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ANALYSIS AND DESIGN OF DOUBLE LANE ROAD BRIDGE

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ABSTRACT

A Bridge is a structure providing passage over an obstacle without closing the way beneath. The required passage may be for a road, a railway, pedestrians, a canal or a pipeline. The obstacle to be crossed may be a river, a road, railway or a valley. In other words, bridge is a structure for carrying the road traffic or other moving loads over a depression or obstruction such as channel, road or railway. A bridge is an arrangement made to cross an obstacle in the form of a low ground or a stream or a river without closing the way beneath. In this study, a Double lane road bridge is proposed at any road crossings of irrigation Canal Bridge is a structure having a total length above 6 m between the inner faces of the dirt walls for carrying traffic or other moving loads over a depression or obstruction such as channel, road or railway. All these RCC spans will have tar paper bearings. The type plans of MORTH are available at the above interval and if the design span does not exactly match with the available type design, the details of next higher span length be used. These are designed for varying bearing capacity of foundation stratum as per existing ground strata.

When the canal is crossing the road or cart track a structure required to cross the canal from one side of canal bank to another side of canal bank then a Double Lane Road Bridge may be proposed.

1.INTRODUCTION

A bridge is a structure built to span physical obstacles without closing the way underneath such as a body of water, valley, or road, for the purpose of providing passage over the obstacle. There are many different designs that each serve a particular purpose and apply to different situations. 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. The first bridges made by humans were probably spans of cut wooden logs or planks and eventually stones, using a simple support and crossbeam arrangement. A common form of lashing sticks, logs, and deciduous branches together involved the use of long reeds or other harvested fibers woven together to form a huge rope capable of binding and holding together the materials used in early bridges.

When a canal crossing a major road that is District high ways then we are going to propose a structure is called Double Lane Road Bridge under the specifications of IRC standards.

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Abutment

abutment refers to the substructure at the ends of a bridge span or dam whereon the structure's superstructure rests or contacts. Single-span bridges have abutments at each end which provide vertical and lateral support for the bridge, as well as acting as retaining walls to resist lateral movement of the earthen fill of the bridge approach. Multi-span bridges require piers to support ends of spans unsupported by abutments.

Concrete abutment

PIER

A pier is a raised structure in a body of water, typically supported by well-spaced piles or pillars. Bridges, buildings, and walkways may all be supported by piers. Their open structure allows tides and currents to flow relatively unhindered, whereas the more solid foundations of a quay or the closely spaced piles of a wharf can act as a breakwater, and are consequently more liable to silting.

Bridge pier

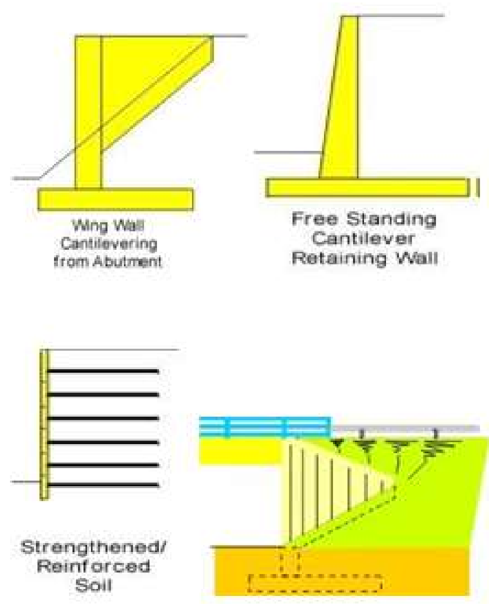
Pier cap

Pier Caps are the stones that cap piers, or gate pillars. They can be a cap on their own, or be a base for a ball finial, light or other feature to stand on. They are used to protect the pier from weather damage, as well as please the eye. They are also used for Balustrading piers.

Pier cap

Wing wall

Wing walls are essentially retaining walls adjacent to the abutment. The walls can be independent or integral with the abutment wall.



Wing wall

Parapet walls

BS EN 1317-1:1998 describes a Vehicle Parapet as a safety barrier that is installed on the edge of a bridge or on a retaining wall or similar structure where there is a vertical drop, and which may contain additional protection and restraint for pedestrians and other road users.

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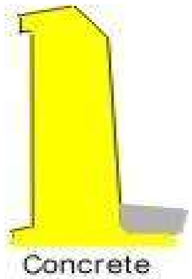

OBJECTIVES OF STUDY

The present study is taken up with the following objectives:

1. To study the functioning of DOUBLE LANE ROAD BRIDGE.

2. To Design the cross masonry concrete structure in canal irrigation system.

3. Steady flow of Traffic across the canal.

4. This structure is to provide the vehicles passage from one side to another side of banks of canal

SCOPE OF PROJECT

1. Site plan with net levels at 10m intervals and contours and duly marking the flow direction of the canal and the stream.
2. Hydraulic particulars of the canal
3. LS of the road covering 500m on u/s and d/s with levels at 10m to 20m intervals and CSs at centre line and at 10m, 25m, 50m, 100m, 200m, 300m,400m, and 500m on both sides.
4. Levels on the CS to be 3m, to 5m intervals
5. Topo sheet for a distinct view of road.
6. Safe bearing capacity of the strata may be obtained and furnished

2. LITERATURE REVIEW

Irrigation

Irrigation is defined as the process of artificial application of water to the soil in order to reach these following objectives: ensure enough moisture for agricultural crop growth, provide crop insurance against short duration drought, reduce hazards of soil piping, soften the tillage pan (a dense compact layer), cool the soil and atmosphere to provide a good atmosphere for plant growth, and wash out or dilute harmful salts in the soil (Mazumder, 1983; Basak, 1999; and Misra, 1981).

Shukla V.P. (1973) in his paper on 'Well Irrigation – Its Costs and Benefits in Jabalpur District in Madhya Pradesh' examined how far irrigation from wells either through electricity or diesel pumps was profitable in Jabalpur district in Madhya Pradesh, especially in the context of advanced technology.

The Irrigation and **Cross Masonry Design Report (1979)** explains that the purposes of constructing protective structures in an open irrigation system are to passage of traffic at one side bank to opposite bank. The protective structures generally constructed are **cross-masonay structures** and **Road Bridge structures.**

3. DESIGN METHODOLOGY AND MODELLING

Necessity of the structure:

The Chittakoduru Right Main Canal on its way is crossing the existing road at Km. 1.365. A Double Lane Bridge is proposed at the crossing.

The Hydraulic particulars :

The H.Ps of the canal at the proposed site at Km. 1.365 are as under.

S.No.	Description	Particulars
1.	Discharge (Required)	2.319 Cumecs
2.	Discharge (Designed)	2.375 Cumecs
3.	Bed Width	2.500 M
4.	F.S.D.	1.050 M
5.	Side Slopes	1.5:1
6.	Surface fall	1 in 6000
7.	Value of 'n'	0.018
8.	Velocity	0.550 M/Sec
9.	Canal Bed Level	+382.773 M
10.	Full Supply Level	+383.823 M
11.	Top of Bank Level	+384.573 M
12.	Proposed Road Level	+389.410 M
13.	Existing Road Level	+389.410 M

Vent Way:

Keeping in view of the canal bed width and depth of cutting, 2 vents (overall spans) of 8.400 M are proposed. To minimize the loss of head due obstruction of piers, the canal bed width is increased to the extent of pier thickness at the location of the structure and 1:5 transitions are proposed to connect the normal canal bed width.

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Super Structure:
A clear carriage way width of 10.900 M is proposed between the kerbs. R.C.C. Solid Slab of 8.000 M effective span is proposed. Superstructure is adopted from M.O.S.T. drawings (SD drawings) for effective span of 8.000 m without footpaths.

Sub Structure:
The height of pier above the top of foundation level to the bottom of R.C.C. slab is 6.612 M. Solid piers of 1.00m x 7.70 m with semi circular cut and ease waters is proposed in RCC M25 grade of concrete. Rectangular Pier pedestals of size 8.70 x 1.0 x 0.30 m in M25 grade is proposed between pier cap and pier. Pier cap of size 12.00 x 1.0 x 1.0 m is proposed in R.C.C. M25 grade with 1.65 m cantilever on either side of rectangular pier pedestal at top. The stability of the pier is checked and the reinforcement steel is proposed as per IRC:21-2000 and IRC:78-2000.

Foundations:

a) Pier: Foundations are proposed in R.C.C. M25 grade.

b) Abutments: Foundations are proposed in C.C. M15 grade.

Pier cap and Bed block:
Pier cap and Bed block for abutment are proposed in R.C.C. M25 grade.

Lining:
100 mm Thick lining is proposed for bed and sides of the canal for a length of 10.0m on either side of the structure in C.C. M10 grade or as per agreement conditions.

Miscellaneous items:
Approach slab, Railing, Drainage Spouts, Expansion Joints, Approaches etc., are proposed as per M.O.S.T. Drawings and IRC Codes.
The design is prepared based on the relevant provisions of IRC and IS Codes keeping in view the stability and feasibility.

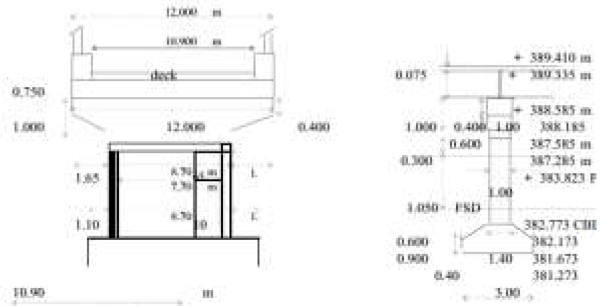
DESIGN OF SUPER STRUCTURE

Super structure is adopted from Standard design of concrete bridges of MOST for RCC slab bridge without footpaths. for effective span of 8.00 mts.

VERTICAL CLEARANCE
Vertical clearance required(Vide CL106.2.1 of IRC: 5- 1998)
Existing road level
Proposed road level
Vertical clearance available =388.585-383.823 =4.762 m
Hence OK

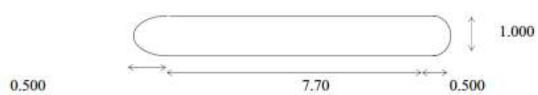
DESIGN OF PIER

Longitudinal section of pier



Width of slab in the normal direction	=	12.000	m
Carriageway width	=	10.900	m
width of pier cap	=	1.000	m
Length of pier cap	=	12.000	m
Depth of pier cap at edge	=	0.400	m
Depth of pier cap at pier face	=	1.000	m
Width of pier	=	1.000	m
Length of pier	=	7.700	m
Width of foundation	=	3.000	m
Depth of foundation at pier face	=	0.900	m
Depth of foundation at edge	=	0.400	m
Total Length of span	=	8.400	m
	=	7.400	m

SECTIONAL PROPERTIES OF PIER:



Length of pier =8.70m
Area of cut and ease waters=0.786m2
Area of straight portion =7.700m2
Total cross section area=8.486m2
Equivalent length =8.484m2

Modulus of section of pier at base ie at +382.173 m

Area of pier at base	=	8.486 x	1.000	=	**8.486**	m^2
Zxx of pier at base (road way dir)	= 1/6 x	8.486 x	1.000^2	=	**1.414**	m^3
Zyy of pier at base (canal flow dir.)	= 1/6 x	8.486^2 x	1.000	=	**12.001**	m^3
M.I xx of pier at base (road way dir)	= 1/12 x	8.486 x	1.000^3	=	**0.707**	m^3
M.I yy of pier at base (canal flow dir.)	= 1/12 x	8.486^3 x	1.000	=	**50.919**	m^3

Modulus of section of foundation concrete ie at +381.273 m

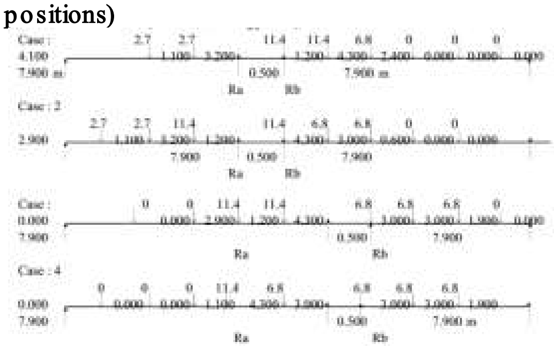
Area of foundation		10.900 x	3.000	=	**32.700**	m^2
Zxx of foundation (road way dir.)	= 1/6 x	10.90 x	3.000^2	=	**16.350**	m^3
Zyy of foundation (canal flow dir.)	= 1/6 x	10.90^2x	3.000	=	**59.405**	m^3

LOADS COMING ON TO PIER :
a. Dead load:
1 Dead load from superstructure (IRC for 10.00 m spans without footpaths)
Dead weight of deck slab
8.40 x 12.000 x 0.675 2.5 = 170.10 t
Dead weight of wearing coat

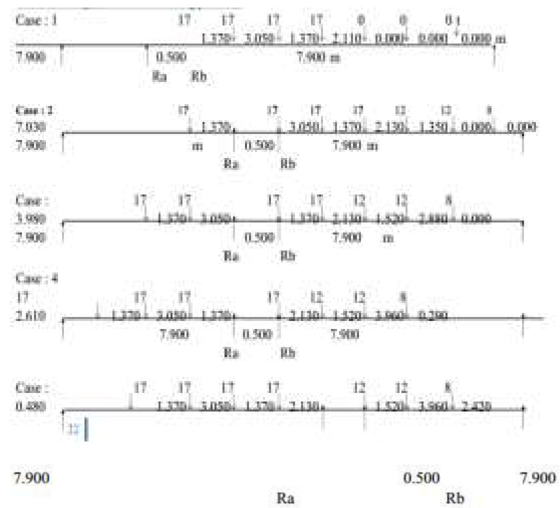
8.40 x 10.900 x 0.075 x 2.4 = 16.48 t
Dead weight of kerbs
2 x 8.40 x 0.550 x 0.315 x 2.5 = 7.28 t
Total cross section area=8.486m2
Equivalent length =8.484m221
Dead weight of hand rails
2 x 8.40 x 0.240 x 0.450 x 2.5 = 4.54 t
198.39 t
2 Dead load from pier cap
[(12.0 + 8.7) / 2 x 0.600 +
(12.0 x 0.40)] x 1.00 2.400 x = 26.424 t
3 Dead load from pier bed block(rectangular portion at top)
8.70 x 1.000 x 0.30 x 2.400 = 6.264 t
4 Weight of pier (with semi circular cut and ease waters)
I Above pier base 8.486 x 5.112 x 2.4 = 104.110 t
ii Below FSL 8.486 x 1.650 x 2.4 = 33.603 t
5 Weight of pier with 15% buoyancy
104.1 - (33.60 / 2.4) x 0.15 = 102.01 t
6 Weight of foundation
10.90 x 3.000 x 0.900 x 2.4 -
2 x 1/2x 10.90 x 0.800 x 0.500 x 2.4 = 60.168 t
7 Weight of foundation with 100% buoyancy
60.168 x 1.4 / 2.4 = 35.098 t

b. Live load Reactions :

for class A train of vehicles (with 4 cases of loading positions)



for 70R loading (with 5 cases of loading positions)



One lanes of class A loading

Case N	Ra	Rb	Ra+Rb	Ra-Rb
Case: 1	3.178	23.134	26.313	19.956
Case: 2	12.748	15.015	27.763	2.267
Case: 3	10.101	12.653	22.754	2.552
Case: 4	6.235	12.653	18.889	6.418

Two lanes of class A loading

Ra+ Rb max Ra - = 55.527 t
Rb min = 4.534 t
Max. load in span = 59.2 t
Max reaction Ra or Rb from one span
Ra+ Rb max Ra - Rb min = 83.290 t
Max. load in span = 6.801 t
Max reaction Ra or Rb from one span = 88.8 t
Live load considered in the design (with out impact) = 89.951 t

Three lanes of class A loading

1 lane of class A loading+1 lane of 70R loading
Ra+ Rb max = 89.951 t
Ra - Rb min = 5.472 t
Max. load in span = 112.600 t
= 69.403

Impact cann be neglected as the height of pier is more than 3.00m (vide cl 211.7© of IRC: 6-2000)

HORIZONTAL FORCES :

Tractive force or Braking force on pier due to vehicles :
The Braking force for this loading is the maximum that is coming on the span
I.e., 112.600 t for 1 lane of class A loading + 1 lane of class 70R loading
Braking force 112.6 x 1x 20% /2=11.260t

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acting at 1.20 m above road level = 1.2+389.4 =390.610m

Change in vertical reaction due to braking force=11.260(1.2+7.90)=2.886t

Moment at the base of pier = 11.260 x 6.41=72.199t.m

Moment about top of soil = 11.260 x 7.31=82.333t.m

Moment due to live load eccentricity

Eccentricity perpendicular to road way in the canal flow direction (longitudinal) :

	2 lanes of class A Loading		1 lane of class 70R Loading	
Distance of C.G of L.L from the edge of the kerb	0.15+0.5/2+1.8+0.5/2+1.2/2		1.2+2.79/2	
	3.05	m	2.595	m
Eccentricity of loads from the centre line of bridge	2.400	m	2.855	m
Max. liveload	55.527	t	62.187	t
Moment	133.26	t.m	177.545	t.m

Moment to be considered in the design =177.545 tm

b). **Transverse eccentricity :-**

Moment due to Live load eccentricity

Max.live load = 89.951 t

Eccentricity = 0.500 / 2 =0.250 m

Moment = 89.951 x 0.250 =**22.488 t.m**

Moment due to Dead load eccentricity :- (for one span condition)

Max.Dead load = 198.393 / 2 =99.197 t

Eccentricity = 0.500 / 2 =0.250 m

Moment = 99.197 x 0.250 = **24.799 t.m**

DESIGN OF FOOTING

Stresses on soil in t/m2 A = 32.700 m2

Zxx(road way dir)= 16.350 m3

(from pier design Zyy(canal flow dir.)= 59.405 m3

Load case.	Load combination	Load	Moment in Road way	Moment in Canal flow	Direct Stress	Bending Stress	Max Stress	Min Stress	SBC of soil
		P	ML	MT	P/A	S M/Z	P/A+M/Z	P/A-M/Z	50 t/m²
1	Service Condition DL+LL	488.20	141.09	177.54	14.93	11.62	26.55	3.31	No tension & < SB
	DL+LL+Buoy.	461.03	141.25	177.57	14.10	11.63	25.73	2.47	No tension & < SB
3	DL+LL+Wind	500.66	159.60	251.60	15.31	14.00	29.31	1.31	No tension & < SB
4	DL+LL+Buoy.+Wind	473.49	159.77	251.62	14.48	14.01	28.49	0.47	No tension & < SB
5	One span condition DL+Buoy.	252.65	24.96	0.02	7.73	1.53	9.25	6.20	No tension & < SB
6	DL+Wind	286.05	43.31	74.06	8.75	3.90	12.64	4.85	No tension & < SB
7	DL+Buoy.+Wind	265.11	43.48	148.13	8.11	5.15	13.26	2.95	No tension & < SB

Grade of concrete

: Stress in concrete

M 25

83.3 kg/cm² k = 0.294

Stress in steel = 2000 kg/cm² j = 0.902

modular ratio =

Stresses at corners:

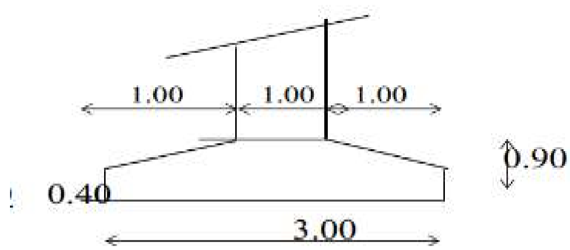
10 R = 11.046

Stress at P1 29.308 t/m²

Stress at P2 20.837 t/m²

Stress at P3 9.784 t/m²

Stress at P4 1.314 t/m



From Stress trepezoid on P1 and P2

Stress at the face of pier = 26.484 t/m² From Stress trepezoid on P1 and P3

Stress at the face of pier = 27.146 t/m²

1.207

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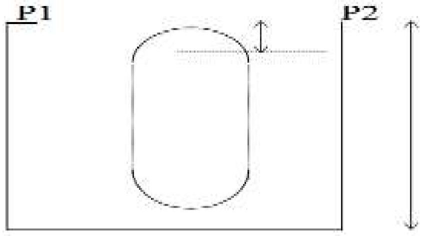
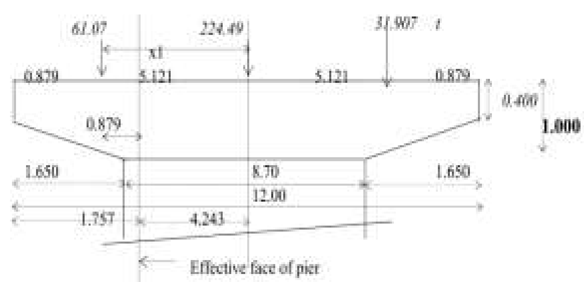


using 20 f bars and clear cover of 75 mm effective depth = 0.815 m
Stress at the distance 'd' from face of the pier = 28.785 t/m
Moment and shear:
Moment in traffic direction
29.308 - 26.484)1 2 / 3 +
26.484 x 1.00 2 / 2 = 14.183 tm
Shear in traffic direction at dist of eff depth
P3 P4 (1
- 0.815)x 1.0 x 29.308 = 5.422 t
Moment in canal flow direction
= 29.308 - 27.146) 1.207 2 / 3 + 27.146 x 1.21 2 / 2 = 19.778 tm
Shear in canal flow direction at dist of eff depth 1.207 - 0.815)x 1.0 x 29.308 = 11.493t
Effective depth :
Eff. Depth required =
=42.31< 81.5 cm
Hence O.K.

DESIGN OF PIER CAP

Dead Load from superstructure = 198.39 /12 = 16.533 t/m
Dead Load from bearing pedestal
=
= 0.000 t/m
Total dead load = 16.533 t/m
Maximum live load with out impact =
= 89.951 t
impact percentage = 4.5 / (6 + L) = 0.324 %
Maximum live load with impact = = 119.07
1 t

Eccentricity for live load from centre linr of bridge - (e) = 2.855 m
Equivalent length of pier = 8.486 m
Length of effective cantilever = 1.757 m
Length of effective cantilever from centre linr of bridge -
(x1) = 5.121 m
No of load concentrated areas - (n) = 3 Nos
Courbon's factor for distribution of liveload for supporting
Beams = 1 n e x1
S x2
Reaction from live load
for outer cantilever beam (l 119.07
1 x 0.269 = 32.015 t
for inner pier cap 119.07
1 x 0.7071 = 84.200 t
for outer cantilever beam (ri 119.07 1 x 0.024 = 2.856 t
Dead Load of pier cap(cantilever) = 1.650 x (0.4 +1.000) /2 x 1.00 x 2.40 = 2.772 t
acting at
0.707 from the face of pier pedestal
0.814 from the effective face of pier



Torsion:
Due to live load eccentricity in road119.07 x 0.250 12 = 2.4 tm
Due to max live load comb in road w62.19 x 0.250 12 = 1.30 tm
Torsion considered for design = 2.48 tm
Moment:
BM at the face of pier =
61.065x0.879+2.772x0.814 =55.91 t.m

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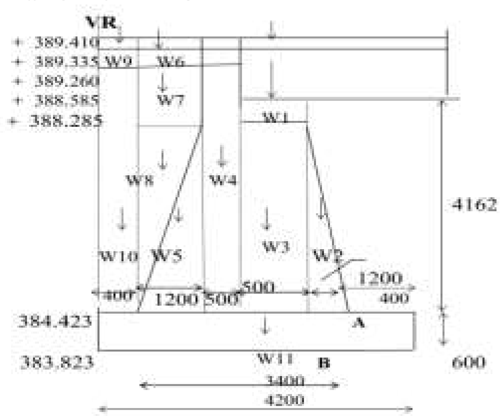
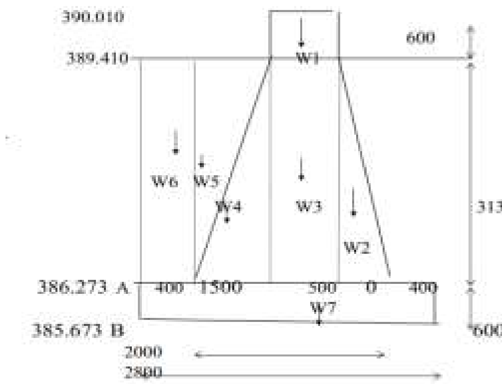
Longitudinal Reinforcement(As per cl.304.7 .2.4.2 of IRC:21-2000)
Shall be designed to resist an equivalent moment Me.l given by
Me x l = M + Mt
where M = bending moment due to vertical loads =55.91 t.m
Mt =T (1 + D/ b)
1.7
where T = Torsion = 2.48 t.m.
D = overall depth of beam = 1.00 m
b = breadth of beam = 1.00 m
Mt = 2.48 (1 + 1.00) =2.92 tm
1.00 1.7
Total moment =2.92+55.91 =58.83 tm

DESIGN OF ABUTMENT



FSL 383.823
Density of soil :2.10 t/m3
Density of concrete :2.20 t/m3
Density of Rcc :2.40 t/m3
Live load surcharge :1.20 m

DESIGN OF WING WALL
Grade of concrete : M15
Density of RCC : 2.4 t/m3
Density of Concrete : : 2.2 t/m3
Density of Soil : 2.1 t/m3
Live load : 1.2 m
Surcharge



4. RESULT

STRSS TABLE

S.No	DESCRIPTION	STRESS ON CONCRET MAX (t/m2)	STRESS ON CONCRET MIN (t/m2)	STRESS ON SOIL(t/m2) MAX (t/m2)	STRESS ON SOIL(t/m2) MIN (t/m2)
1	PIER	173.25	-69.75	29.31	0.47
2	ABUTMENT	32.09	-3.65	26.25	1.72
3	RETURN WALL	18.01	-2.34	13.20	2.85

The stress obtained is satisfying the stress of soil at site. Hence the design is safe.

5 .CONCLUSIONS& SUMMARY

The main objective of the thesis is to study the functioning of a DOUBLE LANE ROAD BRIDGE; the design is done by considering the site conditions and hydraulic particulars of canal.

Conclusions

1. This enables us to pass vehicles from one side of canal to another side.
2. Our project is Study of the construction of double lane Road Bridge that are a sub- part of the DLIS, which is package-ARMC situated at Janagoan.
3. The double lane road bridges also have a low Operation and Maintenance of them. It is both effective and economical with use of double lane road bridge system in cross masonry work.
4. Through this structure not only an IRC roads but also inspection path of canal also communicated.

Scope of future work

- The studies can be carried out for more number of varying site conditions.

- Studies can be further conducted on the different elevation for same bearing capacity of soil.
- Studies can be further conducted on the same carriage way road.

REFERENCES

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2. IRC 6-2000 for load calculation

3. IRC 5-1995 RCC Deck Slab

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