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CONSTRUCTION OF PIERS FOR ROAD OVER BRIDGE

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ABSTRACT
Piers are the main components of any type of bridge. They initially exhibits compressive stresses and laterally exhibits tensile stresses. Road over bridge at Shankarpally constructed on black cotton soil, various soil tests done by making optimum use of residual strength of its various components. The weak components have been strengthened and complete replacement of material has been done where required. This paper deals with the various aspects of planning and execution of the work. The ROB at Shankarpally is an important link between Shankarpally and chevella. The level crossings was constructed by Municipal Corporation and Railways some time in 1980 for passing local traffic. During the past20 years the traffic had grown considerably and the level crossings had become the main link to cross the Railway Track. Pier foundations are similar to pile foundations but typically larger in area than pile foundations. These pier foundations involves the adjectives like driven , bored or drilled and precast and cast in situ being used to indicate the method of installation and construction. Arrangement of shuttering for casting of RCC deck slabs was to be done with uninterrupted flow of rail traffic under the ROB. A bridge projects from its conception to completion involves various stages of planning, design, approval/sanction, tendering and execution. Also inspections, maintenance and repairs are continuing activities for enhancing the service life of the structure.
Keywords: *Safe bearing capacity (SBC), Concrete mix design.*

INTRODUCTION:
The purpose of this study was to determine the general subsurface conditions at the project site, to evaluate those conditions with respect to geotechnical engineering considerations for the proposed construction, and provide final geotechnical recommendations to guide design of bridge foundations and wing walls. The specific scope of our services on this project consisted of evaluating data acquired using soil borings, in situ testing, laboratory testing, developing geotechnical recommendations, and submitting our findings in a FFR. Based on this geotechnical study, recommendations are provided for bridge foundation design, bridge wing wall foundation design, sequence of construction, and other geotechnical concerns
Here it is mandatory to provide piers at railway boundary. Provision of pier in railway land shall be decided on techno-economic considerations. It may be noted that with small sub structure height, in most cases in ROBs, longer spans will in general be costlier than medium length spans. However, long term interests of Railways must be guarded while planning the piers. The following may be kept in mind in this respect:
i. Piers shall not be planned where there is a possibility of current tracks shifting due to realignment, yard remodelling etc or where future tracks might come. Provision for future track(s) shall be considered for most locations outside yards. Since the alignment of the future track(s) is not always known, various possibilities for the same may be examined. If it is feasible, space for minimum one track on either side of existing tracks may be kept. For terminals and major yards, and their approaches, keeping land free from obstructions might be desirable as the entire layout might get changed during remodelling or fresh planning.

ii. Piers may be planned in railway land near the edges if it does not affect the number of tracks that can be laid at that location.

iii. Piers may be planned along other structures already constructed on railway land like piers of other bridge/ major structures which are not likely to be removed.
iv. Piers may be planned if the railway land availability at a location is more than that available at adjoining locations and which, thus, will not affect the planning of the Railways.

SCOPE OF PROJECT:

Infrastructure development including highways, bridges, power stations, dams, etc., which was the sole monopoly of the government, has now been opened to private sector participation because of the huge requirements of funds which are beyond the reach of government. A very large gap exists between the budgetary allocation of financial resources and actual requirements of funds for development and maintenance of infrastructure system in India. While traffic on highways has been growing at a rapid pace, it has not been possible for the government to provide matching funds due to competing demand from other priority sectors. The shrinking funds in the public sector have necessitated the need for attracting private funds. Since infrastructure is the most important element of any development strategy for accelerating the economic growth of a country, private financing of infrastructure has to be encouraged in a large way. The adequacy of infrastructure will help in achieving the country's success in expanding trade, reducing poverty, improving environment and creating wealth and prosperity. The importance of a sound road network for the economic growth of any nation has been realized. Ambitious plans for phased development of National Highways and Expressways have been drawn up for India. To achieve goals within the required time frame,

this infrastructure sector has been opened to private sector investment. The experience, generally, is available for small sections like providing a by-pass, a bridge etc.
The tax collected should be used exclusively for the development of urban road works only. This may be levied as some percentage of the property tax. The bonds for urban road developments should have tax exemptions and other attractions as offered by infrastructure bonds offered by the leading financial institutions
It is suggested that the State Government should establish a separate body to monitor the developmental aspects of the urban road projects of all the cities coming under their jurisdictions

PURPOSE OF PROJECT:

In the recent years, the traffic volume on the roads have increased considerably. To cater this, large scale road improvements like widening and strengthening of pavements had been undertaken by Govt. to increase the speed and safety of the traffic. However the railway level crossings proved to be bottlenecks for smooth flow of traffic. Therefore there were demands to construct Railway Over Bridges at those locations. Due to financial constraints, it was not possible for the Govt. to construct these bridges, through budgeted grants.
Therefore Govt of Andrapradesh decided to undertake the construction of the Railway Over Bridges on Build, Operate and Transfer basis. Therefore PVR.Ltd was appointed as construction agency of for construction of ROBs through.PVR Ltd was assigned the task of planning, designing and execution of these ROB in consultation with Govt of Andrapradesh Each time the level crossing gate next to the shankarpally railway station closes, the vehicle pile-up on the fatehpur Trunk Road

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to chevella only grows. "It takes us up to an hour-and-a-half to get to the other side.

IMPORTANT DETAILS OF THE PROJECT

Project Cost: The project cost includes the cost of construction, commissioning and maintenance during concession period. It also includes the cost of the arrangements to be made for collection of fee, interest on expenditure to be incurred by the entrepreneur, the cost of renewal of wearing surface in the entire length of the project including approaches and of painting the bridge structure before the end of the concession period. The project cost also includes entrepreneur's profit and interest thereon. The project cost worked out by the entrepreneur is Rs.28crores Cost of Construction: The cost of construction of the project is Rs.28crores
Location of the Project: The proposed ROB would be constructed at level crossing No. 20at shankarpally,telangana Entrepreneur: The entrepreneur for the project is the joint venture group of PVR construction Ltd
Construction Program: The construction work is to be carried out in accordance with the MOST-Railway specifications as per standards specified in the Concession Agreement and as per the directions of the Railways. Rationale for the Proposed Project: The following are the important details associated with the project The absence of ROB on this crossing results in delay, frequent traffic jams and wastage of fuel whenever the trains pass through the crossing. It is reported that the railway crossing is closed for road traffic about 28-30 times every 24 hours. There are 16 scheduled trains passing through the crossing besides shunting and special trains. The haphazard movement of vehicles after the opening of crossing also results in frequent accidents.
A large number of government as well as private buses ply on this road. With the growing automobile industry, the traffic is expected to increase further on this route.
There is no alternate route connecting shankarpally and chevella

LITERATURE REVIEW:

1. Pandian *et al*. (2001) had made an effort to stabilize expansive soil with a class –F Fly ash and found that the fly ash could be an effective additive (about 20%) to improve the CBR of Black cotton soil (about 200%) significantly.
2. Jain and Jain (2006) studied the effect of addition of stone dust and nylon fiber to Black cotton soil and found that mixing of stone dust by 20% with 3% randomly distributed nylon fibers decreased the swelling pressure by about 48%. The ultimate bearing capacity increased and settlement decreased by inclusion of fiber to stone dust stabilized expansive soil.
3. Seda *et al*. (2007) used waste tyre rubber for stabilization of highly expansive clays. The index properties and compaction parameters of the rubber, expansive soil, and expansive soil-rubber (ESR) mixture were determined. While the ESR mixture is more compressible than the untreated soil, both the swell percent and the swelling pressure are significantly reduced by the addition of rubber to the expansive soil. Attom *et al*. (2007) investigated the effect of shredded waste tire on the shear strength, swelling and compressibility properties of the clayey soil from northern part of Jordan. The shredded tires passed US sieve number 4 were added to the soil at 2%, 4%, 6%, and 8% by dry weight of soil. The test results showed that increasing the amount of shredded waste tires

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REINFORCED CONCRETE CEMENT WORK

General: Reinforced cement concrete work may be cast-in-situ or Precast as may be directed by Engineer-in-charge according to the nature of work. Reinforced cement concrete work shall comprise of the following which may be separately or collectively as per the description of the item of work.

a) Form work (Centering and shuttering)
b) Reinforcement
c)concreting 1. Cast-in-situ 2.precast

Steel for reinforcement:

The steel used for reinforcement shall be any of the following types

a) Mild steel and medium tensile bars conforming to IS 432 (Pt.) .1982

i) Mild steel bars grade I designated as Fe41O-S

ii) Mild steel bars grade II designated as Fe 410-0

b) Medium tensile steel bars, grade II designated as Fe 540-W-HT.

Mild steel and Medium tensile steel

Physical requirement are given in the following table

S.No.	Type and nominal size of bar	Ultimate tensile stress N/mm2 minimum	Yield stress N/mm2 minimum	Elongation percent minimum
1.	Mild steel grade I			
	For bars upto and including 20mm.	410	250	23
	For bars over 20 mm upto and including 50mm	410	240	23
2.	Mild steel grade II			
	For bars upto and including 20mm	370	225	23
	For bars over 20mm, upto and including 50mm	370	215	23
3.	Medium tensile steel			
	For bars upto & including 16mm	540	350	20
	For bars over 16mm, upto and including 32mm	540	340	20
	For bars over 32mm, upto and including 50mm	510	330	20

Tests:

Selection and preparation of Test sample All the tests pieces shall be selected by the Engineer-in-Charge or his authorized representative or If he so desires, from any bar after it has been cut to the required or specified size and the test piece taken from any part of it. In neither case, the test pieces shall be detached from the bar or coil except in presence of the Engineering-Charge or his authorized representative.

The test pieces obtained in accordance with as above shall be full sections of the bars as rolled arid subsequently cold worked and shall be subjected to physical tests without any further modifications. deductions in size by machining or otherwise shall be permissible. No test piece shall be enacted or otherwise subject to heat treatment. Any straightening which a test piece may require shall be done cold.

Following type of lab test shall be carried out

1) Tensile Tests: This shall be done as per IS 1608 - 1972

2) Bend Test: This shall be done as per IS 1599 - 1974

3) Re-test: This shall be done as per IS 1786 - ·1985

4.) Rebend Test: This shall be done as per IS 1786 – 1985

DESIGN MIX CONCRETE:

Definition:

Design mix concrete is that concrete in which the design of mix determination of portions of cement, aggregate & water is arrived as to have target mean strength for specified grade of concrete. It will be designed based on the principles given in I.S. 456-1978 and SP 23-1982" Handbook for design mix concrete".

In order to ensure that not' more than the specified proportion of test results are likely to fall below the characteristic strength, the concrete mix has to be designed for higher average compressive strength and this higher average compressive strength for a specified grade of concrete is defined a target mean strength

Cement: One of the following types of Cement as specified shall be used:

1. Ordinary Portland Cement 33 grade conforming to IS 269-1989.
2. Ordinary Portland Cement 43 grade conforming to IS 8112-1987.

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3. Ordinary Portland Cement 53 grade conforming to IS 12269-1987.
4. Rapid hardening Portland Cement Conforming to IS 8041-1990.
5. Blast Furnace slag cement conforming to IS 455-1989.

The compressive strength of various grades of designation concrete shall be as given below:

Grades Designation	Comprssive strength on 15cm Cubes min at 7 days (N/mm2)	Specified characterstic compressive strength at 28 days. (N/mm2)
M 15	10.0	15
M 20	13.5	20
M 25	17.0	25
M 30	20.0	30
M 35	23.5	35

Note: In the designation of a concrete mix letter M refer to the mix and the number to the specified characterestic compressive strength of 15 cm-cube at 28 days expressed in N/mm².

Scope:
The procedure described below for design mix is for concrete up to grade M-35 which are generally used for reinforced concrete structure. Minimum grade of concrete for design mix will be M 20 normally. However in cases of projects having some parts of M15 also in addition 'to M 20 to M35 grade, then design mix concrete will cover M-15 grade as an exception only.
Data for Mix Design: The following basic data are required to' be specified for design of concrete mix.
(1) Characteristic compressive strength of concrete at 28 days'.
(2) Degree of workability desired.
(3) Limitation on water cement ratio and minimum cement content to ensure adequate durability.
(4) Type and maximum size of aggregate to be used.
(5) Standard deviation of compressive strength of concrete
Minimum cement content required in Reinforced cement concrete to ensure durability under specified conditions of exposure, will be in accordance with I.S. 456-1978. However it shall not be less than 300 Kg/m 3 of concrete for 33 grade cement.
(a) Standard Deviation of concrete for each grade shall depend upon the degree of quality control expected to be exercised at site. As per IS 10262-1982 the values of standard deviation for various grades of concrete for different degree of control shall be as specified in table .6.4

Grade of concrete	Standard Deviation for different degree of control In N/mm²		
	Very Good	Good	Fair
M15	2.5	3.5	4.5
M20	3.6	4.6	5.6
M25	4.3	5.3	6.3
M30	5.0	6.0	7.0
M35	5.7	6.7	7.7

Degree of control & Condition of Production of concrete:
Very Good: Fresh cement from single source and regular tests, weigh batching of all materials, aggregates grading and moisture content, control of water added, frequent supervision, regular workability and strength tests and field laboratory facilities.

Fair: Proper storage of cement, volume batching of all aggregates allowing for bulking of sand, weigh batching of cement, water content controlled by inspection of mix and occasional supervision and tests
Good: Carefully stored cement and periodic test, weigh batching of all materials, controlled water, graded aggregate supplied, occasional grading and moisture tests, periodic check of workability and strength, intermitted supervision
and experienced workers.
Batching:
In proportioning concrete, the quantity of both cement and aggregate should be determined by mass. Cement shall be used on the basis of mass & should be weighed separately from the aggregate. Water should be measured by

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volume in calibrated tanks or weighed. Any solid admixture that may be added, may be measured by mass, liquid and paste admixture by volume or mass. Batching plant where used should conform to IS 4925-1968. All measuring equipment should be maintained in a clean serviceable condition and their accuracy periodically checked. Except where it can be shown to the satisfaction of Engineer -in-charge that supply of properly graded aggregate of uniform quality can be maintained over the period of work, the grading of aggregate should be controlled by obtaining the coarse aggregate in different sizes and blending them in the right proportions when required, the different sizes being stocked in separate stock piles. The material should be stock-piled for several hours preferably a day before use. The grading of coarse and fine aggregate should be checked as frequently as possible, the frequency for a given job being determined by Engineer- in -Charge to ensure that the specified grading is maintained.

It is important to maintain the water-cement ratio .constant at its correct value. To this end, determination of moisture contents in both fine and coarse aggregate shall be made as frequently as possible, the frequency for a given job being determined by the Engineer –in Charge according to weather conditions. The amount of the water to be added shall be adjusted to compensate for any observed variations in the moisture contents.

For the determination of moisture content in the aggregates, IS 2386 (part III) -1963 may be referred to allow for the variation in mass of aggregate due to variation in their moisture content, suitable adjustments in the masses of aggregates shall also be made.!n the absence of exact data, only in the case of nominal mixes, the amount of surface water may be estimated from the values given in the

Table

Surface Water Carried by Aggregate
(Clause 5.8.4.1)

Aggregate	approximate Quantity of Surface Water	
	percent by Mass	l/m³
Vey wet sand	7.5	120
Moderately wet sand	5.0	80
Moist sand	2.5	40
Moist gravel to crushed rock	1.25-2.5	20-40

Mixing:

Concrete shall be mixed in a mechanical mixer. The mixer should comply with IS 1791-1968.1t shall be fitted with hopper. The mixing shall be continuous until there is uniform distribution of the material & the mass is uniform in color and consistency. If there is segregation after unloading from the mixer, the concrete should be remixed. The mixing time shall not be less than 2 minutes.

Approval of Design Mix:

The preliminary test for approval of design mix shall consists of three sets of separate tests and each set of test shall be conducted on six specimens. Not more than one set of six specimen shall be made on any particular day. Of the six specimens of each set, three shall be tested at seven days and remaining three at 28 days. The preliminary tests at seven days are intended only to indicate the strength to be attained at 28 days.

Pillar number: 12

Safe Bearing Capacity Calculations
(As per I.S:6403-1981)
DATA:
Bore Hole No: 1
Sample No: 1
Location: Shankarpally
Depth of U.D.Sample(d): 4.50m,y_d=1.94
Bulk Density(γ_d): 2.142 t/m^3 , fmc=1040%, y_d=2.142
Cohesion (c): 0.20t/m^2
For Local Shear Failure (C) :0.13t/m^3
Angle of internal Friction (ϕ): 30^0
Type of failure is: Intermediate Shear Failure

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N^1_c=16.182, N^1_q=7.377, N^1_γ=6.650
Breath of the footing assumed (B): 7.50m
Depth of Ground Water Table: 0.00m Hence W^1=0.5
Shape Factors for Square Footing
S_c=1.3, S_q=1.2, S_γ=0.8
Depth Factor Correction is to be applied only when back filling is done with proper compaction
Inclination Factors $i_c=i_q=i_\gamma$= 1 as angle of inclination is taken as 0^0
Factor of Safety (F) = 2.5
SBC = $1/F\{CN^1_cS_cd_c\ i_c + q\ (N^1_q-1)S_qd_qi_q + ½ \times B\gamma_bN^1_\gamma S_\gamma d_\gamma i_\gamma W^1\} + (\gamma_b-1)d$
=1/2.5 {2.805 + 39.320 + 21.363} + 5.13792
= 63.488/2.5 + 5.13792
=25.395 + 5.13792
= 30.533 or say 30 t/m^2

Pillar number: 17
Safe Bearing Capacity Calculations
(As per I.S:6403-1981)
DATA:
Bore Hole No: 1
Sample No: 1
Location: Shankarpally
Depth of U.D.Sample(d): 4.50m,y_d=1.388
Bulk Density(γ_d): 1.707 t/m^3 , fmc = 2300%, y_d=1.707
Cohesion (c): 4.50t/m^2
For Local Shear Failure (C) :3.00t/m^3
Angle of internal Friction (ϕ): 7^0
Type of failure is: Intermediate Shear Failure
N^1_c=6.410, N^1_q=1.609, N^1_γ=0.497
Breath of the footing assumed (B): 7.50m
Depth of Ground Water Table: 0.00m Hence W^1=0.5
Shape Factors for Square Footing
S_c=1.3, S_q=1.2, S_γ=0.8
Depth Factor Correction is to be applied only when back filling is done with proper compaction
Inclination Factors $i_c=i_q=i_\gamma$= 1 as angle of inclination is taken as 0^0
Factor of Safety (F) = 2.5
SBC = $1/F\{CN^1_cS_cd_c\ i_c + q\ (N^1_q-1)S_qd_qi_q + ½ \times B\gamma_bN^1_\gamma S_\gamma d_\gamma i_\gamma W^1\} + (\gamma_b-1)d$
=1/2.5 {39.998 + 2.328 + 1.274} + 3.18258
= 28.600/2.5 + 3.18258
= 28.440 + 3.18258
= 31.623 or say 31 t/m^2

TEST RESULTS FOR CONCRETE MIX DESIGN
CEMENT53 Grade OPC

S.No	Particulars	Test Results	Limits as per IS code
1.	Consistency	29.5%	
2.	Initial Setting time(in minutes)	88 minutes	Not less than 30min.
3.	Final Setting time(in minutes)	218 minutes	Not less than 600 min.
4.	Fineness of cement by Dry Seiving	4%	Should not exceed 10%
5.	Compressive Strength(in kg/cm2		
	a)3 days	28.09 N/mm^2	Not less than 27 N/mm^2
	b)7days	38.45 N/mm^2	Not less than 37 N/mm^2
	c)28days	54.84 N/mm^2	Not less than 53 N/mm^2

6.	Soundness(by Le-chatliers method)	3	Not more than 10mm

SAND: (FINE AGGREGATE)

1.	Specific gravity		2.85
2.	Water absorption		1.50
3.	Sieve Analysis of fine aggregate		Confirming to the limits Grading as per IS:383-70
			ZONE-II
	10mm	100.00	100
	4.75mm	95.31	90-100
	2.36mm	86.82	75-100
	1.18mm	56.91	55-90
	600mic	44.47	35-59
	300mic	14.61	8-30
	150mic	0.35	0-10

s.no	Coarse aggregate	40mm size	20 mm size	10mm size	Limits
1.	Specific Gravity	2.70	2.72	2.69	2.5-3.0
2.	Impact value			28.14	30%-45%
3.	Flakiness index& Elongation	26.2	25.81	28.14	Not more than 30%
4.	Water absorption	0.94	1.02	0.96	Not more than 2%
5.	Sieve analysis of Coarse Aggregate:				
a)	40mm size	Sieve size		%wt of passing	Limits as per IS 383-1970
		40mm		100.00	85-100
		20mm		0.47	0-20
		10mm		0.00	0-5
		4.75mm		0.00	0
b)	20mm size	Sieve size		% wt passing	Limits as per IS 383-1970
		40mm		100.00	100
		20mm		90.97	85-100
		10mm		0.00	0-20
		4.75mm		0.00	0-5
c)	10mm size	12.5mm		100.00	90-100
		10mm		60.35	40-85
		4.75mm		4.01	0-10
		2.36mm		0.00	0.00

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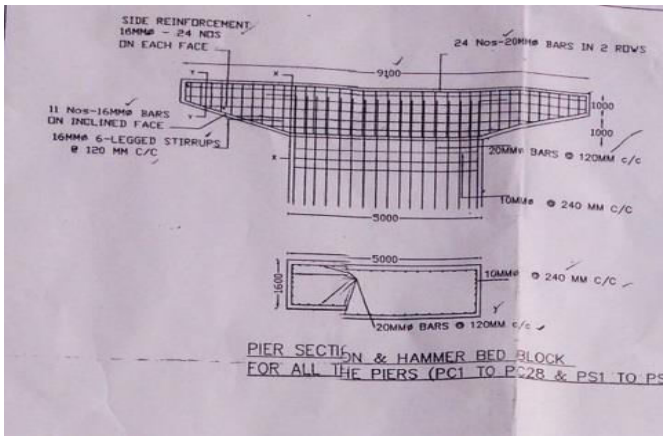
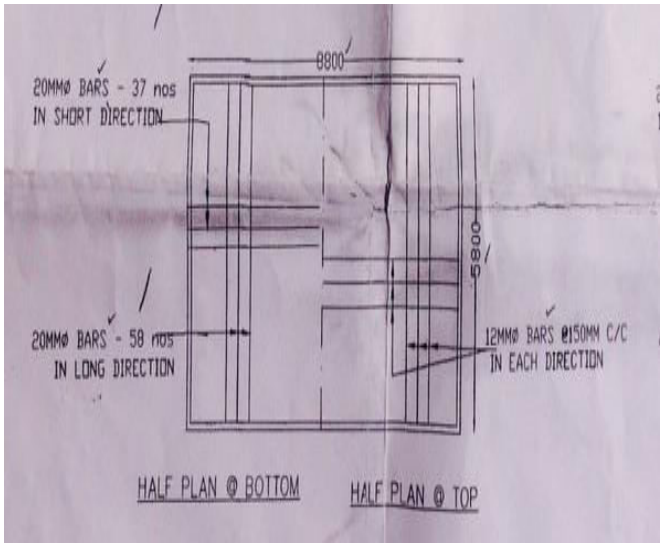
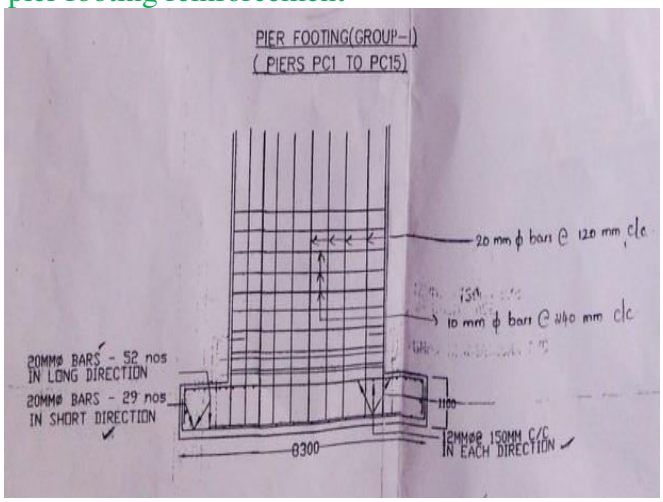
DIAGRAMS OF PIERS AND PIER CAP



Pier cap section and quantity of reinforcement used



pier footing reinforcement



Footing reinforcement

Shuttering work at project site

Casting work at project site

CONCLUSION

- The total no. of piers used for Road Over Bridge are 38 and 2 abutments.
- No. of piers considered for our project are 6.
- Type of Foundation used for construction of piers are shallow foundation.
- The span between the two piers are 16.600m.

- The width of piers used is 5m.
- Test Results of the soil near the project site are-

-Sieve analysis 40mm sieve 100% passing 20mm sieve 90.86% 10mm sieve 60.35%.

-Consistency limits from PC12 to PC17 the value varied from 38 to 39.

-Field dry density observed was 1.809 gm/cc.

- To get the safe bearing capacity soil tests are conducted should ensure that value of bearing capacity must be 30 t/m^2
- The soil is further excavated to ensure safe bearing capacity.
- The total amount of reinforcement used for each pier is 1.6 to 1.8 tones.
- Uses of these piers are mainly to overcome the railway traffic.
- The main advantages of the project are saves the time of passengers , people travelling on that road and to overcome the human errors at present level crossing.
- Provides safe crossings to the other side.

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