PROJECT REPORT

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(Integrated course No:12101)

INDIAN RAILWAY INSTITUTE OF CIVIL ENGINEERING
PUNE 411001

PROJECT REPORT

A CASE STUDY ON REPLACEMENT OF SCREW PILES BY WELL FOUNDATION UNDER RUNNING TRAFFIC

Under the Guidance of
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By

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Introduction:

Necessitattion of the work:-

Photograph showing the accident of Exp.train At Kadalundi Bridge.

In the year 2001, there was an ***accident of Express train No:6602*** *– (running between Mangalore-Chennai) at Bridge No:924(Kadalundi) in Shoranur Junction – Mangalore Junction. section of Southern Railway.* ***with span 12x19.51m steel girder on Cast iron screw piles resulting loss of 52 human lives and 105 grievously injured.***

A decision has been taken by the Railway Board to replace all the bridges in Indian Railways which are all resting on screw piles taking the possible chance of such accident.

The bridge No 7 across Buckingham canal located between Chennai Central and Basin Bridge Junction which is resting on cast iron screw pile has also been proposed to Rebuild with Well foundation.

Planning

This bridge is covering six number of railway tracks which are utilised for

(i) **Reception and Despatch of all passenger trains from Gudur, Arakkonam and Chennai beach side .**

(ii) **Transshipment of empty passenger train racks from the coaching yard of Chennai central, Chennai central to coaching yard .**

(iii) Movement of shunting engine, engine for the hauling.

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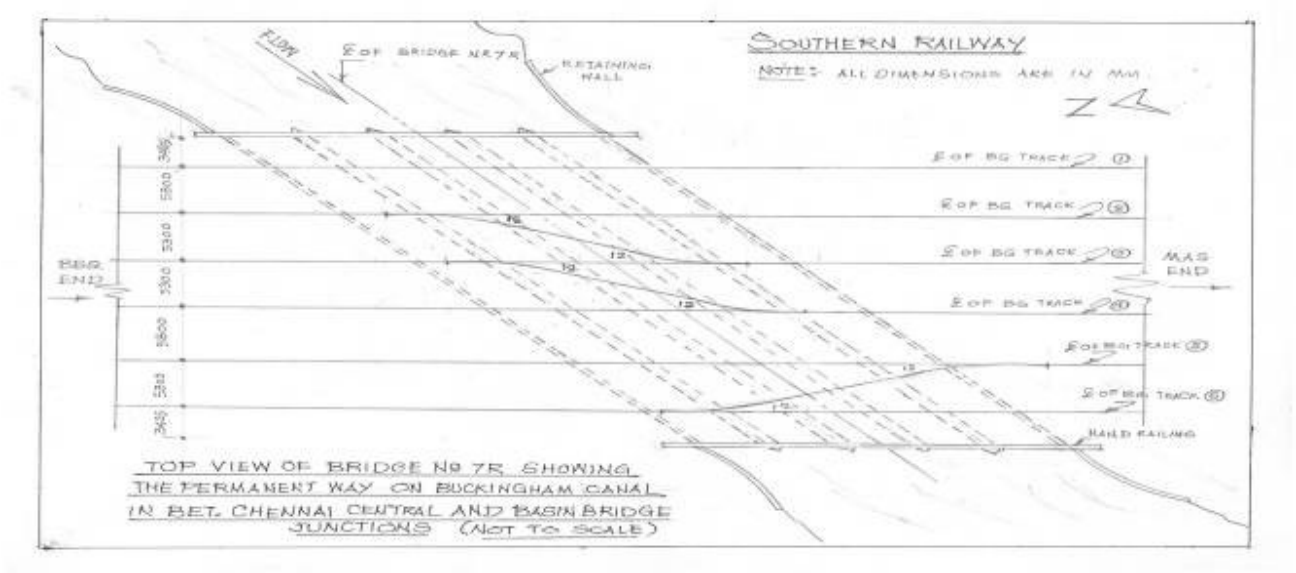
Following sketch shows the location of the bridge.



Traffic over the existing bridge:

Movement involving an engine or an empty rake or reception and dispatch of a passenger train is continuously carried out during day and night. except a small recess between.0 .00 TO 2.30 Hrs.

Discussion of Method of carrying out works:

Existing bridge No :7 laid on screw piles has to be rebuilt with well foundation and the rebuilding may be done in two ways.

(1) By providing Temporary diversion and taking up the work duly dismantling the exg.bridge and constructing a new bridge at same location.
(2).Construction of a new bridge at a diverted location and connecting the new bridge.

The first method could not be taken up at the proposed site due to high volume of traffic over the existing bridge, may not be possible to be taken on the diverted track.

The second option could not work out since, the space for the construction of seven span bridge is not available. Since, on one side suburban tracks are existing and on the other side developed metro city of Chennai is situated, acquisition of land will be extremely difficult, also connection to coaching sidings and reception and dispatch siding on Chennai central side and basin bridge side is not practicable.

Under the above circumstances, it was decided to rebuild the bridge at same location without diverting the traffic..

Photograph showing the Exg.bridge with traffic.

Rebuilding of the bridge has been planed at the same location as it necessitates dismantling , which requires suspension of train traffic to and fro Chennai Central.
It was appreciated that , by suspension of train traffic to and fro Chennai Central , several long distance express train originating from Chennai central, passing through Chennai central will be affected seriously and the passengers would be subjected to hardships beyond the tolerable limits during construction of this bridge which likely to consume minimum period.

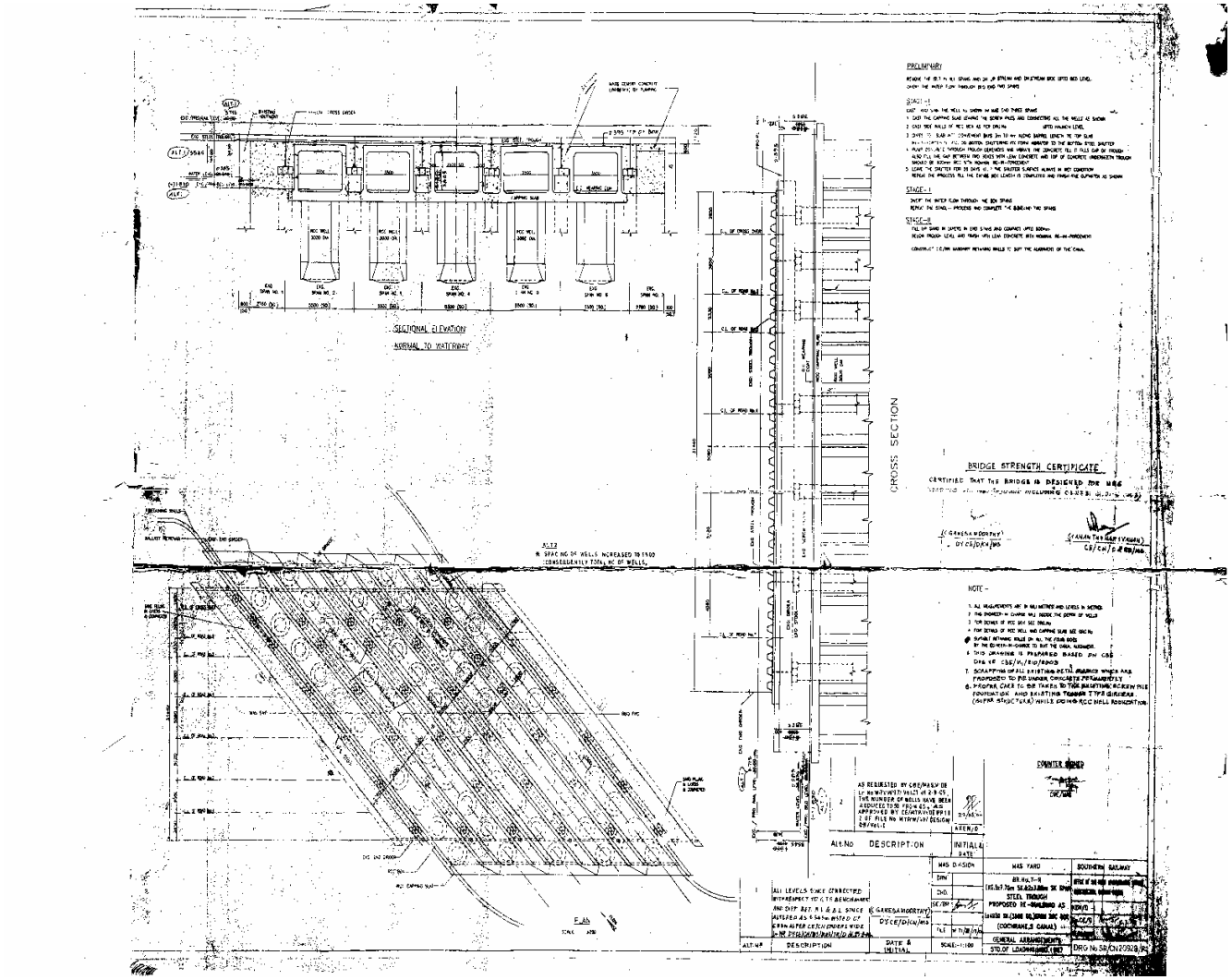
A decision has been taken by the Engineering Department of Southern Railway to rebuild a the bridge under the running traffic by deploying suitable designs and methods of construction during construction of such bridge which would likely to consume minimum period of one year.

A decision has been taken by the engineering department of Southern Railway to rebuild a new bridge under the running traffic by deploying suitable designs and methods of construction.

Design Proposed

It has been designed in such a way that providing new RCC box over well foundation in between the existing spans leaving the existing screw piles as it is. As long as the screw piles are able to bear the load, the existing bridge will be functioning safely. Once, the screw piles fails, all the loads will be taken up by the new RCC box over the well foundation. However, the percentage of sharing in taking the loads by the old bridge and new bridge has not been estimated.

The existing Bridge and the proposed bridge is shown in the following drawings.



Rebuilding has been designed in such a way that RCC box would rest on well foundation sunk in between the existing spans without disturbing the existing screw piles, steel girders and steel trough deck.

Existing bridge steel trough deck steel girders resting on screw piles are able to bear the load, would continue to function, once, the screw piles fails, all the loads will be borne by the new RCC box over the well foundation.

However, the percentage of sharing the loads by the old bridge and new bridge has not been estimated.

Salient features of Existing and New bridges.

Sl No	Description of item	Existing Bridge	Proposed Bridge
1	No of span	5 x 7.7(SK)middle span +2x3.89(SK)End span.	5x4.95(SK) All span
2	Foundation	900 mm dia driven cast iron screw piles	Well foundation of 2000/3000 mm dia of inner and outer of well.
3	Total width of bridge	33.02m Sk	33.02m Sk
4	Depth of foundation	-	13 to 15 m duly resting on hard rock.
5	Sub structure	Steel girder"I" section laid on the screw pile through a stool.	RCC Box laid on the wells.
6	Super structure	Steel trough bridge over the "I" girder.	Top slab of RCC box laid beneath the steel trough.

End spans are filled up with sand and lean concrete, The space between the walls of box segment are filled up with lean concrete duly concealing the cast iron screw piles, MS stool and steel"I" girder and embedding of the steel trough.

The water course:

The Buckingham canal carries surface and surplus flow and discharges into bay of Bengal since the water coarse is connected to the sea during day time the flow will be towards the sea and during night time the flow will be from the sea. The flow from the sea carries huge amount of silt and silt deposited into bridge and in the adjoining length.

It is absolutely essential to ensure that flow through the above canal is always available which means work can not be carried out the work duly obstructing the water flow completely. It has been planned for the availability of working area in two span at a time duly diverting the water flow through the other spans with the help of providing coffer dam.

Execution of the work are discussed under the following needs:

Preparatory works.

Bridge proper works.

Ancillary works.

Preparatory works

Following preparatory works have been carried out prior to the actual commencement of rebuilding of the bridge.

Detailed soil investigation have been carried out on both upstream and down stream end and it has been observed that hard rock is available at varying depth from 12.5m to 13.5m. Construction materials proposed to be used for the rebuilding of bridge such as cement, steel, aggregates and water has been tested. Based on the test results, design mix has been prepared, test cubes have been cast and the results verified for its adoption in the work.

For the movement of Transit mixers carrying concrete and trucks carrying other materials approach road have been formed on a bigger way on the down stream end and comparatively smaller way on up stream end . Laying RCC pipes beneath the approach road for the through flow of water has also been ensured.

Photograph showing Approach Road

Due to the site condition, it has been proposed to use Ready Mixed Concrete.RMC plant near Poonthamalli has been selected. This plant has been inspected in detail and appropriate tests have been carried out to obtain the desired standards. To transport the concrete from RMC plant to site of work a Transit Mixer has been deployed. Necessary trial runs were made for the deployment of transit mixer from RMC plant to site. It was observed that about 35 to 45 min was required. Concreting was programmed during day as well as night time, Special permission have been obtained for the movement of transit mixer during day time from the concerned authorities.

Necessary training and counseling have been imparted to the work man engaged at the bridge site in view of the nature of the work and the site condition. An emphasis has been made for ensuring the personal safety in view of the difficulty encountered due to the restricted working space and also working in the vicinity of railway track which carry regular and continuous flow of traffic.

The field supervisors have been counseled to maintain necessary records to control the progress of work duly achieving the quality up to the required level.

BRIDGE PROPOER WORKS (ACTUAL EXECUTION)

- ❖ Diversion of water flow by providing coffer dams.
- ❖ De silting in the working area.
- ❖ Sinking of Well foundation.
- ❖ Casting of well cap/Bottom slab of Box segment.
- ❖ Construction of side walls and filling the gaps between the side walls
- ❖ Construction of the top slab of the box
- ❖ Filling up of the end spans.
- ❖ Embedding of the exg.steel trough.
- ❖ Ancillary works.

Diversion of water flow by providing coffer dams.

Water flowing through stream is to be regulated to ensure working space for construction since, complete stopping of the flow through the water course is not feasible at this bridge site. During the initial planning stage it was planned to allow the flow through the end spans ie, span 1 and 7 which will enable working for all the spans ie A to E simultaneously. During execution of the work it could not materialized. Appropriate planning has been made to ensure span A and B is available initially duly diverting the water through span C,D&E

Photograph showing coffer Dam

- A coffer dam has been provided between span No 3 & 4 from the upstream end to a length 30 metres from the bridge and extended to a length of 40 metres for the down stream end duly permitting the flow through span 4 , 5 & 6.
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The coffer dam has been constructed by removing the silt up to the bed level completely.

Two rows of casurina post driven at an interval of about 1.50 m centre to centre and anchored by 1 m into ground level ,horizontal connection has been made to the vertical casurina post. at an interval of 0.60m duly ensuring the width of coffer dam as 1.50m for the entire length extending for the 30m on up stream and 40 m Downstream.

Earth packed Gunny bags laid closely between the vertical casurina posts .

Photograph showing coffer Dam

De silting in the working area.

The surface flow carried on this water course transmits fine grained soil mass of huge volume along with it and these soil mass get deposited in the water way of the bridge as well as on the upstream end of the bridge.

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It has been observed that silt exist for the depth of more than 2.50 metre above the bed level of the bridge portion as well as on the Upstream end.It is also seen some organic materials also getting deposited.

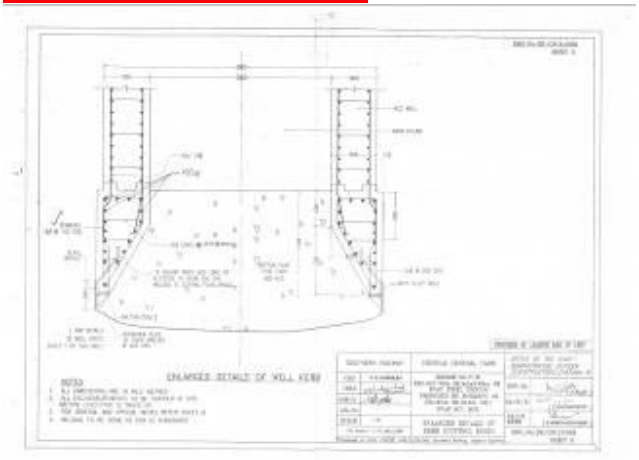
In spite of the provision of the coffer dam some minor leakage of water also observed .

It has been decided to deploy mechanical means for de silting.

One poclain of capacity of D 60 was taken inside the span and D 120 has been deployed near the end span.

De silting has been carried out with the help of D120 and D60 in the proposed span A & B . Silt has been removed up to the bed level.

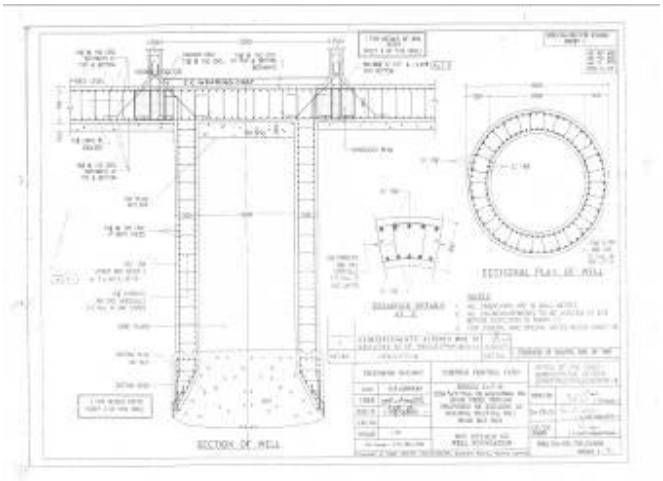
Well foundation:



It has been decided to provide Well foundation in addition to screw piles.

Since the existing bridge is not proposed to be dismantled, sinking of wells have been proposed in between the span without disturbing the screw piles.

Well foundation proposed is of Reinforced Cement Concrete with internal dia of 2000mm and outer dimension of 3000mm.



The center line of well on spans are accurately marked using Theodolite at a distance of 5500mm center to center. 10 Nos of wells are to be constructed in one span.

The cutting edge of the well is prepared by using MS angles and MS sheets of 10mm thick , well curb has been cast using RCC M 35 design mix accurately as indicated in the Sketch.

On the well curb, well steining has been cast for a height of 1.0m , thickness of well steining is 500mm. Offset of 75 mm between well steining and curb has been provided.

Reinforcement for steining has been provided as per the drawing. Protective coating for Steel has been done by CECRI method. Necessary curing has been carried out .

The cross girders resting on screw piles have been temporarily supported using steel cribs and wooden blocks enabling suitable space for the sinking of wells which also ensures against

the safety in the event of settlement of screw piles during the sinking of wells .

Well sinkers have been deployed for sinking. Manual extraction of the material has been carried out inside the well, the excavated material was brought out by bucket and pully arrangement to the bed level.

Care has been taken to remove the material underneath the cutting edge thoroughly so that uniform sinking of the well is achieved.

The excavated material have been disposed off without any disturbance to Railway traffic as well as progress of the bridge work

Further sinking of the well has been carried out by manual removal of the material.

The steining portion of the well systematically sunk duly observing high precaution avoiding tilting of the well. In this method well sinking was continued.

The well sinking was carried out with great difficulty due to restricted space available.

After sinking of well about 3 to 4 metres, the sinkers have been provided with life saving supports

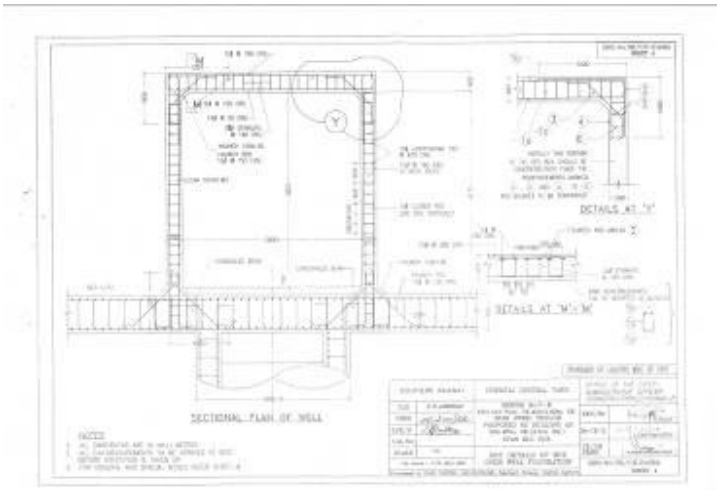
The well has been founded by suitably resting on hard rock at a depth of 13 to 15m.In these process, sinking of all the wells have been completed.

After complete sinking of the well bottom plug has been provided by using plain concrete to the depth of 1250mm.

The inner portion of the wells have been filled up with sands and top plug is made using plain

concrete. By this method well foundation is fully completed.

Casting of well cap/Bottom slab of Box segment.



Earth surrounding the well and screw piles have been properly leveled and a leveling course of 150 mm using plain concrete has been laid covering surrounding all the screw piles.

Consolidation of the plain concrete has been made. Adequate care has been taken to ensure to obtain an uniform surface.

Over this leveling course, reinforcement for the bottom slab of the box segment is laid

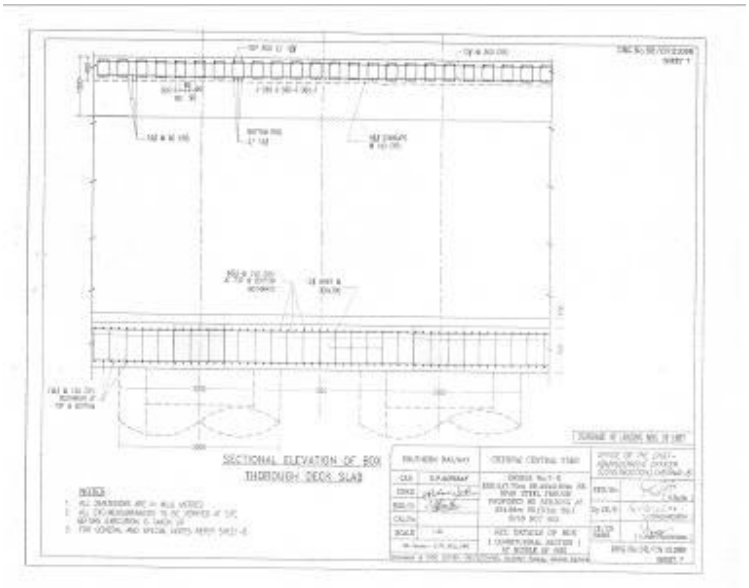
Reinforcements have been placed for the bottom slab / well cap duly inter lacing the reiforcements from the well steining.

Reinforcements for the side walls have been interlaced into the bottom slab.

Protective coating for Steel has been done by CECRI method.

A thickness of 750 mm has been provided for the bottom slab .

The bottom slab function as well cap also.



Concreting of bottom slab /well cap has been carried out by pumping from the RMC Transit Mixer .

The bottom slab/well cap has been laid without any joints.

Construction joints for a width of 40mm has been provided at a distance of 1.5 m from the center line of the screw piles.

Construction of side walls.

Distributor reinforcements have been introduced to the vertical reinforcements for the side walls of the box already provided.

Protective coating for reinforecements by CECRI method has been done.

Initially the hunch portion 150 x 150mm has been constructed on both sides throught the length duly providing appropriate shuttering arrangement.

Shuttering for the wall portion for the height of 1m has been made throught the length on both sides simultaneously.

Construction of side walls have been carried out in stages.

While constructing side walls of the box segments, care was taken to ensure the longitudinal and vertical alignment so as to achieve to the desired water way.The total height of side walls to be constructed was 3.825 m .

The side walls of the box have been planed and constructed in three stages of 1 metre height

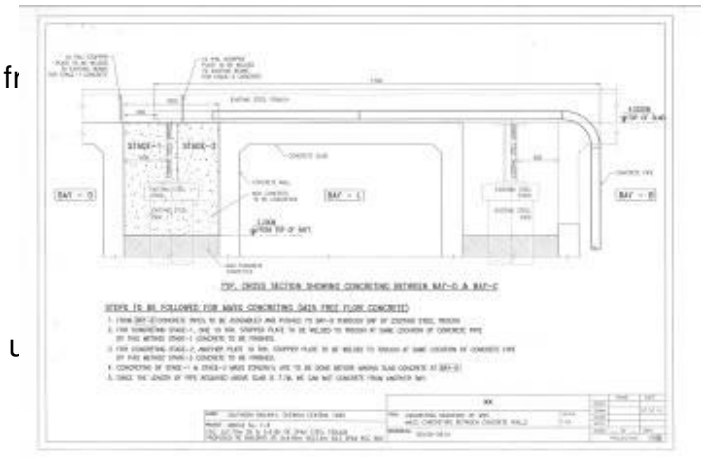
each to achieve a height of 2.825 m from the top of the bottom slab Space for consolidation of concrete by vibration was not available and hence the balance top portion of the side walls have been planed and concreted along with the top slab.

Filling up the space between Box

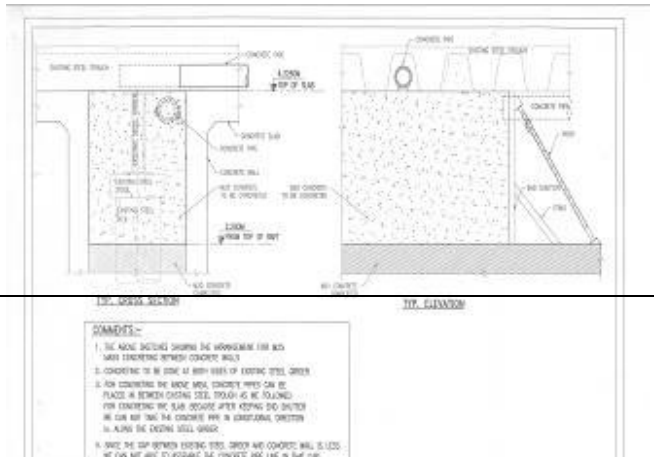
The gap between the walls of the RCC Box segments of adjacent spans have been filled with plain concrete of M 20 immediately after the construction of the side wall for a height of 1 m both adjacent spans, since filling up the gap cannot be carried out in later stages,

Filling up of the mass concrete covers the screw piles and screw piles get encased in the mass concrete simultaneously.

Filling up the gaps between the walls have been carried out by pumping the concrete fr filling up also under progress along with the construction of the side walls.



While filling up the gap between the box segment cutwater arrangement provided on the u arrangement provided on Down stream for proper regulation of the water flow.



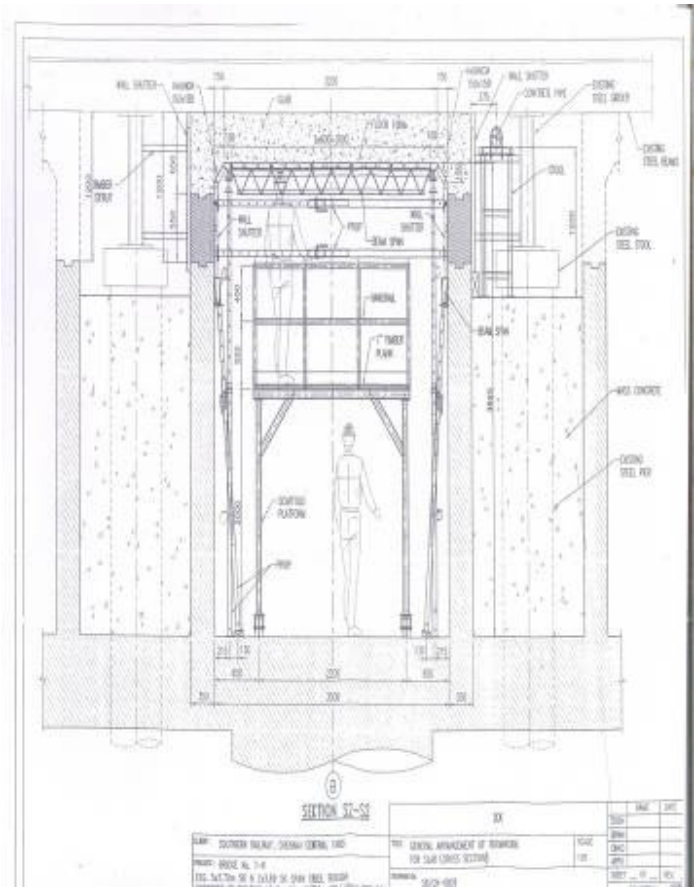
The steel stool resting over the screw piles for supporting the girders have also been embedded in the mass concrete.

Embedding of Steel girder supporting the deck with trough arrangement duly filling up gap on either side of steel girders and the side walls have been carried out in two stages,

Stage 1, 10mm thick stopper plate is welded to the trough in some location for taking the concreting pipe.

Stage 2 another stopper welded for carrying the concrete pipe filling up of this area has been carried out along with concreting the top slab.

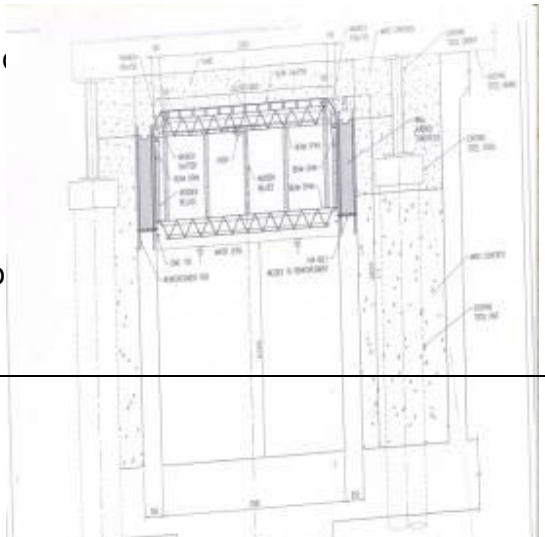
Construction of the top slab of the box



Top slab of box segment have been constructed beneath the steel rough for a depth of 400mm , if the form work for the top slab was provided first , the reinforcement steel for the top slab can not be provided on the formwork , since the gap between top of the slab to be cast and bottom of steel trough was only 2 mm.

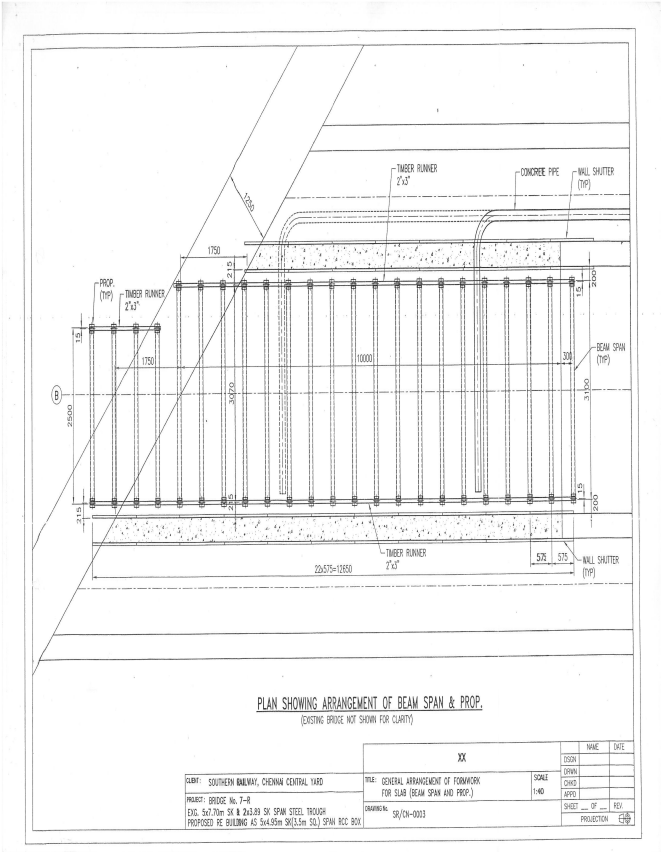
It has been decided to provide reinforcement steel first by providing the reinforcement for the concealed beams duly supporting them by temporary staging arrangement and placing all reinforcements and form work for the slab provided as shown in the sketch.

Concreting of the top 1metre of the side wall , filling the space between the side walls could not be done deployment of vibrator for consolidation of concrete.



It has been decided to concrete the top portion of the side wall of the top portion of 1 m, including the top slab of 400 mm thick in a single pour .

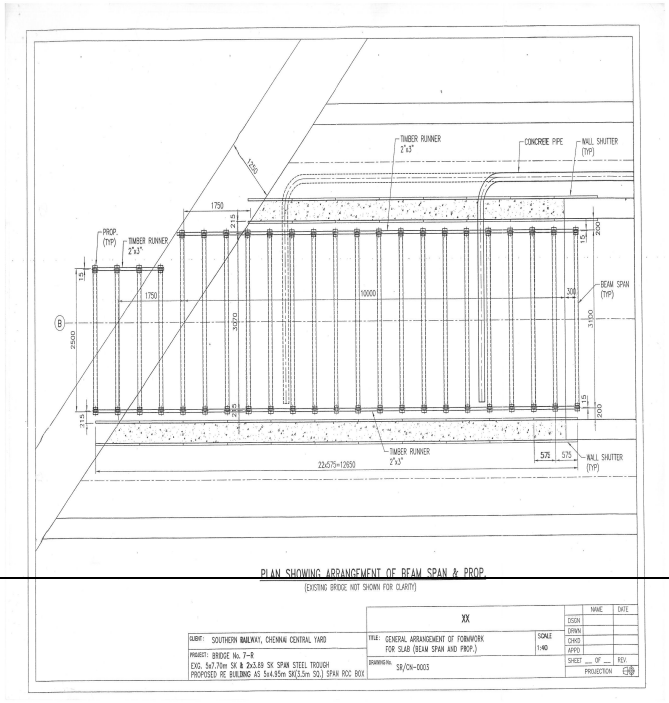
It has been decided for the provision of shuttering arrangement, the span has been divided into panels of 600mm wide and the shuttering arrangement has been made as per the drawing.



It has been decided to provide Self Compacting Concrete for concreting the top portion of the side wall of the top portion of 1 m , including the top haunch 150x150 mm and the top slab of 400 mm thick in a single pour . since consolidation by vibrator is not feasible.

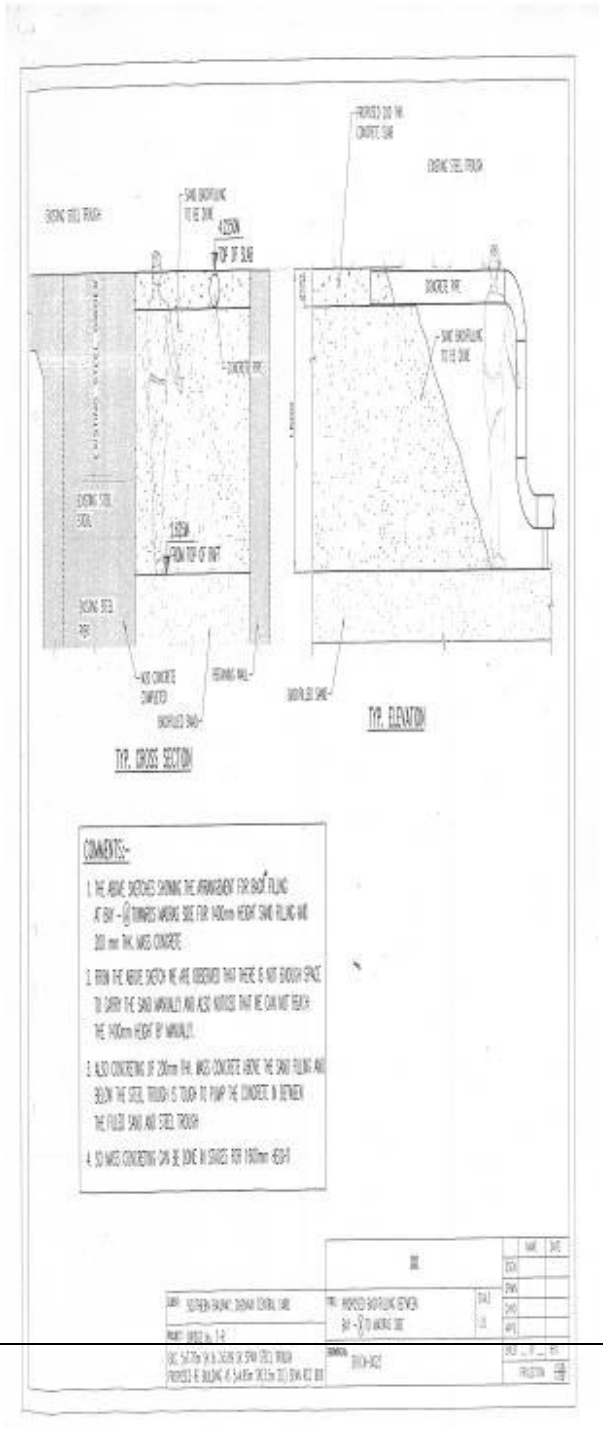
Pipes of 100mm diameter have been introduced 3000mm centre to centre between the shutters and the steel trough through the space between the side walls.

Self Compacting Concrete to the required strength has been prepared at the RMC plant and transported to site by using transit mixer and concrete is pumped through these pipes. Concrete has flown in to entire surface area of the top slab , haunch the wall portion and the space contained between the side walls. Shifting of pipes connected to the pumps were done to cover the entire length. Adequate care



has been exercised to ensure that concrete has flown to all required area.

Filling up of the end spans.



In terms of GAD the end span are to be closed by filling up sand in layer and provide a mass concrete for a thickness of 200mm.

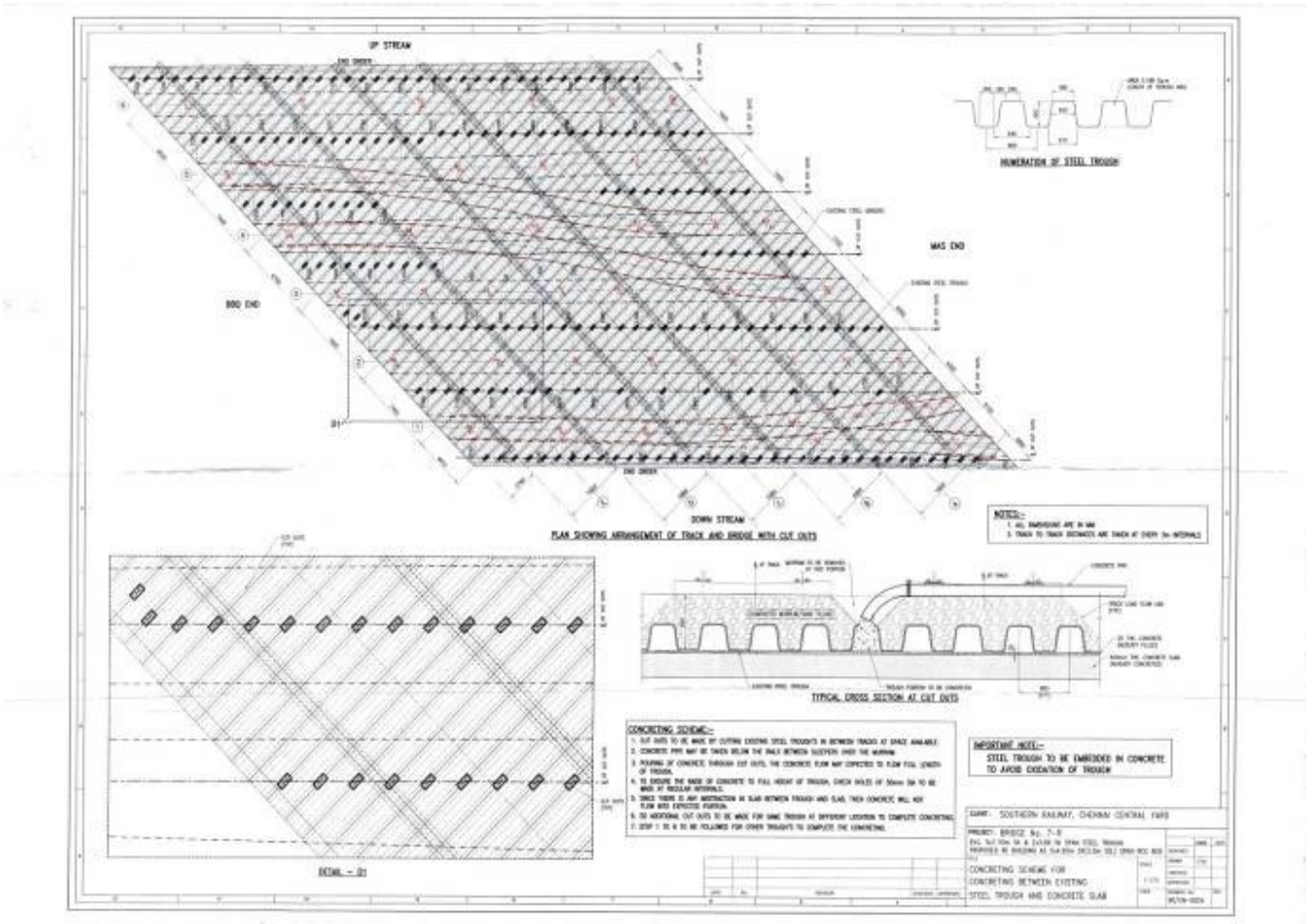
It is possible to appreciate from the sketch that adequate space was not available to carry the sand manually for filling and compact it. It was also observed that filling up to a height of 1.40 m by manual means cannot be done.

Filling with mass concreting for a thickness of 200mm above the sand filling beneath the steel trough was not feasible.

Hence, It has been decided to fill up the end span using mass concrete in stages by introducing the pipe and

pumping the concrete to fill up the space.

❖ Embedding of the existing Steel trough.



A gap of 2 mm exists between the top slab of the box segment and bottom of the steel trough. It is to be appreciated that the load is to be transmitted to the box segment by the steel trough and the box segment would transfer the load to the well foundation laid beneath.

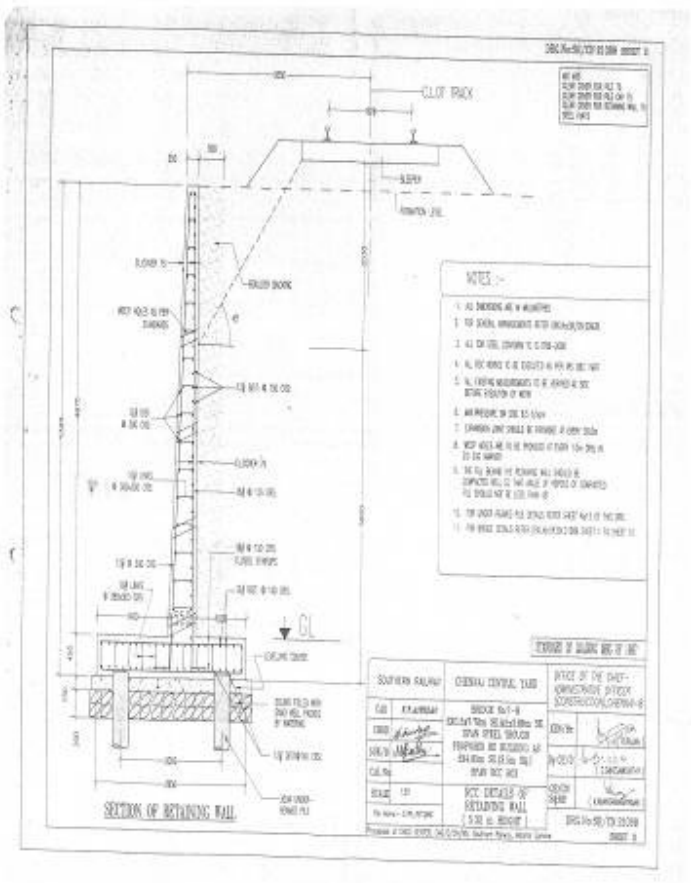
To ensure transmission of the load by the deck (i.e) steel trough to the top slab of the box segment directly, it has been decided to fill up the gap between the top slab of the box segment and bottom of the steel trough as well as the hollow portion of the steel trough.

Embedding of the steel trough has been carried out introducing cutouts by cutting the steel trough in between the tracks at space available as shown in the sketch.

Pipe has been taken below the rail and sleepers , Self compacting concrete has been used, pumping of the concrete has been carried out through the cut outs and the self compacting concrete as flown in either direction to fill up the gap between the top of the slab and bottom portion of the hollow portion of the trough .

To verify the flow of the concrete ,check holes of 50mm diameter has been made and it was noticed that concrete has flown to the required area

Ancillary works

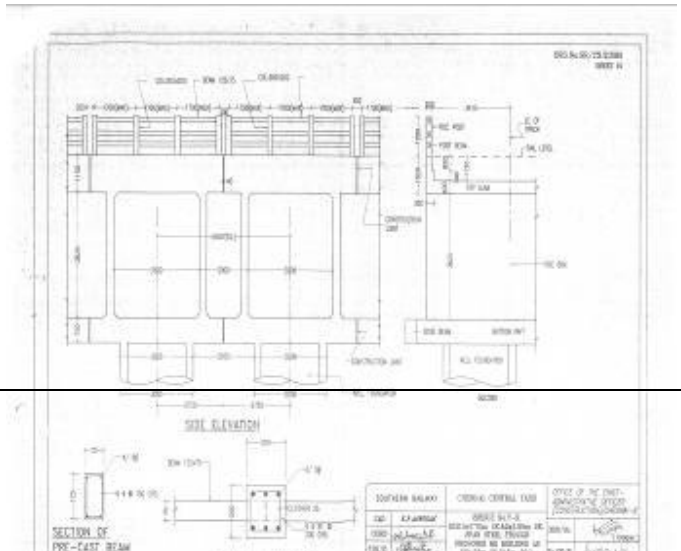


Return wall in the form of retaining wall has been constructed on Chennai central and basin bridge end on both sides of up stream and down stream side of the bridge.

Retaining wall of 20 metre length on up stream and 15 metre of down stream has been provided.

For the construction of this retaining wall under reamed piles of 300mm dia to a depth of 5m below the bed level has been provided.

Two rows of under reamed pile at 2.50 metre centre to centre has been provided..



Pile cap to a width of 3 m to the thickness of 400 mm has been provided.

The retaining wall to the height of 5 m has been constructed above the pile cap using the reinforcement as shown in the sketch.

Back filling of the retaining wall has been done.

Parapet wall has been provided on both sides of the bridge.

Finishing works.

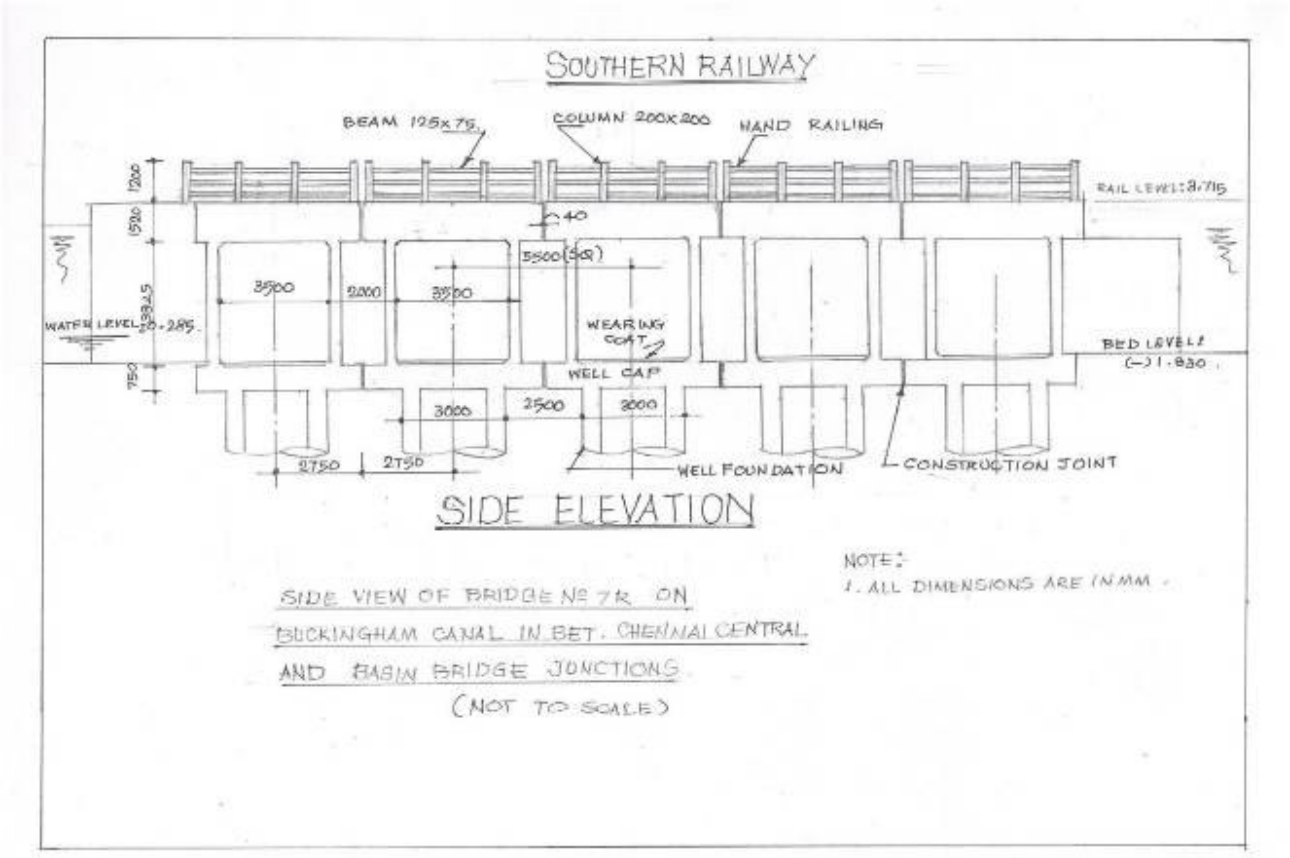
Rebuilding of the bridge has been fully completed,

Waterway has been cleared for the length of 100m on upstream side and 200m on downstream side

Bridge as well as Return wall has been finished with two coats of protective paints.

Necessary bridge plaque has been provided.

HFL and Danger Level has been marked on each span.



Conclusion

Rebuilding of this bridge has been completed by September 2010 , ancillary works have been completed by the end of March 2011

The following decisions with regard to the rebuilding of this bridge are appreciable.

(1) Planning of the rebuilding under running traffic condition.

(2) Designing the new bridge in such a way that existing bridge would continue to take the loadings and the new bridge would come into action once the existing bridge screw pile collapses.

(3) Rebuilding without any interference to running traffic by way of speed restrictions, regulation of traffic .

(4) The ideology and methods adopted in rebuilding of this bridge covering six railway tracks, carrying traffic on all the tracks throught the day and night , with typical water flow pattern through the bridge.

It may be pointed out that after completion of the rebuilding of this bridge there is a reduction in the water way, however it is seen that adequacy of the water way has been checked.

Similar ideology, methods may be adopted in similar works to achieve optimization of resources.