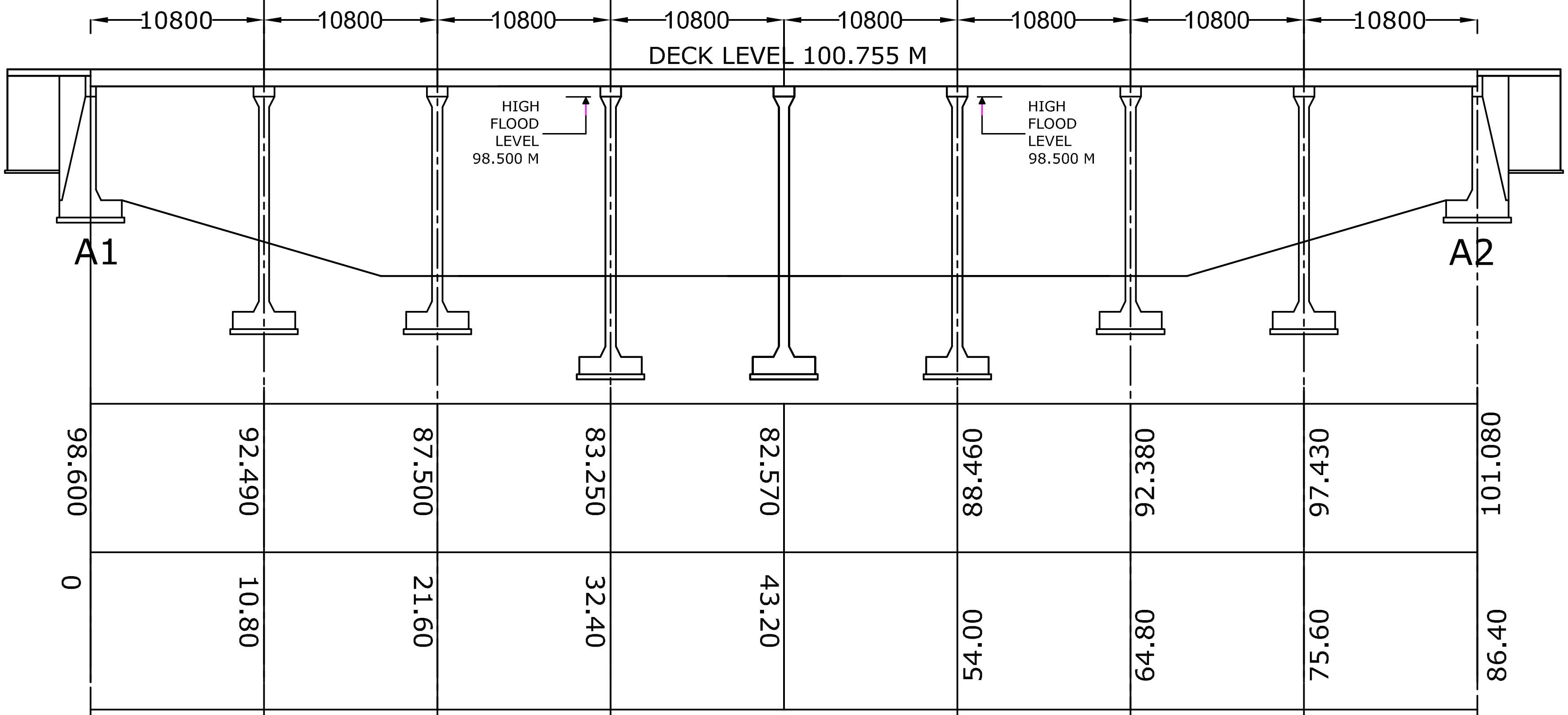
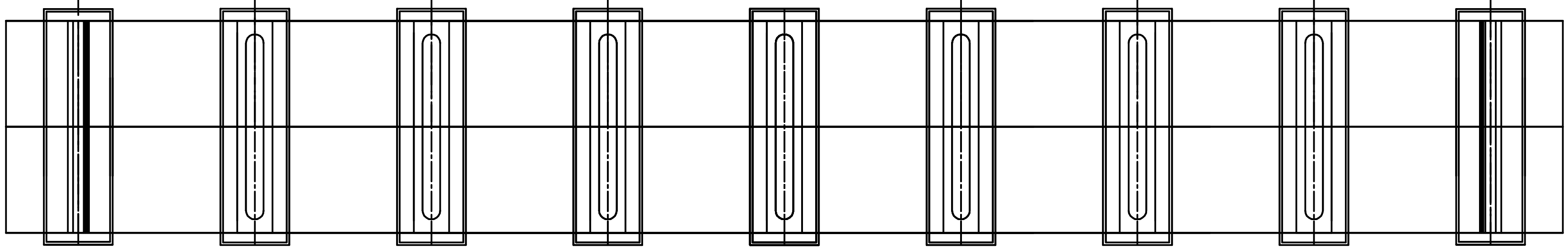
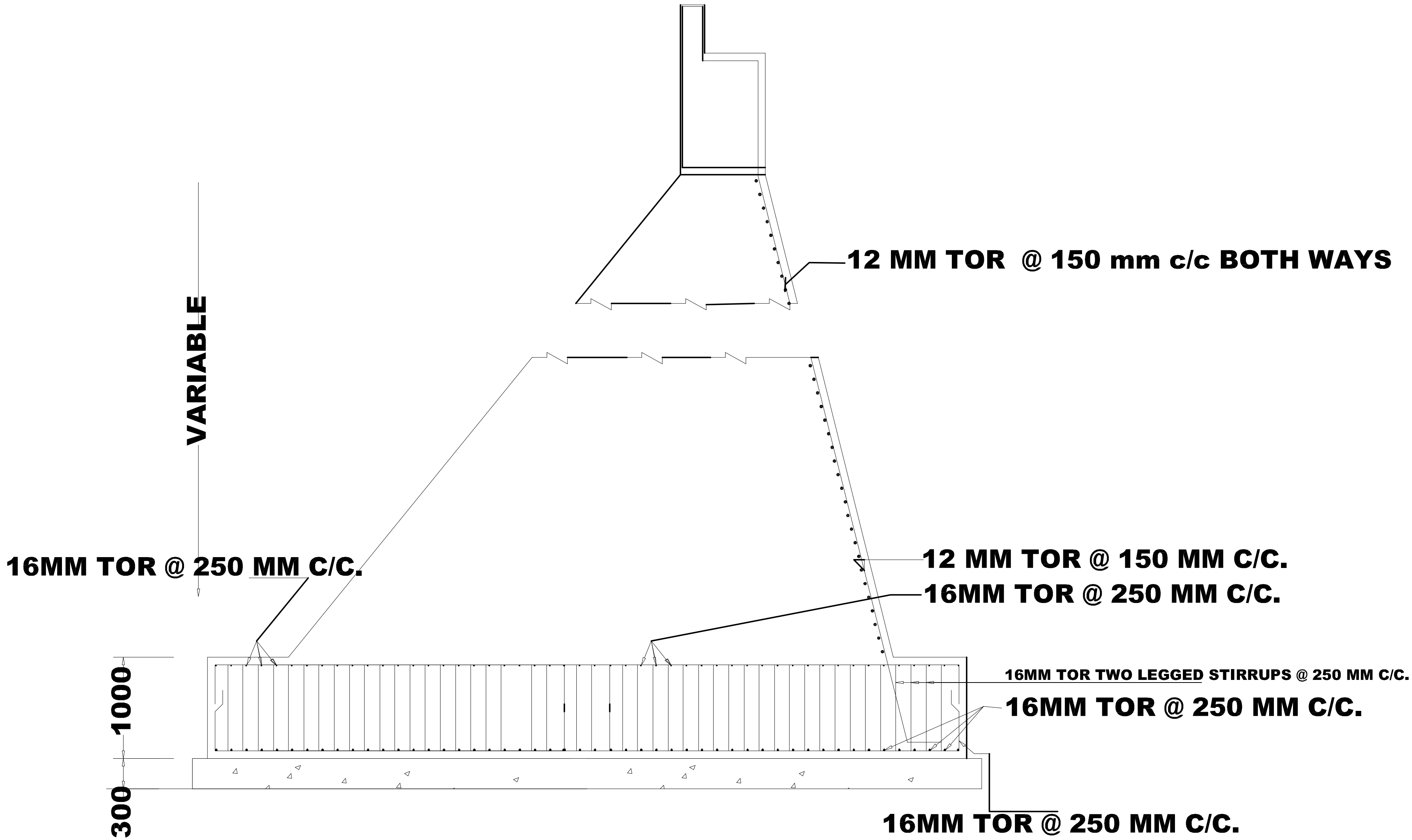


SECTIONAL ELEVATION

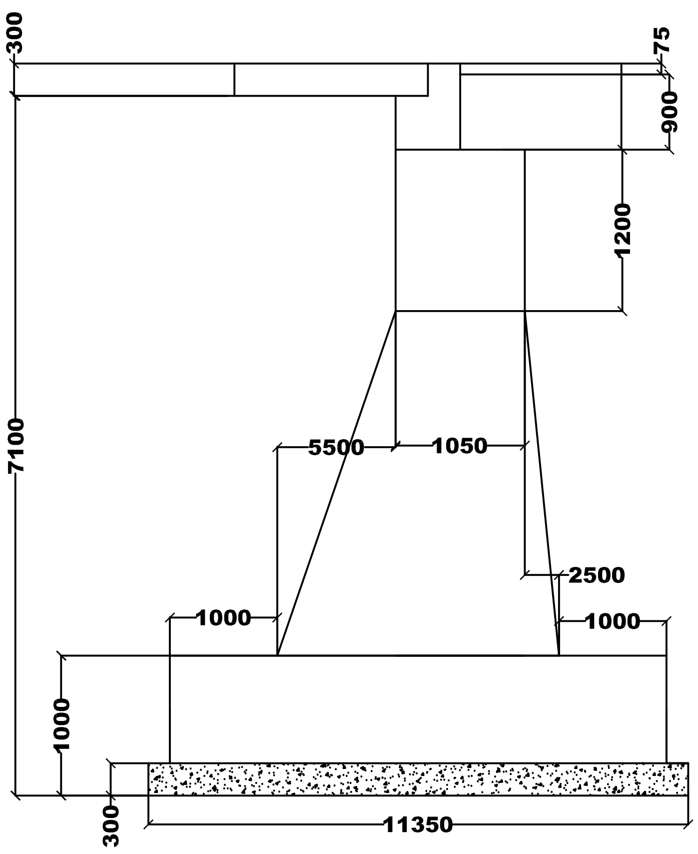


PLAN

GENERAL ARRANGEMENT DRAWING OF PROPOSED HIGH LEVEL BRIDGE ON KELWARA KUMBHALGARH ROAD, OVER KELWARA LAKE



REINFORCEMENT DETAIL



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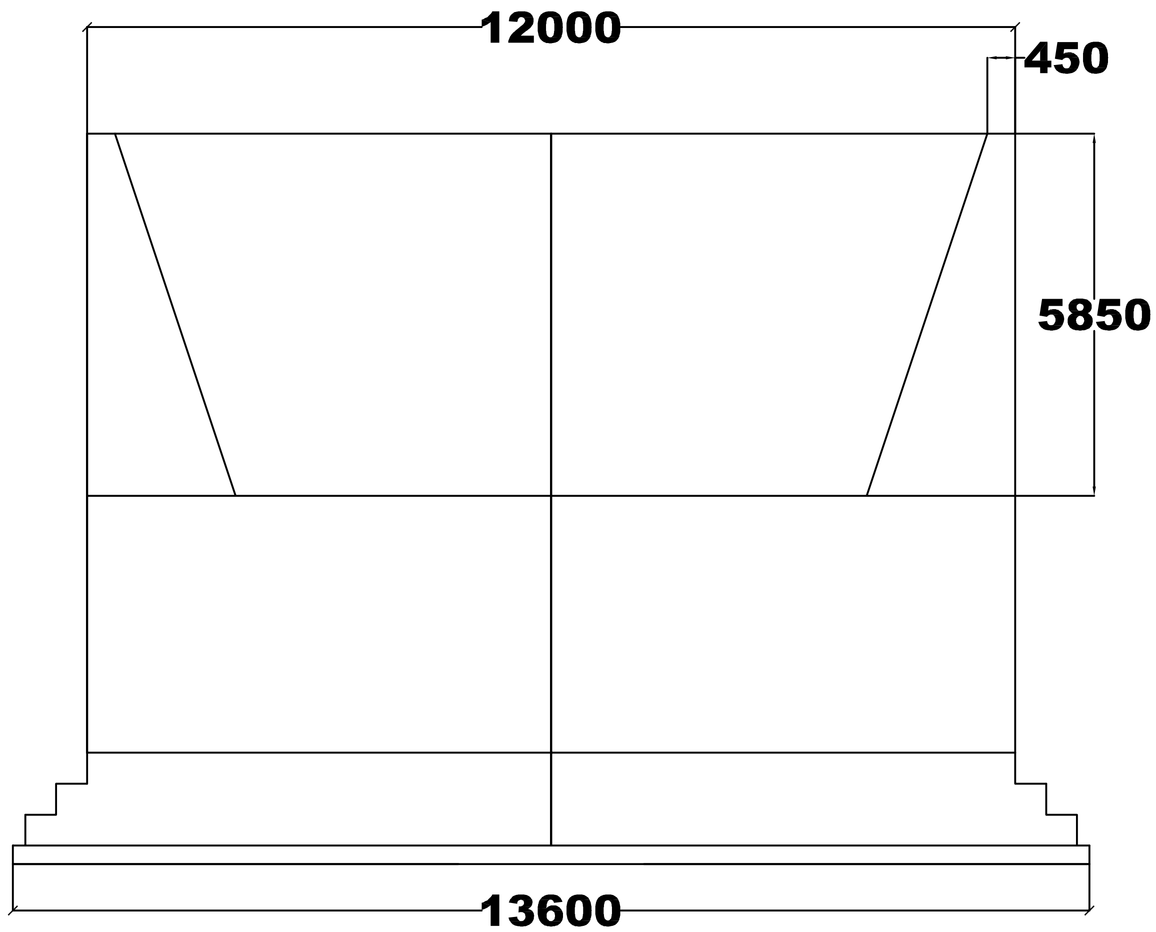
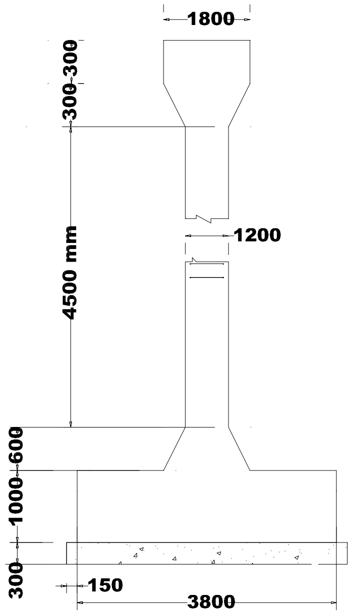
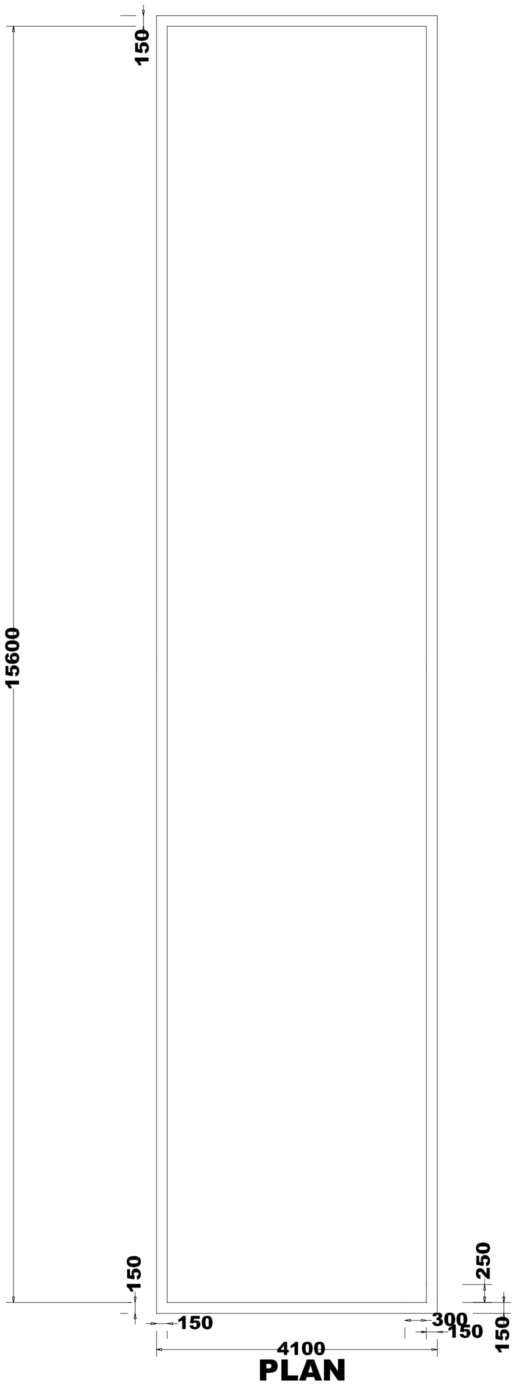


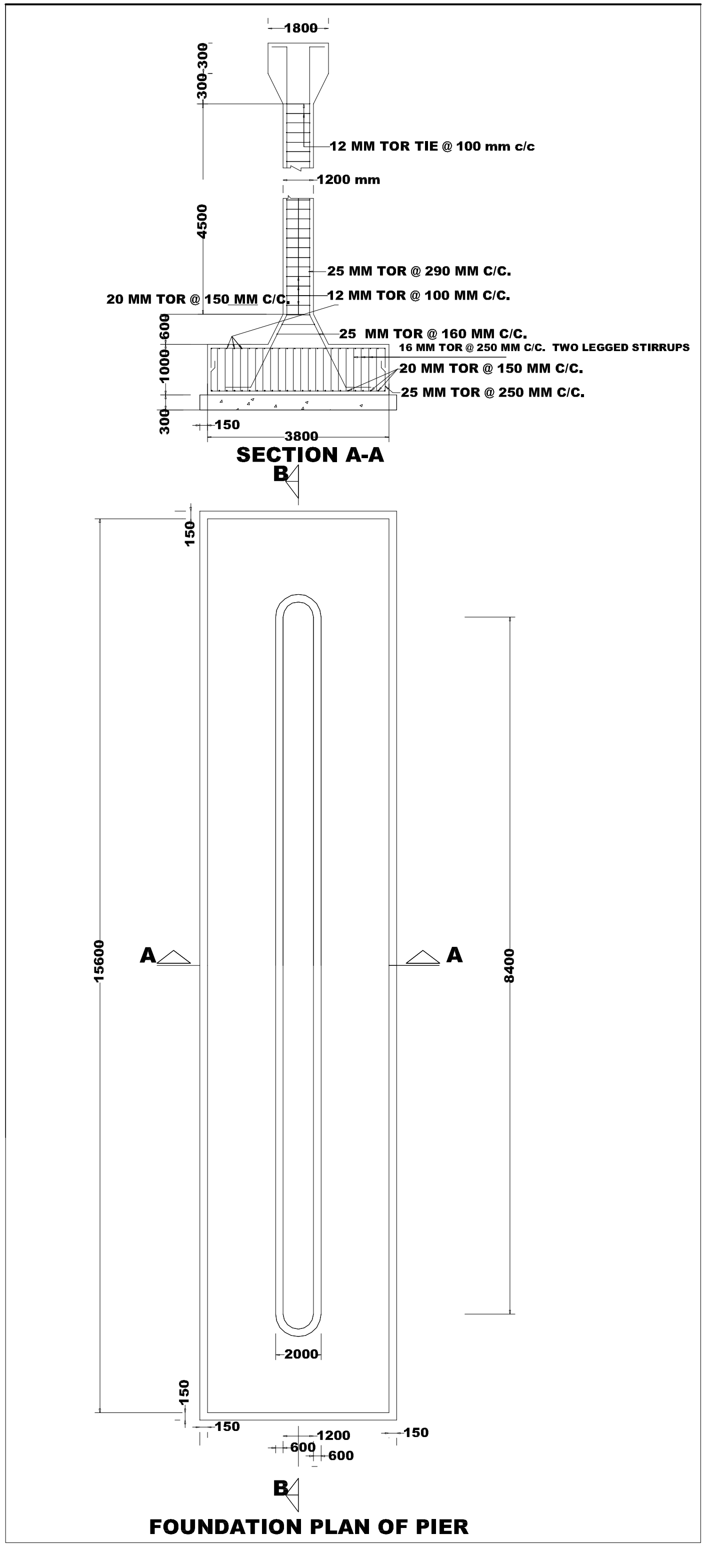
SECTION "A-A"OF ABUTMENT

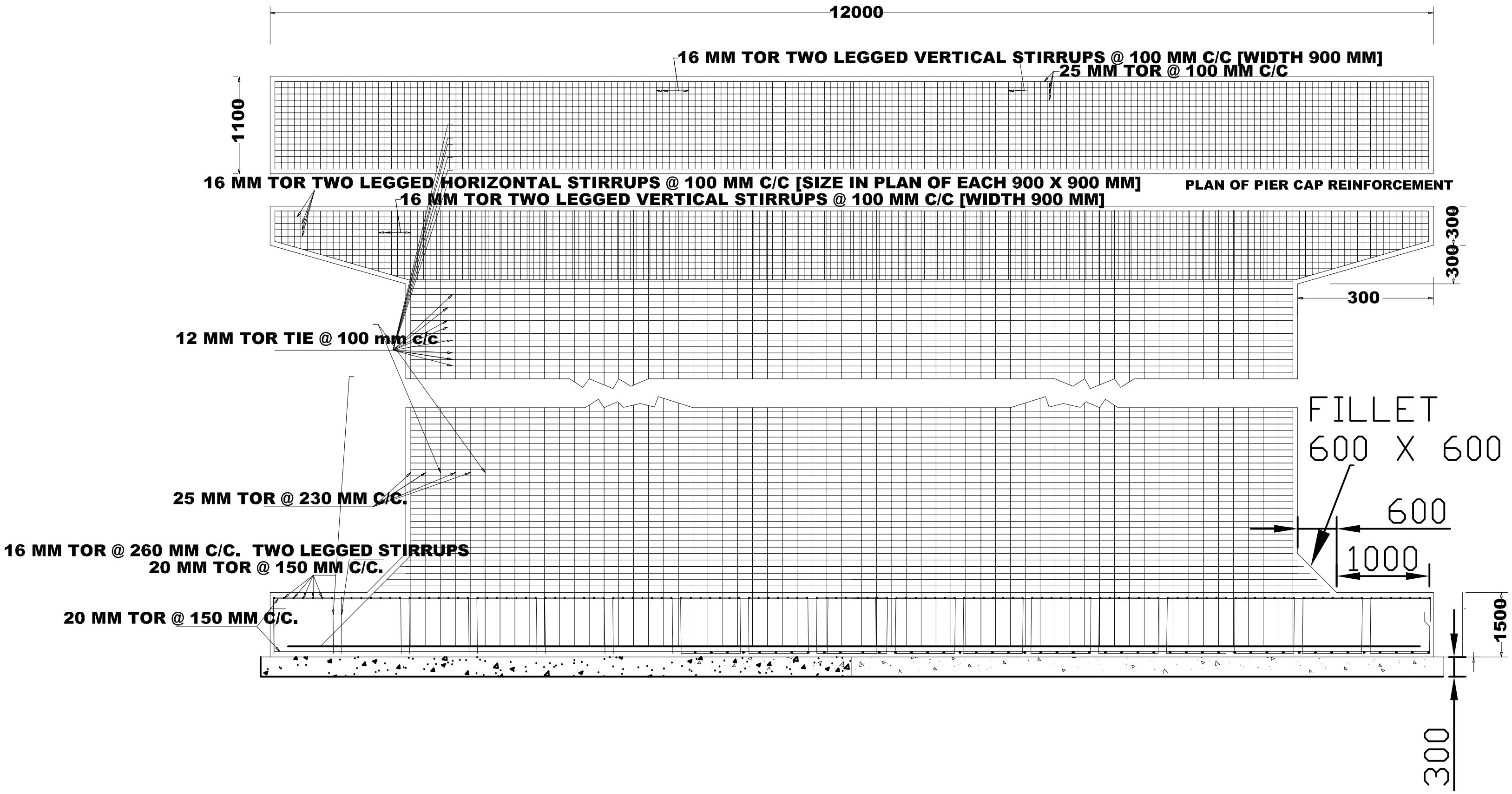


DETAILS OF FOUNDATION

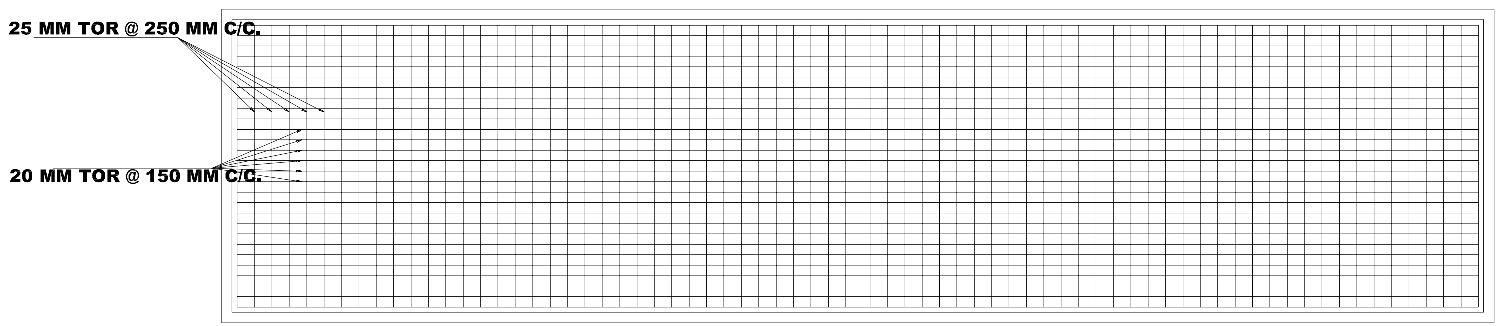


PLAN

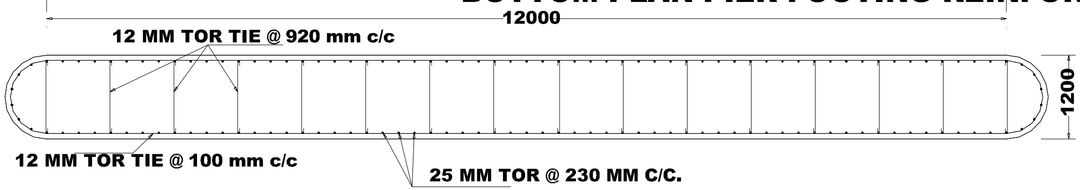

1800
300-300
12 MM TOR TIE @ 100 mm c/c
1200 mm
4500
25 MM TOR @ 290 MM C/C.
20 MM TOR @ 150 MM C/C.
12 MM TOR @ 100 MM C/C.
600
25 MM TOR @ 160 MM C/C.
16 MM TOR @ 250 MM C/C. TWO LEGGED STIRRUPS
1000
20 MM TOR @ 150 MM C/C.
25 MM TOR @ 250 MM C/C.
300
150
3800
SECTION A-A
B
150
15600
A
A
8400
2000
150
150
1200
150
600
600
B
FOUNDATION PLAN OF PIER



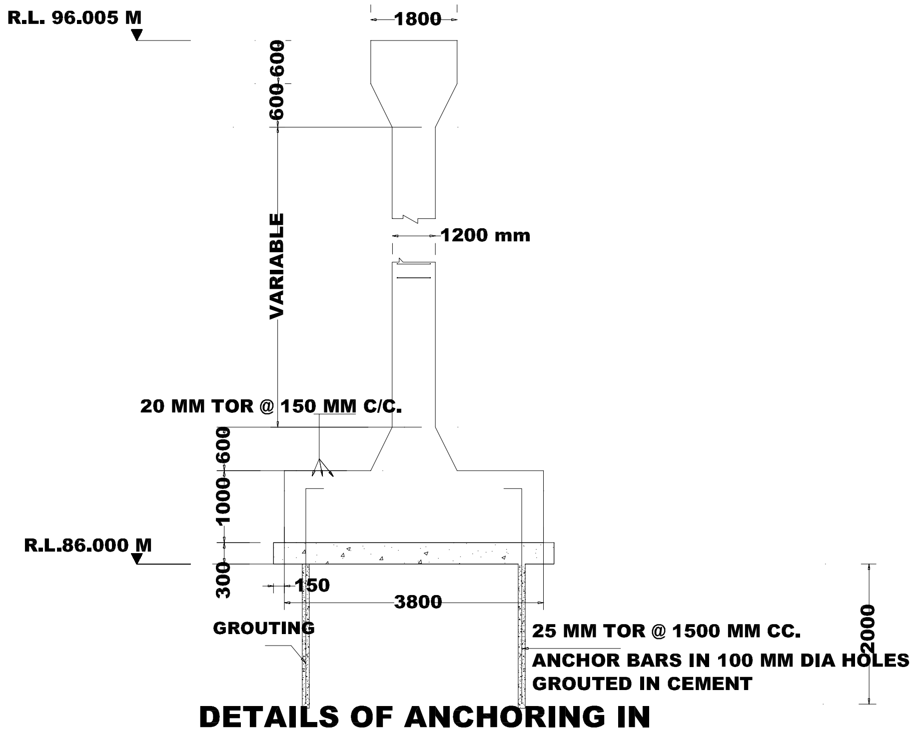
SECTION B-B



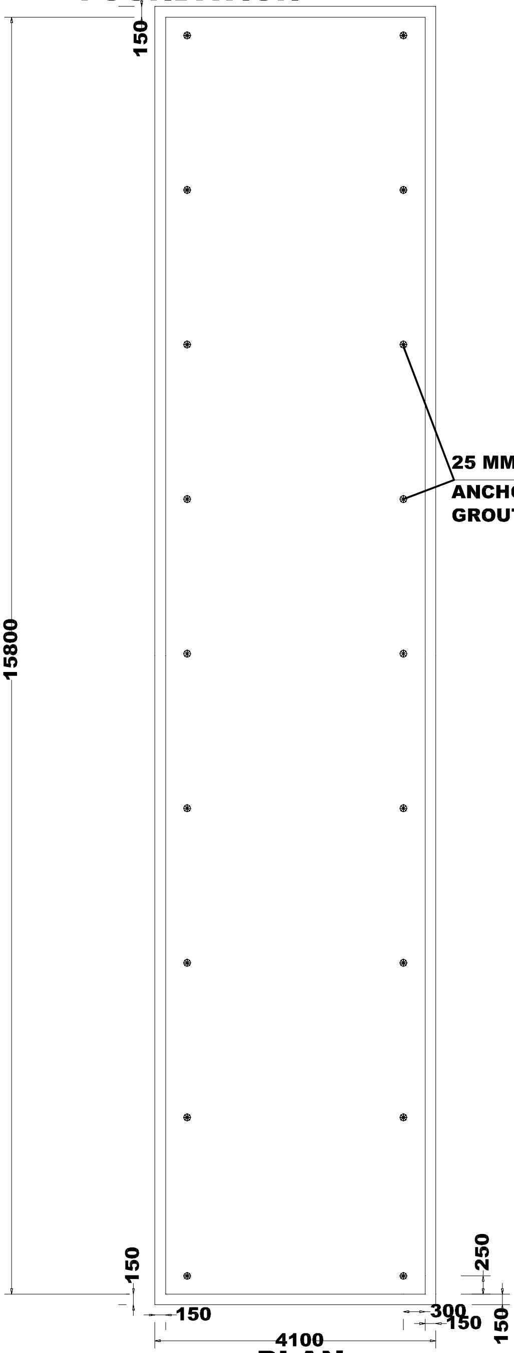
BOTTOM PLAN PIER FOOTING REINFORCEMENT



SECTION C-C

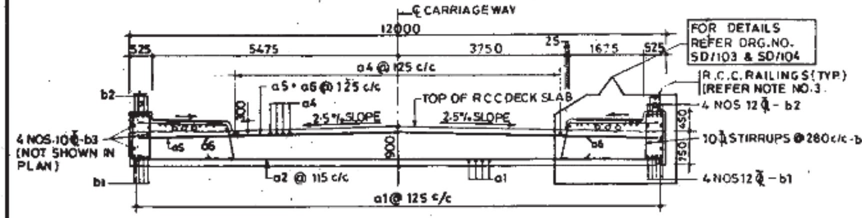


DETAILS OF ANCHORING IN FOUNDATION

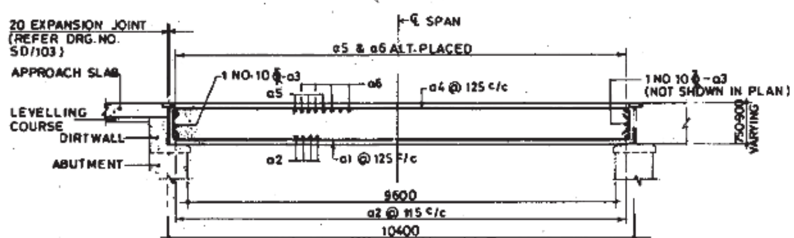


PLAN
DETAILS OF ANCHORING IN FOUNDATION

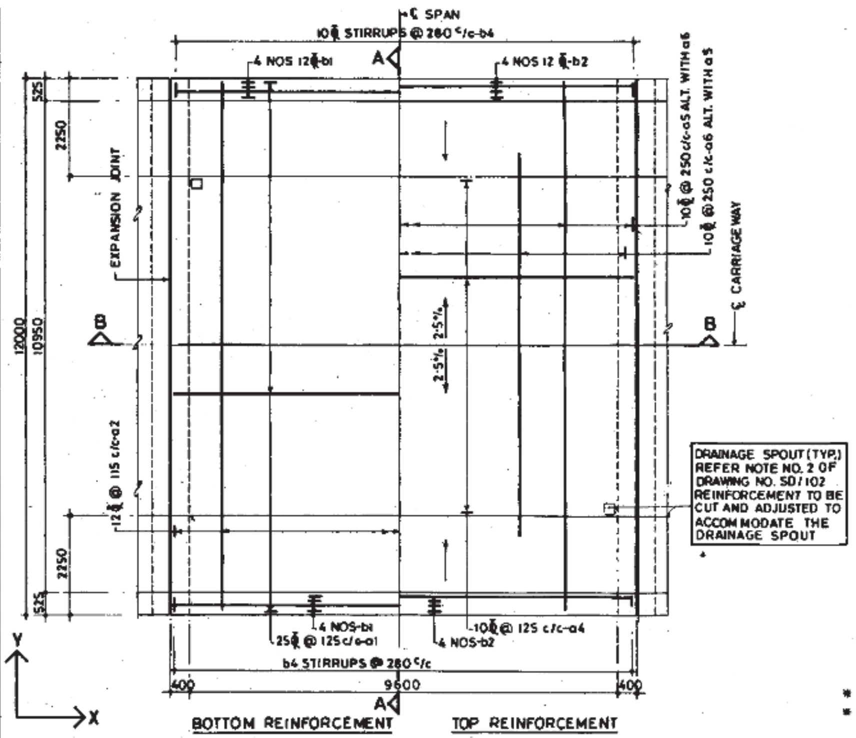
DRG. NO. SD/122



SECTION A-A



SECTION B-B *



PLAN SHOWING REINFORCEMENT DETAILS OF DECK SLAB *

DRAINAGE SPOUT (TYP.) REFER NOTE NO. 2 OF DRAWING NO. SD/102 REINFORCEMENT TO BE CUT AND ADJUSTED TO ACCOMMODATE THE DRAINAGE SPOUT

SCHEDULE OF REINFORCEMENT (PER SPAN)

SL.NO.	LOCATION	BAR MKD	SHAPE	DIA. (mm)	SPACING (mm)	LENGTH (mm)	NOS.	TOTAL LENGTH (m)	WEIGHT (kg)
1	SLAB-BOTTOM ALONG-X	a1	500, R=100, 10300, 500	25	125	11150	96	1070·40	4121
2	SLAB-BOTTOM ALONG-Y	a2	300, R=50, 11900, 300	12	115	12430	91	1131·13	1004
3	SLAB-SIDE ALONG-Y	a3	11900	10	—	11900	2	23·80	15
4	SLAB-TOP ALONG-X	a4	10300, 500, R=40, 500	10	125	11240	61	685·64	423
5	SLAB-TOP ALONG-Y	a5	5800, 5800	10	250	11600	42	487·20	301
6	SLAB-TOP ALONG-Y	a6	4050, 4050	10	250	8100	42	340·20	210
7	KERB-BOTTOM	b1	650, R=50, 10275, 650	12	—	11500	8	92·00	82
8	KERB-TOP	b2	10300, 650, R=50, 650	12	—	11530	8	92·24	82
9	KERB-SIDES	b3	325, R=40, 10250, 325	10	-	10840	8	86·72	54
10	KERB-STIRRUPS	b4	403, 1053, R=40	10	280®	3110	76®	236·36	146
11	FOOTPATH-TOP ALONG-Y	f1	2050, R=30, 300	8	200	3275	106	347·15	137
12	FOOTPATH-TOP ALONG-X	f2	10300, 600, R=80, 600	8	—	11450	20	229·00	90
13	FOOTPATH-MIDDLE ALONG-X	f3	10250	10	—	10250	16	164·00	101
14	FOOTPATH-EDGES ALONG-X	f4	500, R=30, 10250, 500	8	—	11200	4	44·80	18

® DOES NOT INCLUDE THE ADDITIONAL STIRRUPS AT LAPS OF LONGITUDINAL BARS - REFER DRG. NO. SD/103

Dead load of the superstructure per span including R.C.C. railings @ 3 kN/m and wearing coat @ 2 kN/sq m = 3094 kN.

REFERENCE DRAWINGS

DRAWING NO.	TITLE
SD/101	GENERAL NOTES
SD/102	GENERAL ARRANGEMENT
SD/103 & SD/104	MISCELLANEOUS DETAILS
SD/106	DETAILS OF R.C.C. RAILINGS (WITH FOOTPATHS)

QUANTITIES (PER SPAN)

EFFECTIVE SPAN (m)	10·0
CONCRETE (cu.m)	118·70
STEEL INCLUDING 5% EXTRA FOR LAPS AND WASTAGE (kg)	7124
ASPHALTIC WEARING COAT (sq.m)	78·00

NOTES:-

1. All dimensions are in millimetres unless otherwise mentioned. Only written dimensions are to be followed.
2. Special attention is invited to note no.(8)-I of drawing no SD/101 regarding the design mix to be adopted.
3. The reinforcement of railing posts shall be incorporated before casting of the deck slab. The railings shall conform to drawing no. SD/106 or any other approved type.
4. Dimensions in schedule of reinforcement are given as per IS 2502
* 5. Reinforcement of adjacent span superstructure, approach slab not shown.
* 6 Service ducts and reinforcement of footpath not shown in plan.

MKD	DATE	DESCRIPTION	BY

R E V I S I O N

GOVERNMENT OF INDIA
MINISTRY OF SURFACE TRANSPORT
(ROADS WING), NEW DELHI

STANDARD DRAWINGS FOR ROAD BRIDGES

R.C.C. SOLID SLAB
SUPERSTRUCTURE (RIGHT) SPAN 10·0m
(WITH FOOTPATHS)

RECOMMENDED BY		APPROVED BY	1990
(S.S.REDDY) E.E.	(S.K.KAISTHA) S.E.	(P.N.SHIVAPRASAD) C.E.	DRG. NO. SD/122

Ministry of Surface Transport
(Roads Wing)

STANDARD PLANS FOR HIGHWAY BRIDGES
R.C.C. SLAB SUPERSTRUCTURE

Published by
The Indian Roads Congress
on behalf of the Govt. of India,
Ministry of Surface Transport (Roads Wing)

Copies can be had from :
The Secretary, Indian Roads Congress,
Jamnagar House, Shahjahan Road,
New Delhi- 110011

NEW DELHI 1992 Price Rs. 400/-
(plus packing & postage charges)

FOREWORD

I have great pleasure in placing before the community of Bridge Engineers, this Volume of Standard Plans for Highway Bridges covering RCC right slab type superstructure. This publication is the first in the series of new Standard Plans for Highway Bridge Superstructure being brought out keeping in view the recent changes in specifications and provisions in the Bridge Codes. I am sure this publication will prove extremely useful in proper planning, estimation and execution of highway bridges in the country.

The publication has been made possible by the sustained efforts of the personnel of the Bridges Standards and Research zone of the Bridges Directorate of this Ministry and the Consultant associated with the work, who deserve commendation for the work done by them. The keen interest of the Addl. Director General (Bridges), in taking up this work and bringing out this publication in a short time is worthy of special mention.

(K.K. SARIN)
Director General (Road Development) &
Addl. Secretary to the Govt. of India

New Delhi, June 1, 1991

PREFACE

The Standard Plans for Highway Bridges with RCC Slab Type Superstructure (Volume II) were first issued by the Ministry of Surface Transport (Roads Wing) in the year 1977. Since then there have been several revisions in the specifications and provisions of the Bridge Codes. The preparation of revised Standard Drawings was, therefore, taken up towards the end of 1989 and completed on top priority.

This Volume, the first in the series of new Standard Drawings for Superstructure, contains Standard Plans for RCC Slab type highway bridge superstructure for 3.0 to 10.0 metre effective spans. It also contains drawings for wearing coat, railings and miscellaneous items. A separate volume containing bill of quantities for various items of superstructures will also be issued shortly.

The design caters for one lane of IRC Class 70-R wheeled/tracked loading or 2-lanes of IRC Class A loading whichever produces more severe effect. Footpaths have been designed for a crowd load of 5 kN/m^2. Keeping in view the current practice of providing a deck of the same width as the adjoining road for NH bridges having total length less than 30 m, the overall width between the outer faces of the railing kerb has been kept as 12 m. The wearing coat will be of mastic and asphaltic concrete type, except in remote areas where average 75 mm thick cement concrete wearing coat may also be adopted. The designs are based on Standard Specifications and Codes of Practice for Highway Bridges issued by the Indian Roads Congress. For construction purposes, Specifications for Road and Bridge works issued by the Govt. of India, Ministry of Surface Transport (Roads Wing), as amended from time to time, will apply.

The plans have been made complete in all respects so that they could be readily adopted for preparation of estimates and also serve as construction drawings in the field. The entire design philosophy adopted lays great emphasis on constructability i.e. convenient and full translation of the design on to the ground. A great deal of attention has, therefore, been paid to dimensioning and detailing. I have no doubt that the wide spread adoption of these Standard Plans will lead to reduction in time of construction and enhancement of the quality and durability of our road bridges.

Every possible care has been taken to eliminate errors in the Drawings but users are requested to bring to our notice errors or omissions, if any, which may come to light while using these Drawings in their bridge works.

The work of preparing the Designs and Drawings was carried out by the Consultant, M/s. Consulting Engineering Services (India) Pvt. Ltd., New Delhi. Equally important contributions in the finalisation of the designs and details were made by officers of the Ministry whose names appear in the title blocks of various drawings. The enthusiasm and dedication which they brought to bear on the task are to be highly appreciated.

(NINAN KOSHI)
Addl. Director General (Bridges),
Ministry of Surface Transport (Roads Wing)

New Delhi, June 1, 1991

CONTENTS

DRG. NO. SD/101

(A) GENERAL

1. These notes are applicable for the Standard Drawings for R.C.C. solid slab superstructure with and without footpaths.
2. These drawings are applicable only for right bridges with overall width of 12 m.
3. No raised footpaths shall be provided on the bridges having length less than 30m unless the same are otherwise existing on the approaches.
4. All dimensions are in millimetres unless otherwise mentioned. Only written dimensions are to be followed. No drawing shall be scaled.
5. Design criteria:
   I. The design is according to the following codes:
      (a) IRC : 5-1985
      (b) IRC : 6-1966 (1985 reprint)
      (c) IRC : 21-1987.
   II. The following loads have been considered in the design:
      (a) One lane of IRC class 70R or two lanes of IRC class A on carriage way, whichever governs.
      (b) Footpath load of 5 kN/sq.m for superstructure having footpaths.
      (c) Wearing coat load of 2 kN/sq.m.
   III. The designs are applicable for 'MODERATE' AND 'SEVERE' conditions of exposure.
6. Public utility services (except water supply and sewerage), if required, shall be carried over the bridge through 150mm diameter ducts provided in the footpaths. Total load of such services shall not be more than 1.0 kN per metre on each footpath. Water/sewerage pipeline shall not be carried over any part of the superstructure. Inspection chambers in footpaths may be provided as shown in the drawing. The location and spacing of chambers along the footpath will be decided by the Engineer-in-charge in consultation with the users.
7. Wearing coat shall consist of the following:
   I.(a) A coat of mastic asphalt 6mm thick with a prime coat over the top of the deck before the wearing coat is laid. The prime coat of mastic asphalt shall be 30% straight run 30/40 penetration grade bitumen and 50% light solvent (Benzol) to be laid over the deck slab. The insulating layer of 6mm thick mastic asphalt with 75% lime stone dust filler and 25% of 30/40 penetration grade bitumen shall be laid at 375°F with broom over prime coat.
   (b) 50mm thick asphaltic concrete wearing coat in two layers of 25mm each as per Clause 512 of MOST's Specifications for Road and Bridge Works (Second Revision-1988)
   II. In case of isolated bridge construction or bridges located in remote areas where provision of mastic and asphaltic concrete wearing coat is not practicable, the Engineer-in-charge may permit provision of 75mm thick cement concrete wearing coat in M30 grade concrete with maximum water cement ratio as 0.40. The reinforcement shall consist of 8mm High Yield Strength Deformed bars @ 200mm centres reducing to 100 centres in both the directions over a strip of 300mm near the expansion joint. Reinforcement shall be placed at the centre of the wearing coat. Wearing coat shall be discontinued at expansion joint locations. Joint fillers shall extend upto the top of wearing coat.
8. 20mm expansion joint does not cater for any allowance for possible tilting of abutment.
9. Support for the deck slab shall provide a bearing width of 400mm.
10. In urban areas, chequered tiles may be provided in the footpath portion by suitably adjusting the thickness of the footpath slab.
11. Type/position of return walls, railings, guard posts, ramp etc. in approach portion shall be decided by the Engineer-in-charge.

(B) MATERIALS SPECIFICATIONS

Concrete

1. Concrete shall be of design mix and shall have minimum 28 days characteristic strength on 150mm cubes for all elements of superstructure as indicated below:

Conditions of exposure	Concrete grade	Characteristic Strength
'MODERATE'	M 25	25 MPa (for 3m to 9m span)
'MODERATE'	M 30	30 MPa (for 10m span)
'SEVERE'	M 30	30 MPa (for 3m to 10m span)

2. High strength ordinary portland cement conforming to IS:8112 or ordinary portland cement conforming to IS 269 capable of achieving the required design concrete strength shall only be used.
3. The minimum cement content and maximum water cement ratio in the concrete design mix shall be 310 kg/cu.m and 0.45 respectively for 'MODERATE' conditions of exposure. The minimum cement content and maximum water cement ratio in the concrete design mix shall be 400 kg/cu.m and 0.40 respectively for 'SEVERE' conditions of exposure.

Reinforcement

All reinforcing bars shall be High Yield Strength Deformed bars (Grade designation S 415) conforming to IS 1786.

Water

Water to be used in concreting and curing shall conform to Clause 302.4 of IRC 21-1987.

(C) WORKMANSHIP/DETAILING

1. Minimum clear cover to any reinforcement including stirrups shall be 50mm unless shown otherwise in the drawings.
2. For ensuring proper cover of concrete to reinforcement bars specially made polymer cover blocks shall only be used.
3. Construction Joints
   I. The location and provision of construction joints shall be approved by Engineer-in-charge. The concreting operation shall be carried out continuously upto the construction joint.
   II. The concrete surface at the joint shall be brushed with a stiff brush after casting while the concrete is still fresh and it has only slightly hardened.
   III. Before new concrete is poured the surface of old concrete shall be prepared as under:
      a) For hardened concrete, the surface shall be thoroughly cleaned to remove debris/laitance and made rough so that 1/4 of the size of the aggregate or structurally damaging the concrete.
      b) For partially hardened concrete, the surface shall be treated by wire brush followed by an air jet.
      c) The old surface shall be soaked with water without leaving puddles immediately before starting concreting to prevent the absorption of water from new concrete.
   IV. New concrete shall be thoroughly compacted in the region of the joint.
4. Welding of reinforcement bars shall not be permitted.
5. Laps in reinforcement:
   I. Minimum lap length of reinforcement shall be kept as 83 d where 'd' is the diameter of bar.
   II. Not more than 50% of reinforcement shall be lapped at any one location.
6. Bending of reinforcement bars shall be as per IS : 2502.
7. Supporting chairs of 12mm diameter shall be provided at suitable intervals as per IS : 2502.
8. Concrete shall be produced in a mechanical mixer of capacity not less than 200 litres having integral weigh-batching facility and automatic water measuring and dispensing device.
9. Proper compaction of concrete shall be ensured by use of full width screed vibrators for concrete in deck slab.
10. Properly braced steel plates shall be used as shuttering.
11. Sharp edges of concrete shall be chamfered.

(D) GENERAL SPECIFICATIONS

The work shall be executed in accordance with MOST's Specification for Road and Bridge Works (Second Revision, 1988) except wherever otherwise mentioned.

(E) REFERENCE TO DRAWINGS

Drawing No.	Title.
SD/101	GENERAL NOTES
SD/102	GENERAL ARRANGEMENT
SD/103 & SD/104	MISCELLANEOUS DETAILS
SD//105	DETAILS OF R.C.C. RAILINGS (WITHOUT FOOTPATHS)
SD/106	DETAILS OF R.C.C. RAILINGS (WITH FOOTPATHS)
SD/107 THROUGH SD/114	R.C.C. SOLID SLAB SUPERSTRUCTURE (RIGHT) SPANS 3m To 10m (WITHOUT FOOTPATHS)
SD/115 THROUGH SD/122	R.C.C. SOLID SLAB SUPERSTRUCTURE (RIGHT) SPANS 3m To 10m (WITH FOOTPATHS)

MKD	DATE	DESCRIPTION	BY

R E V I S I O N

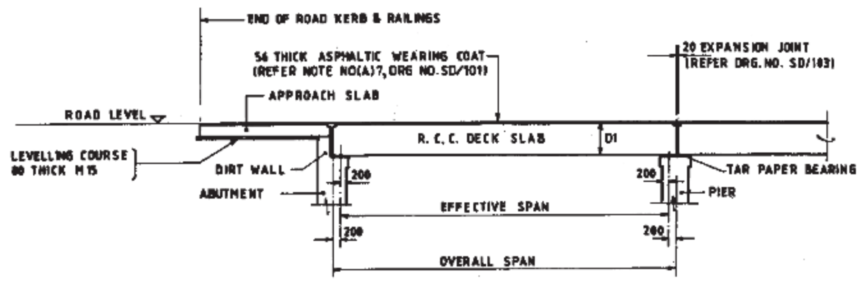
GOVERNMENT OF INDIA
MINISTRY OF SURFACE TRANSPORT
(ROADS WING), NEW DELHI

STANDARD DRAWINGS FOR ROAD BRIDGES

R.C.C. SOLID SLAB
SUPERSTUCTURE (RIGHT) SPAN 3.0m To 10.0 m
(WITH AND WITHOUT FOOTPATHS)
GENERAL NOTES

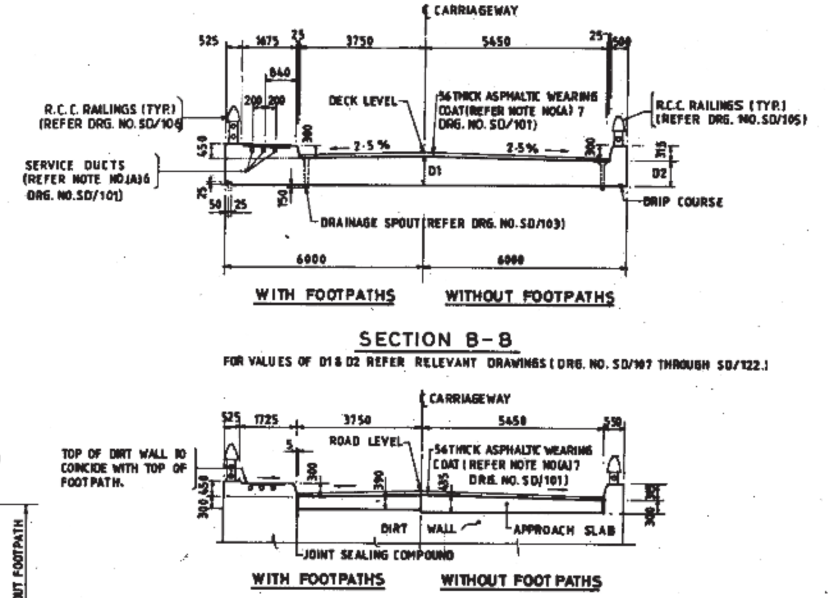
RECOMMENDED BY		APPROVED BY	1990
(U. JAYAKODI) E.E.	(S.K. KAISTHA) S.E.	(M.K MUKHERJEE) C.E.	DRG. NO. SD/101

DRG. NO. SD/102



SECTION. A – A

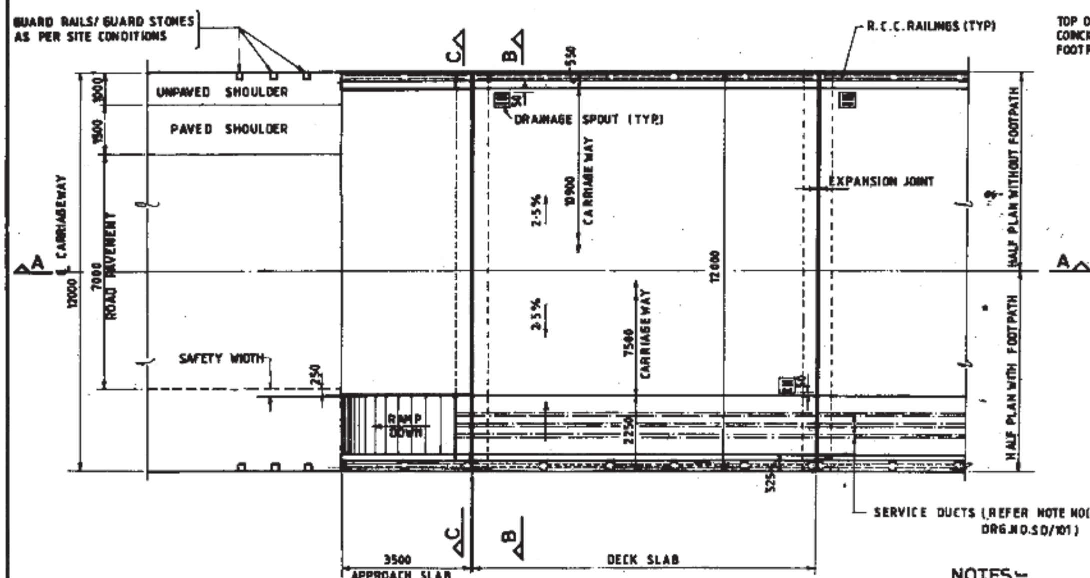
(ROAD KERB & RAILINGS NOT SHOWN.)



SECTION B – B

FOR VALUES OF D1 & D2 REFER RELEVANT DRAWINGS (DRG. NO. SD/107 THROUGH SD/122.)

SECTION. C – C



PLAN.

NOTES:-

1. All dimensions are in millimetres unless otherwise mentioned. Only written dimensions are to be followed.
2. Typical arrangement of drainage spouts has been shown in plan. Suitable modifications may be made by the Engineer-in-charge as per site conditions and intensity of rainfall.

REFERENCE DRAWINGS

DRAWING NO.	TITLE
SD/101	GENERAL NOTES
SD/103 & SD/104	MISCELLANEOUS DETAILS
SD/105	DETAILS OF R.C.C. RAILINGS (WITHOUT FOOTPATHS)
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SD/115 THROUGH SD/122	R.C.C. SOLID SLAB SUPERSTRUCTURE (RIGHT) SPANS 3·0 m TO 10·0 m (WITH FOOTPATHS)

MKD	DATE	DESCRIPTION	BY

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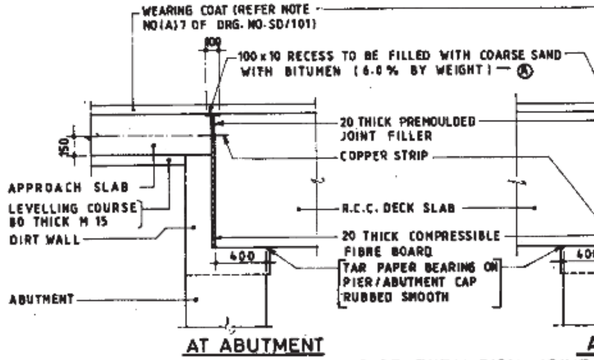
GOVERNMENT OF INDIA
MINISTRY OF SURFACE TRANSPORT
(ROADS WING), NEW DELHI

STANDARD DRAWINGS FOR ROAD BRIDGES

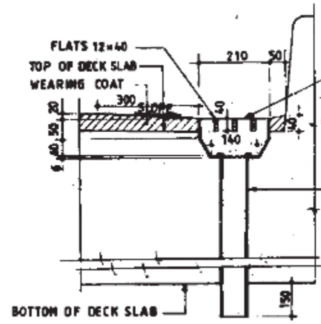
R.C.C. SOLID SLAB
SUPERSTRUCTURE(RIGHT) SPAN 3·0m TO 10·0m
(WITH AND WITHOUT FOOTPATHS)
GENERAL ARRANGEMENT

RECOMMENDED BY		APPROVED BY	1990
(U. JAYAKODI) E.E.	(S.K.KAISTHA) S.E.	(M.K.MUKHERJEE) C.E.	DRG. NO. SD/102

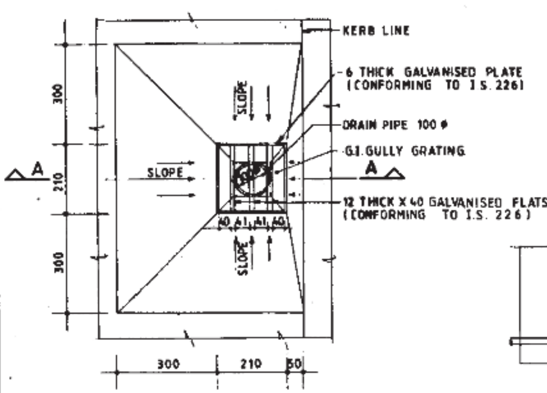
DRG. NO. SD/103



DETAILS OF EXPANSION JOINT

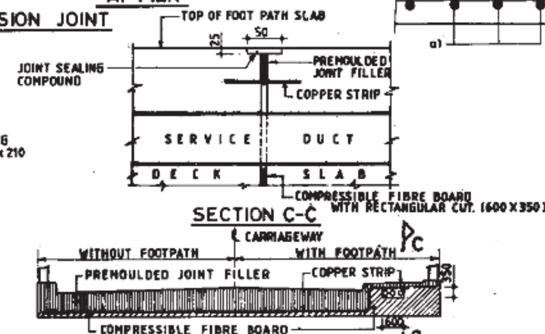


SECTION A-A

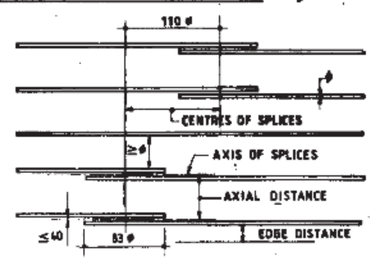


PLAN

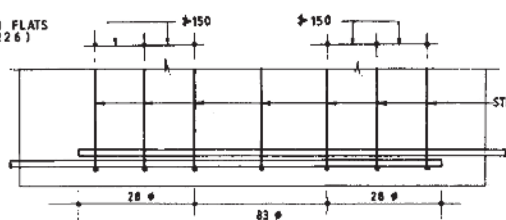
(DETAILS OF DRAINAGE SPOUT & COLLECTION PIT)



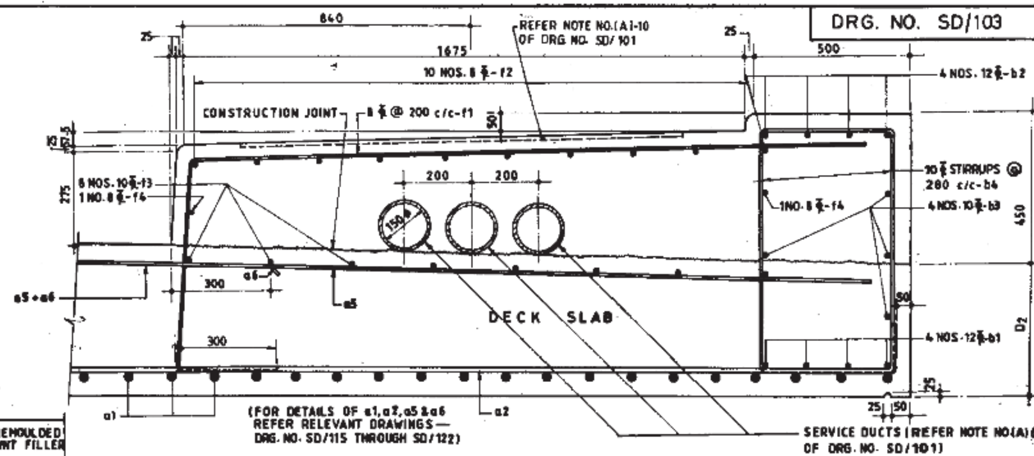
LAYOUT OF COPPER STRIP



LAP SPLICES OF BARS IN TENSION

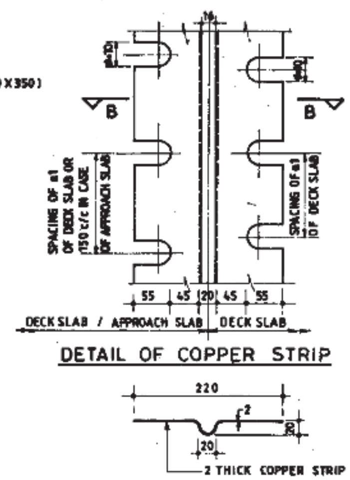


TRANSVERSE REINFORCEMENT AT LAP SPLICES IN KERBS



ENLARGED DETAILS OF FOOTPATH & KERB

(REINFORCEMENT OF RAILING POST NOT SHOWN)



DETAIL OF COPPER STRIP

SECTION B-B

REFERENCE DRAWINGS

DRAWING NO.	TITLE
SD/101	GENERAL NOTES
SD/102	GENERAL ARRANGEMENT
SD/104	MISCELLANEOUS DETAILS
SD/105	DETAILS OF R.C.C. RAILINGS (WITHOUT FOOTPATHS)
SD/106	DETAILS OF R.C.C. RAILINGS (WITH FOOTPATHS)
SD/107 THROUGH SD/114	R.C.C SOLID SLAB SUPERSTRUCTURE (RIGHT) SPANS 3.0m TO 10.0m (WITHOUT FOOTPATHS)
SD/115 THROUGH SD/122	R.C.C. SOLID SLAB SUPERSTRUCTURE (RIGHT) SPANS 3.0m TO 10.0m (WITH FOOTPATHS)

NOTES:-

1. All dimensions are in millimetres unless otherwise mentioned. Only written dimensions are to be followed.
2. Splicing of main longitudinal bars in deck slab shall be avoided as far as practicable. In case the splicing of bars becomes unavoidable, the arrangement shall be as shown in the drawing.
3. Area of bars spliced at any section shall not exceed 50 % of the total area of the bars provided at the section.
4. Joint filler shall conform to I.S 1838. Products with I.S.I certification mark shall only be used.
5. The reinforcement of deck slab shall be suitably modified to accommodate the drainage spout. Also refer note no.2 of drawing no SD/102. The reinforcements marked f1 and f2 shall be modified in the region of inspection chamber.
6. The drainage spout shall be galvanised after welding the plates/flats.

MKD	DATE	DESCRIPTION	BY

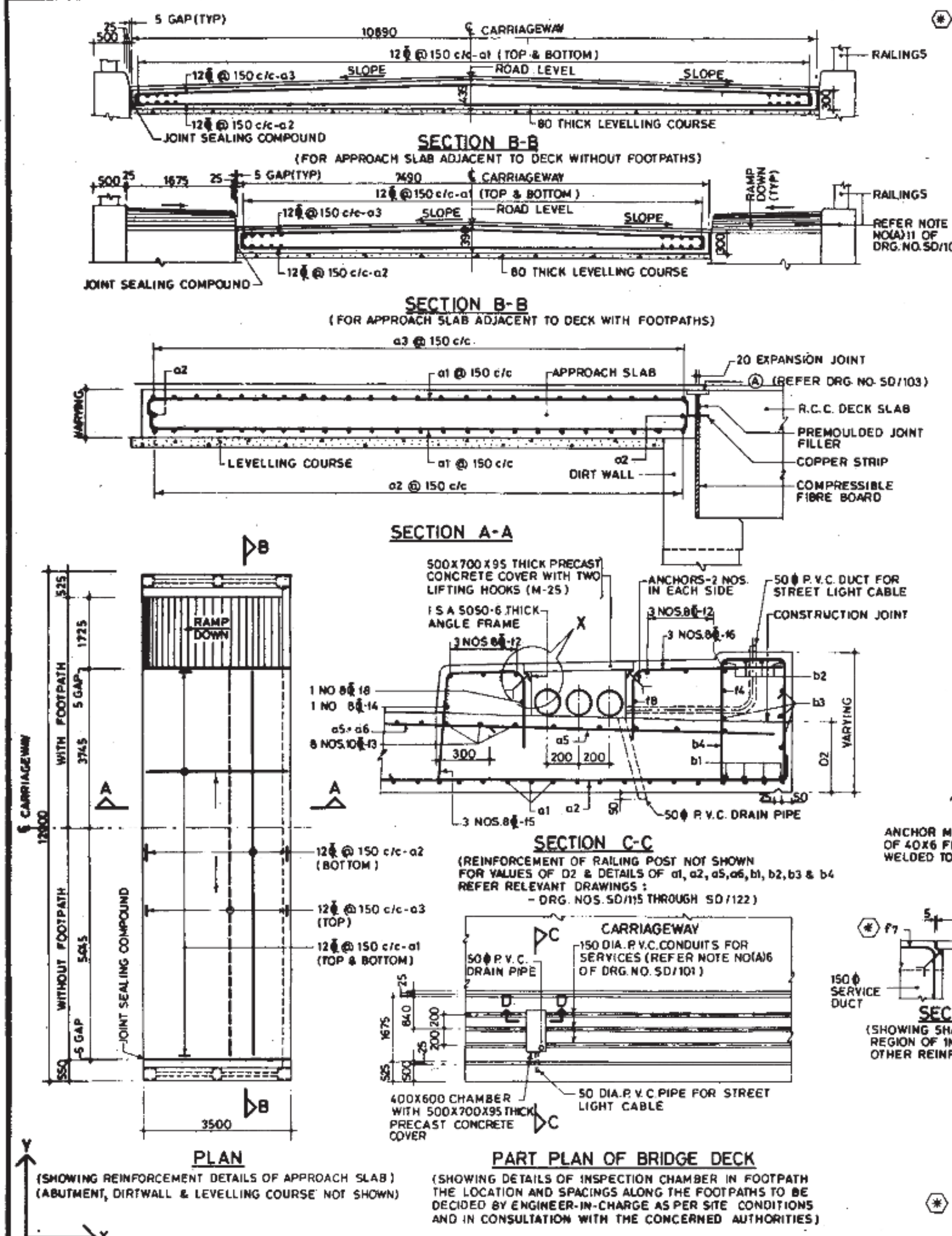
REVISION

GOVERNMENT OF INDIA
MINISTRY OF SURFACE TRANSPORT
(ROADS WING), NEW DELHI

STANDARD DRAWINGS FOR ROAD BRIDGES

R.C.C. SOLID SLAB
SUPERSTRUCTURE (RIGHT) SPAN 3.0m TO 10.0m
(WITH AND WITHOUT FOOT PATHS)
MISCELLANEOUS DETAILS

RECOMMENDED BY		APPROVED BY	1990
(S.S. REDDY) E.E.	(S.K. KAISTHA) S.E.	(P.N. SHIVAPRASAD) C.E.	DRG. NO. SD/103



⊛ SCHEDULE OF REINFORCEMENT (PER APPROACH SLAB)

DRG. NO. SD/104

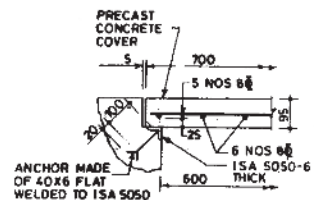
SL.NO	LOCATION	BAR MKD	SHAPE	DIA. (m.m.)	SPACING (m.m)	LENGTH (m.m)	NOS.	TOTAL LENGTH (m)	WEIGHT (kg)
APPROACH SLAB ADJACENT TO DECK WITHOUT FOOTPATHS									
1	SLAB TOP & BOTTOM ALONG-X	a1	200 / 3400 / 200, R=50	12	150	3730	146	544·58	484
2	SLAB BOTTOM ALONG-Y	a2	150 / 10790 / 150, R=50	12	150	11020	26	286·52	254
3	SLAB TOP ALONG-Y	a3	150 / 5395 / 5395 / 150, R=50	12	150	11020	24	264·48	235
APPROACH SLAB ADJACENT TO DECK WITH FOOTPATHS									
4	SLAB TOP & BOTTOM ALONG-X	a1	200 / 3400 / 200, R=50	12	150	3730	100	373·00	331
5	SLAB BOTTOM ALONG-Y	a2	150 / 7390 / 150, R=50	12	150	7620	26	198·12	176
6	SLAB TOP ALONG-Y	a3	150 / 3695 / 2895 / 50 / 150, R=50	12	150	7620	24	182·88	162

QUANTITIES

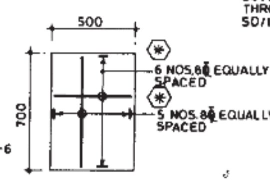
CONCRETE IN APPROACH SLAB (cu. m.)	WITH FOOTPATHS	9·04
	WITHOUT FOOTPATHS	14·01
STEEL INCLUDING 5% EXTRA FOR LAPS AND WASTAGE (kg)	WITH FOOTPATHS	702
	WITHOUT FOOTPATHS	1022
ASPHALTIC WEARING COAT (sq. m.)	WITH FOOTPATHS	26·22
	WITHOUT FOOTPATHS	38·12

REFERENCE DRAWINGS

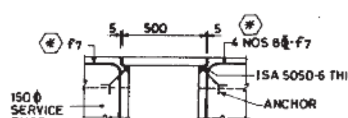
DRAWING NO.	TITLE
SD/101	GENERAL NOTES
SD/102	GENERAL ARRANGEMENT
SD/103	MISCELLANEOUS DETAILS
SD/105	DETAILS OF R.C.C. RAILINGS (WITHOUT FOOTPATHS)
SD/106	DETAILS OF R.C.C. RAILINGS (WITH FOOTPATHS)
SD/107 THROUGH SD/114	R.C.C. SOLID SLAB SUPERSTRUCTURE (RIGHT) SPANS 3·0m TO 10·0 m (WITHOUT FOOTPATHS)
SD/115 THROUGH SD/122	R.C.C. SOLID SLAB SUPERSTRUCTURE (RIGHT) SPANS 3·0m TO 10·0 m (WITH FOOTPATHS)



DETAIL-X



DETAILS OF PRECAST CONCRETE COVER FOR INSPECTION CHAMBER



SECTION D-D
(SHOWING SHAPE OF BARS IN THE REGION OF INSPECTION CHAMBER OTHER REINFORCEMENTS ARE NOT SHOWN)

NOTES:-

1. All dimensions are in millimetres unless otherwise mentioned. Only written dimensions are to be followed.
2. The reinforcement of railing posts shall be incorporated before casting of deck slab. The railings shall conform to drawing no. SD/105 or SD/106 or any other approved type.
3. Dimensions in schedule of reinforcement are given as per I.S. 2502
4. ⊛ Schedule of reinforcement does not include change in reinforcement around inspection chamber, precast cover to chamber and railings.

MKD	DATE	DESCRIPTION	BY

REVISION

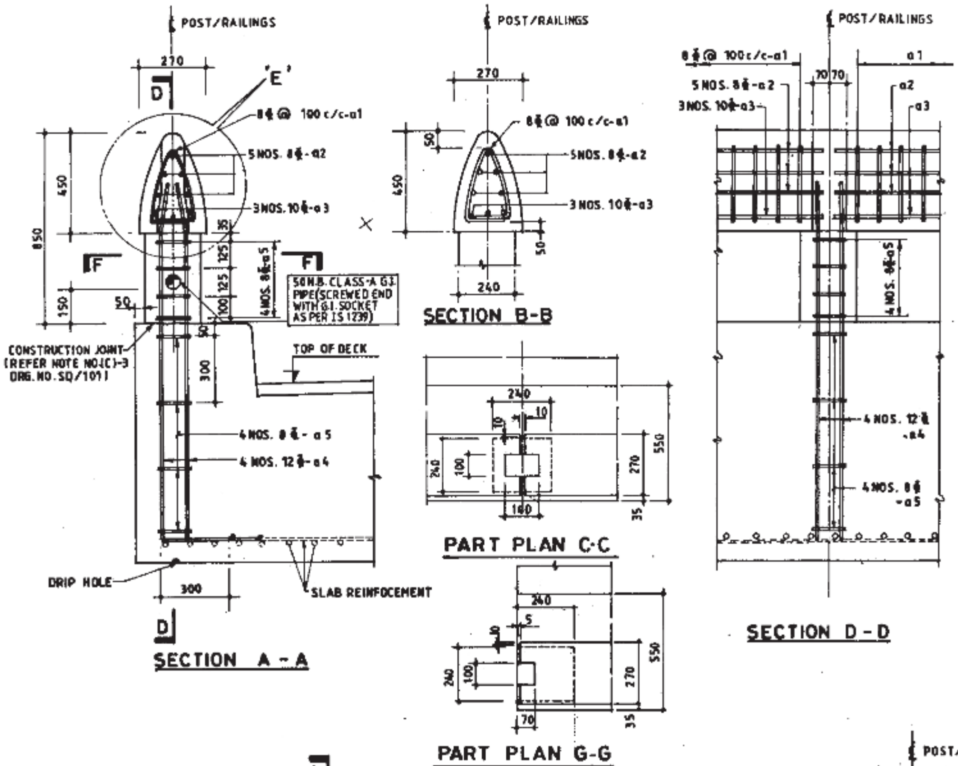
GOVERNMENT OF INDIA
MINISTRY OF SURFACE TRANSPORT
(ROADS WING), NEW DELHI

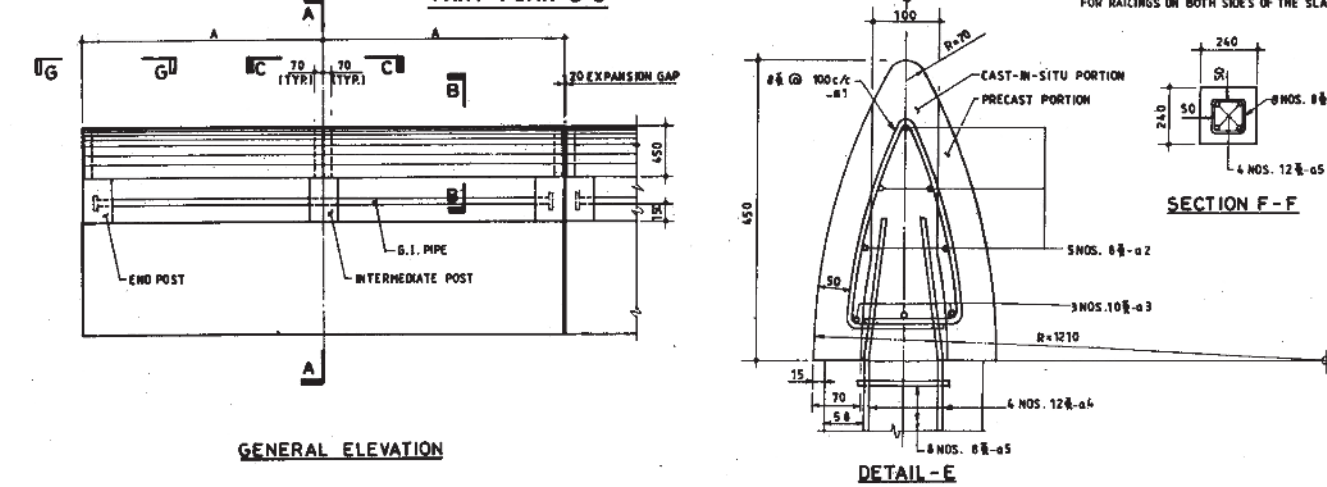
STANDARD DRAWINGS FOR ROAD BRIDGES

R.C.C. SOLID SLAB
SUPERSTRUCTURE (RIGHT) SPAN 3·0m TO 10·0m
(WITH AND WITHOUT FOOTPATHS)
MISCELLANEOUS DETAILS

RECOMMENDED BY		APPROVED BY	1990
(U. JAYAKODI) E.E.	(S. K. KAISTHA) S.E.	(P.N. SHIVAPRASAD) C.E.	DRG. NO. SD/104

DRG. NO. SD/105





SCHEDULE OF REINFORCEMENT FOR RAILING ON ONE SIDE

SL.NO	LOCATION	BAR MKD.	SHAPE	DIA (mm)	SPACING (mm)	LENGTH (mm)	NOS	TOTAL LENGTH(m)	WEIGHT (kg)
1	RAILINGS	a1	△	8	100	940	$\left[\frac{A-160}{100}+1\right]\times N = N1$	$N1\times\frac{940}{1000} = L1$	L1 × 0·395
2	RAILINGS	a2	—	8	-	(A-50)	5 × N = N2	$\frac{N2\times(A-50)}{1000} = L2$	L2 × 0·395
3	RAILINGS	a3	—	10	-	(A-50)	3 × N = N3	$\frac{N3\times(A-50)}{1000} = L3$	L3 × 0·617
4	POST	a4	L-bar (225, h, 300); 225 *	12	-	h + 689	4 × (N + 1) = N4	$\frac{h+689}{1000}\times N4 = L4$	L4 × 0·888
5	POST	a5	square tie (124 × 124)	8		688	8 × (N + 1) = N5	$\frac{688}{1000}\times N5 = L5$	L5 × 0·395

* FOR END POST INNER TWO BARS THE SHAPE IS L (h, 300)

QUANTITIES (PER SPAN)

EFFECTIVE SPAN(m)	NUMBER OF DIVISIONS 'N'	A (mm)	h (mm)	QUANTITY: STEEL (Kg) ●	QUANTITY: CONCRETE (m³) RAILINGS	QUANTITY: CONCRETE (m³) RAIL POSTS
3	2	1700	915	95	0·65	0·14
4	3	1467	965	127	0·84	0·18
5	3	1800	1015	143	1·03	0·18
6	4	1600	1065	176	1·22	0·23
7	4	1850	1115	195	1·41	0·23
8	5	1680	1215	230	1·60	0·27
9	5	1880	1285	249	1·79	0·27
10	6	1734	1365	288	1·98	0·32

● STEEL QUANTITIES INCLUDE 5% EXTRA FOR LAPS & WASTAGE. THE QUANTITIES ARE FOR RAILINGS ON BOTH SIDES OF THE SLABS.

NOTES:-

1. All dimensions are in millimetres unless otherwise mentioned. Only written dimensions are to be followed.
2. The maximum size of the aggregate to be used for precast concrete work shall be limited to 12mm.
3. The centre to centre spacing 'A' between successive vertical posts shown in the elevation shall be adjusted to suit the length of the bridge span for which the railing is used but in no case shall its value exceed 2000.
4. The details of reinforcement in kerb and deck slab have not been shown in the drawing.
5. Railings to be built after the structural concrete of superstructure has hardened and the shuttering for the superstructure is released.
6. Railings shall be carefully constructed true to line and grade. Post shall be vertical with a tolerance not to exceed 1 in 500.
7. Special care shall be taken to match the surface of the cast-in-situ portion.

REFERENCE DRAWINGS

DRAWING NO.	TITLE
SD/101	GENERAL NOTES
SD/102	GENERAL ARRANGEMENT
SD/103 & SD/104	MISCELLANEOUS DETAILS
SD/107 THROUGH SD/114	R.C.C. SOLID SLAB SUPERSTRUCTURE (RIGHT) SPANS 3·0m TO 10·0m (WITHOUT FOOTPATHS)

MKD	DATE	DESCRIPTION	BY

R E V I S I O N

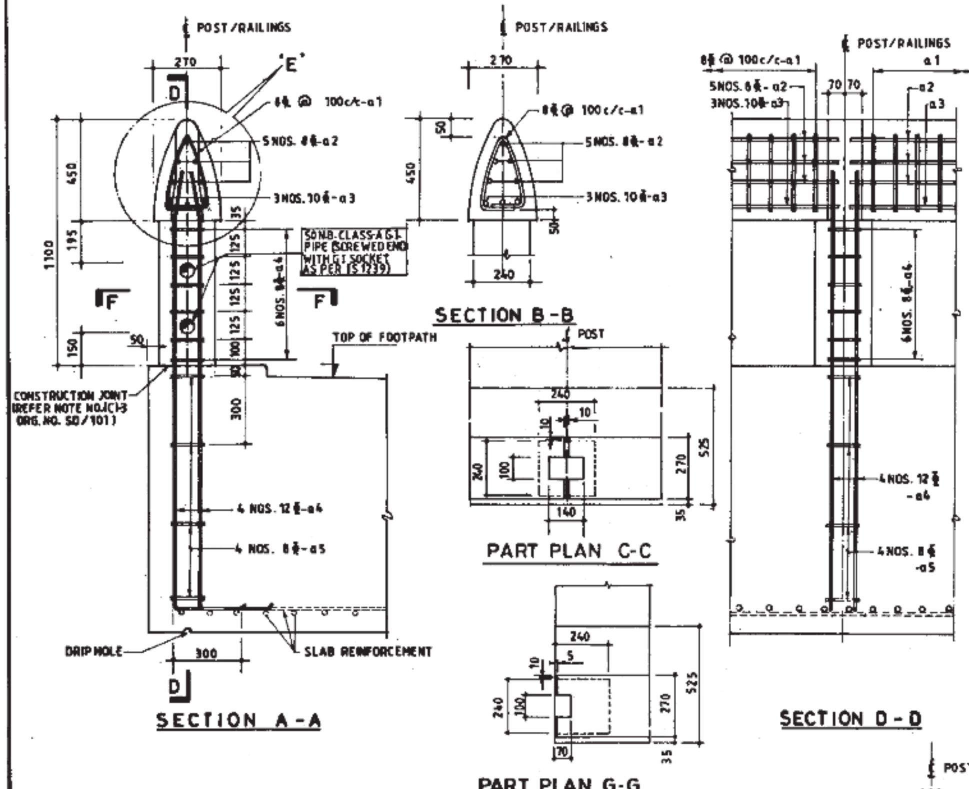
GOVERNMENT OF INDIA
MINISTRY OF SURFACE TRANSPORT
(ROADS WING), NEW DELHI

STANDARD DRAWINGS FOR ROAD BRIDGES

R.C.C. SOLID SLAB
SUPERSTRUCTURE (RIGHT) SPAN 3·0m TO 10·0m
(WITHOUT FOOTPATHS)

DETAILS OF R.C.C. RAILINGS

RECOMMENDED BY		APPROVED BY	1990
(U. JAYAKODI) E.E.	(S.K. KAISTHA) S.E.	(N.K. MUKHERJEE) C.E.	DRG. NO. SD/105



SCHEDULE OF REINFORCEMENT FOR RAILING ON ONE SIDE

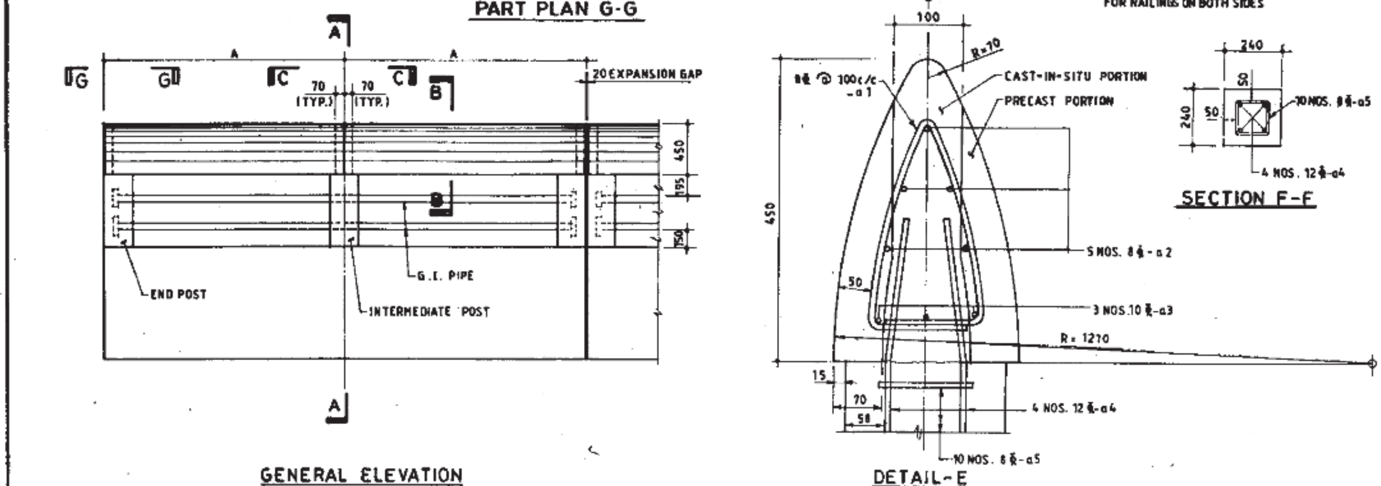
SL. NO.	LOCATION	BAR MKD	SHAPE	DIA (mm)	SPACING (mm)	LENGTH (mm)	NOS	TOTAL LENGTH (m)	WEIGHT kg
1	RAILINGS	a1	△	8	100	940	$\left[\frac{A-160}{100}+1\right]\times N = N1$	$N1 \times \frac{940}{1000} \simeq L1$	L1 × 0.395
2	RAILINGS	a2	———	8	-	(A-50)	7 × N = N2	$\frac{N2 \times (A-50)}{1000} \simeq L2$	L2 × 0.395
3	RAILINGS	a3	———	10	-	(A-50)	3 × N = N3	$\frac{N3 \times (A-50)}{1000} \simeq L3$	L3 × 0.617
4	POST	a4	225, h, 300; 225*, h, 300	12	-	h + 489	4 × (N+1) = N4	$\frac{(h+489) \times N4}{1000} \simeq L4$	L4 × 0.888
5	POST	a5	124 × 124	8	-	688	10 × (N+1) = N5	$\frac{688 \times N5}{1000} \simeq L5$	L5 × 0.395

* FOR END POST INNER TWO BARS, THE SHAPE IS h, 300

QUANTITIES (PER SPAN)

EFFECTIVE SPAN (m)	NUMBER OF DIVISIONS 'N'	A (mm)	h (mm)	QUANTITY: STEEL (Kg) ⊛	QUANTITY: CONCRETE (m3) RAILINGS	QUANTITY: CONCRETE (m3) RAIL POSTS
3	2	1700	1300	107	0·65	0·22
4	3	1467	1350	143	0·84	0·29
5	3	1800	1400	159	1·03	0·29
6	4	1600	1450	196	1·22	0·36
7	4	1850	1500	215	1·41	0·36
8	5	1680	1600	254	1·60	0·44
9	5	1880	1670	273	1·79	0·44
10	6	1734	1750	316	1·98	0·51

⊛ STEEL QUANTITIES INCLUDE 5% EXTRA FOR LAPS & WASTAGE. THE QUANTITIES ARE FOR RAILINGS ON BOTH SIDES



NOTES:–

1. All dimensions are in millimetres unless otherwise mentioned. Only written dimensions are to be followed.
2. The maximum size of the aggregate to be used for precast concrete work shall be limited to 12 mm.
3. The centre to centre spacing 'A' between successive vertical posts shown in the elevation shall be adjusted to suit the length of the bridge span for which the railing is used but in no case shall its value exceed 2000.
4. The details of reinforcement in kerb and deck slab have not been shown in the drawing.
5. Railings to be built after the structural concrete of superstructure has hardened and the shuttering for the superstructure is released.
6. Railings shall be carefully constructed true to line and grade. Post shall be vertical with a tolerance not to exceed 1 in 500.
7. Special care shall be taken to match the surface of the cast-in-situ portion.

REFERENCE DRAWINGS

DRAWING NO.	TITLE
SD/101	GENERAL NOTES
SD/102	GENERAL ARRANGEMENT
SD/103 & SD/104	MISCELLANEOUS DETAILS
SD/115 THROUGH SD/122	R.C.C. SOLID SLAB SUPERSTRUCTURE (RIGHT) SPANS 3·0m TO 10·0m (WITH FOOTPATHS)

MKD	DATE	DESCRIPTION	BY

REVISION

GOVERNMENT OF INDIA
MINISTRY OF SURFACE TRANSPORT
(ROADS WING), NEW DELHI

STANDARD DRAWINGS FOR ROAD BRIDGES

R.C.C. SOLID SLAB
SUPERSTRUCTURE (RIGHT) SPAN 3·0m TO 10·0m
(WITH FOOTPATHS)

DETAILS OF R.C.C. RAILINGS

RECOMMENDED BY		APPROVED BY	1990
(U. JAYAKODI) E.E.	(S. K. KAISTHA) S.E.	(M.K. MUKHERJEE) C.E.	DRG. NO. SD/106

PUBLIC WORKS DEPARTMENT

DESIGN
OF
HIGH LEVEL BRIDGE
ON
KELWARA KUMBHALGARH ROAD
OVER KELWARA LAKE

Design Of High Level Bridge
on Kelwara Kumbhalgarh Road
Over Kelwara Lake

INDEX

Design of High Level Bridge on Kelwara Kumbhalgarh Road Over Kelwara Lake

PREAMBLE

Type of Bridge

The bridge shall be a High Level bridge. The HFL is 98.500 m and the proposed deck level is 100.755 m. The free board shall be 1200 mm in accordance to IRC:5-1998 Clause 106.2.1

Decking Arrangement

The Deck Slab shall standard RCC deck slabs each 12000 mm wide i.e. 7500 mm carriage way and Footpath and Railings on both sides. There shall be 25 mm wide expansion joint between the adjacent deck slabs along the length of the bridge. The location of proposed road is right angle to the direction of flow.

There shall be 8 Nos. of spans. The centre to centre distance for the spans shall be 10.8 m.

Standard RCC Solid Slab Superstructure with right effective span 10 M with footpath shall be provided in accordance to the Ministry of Surface Transport (Roads Wing), New Delhi drawings. [Drawing No. SD/112].

It is proposed to construct 12000 mm wide slabs as per these standard drawings. As per requirement of use in the proposed bridge the deviation with respect to these drawings shall be as follows:-

1. Pier Cap Width 1200 mm [In the reference drawing the pier cap width is 800 mm]. The width of piers shall be 1200 mm. Due to this change the Centre to Centre distance shall be 10800 mm (centre to centre over piers). For all spans the clear span shall be 9600 mm and the centre to centre distance shall be 10800 mm. The length of reinforcement shall be modified as per these geometrical requirements however spacing of the reinforcement shall not be altered.
2. Footpath & Railing: - As per drawing No. SD/102, SD/103, Sd/104, SD/105 and SD/106.
3. Reinforcement Detailing: - The reinforcement detailing is suitably modified as required for the modifications referred above in points 1.

The proposed decking arrangement is shown in Drawing – D-01 titled as Decking arrangement.

Design Loads

The following loads have been considered in the design of deck slab and for the stability of the sub structure:-

[A] Maximum of the following cases

I. One lane of IRC class 70R on carriage way
II. One lanes of IRC Class A on carriage way
III. Two lanes of IRC Class A on carriage way
IV. Three lanes of IRC Class A on carriage way

V. One lane of IRC class 70R and one lane of IRC Class A on carriage way
VI. One lane of IRC class AA TRACKED VEHICLE on carriage way

In order to account for two adjacent slabs the resultant reactions and moments have been multiplied by 2 for stability check of the sub structure.

[B] Other Loads

a) Footpath load of 5KN/Sqm.

b) Wearing coat land of 2 KN/Sqm.

Safe Bearing Capacity

The detailed sub soil investigation report for a bridge constructed in the vicinity of the bridge is enclosed.

The foundation rock is safe against the eroding effects of the water flow and other climatic conditions.

As per detailed test of foundation rock the lowest safe bearing capacity for rectangular footing at depth 2.5 m and downwards is 250 kN/ Sq M; Hence the Safe Bearing Capacity adopted for design is 250 kN/ Sq M.

Depth of Foundation/Founding Level

For all the footings hard rock is available hence the foundation shall be laid at 1.5 m depth embedded in rock.

Scour Depth

The maximum scour depth computed is 7.04 M. As per Clause No. 703-2-3-1 of IRC 78-1983 considering Scour at the pier two times of calculated scour depth below the highest flood level. But we shall provide foundation at 1.5 m ANCHORED IN BED ROCK AVAILABLE.

Reinforcement Detail & other Detail of Deck slab

Ministry of surface transport details drawings are enclosed which contains miscellaneous details of deck slab including reinforcement drawing.

The right effective span of the proposed bridge is 7.60 m. The length along the centre line of road between pier centers is 8.80 m.

The deck slab pertaining to 10 m. right effective span shall be provided as given in MOST drawings No. SD/101, SD/102, SD/103, SD/104, SD/105, SD/106 and SD/122.

In the drawing the clear right span is 7600 mm. The proposed bridge shall have clear right span as 7600 mm conforming to the standard drawing adopted.

Bearing detail

Tar paper bearing shall be providing on top of pier cap & abutment cap.

Approach slab

The detail of approach slab is enclosed as drawing JK-03.

Pier Cap Detail

Pier cap drawing is enclosed as annexure JK-05.

DESIGN OF HIGH LEVEL BRIDGE

Name Of Work :- Construction Of High Level Bridge on Kelwara Kumbhalgarh Road Over Kelwara Lake

Hydraulic Calculation

Computation of Discharge

1 Flood calculation by Area Velocity Method (As per Article- 5 of IRC SP-13)

Q = A x V

Where

A =	751.37 m2		A =	Cross sectional area in m^2
P =	89.44 m		P =	Perimeter calculated in m
S =	1 IN	8333	S =	Slope as per drain LS taken at Proposal site
n =	0.033		n =	Rugosity coefficient (As per IRC SP-13)
V =	$I/n x (A/P)^{2/3}$ x$(S)^{1/2}$		V =	Velocity in m/sec.
=	1.38 m/sec.			
Q =	1036.89 Cumecs			

Linear Water Way Calculation

Regime Surface width of the stream is given by :- L = 4.8 (Q)1/2

= 154.57 m

Looking to the approach gradient constraints adopt 8 Spans of 10 M each.

This will cause contraction and afflux. Calculation is done for the same to fix deck level.

Effective linear water way proposed = 8 x 10 = 80 M

Total 80 M

Scour Depth Calculation

(As per clause no. 703.2.2.1 of IRC : 78.1983)

$dsm = 1.34x (Db^2 /Ksf)^{1/3}$

Where

Db = The discharge in Cumecs per meter width

Ksf = the silt factor

= 1.5

Effective linear waterway = Width of waterway - Obstructed width of piper

= 78.80 - (7 x 1.2)

= 70.40 m

Db = 1036.89 / 70.40

= 14.73 Cumecs per metre width

dsm = 7.04 m

As per Clause No. 703-2-3-1 of IRC 78-1983 considering Scour at the pier two times of calculated scour depth below the highest flood level. But hard rock is available in foundation so the foundation will be anchored in the rock as per IRC guidelines.

Afflux Calculation

As per IS: 7784 (Part -I) 1975

Molesworth Formula for Afflux

Afflux h = $((V^2/17.85) + 0.0152) x (A^2/a^2 - 1)$

Where,

h = afflux in m,

v = Velocity in the unobstructed stream in m/s,

A = the unobstructed sectional area of the river in m^2

a = the obstructed sectional area of the river at the cross drainage work in m^2.

As per Annexure- 1

Unobstructed Area of Flow after Bridge Construction = 739.74 m^2

A = 739.744 m^2

V = 1.38 m/sec.

Computation of Area obstructed by Deck Slab

HFL :	98.500	m
Top Level of Deck slab :	100.755	m
Free Board	1.200	m
Thickness of Slab and Wearing Coat	0.975	m
Length Of Slab	78.800	m
Height of Obstruction	0.975	m
Area obstructed by deck slab	78.800 x	0.98
=	76.83 m^2	

Computation of Area obstructed by Piers

HFL :	98.500 m				
Soffit of Deck slab :	99.780 m				
Average river bed level =	89.816 m				
Nos. of pier =		7			
Height of Obstruction	98.500	-	89.816 =	8.684	m
Area obstructed by one pier : =	1.2 x		8.68		
=		10.421 m^2			
For 7 Nos. of piers =	7 x		10.421		
A1 =		72.94 m^2			

Computation of Area obstructed by Abutments

Average ground level =		89.816	m			
Height of Obstruction		98.500	-	91.316	=	7.184 m
Area obstructed by one Abutment : A2 =	(0.40+0.75)/2		x	7.18		
	=	4.13	m^2			
For two Abutments =		2	x	4.13		
	=	8.26	m^2			
Total area of obstruction due to slab, piers and abutments A	=	A0 +A1 + A2				
	=	76.83	+	72.94	+	8.26
	=	158.04	m^2			
Actual Area of flow a =		739.744	-	158.04		
	=	581.71	m^2			
Afflux h =		0.08	m			
Afflux flood level =		98.500	+	0.08	=	98.580 m
Obstructed Velocity	V	=		Q/a	-	
Obstructed Velocity	=	1036.89	/	581.71		
	=	1.79	m/sec			
However we consider design velocity		2.00	m/sec.			
Afflux flood level	=	**98.580**	**M**			
Soffit of deck slab	=	**99.780**	**M**			

This is well above the Afflux flood level.

Though it is not a high level bridge; there shall be no hindrance to traffic during high floods.

Hence OK.

DETERMINATION OF VELOCITY AT PROPOSED SUBMERSIBLE BRIDGE

Name Of Work :- Construction Of High Level Bridge on Kelwara Kumbhalgarh Road Over Kelwara Lake

AS PER UP-STREAM SECTION

HIGHEST FLOOD LEVEL 98.500 M

CHAINAGE	G.L.	DEPTH OF FLOW IN M	LENGTH OF FLOW	AVERAGE DEPTH OF FLOW	CROSS SECTIONAL AREA OF FLOW	WETTED PERIMETER
0	91.96	1.30	0.00	0.00	0.00	0.00
5	90.5	8.00	5.00	4.65	23.24	8.36
10	88.76	9.74	5.00	8.87	44.35	5.29
15	87.91	10.59	5.00	10.17	50.83	5.07
20	87.61	10.89	5.00	10.74	53.70	5.01
25	87.3	11.20	5.00	11.05	55.23	5.01
30	86.99	11.51	5.00	11.36	56.78	5.01
35	86.69	11.81	5.00	11.66	58.30	5.01
40	86.38	12.12	5.00	11.97	59.83	5.01
45	86.07	12.43	5.00	12.28	61.38	5.01
50	85.77	12.73	5.00	12.58	62.90	5.01
55	86.76	11.74	5.00	12.24	61.18	5.10
60	88.76	9.74	5.00	10.74	53.70	5.39
65	90.81	7.69	5.00	8.72	43.58	5.40
70	93.08	5.42	5.00	6.56	32.78	5.49
75	95.36	3.14	5.00	4.28	21.40	5.50
80	97.43	1.07	5.00	2.11	10.53	5.41
83.18	98.55	0.00	3.18	0.53	1.70	3.36
		TOTAL	83.18		751.37	89.44

A		751.37	SQM
P		89.44	M
R		8.40	M
N		0.033	
S	1 IN	8333	
V		1.37	M/SEC

CHAINAGE	G.L.	DEPTH OF FLOW IN M	LENGTH OF FLOW	AVERAGE DEPTH OF FLOW	CROSS SECTIONAL AREA OF FLOW	WETTED PERIMETER

Q 1030.74 CUMECS

The design engineer visually observed the river to ascertain the Roughness Coefficient n for the Manning's formula. Upon visual inspection of the river in the vicinity of the proposed bridge site it was found that the River bed surface is good with clean straight banks, no rifts or deep pools however containing some weeds and stones. Roughness Coefficient pertaining to these characteristics is 0.033

Design Discharge = 1030.74 CUMECS

Critical Levels		
Road top level (RTL)	100.755	M
Average Ground Level(AGL)	89.816	M
Average Height Of Bridge	4.500	M
Nala Bed level (NBL)	82.570	M
Ordinary flood level (OFL)	96.000	M
Foundation level (FL)	79.000	M
Ht. of bridge h= (RTL-NBL)	18.185	M
Ht. of bridge H=(RTL-FL)	21.755	M

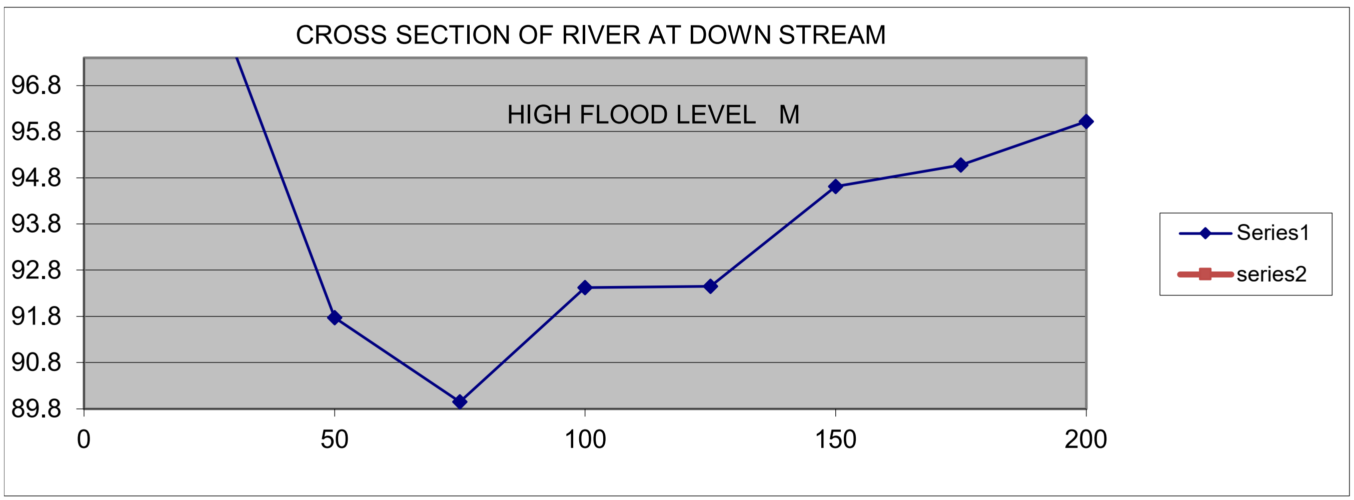
**** Needs Rational Evaluation w.r.t. afflux.**

**** Average of GL for points lying below HFL.**

CROSS SECTION OF RIVER DOWN-STREAM

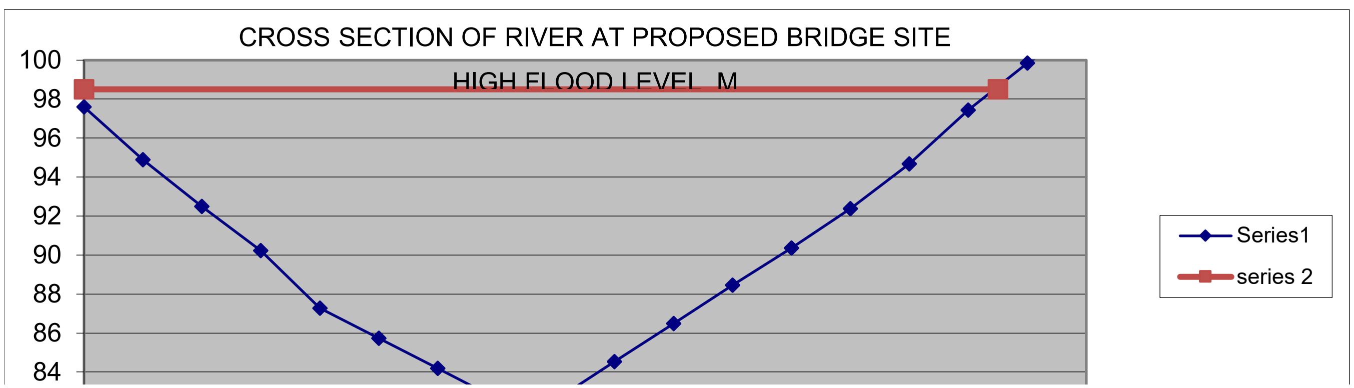
Name Of Work :- Construction Of High Level Bridge on Kelwara Kumbhalgarh Road Over Kelwara Lake

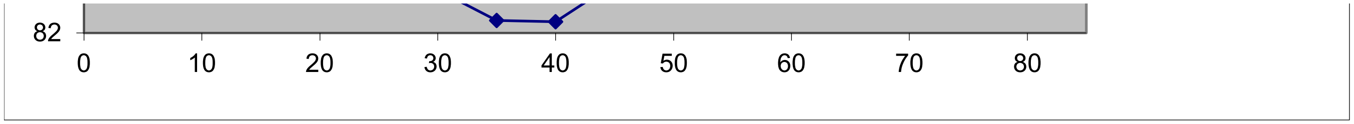
Chainage in M (u/s or d/s)	RL in M
0	100.63
25	98.976
50	91.771
75	89.95
100	92.423
125	92.451
150	94.611
175	95.074
200	96.02
30.00	98.50
180.00	98.50



CROSS SECTION OF RIVER AT PROPOSED BRIDGE SITE

					HIGHEST FLOOD LEVEL 98.500	M
Chainage in M (u/s or d/s)	RL in M	DEPTH OF FLOW IN M	LENGTH OF FLOW	AVERAGE DEPTH OF FLOW	CROSS SECTIONAL AREA OF FLOW	WETTED PERIMETER
0	97.59	0.91	0.00	0.00	0.00	0.00
5	94.89	3.61	5.00	2.26	11.30	5.68
10	92.49	6.01	5.00	4.81	24.05	5.55
15	90.23	8.27	5.00	7.14	35.70	5.49
20	87.27	11.23	5.00	9.75	48.75	5.81
25	85.73	12.77	5.00	12.00	60.00	5.23
30	84.18	14.32	5.00	13.55	67.73	5.23
35	82.63	15.87	5.00	15.10	75.48	5.23
40	82.57	15.93	5.00	15.90	79.50	5.00
45	84.53	13.97	5.00	13.37	66.85	5.70
50	86.48	12.02	5.00	13.17	65.85	5.06
55	88.46	10.04	5.00	9.16	45.78	5.30
60	90.36	8.14	5.00	9.09	45.45	5.35
65	92.38	6.12	5.00	8.08	40.40	6.35
70	94.68	3.82	5.00	5.98	29.90	7.98
75	97.43	1.07	5.00	3.60	17.98	8.66
80	99.84	0.00	5.00	3.06	15.30	9.55
83.18	101.08	0.00	3.18	3.06	9.74	8.74
		TOTAL	83.18		739.74	105.93
0.00	98.50					
77.50	98.50					



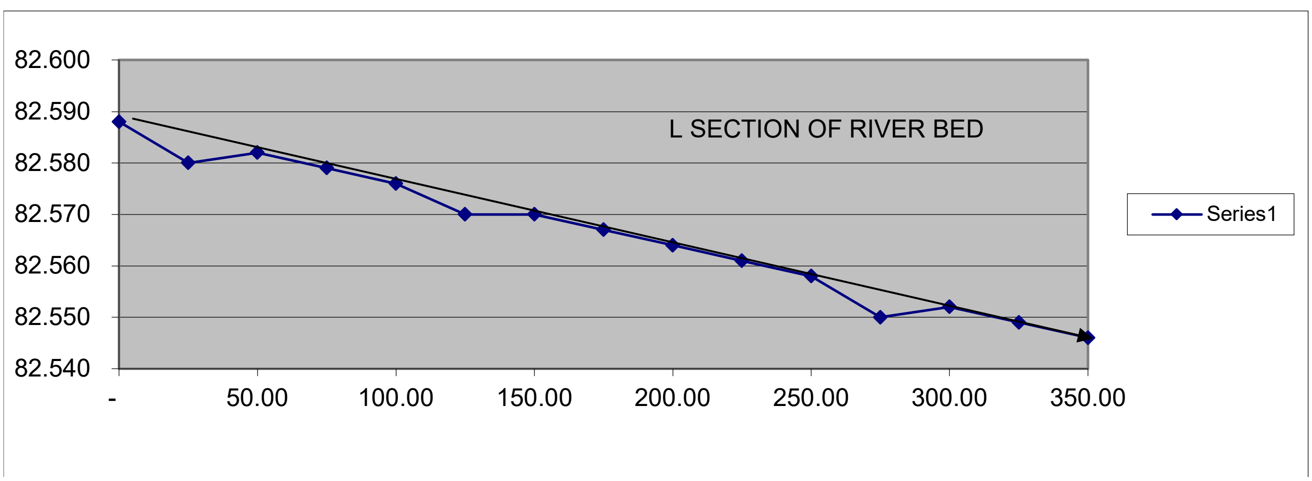

82
0
10
20
30
40
50
60
70
80

DETERMINATION OF BED SLOPE OF THE RIVER
Name Of Work :- Construction Of High Level Bridge on Kelwara Kumbhalgarh Road Over Kelwara Lake

Chainage in M (u/s or d/s)	RL in M
-	82.588
25.00	82.580
50.00	82.582
75.00	82.579
100.00	82.576
125.00	82.570
150.00	82.570
175.00	82.567
200.00	82.564
225.00	82.561
250.00	82.558
275.00	82.550
300.00	82.552
325.00	82.549
350.00	82.546

Reference Poits	
Ch	RL
0.00	82.588
350.00	82.546

DISTANCE		350	M
FALL		0.042	M
SLOPE	1	IN	8333



DESIGN OF PIER AND CHECK FOR STABILITY- SUBMERSIBLE BRIDGE

Name Of Work :- Construction Of High Level Bridge on Kelwara Kumbhalgarh Road Over Kelwara Lake

DESIGN DATA

1	RIGHT EFFECTIVE SPAN	=	9.60	M	
2	SPAN C/C OF PIERS	=	10.80	M	
3	OVERALL WIDTH OF PIER CAP	=	12.00	M	
4	H.F.L.	=	98.50	M	
5	BUOYANCY				
6	AT FOOTING LEVEL	=	100.00	%	
7	AT PIER LEVEL	=	100.00	%	
8	AQUEDUCT FALLS UNDER ZONE-II SO SEISMIC CASE IS NOT GOVERNING HERE.				
9	FLOOD DISCHARGE	=	**1030.74**	**CUMECS**	
10	RIVER BED SLOPE	=	1	IN	8333
11	DESIGN VELOCITY	=	2.00	m/sec	
12	BED LEVEL OF THE HEIGHEST PIER	=	82.57	M	
13	SAFE BEARING CAPACITY	=	**25.00**	**t/m2**	**250.00** kN/m^2
14	TOP LEVEL OF FOUNDING ROCK	=	80.50	M	
15	EMBEDMENT OF PIER IN HARD ROCK	=	1.50	M	
16	FOUNDATION LEVEL OF THE HIGHEST PIER	=	79.000	M	
17	DECK LEVEL OF THE BRIDGE	=	100.755	M	
18	TOP LEVEL OF THE PIER CAP	=	99.780	M	
19	LEVEL DIFFERENCE OF PIER CAP TOP AND FOUNDING LEVEL	=	20.78	M	

CHECKING STABILITY OF PIER AT R.L.79 M FOOTING LEVEL

A DEAD LOAD CALCULATION

SUPER STRUCTURE

Self Weight of Slab =	10.80 x	12.00 x	0.90 x	24.00 =	2799.36 kN	
Self Weight of Wearing Coat =	10.80 x	12.00 x	0.075 x	24.00 =	233.28 kN	
Railings and Footpath					62.00 kN	
TOTAL					**3094.64 kN**	

SUB STRUCTURE

Pier Cap

Pier Cap =	1.50 x	12.00 x	0.60 x	24.00		=	259.200 kN
Flared Portion Sides =	0.50 x	0.15 x	0.60 x	12.00 x	2.00 x	24.00 =	25.920 kN
=	0.50 x	0.15 x	0.60 x	3.14 x	1.20 x	24.00 =	4.069 kN
Flared Portion u/s & d/s Sides =	0.60 x	0.60 x	1.50 x	24.00		=	12.960 kN
=	3.14 /	4.00 x	1.20 x	1.20 x	0.60 x	24.00 =	16.278 kN
TOTAL							**318.427 kN**

Pier

Flared Portion Top =	**0.50** x	0.15 x	0.60 x	12.00 x	**2** x	24.00 =	25.920 kN
=	**0.50** x	0.15 x	0.60 x	**3.14** x	1.20 x	24.00 =	4.069 kN
Pier Rectangular portion =	1.20 x	12.00 x	17.93 x	24.00		=	6196.608 kN

Pier Curved portion =	3.14 /	4 x	1.20 x	1.20 x	17.93 x	24.00 =	486.434 kN
Flared Portion bottom =	0.50 x	0.60 x	0.30 x	24.00		=	2.160 kN
=	3.14 /	4 x	1.20 x	1.20 x	0.60 x	24.00 =	16.278 kN
TOTAL							**6736.895 kN**
Weight of Pier Above H.F.L. =							**0.000 kN**
Weight of Pier Below H.F.L. =	6736.89 -	0.00				=	**6736.895 kN**
Weight of Sub Structure with 15% Buoyancy =	0.00 + (	6736.89 x	22.50 /	24.00)		=	**6315.839 kN**
Footing	**SIZE**	**15.60 M x**	**3.80 M x**	**1.50 M**			
Weight without Buoyancy =	15.60 x	3.80 x	1.50 x	24.00		=	2134.080 kN
Weight with 100% Buoyancy =	15.60 x	3.80 x	1.50 x	**14.00**		=	1244.880 kN
Total Weight of Substructure Without Buoyancy							
=	318.43 +	6736.89 +	2134.08			=	**9189.402 kN**
Total Weight of Substructure With Buoyancy							
=	318.43 +	6315.84 +	1244.88			=	**7879.146 kN**

B LIVE LOAD CALCULATION

Maximum Reaction due Live Load including Impact = 788.27 x 1.00 = **788.27 kN**

Refer Live load Computation sheet showing maximum reaction = 78.83 T which is = 788.27 kN

Haunch	0.60	M
PCC Offset	0.20	M
Length Variant	1.00	M
Width Variant	0.50	M

TOTAL LONGITUDINAL MOMENT DUE TO LIVE LOAD & BREAKING FORCE

Maximum Longitudinal moment due to Live Load including Impact and Breaking Force = 122.13 x 2.00 = **244.25 kN-m**

Refer Live load Computation sheet showing maximum reaction = 12.21 T- m which is = 122.13 kN-m

243.85	Stress
144.78	

TOTAL TRANSVERSE MOMENT DUE TO LIVE LOAD & BREAKING FORCE

Maximum Transverse moment due to Live Load including Impact and Breaking Force = 1123.94 x 2.00 = **2247.88 kN-m**

Refer Live load Computation sheet showing maximum reaction = 112.39 T- m which is = 1123.94 kN-m

C LOADS DUE TO WATER CURRENT

WATER CURRENT IN LONGITUDINAL DIRECTION (ALONG THE BRIDGE)

As per IRC- II (6-1966) clause 213.5 For V= 2.00 m/sec

Since the bridge is at Zero Degrees skew from the direction of current as per IRC- II (6-1966) clause 213.5 it should be designed for (20+0) =20 Degrees or (20-0) = 20 Degrees whichever gives higher quantum of water current forces.

Obstructed Velocity = V Sin 20^0 = **2.00 x Sin 20^0**

= 0.68

$2v^2$ =	0.93								
Total SUBMERGED Height =	18.00 M		0.93	0.88	0.88	0.00			
FORCE ON DECK SLAB BETWEEN Deck Level 100.755 M to Soffit Level 99.93 M									
$2v^2$ = (	0.93 +		0.88) /2 =	0.91					
Area Obstructed =	8.00 x		0.00 =	0.00 Sqm					
Force on Pier =	52.00 x	k	x	v^2 x	Area Obstructed				
=	52.00 x		1.50 x	0.91 x	0.00 / 100	=	**0.00 kN**	at R.L.	100.343 M
Moment @ R. L.	80.60 M =		0.00 x	19.74 =	**0.00 kN-m**				
Moment @ R. L.	80.00 M =		0.00 x	20.34 =	**0.00 kN-m**				
Moment @ R. L.	79.00 M =		0.00 x	21.34 =	**0.00 kN-m**				
FORCE ON PIER CAP BETWEEN 99.93 M to Soffit Level 99.33 M									
$2v^2$ = (	0.88 +		0.88) /2 =	0.88					
Area Obstructed =	8.00 x		0.60 =	4.80 Sqm					
Force on Pier =	52.00 x	k	x	v^2 x	Area Obstructed				
=	52.00 x		1.50 x	0.88 x	4.80 / 100	=	**3.30 kN**	at R.L.	89.465 M
Moment @ R. L.	80.60 M =		3.30 x	8.86 =	**29.24 kN-m**				
Moment @ R. L.	80.00 M =		3.30 x	9.46 =	**31.22 kN-m**				
Moment @ R. L.	79.00 M =		3.30 x	10.47 =	**34.52 kN-m**				
FORCE ON PIER BETWEEN 99.33 M to 80.5 M									
$2v^2$ = (	0.88 +		0.00) /2 =	0.44					
Area Obstructed =	7.33 x		13.20 =	96.82 Sqm					
Force on Pier =	52.00 x	k	x	v^2 x	Area Obstructed				
=	52.00 x		1.50 x	0.44 x	96.82 / 100	=	**33.15 kN**	at R.L.	89.165 M
Moment @ R. L.	81.10 M =		33.15 x	8.07 =	**267.32 kN-m**				
Moment @ R. L.	80.50 M =		33.15 x	8.66 =	**287.21 kN-m**				
Moment @ R. L.	79.00 M =		33.15 x	10.17 =	**336.92 kN-m**				
TOTAL LONGITUDINAL MOMENT DUE TO WATER CURRENT									
Moment @ R. L.	81.10 M =		0.00 +	29.24					
			+	267.32 =	**296.56 kN-m**				
Moment @ R. L.	80.50 M =		0.00 +	31.22					
			+	287.21 =	**318.43 kN-m**				
Moment @ R. L.	79.00 M =		0.00 +	34.52					
			+	336.92 =	**371.44 kN-m**				
WATER CURRENT IN TRANSVERSE DIRECTION (ACROSS THE BRIDGE)									
As per IRC- II (6-1966) clause 213.5	**For V=**	**2.00 m/sec**		**Maximum velocity being 1.414 x mean velocity**			(1.414= Root of 2)		
Obstructed Velocity = V Cos 20 0 =	**2.00 x**	**Cos 20 0**							
=	1.88								
2v2 =	7.07								
Total Height =	18.00 M		7.07	6.68	6.63	0.00			
FORCE ON DECK SLAB BETWEEN Deck Level 100.755 M to Soffit Level 99.93 M									
$2v^2$ = (	7.07 +		6.68) /2 =	6.87					
Area Obstructed =	10.80 x		0.000 =	0.00 Sqm					
Force =	52.00 x	k	x	v^2 x	Area Obstructed				
=	52.00 x		1.50 x	6.87 x	0.00 / 100	=	**0.00 kN**	at R.L.	100.343 M

Moment @ R. L.	80.60 M =	0.00 x	19.74 =	**0.00 kN-m**			
Moment @ R. L.	80.00 M =	0.00 x	20.34 =	**0.00 kN-m**			
Moment @ R. L.	79.00 M =	0.00 x	21.34 =	**0.00 kN-m**			

FORCE ON PIER CAP BETWEEN 99.93 M to Soffit Level 99.33 M

$2v^2$ = (	6.68 +		6.63) /2 =	6.66				
Area Obstructed =	1.50 x		0.60 =	0.90 Sqm				
Force on Pier =	52.00 x	k	x	v^2 x	Area Obstructed			
=	52.00 x		1.50 x	6.66 x	0.90 / 100	=	**4.67 kN**	at R.L. 89.465 M
Moment @ R. L.	80.60 M =		3.30 x	8.86 =	**29.24 kN-m**			
Moment @ R. L.	80.00 M =		3.30 x	9.46 =	**31.22 kN-m**			
Moment @ R. L.	79.00 M =		3.30 x	10.47 =	**34.52 kN-m**			

FORCE ON PIER BETWEEN 99.33 M to 80.5 M

$2v^2$ = (	6.63 +		0.00) /2 =	3.32				
Area Obstructed =	7.33 x		1.20 =	8.80 Sqm				
Force on Pier =	52.00 x	k	x	v^2 x	Area Obstructed			
=	52.00 x		1.50 x	3.32 x	8.80 / 100	=	**22.77 kN**	at R.L. 89.165 M
Moment @ R. L.	80.60 M =		33.15 x	8.57 =	**283.89 kN-m**			
Moment @ R. L.	80.00 M =		33.15 x	9.16 =	**303.78 kN-m**			
Moment @ R. L.	79.00 M =		33.15 x	10.17 =	**336.92 kN-m**			

TOTAL TRANSVERSE MOMENT DUE TO WATER CURRENT

Moment @ R. L.	80.60 M =	0.00 +	29.24 =	
		+	283.89	**313.13 kN-m**
Moment @ R. L.	80.00 M =	0.00 +	31.22 =	
		+	303.78	**335.00 kN-m**
Moment @ R. L.	79.00 M =	0.00 +	34.52 =	
		+	336.92	**371.44 kN-m**

D SEISMIC CONDITION

According to clause 222.1 of IRC : 6- 1966 the Aqueduct is situated in the standard Zone- II ; therefore the aqueduct need not to be designed for Seismic Forces.

E WIND FORCE

Slab

Area =	11.10 x	0.98				=	10.82 Sqm
height of C.G. above Bed level =	100.34 -	82.57 =	17.77 m				
According to Clause 212.3 IRC -6 -1966	Wind pressure =	114.10 Kg/Sqm	=	1.14	kN/Sqm		
Wind Force =	10.82 x	1.14				=	**12.35 kN**
Moment @ R. L.	80.60 M =	12.35 x	19.74 =	**243.79 kN-m**			
Moment @ R. L.	80.00 M =	12.35 x	20.34 =	**251.20 kN-m**			
Moment @ R. L.	79.00 M =	12.35 x	21.34 =	**263.55 kN-m**			

Pier Cap

Area A1 =	1.50 x	0.60			=	0.90 Sqm
Area A2 =	1.35 x	0.60			=	0.81 Sqm
					Total	**1.71 Sqm**
¥ = (	0.90 x	0.90)+ (	0.81 x	0.30) /	1.71	0.62 M
height of C.G. above Bed level =	89.47 -	82.57 =	6.90 m			

According to Clause 212.3 IRC -6 -1966	Wind pressure =	90.17 Kg/Sqm =		0.90 kN/Sqm		
Wind Force =	1.71 x	0.90			=	**1.54 kN**
Moment @ R. L.	80.60 M =	1.54 x	8.86 =	**13.67 kN-m**		
Moment @ R. L.	80.00 M =	1.54 x	9.46 =	**14.59 kN-m**		
Moment @ R. L.	79.00 M =	1.54 x	10.47 =	**16.14 kN-m**		
(I) **Pier from R.L.**	**99.780 to**	**82.57 M**				
Area =	1.20 x	17.21			=	20.65 Sqm
height of C.G. above Bed level =	91.18 -	82.57 =	8.61 m			
According to Clause 212.3 IRC -6 -1966	Wind pressure =	93.93 Kg/Sqm =		0.94 kN/Sqm		
Wind Force =	20.65 x	0.94			=	**19.40 kN**
Moment @ R. L.	80.60 M =	19.40 x	10.58 =	**205.14 kN-m**		
Moment @ R. L.	80.00 M =	1.54 x	11.18 =	**17.23 kN-m**		
Moment @ R. L.	79.00 M =	1.54 x	12.18 =	**18.77 kN-m**		
TOTAL TRANSVERSE MOMENT DUE TO WIND FORCE						
Moment @ R. L.	80.60 M =	243.79 +	13.67 +	205.14 +		
				=	462.60 **kN-m**	
Moment @ R. L.	80.00 M =	251.20 +	14.59 +	17.23 +		
				=	283.02 **kN-m**	
Moment @ R. L.	79.00 M =	263.55 +	16.14 +	18.77 +		
				=	298.45 **kN-m**	

BASE PRESSURE CALCULATION

CASE- 1 FOR SERVICE CONDITION AT R. L.79 M

VERTICAL LOADS

DEAD LOAD CALCULATION

SUPER STRUCTURE	=	**3094.64 kN**			
SUB STRUCTURE	=	**9189.40 kN**	**Without Buoyancy**		
SUB STRUCTURE	=	**7879.15 kN**	**With Buoyancy**		
LIVE LOAD	=	**788.27 kN**			
Total Load without Buoyancy	=	**13072.31 kN**			
Total Load with Buoyancy	=	**11762.05 kN**			
Total LONGITUDINAL MOMENT	=	**371.44 +**	**244.25 =**	**615.70 kN-m**	
Total TRANSVERSE MOMENT	=	**371.44 +**	**2247.88 =**	**2619.32 kN-m**	

C.S.A. =	15.60	x	3.80			=	59.28 m^2			
I_{xx} =	1/6x	15.60	x	3.80 ^{2}		=	37.54 m^3			
I_{yy} =	1/6x	15.60 ^{2}		x	3.80	=	154.13 m^3			
STRESS with Buoyancy = (	11762.05 /		59.28	)+ / - (	615.70	/	37.54	)+ / - (	2619.32 /	154.13)
=	198.42	+ / -	16.40	+ / -	16.99					
P_{max} =	198.42	+	16.40	+	16.99					
=	**231.81** kN/m^2									
	< 250 kN/m2 Hence O.K.									
P_{min} =	198.42	-	16.40	-	16.99					
=	**165.02** kN/m^2									
	> 0 Hence O.K.									
STRESS without Buoyancy = (	13072.31 /		59.28	)+ / - (	615.70	/	37.54	)+ / - (	2619.32 /	154.13)
=	220.52	+ / -	16.40	+ / -	16.99					
P_{max} =	220.52	+	16.40	+	16.99					
=	**241.91** kN/m^2									

< 250 kN/m2 Hence O.K.

P_{min} = 220.52 - 16.40 - 16.99

= **187.12** kN/m^2

> 0 Hence O.K.

CASE- 2 FOR IDLE CONDITION AT R. L.79 M **(WHEN THERE IS NO LIVE LOAD)**

A CHECK OF STABILITY DUE TO BUOYANCY EFFECT

SUPER STRUCTURE	=	**3094.64 kN**	
SUB STRUCTURE	=	**9189.40 kN**	**Without Buoyancy**
SUB STRUCTURE	=	**7879.15 kN**	**With Buoyancy**
LIVE LOAD	=	**0.00 kN**	
Total Load without Buoyancy	=	**12284.04 kN**	
Total Load with Buoyancy	=	**10973.79 kN**	

STRESS with Buoyancy = (10973.79 / 59.28)+ / - (371.44 / 37.54)+ / - (371.44 / 154.13)

= 185.12 + / - 9.89 + / - 2.41

P_{max} = 185.12 + 9.89 + 2.41

= **197.42** kN/m^2

< 250 kN/m2 Hence O.K.

P_{min} = 185.12 - 9.89 - 2.41

= **172.81** kN/m^2

> 0 Hence O.K.

STRESS without Buoyancy = (12284.04 / 59.28)+ / - (371.44 / 37.54)+ / - (371.44 / 154.13)

= 207.22 + / - 9.89 + / - 2.41

P_{max} = 207.22 + 9.89 + 2.41

= **219.52** kN/m^2

< 250 kN/m2 Hence O.K.

P_{min} = 207.22 - 9.89 - 2.41

= **194.92** kN/m^2

> 0 Hence O.K.

CASE- 3 FOR WIND FORCE AT SERVICE CONDITION AT R. L.79 M

SUPER STRUCTURE	=	**3094.64 kN**				
SUB STRUCTURE	=	**9189.40 kN**	**Without Buoyancy**			
SUB STRUCTURE	=	**7879.15 kN**	**With Buoyancy**			
LIVE LOAD	=	**788.27 kN**				
Total Load without Buoyancy	=	**13072.31 kN**				
Total Load with Buoyancy	=	**11762.05 kN**				
Total LONGITUDINAL MOMENT	=	**371.44 +**	**244.25**		**=**	**615.70 kN-m**
Total TRANSVERSE MOMENT	=	**371.44 +**	**298.45 +**	**2247.88**	**=**	**2917.78 kN-m**

STRESS with Buoyancy = (11762.05 / 59.28)+ / - (615.70 / 37.54)+ / - (2917.78 / 154.13)

= 198.42 + / - 16.40 + / - 18.93

P_{max} = 198.42 + 16.40 + 18.93

= **233.75** kN/m^2

< 250 kN/m2 Hence O.K.

P_{min} = 198.42 - 16.40 - 18.93

= **163.08** kN/m^2

> 0 Hence O.K.

STRESS without Buoyancy = (13072.31 / 59.28)+ / - (615.70 / 37.54)+ / - (2917.78 / 154.13)
= 220.52 + / - 16.40 + / - 18.93

P_{max} = 220.52 + 16.40 + 18.93
= **243.85** kN/m^2
< 250 kN/m2 Hence O.K.

P_{min} = 220.52 - 16.40 - 18.93
= **185.19** kN/m^2
> 0 Hence O.K.

CASE- 4 FOR WIND FORCE AT IDLE CONDITION AT R. L.79 M **[NO LIVE LOAD]**

SUPER STRUCTURE	=	**3094.64 kN**	
SUB STRUCTURE	=	**9189.40 kN**	**Without Buoyancy**
SUB STRUCTURE	=	**7879.15 kN**	**With Buoyancy**
LIVE LOAD	=	**0.00 kN**	
Total Load without Buoyancy	=	**12284.04 kN**	
Total Load with Buoyancy	=	**10973.79 kN**	
Total LONGITUDINAL MOMENT	=	371.44 **kN-m**	
Total TRANSVERSE MOMENT	=	**371.44 +**	**298.45 = 669.90 kN-m**

STRESS with Buoyancy = (10973.79 / 59.28)+ / - (371.44 / 37.54)+ / - (669.90 / 154.13)
= 185.12 + / - 9.89 + / - 4.35

P_{max} = 185.12 + 9.89 + 4.35
= **199.36** kN/m^2
< 250 kN/m2 Hence O.K.

P_{min} = 185.12 - 9.89 - 4.35
= **170.88** kN/m^2
> 0 Hence O.K.

P_3 = 185.12 + 9.89 - 4.35
= **190.67** kN/m^2
< 250 kN/m2 Hence O.K.

P_4 = 185.12 - 9.89 + 4.35
= **179.57** kN/m^2
> 0 Hence O.K.

190.67 179.57

170.88 199.36
Stress Diagram

STRESS without Buoyancy = (12284.04 / 59.28)+ / - (371.44 / 37.54)+ / - (669.90 / 154.13)
= 207.22 + / - 9.89 + / - 4.35

P_{max} = 207.22 + 9.89 + 4.35
= **221.46** kN/m^2
< 250 kN/m2 Hence O.K.

P_{min} = 207.22 - 9.89 - 4.35
= **192.98** kN/m^2
> 0 Hence O.K.

201.67 212.77

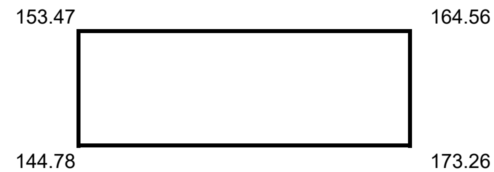
192.98 221.46
Stress Diagram

CASE- 5 FOR ONE SPAN DISLODGED CONDITION AT R. L.79 M

SUPER STRUCTURE	=	**1547.32 kN**	
SUB STRUCTURE	=	**9189.40 kN**	**Without Buoyancy**
SUB STRUCTURE	=	**7879.15 kN**	**With Buoyancy**
LIVE LOAD	=	**0.00 kN**	

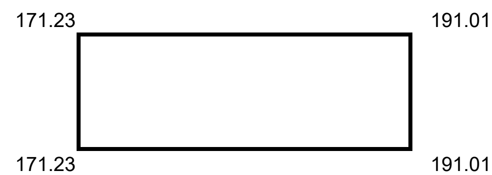
Total Load without Buoyancy = **10736.72 kN**
Total Load with Buoyancy = **9426.47 kN**
Total LONGITUDINAL MOMENT = **371.44 kN-m**
Total TRANSVERSE MOMENT = **371.44 +** **298.45 =** **669.90 kN-m**

STRESS with Buoyancy = (9426.47 / 59.28)+ / - (371.44 / 37.54)+ / - (669.90 / 154.13)
= 159.02 + / - 9.89 + / - 4.35
P_{max} = 159.02 + 9.89 + 4.35
= **173.26** **kN/m²**
< 250 kN/m2 Hence O.K.
P_{min} = 159.02 - 9.89 - 4.35
= **144.78** **kN/m²**
P_3 = 159.02 + 9.89 - 4.35
= **164.56** **kN/m²**
P_4 = 159.02 - 9.89 + 4.35
= **153.47** **kN/m²**



Stress Diagram

STRESS without Buoyancy = (10736.72 / 59.28)+ / - (371.44 / 37.54)+ / - (0.00 / 154.13)
= 181.12 + / - 9.89 + / - 0.00
P_{max} = 181.12 + 9.89 + 0.00
= **191.01** **kN/m²**
P_{min} = 181.12 - 9.89 - 0.00
= **171.23** **kN/m²**
P_3 = 181.12 + 9.89 - 0.00
= **191.01** **kN/m²**
P_4 = 181.12 - 9.89 + 0.00
= **171.23** **kN/m²**



Stress Diagram

CASE- 6 FOR SERVICE CONDITION AT R. L.80 M
VERTICAL LOADS
DEAD LOAD CALCULATION

SUPER STRUCTURE = **3094.64 kN**
SUB STRUCTURE = **7055.32 kN** **Without Buoyancy**
SUB STRUCTURE = **6634.27 kN** **With Buoyancy**
LIVE LOAD = **788.27 kN**
Total Load without Buoyancy = **10938.23 kN**
Total Load with Buoyancy = **10517.17 kN**
Total LONGITUDINAL MOMENT = **296.56 +** **244.25 =** **540.81 kN-m**
Total TRANSVERSE MOMENT = **313.13 +** **2247.88 =** **2561.01 kN-m**

C.S.A. = 12.00 x 1.20 = 14.40 m^2
I_{xx} = 1/6x 12.00 x 1.20^2 = 2.88 m^3
I_{yy} = 1/6x 12.00^2 x 1.20 = 28.80 m^3
STRESS with Buoyancy = (10517.17 / 14.40)+ / - (540.81 / 2.88)+ / - (2561.01 / 28.80)

	=	730.36	+ / -	187.78	+ / -	88.92							
P_{max}	=	730.36	+	187.78	+	88.92							
	=	**1007.07**	**kN/m^2**										
		< 8000 kN/m^2 (that is 8 N/mm^2) Hence O.K.											
P_{min}	=	730.36	-	187.78	-	88.92							
	=	**453.65**	**kN/m^2**										
		> (- 3600 kN/m^2 (that is 3.6 N/mm^2) Hence O.K.											
STRESS without Buoyancy	= (	10938.23 /		14.40	)+ / - (	540.81	/	2.88	)+ / - (	2561.01	/	28.80	)
	=	759.60	+ / -	187.78	+ / -	88.92							
P_{max}	=	759.60	+	187.78	+	88.92							
	=	**1036.31**	**kN/m^2**										
		< 8000 kN/m^2 (that is 8 N/mm^2) Hence O.K.											
P_{min}	=	759.60	-	187.78	-	88.92							
	=	**482.89**	**kN/m^2**										
		> (- 3600 kN/m^2 (that is 3.6 N/mm^2) Hence O.K.											

<u>CASE- 7 FOR IDLE CONDITION AT R. L.80 M</u>

SUPER STRUCTURE	=	**3094.64 kN**	
SUB STRUCTURE	=	**7055.32 kN**	**Without Buoyancy**
SUB STRUCTURE	=	**6634.27 kN**	**With Buoyancy**
LIVE LOAD	=	**0.00 kN**	
Total Load without Buoyancy	=	**10149.96 kN**	
Total Load with Buoyancy	=	**9728.91 kN**	

STRESS with Buoyancy	= (	9728.91 /		14.40	)+ / - (	296.56	/	2.88	)+ / - (	313.13 /		28.80	)
	=	675.62	+ / -	102.97	+ / -	10.87							
P_{max}	=	675.62	+	102.97	+	10.87							
	=	**789.46**	**kN/m^2**										
		< 8000 kN/m^2 (that is 8 N/mm^2) Hence O.K.											
P_{min}	=	675.62	-	102.97	-	10.87							
	=	**561.77**	**kN/m^2**										
		> (- 3600 kN/m^2 (that is 3.6 N/mm^2) Hence O.K.											
STRESS without Buoyancy	= (	10149.96 /		14.40	)+ / - (	296.56	/	2.88	)+ / - (	313.13 /		28.80	)
	=	704.86	+ / -	102.97	+ / -	10.87							
P_{max}	=	704.86	+	102.97	+	10.87							
	=	**818.70**	**kN/m^2**										
		< 8000 kN/m^2 (that is 8 N/mm^2) Hence O.K.											
P_{min}	=	704.86	-	102.97	-	10.87							
	=	**591.01**	**kN/m^2**										
		> (- 3600 kN/m^2 (that is 3.6 N/mm^2) Hence O.K.											

<u>CASE- 8 FOR WIND FORCE AT SERVICE CONDITION AT R. L.80 M</u>

SUPER STRUCTURE	=	**3094.64 kN**	
SUB STRUCTURE	=	**7055.32 kN**	**Without Buoyancy**
SUB STRUCTURE	=	**6634.27 kN**	**With Buoyancy**
LIVE LOAD	=	**788.27 kN**	

Total Load without Buoyancy	=	**10938.23 kN**											
Total Load with Buoyancy	=	**10517.17 kN**											
Total LONGITUDINAL MOMENT	=	**296.56 +**		**244.25**			=	**540.81 kN-m**					
Total TRANSVERSE MOMENT	=	**313.13 +**		**462.60 +**		**2247.88 =**		**3023.61 kN-m**					
STRESS with Buoyancy	= (	10517.17 /		14.40	)+ / - (	540.81	/	2.88	)+ / - (	3023.61	/	28.80	)
	=	730.36	+ / -	187.78	+ / -	104.99							
P_{max}	=	730.36	+	187.78	+	104.99							
	=	**1023.13** kN/m^2											
		< 8000 kN/m^2 (that is 8 N/mm^2) Hence O.K.											
P_{min}	=	730.36	-	187.78	-	104.99							
	=	**437.59** kN/m^2											
		> (- 3600 kN/m^2 (that is 3.6 N/mm^2) Hence O.K.											
STRESS without Buoyancy	= (	10938.23 /		14.40	)+ / - (	540.81	/	2.88	)+ / - (	3023.61	/	28.80	)
	=	759.60	+ / -	187.78	+ / -	104.99							
P_{max}	=	759.60	+	187.78	+	104.99							
	=	**1052.37** kN/m^2											
		< 8000 kN/m^2 (that is 8 N/mm^2) Hence O.K.											
P_{min}	=	759.60	-	187.78	-	104.99							
	=	**466.83** kN/m^2											
		> (- 3600 kN/m^2 (that is 3.6 N/mm^2) Hence O.K.											

CASE- 9 FOR WIND FORCE AT IDLE CONDITION AT R. L.80 M

SUPER STRUCTURE	=	**3094.64 kN**											
SUB STRUCTURE	=	**7055.32 kN**		**Without Buoyancy**									
SUB STRUCTURE	=	**6634.27 kN**		**With Buoyancy**									
LIVE LOAD	=	**788.27 kN**											
Total Load without Buoyancy	=	**10938.23 kN**											
Total Load with Buoyancy	=	**10517.17 kN**											
Total LONGITUDINAL MOMENT	=	**296.56 kN-m**											
Total TRANSVERSE MOMENT	=	**313.13 +**		**462.60 =**		**775.73 kN-m**							
STRESS with Buoyancy	= (	10517.17 /		14.40	)+ / - (	296.56	/	2.88	)+ / - (	775.73 /		28.80	)
	=	730.36	+ / -	102.97	+ / -	26.94							
P_{max}	=	730.36	+	102.97	+	26.94							
	=	**860.27** kN/m^2											
		< 8000 kN/m^2 (that is 8 N/mm^2) Hence O.K.											
P_{min}	=	730.36	-	102.97	-	26.94							
	=	**600.45** kN/m^2											
		> (- 3600 kN/m^2 (that is 3.6 N/mm^2) Hence O.K.											
STRESS without Buoyancy	= (	10938.23 /		14.40	)+ / - (	296.56	/	2.88	)+ / - (	775.73 /		28.80	)
	=	759.60	+ / -	102.97	+ / -	26.94							
P_{max}	=	759.60	+	102.97	+	26.94							
	=	**889.51** kN/m^2											
		< 8000 kN/m^2 (that is 8 N/mm^2) Hence O.K.											
P_{min}	=	759.60	-	102.97	-	26.94							

= **629.69** **kN/m^2**

> (- 3600 kN/m^2 (that is 3.6 N/mm^2) Hence O.K.

ABSTRACT OF BASE PRESSURE AND STRESSES

Name Of Work :- Construction Of High Level Bridge on Kelwara Kumbhalgarh Road Over Kelwara Lake

CASE- 1 FOR SERVICE CONDITION AT R. L.79 M	231.81	165.02	241.91	187.12		
CASE- 2 FOR IDLE CONDITION AT R. L.79 M	197.42	172.81	219.52	194.92		
CASE- 3 FOR WIND FORCE AT SERVICE CONDITION AT R. L.79 M	233.75	163.08	243.85	185.19		
CASE- 4 FOR WIND FORCE AT IDLE CONDITION AT R. L.79 M	199.36	170.88	190.67	179.57	221.46	192.98
CASE- 5 FOR ONE SPAN DISLODGED CONDITION AT R. L.79 M	173.26	144.78	164.56	153.47	181.12	171.23

Maximum 243.85 **144.78 Minimum**

CASE- 6 FOR SERVICE CONDITION AT R. L.80 M	1007.07	453.65	1036.31	482.89
CASE- 7 FOR IDLE CONDITION AT R. L.80 M	789.46	561.77	818.70	591.01
CASE- 8 FOR WIND FORCE AT SERVICE CONDITION AT R. L.80 M	1023.13	437.59	1052.37	466.83
CASE- 9 FOR WIND FORCE AT IDLE CONDITION AT R. L.80 M	860.27	600.45	889.51	629.69

Maximum 1052.37 **437.59 Minimum**

REINFORCEMENT CALCULATION IN PIER IN LOWER FLARED PORTION
Name Of Work :- Construction Of High Level Bridge on Kelwara Kumbhalgarh Road Over Kelwara Lake

R.L. 80.50 M TO 81.10 M

FOR SERVICE CONDITION

VERTICAL LOADS				
SUPER STRUCTURE	=	3094.64	kN	
SUB STRUCTURE	=	7055.32	kN	Without Buoyancy
SUB STRUCTURE	=	6634.27	kN	With Buoyancy
LIVE LOAD	=	788.27	kN	
Total Load without Buoyancy	=	10938.23	kN	
Total Load with Buoyancy	=	10517.17	kN	

Total LONGITUDINAL MOMENT

Moment @ R. L. 80.00 M = 540.81 kN-m

Total TRANSVERSE MOMENT

Moment @ R. L. 80.00 M = 3023.61 kN-m

CONCRETE MIX M-25

CHARACTERISTIC STRENGTH OF REINFORCEMENT 415 N/mm2

PERMISSIBLE STRESSES

IN STEEL 190

IN CONCRETE

CHARACTERISTIC STRENGTH OF Concrete	fck	=	30	N/mm2
Permissible Compressive Stress in Bending	σcbc	=	8	N/mm2
Permissible Compressive Stress in Direct Compression	σcc	=	8	N/mm2
	σct	=	3.6	N/mm2

Ultimate Axial Load P_U	=	1.5 X	10938.23	=	16407.34	kN
Ultimate Longitudinal Moment M_U	=	1.5 X	540.81	=	811.2195	kN-m
Ultimate Transverse Moment M_U	=	1.5 X	3023.61	=	4535.417	kN-m

INCREASE WHEN WIND CONDITION IS CONSIDERED 33.33 %

Neglecting area of Cut and Ease water parts Rectangular Section considered is

12001 mm x 1201 mm

Assume cover as 75

d^1/d	=	87.5 /	1201.2 =	0.0728			
$P_U/(f_{ck}\ b\ d)$	=	16407.34 x	1000 / (	30 x	12001 x	1201.2)	
	=	0.0379					

FOR LONGITUDINAL MOMENT

$Mu/(f_{ck}\ b\ d^2)$	=	811.22 x	1000000 / (	30 x	12001 x	1201.2^2)
	=	0.0016				

Refer Chart 31 & 32 of Design Aids for Reinforced concrete SP-16 the point lies below the range of applicability. Hence provide minimum percentage of steel.

The point lies below the range of applicability. Hence provide minimum percentage of steel
CRITERIA 1 FOR MINIMUM STEEL Pt = 0.8 % OF CROSS SECTION AREA OF COLUMN REQUIRED FOR COMPRESSION

Area Required due to Compression =		10517.17 x	1000 /	8	
	=	1314647 mm^2			
Area of steel @ 0.8% =		0.8 x	1314647 /	100	
	=	**10517 mm^2**			

CRITERIA 2 FOR MINIMUM STEEL Pt = 0.3 % OF GROSS SECTION AREA OF COLUMN

Area of steel @ 0.3% =		0.3 x	12001.2 x	1201.2 /	100
	=	**43248 mm^2**			
PROVIDE STEEL AREA	=	**43248 mm^2**			
NO. OF		25 MM BARS =	88 Nos.		
SPACING	=	290 MM			
FOR TRANSVERSE MOMENT					
$Mu/(f_{ck}\ b\ d^2)$	=	4535.42 x	1000000 / (	30 x	
			12001.2 x	1201.2^2)	
	=	0.0087			

Refer Chart 31 & 32 of Design Aids for Reinforced concrete SP-16 the point lies below the range of applicability. Hence provide minimum percentage of steel.

TRANSVERSE REINFORCEMENT

Shear Force to be resisted by the pier In Accordance to IS 1893

3023.61 / 11.87 = 254.67 kN

Check for Shear

Nominal Shear Stress =	254.67	x	1000	/ (	12001 x	1201)
	=	0.02 N/mm^2				
Pt	0.30					
Permissible Shear Stress =	0.40 N/mm^2	Refer table 61				

Nominal Shear Reinforcement will suffice

According to IRC 21-1987 Clause 306.3

Dia of Transverse Reinforcement	=	25 /	4 =	6.25 mm
Provide		12 mm dia rings		
Pitch of the Transverse should be least of				
a) Least lateral Dimension =		1201.2 mm		
b) 12 d =		12 x	12 =	144 mm
c) 300 mm =		300 mm		
d) As per IS IS 13920:1993 Cl. 7.4.6	< or =	100 mm		
Provide		12 mm dia rings @	100 mm c/c.	

This spacing is in accordance to IS 13920:1993 Cl. 7.4.6

CODE OF PRACTICE FOR DUCTILE DETAILING OF REINFORCED CONCRETE STRUCTURES SUBJECTED TO SEISMIC FORCES

Check for Size of Hoop Reinforcement **Refer IS 13920:1993 Cl. 7.4.8**

Ash= 0.18 Sh (Fck/Fy)x(Ag/Ak-1)

S	=	100.00	mm	
h	=	300.00	N/mm^2	(Spacing of long. bars+ effective cover) or 300 mm whichever is less
Fck	=	30.00	N/mm^2	**Cover 75 mm to main reinforcement**
Fy	=	415.00	N/mm^2	
Ag	=	1201.20	mm^2	Considering 1 mm Wide Pier
Ak	=	1100.20	mm^2	Considering 1 mm Wide Pier Effective
Hence Ash	=	35.84	mm^2	
Ash ProvideD	=	113.04	mm^2	Which is OK

d) As per IS IS 13920:1993 Cl. 7.4.6 < or = 100 mm

Provide 12 mm dia rings @ 100 mm c/c.

This spacing is in accordance to IS 13920:1993 Cl. 7.4.6

CODE OF PRACTICE FORDUCTILE DETAILING OF REINFORCED CONCRETE STRUCTURES SUBJECTED TO SEISMIC FORCES

ABSTRACT

LONGITUDINAL REINFORCEMENT	**25**	**MM BARS**	**290**	**MM**	**However Adopt spacing as 250 mm**
TRANSVERSE REINFORCEMENT	**12mm dia rings @100mm c/c.**				

REINFORCEMENT CALCULATION IN PIER

Name Of Work :- Construction Of High Level Bridge on Kelwara Kumbhalgarh Road Over Kelwara Lake

R.L. 81.10 M TO 100.80 M

FOR SERVICE CONDITION

VERTICAL LOADS

SUPER STRUCTURE	=	**3094.64**	kN	
SUB STRUCTURE	=	**9189.40**	kN	Without Buoyancy
SUB STRUCTURE	=	**7879.15**	kN	With Buoyancy
LIVE LOAD	=	**788.27**	kN	
Total Load without Buoyancy	=	**13072.31**	kN	
Total Load with Buoyancy	=	**11762.05**	kN	

Total LONGITUDINAL MOMENT

Moment @ R. L. 81.10 M = 615.70 kN-m

Total TRANSVERSE MOMENT

Moment @ R. L. 81.10 M = 2619.32 kN-m

CONCRETE MIX M-25

CHARACTERISTIC STRENGTH OF REINFORCEMENT 415 N/mm2

PERMISSIBLE STRESSES

IN STEEL 190

IN CONCRETE

CHARACTERISTIC STRENGTH OF Concrete fck = 30 N/mm2

Permissible Compressive Stress in Bending σcbc = 8 N/mm2

Permissible Compressive Stress in Direct Compression σcc = 8 N/mm2

σct = 3.6 N/mm2

Ultimate Axial Load P_U	=	1.5 X	13072.31 =	19608.46	kN
Ultimate Longitudinal Moment M_U	=	1.5 X	615.70 =	923.5442	kN-m
Ultimate Transverse Moment M_U	=	1.5 X	2619.32 =	3928.986	kN-m

INCREASE WHEN WIND CONDITION IS CONSIDERED 33.33 %

Neglecting area of Cut and Ease water parts Rectangular Section considered is

12000 mm x 1200 mm

Assume cover as 75

d^1/d = 87.5 / 1200 = 0.0729

$P_U/(f_{ck}\ b\ d)$ = 19608.46 x 1000 / (30 x 12000 x 1200)

= 0.0454

FOR LONGITUDINAL MOMENT

$Mu/(f_{ck}\ b\ d^2)$ = 923.54 x 1000000 / (30 x 12000 x 1200^2)

= 0.0018

Refer Chart 31 & 32 of Design Aids for Reinforced concrete SP-16 the point lies below the range of applicability. Hence provide minimum percentage of steel.

The point lies below the range of applicability. Hence provide minimum percentage of steel

CRITERIA 1 FOR MINIMUM STEEL Pt = 0.8 % OF CROSS SECTION AREA OF COLUMN REQUIRED FOR COMPRESSION

Area Required due to Compression =		11762.05 x		1000 /		8
	=	1470257 mm^2				
Area of steel @ 0.8% =		0.8 x	1470257 /		100	
	=	**11762 mm^2**				

CRITERIA 2 FOR MINIMUM STEEL Pt = 0.3 % OF GROSS SECTION AREA OF COLUMN

Area of steel @ 0.3% =		0.3 x	12000 x	1200 /	100
	=	**43200 mm^2**			
PROVIDE STEEL AREA	=	**43200 mm^2**			
NO. OF		25 MM BARS	=	88 Nos.	
SPACING	=	290 MM			

FOR TRANSVERSE MOMENT

$Mu/(f_{ck}\ b\ d^2)$	=	3928.99 x	1000000 / (		30 x
			12000 x	1200 ^{2})	
	=	0.0076			

Refer Chart 31 & 32 of Design Aids for Reinforced concrete SP-16 the point lies below the range of applicability. Hence provide minimum percentage of steel.

TRANSVERSE REINFORCEMENT

Shear Force to be resisted by the pier In Accordance to IS 1893

2619.32 / 11.87 = 220.62 kN

Check for Shear

Nominal Shear Stress = 220.62 x 1000 / (12000 x 1200)

= 0.02 N/mm^2

Pt 0.30

Permissible Shear Stress = 0.40 N/mm^2 Refer table 61

Nominal Shear Reinforcement will suffice

According to IRC 21-1987 Clause 306.3

Dia of Transverse Reinforcement = 25 / 4 = 6.25 mm

Provide 12 mm dia rings

Pitch of the Transverse should be least of

a) Least lateral Dimension =		1200 mm		
b) 12 d =		12 x	12 =	144 mm
c) 300 mm =		300 mm		
d) As per IS IS 13920:1993 Cl. 7.4.6	< or =	100 mm		

Provide 12 mm dia rings @ 100 mm c/c.

This spacing is in accordance to IS 13920:1993 Cl. 7.4.6

CODE OF PRACTICE FOR DUCTILE DETAILING OF REINFORCED CONCRETE STRUCTURES SUBJECTED TO SEISMIC FORCES

Check for Size of Hoop Reinforcement **Refer IS 13920:1993 Cl. 7.4.8**

Ash= 0.18 Sh (Fck/Fy)x(Ag/Ak-1)

S	=	100.00	mm	
h	=	300.00	N/mm^2	(Spacing of long. bars+ effective cover) or 300 mm whichever is less
Fck	=	30.00	N/mm^2	**Cover 75 mm to main reinforcement**
Fy	=	415.00	N/mm^2	

Ag	=	1200.00	mm^2	Considering 1 mm Wide Pier
Ak	=	1099.00	mm^2	Considering 1 mm Wide Pier Effective
Hence Ash	=	35.87	mm^2	
Ash ProvideD	=	113.04	mm^2	Which is OK

d) As per IS IS 13920:1993 Cl. 7.4.6 < or = 100 mm

Provide 12 mm dia rings @ 100 mm c/c.

This spacing is in accordance to IS 13920:1993 Cl. 7.4.6

CODE OF PRACTICE FORDUCTILE DETAILING OF REINFORCED CONCRETE STRUCTURES SUBJECTED TO SEISMIC FORCES

ABSTRACT

LONGITUDINAL REINFORCEMENT	**25**	**MM BARS**	**290**	**MM**	**However Adopt spacing as 250 mm**
TRANSVERSE REINFORCEMENT	**12mm dia rings @100mm c/c.**				

DESIGN OF PIER FOOTING SUBMERSIBLE BRIDGE

Name Of Work :- Construction Of High Level Bridge on Kelwara Kumbhalgarh Road Over Kelwara Lake

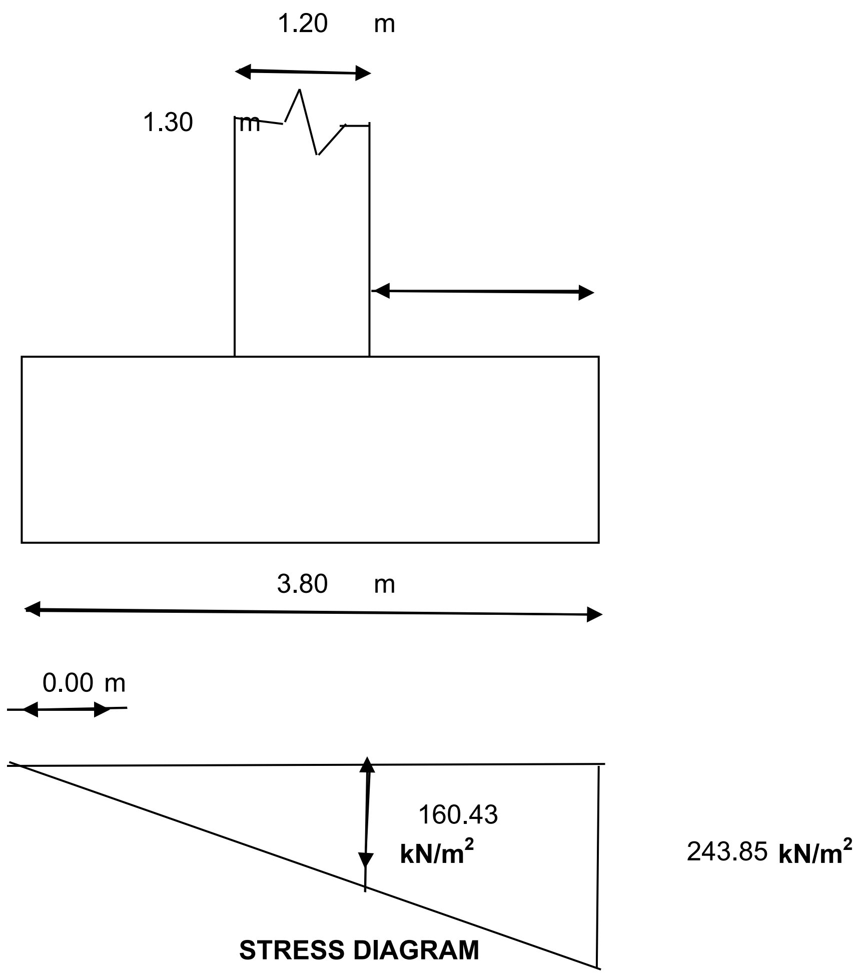
FOR WIND AT SERVICE CONDITION

Length of footing	l_f	15.60	m	
Width of Footing	l_b	3.80	m	
Width of Pier		1.20	m	
Vertical Load	P	13072.31	kN	
Longitudinal Moment	M_e	615.70	kN-m	
Transverse Moment	M_b	2917.78	kN-m	
Area in Tension = y x l_b		0.00	m^2	0.00 %
Maximum Pressure before Redistribution		243.85	kN/m^2	
Maximum Pressure After Redistribution = pxK		243.85	kN/m^2	
Maximum Stress at Edge of Pier		243.85	kN/m^2	
Distance From Face of Pier to the Edge		1.30	m	
Stress at the Edge of Pier		160.43	kN/m^2	
Average Stress on Cantilevered Area		202.14	kN/m^2	
Area of the Cantilever Portion		1.30	m^2	
Distance of Centroid of the Stress in Cantilever Portion		0.69	m	
Moment about the Face of Pier		**182.55**	**kN-m**	
CONCRETE GRADE		**M-25**		
FOR THIS GRADE σcbc		**10**	N/mm2	
m		**9.33**		
σst		**200**		
factor k		0.318		
j		0.894		
R		1.422		
Effective Depth Required		358	mm	
Adopt Total Depth		1500	mm	
Cover		50	mm	
Assume Bar Dia		25	mm	
Keeping A Cover Of 50 mm Effective Depth		1438	mm	
Adopt Effective Depth		1437.5	mm	
Steel Required Ast		710	mm^2	
Area Of One Bar		491	mm^2	
Spacing S		**691**	**mm**	

Provide Bars Of Dia And Spacing	25 mm	**Adopt spacing as 250 mm**	
Area Of Distribution Steel		2000	mm^2
Dia Of Bar For Distribution Steel		20	mm
Area Of One Bar In Distribution Reinforcement		314	mm^2
Using The Bars Spacing Required		157	mm
Provide Bars Of Dia And Spacing	20 mm	150	mm
Provide Bars Of Dia And Spacing for Top Main Steel	12 mm	150	mm
Provide Bars Of Dia And Spacing for Top Distribution Steel	12 mm	150	mm

CHECK FOR SHEAR (As per IRC 21-1987 Cl. 304.7)

Critical Section is at a distance equal to effective depth from pier face		1437.5	mm
Section of Shear from end of pier		-0.14	m
Maximum Stress at Edge of Pier		243.85	**kN/m^2**
Stress at the Section for Shear Check		253.16	**kN/m^2**
Average Stress on Cantilevered Area		248.51	**kN/m^2**
Shear Force		-34.17	kN
V=V' + M/d tanB	(B=0) Hence V =V'		
Actual Shear Stress		-0.02	**N/mm^2**
Percentage Steel	100As/bd	0.05	
Tc		0.23	**N/mm^2**
k=1			
Permissble Shear Stress = k Tc		0.23	**N/mm^2**
		< Actual Shear Stress hence Shear Reinforcement should be provided	
Dia Of two Legged Stirrups		16	mm
Area Of One Bar In Distribution Reinforcement		201	mm^2
Using The Bars Spacing Required s= Asw ts d/V		-3382	mm
Provide Bars Of Dia And Spacing	**16 mm**	**Adopt spacing as 250 mm**	



DESIGN OF PIER FOOTING

LIVE LOAD CALCULATION :-

[1] CLASS AA TRACKED VEHICLE :-

(a) <u>Dispersion width along the span</u>

According to clause 305.13 IRC- 21-2000

= Length of Contact + 2 (Wearing coat + depth of Slab)

= 3.6 + 2 (0.075 + 0.775)

= 5.3 M

(b) <u>Dispersion width across the span</u>

According to clause 305.13 IRC- 21-2000

be = K x (1 - x/Le) +bw

K = A Constant having the value depending upon the ratio
(L1/Le where.
be = the effective width of the slab on which the load acts.
Le = Effective Span
x = the distance of c.g. of concentrate load from the near support
bw = The breadth of concentration area of the load i.e. Dimension of the tyre or track contact area over the road surface
Heve ,

Le = 10.00 M & L1 = 7.00 M

$$= \frac{L1}{Le} = \frac{7.00}{10.0} = 0.7$$

Value of K = 2.4

bw = 0.85 + 2 x 0.075 = 1.0 M

$$X = \frac{L}{2} = \frac{10}{2} = 5.0 \text{ M}$$

be = 2.4 x 4 (1 - 5/10) + 1

= 5.8 M

Impact factor is 13.75% as pere IRC Section-II, Clause - 211-3 (a) (i)

DISPERSION ACROSS SPAN (CLASS AA TRACKED VEHICAL

The tracked vehicle is placed at a distance of minimum clearence of 1-2 m from Kerb

Dispersion across span

= C/C distance between wheels

+ width from centre of wheel on clearence side

+ Least on other side or halp the dispersion of one wheel.

= 2.05 + 1.93 + Least of 2.715 OR 5.8/2

= 2.05 + 1.93 + 2.715

= 6.695

Impact factor = 1.1375

Total load with impact

= 70 x 1.1375

= 79.63 T

= Intensity of Load

$$= \frac{79.63}{5.30 \times 6.695} = 2.24 \text{ T/M}$$

Maximum Reaction

For Maximum reaction at support the Centre of gravity of the loads should be adjacent to one support should be adjacent to one support

Reaction R_A= 2.24x 3.00 x 1.50 /10.00

= 1.01 T

Reaction R_B= 2.24x 3.00 -1.01

= 5.71 T

DISPERSION ALONG SPAN (CLASS AA TRACKED VEHICLE

(a) Dispersion width along the span :-

tp = tc = 2 (tw + ts)

tp = width of dispersion parallel to span

tc = width of tyre contact area parallel to span

ts = Overall depth of slab

tw = Thickness of Wearing coat

Dispersion along the span

= 0.15 + 2 (0.075 + 0.775)

= 1.9 M

Dispersion between two wheel is overlapping hence restricted to 1-2 M

= Dispersion combined for two wheels

= C/c distance between two wheels + Longitudinal dispersion

= 1-2 + 1.9

= 3.1 M (along the span)

Impact factor = 1.1375

Total load with impact

= 70 x 1.1375

= 79.63 T

= Intensity of Load

$$= \frac{79.63}{1.90 \times 5.30} = 7.91 \text{ T/M}$$

Maximum Reaction

For Maximum reaction at support the Centre of gravity of the loads should be adjacent to one support should be adjacent to one support

Reaction R_A= 7.91x 3.00 x 1.50 /10.00

= 3.56 T

Reaction R_B= 7.91x 3.00 -3.56

= 20.17 T

DESIGN OF PIER CAP :-

D.L./ M Width along bridge				
DL. Of Slab =	0.75 x	8.40 x.	2.4 =	15.12 T
D.L. of Wearing coat =	0.08 x	8.40 x.	2.4 =	1.51 T
			TOTAL	16.63 T
D.L. of Slab & Wearing coat on half of the pier	=			
		16.63 /	2 =	8.32 T
L.L. on Pier cap including impact along bridge				
	=	82.50 x	1.1375 =	93.84 T
(Refer Live Load Computation)				
Dispersion width across the span for				
70 T TRACKED VEHTCLE	=	6.695 M		
(Refer Solid slab design page SS-16)				
Live Load u.d.l. on Pier	=	93.84 /	6.695 =	14.02 T
Per M width				
Total Load on Half =	8.32 +	14.02	=	22.33 T
of pier along bridge				Per M width
Effective depth of slab =90-2.5-2.5/2 =	71.25 cm			
Placement of the live load at effective depth from the support (taking support width 750 mm)				
Eccentricity = 71.25 -75/2	=	33.75 cm	=	0.34 M
Bending Moment along the bridge =				
	22.33 x	0.34		7.54 T - M/M width
=				
	7.54 x	10.00 =	**75.4 kN-M/M width**	
This moment is too small hence it will not/be the governing B.M.				
Moment in pier cap		**75.40 kN-m**		
CONCRETE GRADE		**M30**		
FOR THIS GRADE σcbc		**10** N/mm2		
m		**9.33**		
σst		**200**		
factor k		0.318		
j		0.894		
R		1.422		
Effective Depth Required		230 mm		
Adopt Total Depth		1200 mm		
Cover		50 mm		
Assume Bar Dia		25 mm		
Keeping A Cover Of 50 mm Effective Depth		1138 mm		
Adopt Effective Depth		1137.5 mm		
Steel Required Ast		371 mm^2		
Area Of One Bar		491 mm^2		
Spacing S		1323 mm		
Provide Bars Of Dia And Spacing	25 mm	**100** mm	**Adopt spacing as 100 mm**	
Provide Bars Of Dia And Spacing for Top Main Steel	25 mm	100 mm		
Provide Bars Of Dia And Spacing for Bottom Steel	16 mm	100 mm		
PIER SECTION ACROSS BRIDGE				
DEAD LOAD MOMENT PER METRE Width across bridge :-				
Slab D.L.	0.975 x	15 x.	2.4 =	35.10 T
D.L. of Wearing coat =	0.075 x	12 x.	2.4 =	2.16 T
			TOTAL	**37.26** T
D.L. of Slab & Wearing coat on half of the pier	=			
		37.26 /	2 =	18.63 T/ M width

L.L on pier		=			64.69 T
Dispersion width along the span for 70 T Tracked vehical	=	5.3 M			
L.L. . per M width on pier =		64.69 /	5.3 =		12.21 T/ M width
Total D.L. + L.L. on half of Pier across bridge per M width		18.63 +	12.21	=	30.84 T Per M width

The Live Load is with clearance from the Footpath and kerb. The cantilever portion of pier cap and width of footpath is 1500 mm
Hence There is no eccentricity.

Bending Moment across the bridge =

30.84 x	0	0.00 T - M/M width

Provide Minimum steel

Minimum Reinforcement calculation for Pier cap :-

As per clause 710.8.2, IRC- 78 - 2000, the thickness of pier cap shall be at least 200 mm However the thickness of Pier cap here is 1200 MM.

Grade of Concrete M 30

Minimum Shrinkage and Temperature reinforcement required as per Clause 305.10 IRC 21-2000 in any RC structure is 250 Sq mm per m in each direction. Allowable maximum spacing is 300 mm.

Shrinkage and Temperature reinforcement required =	250 x	1.2 =	300 mm^2

Provide 25 mm tor reiforcement @ 100 mm c/c (14 Nos.) in top along the pier cap
Provide 16 mm tor reiforcement @ 100 mm c/c (14 Nos.) in bottom along the pier cap

Area of Steel Provided at top = (14x 491)	=	6874 mm^2	> 300 mm^2	OK
Area of Steel Provided at bottom = (14x 201)	=	2814 mm^2	> 300 mm^2	OK

CHECK FOR SHEAR ALONG BRIDGE DIRECTION

V =		30.84 T			
Shear Force			308.40 kN		
V=V' + M/d tanB	(B=0) Hence V =V'				
Actual Shear Stress			0.27 **N/mm^2**		
Percentage Steel	100As/bd		0.25		
Tc			0.23 **N/mm^2**		
k=1					
Permissble Shear Stress = k Tc			0.23 **N/mm^2**		
			< Actual Shear Stress hence Shear Reinforcement should be provided		
Dia Of two Legged Stirrups			16 mm		
Area Of One Bar In Distribution Reinforcement			201 mm^2		
Using The Bars Spacing Required s= Asw ts d/V			296 mm		
Provide Bars Of Dia And Spacing		16 mm	100 mm	**Adopt spacing as 100 mm**	

HOWEVER
Provide 16 mm tor 2 legged vertical stirrups @ 100 mm centre to centre along the pier cap
Provide 16 mm tor 2 legged horizontal stirrups @ 100 mm centre to centre along the pier cap

SHEAR CHECK ACROSS BRIDGE DIRECTION

V =		20.3 T	
Shear Force			203.00 kN
V=V' + M/d tanB	(B=0) Hence V =V'		

Actual Shear Stress		0.18	**N/mm^2**
Percentage Steel	100As/bd	0.25	
Tc		0.23	**N/mm^2**
k=1			
Permissble Shear Stress = k Tc		0.23	**N/mm^2**
		> Actual Shear Stress hence No Shear Reinforcement is required.	

HOWEVER
Provide 16 mm tor 2 legged vertical stirrups @ 100 mm centre to centre along the pier cap
Provide 16 mm tor 2 legged horizontal stirrups @ 100 mm centre to centre along the pier cap

CALCULATION OF LIVE LOAD REACTION FOR PIER SUBSTRUCTURE
FOR SIMPLY SUPPORTED SPANS OF A TWO LANE BRIDGE STRUCTURE

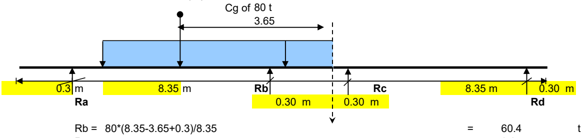
Centre line of pier w.r.t. the bearings :-

Rb = **0.3** m
Rc = **0.3** m

Reaction has been calculated for the following cases
1. One lane of class 70-R(W)
2. One lane of class - A
3. Two lane of class - A
4. Three lane of class - A
5. One lane of class 70-R(W) + One lane of class - A

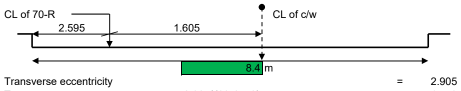
Condition A: **MAXIMUM LONGITUDINAL MOMENT CASE**

Case 1: **One lane of class 70-R(W)**



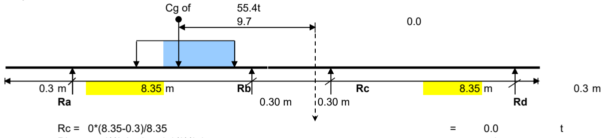
Rb = 80*(8.35-3.65+0.3)/8.35		=	60.4	t
Rc =		=	0.0	t
Ra=		=	19.6	t
Vert.Reaction=	60.4 + 0	=	60.4	t
Braking Force, B =	0.2*80	=	16.0	t
Dead load reaction on the pier , Rg		=	485.0	t
Value of " μ " =		=	0.00	
Horizontal force due to temperature, T μ*(Rg+Ra)		=	0.0	t
Design horizontal force is higher of either (B/2+T) or (B-T)		=	16.0	t

(neglecting shear rating of elastomeric bearing in the adjacent span, which is on the conservative side)



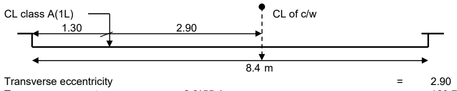
Transverse eccentricity		=	2.905	m
Transverse moment =	2.905*(60.4 + 0)	=	175.3	t.m
Long. moment =	60.4*0.3-0*0.3	=	18.1	t.m
Long. Eccentricity (for input)		=	0.300	m

B) **One lane of class-A**



Rc = 0*(8.35-0.3)/8.35		=	0.0	t
Rb = 55.4*(8.35-9.7+0.3/2)/8.35		=	7.0	t
Ra=		=	48.4	t
Vert.Reaction =	48.4 + 7	=	55.4	t
Braking Force, B =	0.2*(0+55.4)	=	11.1	t
Dead load reaction on the pier , Rg		=	485.0	t
Value of " μ " =		=	0.00	
Horizontal force due to temperature, T μ*(Rg+Ra)		=	0.0	t
Design horizontal force is higher of either (B/2+T) or (B-T)		=	11.1	t

(neglecting shear rating of elastomeric bearing in the adjacent span, which is on the conservative side)



Transverse eccentricity		=	2.90	m
Transverse moment =	2.9*55.4	=	160.7	t.m
Long. moment =	7*0.3-0*0.3	=	2.1	t.m
Long. Eccentricity (for input)		=	0.038	m

Case 3 : **Two lane of class-A**

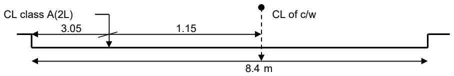
Rc = 2*0		=	0.0	t
Rb = 2*7		=	13.9	t
Ra=		=	96.9	t
Vert.Reaction =	0 + 13.9	=	13.9	t
Braking Force(For single lane only)		=	11.1	t
Dead load reaction on the pier , Rg		=	485.0	t
Value of " μ " =		=	0.00	
Horizontal force due to temperature, T μ*(Rg+Ra)		=	0.0	t

span	load	cg
4.42	51	1.93
5.79	68	2.895
7.92	80	3.65
9.44	92	4.4
13.4	100	5.12

8.78

SPAN	LOAD	CG
5.5	29.6	1.73
8.5	36.4	2.99
11.5	43.2	4.33
14.5	50	5.71
24	50	5.71
8.78		

Design horizontal force is higher of either (B/2+T) or (B-T) = 11.1 t
(neglecting shear rating of elastomeric bearing in the adjacent span, which is on the conservative side)

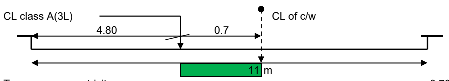


Transverse eccentricity		=	1.15	m
Transverse moment =	1.15*13.9	=	16.0	t.m
Long. moment =	13.9*0.3-0*0.3	=	4.2	t.m
Long. Eccentricity (for input)		=	0.300	m

Case 4 : **Three lane of class-A**

Rc =	90% of 3*0	=	0.0	t
Rb =	90% of 3*7	=	18.8	t
Ra=		=	61.1	t
Vert.Reaction =	0 + 18.8		18.8	
Braking Force, B =	(0.2)*55.4+0.05*55.4	=	13.9	t
(5% extra taken for third lane)				
Dead load reaction on the pier , Rg		=	485.0	t
Value of "μ" =		=	0.00	
Horizontal force due to temperature, T	μ*(Rg+Ra)	=	0.0	t
Design horizontal force is higher of either (B/2+T) or (B-T)		=	13.9	t

(neglecting shear rating of elastomeric bearing in the adjacent span, which is on the conservative side)

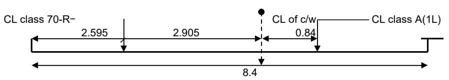


Transverse eccentricity		=	0.70	m
Transverse moment =	0.7*18.8	=	13.2	t.m
Long. moment =	18.8*0.3-0*0.3	=	5.6	t.m
Long. Eccentricity (for input)		=	0.300	m

Case 5 : **One lane of class-70R(W)+One lane of class-A**

Rc =	90% of(0+0)	=	0.0	t
Rb =	90% of(6.97+60.36)	=	60.6	t
Ra=		=	61.3	t
Braking Force =	16 + 5% of 55.4	=	18.8	t
(5% extra taken for class A)				
Dead load reaction on the pier , Rg		=	485.0	t
Value of "μ" =		=	0.00	
Horizontal force due to temperature, T	μ*(Rg+Ra)	=	0.0	t
Design horizontal force is higher of either (B/2+T) or (B-T)		=	18.8	t

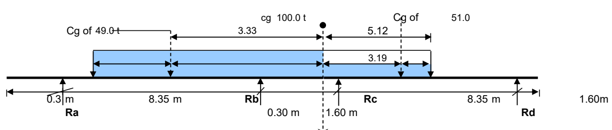
(neglecting shear rating of elastomeric bearing in the adjacent span, which is on the conservative side)



Transverse ecc.(class 70 R)		=	2.905	m
Transverse ecc.(class A)		=	-0.84	m
Trans. moment =	0.9*(60.4*2.905-55.4*-0.84)	=	115.9	
Net transverse ecc. (for input)		=	1.913	t.m
Long. moment =	60.6*0.3-0*0.3	=	18.2	t.m
Long. Eccentricity (for input)		=	0.300	m

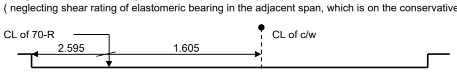
Condition B: **MAXIMUM TRANSVERSE MOMENT / REACTION CASE**

CASE 1: **ONE LANE OF CLASS 70-R(W)**



Rb =	49*(8.35 - 3.33 + 0.3)/8.35	=	31.22	t
Rc =	51*(8.35-3.19+1.6)/8.35	=	21.74	t
Ra=		=	27.3	t
Vert. Reaction =	31.2 + 21.7	=	53.0	t
Braking Force, B =	0.2*100	=	20.0	t
Dead load reaction on the pier , Rg		=	485.0	t
Value of "μ" =		=	0.00	
Horizontal force due to temperature, T	μ*(Rg+Ra)	=	0.0	t
Design horizontal force is higher of either (B/2+T) or (B-T)		=	20.0	t

(neglecting shear rating of elastomeric bearing in the adjacent span, which is on the conservative side)



first span

SPAN	LOAD	CG
8.28	49	3.33
5.04	58	2.18
8.95		

second span

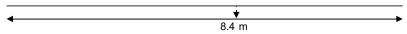
SPAN	LOAD	CG
3	80	3.65
4.52	92	4.4
8.48	100	5.12
24	100	5.12
8.95		

second span

4.4	34	3.715
5.12	51	3.19
11.55		

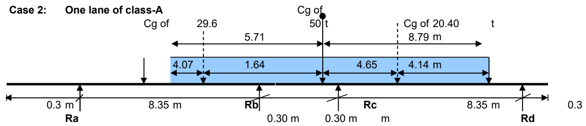
first span

3	17	0.87
4.52	29	1.75
8.48	41	2.56
24	49	3.53
8.95		



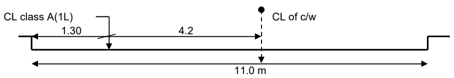
Transverse eccentricity		= 2.905	m
Transverse moment =	2.905*(31.2 + 21.7)	= 154.0	t.m
Long. moment =	31.22*0.3-21.74*0.3	= 2.8	t.m
Long. Eccentricity (for input)		= 0.054	m

Case 2: One lane of class-A



Rc = 20.4*(8.35-4.65+0.3)/8.35		= 9.77	t
Rb = 50*(8.35-1.64+0.3)/8.35		= 24.85	t
Ra=		= 4.8	t
Vert.Reaction =	9.77 + 24.85	= 34.62	t
Braking Force, B =	0.2*(50)	= 10.0	t
Dead load reaction on the pier , Rg		= 485.0	t
Value of "μ" =		= 0.00	
Horizontal force due to temperature, T μ*(Rg+Ra)		= 0.0	t
Design horizontal force is higher of either (B/2+T) or (B-T)		= 10.0	t

(neglecting shear rating of elastomeric bearing in the adjacent span, which is on the conservative side)

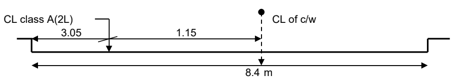


Transverse eccentricity		= 4.20	m
Transverse moment =	4.2*34.6	= 145.4	t.m
Long. moment =	24.8*0.3-9.8*0.3	= 4.5	t.m
Long. Eccentricity (for input)		= 0.131	m

Case 3 : Two lane of class-A

Rc = 2*9.8		= 19.5	t
Rb = 2*24.8		= 49.7	t
Ra=		= 9.5	t
Vert.Reaction =	19.5 + 49.7	= 69.2	t
Braking Force(For single lane only)		= 11.1	t
Dead load reaction on the pier , Rg		= 485.0	t
Value of "μ" =		= 0.00	
Horizontal force due to temperature, T μ*(Rg+Ra)		= 0.0	t
Design horizontal force is higher of either (B/2+T) or (B-T)		= 11.1	t

(neglecting shear rating of elastomeric bearing in the adjacent span, which is on the conservative side)

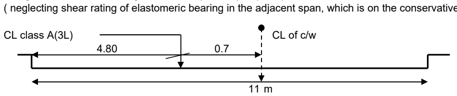


Transverse eccentricity		= 1.15	m
Transverse moment =	1.15*69.2	= 79.6	t.m
Long. moment =	49.7*0.3-19.5*0.3	= 9.0	t.m
Long. Eccentricity (for input)		= 0.131	m

Case 4 : Three lane of class-A

Rc = 90% of 3*9.8		= 26.4	t
Rb = 90% of 3*24.8		= 67.1	t
Ra=		= 12.8	t
Vert.Reaction =	26.4 + 67.1	93.5	
Braking Force, B =	(0.2)*55.4+0.05*55.4	= 13.9	t
(5% extra taken for third lane)			
Dead load reaction on the pier end , Rg		= 485.0	t
Value of "μ" =		= 0.00	
Horizontal force due to temperature, T μ*(Rg+Ra)		= 0.0	t
Design horizontal force is higher of either (B/2+T) or (B-T)		= 13.9	t

(neglecting shear rating of elastomeric bearing in the adjacent span, which is on the conservative side)



Transverse eccentricity		= 0.70	m
Transverse moment =	0.7*93.5	= 65.4	t.m
Long. moment =	67.1*0.3-26.4*0.3	= 12.2	t.m
Long. Eccentricity (for input)		= 0.131	m

Case 5 : One lane of class-70R(W)+One lane of class-A

Rc = 90% of(9.77+21.74)		= 28.4	t
Rb = 90% of(24.85+31.22)		= 50.5	t
Ra=		= 29.5	t

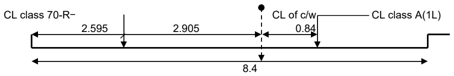
two span length	load	cg6.8 end	cg2.7 end
9	27.2	4.5	4.5
13.3	38.6	7.1	6.2
14.5	50	8.79	5.71
18.7	52.7	9.24	9.46
18.8	55.4	9.71	9.09
17.6	55.4	9.71	9.09

load	Span2load	cg 6.8	load	Span2 load	cg 6.8
27.2	13.6	1.5	55.4	27.2	4.5
38.6	20.4	4.14	52.7	27.2	4.5
50	20.4	4.14	50	20.4	4.14
52.7	27.2	4.5	38.6	20.4	4.14
55.4	27.2	4.5	27.2	13.6	1.5
			span2	8.78	

load 1	Cg 2.7 end	load 1	Cg 2.7 end
13.6	1.5	28.2	4.07
18.2	1.81	25.5	3.4
25.5	3.4	29.6	1.73
28.2	4.07	18.2	1.81

Braking Force =	16 + 5% of 55.4	=	18.8	t
(5% extra taken for class A)				
Dead load reaction on the pier , Rg		=	485.0	t
Value of " μ " =		=	0.00	
Horizontal force due to temperature, T	μ*(Rg+Ra)	=	0.0	t
Design horizontal force is higher of either (B/2+T) or (B-T)		=	18.8	t

(neglecting shear rating of elastomeric bearing in the adjacent span, which is on the conservative side)



Transverse ecc.(class 70 R)		=	2.905	m
Transverse ecc.(class A)		=	-0.84	m
Trans. moment =	0.9*(60.4*2.9-0*-0.8)	=	112.4	
Net transverse ecc. (for input)		=	1.426	t.m
Long. moment =	50.5*0.3-28.4*0.3	=	6.6	t.m
Long. Eccentricity (for input)		=	0.084	m

Summary of Loads

Max. Longitudinal Moment			Design horizontal force (t)	Transverse ecc. (m)	Longitudinal ecc. (m)
Max. vertical reaction (t)	Transverse moment (t.m)	Longitudinal moment (t.m)			
60.4	175.3	18.1	16.0	2.905	0.300
55.4	160.7	2.1	11.1	2.900	0.038
13.9	16.0	4.2	11.1	0.700	0.300
18.8	13.2	5.6	13.9	0.700	0.300
60.6	115.9	18.2	18.8	1.913	0.300

	Max.Transverse Moment			Design horizontal force (t)	Transverse ecc. (m)	Longitudinal ecc. (m)
Load case	Max. vertical reaction (t)	Transverse moment (t.m)	Longitudinal moment (t.m)			
1L class 70 - R	53.0	154.0	2.8	20.0	2.905	0.054
1L class - A	34.6	145.4	4.5	10.0	4.200	0.131
2L class - A	69.2	79.6	9.0	11.1	9.046	0.131
3L class - A	93.5	65.4	12.2	13.9	0.700	0.131
1L class 70 - R + 1L class - A	78.8	112.4	6.6	18.8	1.426	0.084

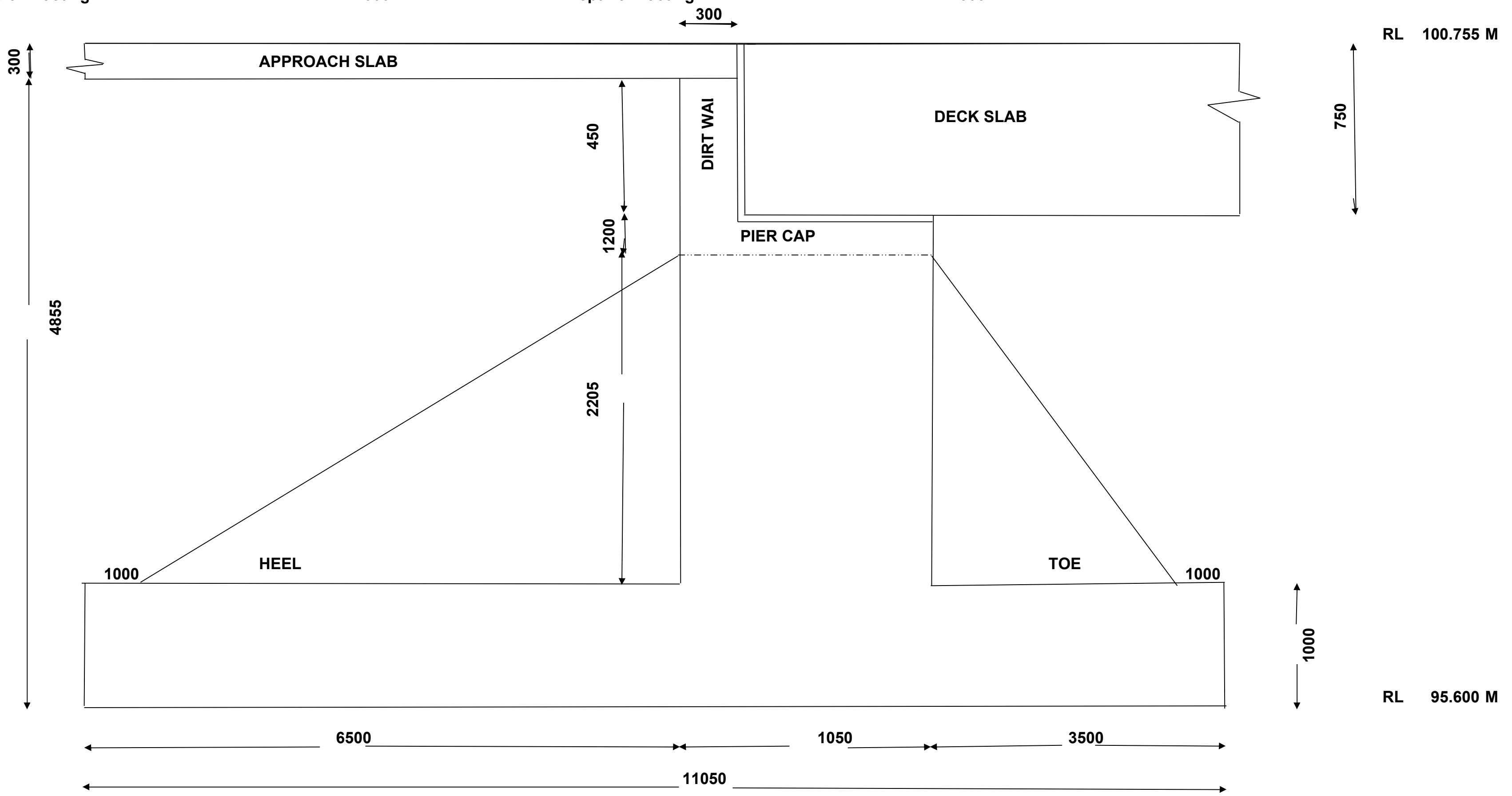
Vertical reaction due to braking has been neglected.

Maximum Reaction due Live Load including Impact	78.83	MT	=	788.27	KN
Maximum Longitudinal moment due to Live Load including Impact and Breaking Force	12.21	T-M	=	122.13	KNM
Maximum Transverse moment due to Live Load including Impact and Breaking Force	112.4	T-M	=	1123.94	KNM

Component	Chainage	NSL
Central Pier at Chainage	40	82.57
A1	-3.2	98.6
P1	7.6	
P2	18.4	
P3	29.2	
P4	40	82.57
P5	50.8	
P6	61.6	
P7	72.4	
A2	83.2	101

Name Of Work :- Construction Of High Level Bridge on Kelwara Kumbhalgarh Road Over Kelwara Lake

Deck Level	100.755 M	Length of Heel projection	6500 mm
Foundation Level	95.600 M	Length of Toe projection	3500 mm
Thickness of Deck Slab	750 mm	Width of Stem	1050 mm
Thickness of Approach Slab	300 mm	Thickness of Abutment Cap	1200 mm
Height below Approach Slab	4855 mm	Thickness of Dirt Wall	300 mm
Offsets on Footing	1000 mm	Depth of Footing	1000 mm



TYPICAL SECTION OF THE ABUTMENT TYPABUT-01

Design of ABUTMENT

Name Of Work :- Construction Of High Level Bridge on Kelwara Kumbhalgarh Road Over Kelwara Lake

(a) Data	Preliminary dimensions	: Assumed as in Fig. **TYPABUT-01**		
	Superstructure	: RCC Slab Bridge	Total Width of Slab =	12.00 M
		overall length = 10.80 m		
	Type of abutment	: Reinforced concrete		
	Loading	: As for National Highway		
	Back fill	: Gravel with angle of repose	Φ =	35 °
		Unit weight of back fill, w =	18 kN/m3	
		Angle of internal friction of soil on wall, z =		17.5 °
	Approach slab	: R.C. slab 300 mm thick, adequately reinforced		

Load from superstructure per running foot of abutment wall:

Dead load	=	802.01	kN/m
Live load	=	93.84	kN/m

(Refer Stability Analysis for sub structure. The above two values are obtained from the calculations for superstructure, and are taken to act over a width of 15 m).

Bearing : Tar Paper Bearings

(C) Self weight of abutment

Treating the section as composed of 6 elements as shown in Fig. 1the weight of each element and moment about the point O on the front toe are computed as in Table 1

(d) Longitudinal forces

(i) Force due to braking

Force due to 70 R wheeled vehicle =	0.2 x	1000 =	200 kN

This force acts at 1.2 m above the road level(Clause 214.3).

Force on one abutment wall =	200 /	2 =	100 kN
Horizontal force per m of wall =	100 /	12.00 =	8.34 kN/ m

(ii) Force due to temperature variation and shrinkage

Assuming moderate climate, variation in temperature is taken as + 17 oC as per Clause 218.5 of Bridge Code.

Coefficient of Thermal expansion =	1.17E-05 /°C		
Strain due to temperature variation =	17 x	1.17E-05 =	1.99E-04
From Clause 220.3, strain due to concrete shrinkage =	2.00E-04		
Total strain due to temperature and shrinkage =	1.99E-04 +	2.00E-04 =	3.99E-04

Horizontal deformation of deck due to temperature and shrinkage affecting one abutment = 3.99E-04 x 10800 /2 = 2.15E+00 mm

Modulus of Elasticity Ec = 5000x $fck^{1/2}$ = 31220.19 N/mm2

Horizontal Stress due to strain in longitudinal direction at bearing level = 3.99E-04 x 31220.19 = 12.45 N/mm2

Horizontal Force due to strain in longitudinal direction at bearing level (For 1 m width of Slab) = 1.25E+01 x 900 = 11208.36 N/m

= 11.21 kN/m

(iii) Vertical reaction due to braking

$$\text{Vertical reaction at one abutment} = \frac{200(1.2 + 0.975)}{11.10\text{x}15} = 2.61 \text{ kN/m}$$

(d)Earth pressure

Active earth pressure P = 0.5 $wh^2 K_a$

where K_a is obtained from Equation (3.5)

$K_a = \sec\Theta \sin(\Theta-\Phi)/[(\sin(\Theta+z))^{1/2} + \{\sin(\Phi+z)\sin(\Phi-\delta)/\sin(\Theta-\delta)\}^{1/2]}$

Where P= Total active pressure, acting at a height of 0.42 h inclined at z to the normal to the wall on the earth side

w = unit weight of earth fill

h = height of wall

Θ = Angle subtended by the earthside wall with thw horizontal on the earth side

Φ = Angle of internal friction of the earthfill

z = angle of friction of the earthside wall with the earth

δ = Inclination of earthfill surface with the horizontal

Θ = 90^0 Φ = 35^0

z = 17.5^0 δ = 0^0

Substituting values in Equation (3.5), we get K_a = 0.496 Coefficient

Height of backfill below approach slab = 4.86 m

Active earth pressure = 0.5 x 18 x 4.86^2 x 0.496

= 105.23 kN/m

Height above base of centre of pressure = 0.42 x 4.86 = 2.04 m

Passive pressure in front of toe slab is neglected.

(e) Live load surcharge and approach slab

Equivalent height of earth for live load surcharge as per clause 714.4 is 1.20 m

Horizontal force due to L.L. surcharge =1.2 x 18 x 0.496 x 9.20 =		52.02	kN/m
Horizontal force due to approach slab = 0.3 x 24 x 0.496 x 9.20 =		17.34	kN/m
	Total	**69.36**	**kN/m**

The above two forces act at **2.4275 m above the base.**

Vertical load due to L.L. surcharge and approach slab

= (1.2 x 18 + 0.3 x 24) x 6.5 = 187.2 kN/m

(f) Weight of earth on heel slab

Vertical load = 18 x6.5x (4.855 - 1) = 34.7 kN/m

(g) Check for stability - overturning

The forces and their position are as shown in Fig. 1

The forces and moments about the point O at toe on the base are tabulated as in

Table 1 Two cases of lading condition are examined (i) Span loaded condition and (ii) Span unloaded condition.

Case (i) Span loaded condition

See Row 15 of Table 12.3

Overturning moment about toe =	469.25 kN-m		
Restoring moment about toe =	9783.99 kN-m		
Factor of safety against overturning =	9783.99 /	469.25 =	**20.85**
Location of Resultant from O			**> 1.5 Hence Safe**

$X_0 = (M_V - M_H) / V = (1740.9 - 623.1) / 691.4 = 1.62$ m

=(9783.986 - 469.25) / 1904.726) = 4.89 m

Eccentricity of resultant

$e_{max} = B/6 =$	11.05 /6 =	1.84 m	
$e = (B/2 - X_{0)} = 0.78$ m < 0.80 m	5.53 -	4.89 =	0.64 m
		<	1.84 m

Case (ii) Span unloaded condition

See Row 11 of Table 12.3

Overturning moment about toe =	432.47 kN-m		
Restoring moment about toe =	9410.21 kN-m		
Factor of safety against overturning =	9410.21 /	432.47 =	**21.76**
Location of Resultant from O			**> 1.5 Hence Safe**

$X_0 = (M_V - M_H) / V=$

=(9410.214 - 432.47) / 1808.272) = 4.96 m

(h)Check for stresses at base

For Span loaded condition

Total downward forces = 1904.73 kN

1904.73 6 x 0.78

Extreme stresses at base =

Maximum Stress = 1904.726/(11.05x1)(1 +(6x0.64/11.05)) = 232.28 kN/m2

Minimum Stress = 1904.726/(11.05x1)(1 -(6x0.64/11.05)) = 112.48 kN/m2

Table 1 Forces and Moments About Base for Abutment.

Sl. No.	Details	Force, kN		Moment about O, kn-m		
		V	H	Arm m	Mv	M_H
1.	D.L. from superstructure	802.01	-	3.88	3111.810	-
2.	Horizontal force due to temperatre and shrinkage	0	11.21	4.41	-	49.429
3.	Active earth pressure	0	105.23	2.04	-	214.669
4.	Horizontal force due to L.L surcharge and approach slab	0	69.36	2.4275	-	168.371
5.	Vertical load due to L.L. surcharge and approach slab	187.20	-	7.8	1460.16	-
6.	Self weight - part 1 11.05x1x 24 =	265.20	-	5.525	1465.23	-
7.	Self weight - part 2 2.205x1.05x 24 =	55.57	-	4.03	223.9471	-
8.	Self weight - part 3 1.2x1.05x 24 =	30.24	-	1.68	50.8032	-
9.	Self weight - part 4 0.3x0.45x 24 =	3.24	-	2.05	6.642	-
9.	Self weight - part 5 Triangular River Side 1/2x3x2.655x24=	95.58	-	2.50	238.95	-
9.	Self weight - part 5 Triangular Earth Fill Side 1/2x6x2.855x24=	191.16	-	6.55	1252.098	-
10.	Weight of earth on heel slab part 1 Rectangular Portion 0.5 x 3.855 x 18=	34.7	-	10.8	374.76	-
10.	Weight of earth on heel slab part 2 Triangular Portion 1/2x6x3.855x18=	143.37	-	8.55	1225.814	-
11.	**Items 1 to 10**	**1808.27**			**9410.21**	**432.47**

	(Span unloaded condition)					
12.	L.L. from Superstructure Class 70 R wheeled vehicle	93.84	-	3.875	363.6348	-
13.	Vertical force due to braking	2.61	-	3.88	10.137	-
14.	Horizontal force due to braking	0.00	8.34	4.41		36.7794
15.	**Items 11 to 14** **(Span loaded condition)**	**1904.73**	**194.14**	**-**	**9783.99**	**469.25**

NET LONGITUDINAL MOMENT 9783.99 - 469.25 = 9314.74

Maximum pressure = 232.28 kN/m2 < 250.00 kN/m2 permissible HENCE OK.

Minimum pressure = 112.48 kN/m2 >0 (No tension) HENCE OK.

(i) Check for sliding

See Row 15 of Table 1

Sliding force = 194.14 kN

Force resisting sliding = 0.6 x 1904.73 = 1142.84 kN

Factor of Safety against sliding = 1142.84 / 194.14 = **5.89**

(j) Summary

> 1.5 Hence Safe

The assumed section of the abutment is adequate.

DESIGN OF ABUTMENT FOOTING

Name Of Work :- Construction Of High Level Bridge on Kelwara Kumbhalgarh Road Over Kelwara Lake

REDISTRIBUTION OF PRESSURE

FOR WIND AT SERVICE CONDITION

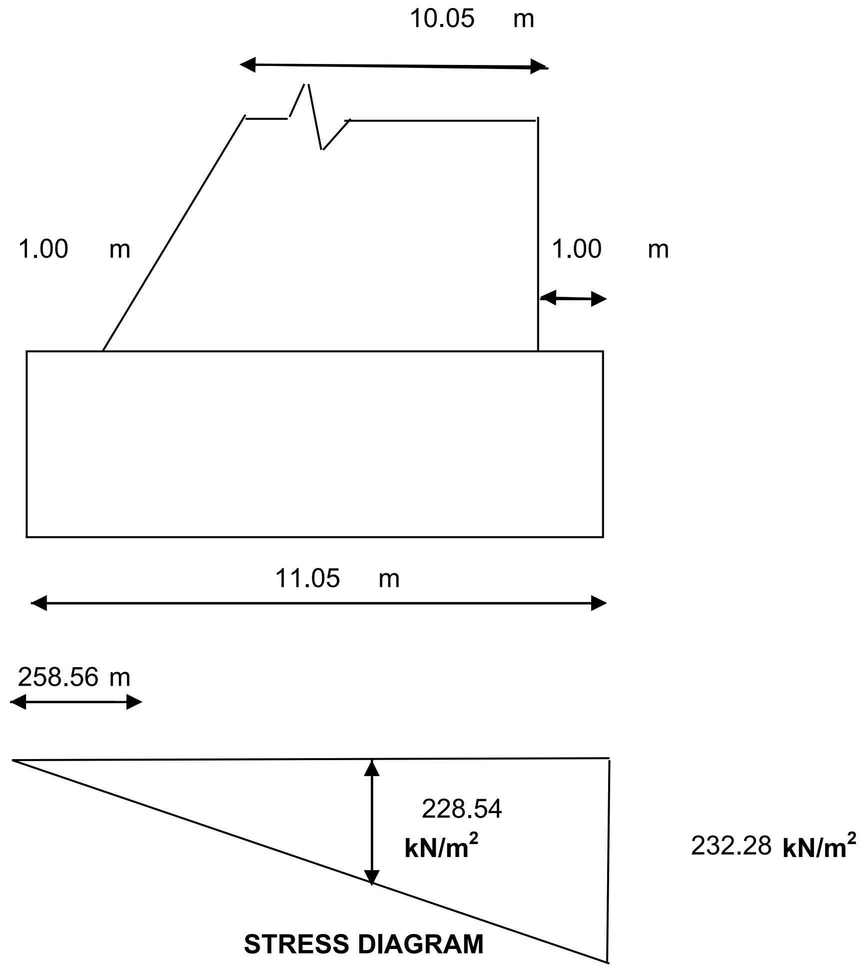
Length of footing	l_f	15.20	m
Width of Footing	l_b	11.05	m
Width of Abutment just above footing		9.05	m
Vertical Load	P	1904.73	kN
Longitudinal Moment	M_e	9314.74	kN-m
Transverse Moment	M_b	0.00	kN-m

Area in Tension = y x l_b	0.00	**m^2**	0.00 %
Maximum Pressure before Redistribution	232.28	**kN/m^2**	
Maximum Pressure After Redistribution = pxK	232.28	**kN/m^2**	
Maximum Stress at Edge of Pier	232.28	**kN/m^2**	
Distance From Face of Pier to the Edge	1.00	m	
Stress at the Edge of Pier	211.26	**kN/m^2**	
Average Stress on Cantilevered Area	221.77	**kN/m^2**	
Area of the Cantilever Portion	1.00	**m^2**	
Distance of Centroid of the Stress in Cantilever Portion	0.51	m	
Moment about the Face of Pier	**112.64**	**kN-m**	
CONCRETE GRADE	**M-25**		
FOR THIS GRADE σcbc	**10**	N/mm2	
m	**9.33**		
σst	**200**		
factor k	0.318		
j	0.894		
R	1.422		
Effective Depth Required	281	mm	
Adopt Total Depth	1000	mm	
Cover	50	mm	
Assume Bar Dia	16	mm	
Keeping A Cover Of 50 mm Effective Depth	942	mm	
Adopt Effective Depth	942	mm	
Steel Required Ast	669	mm^2	
Area Of One Bar	201	mm^2	

Spacing S			300 mm	
Provide Bars Of Dia And Spacing		16 mm	**150** mm	**Adopt spacing as 150 mm**
Area Of Distribution Steel			1884 mm^2	
Dia Of Bar For Distribution Steel			20 mm	
Area Of One Bar In Distribution Reinforcement			314 mm^2	
Using The Bars Spacing Required			167 mm	
Provide Bars Of Dia And Spacing		16 mm	160 mm	**Adopt spacing as 150 mm**
Provide Bars Of Dia And Spacing for Top Main Steel		12 mm	150 mm	
Provide Bars Of Dia And Spacing for Top Distribution Steel		12 mm	150 mm	

CHECK FOR SHEAR (As per IRC 21-1987 Cl. 304.7)

Critical Section is at a distance equal to effective depth from pier face		942 mm	
Section of Shear from end of pier		0.06 m	
Maximum Stress at Edge of Pier		232.28 **kN/m^2**	
Stress at the Section for Shear Check		228.54 **kN/m^2**	
Average Stress on Cantilevered Area		230.41 **kN/m^2**	
Shear Force		13.36 kN	
V=V' + M/d tanB	(B=0) Hence V =V'		
Actual Shear Stress		0.01 **N/mm^2**	
Percentage Steel	100As/bd	0.14	
Tc		0.23 **N/mm^2**	
k=1			
Permissble Shear Stress = k Tc		0.23 **N/mm^2**	
		< Actual Shear Stress hence Shear Reinforcement should be provided	
Dia Of two Legged Stirrups		16 mm	
Area Of One Bar In Distribution Reinforcement		201 mm^2	
Using The Bars Spacing Required s= Asw ts d/V		5666 mm	
Provide Bars Of Dia And Spacing	16 mm	150 mm	**Adopt spacing as 150 mm**



DESIGN OF ABUTMENT FOOTING

REINFORCEMENT CALCULATION IN ABUTMENT SUBMERSIBLE BRIDGE

Name Of Work :- Construction Of High Level Bridge on Kelwara Kumbhalgarh Road Over Kelwara Lake

Minimum Shrinkage and Temperature reinforcement required as per Clause 305.10 IRC 21-2000
in any RC structure is 250 Sq mm per m in each direction. Allowable maximum spacing is 300 mm.

Shrinkage and Temperature reinforcement required per metre =			250 mm^2			
Area Of One Bar	12 mm dia		113 mm^2			
Spacing S			452 mm			
Provide Bars Of Dia And Spacing	12 mm		**125** mm			
Provide Bars Of Dia And Spacing	12 mm		125 mm			
HORIZONTAL SHRINKAGE &TEMPERATURE REINFORCEMENT	**12**	**MM BARS**	**125**	**MM**	**In Vertical direction on all FOUR faces**	
VERTICAL SHRINKAGE &TEMPERATURE REINFORCEMENT	**12**	**MM BARS**	**125**	**MM**	**In Lateral direction on all FOUR faces**	

DESIGN OF Abutment CAP SUBMERSIBLE BRIDGE

Name Of Work :- Construction Of High Level Bridge on Kelwara Kumbhalgarh Road Over Kelwara Lake

DESIGN OF Abutment CAP :-

D.L./ M Width along bridge				
DL. Of Slab =	0.975 x	15 x.	2.4 =	35.10 T
D.L. of Wearing coat =	0.075 x	12 x.	2.4 =	2.16 T
			TOTAL	**37.26 T**
D.L. of Slab & Wearing coat on half of the Abutment	=			
		37.26 /	2 =	18.63 T
L.L. on Abutment cap including impact along bridge				
	=	82.50 x	1.1375 =	93.84 T
(Refer Live Load Computation)				
Dispersion width across the span for				
70 T TRACKED VEHTCLE	=	6.695 M		
(Refer Solid slab design page SS-16)				
Live Load u.d.l. on Abutment	=	93.84 /	6.695 =	14.02 T
Per M width				
Total Load on Half =	18.63 +	14.02	=	32.65 T
of Abutment along bridge				Per M width
Effective depth of slab =90-2.5-2.5/2 =	86.25 cm			
Placement of the live load at effective depth from the support (taking support width 750 mm)				
Eccentricity = 71.25 -75/2	=	33.75 cm	=	0.34 M
Bending Moment along the bridge =				
	32.65 x	0.34		11.02 T - M/M width
=				
	11.02 x	10.00 =	**110.2 kN-M/M width**	
This moment is too small hence it will not/be the governing B.M.				

Moment in Abutment cap		**110.20 kN-m**	
CONCRETE GRADE		**M30**	
FOR THIS GRADE σcbc		**10** N/mm2	
m		**9.33**	
σst		**200**	
factor k		0.318	
j		0.894	
R		1.422	
Effective Depth Required		278 mm	
Adopt Total Depth		1200 mm	
Cover		50 mm	
Assume Bar Dia		25 mm	
Keeping A Cover Of 50 mm Effective Depth		1138 mm	
Adopt Effective Depth		1137.5 mm	
Steel Required Ast		542 mm^2	
Area Of One Bar		491 mm^2	
Spacing S		905 mm	
Provide Bars Of Dia And Spacing	25 mm	**100** mm	**Adopt spacing as 100 mm**
Provide Bars Of Dia And Spacing for Top Main Steel	25 mm	100 mm	
Provide Bars Of Dia And Spacing for Bottom Steel	16 mm	100 mm	

Abutment SECTION ACROSS BRIDGE

DEAD LOAD MOMENT PER METRE Width across bridge :-				
Slab D.L.	0.975 x	15 x.	2.4 =	35.10 T
D.L. of Wearing coat =	0.075 x	12 x.	2.4 =	2.16 T
			TOTAL	**37.26 T**

D.L. of Slab & Wearing coat on half of the Abutment = 37.26 / 2 = 18.63 T/ M width

L.L on Abutment = 64.69 T

Dispersion width along the span for
70 T Tracked vehical = 5.3 M

L.L. . per M width on Abutment = 64.69 / 5.3 = 12.21 T/ M width

Total D.L. + L.L. on half of Abutment across bridge per M width 18.63 + 12.21 = 30.84 T Per M width

The Live Load is with clearance from the Footpath and kerb. The cantilever portion of Abutment cap and width of footpath is 1500 mm
Hence There is no eccentricity.

Bending Moment across the bridge = 30.84 x 0 0.00 T - M/M width

Provide Minimum steel

Minimum Reinforcement calculation for Abutment cap :-

As per clause 710.8.2, IRC- 78 - 2000, the thickness of Abutment cap shall be at least 200 mm However the thickness of Abutment cap here is 1200 MM.

Grade of Concrete M 30

Minimum Shrinkage and Temperature reinforcement required as per Clause 305.10 IRC 21-2000 in any RC structure is 250 Sq mm per m in each direction. Allowable maximum spacing is 300 mm.

Shrinkage and Temperature reinforcement required = 250 x 1.2 = 300 mm^2

Provide 25 mm tor reiforcement @ 100 mm c/c (14 Nos.) in top along the Abutment cap

Provide 16 mm tor reiforcement @ 100 mm c/c (14 Nos.) in bottom along the Abutment cap

Area of Steel Provided at top
= (14x 491) = 6874 mm^2 > 300 mm^2 OK

Area of Steel Provided at bottom
= (14x 201) = 2814 mm^2 > 300 mm^2 OK

CHECK FOR SHEAR ALONG BRIDGE DIRECTION

V =		30.84 T
Shear Force		308.40 kN
V=V' + M/d tanB	(B=0) Hence V =V'	
Actual Shear Stress		0.27 **N/mm^2**
Percentage Steel	100As/bd	0.25
Tc		0.23 **N/mm^2**
k=1		
Permissble Shear Stress = k Tc		0.23 **N/mm^2**
		< Actual Shear Stress hence Shear Reinforcement should be provided
Dia Of two Legged Stirrups		16 mm
Area Of One Bar In Distribution Reinforcement		201 mm^2
Using The Bars Spacing Required s= Asw ts d/V		296 mm
Provide Bars Of Dia And Spacing	16 mm	100 mm **Adopt spacing as 100 mm**

HOWEVER

Provide 16 mm tor 2 legged vertical stirrups @ 100 mm centre to centre along the Abutment cap

Provide 16 mm tor 2 legged horizontal stirrups @ 100 mm centre to centre along the Abutment cap

SHEAR CHECK ACROSS BRIDGE DIRECTION

V = 20.3 T

Shear Force		203.00 kN
V=V' + M/d tanB	(B=0) Hence V =V'	
Actual Shear Stress		0.18 **N/mm^2**
Percentage Steel	100As/bd	0.25
Tc		0.23 **N/mm^2**
k=1		
Permissble Shear Stress = k Tc		0.23 **N/mm^2**
		> Actual Shear Stress hence No Shear Reinforcement is required.

HOWEVER

Provide 16 mm tor 2 legged vertical stirrups @ 100 mm centre to centre along the Abutment cap

Provide 16 mm tor 2 legged horizontal stirrups @ 100 mm centre to centre along the Abutment cap

DESIGN OF DIRT WALL AS COLUMN WITH BENDING

AXIAL LOAD ON THE DIRT WALL	**31.60**	KN		
ASSUME WIDTH OF DIRT WALL	1000	MM	EMIN/B	0.00
ASSUME DEPTH OF DIRT WALL	300	MM	EMIN/D	0.01
MOMENT TRANSFERRED TO DIRT WALL	12.80	KN-M		
FACTORED AXIAL LOAD	**47.40**	KN		
FACTORED MOMENT	19.20	KN-M		
DIA OF LONGITUDINAL REINFORCEMENT	**10**	MM		
CLEAR COVER	40	MM		
d'	45	MM		
d'/D	0.15			
ADOPT d'/D	0.15			
PU/FCKBD	0.01			
MU/FCKBD^2	0.01			
REINFORCEMENT EQUALLY DISTRIDUTED ON **TWO** SIDES				
USING CHART NO- OF RCC DESIGN AIDS	**33**		**CONC GRADE M-30**	
P/FCK	0.01			
P	0.3		> Minimum Steel 0.2% Hence OK	
AS	900	SQ MM		
TOTAL NUMBER OF BARS REQUIRED	12			
NUMBER OF BARS ON EACH SIDE	6			
SPACING	**200**	MM		

Alternate design Considering dirt wall as cantilever

B.M. = 12.80 KN-M

$$\text{deff reqd.} = \frac{12.80 \times 10^6}{1000 \times 0.972} = 118.7 \text{ mm}$$

$$\text{dpro} = 300 - 50 - \frac{16}{2} = 245 \text{ mm} > 118.7 \text{ mm (OK)}$$

$$\text{Ast} = \frac{12.80 \times 10^6}{200 \times 0.917 \times 245} = 284.87 \text{ mm}^2$$

This steel is to be provided on back i.e. approach slab side

Provide Vertical steel as follows

On River side 10mm bars @ 150 mm c/c = 524 mm^2

On Approach Slab side 10mm bars @ 150 Mm c/c = 524 mm^2

Minimum steel required in Horizontal direction

= 0.002 x 1000 x 250

= 500 mm^2

i.e. 250 mm^2 on each face

provide 10 @ 250 mm c/c = 314 mm^2

<u>ABSTRACT</u>

VERTICAL REINFORCEMENT IN SHAPE OF STIRRUPS on both faces

DIA	**10**	**mm**
SPACING	**150**	**mm**

HORIZONTAL REINFORCEMENT BAR DIA on both faces

DIA	**10**	**mm**
SPACING	**250**	**mm**

Design of Dirt Wall

Dirt wall is subjected to

(1) Live load

(2) Live load surcharge

(3) Braking force

(3) Earth Pressure

1) Consider 70 T tracked vehicle case is governing & 14 T Axle over dirt wall, Dispersion width at top of DIRT WALL

= 2.90 + (1.2 + 0.305) + 0.83

= 2.90 + 1.53 + 0.825

= 5.255 M

$$\frac{\text{Live Load}}{\text{M Length}} = \frac{14}{5.255} = 2.66 \text{ T/M}$$

2) Self wt. of dirt wall

= 0.6 x 0.3 x 2.4

= 0.495 T/M

Say 0.5 T/M

Total direct loads = 2.66 + 0.5 = 3.16 T/M = **31.6 kN**

Here considering that only 70% of Braking force will be on dirt wall & the rest of braking force will be on soil.

$$= \text{Braking force/mt.} = \frac{0.2 \times 14 \times 1}{5.255} = 0.53 \text{ T}$$

= B.M. due to Braking force

= 0.53 x (1.2 + [0.83])

= 1.07 T-M

Intensity of Earth Pressure at Deck Level

$= 0.224 \times 1.8 \times 1.2$

$= 0.483$ T/M^2

Intensity of Earth Pressure at top of Abutment Ca =

$= 0.224 \times 1.8 \times (1.2 + 0.825)$

$= 0.816$ T/M^2

B.M. due to Earth Pressure & Live Load Surcharge/M width

$$= \frac{1}{2} = (0.816 - 0.483) \times 0.825 \times 0.42 \times 0.875$$

$$+ \quad 0.483 \times 0.825 \times \frac{0.528}{2}$$

$= 0.048 + 0.164$

$= 0.21$ T-M

Total BM at top of DIRT WALL

$= 1.07 + 0.21$

$= 1.28$ T-M $=$ **12.8 kN-m**

Direct Stress $= \dfrac{3.16 \times 10^{3}}{30 \times 100}$

$= 1.05$ Kg./Cm^2

Bending Stress $= \dfrac{1.28 \times 10^{3}}{\frac{1}{6} \times 100 \times 30^{2}}$

$= 0.09$ Kg./Cm^2

For M 30 Grade,

Permissible Bending Stress = 67 $Kg./Cm^2$

Permissible Direct Compressive Stress = 50 $Kg./Cm^2$

$$= \frac{1.05}{50} + \frac{0.09}{67} \leq 1$$

$$= 0.021 + 0.001 \leq 1$$

$$= 0.022 \leq 1$$ **HENCE OK.**

DEAD LOAD CALCULATION :-

DEPTH OF DECK SLAB =	925 mm			
DEPTH OF WEARING COAT =	75 mm			
DIA OF MAIN BAR =	25 mm			
Clear cover =	25 mm			
Effective depth of slab deffective =	925 -	25 -	25 /2 =	887.5 mm
Effective SpanLeffective =	10 m			

DESIGN DEAD LOAD :-

(1) Weight / Sqm of Slab	0.925 x	2.4 =	2.22 T/ Sqm
(2) Weight / Sqm of wearing coat	0.075 x	2.4 =	0.18 T/ Sqm
Total DL			**2.4** T/ Sqm
DEAD LOAD BENDING MOMENT		2.4x10x10/8 =	30.00 T-M

LIVE LOAD CALCULATION :-

[1] CLASS AA TRACKED VEHICLE :-

(a) Dispersion width along the span

= Length of Contact + 2 (Wearing coat + depth of Slab)

= 3.6+2(0.075+0.925)= = **5.60** m

(b) Dispersion width across the span

be = K x (1 - x/Le) + Bw

K = A Constant having the value depending upon the ratio (be/Le) where ---

be = the effective width of the slab on which the load acts.

Le = Effective Span

x = the distance of c.g. of concentrate load from the near support

bw = The breadth of concentration area of the load i.e. Dimension of the tyre or track contact area over the road surface

Here ,

be = 7.50 m

Le = 10.00 m

be/Le = 0.75

Value of K = 2.4

Bw = 0.85 + (2 x 0.075) = 1.00 m

x = Le/2 = 10.00 /2 = 5.00 m

be = 2.20 m

Impact factor is 13.75% as pere IRC Section-II, Clause - 211-3 (a) (i)

DISPERSION ACROSS SPAN (CLASS AA TRACKED VEHICAL)

The tracked vehicle is placed at a distance of minimum clearence of 1.2 m from Kerb

Dispersion across span = C/C distance between wheels + width from centre of wheel on clearence side + Least on other side or half the dispersion of one wheel.

= 2.05 + 1.93 + **Least of 3.825 Or 5.6/2** 5.75

= 2.05 + 1.93 + 2.8 = 6.78 M

Impact factor = 1.1375

Total load with impact = 70 x 1.1375

= 79.63 T

Intensity of Load = 79.63 /(2.20 x 6.78) =

= 5.34 T

DISPERSION ALONG SPAN (CLASS AA TRACKED VEHICLE

Maximum Bending Moment due to Live load , at centre

$$= 5.34 \times \frac{5.6}{2} \left(10.00 - \frac{5.6}{5}\right)$$

= **132.77** T - M

Class AA wheeled vehicle :-

For Maximum B.M. at Centre of the span, the Centre of gravity of the loads and the centre of the span should coincide

(a) Dispersion width along the span :-

tp = tc = 2 (tw + ts)

tp = width of dispersion parallel to span

tc = width of tyre contact area parallel to span

ts = Overall depth of slab

tw = Thickness of Wearing coat

Dispersion along the span

= 0.15 + 2 (0.075 + 0.75) = 1.8 m

Dispersion between two wheel is overlapping hence restricted to 1.2 M

= Dispersion combined for two wheels

= C/c distance between two wheels + Longitudinal dispersion

= 1.2 + 1.8

= 3.0 m (along the span)

DISPERSION ALONG SPAN (CLASS AA WHEELED VEHICLE)

(B) Dispersion width across the span :-

be = k x (1 - X/L) + w

Le = 10.0 M & L1 = 7.5 M

= Value of K = 2.4

4.8

X = L/2 = 10/2 = 5.00 M

Bw = 0.30 + 2 (0.075) = 0.45 M

be = 2.4 x 5 x (1 - 5.00/10.00) + 0.45 = 6.45 M (For one Wheel)

DISPERSION ACROSS THE SPAN (CLASS AA WHEELED HEVHICLE)

When the wheel is placed at a distnace of minimum clearance of 1-2 M from Kerb,

Combined effective width

= c/c distance between wheels
+ 1/2 of the dispersion of one wheel
+ least of available width from centre of wheel on clearance side or half the dispersion of one wheel

$$= 2.2 + \frac{6.45}{2} + \text{Lesser of } 1.655 \ \& \ \frac{6.45}{2}$$

= 2.2 + 3.225 + 1.655

= **7.08** m

According to clause 211.3 (a) (ii) section-III, IRC 6- 1966

Impact factor = 25% = 1.25

= Total load of tracks with impact

= 20 x 1.25

= 25 T

Intensity = $\dfrac{\text{Load}}{\text{dispersion along x across the span}}$

$= \dfrac{25 \times 2}{3.00 \times 7.08}$

= 2.35 T/M

DISPERSION ACROSS THE SPAN (CLASS AA WHEELED HEVHICLE)

Maximum B.M. due to Live load at centre

$= 2.35 \times \dfrac{7.08}{2} \left(10.00 - \dfrac{7.08}{5}\right)$

= **71.41** T - M

$= 2.35 \times \dfrac{3}{2} \left(5 - \dfrac{3}{2}\right)$

=

Here from bending moment view point class AA tracked vehical is governing

Hence Maximum Bending Moment due to Live load = 15.527 T - M **132.77** T - M

Total B.M = B.M due to Dead load + BM. Due to Live load

= **30.00** + 132.77

= 162.77 T-M