER AXIS [m]
1	0.00	-2.70
2	0.00	-2.70
3	0.00	-2.70
4	0.00	-2.70
5	0.00	-1.35
6	0.00	-1.35
7	0.00	-1.35
8	0.00	-1.35
9	0.00	-0.68
10	0.00	-0.68
11	0.00	0.00
12	0.00	0.00
13	0.00	0.00
14	0.00	0.00
15	0.00	0.68
16	0.00	0.68
17	0.00	1.35
18	0.00	1.35
19	0.00	1.35
20	0.00	1.35
21	0.00	2.70
22	0.00	2.70
23	0.00	2.70
24	0.00	2.70

EXTERNAL FORCE :

- MOMENT	:	558.08 tf m.
- VERTICAL FORCE	:	771.75 tf.
- HORIZONTAL FORCE	:	75.35 tf.

N VALUE : 3

COEFFICIENT OF HORIZONTAL SUBGRADE REACTION :
Ko : 0.97 kg-f/cm3.
k : 1.53 kg-f/cm3 = 1528.87 t-f/m3.

CHRACTERISTIC VALUE OF PILE :
β : 0.49784 1/m.
Γ : 2.01 m.

SPRING CONSTANTS OF PILE :

k1	:	1381.95 tf/m.			
k2 = k3	:	1387.94 tf/rad.			
k4	:	2787.91 tm-f/rad.			
a	:	0.92	---->	kv :	9170.94 t/m.

DISPLACEMENT EQUATIONS :

(3.3E+04)	δx+	(0.0E+00)	δy+	(-3.3E+04)	α =	75.35
(0.0E+00)	δx+	(2.2E+05)	δy+	(-3.6E-07)	α =	771.75
(-3.3E+04)	δx+	(-3.6E-07)	δy+	(7.5E+05)	α =	558.08

DISPLACEMENT AT CENTERLINE OF PILECAP :

δx	:	0.32 cm
δy	:	0.35 cm
α	:	0.00088 rad

DISPLACEMENT AND AXIAL/ORTHOGONAL FORCE :

No. PILE	δ'x [cm]	δ'y [cm]	PH [tf]	PN [tf]
1	0.32	0.11	3.14	10.32
2	0.32	0.11	3.14	10.32
3	0.32	0.11	3.14	10.32
4	0.32	0.11	3.14	10.32
5	0.32	0.23	3.14	21.24
6	0.32	0.23	3.14	21.24
7	0.32	0.23	3.14	21.24
8	0.32	0.23	3.14	21.24
9	0.32	0.29	3.14	26.70
10	0.32	0.29	3.14	26.70
11	0.32	0.35	3.14	32.16
12	0.32	0.35	3.14	32.16
13	0.32	0.35	3.14	32.16
14	0.32	0.35	3.14	32.16
15	0.32	0.41	3.14	37.61
16	0.32	0.41	3.14	37.61
17	0.32	0.47	3.14	43.07
18	0.32	0.47	3.14	43.07
19	0.32	0.47	3.14	43.07
20	0.32	0.47	3.14	43.07
21	0.32	0.59	3.14	53.99
22	0.32	0.59	3.14	53.99
23	0.32	0.59	3.14	53.99
24	0.32	0.59	3.14	53.99

REACTION ON HEAD OF PILE :

No. PILE	H [tf]	N [tf]	Mt [tf-m]
1	3.14	10.32	-1.92
2	3.14	10.32	-1.92
3	3.14	10.32	-1.92
4	3.14	10.32	-1.92
5	3.14	21.24	-1.92
6	3.14	21.24	-1.92
7	3.14	21.24	-1.92
8	3.14	21.24	-1.92
9	3.14	26.70	-1.92
10	3.14	26.70	-1.92
11	3.14	32.16	-1.92

12	3.14	32.16	-1.92
13	3.14	32.16	-1.92
14	3.14	32.16	-1.92
15	3.14	37.61	-1.92
16	3.14	37.61	-1.92
17	3.14	43.07	-1.92
18	3.14	43.07	-1.92
19	3.14	43.07	-1.92
20	3.14	43.07	-1.92
21	3.14	53.99	-1.92
22	3.14	53.99	-1.92
23	3.14	53.99	-1.92
24	3.14	53.99	-1.92

ALLOWABLE HORZONTAL FORCE

δ = 1 cm (Normal Condition)
H all = 13.82 tf

CONCRETE PILE CALCULATION
No : 1

BH. 10-120

PROJECT : RAILWAY BRIDGE ACROSS FLOODWAY
LOCATION : BH. 10 , PIER (DL+E+EQ) , LWL CONDITION

DISPLACEMENT METHOD

DATA OF PILE :

- NUMBER OF PILE	:	24
- LENGTH	:	13.06 m.
- DIAMETER	:	0.45 m.
- AREA	:	0.0930 m2.
- INERSIA	:	0.002000 m4
- MODULUS ELASTICITY [E]	:	1400000.00 tf/m2.

ANGLE AND COORDINATE OF PILE :

No. PILE	ANGLE TO THE VERTICAL AXIS [°]	DISTANCE TO THE POER AXIS [m]
1	0.00	-2.70
2	0.00	-2.70
3	0.00	-2.70
4	0.00	-2.70
5	0.00	-1.35
6	0.00	-1.35
7	0.00	-1.35
8	0.00	-1.35
9	0.00	-0.68
10	0.00	-0.68
11	0.00	0.00
12	0.00	0.00
13	0.00	0.00
14	0.00	0.00
15	0.00	0.68
16	0.00	0.68
17	0.00	1.35
18	0.00	1.35
19	0.00	1.35
20	0.00	1.35
21	0.00	2.70
22	0.00	2.70
23	0.00	2.70
24	0.00	2.70

EXTERNAL FORCE :

- MOMENT	:	515.36 tf m.
- VERTICAL FORCE	:	550.90 tf.
- HORIZONTAL FORCE	:	104.89 tf.

N VALUE : 3

COEFFICIENT OF HORIZONTAL SUBGRADE REACTION :
Ko : 0.97 kg-f/cm3.
k : 1.44 kg-f/cm3 = 1441.43 t-f/m3.

CHRACTERISTIC VALUE OF PILE :
β : 0.49057 1/m.
Γ : 2.04 m.

SPRING CONSTANTS OF PILE :

KA	:	1322.24 tf/m.		
KI = KB	:	1347.67 tf/rad.		
KA	:	2747.17 tm-f/rad.		
S	:	0.92 ---->	kv :	9170.94 t/m.

DISPLACEMENT EQUATIONS :

(3.7E+04) δx+(0.0E+00) δy+(-3.2E+04) α =	104.89
(0.0E+00) δx+(2.2E+05) δy+(-3.6E-07) α =	550.90
(-3.2E+04) δx+(-3.6E-07) δy+(7.5E+05) α =	515.36

DISPLACEMENT AT CENTERLINE OF PILECAP :

δx :	0.42 cm
δy :	0.25 cm
α :	0.00087 rad

DISPLACEMENT AND AXIAL/ORTHOGONAL FORCE :

No. PILE	δ x [cm]	δ y [cm]	PH [tf]	PN [tf]
1	0.42	0.02	4.37	1.50
2	0.42	0.02	4.37	1.50
3	0.42	0.02	4.37	1.50
4	0.42	0.02	4.37	1.50
5	0.42	0.13	4.37	12.23
6	0.42	0.13	4.37	12.23
7	0.42	0.13	4.37	12.23
8	0.42	0.13	4.37	12.23
9	0.42	0.19	4.37	17.59
10	0.42	0.19	4.37	17.59
11	0.42	0.25	4.37	22.95
12	0.42	0.25	4.37	22.95
13	0.42	0.25	4.37	22.95
14	0.42	0.25	4.37	22.95
15	0.42	0.31	4.37	28.32
16	0.42	0.31	4.37	28.32
17	0.42	0.37	4.37	33.68
18	0.42	0.37	4.37	33.68
19	0.42	0.37	4.37	33.68
20	0.42	0.37	4.37	33.68
21	0.42	0.48	4.37	44.41
22	0.42	0.48	4.37	44.41
23	0.42	0.48	4.37	44.41
24	0.42	0.48	4.37	44.41

REACTION ON HEAD OF PILE :

No. PILE	H [tf]	N [tf]	Mt [tf-m]
1	4.37	1.50	-3.26
2	4.37	1.50	-3.26
3	4.37	1.50	-3.26
4	4.37	1.50	-3.26
5	4.37	12.23	-3.26
6	4.37	12.23	-3.26
7	4.37	12.23	-3.26
8	4.37	12.23	-3.26
9	4.37	17.59	-3.26
10	4.37	17.59	-3.26
11	4.37	22.95	-3.26

12	4.37	22.95	-3.26
13	4.37	22.95	-3.26
14	4.37	22.95	-3.26
15	4.37	28.32	-3.26
16	4.37	28.32	-3.26
17	4.37	33.68	-3.26
18	4.37	33.68	-3.26
19	4.37	33.68	-3.26
20	4.37	33.68	-3.26
21	4.37	44.41	-3.26
22	4.37	44.41	-3.26
23	4.37	44.41	-3.26
24	4.37	44.41	-3.26

ALLOWABLE HORZONTAL FORCE

δ = 1 cm (Normal Condition)
H all = 13.22 tf

CONCRETE PILE CALCULATION
No : 1

PROJECT : RAILWAY BRIDGE ACROSS FLOODWAY
LOCATION : BH. 10 , PIER (DL+LL+I+E), LWL CONDITION

DISPLACEMENT METHOD

DATA OF PILE :

- NUMBER OF PILE	:	24
- LENGTH	:	13.06 m.
- DIAMETER	:	0.45 m.
- AREA	:	0.0930 m2.
- INERSIA	:	0.002000 m4
- MODULUS ELASTICITY [E]	:	1400000.00 tf/m2.

ANGLE AND COORDINATE OF PILE :

No. PILE	ANGLE TO THE VERTICAL AXIS [°]	DISTANCE TO THE POER AXIS [m]
1	0.00	-2.70
2	0.00	-2.70
3	0.00	-2.70
4	0.00	-2.70
5	0.00	-1.35
6	0.00	-1.35
7	0.00	-1.35
8	0.00	-1.35
9	0.00	-0.68
10	0.00	-0.68
11	0.00	0.00
12	0.00	0.00
13	0.00	0.00
14	0.00	0.00
15	0.00	0.68
16	0.00	0.68
17	0.00	1.35
18	0.00	1.35
19	0.00	1.35
20	0.00	1.35
21	0.00	2.70
22	0.00	2.70
23	0.00	2.70
24	0.00	2.70

EXTERNAL FORCE :

- MOMENT	:	137.65 tf m.
- VERTICAL FORCE	:	618.34 tf.
- HORIZONTAL FORCE	:	0.00 tf.

N VALUE : 3

COEFFICIENT OF HORIZONTAL SUBGRADE REACTION :
Ko : 0.97 kg-f/cm3.
k : 3.06 kg-f/cm3 = 3057.74 t-f/m3.

CHRACTERISTIC VALUE OF PILE :
β : 0.59204 1/m.
Γ : 1.69 m.

SPRING CONSTANTS OF PILE :

k1	:	2324.15 tf/m.			
k2 = k3	:	1962.84 tf/rad.			
k4	:	3315.41 tm-f/rad.			
a	:	0.92	----->	kv :	9170.94 t/m.

DISPLACEMENT EQUATIONS :

(5.6E+04) δx+(0.0E+00) δy+(-4.7E+04) α = 0.00
(0.0E+00) δx+(2.2E+05) δy+(-3.6E-07) α = 618.34
(-4.7E+04) δx+(-3.6E-07) δy+(7.6E+05) α = 137.65

DISPLACEMENT AT CENTERLINE OF PILECAP :

δx	:	0.02 cm
δy	:	0.28 cm
α	:	0.00019 rad

DISPLACEMENT AND AXIAL/ORTHOGONAL FORCE :

No. PILE	δ'x [cm]	δ'y [cm]	PH [tf]	PN [tf]
1	0.02	0.23	-0.00	21.06
2	0.02	0.23	-0.00	21.06
3	0.02	0.23	-0.00	21.06
4	0.02	0.23	-0.00	21.06
5	0.02	0.26	-0.00	23.41
6	0.02	0.26	-0.00	23.41
7	0.02	0.26	-0.00	23.41
8	0.02	0.26	-0.00	23.41
9	0.02	0.27	-0.00	24.59
10	0.02	0.27	-0.00	24.59
11	0.02	0.28	-0.00	25.76
12	0.02	0.28	-0.00	25.76
13	0.02	0.28	-0.00	25.76
14	0.02	0.28	-0.00	25.76
15	0.02	0.29	-0.00	26.94
16	0.02	0.29	-0.00	26.94
17	0.02	0.31	-0.00	28.11
18	0.02	0.31	-0.00	28.11
19	0.02	0.31	-0.00	28.11
20	0.02	0.31	-0.00	28.11
21	0.02	0.33	-0.00	30.47
22	0.02	0.33	-0.00	30.47
23	0.02	0.33	-0.00	30.47
24	0.02	0.33	-0.00	30.47

REACTION ON HEAD OF PILE :

No. PILE	H [tf]	N [tf]	Mt [tf-m]
1	-0.00	21.06	0.31
2	-0.00	21.06	0.31
3	-0.00	21.06	0.31
4	-0.00	21.06	0.31
5	-0.00	23.41	0.31
6	-0.00	23.41	0.31
7	-0.00	23.41	0.31
8	-0.00	23.41	0.31
9	-0.00	24.59	0.31
10	-0.00	24.59	0.31
11	-0.00	25.76	0.31

12	-0.00	25.76	0.31
13	-0.00	25.76	0.31
14	-0.00	25.76	0.31
15	-0.00	26.94	0.31
16	-0.00	26.94	0.31
17	-0.00	28.11	0.31
18	-0.00	28.11	0.31
19	-0.00	28.11	0.31
20	-0.00	28.11	0.31
21	-0.00	30.47	0.31
22	-0.00	30.47	0.31
23	-0.00	30.47	0.31
24	-0.00	30.47	0.31

ALLOWABLE HORZONTAL FORCE

δ = 1 cm (Normal Condition)
H all = 23.24 tf

CONCRETE PILE CALCULATION
No : 1

PROJECT : RAILWAY BRIDGE ACROSS FLOODWAY
LOCATION : BH. 10 , PIER (DL+LL+I+E+Lr), LWL CONDITION

DISPLACEMENT METHOD

DATA OF PILE :

- NUMBER OF PILE	:	24
- LENGTH	:	13.06 m.
- DIAMETER	:	0.45 m.
- AREA	:	0.0930 m2.
- INERSIA	:	0.002000 m4
- MODULUS ELASTICITY [E]	:	1400000.00 tf/m2.

ANGLE AND COORDINATE OF PILE :

No. PILE	ANGLE TO THE VERTICAL AXIS [°]	DISTANCE TO THE POER AXIS [m]
1	0.00	-2.70
2	0.00	-2.70
3	0.00	-2.70
4	0.00	-2.70
5	0.00	-1.35
6	0.00	-1.35
7	0.00	-1.35
8	0.00	-1.35
9	0.00	-0.68
10	0.00	-0.68
11	0.00	0.00
12	0.00	0.00
13	0.00	0.00
14	0.00	0.00
15	0.00	0.68
16	0.00	0.68
17	0.00	1.35
18	0.00	1.35
19	0.00	1.35
20	0.00	1.35
21	0.00	2.70
22	0.00	2.70
23	0.00	2.70
24	0.00	2.70

EXTERNAL FORCE :

- MOMENT	:	335.46 tf m.
- VERTICAL FORCE	:	618.33 tf.
- HORIZONTAL FORCE	:	27.04 tf.

N VALUE : 3

COEFFICIENT OF HORIZONTAL SUBGRADE REACTION :
Ko : 0.97 kg-f/cm3.
k : 2.16 kg-f/cm3 = 2162.15 t-f/m3.

CHRACTERISTIC VALUE OF PILE :
β : 0.54290 1/m.
r : 1.84 m.

SPRING CONSTANTS OF PILE :

k1	:	1792.16 tf/m.			
k2 = k3	:	1650.55 tf/rad.			
k4	:	3040.24 tm-f/rad.			
a	:	0.92	---->	kv :	9170.94 t/m.

DISPLACEMENT EQUATIONS :

(4.3E+04)	δx+	(0.0E+00)	δy+	(-4.0E+04)	α =	27.04
(0.0E+00)	δx+	(2.2E+05)	δy+	(-3.6E-07)	α =	618.33
(-4.0E+04)	δx+	(-3.6E-07)	δy+	(7.6E+05)	α =	335.46

DISPLACEMENT AT CENTERLINE OF PILECAP :

δx	:	0.11 cm
δy	:	0.28 cm
α	:	0.00050 rad

DISPLACEMENT AND AXIAL/ORTHOGONAL FORCE :

No. PILE	δ'x [cm]	δ'y [cm]	PH [tf]	PN [tf]
1	0.11	0.15	1.13	13.40
2	0.11	0.15	1.13	13.40
3	0.11	0.15	1.13	13.40
4	0.11	0.15	1.13	13.40
5	0.11	0.21	1.13	19.58
6	0.11	0.21	1.13	19.58
7	0.11	0.21	1.13	19.58
8	0.11	0.21	1.13	19.58
9	0.11	0.25	1.13	22.67
10	0.11	0.25	1.13	22.67
11	0.11	0.28	1.13	25.76
12	0.11	0.28	1.13	25.76
13	0.11	0.28	1.13	25.76
14	0.11	0.28	1.13	25.76
15	0.11	0.31	1.13	28.85
16	0.11	0.31	1.13	28.85
17	0.11	0.35	1.13	31.95
18	0.11	0.35	1.13	31.95
19	0.11	0.35	1.13	31.95
20	0.11	0.35	1.13	31.95
21	0.11	0.42	1.13	38.13
22	0.11	0.42	1.13	38.13
23	0.11	0.42	1.13	38.13
24	0.11	0.42	1.13	38.13

REACTION ON HEAD OF PILE :

No. PILE	H [tf]	N [tf]	Mt [tf-m]
1	1.13	13.40	-0.28
2	1.13	13.40	-0.28
3	1.13	13.40	-0.28
4	1.13	13.40	-0.28
5	1.13	19.58	-0.28
6	1.13	19.58	-0.28
7	1.13	19.58	-0.28
8	1.13	19.58	-0.28
9	1.13	22.67	-0.28
10	1.13	22.67	-0.28
11	1.13	25.76	-0.28

12	1.13	25.76	-0.28
13	1.13	25.76	-0.28
14	1.13	25.76	-0.28
15	1.13	28.85	-0.28
16	1.13	28.85	-0.28
17	1.13	31.95	-0.28
18	1.13	31.95	-0.28
19	1.13	31.95	-0.28
20	1.13	31.95	-0.28
21	1.13	38.13	-0.28
22	1.13	38.13	-0.28
23	1.13	38.13	-0.28
24	1.13	38.13	-0.28

ALLOWABLE HORZONTAL FORCE

δ = 1 cm (Normal Condition)
H all = 17.92 tf

CONCRETE PILE CALCULATION
No : 1

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

DISPLACEMENT METHOD

DATA OF PILE :

- NUMBER OF PILE	:	24
- LENGTH	:	13.06 m.
- DIAMETER	:	0.45 m.
- AREA	:	0.0930 m2.
- INERSIA	:	0.002000 m4
- MODULUS ELASTICITY [E]	:	1400000.00 tf/m2.

ANGLE AND COORDINATE OF PILE :

No. PILE	ANGLE TO THE VERTICAL AXIS [°]	DISTANCE TO THE POER AXIS [m]
1	0.00	-2.70
2	0.00	-2.70
3	0.00	-2.70
4	0.00	-2.70
5	0.00	-1.35
6	0.00	-1.35
7	0.00	-1.35
8	0.00	-1.35
9	0.00	-0.68
10	0.00	-0.68
11	0.00	0.00
12	0.00	0.00
13	0.00	0.00
14	0.00	0.00
15	0.00	0.68
16	0.00	0.68
17	0.00	1.35
18	0.00	1.35
19	0.00	1.35
20	0.00	1.35
21	0.00	2.70
22	0.00	2.70
23	0.00	2.70
24	0.00	2.70

EXTERNAL FORCE :

- MOMENT	:	688.66 tf m.
- VERTICAL FORCE	:	615.79 tf.
- HORIZONTAL FORCE	:	75.04 tf.

N VALUE : 3

COEFFICIENT OF HORIZONTAL SUBGRADE REACTION :
Ko : 0.97 kg-f/cm3.
k : 1.37 kg-f/cm3 = 1367.46 t-f/m3.

CHRACTERISTIC VALUE OF PILE :
β : 0.48415 1/m.
I : 2.07 m.

SPRING CONSTANTS OF PILE :

k1	:	1271.01 tf/m.			
k2 = k3	:	1312.63 tf/rad.			
k4	:	2711.22 tm-f/rad.			
a	:	0.92	---->	kv :	9170.94 t/m.

DISPLACEMENT EQUATIONS :

(3.1E+04) δx+(0.0E+00) δy+(-3.2E+04) α = 75.04
(0.0E+00) δx+(2.2E+05) δy+(-3.6E-07) α = 615.79
(-3.2E+04) δx+(-3.6E-07) δy+(7.5E+05) α = 688.66

DISPLACEMENT AT CENTERLINE OF PILECAP :

δx	:	0.36 cm
δy	:	0.28 cm
α	:	0.00107 rad

DISPLACEMENT AND AXIAL/ORTHOGONAL FORCE :

No. PILE	δ'x [cm]	δ'y [cm]	PH [tf]	PN [tf]
1	0.36	-0.01	3.13	-0.77
2	0.36	-0.01	3.13	-0.77
3	0.36	-0.01	3.13	-0.77
4	0.36	-0.01	3.13	-0.77
5	0.36	0.14	3.13	12.44
6	0.36	0.14	3.13	12.44
7	0.36	0.14	3.13	12.44
8	0.36	0.14	3.13	12.44
9	0.36	0.21	3.13	19.05
10	0.36	0.21	3.13	19.05
11	0.36	0.28	3.13	25.66
12	0.36	0.28	3.13	25.66
13	0.36	0.28	3.13	25.66
14	0.36	0.28	3.13	25.66
15	0.36	0.35	3.13	32.27
16	0.36	0.35	3.13	32.27
17	0.36	0.42	3.13	38.87
18	0.36	0.42	3.13	38.87
19	0.36	0.42	3.13	38.87
20	0.36	0.42	3.13	38.87
21	0.36	0.57	3.13	52.09
22	0.36	0.57	3.13	52.09
23	0.36	0.57	3.13	52.09
24	0.36	0.57	3.13	52.09

REACTION ON HEAD OF PILE :

No. PILE	H [tf]	N [tf]	Mt [tf-m]
1	3.13	-0.77	-1.78
2	3.13	-0.77	-1.78
3	3.13	-0.77	-1.78
4	3.13	-0.77	-1.78
5	3.13	12.44	-1.78
6	3.13	12.44	-1.78
7	3.13	12.44	-1.78
8	3.13	12.44	-1.78
9	3.13	19.05	-1.78
10	3.13	19.05	-1.78
11	3.13	25.66	-1.78

12	3.13	25.66	-1.78
13	3.13	25.66	-1.78
14	3.13	25.66	-1.78
15	3.13	32.27	-1.78
16	3.13	32.27	-1.78
17	3.13	38.87	-1.78
18	3.13	38.87	-1.78
19	3.13	38.87	-1.78
20	3.13	38.87	-1.78
21	3.13	52.09	-1.78
22	3.13	52.09	-1.78
23	3.13	52.09	-1.78
24	3.13	52.09	-1.78

ALLOWABLE HORZONTAL FORCE

δ = 1 cm (Normal Condition)
H all = 12.71 tf

CONCRETE PILE CALCULATION
No : 1

BH. 10 - 132

PROJECT : RAILWAY BRIDGE ACROSS FLOODWAY
LOCATION : BH. 10 , PIER (DL+E+Eq) , LWL CONDITION

DISPLACEMENT METHOD

DATA OF PILE :

- NUMBER OF PILE	:	24
- LENGTH	:	13.06 m.
- DIAMETER	:	0.45 m.
- AREA	:	0.0930 m2.
- INERSIA	:	0.002000 m4
- MODULUS ELASTICITY [E]	:	1400000.00 tf/m2.

ANGLE AND COORDINATE OF PILE :

No. PILE	ANGLE TO THE VERTICAL AXIS [°]	DISTANCE TO THE POER AXIS [m]
1	0.00	-2.70
2	0.00	-2.70
3	0.00	-2.70
4	0.00	-2.70
5	0.00	-1.35
6	0.00	-1.35
7	0.00	-1.35
8	0.00	-1.35
9	0.00	-0.68
10	0.00	-0.68
11	0.00	0.00
12	0.00	0.00
13	0.00	0.00
14	0.00	0.00
15	0.00	0.68
16	0.00	0.68
17	0.00	1.35
18	0.00	1.35
19	0.00	1.35
20	0.00	1.35
21	0.00	2.70
22	0.00	2.70
23	0.00	2.70
24	0.00	2.70

EXTERNAL FORCE :

- MOMENT	:	547.71 tf m.
- VERTICAL FORCE	:	539.52 tf.
- HORIZONTAL FORCE	:	96.79 tf.

N VALUE : 3

COEFFICIENT OF HORIZONTAL SUBGRADE REACTION :
Ko : 0.97 kg-f/cm3.
k : 1.37 kg-f/cm3 = 1367.46 t-f/m3.

CHRACTERISTIC VALUE OF PILE :
β : 0.48415 1/m.
Γ : 2.07 m.

SPRING CONSTANTS OF PILE :

k1	:	1271.01 tf/m.			
k2 = k3	:	1312.63 tf/rad.			
k4	:	2711.22 tm-f/rad.			
a	:	0.92	---->	kv :	9170.94 t/m.

DISPLACEMENT EQUATIONS :

(3.1E+04) δx+(0.0E+00) δy+(-3.2E+04) α = 96.79
(0.0E+00) δx+(2.2E+05) δy+(-3.6E-07) α = 539.52
(-3.2E+04) δx+(-3.6E-07) δy+(7.5E+05) α = 547.71

DISPLACEMENT AT CENTERLINE OF PILECAP :

δx	:	0.41 cm
δy	:	0.25 cm
α	:	0.00090 rad

DISPLACEMENT AND AXIAL/ORTHOGONAL FORCE :

No. PILE	δ'x [cm]	δ'y [cm]	PH [tf]	PN [tf]
1	0.41	0.00	4.03	0.14
2	0.41	0.00	4.03	0.14
3	0.41	0.00	4.03	0.14
4	0.41	0.00	4.03	0.14
5	0.41	0.12	4.03	11.31
6	0.41	0.12	4.03	11.31
7	0.41	0.12	4.03	11.31
8	0.41	0.12	4.03	11.31
9	0.41	0.18	4.03	16.89
10	0.41	0.18	4.03	16.89
11	0.41	0.25	4.03	22.48
12	0.41	0.25	4.03	22.48
13	0.41	0.25	4.03	22.48
14	0.41	0.25	4.03	22.48
15	0.41	0.31	4.03	28.07
16	0.41	0.31	4.03	28.07
17	0.41	0.37	4.03	33.65
18	0.41	0.37	4.03	33.65
19	0.41	0.37	4.03	33.65
20	0.41	0.37	4.03	33.65
21	0.41	0.49	4.03	44.82
22	0.41	0.49	4.03	44.82
23	0.41	0.49	4.03	44.82
24	0.41	0.49	4.03	44.82

REACTION ON HEAD OF PILE :

No. PILE	H [tf]	N [tf]	Mt [tf-m]
1	4.03	0.14	-2.94
2	4.03	0.14	-2.94
3	4.03	0.14	-2.94
4	4.03	0.14	-2.94
5	4.03	11.31	-2.94
6	4.03	11.31	-2.94
7	4.03	11.31	-2.94
8	4.03	11.31	-2.94
9	4.03	16.89	-2.94
10	4.03	16.89	-2.94
11	4.03	22.48	-2.94

12	4.03	22.48	-2.94
13	4.03	22.48	-2.94
14	4.03	22.48	-2.94
15	4.03	28.07	-2.94
16	4.03	28.07	-2.94
17	4.03	33.65	-2.94
18	4.03	33.65	-2.94
19	4.03	33.65	-2.94
20	4.03	33.65	-2.94
21	4.03	44.82	-2.94
22	4.03	44.82	-2.94
23	4.03	44.82	-2.94
24	4.03	44.82	-2.94

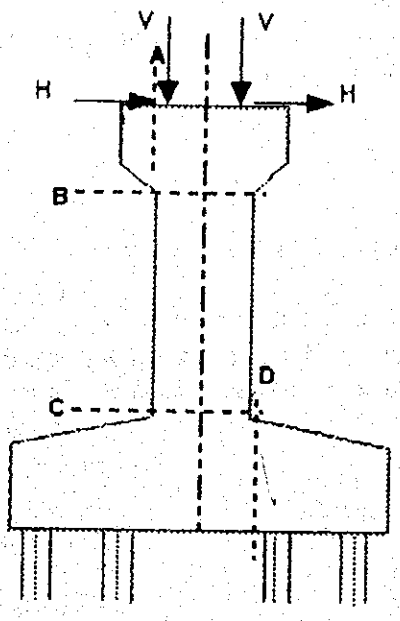
BH: 18 = 134

ALLOWABLE HORZONTAL FORCE

δ = 1 cm (Normal Condition)
H all = 12.71 tf

4.6. REINFORCEMENT CALCULATION

4.6.1.SKETCH



4.6.2.REINFORCEMENT

a) SECTION A - A

- Vertical Dead Load (concrete)

						V [tf/m]	X [m]	M [tf-m/m]
	0.500 x	0.400 x	1.000 x	2.400	=	0.480	0.250	0.120
	0.500 x	0.700 x	1.000 x	2.400	=	0.840	0.250	0.210
0.5 x	0.500 x	0.500 x	1.000 x	2.400	=	0.600	0.167	0.100
						1.920		0.430

Load from Super strucrure

distribution area = 1.30 x 1.30 = 1.69 m2

						V [tf/m]	X [m]	M [tf-m/m]
V dl =	16.750 x	0.592 x	1.000 x	0.500	=	4.956	0.250	1.239
V ll	64.980 x	0.592 x	1.000 x	0.500	=	19.225	0.250	4.806
V l	33.002 x	0.592 x	1.000 x	0.500	=	9.764	0.250	2.441
						33.944		8.486

M^{ς} = 0.430 + 8.486 = 8.916 tf-m/m

V = 1.920 + 33.944 = 35.864 tf/m

h = 112 cm

b = 100 cm

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

Ce = 12.278

δ = 0

ϕ = 8.09

ζ = 0.963

A min = 28 cm2 D 19 - 10.00 cm

$$\tau = \frac{35.864 \times 1000}{0.875 \times 100 \times 112} = 3.66 \text{ kgf/cm2}$$

b) SECTION B - B

Vertical Dead Load (concrete)

				V [tf/m]	X [m]	M [tf-m/m]
2.500 x	0.400 x	1.000 x	2.400 =	2.400	0.000	0.000
0.600 x	0.700 x	1.000 x	2.400 =	0.840	0.000	0.000
0.500 x	0.500 x	1.000 x	2.400 =	0.600	0.000	0.000
				3.840		0.000

Load from Super strucrure

			V [tf/m]	X [m]	M [tf-m/m]
Vdl =	33.500 x	0.167 =	5.583	0.650	3.629
=	33.500 x	0.167 =	5.583	-0.650	-3.629
Vll =	129.960 x	0.167 =	21.660	0.650	14.079
	124.150 x	0.167 =	20.692	-0.650	-13.450
Vl =	66.004 x	0.167 =	11.001	0.650	7.150
	63.054 x	0.167 =	10.509	-0.650	-6.831
			75.028		0.949

M	=	0 + 0.9491 =	0.95 tf-m/m
V	=	3.84 + 75.028 =	78.87 tf/m
Q	=	0.00 tf/m	
b	=	1.00 m	
h	=	1.50 m	
d	=	1.43 m	
d'	=	0.07 m	
n	=	21	
ϕ o	=	1.4286	
e o1	=	0.01 m	
e o2	=	0.05 m	
e o	=	0.06 m	
e o / h	=	0.04	
C	=	5.86	
lk	=	1.60 m ✓	
e 1	=	0.00 m	
e 2	=	0.23 m	
e	=	0.29 m	
e a	=	0.97 m	
N ea	=	76.27 tf m/m	
C a	=	6.053 ——— 5.360	
A min	=	35.75 cm2	

$\gamma = 1 - 7/8 \times \frac{1.43}{0.97} = -0.27$

c) SECTION C - C

Train on both of side of Pier

- Vertical Dead Load (concrete)

					V [tf]	X [m]	M [tf-m]
2.500	x 0.400	x 6.000	x 2.400	=	14.400	0.000	0.000
2.500	x 0.700	x 6.000	x 2.400	=	25.200	0.000	0.000
2.000	x 0.500	x 6.000	x 2.400	=	14.400	0.000	0.000
1.500	x 3.990	x 6.000	x 2.400	=	86.184	0.000	0.000
					140.184	0.000	0.000

1) Dead Load + Train Load + Earth Pressure

ITEMS	V [tf]	x [m]	M [tf-m]	H [t]	y [m]	M [tf-m]
Vd [DL]	33.5	0.6	20.10			
Vd [LL]	129.96	0.6	77.98			
Ve [DL]	33.5	-0.6	-20.10			
Ve [LL]	124.15	-0.6	-74.49			
Sub- total	321.11		3.49	0.00		0.00
W	140.18	0.00	0.00			
Total	461.29		3.49			

M = 3.486 x 0.1667 = 0.581 tf-m / m
V = 461.29 x 0.1667 = 76.882 tf / m
H = 0 x 0.1667 = 0 tf / 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]	33.5	0.6	20.10			
Vd [LL]	129.96	0.6	77.98			
Vd [I]	66.004	0.6	39.60			
Ve [DL]	33.5	-0.6	-20.10			
Ve [LL]	124.15	-0.6	-74.49			
Ve [I]	63.054	-0.6	-37.83			
Sub- total	460.17		5.26	0.00		0.00
W	140.18	0.00	0.00			
Total	590.35		5.26			

M = 5.2565 x 0.1667 = 0.8761 tf-m
V = 590.35 x 0.1667 = 98.392 tf
H = 0 x 0.1667 = 0 tf

3) Dead Load + Earth Pressure + Long Rail Load

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	5.59	170.41
He [Lr]				3.35	5.59	18.73
Sub- total	66.99		-2.04	33.84		189.14
W	140.18	0.00	0.00			
Total	207.18		-2.04			

M = 187.10 x 0.17 = 31.18 tf-m
V = 207.18 x 0.17 = 34.53 tf
H = 33.84 x 0.17 = 5.64 tf

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

ITEMS	V [tf]	x [m]	M [tf-m]	H [t]	y [m]	M [tf-m]
Vd [DL]	33.5	0.6	20.10			
Vd [LL]	129.96	0.6	77.98			
Vd [I]	66.004	0.6	39.60			
Ve [DL]	33.5	-0.6	-20.10			
Ve [LL]	124.15	-0.6	-74.49			
Ve [I]	63.054	-0.6	-37.83			
Vd [Lr]	-1.701	0.6	-1.02			
Ve [Lr]	1.6956	-0.6	-1.02			
Hd [Lr]				25.583	5.59	143.01
He [Lr]				15.765	5.59	88.126
Sub- total	450.16		3.22	41.35		231.14
W	140.18	0.00	0.00			
Total	590.35		3.22			

M = 234.35 x 0.1667 = 39.059 tf-m
V = 590.35 x 0.1667 = 98.391 tf
H = 41.348 x 0.1667 = 6.8913 tf

5) 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]	33.5	0.6	20.10			
Vd [LL]	129.96	0.6	77.98			
Ve [DL]	33.5	-0.6	-20.10			
Ve [LL]	124.15	-0.6	-74.49			
Vd [Lr + B]	-3.499	0.6	-2.10			
Ve [Lr + B]	3.1719	-0.6	-1.90			
Hd [Lr + B]				59.583	5.59	333.07
He [Lr + B]				15.765	5.59	88.126
Sub- total	320.78		-0.52	75.35		421.20
W	140.18	0.00	0.00			
Total	460.97		-0.52			

M = 420.68 x 0.1667 = 70.113 tf-m
V = 460.97 x 0.1667 = 76.828 tf
H = 75.348 x 0.1667 = 12.558 tf

6) 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]	33.5	0.6	20.10			
Vd [LL]	129.96	0.6	77.98			
Vd [I]	66.004	0.6	39.60			
Ve [DL]	33.5	-0.6	-20.10			
Ve [LL]	124.15	-0.6	-74.49			
Ve [I]	63.054	-0.6	-37.83			
Vd [Lr + B]	-3.499	0.6	-2.10			
Ve [Lr + B]	3.1719	-0.6	-1.90			
Hd [Lr + B]				59.583	5.59	333.07
He [Lr + B]				15.765	5.59	88.126
Sub- total	449.84		1.25	75.35		421.20
W	140.18	0.00	0.00			
Total	590.02		1.26			

M = 422.45 x 0.1667 = 70.408 tf-m
V = 590.02 x 0.1667 = 98.337 tf
H = 75.348 x 0.1667 = 12.558 tf

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

ITEMS	V [tf]	x [m]	M [tf-m]	H [t]	y [m]	M [tf-m]
Vd [DL]	33.5	0.6	20.10			
Vd [LL]	0	0.6	0.00			
Ve [DL]	33.5	-0.6	-20.10			
Ve [LL]	0	-0.6	0.00			
Vd [Eq]	-0.638	0.6	-0.38			
Ve [Eq]	0.6359	-0.6	-0.38			
Hd [Eq]				10.385	6.69	69.052
He [Eq]				3.35	5.59	18.727
Sub- total	67.00		-0.76	13.74		76.78
W	140.18	0.00	0.00			
Total	207.18		-0.76			

M = 76.014 x 0.1667 = 12.669 tf-m
V = 207.18 x 0.1667 = 34.53 tf
H = 13.735 x 0.1667 = 2.2892 tf

REINFORCEMENT ANALYSIS seed C-C.

ITEMS	CASE						
	A	B	C	D	E	F	G
Internal Force							
M [tf m]	0.58	0.88	31.18	39.06	70.11	70.41	12.67
V [tf]	76.88	98.39	34.53	98.39	76.83	98.34	34.53
Q [tf]	0.00	0.00	5.64	6.89	12.56	12.56	2.29
b [m]	1.00	1.00	1.00	1.00	1.00	1.00	1.00
h [m]	1.50	1.50	1.50	1.50	1.50	1.50	1.50
d [m]	1.43	1.43	1.43	1.43	1.43	1.43	1.43
d' [m]	0.07	0.07	0.07	0.07	0.07	0.07	0.07
n	21	21	21	21	21	21	21
ϕ o	1.4286	1.4286	1.4286	1.4286	1.2190	1.2190	1.2190
e o1 [m]	0.01	0.01	0.90	0.40	0.91	0.72	0.37
e o2 [m]	0.05	0.05	0.05	0.05	0.05	0.05	0.05
e o [m]	0.06	0.06	0.95	0.45	0.96	0.77	0.42
e o / h	0.04	0.04	0.64	0.30	0.64	0.51	0.28
C	6.86	6.86	6.95	6.79	6.95	6.92	6.79
lk [m]	5.59	5.59	5.59	5.59	5.59	5.59	5.59
e 1 [m]	0.012	0.012	0.014	0.014	0.014	0.014	0.014
e 2 [m]	0.23	0.23	0.23	0.23	0.23	0.23	0.23
e [m]	0.29	0.30	1.19	0.69	1.20	1.01	0.66
e a [m]	0.97	0.98	1.87	1.37	1.88	1.69	1.34
N ea [tf m]	74.94	96.04	64.66	134.41	144.60	165.74	46.13
C e	5.098	4.603	5.488	3.806	4.642	4.336	6.218
δ	1.000	1.000	0.400	0.200	0.400	0.200	0.200
ϕ	3.255	2.922	3.348	2.175	2.774	2.509	5.260
ϕ !	6.667	4.806	5.923	3.186	4.454	3.865	14.000
ξ	0.235	0.255	0.230	0.315	0.265	0.285	0.160
ζ	0.921	0.912	0.922	0.895	0.911	0.905	0.946
C b	2.865	2.492	2.648	2.439	2.621	2.580	3.510
nw	0.037	0.055	0.037	0.077	0.053	0.060	0.015
Reinforcement							
l	1.000	1.000	3.379	15.835	3.249	4.308	1.000
A [cm]	25.48	37.45	7.39	3.31	11.11	9.48	10.21
A' [cm]	25.48	37.45	10.00	10.49	14.44	8.17	2.04
A min [cm2]	35.75	35.75	35.75	35.75	35.75	35.75	35.75
Therefore							
A [cm]	35.75	37.45	35.75	35.75	35.75	35.75	35.75
Rebar diameter	22	22	22	22	22	22	22
Distance [cm]	11	10	11	11	11	11	11
A' [cm2]	35.75	37.45	35.75	35.75	35.75	35.75	35.75
Rebar diameter	22	22	22	22	22	22	22
Distance [cm]	11	10	11	11	11	11	11
Checking Shear Stress							
τ [kg f/cm2]	0.00	0.00	0.45	0.55	1.00	1.00	0.18

Train on one of side of Pier

- Vertical Dead Load (concrete)

					V [tf]	X [m]	M [tf-m]
2.500	x 0.400	x 6.000	x 2.400	=	14.400	0.000	0.000
2.500	x 0.700	x 6.000	x 2.400	=	25.200	0.000	0.000
2.000	x 0.500	x 6.000	x 2.400	=	14.400	0.000	0.000
1.500	x 3.990	x 6.000	x 2.400	=	86.184	0.000	0.000
					140.184	0.000	0.000

1) Dead Load + Train Load + Earth Pressure

ITEMS	V [tf]	x [m]	M [tf-m]	H [t]	y [m]	M [tf-m]
Vd [DL]	33.5	0.6	20.10			
Vd [LL]	152.15	0.6	91.29			
Ve [DL]	33.5	-0.6	-20.10			
Ve [LL]	0	-0.6	0.00			
Sub-total	219.15		91.29	0.00		0.00
W	140.18	0.00	0.00			
Total	359.33		91.29			

M = 91.29 x 0.1667 = 15.215 tf-m / m
V = 359.33 x 0.1667 = 59.889 tf / m
H = 0 x 0.1667 = 0 tf / 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]	33.5	0.6	20.10			
Vd [LL]	152.15	0.6	91.29			
Vd [I]	77.274	0.6	46.36			
Ve [DL]	33.5	-0.6	-20.10			
Ve [LL]	0	-0.6	0.00			
Ve [I]	0	-0.6	0.00			
Sub-total	296.42		137.65	0.00		0.00
W	140.18	0.00	0.00			
Total	436.61		137.65			

M = 137.65 x 0.1667 = 22.942 tf-m
V = 436.61 x 0.1667 = 72.768 tf
H = 0 x 0.1667 = 0 tf

3) Dead Load + Earth Pressure + Long Rail Load

ITEMS	V [tf]	x [m]	M [tf-m]	H [t]	y [m]	M [tf-m]
Vd [DL]	33.5	0.6	20.10			
Vd [LL]	0	0.6	0.00			
Ve [DL]	33.5	-0.6	-20.10			
Ve [LL]	0	-0.6	0.00			
Vd [Lr]	-1.701	0.6	-1.02			
Ve [Lr]	1.6956	-0.6	-1.02			
Hd [Lr]				30.485	5.59	170.41
He [Lr]				3.35	5.59	18.73
Sub- total	66.99		-2.04	33.84		189.14
W	140.18	0.00	0.00			
Total	207.18		-2.04			

M = 187.10 x 0.17 = 31.18 tf-m
V = 207.18 x 0.17 = 34.53 tf
H = 33.84 x 0.17 = 5.64 tf

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

ITEMS	V [tf]	x [m]	M [tf-m]	H [t]	y [m]	M [tf-m]
Vd [DL]	33.5	0.6	20.10			
Vd [LL]	152.15	0.6	91.29			
Vd [I]	77.274	0.6	46.36			
Ve [DL]	33.5	-0.6	-20.10			
Ve [LL]	0	-0.6	0.00			
Ve [I]	0	-0.6	0.00			
Vd [Lr]	-1.701	0.6	-1.02			
Ve [Lr]	1.6956	-0.6	-1.02			
Hd [Lr]				23.693	5.59	132.44
He [Lr]				3.35	5.59	18.727
Sub- total	296.42		135.62	27.04		151.17
W	140.18	0.00	0.00			
Total	436.60		136.62			

M = 286.78 x 0.1667 = 47.797 tf-m
V = 436.6 x 0.1667 = 72.767 tf
H = 27.043 x 0.1667 = 4.5071 tf

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]	33.5	0.6	20.10			
Vd [LL]	152.15	0.6	91.29			
Ve [DL]	33.5	-0.6	-20.10			
Ve [LL]	0	-0.6	0.00			
Vd [Lr + B]	-4.239	0.6	-2.54			
Ve [Lr + B]	1.6956	-0.6	-1.02			
Hd [Lr + B]				71.693	5.59	400.76
He [Lr + B]				3.35	5.59	18.727
Sub- total	216.61		87.73	75.04		419.49
W	140.18	0.00	0.00			
Total	356.79		87.73			

M = 507.22 x 0.1667 = 84.536 tf-m
V = 356.79 x 0.1667 = 59.465 tf
H = 75.043 x 0.1667 = 12.507 tf

6) 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]	33.5	0.6	20.10			
Vd [LL]	152.15	0.6	91.29			
Vd [I]	77.274	0.6	46.36			
Ve [DL]	33.5	-0.6	-20.10			
Ve [LL]	0	-0.6	0.00			
Ve [I]	0	-0.6	0.00			
Vd [Lr + B]	-4.239	0.6	-2.54			
Ve [Lr + B]	1.6956	-0.6	-1.02			
Hd [Lr + B]				71.693	5.89	422.27
He [Lr + B]				3.35	5.89	19.732
Sub- total	293.88		134.09	75.04		442.00
W	140.18	0.00	0.00			
Total	434.06		134.09			

M = 576.09 x 0.1667 = 96.016 tf-m
V = 434.06 x 0.1667 = 72.344 tf
H = 75.043 x 0.1667 = 12.507 tf

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

ITEMS	V [tf]	x [m]	M [tf-m]	H [t]	y [m]	M [tf-m]
Vd [DL]	33.5	0.6	20.10			
Vd [LL]	152.15	0.6	91.29			
Ve [DL]	33.5	-0.6	-20.10			
Ve [LL]	0	-0.6	0.00			
Vd [Eq]	-0.638	0.6	-0.38			
Ve [Eq]	0.6359	-0.6	-0.38			
Hd [Eq]				10.385	7.39	76.745
He [Eq]				3.35	7.39	24.757
Sub- total	219.15		90.53	13.74		101.50
W	140.18	0.00	0.00			
Total	359.33		90.53			

M = 192.03 x 0.1667 = 32.005 tf-m
V = 359.33 x 0.1667 = 59.889 tf
H = 13.735 x 0.1667 = 2.2892 tf

REINFORCEMENT ANALYSIS

ITEMS	CASE						
	A	B	C	D	E	F	G
Internal Force							
M [tf m]	16.22	22.94	31.18	47.80	84.54	96.02	32.00
V [tf]	59.89	72.77	34.53	72.77	59.47	72.34	59.89
Q [tf]	0.00	0.00	6.64	4.51	12.51	12.51	2.29
b [m]	1.00	1.00	1.00	1.00	1.00	1.00	1.00
h [m]	1.60	1.60	1.60	1.60	1.60	1.60	1.60
d [m]	1.43	1.43	1.43	1.43	1.43	1.43	1.43
d' [m]	0.07	0.07	0.07	0.07	0.07	0.07	0.07
n	21	21	21	21	21	21	21
φ o	1.4286	1.4286	1.4286	1.4286	1.2190	1.2190	1.2190
e o1 [m]	0.25	0.32	0.90	0.66	1.42	1.33	0.53
e o2 [m]	0.05	0.05	0.05	0.05	0.05	0.05	0.05
e o [m]	0.30	0.37	0.95	0.71	1.47	1.38	0.58
e o / h	0.20	0.24	0.64	0.47	0.98	0.92	0.39
C	6.66	6.74	6.95	6.89	7.69	7.69	7.60
lk [m]	5.59	5.59	5.59	5.59	5.59	5.59	5.59
e 1 [m]	0.014	0.014	0.014	0.014	0.016	0.016	0.016
e 2 [m]	0.23	0.23	0.23	0.23	0.23	0.23	0.23
e [m]	0.54	0.60	1.19	0.95	1.71	1.62	0.83
e a [m]	1.22	1.28	1.87	1.63	2.39	2.30	1.51
N ea [tf m]	73.24	93.46	64.66	118.33	142.28	166.26	90.15
C a	5.157	4.565	5.488	4.057	4.680	4.329	5.879
δ	1.000	1.000	0.400	0.200	0.400	0.400	0.200
φ	3.348	2.922	3.348	2.333	2.846	2.636	3.545
φ !	6.932	4.806	6.923	3.500	4.625	4.143	6.500
ξ	0.230	0.255	0.230	0.300	0.260	0.275	0.220
ζ	0.919	0.912	0.922	0.900	0.912	0.908	0.926
C b	2.688	2.492	2.848	2.507	2.621	2.563	2.968
nw	0.041	0.055	0.037	0.068	0.050	0.058	0.032
Reinforcement							
t	1.000	1.000	3.379	4.794	2.198	2.299	1.000
A [cm]	27.92	37.45	7.39	9.66	15.49	17.18	21.79
A' [cm]	27.92	37.45	10.00	9.26	13.62	15.80	4.36
A min [cm2]	35.75	35.75	35.75	35.75	35.75	35.75	35.75
Therefore							
A [cm]	35.75	37.45	35.75	35.75	35.75	35.75	35.75
Rebar diameter	22	22	22	22	22	22	22
Distance [cm]	11	10	11	11	11	11	11
A' [cm2]	35.75	37.45	35.75	35.75	35.75	35.75	35.75
Rebar diameter	22	22	22	22	22	22	22
Distance [cm]	11	10	11	11	11	11	11
Checking Shear Stress							
τ [kg f /cm2]	0.00	0.00	0.45	0.36	1.00	1.00	0.16

d) SECTION D - D

Pararel with Track

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

Vertical Force

Vd	=	2.66	x	1.50	x	2.40	x -2.40 =	-22.03 tf	(concrete)
		2.55	x	0.75	x	2.40	x -2.40 =	-11.02 tf	(concrete)
Vp	=					32.25	x 2 =	64.50 tf	(reaction of pile)
						32.26	x 2 =	64.52 tf	(reaction of pile)
							total =	95.972 tf	

Moment

Mvd	=	-22.03	x	1.275		=	-28.09	tf m
		-11.02	x	0.85		=	-9.364	tf m
Mp	=	32.25	x	1.95	x 2	=	125.78	tf m
		32.26	x	0.60	x 2	=	38.712	tf m
					total	=	127.03	tf m

therefore per m' .

Vd	=	95.972	x	0.4167	=	39.988 tf/m'
Md	=	127.03	x	0.4167	=	52.93 tf m/m'

h = 164 cm

b = 100 cm

$$\phi o = \frac{2250}{21 \times 76} = 1.4286$$

Ca = 7.3786

δ = 0.4

ϕ = 4.882

ϕ l = 11.86

ζ = 0.942

nw = 0.018 ——>

A	=	14.06	cm2
A'	=	5.62	cm2
A min	=	36.00	cm2

D 25 – 100 cm

$$\tau = \frac{39.988 \times 1000}{0.875 \times 100 \times 164} = 2.79 \text{ kg f/cm2}$$

Check Punch

P = 32.25 tf

$$\tau = \frac{32.25 \times 1000}{3.14 \times (45 + 164) \times 164} = 0.30 \text{ kg f/cm2}$$

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

Vertical Force

Vd	=	2.55	x	1.5	x	2.4	x -2.4 =	-22.03 tf	(concrete)
		2.55	x	0.75	x	2.4	x -2.4 =	-11.02 tf	(concrete)
Vp	=					44.07	x 2 =	88.14 tf	(reaction of pile)
						38.12	x 2 =	76.24 tf	(reaction of pile)
							total =	131.33 tf	

Moment

M vd	=	-22.03	x	1.275			=	-28.09 tf m
		-11.02	x	0.85			=	-9.364 tf m
M p	=	44.07	x	1.95	x	2	=	171.87 tf m
		38.12	x	0.6	x	2	=	45.744 tf m
						total	=	180.16 tf m

therefore per m' .

V d	=	131.33	x 0.4167	=	54.722 tf / m'
M d	=	180.16	x 0.4167	=	75.068 t-f m / m'

h = 164 cm

b = 100 cm

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

Ca	=	7.3889				
δ	=	0.4				
ϕ	=	4.714				
ϕ l	=	11				
ζ	=	0.94				
nw	=	0.019	---->	A	=	14.84 cm2
				A'	=	5.94 cm2
				A min	=	36.00 cm2

D $\tilde{2}5$ - 100 cm

$$\tau = \frac{54.722 \times 1000}{0.875 \times 100 \times 164} = 3.81 \text{ kg f/cm2}$$

Check Punch

P = 44.07 tf

$$\tau = \frac{44.07 \times 1000}{3.14 \times (45 + 164) \times 164} = 0.41 \text{ kg f/cm2}$$

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

Vertical Force

Vd	=	2.55 x	1.6 x	2.4 x	-2.4	=	-22.03 tf	(concrete)
		2.55 x	0.75 x	2.4 x	-2.4	=	-11.02 tf	(concrete)
Vp	=			53.99 x	2	=	107.98 tf	(reaction of pile)
				43.07 x	2	=	86.14 tf	(reaction of pile)
					total	=	161.07 tf	

Moment

Mvd	=	-22.03 x	1.275		=	-28.09	tf m
		-11.02 x	0.85		=	-9.364	tf m
Mp	=	53.99 x	1.95 x	2	=	210.56	tf m
		43.07 x	0.6 x	2	=	51.684	tf m
				total	=	224.79	tf m

therefore per m' .

Vd	=	161.07 x	0.4167	=	67.113	tf / m'
Md	=	224.79 x	0.4167	=	93.663	t-f m / m'

$h = 164$ cm

$b = 100$ cm

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

Ce	=	6.6149				
δ	=	0.4				
ϕ	=	4.126				
ϕ 1	=	8.474				
ζ	=	0.933				
nw	=	0.025	⟶	A	=	19.52 cm2
				A'	=	7.81 cm2
				A min	=	36.00 cm2

D 25 - 100 cm

$$\tau = \frac{67.113 \times 1000}{0.875 \times 100 \times 164} = 4.68 \text{ kg f/cm2}$$

Check Punch

$P = 107.98$ tf

$$\tau = \frac{107.98 \times 1000}{3.14 \times (46 + 164) \times 164} = 1.00 \text{ kg f/cm2}$$

Perpendicular with Track

- Vertical Dead Load

2.500	x	0.400	x 2.800	x 2.400	=	6.720 tf
2.500	x	0.700	x 5.600	x 2.400	=	23.520 tf
2.000	x	0.500	x 5.600	x 2.400	=	13.440 tf
0.786	x	6.250	x 0.700	x 2.400	=	8.250 tf
0.786	x	4.000	x 0.500	x 2.400	=	3.771 tf
0.786	x	2.250	x 4.290	x 2.400	=	18.202 tf
1.500	x	3.990	x 5.600	x 2.400	=	80.438 tf
				Total	=	154.342 tf

$$q1 = \frac{154.342}{6.6 \times 8.00} = 2.923 \text{ tf/m'}$$

$$q2 = 1.650 \times 2.400 = 3.960 \text{ tf/m'}$$

$$q\,dl = \frac{33.5 + 33.5}{6.6 \times 8.00} = 10.152 \text{ tf/m'}$$

- Vertical Live Load + Impact

$$q\,ll = \frac{195.96 + 187.2}{6.6 \times 8.00} = 7.257 \text{ tf}$$

Field Moment

M	=	20.332	x	64	x	0.125	=	162.65 tf m/ m'
		0.125	x	3.96	x	64	=	31.68 tf m/ m'
						M	=	194.33 tf m/ m'

Q = 20.332 x 4 + 3.96 x 4

= 97.166 tf / m'

therefore per m' .

Vd = 97.166 tf/m'

Md = 194.33 t-f m / m'

h = 164 cm

b = 100 cm

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

Ca = 3.8508

δ = 0.4

ϕ = 2.279

ϕ l = 3.39

ζ = 0.898

nw = 0.076 ——>

A	=	59.36 cm2	D 29 - 10.00 cm
A'	=	23.74 cm2	D 19 - 10.00 cm
A min	=	36.00 cm2	

$$\tau = \frac{97.166 \times 1000}{0.875 \times 100 \times 164} = 6.77 \text{ kg f/cm2} > \tau a$$

$$\tau - \tau a = 0.77 \text{ kg f/cm2}$$

used stirup D13 - 250

$$\tau = \frac{5.2 \times 2250}{25 \times 100} = 4.68 \text{ kg f/cm2} > 0.77 \text{ kg f/cm2}$$

4.6.3.CHECKING STRESS ON PILE.

-Train on both side of pier.

Data of pile

D	=	45	cm
d	=	29	cm
A	=	930	cm2
W	=	7403	cm3
σ ce	=	82.9	kg / cm2
σ ce	=	8030.9	kg / cm2
n	=	Ea / Eb = 15	

Stress of Pile

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

$\alpha = 1.00$

Force on head pile

M	=	0.01	t f m
N	=	32.25	t f
H	=	0.00	t f

Compressive stress of concrete

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

$$= 82.90 + 0.14 + 34.68$$

$$= 117.71 \text{ kg f / cm2} < 166 \text{ kg f / cm2}$$

Tensile stress of concrete

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

$$= 82.90 + 0.14 + 34.68$$

$$= 117.44 \text{ kg f / cm2} > 0 \text{ kg f / cm2}$$

Tensile stress of PC cable

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

$$= 8030.94 + 2.03 - 520.16$$

$$= 7512.8 \text{ kg f / cm2} < 8700 \text{ kg f / cm2}$$

Stress on joint between pile and footing

Compressive stress

N = 32.25 tf

H = 0.00 tf

l = 10 cm

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

$$= \frac{32.25 \times 1000}{930.29} = 34.67 \text{ kgf/cm2} < 75 \text{ kgf/cm2}$$

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

$$= \frac{0 \times 1000}{45 \times 10} = 0 \text{ kgf/cm2} < 75 \text{ kgf/cm2}$$

Shear stress

h 1 = 140 cm (= distance between pile top and footing)

$$\tau = \frac{N}{22/7 \times (D \times h1)} = \frac{32.25 \times 1000}{19800} = 1.63 \text{ kgf/cm2} < 7.5 \text{ kgf/cm2}$$

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

$\alpha = 1.15$

Force on head pile

M = 0.86 tf m

N = 44.07 tf

H = 1.72 tf

Compressive stress of concrete

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

$$= 82.90 + 11.62 + 47.39$$

$$= 141.9 \text{ kgf/cm2} < 1.15 \times 166 = 190.9 \text{ kgf/cm2}$$

Tensile stress of concrete

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

$$= 82.90 + 11.62 + 47.39$$

$$= 118.67 \text{ kgf/cm2} > 0 \text{ kgf/cm2}$$

Tensile stress of PC cable

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

$$= 8030.94 + 174.26 - 710.81$$

$$= 7494.4 \text{ kg f / cm2} < 8700 \text{ kg f / cm2}$$

Stress on joint between pile and footing

Compressive stress

N = 44.07 tf

H = 1.72 tf

l = 10 cm

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

$$= \frac{44.07 \times 1000}{930.29} = 47.37 \text{ kg f / cm2} < 1.15 \times 75 = 86.25 \text{ kg f /cm2}$$

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

$$= \frac{1.72 \times 1000}{45 \times 10} = 3.82 \text{ kg f / cm2} < 1.15 \times 75 = 86.25 \text{ kg f /cm2}$$

Shear stress

h 1 = 140 cm (= distance between pile top and footing)

$$\tau = \frac{N}{22/7 \times (D \times h1)} = \frac{44.07 \times 1000}{19800} = 2.23 \text{ kg f / cm2} < 7.5 \text{ kgf/cm2}$$

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

$\alpha = 1.25$

Force on head pile

M = 1.92 tf m

N = 53.99 tf

H = 3.14 tf

Compressive stress of concrete

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

$$= 82.90 + 25.94 + 58.05$$

$$= 166.89 \text{ kg f / cm2} < 1.25 \times 166 = 207.5 \text{ kg f / cm2}$$

Tensile stress of concrete

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

$$= 82.90 + 25.94 + 58.06$$

$$= 115.02 \text{ kg f / cm2} > 0 \text{ kg f / cm2}$$

Tensile stress of PC cable

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

$$= 8030.94 + 389.03 - 670.81$$

$$= 7549.2 \text{ kg f / cm2} < 8700 \text{ kg f / cm2}$$ ✓

Stress on joint between pile and footing

Compressive stress

N = 53.99 tf

H = 3.14 tf

l = 10 cm

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

$$= \frac{53.99 \times 1000}{930.29} = 58.04 \text{ kg f / cm2} < 1.25 \times 75 = 93.76 \text{ kg f /cm2}$$

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

$$= \frac{3.14 \times 1000}{45 \times 10} = 6.98 \text{ kg f / cm2} < 1.25 \times 75 = 93.75 \text{ kg f /cm2}$$

Shear stress

h 1 = 140 cm (= distance between pile top and footing)

$$\tau = \frac{N}{22/7 \times (D \times h1)} = \frac{53.99 \times 1000}{19800} = 2.73 \text{ kg f / cm2} < 7.5 \text{ kgf/cm2}$$

d) Dead Load + Earth Pressure + Seismic ——> temporary load

α = 1.60

Force on head pile

M = 3.26 tf m

N = 44.41 tf

H = 4.37 tf

Compressive stress of concrete

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

$$= 82.90 + 44.04 + 47.75$$

$$= 174.69 \text{ kg f / cm2} < 1.5 \times 166 = 249 \text{ kg f / cm2}$$

Tensile stress of concrete

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

$$= 82.90 + 44.04 + 47.75$$

$$= 86.616 \text{ kg f / cm2} > 0 \text{ kg f / cm2}$$

Tensile stress of PC cable

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

$$= 8030.94 + 660.54 - 716.29$$

$$= 7975.2 \text{ kg f / cm2} < 8700 \text{ kg f / cm2}$$

Stress on joint between pile and footing

Compressive stress

N = 44.41 tf

H = 4.37 tf

l = 10 cm

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

$$= \frac{44.41 \times 1000}{930.29} = 47.74 \text{ kg f / cm2} < 1.5 \times 75 = 112.5 \text{ kg f /cm2}$$

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

$$= \frac{4.37 \times 1000}{45 \times 10} = 9.7111 \text{ kg f / cm2} < 1.5 \times 75 = 112.5 \text{ kg f /cm2}$$

Shear stress

h 1 = 140 cm (= distance between pile top and footing)

$$\tau = \frac{N}{22/7 \times (D \times h1)} = \frac{44.41 \times 1000}{19600} = 2.24 \text{ kg f / cm2} < 7.5 \text{ kgf/cm2}$$

-Train on the left side of pier.

Data of pile

D	=	45	cm
d	=	29	cm
A	=	930	cm2
W	=	7403	cm3
σ ce	=	82.9	kg / cm2
σ ce	=	8030.9	kg / cm2
n	= Ea / Eb =	15	

Stress of Plie

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

α = 1.00

Force on head pile

M	=	0.31	t f m
N	=	30.47	t f
H	=	0.00	t f

Compressive stress of concrete

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

$$= 82.90 + 4.19 + 32.76$$

$$= 119.85 \text{ kg f / cm2} < 166 \text{ kg f / cm2}$$

Tensile stress of concrete

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

$$= 82.90 + 4.19 + 32.76$$

$$= 111.48 \text{ kg f / cm2} > 0 \text{ kg f / cm2}$$

Tensile stress of PC cable

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

$$= 8030.94 + 62.81 - 491.45$$

$$= 7602.3 \text{ kg f / cm2} < 8700 \text{ kg f / cm2}$$

Stress on joint between plie and footing

Compressive stress

N	=	30.47	t f
H	=	0.00	t f
l	=	10	cm

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

$$= \frac{30.47 \times 1000}{930.29} = 32.75 \text{ kg f / cm2} < 75 \text{ kg f / cm2}$$

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

$$= \frac{0 \times 1000}{45 \times 10} = 0 \text{ kg f / cm2} < 76 \text{ kg f / cm2}$$

Shear stress

h 1 = 140 cm (= distance between pile top and footing)

$$\tau = \frac{N}{22/7 \times (D \times h1)} = \frac{30.47 \times 1000}{19800} = 1.54 \text{ kg f / cm2} < 7.5 \text{ kgf/cm2}$$

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

$\alpha = 1.15$

Force on head pile

M = 0.28 t f m

N = 38.13 t f

H = 1.13 t f

Compressive stress of concrete

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

$$= 82.90 + 3.78 + 41.00$$

$$= 127.68 \text{ kg f / cm2} < 1.15 \times 166 = 190.9 \text{ kg f / cm2}$$

Tensile stress of concrete

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

$$= 82.90 + 3.78 + 41.00$$

$$= 120.12 \text{ kg f / cm2} > 0 \text{ kg f / cm2}$$

Tensile stress of PC cable

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

$$= 8030.94 + 56.73 - 615.00$$

$$= 7472.7 \text{ kg f / cm2} < 8700 \text{ kg f / cm2}$$

Stress on joint between pile and footing

Compressive stress

N = 38.13 t f

H = 1.13 t f

I = 10 cm

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

$$= \frac{38.13 \times 1000}{930.29} = 40.99 \text{ kg f / cm2} < 1.15 \times 75 = 86.25 \text{ kg f /cm2}$$

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

$$= \frac{1.13 \times 1000}{45 \times 10} = 2.51 \text{ kg f / cm2} < 1.15 \times 75 = 86.25 \text{ kg f /cm2}$$

Shear stress

h 1 = 140 cm (= distance between pile top and footing)

$$\tau = \frac{N}{22/7 \times (D \times h1)} = \frac{38.13 \times 1000}{19800} = 1.93 \text{ kg f / cm2} < 7.5 \text{ kgf/cm2}$$

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

$\alpha = 1.25$

Force on head pile

M = 1.78 t f m

N = 52.09 t f

H = 3.13 t f

Compressive stress of concrete

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

$$= 82.90 + 24.04 + 56.01$$

$$= 162.96 \text{ kg f / cm2} < 1.25 \times 166 = 207.5 \text{ kg f / cm2}$$

Tensile stress of concrete

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

$$= 82.90 + 24.04 + 56.01$$

$$= 114.87 \text{ kg f / cm2} > 0 \text{ kg f / cm2}$$

Tensile stress of PC cable

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

$$= 8030.94 + 360.66 - 840.16$$

$$= 7551.4 \text{ kg f / cm2} < 8700 \text{ kg f / cm2}$$

Stress on joint between pile and footing

Compressive stress

N = 52.09 tf

H = 3.13 tf

l = 10 cm

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

$$= \frac{52.09 \times 1000}{930.29} = 55.99 \text{ kgf/cm2} < 1.25 \times 75 = 93.75 \text{ kgf/cm2}$$

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

$$= \frac{3.13 \times 1000}{45 \times 10} = 6.96 \text{ kgf/cm2} < 1.25 \times 75 = 93.75 \text{ kgf/cm2}$$

Shear stress

h 1 = 140 cm (= distance between pile top and footing)

$$\tau = \frac{N}{22/7 \times (D \times h1)} = \frac{52.09 \times 1000}{19800} = 2.63 \text{ kgf/cm2} < 7.5 \text{ kgf/cm2}$$

d) Dead Load + Earth Pressure + Seismic ——> temporary load

α = 1.50

Force on head pile

M = 2.94 tf m

N = 44.82 tf

H = 4.03 tf

Compressive stress of concrete

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

$$= 82.90 + 39.71 + 48.19$$

$$= 170.81 \text{ kgf/cm2} < 1.5 \times 166 = 249 \text{ kgf/cm2}$$

Tensile stress of concrete

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

$$= 82.90 + 39.71 + 48.19$$

$$= 91.38 \text{ kgf/cm2} > 0 \text{ kgf/cm2}$$

Tensile stress of PC cable

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

$$= 8030.94 + 595.70 - 722.90$$

$$= 7903.7 \text{ kg f / cm2} < 8700 \text{ kg f / cm2}$$

Stress on joint between pile and footing

Compressive stress

N = 44.82 tf

H = 4.03 tf

l = 10 cm

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

$$= \frac{44.82 \times 1000}{930.29} = 48.18 \text{ kg f / cm2} < 1.5 \times 75 = 112.5 \text{ kg f /cm2}$$

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

$$= \frac{4.03 \times 1000}{45 \times 10} = 8.9556 \text{ kg f / cm2} < 1.5 \times 75 = 112.5 \text{ kg f /cm2}$$

Shear stress

h 1 = 140 cm (= distance between pile top and footing)

$$\tau = \frac{N}{22/7 \times (D \times h1)} = \frac{44.82 \times 1000}{19800} = 2.26 \text{ kg f / cm2} < 7.5 \text{ kgf/cm2}$$