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Analysis Of High Level Bridge Across River

[1]Kanchala. Nanchari, [2]Thaniru Ramu, [3]Sabbineni Ramyakala

[1,2,3]*Department of Structural Engineering*

Abstract: The work on designing of proposed HLB across mandoddi river at CH 10/6 – 10/8 on R/F to R&B to pedda dhanwada via mandoddi of waddepalli (M) of mahboobnagar district was carried out. A Bridge is a structure providing passage over an obstacle without closing the way beneath. The obstacle to be crossed may be a river, a road, railway or a valley. The bridge we are dealing with is a high level bridge which carries the roadway above the highest flood level. Highest flood level is the level of the highest calculated level for the design discharge.

This HLB is proposed to reduce the severe problems of increasing traffic & to increase the transport system between the CH 10/6-10/8 to Pedda Dhanwada in Mahboobnagar District. The project is done with the collaboration of the Government of A.P., Roads and buildings department. We are going to do a case study on the present HLB which is proposed. All the design aspects are thoroughly analyzed and are present in this report.

Designing a high level bridge includes: (i) Hydraulic design, (ii) Stability analysis, which includes design of pier, abutments and Wing wall, (iii) Component design i.e., design of Backing wall and Bed Block and the drawings.

With rapid increase in vehicle users in our country, we are facing many traffic problems in many areas. In the way of moving across a river it is highly difficult if the structure is just a normal bridge. So in order to make the traffic flow continous and also avoid accidents, a High Level Bridge should be constructed across the major rivers. This is the only solution for elimination of such problem. This design of the bridge has been proposed to facilitate ease in commuting.

I. INTRODUCTION

A bridge is a structure built to span physical obstacles such as a body of water, valley, or road, having length above 6 m between the inner faces of the dirt wall for carrying traffic across obstruction. Cross drainage structures i.e. culverts are built having total length of 6 m or less. Bridges are classified as minor and major bridge. A minor bridge has a total length upto 60m whereas a major bridge's length is above 60mts. Designs of bridges vary depending on the function of the bridge, the nature of the terrain where the bridge is constructed and anchored, the material used to make it, and the funds available to build it.

There are six basic forms of bridge structures: beam bridges, truss bridges, arch bridges, cantilever bridges, suspension bridges and cable stayed bridges.the beam bridge carries vertical loads by flexure. The truss bridge of simple span behaves like a beam because it carries vertical loads by bending. The cantilever bridge generally consists of three spans, of which the outer spans, known as anchor spans, are anchored down to the shore, and these cantilever over the channel. A suspension bridge carries vertical loads from the deck through curved cables in tension.

Components of a bridge:

The main parts of a bridge structure are

(a) Decking, consisting of deck slab, girders, trusses, etc.

(b) Bearings for the decking;

(c) Abutments and piers;

(d) Foundations for the abutment and the piers;

(e) River training works, like revetment for slopes for embankment of abutments, and aprons at river bed level;

(f) Approaches to the bridge to connect the bridge proper to the roads on either side; and

(g) Handrails, parapets and guard stones.

Normally bridges have to be provided in such a way that they are clear of the high flood level & where there is navigation. Bottom of superstructure has to be kept sufficiently high to permit the boats & ships to pass under. HLB are provided in such a way that they can pass the design flood discharge with sufficient head room. There may be cases where ships may have to pass through them requiring very high clearance. They will then need very high bank approaches or highly graded approaches.

II. LITERATURE SURVEY

SUPERSTRUCTURE:

The part of the bridge on which the loads are directly applied is called the superstructure. Deck slabs-Beam Girders and Trusses are example of the superstructure.

SUBSTRUCTURE: The portion of the bridge structure below the level of bearing and above the foundation is called as sub-structure. Piers and Abutments are called sub-structure.

PIER AND ABUTMENT CAP: The pier or abutment cap is the block resting over the top of the pier or the abutment. It provides the immediate bearing surface for the support of the superstructure at the pier or abutment location, and disperses the loads from the bearings to the substructure evenly. PIERS: Piers are the structures located at the ends of bridge spans at the intermediate points between the abutments. The function of the pier is two-fold: to transfer the vertical loads to the foundation and to resist all horizontal forces and transverse forces acting on the bridge.

ABUTMENT: An abutment is the substructure which supports one terminus of the superstructure of a bridge and at the same time, laterally supports the embankment which serves as an approach to the bridge.

BEARING: Bearings are provides in bridges to transmit the load from the superstructure to the substructure in such a manner the bearing stresses induced in the substructure are within permissible limits.

FOOTING/FOUNDATION: The part of the bridge which is in direct contact with the earth and transmits all the loads directly to the earth is called the footing/foundation.

WING WALL: Wing walls are provided at both ends of the abutments to retain the earth filling of the approaches. The soil and fill supporting the roadway and approach embankment are retained by wing walls, which can be at right angles to the abutment or splayed at different angles.

BED BLOCK: A reinforced concrete bed block resting over the top of the piers & abutments is generally provided to evenly distribute the dead and live loads on the pier and abutments.

SUPERELEVATION: Super elevation is tilting the roadway to help offset centrifugal forces developed as the vehicle goes around a curve. Along with friction it keeps a vehicle from going off the road. Super elevation is required on curved path.

CAMBER: Camber is the cross slope provided to the road surface in the transverse direction to drain off the rain water from the road surface.

SELECTION OF SITE Normally selection of site for bridges is guided by road alignment. The most suitable sites for bridge location are

- Narrow width of the channel**.**
- Cross section having large average depth.
- Straight reach of the channel upstream and downstream.
- Having right angled crossing.
- Avoidance of curves in approach roads.
- Presence of high stable banks.
- Free from obstruction or an island in river bed u/s and d/s.

LOADING: While designing road bridges and culverts, the following loads, forces and stresses should be considered, where applicable.

Dead Load- The dead load carried by a bridge member consists of its• own supported by the member.

Live Loads- Live loads are those caused by vehicles which pass over the• bridge and are transient in nature. There are four types of standard loadings for which road bridges are designed: (a) IRC Class AA Loading, (b) IRC Class 70R Loading, (c) IRC Class A Loading, and (d) IRC Class B Loading.

Impact effect-• Live load trains produce higher stresses than those which would be caused if the loading vehicles were stationery. In order to take into account the increase in stresses due to dynamic action and still proceed with the simpler static al analysis, an impact allowance is made.

Wind Loads-• Though the wind forces are dynamic in nature, the forces can be approximated as equivalent static loads. These forces are considered to act horizontally and in such a direction as to cause the maximum stresses in the member under consideration.

Longitudinal Forces-• These forces are caused in road bridges due to the following. (a) Tractive effort caused through acceleration of driving wheels. (b) Breaking effect due to application of brakes to the wheels. (c) Frictional resistance offered to the movement of free bearing due to change of temperature or any other cause.

Buoyancy Effect• Whenever submersion in water of a part or whole of a structure is possible, the forces due to buoyancy should be considered. For high level bridges, buoyancy forces due to submerged part of the substructure and foundations should be taken into account.

Temperature effects-• Daily and seasonal variations in temperature occur causing material to shorten with a fall in temperature and lengthen with a rise in temperature**.**

III.CODAL PROVISIONS

METHOD OF DESIGN [IRC 21-2000]

- Structure and structural elements shall normally be designed by limit state method.
- Account should be taken of accepted theories, experiment and experience and the need who design durability.
- Calculations alone do not produce safe serviceable and durable structures.Suitable materials, quality control, adequate detailing and good supervision are equally important.
- Where the limit state method cannot be conveniently adopted, working stress method is used. Mostly in bridge designs working stress method is adopted.

CODE REQUIREMENT OF REINFORCEMENT

- Mild steel conforming to IS 432, high strength deformed bars conforming to IS 1786 and hard-drawn steel fabrics conforming to IS 1566 may be used as reinforcements. Structural steel conforming to grade A of IS 2002 is also permitted.
- All bars should be free from loose mill scale, loose rust, mud, cost of paint or any other material which destroy or reduce the bond.
- If required, in exceptional case and for rehabilitation of structures, special chemical coatings may be provided to reinforcements.
- For main bar steel of same grade should be used as main reinforcement.• Simultaneously use of two different grade of steel for main and secondary reinforcement is permitted.
- Bars may be arranged single or in pairs. Use of 3 or 4 bundled bars is also permitted. Bundled bars are to be tied together to insure that they remain together. Bars larger than 32 mm diameter are not to be bundled.

IV.DESIGN OF HIGH LEVEL BRIDGE

Name Of The Work:

PROPOSED HLB ACROSS MANDODDI RIVER AT CH 10/6- 10/8 ON R/F R&B TO PEDDA DHANWADA VIA MANDODDI OF WADDEPALLI (M) IN MAHABOOBNAGAR DISTRICT

Design Of Bridge With Open Foundations. **(13 Vents Of 10.37m Effective Span)**

Salient Features Of The Proposed Hlb Across Local Vagu At Ch 10/6-10/8 On R/F R&B Road To Pedda Dhanwada Via Mandoddi Of Waddepalli(M)In Mahaboobnagar District

1	Mfl	+99.950
2	Design Discharge	638.82 Cumecs
3	Sill level	+97.300
4	Linear Waterway	128.0 M
5	Span Arrangement	13 V X 10.37 M Eff.
6	Vertical Clearence + Afflux	1.35 M
7	Deck Thick Ness	0.790 M
8	. Rcl	+102.190
9	Type Of Superstructure	DECK SLAB
10	Type Of Sub Structure	
	A. Piers	VCC M15 Wall Type
	B. Abutments	VCC M15 Wall Type
	C. Wing Walls	VCC M15 Box Wing
11	Type of Foundation	
	A. For Piers	Open individual
	B. For Abutments	Open individual
	C. For Wing Walls	open
12	Foundation levels	
	A. For Piers	+92.950
	B. For Abutments	+92.950
	C. For Wing Walls	+96.000

13	Skew Angle	Normal Crossing
14	Velocity Of Flow	1.6 M/Sec
15	Type Of Bearings With Size	Craft Paper
16	Type Of Expansion Joints	Mastic Pad
17	Anchorage Arrangements	Nil
18	Type Of Protective Works	Nil
19	Approach Gradients	
	A.------ Mandoddi------Side	1 IN 40
	B. ------- Nasanoor ------Side	1 IN 40
20	Approach Lengths	
	A.------ Mandoddi------Side	90M
	B. ------- Nasanoor ------Side	90M
21	Approach Crust Total Thickness	375MM
22	Approach Formation Width	10.0M
23	Approach Carriageway Width	7.0M
24	Any Other Data Dsm	4.086 M
	1.27 Dsm= 5.186m 2.Dsm= 8.172	

Hydraulic Design:

s.no	location	HFL (M)	Discharge
1	Site of crossing	99.950	683.820

SALIENT FEATURES

1) Design Discharge, Q = 818.00 Cumecs
2) HFL = 99.950 m
3) Velocity = 2.000 m/sec
4) Sill Level = 97.300 m
5) Carriage way width = 7.50 m
6) Span arrangement = 13 vents of 10.37 m (eff)
7) RCL = 102.190 m
8) Bottom of Deck = 101.300 m
9) Type of Sub Strcuture

Pier = VCC M 15 wall TYPE Abutment = VCC M15 Wall Type Return Wall = VCC M15 BOX Type
10) Type of Foundation = Open foundation for both Piers and Abutments
11) Foundation Levels
Pier = 92.950 m
Abutment = 92.950 m Return wall = 96.000 GL-2.0m

DESIGN OF ABUTMENT WITH OPEN FOUNDATION

ABUTMENTS:

An abutment is the substructure which supports one terminus of the superstructure of a bridge and, at the same time, laterally supports the embankment which serves as an approach to the bridge. For a river bridge, the abutment also protects the embankment from scour of the stream.

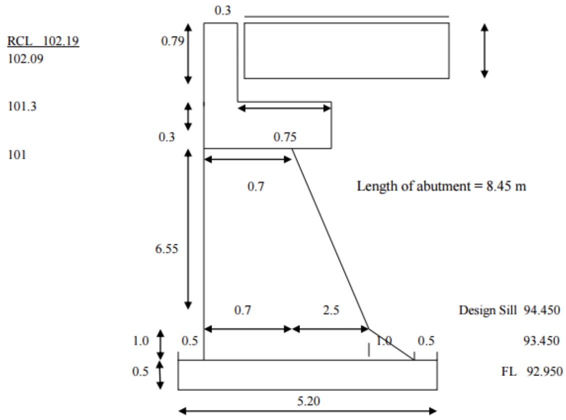
An abutment generally consists of following three distinct structural elements :

(i) The breast wall which directly supports the dead and live loads of the superstructure, and retains the filling of the embankment in its rear, (
(ii) ii) The wing walls, which acts as extensions of breast wall in retaining the fill though not taking any loads from superstructure.
(iii) The back wall, which is a small retaining wall just behind the bridge seat, preventing the flow of material from the fill onto the bridge seat.

Abutment Design calculations for maximum live load condition:
skew angle for span 0.00
Effective span = 10.37 M
Total span = 10.74 M
Expansion joint = 0.02 M
HFL = 99.95 M
Carriageway width = 7.5 M
Skew angle for dividing forces = 0 Degrees
Skew effective span = 10.370 M
Skew total span = 10.740 M
Straight portion of deck slab = 8.450 M
Thickness of deck slab = 0.790 M
Average thickness of Wearing coat = 0.100 M
4)BRIDGE with (FOOTPATH NOT or WITHOUT FOOTPATH)
Footpath Load = (500-((40*10.37-300)/9)) = 487.24 kg/sgm = (487.24*5.37*3) = 7.85 T
Footpath Load 0.0 T
Length of abutment = 8.450 M
Length of backing wall and bed block = 8.450 M
Thickness of bed block = 0.300 M
Thickness of backing wall = 0.300 M
Width of bed block = 0.750 M
Top width of abutment = 0.700 M
Front batter = 2.500 M
Back batter = 0.000 M
Width of abutment at sill level = 3.200 M
Trapezoidal footing thickness = 1.000 M
Footing Rear offset = 0.5 M
Front offset = 0.5 M Thickness = 0.5 M
Width of footing at F.L. = 5.20 M
Live load eccentricity Transverse = 1.100 M
Longitudinal = 0.195 M RCL = 102.190 M
Sill level / top of footing design = 94.450 M
Deck bottom level = 101.300 M
Bed block top level = 101.300 M
Abutment top level / Bed block bottom level = 101.000 M Height of abutment = 6.550 M
Foundation level = 92.950 M
Ground level = 98.500 M
Dead load of superstructure on abutment = 92.3 T (MOST drg.)
Live load reaction on abutment = 54.500 T
Maximum live load on span = 70.000 T
Height of hand rails = 0.860 M
Thickness of kerb = 0.275 M
Region(coastal=c,others=o) O
Unit weight of PCC = 2.300 t/cum
Unit weight of RCC = 2.400 t/cum
Unit weight of wearing coat = 2.300 t/cum
Unit weight of earth = 1.800 t/cum = 36 o
Coefficient of earth pressure at sill Kahsill = 0.217
Coefficient of earth pressure at F.L. Kah fl = 0.217

.Abutment design calculations for minimum live load condition:
Skew angle 0.00 Effective span = 10.37 M
Total span = 10.74 M
Expansion joint = 0.02 M
HFL = 99.95 M
Carriageway width = 7.5 M

Skew angle = 0 degrees
Skew effective span = 10.370 M
Skew total span = 10.740 M
Straight portion of deck slab = 8.450 M
Thickness of deck slab = 0.790 M
Average thickness of Wearing coat = 0.100 M
BRIDGE with (FOOTPATH NOT or WITHOUT FOOTPATH)
Footpath Load = (500-((40*10.37-300)/9) = 487.24 kg/sgm
= (487.24*5.37*3) = 7.85 t
Footpath Load 0.0 T
Length of abutment = 8.450 M
Length of backing wall and bed block = 8.450 M
Thickness of bed block = 0.300 M
Thickness of backing wall = 0.300 M
Width of bed block = 0.750 M
Top width of abutment = 0.700 M
Front batter = 2.500 M
Back batter = 0.000 M
Width of abutment at sill level = 3.200 M
Trapezoidal footing thickness = 1.000 M
Footing Rear offset = 0.5 M
Front offset = 0.5 M Thickness = 0.5 M
Width of footing at F.L. = 5.20 M
Live load eccentricity Transverse = 1.155 M
Longitudinal = 0.195 M RCL = 102.190 M
Sill level / top of footing = 94.450 M
Deck bottom level = 101.300 M
Bed block top level = 101.300 M
Abutment top level / Bed block bottom level = 101.000 M Height of abutment = 6.550 M Foundation level = 92.950 M Ground level = 98.500 M
Dead load of superstructure on abutment = 92.3 T (MOST
Live load reaction on abutment = 14.070 T
Maximum live load on span = 70.000 T
Height of hand rails = 0.860 M
Thickness of kerb 0.275 M
Region(coastal=c,others=o) O
Unit weight of PCC = 2.300 t/cum
Unit weight of RCC = 2.400 t/cum
Unit weight of wearing coat = 2.300 t/cum
Unit weight of earth = 1.800 t/cum = 36 o
Coefficient of earth pressure at sill kahsill = 0.217
Coefficient of earth pressure at F.L. khafl = 0.217



ABUTMENT SECTION

DESIGN OF PIER WITH OPEN FOUNDATION

PIER: Piers are structures located at the end of bridge spans at intermediate points between the abutments. The function of the piers is two-fold; to transfer the vertical loads to the foundation, and to resists all horizontal forces and trasverse forces acting on the bridge. Being one one of the visible components of a bridge, the pier contribute to the aesthetic appearance of the structure. The general shape and features of a pier depend to a large extent on the type, size and dimensions of the superstructure and also on environment in which the pier is located.

skew angle	**0.00**	
Effective Span	10.37	**M**
Effective Span in skew	10.37	M
Total Span	10.74	M
Total Span in skew	10.74	M
Srtright Portion of Deck Slab	7.50	M
Thickness of Deck Slab	0.79	M
Average Thickness of wearing coat	0.10	M
Pier Straight Length	7.50	M
Width of pier bed block	0.90	M
Top width of pier	0.76	M
Thickness of pier bed block	0.30	M
Pier bed block straight length	7.50	M
Bottom width of pier	1.30	M
Pier height	6.550	M
RCL	102.19	M
lowest bed level	97.30	M
BRIDGE with (FOOTPATH	WITHOUT	
longitudinal eccentricity	0.195	M
Live load reaction	70.57	T
cut water on pier cap	0.90	M
footing1 thickness	0.50	M
footing 1 width	2.30	
footing2 thickness	0.50	M
footing 2 width	3.30	
footing 3 thickness	0.50	
footing 3 width	4.30	

Velocity	1.60	m/sec
scour depth	8.172	M
MFL	99.95	M
offset f1 for first footing	0.50	M
offset f2 for second footing	0.50	
offset f3 for third footing	0.50	
Total length of span	10.76	M
Unit weight of comcrete	2.40	
Unit weight of comcrete(Plain)	2.30	
Pi	3.14	
Carrige way width	7.50	
Edge thickness of wearing coat	0.050	
REGION(COASTAL-C OR OTHERS-O)	O	
Bottom level of pier	94.49	
Bottom level of foundation	92.99	
Bottom level of deck slab	101.338	
Bottom level of pier bed block	101.038	
Bottom width of pier	1.30	M
Deepest scour level	91.78	M
Expansion gap	0.02	M

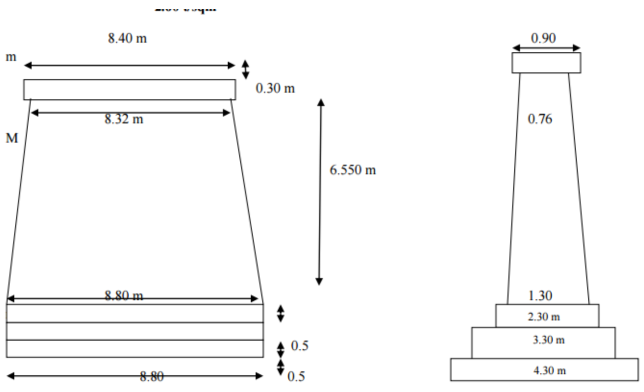
Dead load of superstructure on pier

a) With no buoyancy = 184.58
b) With 15% buoyancy = 184.58
c) With 100% buoyancy = 184.58

Sl.No.	condition	Total moments at sill level transverse	longitudinal	Total moments at foundation level transverse	longitudinal
I Without wind		tm	tm	tm	tm
1.	Friction due to temp & shrinkage	0.00	31.61	0.00	38.54
2.	Breaking force	0.00	47.95	0.00	58.45
3.	Water current force	2.21	5.52	3.13	7.81
4.	Live load eccentricity	81.51	14.47	81.51	14.47
5.	Floating debris	38.51		46.01	
		122.23	99.55	130.65	119.27
II With Wind					
1.	Friction due to temp & shrinkage	0.00	31.61	0.00	38.54
2.	Breaking force	0.00	47.95	0.00	58.45
3.	Water current force	2.21	5.52	3.13	7.81
4.	Live load eccentricity	81.51	14.47	81.51	14.47
5.	Floating debris	38.51		46.01	
6.	Wind load	23.31	11.66	28.11	14.05
		145.54	111.21	158.76	133.32

@ Foundation

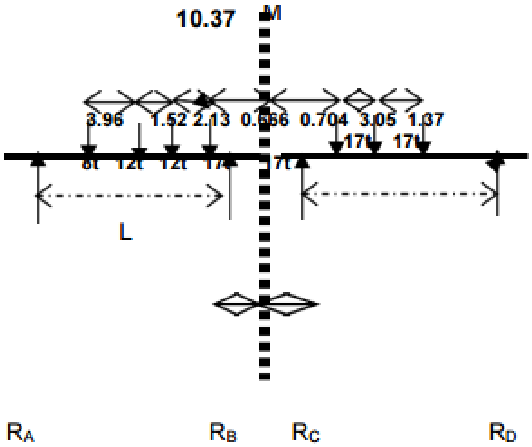
1.	Friction due to temp & shrinkage	0.00	38.54
2.	Breaking force	0.00	58.45
3.	Water current force	3.13	7.81
4.	Wind load	81.51	14.47
5.	Live load eccentricity	46.01	
6.	Floating debris	28.11	14.05
		158.76	133.32



PIER LONGITUDINAL SECTION PIER CROSS SECTION

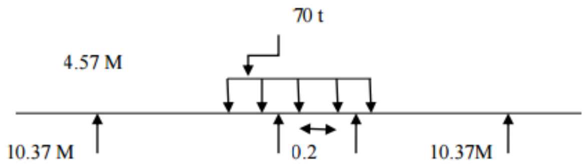
LIVE LOAD FOR PIER

Effective span = 10.37 m



Ra*10.37 = 8*(3.96+1.52+2.13+0.666-0.21)+12*(1.52+2.13+0.6660.210)+12*(2.13+0.666-0.21)+17*(0.666-0.21)
= 152.584
Ra = 152.584/10.37
= 14.71 t
Rb = 8+2+12+17-14.71
= 34.29 t
Rd*10.37 = 17(1.37+3.05+0.704-0.21) 17(3.05+0.704-0.21)+17(0.704-0.21)
Rd = 14.68 t
Rc = 17+17+17-14.68
= 36.32 t
Live load = 70.61 t

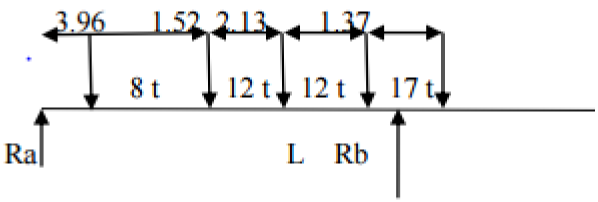
Tracked:



Maximum live load reaction = 1/10.37*(10.37-4.57/4)*70 = 63.64 t
Minimum live load reaction = 70-63.64 = 6.36 t
Maximum live load reaction for pier = 70.61

LIVE LOAD FOR ABUTMENT

Effective span = 10.37 M



Ra* 10.37 = 8*(3.96+1.52+2.13+1.37+3.05+1.37- 0.2)+12*(1.52+2.13+1.37+3.05+1.37-0.2)+12*(2.13+1.37+3.05+1.37-0.2)+17*(1.37+3.05+1.37-0.2)+ 17*(3.05+1.37-0.2)+17*(1.37-0.2)+17*(0-0.2)

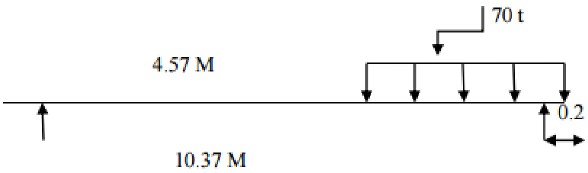
Ra = 183.26/10.37

= 17.67 t

Rb = 68-17.67

= 50.33 t

TRACKED:

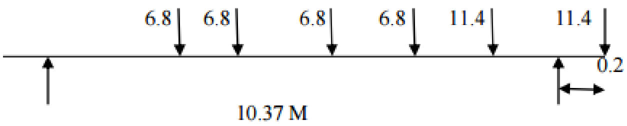


Maximum live load reaction = 1/10.37*(10.57 – 4.57/2)*70

= 55.93 t

Minimum live load reaction = 70 - 55.93 = 14.07 t

CLASS-A



Maximum live load reaction for abutment = 55.93 t

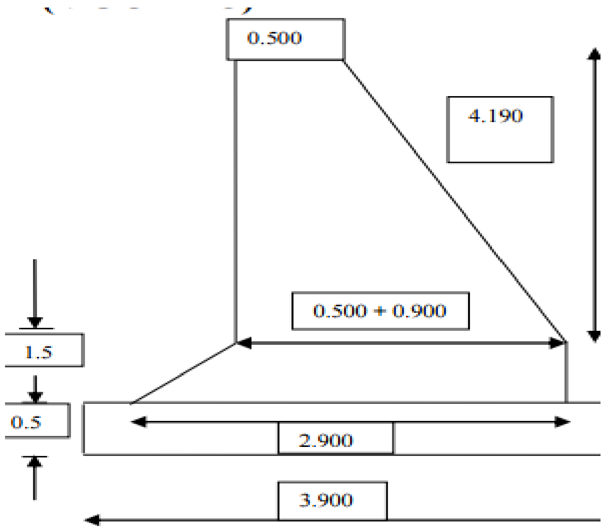
Minimum live load reaction for abutment = 14.07 t

DEAD LOAD:

EFFSPAN IN MET	Thickness IN Met	DL WITHOUT FOOTPATH		DL WITH FOOTPATH	
3	0.45	489	KN	571	KN
4	0.5	696	KN	791	KN
5	0.55	932	KN	1062	KN
6	0.6	1196	KN	1334	KN
7	0.65	1490	KN	1668	KN
8	0.75	1933	KN	2114	KN
9	0.82	2353	KN	2580	KN
10	0.9	2843	KN	3094	KN

DESIGN OF WING WALL(VCC M15)

Grade of concrete = VCC M15
RCL = 102.190 M
Sill Design = 98.000 M
Foundation = 96.000 M
Top width = 0.500 M
Earth side batter = 0.900 M
Other side batter = 0.000 M
Base width at sill = 1.400 M
Ht.of trap.footing = 1.500 M
Footing off set (earth side) = 0.500 M
Footing off set (other side) = 0.500 M
Thichness of footing = 0.500 M
Base width at FL = 3.900 M
Coef.of earth pr.above sill for f = 36o = 0.287 Kah = 0.163 Kav
Coef.of earth pr.below sill = 0.235 Kah
Ht.of wall = 4.190 M
Total height = 6.190 M
Unit wt.of earth = 1.800 T/cum
Unit wt.of concrete = 2.300 T/cum



(a)Moment due to Earth pressure

At sill = (0.287/2)*1.8*4.190² = 4.53*(0.42*4.190) = 7.98 t
At foundation = (0.235/2)*1.8*6.190² = 8.10*(0.42*6.190) = 21.07 tm
Stabilizing moment at sill = 0.163*1.8*4.190² = 5.15*((0.58*0.900)+0.500) = 5.26
Vertical load due to earth = (0.163/2)*1.8*6.190² = 5.62 tm

(b) Moment due to live load surcharge

At sill = 0.287*1.8*1.200*4.190 = 2.60* (0.5*4.190)
= 5.44 tm
At foundation = 0.235*1.8*1.200*6.190 = 3.14*(0.5*6.190)
= 9.72 tm
Vertical load = 0.163*1.8*1.200*6.190 = 2.18 tm

Stresses at sill

Resultant act at = (9.94 – 7.98 – 5.44)/9.16 = -0.381 M Eccentricity , e = (1.400 – (-0.381))/2 = 1.081 M
Stress, P = (9.16/1.4) (1+/- 6 x (1.081/1.4))
Pmax = (9.16/1.4) (1+ 6 x (1.081/1.4)) = 36.822 T/sq.m.
Pmin = (9.16/1.4) (1+ 6 x (1.081/1.4)) = -23.743 T/sq.m.

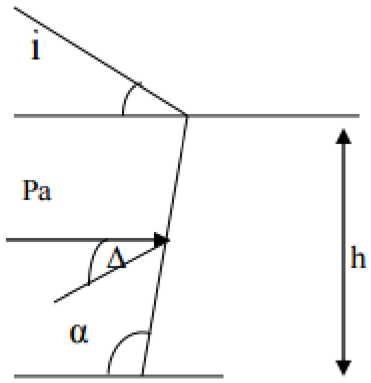
Stresses at foundation

Resultant acts at = (77.86 – 21.07 – 9.72)/29.57 = 1.592 M Eccentricity, e = (3.900/2) – 1.592 = 0.358 M
Stress, P = (29.57/3.9)(1 +/- 6*(0.358/3.9)
Pmax = (29.57/3.9)(1 + 6*(0.358/3.9) = 11.76 T/sq.m.
Pmin = (29.57/3.9)(1 - 6*(0.358/3.9) = 3.40 T/sq.m.

Factor of safety against sliding = μ w/p
= (0.315*(29.57255 + 5.62 + 2.18))/5.15 = 2.2859 > **1.5 [OK]**

Factor of safety against overturning = total stabilisation moment/total ove turning moment
= (5.26+77.86)/(21.07+9.72) = 2.6996 >**2 [OK]**

COULOMB'S EARTH PRESSURE CALCULATIONS:



Angle of internal friction for backfill ϕ = 36º
Angle of inclination of surcharge, i = 0º
Height of wall, h = 4.19 M
Rear batter, rb = 0.9
Angle of wall friction, δ = 17.5º
Angle of vertical face to horizontal, α = 77.88º
Unit weight of earth above sill level, γ = 1.8 t/cu.m.
Unit weight of earth below sill level γ_o = 1.8 t/cu.m.
Unit weight of earth below sill level γ_o sub = 0.8 t/cu.m. Cohesion of soil below sill C = 0 t/sq.m.
Angle of internal friction of soil below sill level ϕ = 36º Coefficient of active earth pressure, Kah (above sill) = 0.287

Calculation of coefficients :

$$Ka = \frac{\sin^2(\alpha + \Phi)}{\sin^2\alpha \, \sin(\alpha - \delta)\left[1 + \text{sqrt}\,\frac{\sin(\Phi+\delta)\,.\,\sin(\Phi - i)}{\sin(\alpha-\delta)\,.\,\sin(\alpha+i)}\right]}$$

A = Sin²(α + Φ) = Sin²(77.88 + 36.00) = 0.836

B = $Sin^2(\alpha)$ = $Sin^2 77.88$ = 0.956
C = Sin(α - δ) = Sin(77.88 – 17.50) = 0.869
D = Sin(Φ + δ) = Sin(36.00 + 17.50) = 0.804
E = Sin(Φ + i) = Sin(36.00 – 0.00) = 0.588
F = Sin(α + i) = Sin(77.88 + 0.00) = 0.978
Numerator = A = 0.836
Denominator = B x C x [1 + {SQRT ((D x E)/(C x F)$)^2$}]
= 0.956 x 0.869 x [1 + {SQRT ((0.804 x 0.588)/(0.869 x 0.978)$)^2$}]
= 2.532
Ka = 0.836/2.532 = 0.330

The horizontal component of Ka = Ka cos ((90 - α) + δ)
KaH = 0.330 x (Cos 90 – 77.88 + 17.50) = 0.287

The vertical component of Ka = Ka Sin(δ)
KaV = 0.330 x (Sin 90 – 77.88 + 17.50) = 0.163

CONSTRUCTION PROCEDURE

Before choosing the alignment, the survey of the area is done by the use of aerial photographic survey and remote sensing in highway. It helps in understanding the present path and forecasting the future path.
There are three stages involved in photogrammetric techniques of highway location:

- Corridor identification
- Preliminary planning and design
- Final design

• **Corridor identification** helps in doing highway survey and locating the route. It shows the terrain slope and drainage facilities. Using technology we not only get 2D images but also can be manipulated into 3D images. The suggested path and the location characteristics can also be understood.

Preliminary planning and design: In this survey the different alignments are drawn or plotted and the best and economical path is choosen.

Final design: The alignment of the best path is marked and important points on the path are noted down like bearing capacity of the soil at a given depth of the area.

CONSTRUCTION CONTROLS AND LAYOUT

Horizontal Controls:

To ensure the bridge lines up correctly with the approach roadways, the initial survey and layout establishes one or more centerlines to guide the construction of the bridge. The important centerlines to check include:

1. The centerline of construction (sometimes referred to as baseline of construction or survey line)
2. The centerline of structure
3. The centerline of roadway
4. The centerline of bearing (may also be called centerline of Pier)

Vertical Controls:

To maintain the proper grade of a bridge and the elevation of the various bridge components, all construction is required to be referenced to benchmarks. Benchmarks guide all elevation measurements from structure excavation and pile driving to pouring the bridge deck.

Benchmarks for bridges are established during the bridge layout and their locations are usually noted on the layout sheet. At least one benchmark on each side of the bridge is required to be checked for accuracy before construction begins.

If a benchmark is on a structure that is to be moved, a temporary benchmark is established and protected at a site convenient to the new bridge. As soon as a footing or other permanent part of the new structure is poured, the temporary benchmark is transferred to the new structure.

EXCAVATION :

Excavation is the next step that will be done in any construction activity. The trenches for the foundations of the piers, abutments and wing walls should be excavated first. This excavation is done by using Machines called JCBS.

The trenches for the foundation are excavated according to the layout and the design parameters that are considered. The location of the pier footing is marked by using the layout that is given to the contractor. The markings are done on the ground surface only.

Then the excavation will begin within the marked areas. The excavations are done according to the sizes and depths that are given in the layout. The excavated soil should immediately transport to other places using labor, trucks. The soil can be used as backfill for abutments and wing walls if it has the sufficient bearing capacity.

Excavation

The soil excavated is used as a backfill for the abutments and retaining walls. The soil gets compacted when the trucks with concrete and other construction materials pass over it when the girders and the slab are being casted in situ.

This helps in saving money spent for compaction of the soil. Then after the whole girder and deck slab are constructed the pavement is laid over the compacted soil.

Laying the Plain cement concrete (PCC): The ground level of the foundation pit is cleaned and leveled for laying the plain cement concrete. The plain cement concrete acts as the bed for the foundation. Plain cement concrete (PCC) is used to provide rigid impervious bed to RCC in foundation. The formwork centering is done according to the design and oil is applied to the formwork so that concrete does not stick to it. Then the PCC is poured and vibrated till it attains uniformity and then cured.

FOUNDATION:

The next step is building the foundation. The foundation rests on the PCC which acts as the rigid impervious bed to the foundation. The formwork and centering is done on the PCC. Then the cover blocks are placed on the PCC. The cover blocks are used for maintaining the level of reinforcement that will be used. The reinforcement at will be placed on the cover blocks and then the concreting is done.The concrete is vibrated by vibrators so that the concrete attains uniformity. The curing is carried out up to required number of days.

FOOTING

PIER:

The reinforcement of the pier is first connected to the reinforcement mat of the footing. The construction of the piers is also done in the same way as of the foundation. The reinforcement and is placed on the foundation firmly and the formwork is done. The concrete is mixed according to the design and poured. Then it is vibrated and left out for curing.

The bearings are just placed on the required level and place over the hammer head. They are manufactured and just bought and placed on the hammer head bed block.A bearing is the one which bears the vertical load and transmits horizontal force in any direction and allows rotation about any axis in horizontal plane without permitting any movement in horizontal plane.

GIRDER: Then is girders are casted in the site. The deck slab is constructed after the girders attain suitable strength

ABUTMENTS: The abutments are constructed at the ends of the bridge where the approach roadway joins the bridge. These abutments act as retaining walls and also pier to the bridge.

ABUTMENT

V.CONCLUSION

(a) We have observed that the soil possessing is soft rock so that the soil bearing capacity is sufficient to bear the structure.
(b) The foundations proposed are open foundations.
(c) The spans taken are thirteen spans of 10.37 m effective span.
(d) The shape of the pier considered is circular.
(e) The abutments and return walls are designed in Working stress Method.
(f) The factor of safety has been considered for the load acting on the structure.
(g) The Wing walls have been designed as per the IRC specifications

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3. Analysis and design of substructures by Swami Saran
4. SP 13 - For hydraulic design
5. IRC Code books
• IRC 5 - For General features
• IRC 6 - For Loading on Bridges
• IRC 78 - For Foundations
• IRC 21 – RCC Procedure