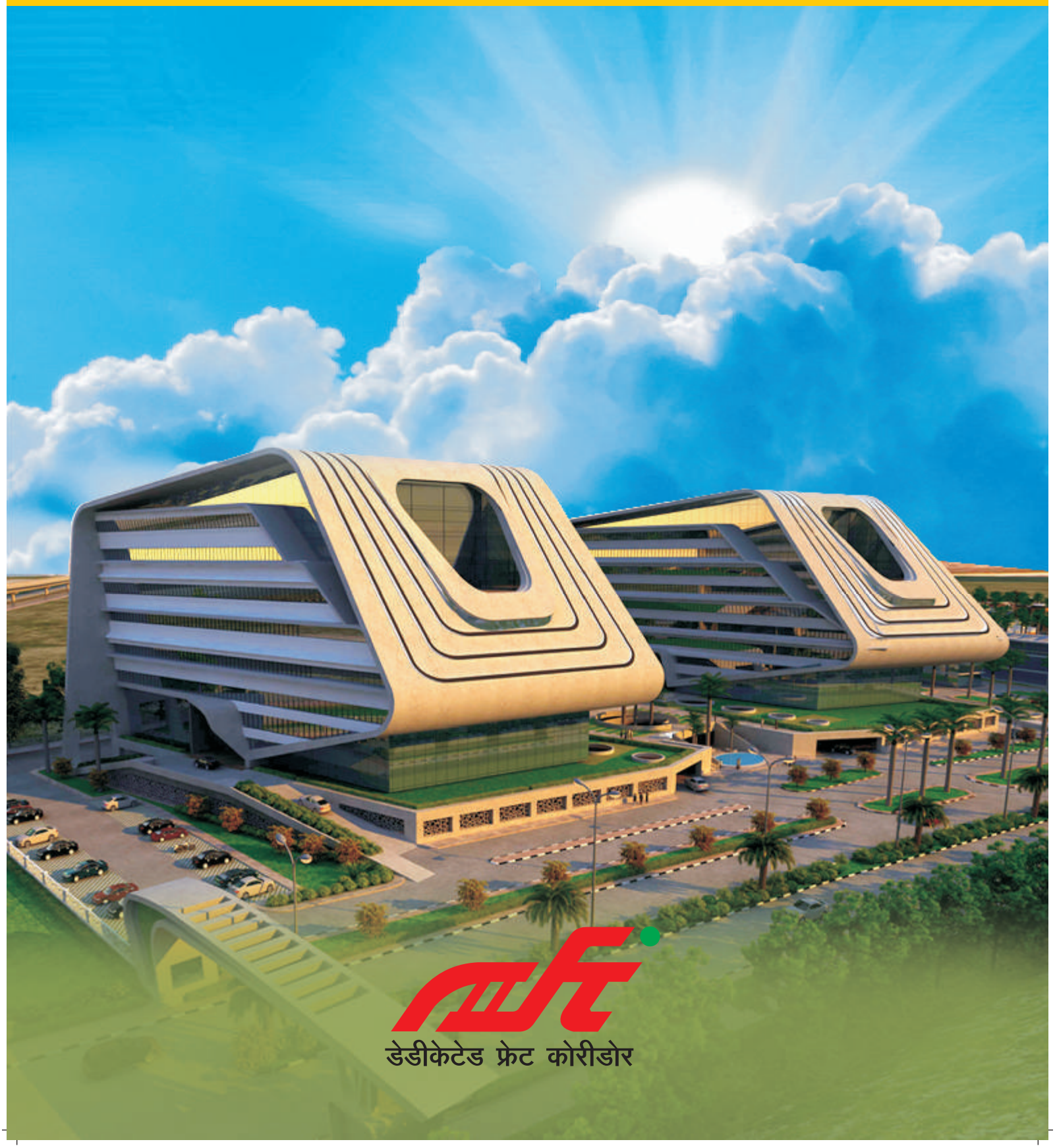
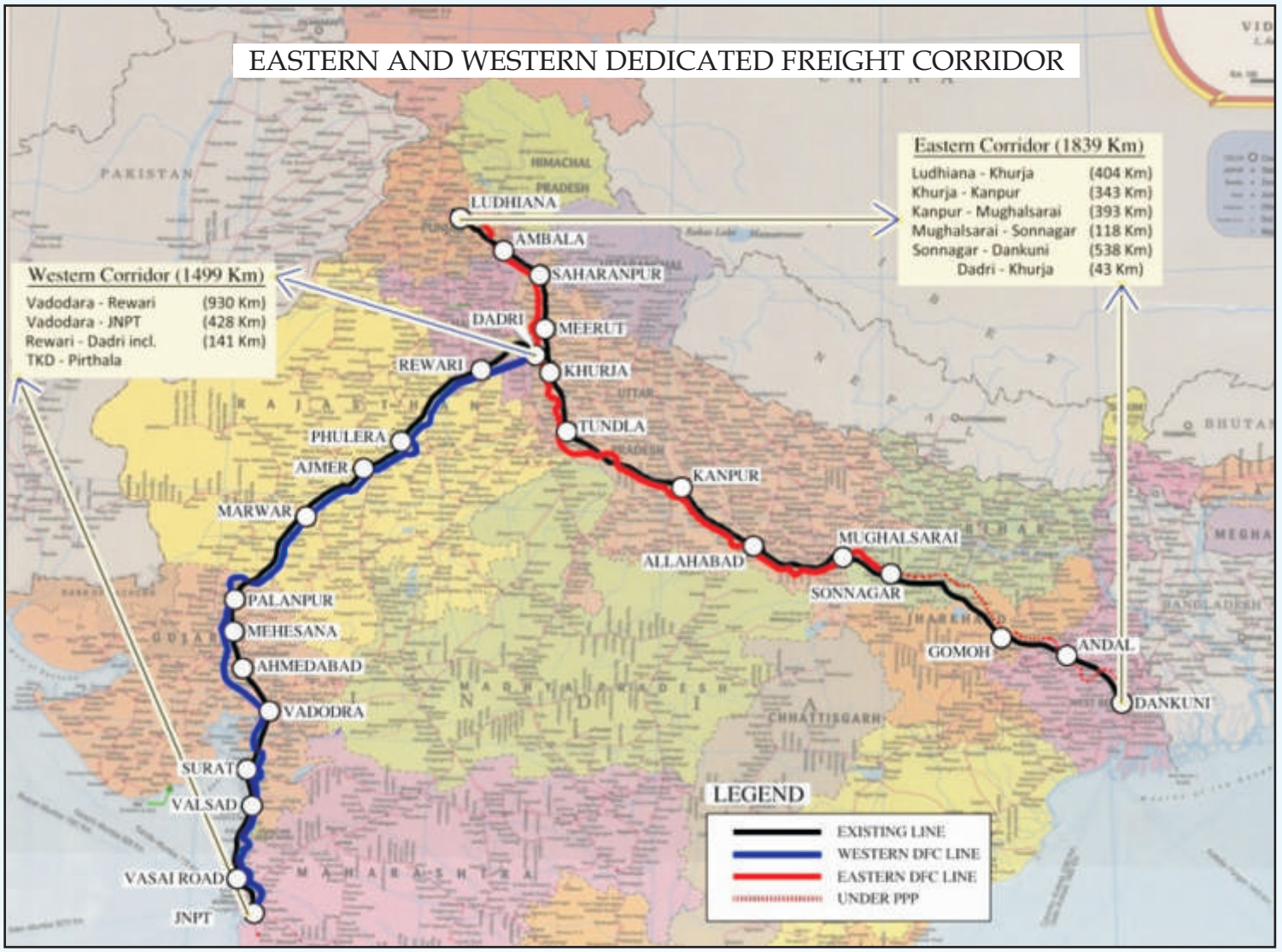
The DFCCIL JOURNAL

ISSUE II, MARCH 2019





Targets

Western Corridor

SN	Sections	Targets
1.	Ateli-Phulera (190 Km)	August - 2018 (completed)
2.	Rewari-Madar (306Km)	December - 2018 (completed)
3.	Madar-Marwar (128 km)	June - 2019
4.	Marwar-Palanpur (207Km)	December - 2019
5	Palanpur-Makarpura (308Km)	2020
6.	Makarpura-JNPT (430Km)	
7.	Rewari–Dadri (127Km)	

Eastern Corridor

SN	Sections	Targets
1.	Khurja-Bhadan (200 km)	November - 2018(completed)
2.	Bhadan-Bhaupur (143 Km)	June - 2019
3.	Bhaupur-Mughalsarai (402 km)	December - 2019
4.	Sonnagar–Mughalsarai (126km)	2020
5	Khurja-Dadri (46km)	
6.	Pilkhani–Sahnewal (179km)	
7.	Khurja–Pilkhani (222km)	

FROM THE EDITOR's DESK

Dear Readers,

I convey my warmest greetings and best wishes for the New Year 2019.

It is heartening to note that the inaugural issue of The DFCCIL JOURNAL(Dec-2018) received such a wide spread and appreciative welcome amongst our Rail Fraternity. It is equally satisfying to note that "The DFCCIL JOURNAL", Issue-I, containing scholarly & insightful articles on a wide range of contemporary technical topics of multiple hues, came up to the cherished objective of dispensing Knowledge and spreading awareness about the various aspects of Iconic DFCCIL Project.

I would like to sincerely thank the learned authors for their contribution of the valued articles, printed in its inaugural issue (Dec-2018). Without their assiduous effort and unwavering commitment, The DFCCIL JOURNAL, Issue-I would not have been such resounding success.

DFCCIL is on the cusp of making a paradigm shift in the Country's Transportation matrix. With the advent of DFCCIL, no longer, transporting bulk goods across large distances between our Industrial and commercial hubs economically, at high speed to pre-stipulated time frame, would be in the dream realm.

In the second issue of The DFCCIL JOURNAL (March-2019), we have made an effort to bring to our readers another bouquet of enlightening multi disciplinary articles which would shed further light on the State-of-the-Art front line technology being adopted for the accelerated Project Implementation. I, sincerely, hope that you would find the current issue of The DFCCIL JOURNAL, satisfyingly informative.

Dear Readers, I take this opportunity to request you to convey your appreciation of the DFCCIL Journal. Your valued suggestions would be most useful in making DFCCIL Journal, more successful and to encompass a much wider range of topics.

Enjoy reading.

Anurag Kumar Sachan
Managing Director, DFCCIL

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Artist's Impression of DFCCIL Corporate Office Building at Greater Noida

Back cover picture

Artist's Impression of Heavy Haul Research Institute

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PHOTO

Completed Station Building at Tundla

Completed View of EDFC Section

Girder Launching in EDFC

CTP -15A: Br. No. 60 PAR (5 x 45.7m) :
P1 Pier concreting in progress

CTP-12: Blanketing work in progress CH: 45.800 – CH 46.100

CTP-15A:Bridge No. 60 on River Par
(5 spans of 45.7 m): Jetty Work in Progress

GALLERY

CTP-15A:Bridge No. 240 on River Tapi (15 spans of 45.7 m): Various Works in Progress

CTP-14: Foundation Work in Progress for Viaduct No. 92

Deck slab work in Progress at ROB-6

Work in Progress at Major Bridge No. 472

EDFC -2 Work in Progress at Tonse Bridge

EDFC -2 Work in Progress at Major Bridge 356

INNOVATIVE CONSTRUCTION TECHNIQUES FOR PRE-CASTING & ERECTION OF FULL SPAN PRE-STRESSED PRE-TENSIONED CONCRETE BOX GIRDERS

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CGM/Noida/DFCCIL

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ABSTRACT:
Strict WDFC Project Time lines have triggered the necessity of discovery of innovative methods of Project implementation. Aravalli Hills topographical Features, prevalent in WDFC Contract Package (CGM/Noida), make the construction of Bridges, earlier planned with Pre Cast I Girders, both onerous and time consuming.
The ensuing Article dwells, at length, upon the innovative way of expediting the Construction of six Bridges involving about 210 Girders by way of switching over to 32 M Box Girders planned for mass production through (2 Beds ; 4+2) long line Method ina special Casting Yard, constructed at site.
Pre casting of full Span Pre-tensioned Box Girders in 4+2 nos. reduces the overall casting duration from 18 months to 12 months and advent of motorized shifting trolleys, while reducing the travel time during shifting and avoids installation of heavy duty Gantry Cranes.

INTRODUCTION:

Package CTP 14 is integrated package involving construction of civil, Building and Track works, Electrical & Mechanical works and Signaling& Telecommunication works for double line electrified track with 2x25 KV AC, 50 Hz. Overhead Catenary System capable of operating at a maximum train speed of 100 Km/h, from Rewari to Dadri (128 km).

Area of Package 14 is located at the end of Northern section from Rewari to Dadri of Rewari – Dadri section of phase – 2 Project. The work shall be carried out between Rewari to Dadri (128 km) through the regions of Rewari – Alwar – Mewat – Gurgaon – Palwal - Faridabad – GB Nagar in the state of Haryana – Rajasthan and Uttar Pradesh. This whole section of 128 km is in de-tour.

The construction of 3 Special Steel Bridges including approaches of 100m / 200m length from abutments on both sides of bridges over Indian Railways and across Yamuna River and Hindon River in Rewari – Dadri section, has been planned to be taken up under separate Package (CTP 15- C) and is excluded from scope of work of CTP 14. However, the necessary Track Works under Package CTP 15- C have been included in CTP-14.

CONTENT:

Innovative Construction method for Pre-casting of Pre-tensioned Full Span Box Girders, Handling of the same with Girder Shifting trolleys & Erection with Full span Launching Gantry to reduce construction duration.

CONSTRUCTION STRATEGY:

There are 306 Bridge structures in this project, among which there are 5 Viaducts & 1 Major Bridge situated at the vertical slopes of Aravalli Hills which are very critical to execute due to its topography and huge height of bridges. All these bridges are having various span configurations of 24.4m, 18.3m, etc. initially. Out of all these Bridges, Viaduct 92 is the Longest Bridge of length 2.7 Kilometer and it comes in the foot slope of Aravalli Hill.

During tender stage, all these 6 Bridges construction were planned with precast I girders. But, as all these bridges are at the vertical slope of Aravalli, a lot of practical major constraints faced during Initial planning such as –

- Transporting the I-girders at the Erection location
- Erection by Tandem Lifting With two cranes
- Construction of deck slab at a height of 25m-30m, etc.

To overcome these constraints, following steps has been taken:

- For ease of construction, all these spans are converted into equal spans of 32m box segment.
- Complete casting is planned with Full span Pre-cast Pre-tensioned Box-girders, with 6 Nos. pre-tensioning bed/mould.
- Precast Yard is planned at the End of Viaduct 92, and all Girders for these 6 bridges will be fed from one single end.
- Erection of Full span Girders with Full span Launching Gantry of 360MT capacity.

Reasons for considering Full Span Box girder of 32m length:

- With further increase in span length, the dead weight of Girder will be much more for Handling & Erection.
- Time Bound is the reason for not considering Segmental Construction as in Segmental Erection of span, it will have a cycle time of Minimum 7-8 days, against asking rate of Erection cycle time of maximum 2-3 days.
- 32m Span is the most economic design solution considering DFCC's 32.5 MT axle load & height of bridge at 22-30m.
- Since Elastomeric Barings are planned for faster erection with Launching gantry, 32m Box girder weight is ideal for the Bearing type.
- Since transportation of precast Girders are planned with tyre transporter for faster & easier transportation over the erected deck, weight of 32m Box girder is ideal for this type of tyre transporter.

SUMMARY OF BRIDGES WITH FULL SPAN BOX GIRDERS

Sl. No.	Bridge Type	Bridge No.	Span Configuration	Span Length	No. of Girders
1	Viaduct	87	3 x 32m	32m	6
2	Viaduct	87A	5 x 32m	32m	10
3	Viaduct	87B	2 x 32m	32m	4
4	Viaduct	88	4 x 32m	32m	8
5	Major Bridge	91	6 x 32m	32m	12
6	Viaduct	92	85 x 32m	32m	170
				Total =	**210**

- **Total No. of Girders : 210 Nos.**
- **Length of each girder : 32 meters**
- **Weight of each girder : 330 MT**
- **Height of Girders : 2.9 meters**
- **Width of Girders : 6.2 meters (straight span) & 6.68 meters (curved span)**
- **Minimum radius of curvature : 700 meters**
- **Maximum longitudinal slope : 1 in 200**

As there are varieties in the curvature of spans, we designed the Box-girders keeping similar cross section in all type of straight & curvature spans and kept provision of adjusting the deck slab length/width as per curvatures. The similar cross-section of girders will facilitate the ease of construction.

Below is the Procedure described for Pre-casting of Box Girders, Stacking, Transportation &Erection of the same with Launching Gantry.

1. PRECASTING OF BOX-GIRDER:

1.1 CASTING YARD PLAN:

The casting yard is planned at the end of the Viaduct, with 2 long-line casting beds comprising of 4 nos. & 2 nos. Box girder moulds respectively. Structural steel shutters are planned to economize the setup & to achieve maximum repetitions.

Two nos. gantry cranes of 20MT capacity are installed over the casting beds, which shall be used for handling of various components such as shutter panels, rebar cages, stressing arrangements, etc.

The casting yard is also equipped with 6 nos. rebar jigs to pre-fabricate the rebar cages of Box girders and a Lifting truss, particularly designed for lifting the 32m long & approx. 12 MT heavy rebar cages. The cage lifting is done with the 20 MT Gantry cranes in synchronization.

The casting yard is having a stacking capacity of approx. 50 nos. Box girders at any instance of time. Also, for shifting the casted Box girders, Track foundations are constructed along transverse direction to side-shift the Girders & along Longitudinal direction to shift the Girders till Erection location.

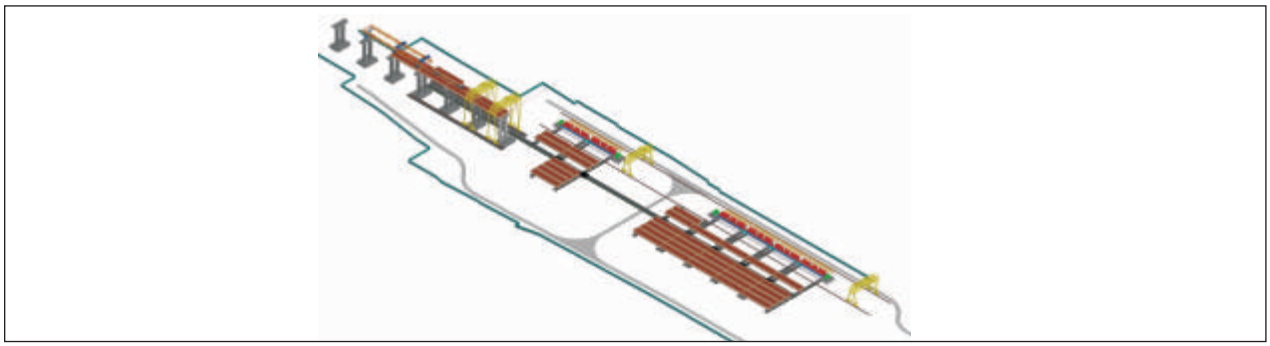


Figure 1: Casting Yard Layout

1.2 PRE-CASTING BED PREPARATION:

The casting beds are designed to withstand a massive 3500 MT of pre-tensioning force, the First-of-its-kind in DFCCIL Projects.

The Stressing end & anchoring end of casting beds are designed with pile foundations. The horizontal pre-tensioning force shall be absorbed by the compression member connecting each of the foundations. The piles at both the ends shall take the tension-compression couple developed from about 3400 MT of stressing force applied at a vertical eccentricity over the ends. The intermediate foundations are designed as open foundations to take the vertical girder loads during pre-casting.

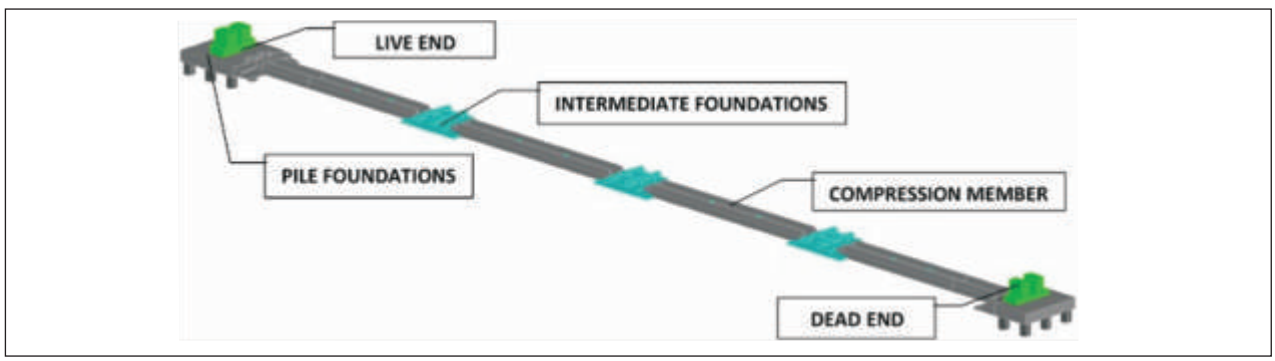


Figure 2: 4-Longline Mould casting bed system

1.3 FORM WORK DESIGN & FIXING:

The Form work system for these box girders are specially designed to achieve smooth operation cycles as a total of 210 nos. girders to be casted. The Outer shutter & truss are designed with mechanical jacks at bottom to adjust the height during de-shuttering process& flanged wheels to shift the shutters. Also, there are tracks, designed specifically for shifting the outer shutters after de-shuttering.

Form work for the precast box girder comprises mainly of following components – Bottom shutter, Outer shutter, Outer truss, Inner shutter, Inner truss & End shutters.

Stages of form work fixing:

- First Bottom shutter shall be assembled over the RCC pedestals. The pedestals to rest the Bottom shutter is designed with Steel insert at top, over which the bottom shutters shall be welded.

Figure 3: Fixing of Bottom shutters

- Then outer truss shall be assembled at the sides of bottom shutters. The outer trusses are supported by mechanical screw jacks to adjust the height of the form & wheels for longitudinal & transverse movement.

Figure 4: Outer truss & outer shutter fixing

- Once trusses are assembled, the outer shutter panels will be placed & assembled over the outer trusses. The shutters shall be aligned as per the box girder dimensions.
- Next, the end shutters shall be fixed at both ends of each girder. Enlarged holes as Imprint of the Strand layout is left over the end shutter panels to pass the strands smoothly thru it.

Figure 5: End shutter

- The inner truss for each girder is supported by 12 nos. 20MT capacity hydraulic jacks for vertical adjustments& flanged wheels to shift the trolleys longitudinally over temporary rails. The temporary rails shall be placed over precast concrete block of similar concrete grade as that of the box-girder, so that the blocks get embedded during girder concreting. First, the inner shutters shall be assembled over the truss externally. Once the rebar cages are placed in position, the inner shutters along with truss shall be placed over the precast blocks inside rebar cage.

Figure 6: Placement of Inner shutter along with inner truss

1.4 PRE-FABRICATED REINFORCEMENT CAGES:

Rebar cages are planned to be pre-fabricated, as it will save the tying time if tied over the rebar jig, as it will not disturb the casting bed. Moreover, cages can be tied parallelly with casting of girders. Thus, eliminating the complete tying time.

- A total of 6 nos. light weight rebar jigs are specifically designed &fabricated with structural steel hollow sections, over which the rebar cages shall be pre-fabricated.Only the reinforcements of bottom slab along with the webs shall be tied in rebar jigs. Once the pre-fabricated cage is placed over the bed & Inner shutter is assembled, the reinforcement for top slab shall be tied over the bed.

Figure 7: Rebar tying over rebar jig

Figure 8: Rebar cage lifting with Spreader beam

- One steel spreader beam of enough capacity is fabricated to lift the pre-fabricated rebar cage weighing approx. 12MT. The spreader beam shall be lifted in tandem by two synchronized 20MT Gantry cranes.
- The deck slab reinforcement shall be tied above bed, after placing inner shutters.

1.5 PRE-TENSIONING WORK:

Pre-tensioning is the method where strands are pre-stressed prior to concreting, against two rigid abutments, i.e. Live End or the Stressing end & Dead End or the Anchoring end.

Straight span Box-Girder:

Strand type: Ply of 15.24mm nominal dia. uncoated stress relieved low relaxation steel conforming to is :14268 having breaking strength of 260.7KN.

No. of strands: 144 nos. at bottom soffit level & 20 nos. at deck slab level.

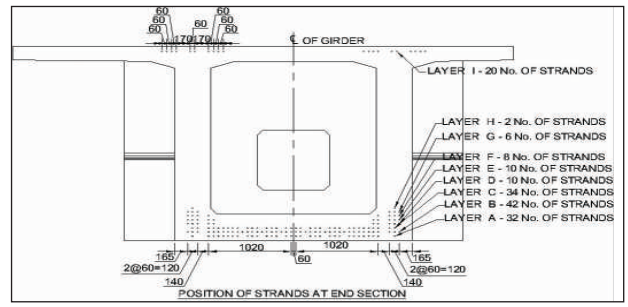


Figure 9: Straight span Strand layout (164 nos. strands)

Stressing on each strand required: 195.525KN.

Total stressing force: 28156KN at soffit level & 3911KN at deck slab level (Total of 32067 KN).

Curvature span Box-Girder:

Strand type: Ply of 15.24mm nominal dia. uncoated stress relieved low relaxation steel conforming to is 14268 having breaking strength of 260.7KN.

No. of strands: 150 nos. at bottom soffit level & 20 nos. at deck slab level.

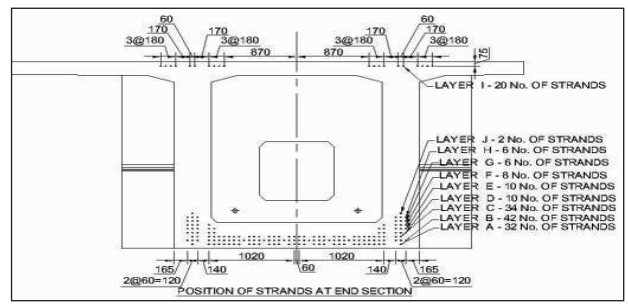


Figure 10: Curvature span Strand layout (170 nos. strands)

Stressing on each strand required: 203.893KN.

Total stressing force: 30584KN at soffit level & 4078KN at deck slab level (Total of 34662 KN).

Application of Stressing load:

First, all the strands shall be laid & shall be de-bonded wherever required as per approved drawing.

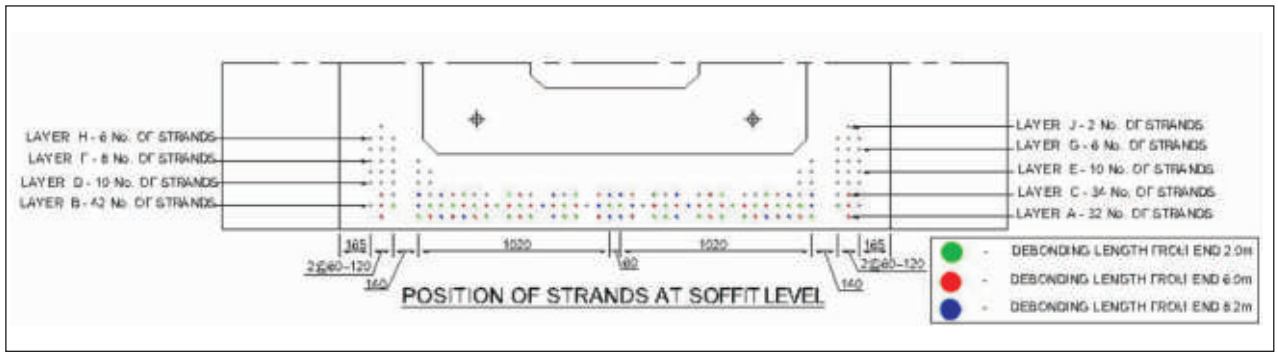


Figure 11: Strand arrangement at soffit level (showing de-bonding arrangement)

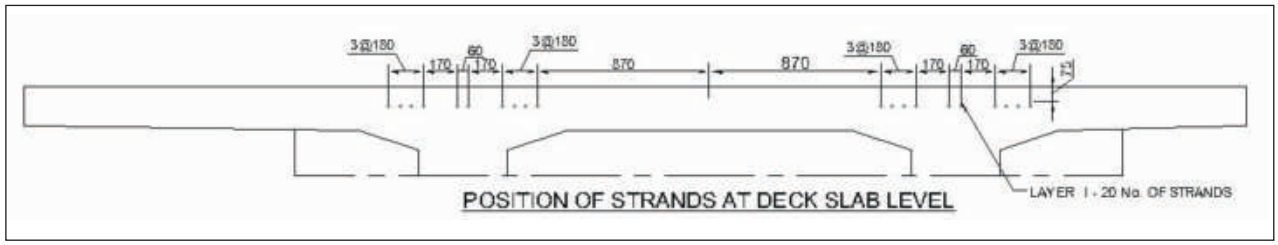


Figure 12: Strand arrangement at deck slab level

- The strands shall be locked at both live end & dead end with Barrels & Master wedges.
- At dead end, the strands shall be anchored directly over the abutment wall.
- At live end, the strands at soffit level shall be locked over a structural steel frame, called the 'Floating beam', designed to withstand the stressing force of 3500 MT and the strands at deck slab level shall be locked over the live end abutment wall.
- The floating beam shall be connected with the Live end abutment by 12 nos. 75mm dia. stress bars of 1030 grade to withstand the pre-tensioning forces.
- PTFE pads are fixed at the base of the floating beam & it shall be rested over SS plates to allow sliding of the beam due to stressing.
- Each of the stress bars shall be locked with one Center hole jack of 300MT capacity.
- All the 12 jacks shall be connected to a single power pack, so that all the jacks can be synchronized.

Figure 13: Floating beam anchoring assembly (Position after complete stressing)

- The power pack shall be operated to stress the bars and simultaneously the stress will be transferred to the strands at soffit level. In no case, the stress in the strands shall exceed the limiting value (195.525KN for straight spans & 203.893KN for curved spans).
- The strands at deck slab level shall be stressed individually with mono-strand jacks, as shown below.

Figure 14: View of stressing arrangement for Bottom layer of strands

1.6 CONCRETING:

Figure 15: View of Strands & Stressing arrangement for top layer

Once pre-tensioning activity is completed for all the strands, the following stages will be followed for concreting of each girder:

- First the soffit slab shall be casted up to haunch level of the girder, which is approx. 35 Cum. The concrete shall be poured through the web reinforcements as well as through temporary pockets left over the inner shutter.

Figure 16: Drone view of Concreting work

- Then within 1-1.5 Hrs., wall casting shall be started up to 1m height of wall, which is approx. 25 Cum., and subsequently next 1m height shall be casted, measuring approx. 25 Cum.
- The shutters are designed to install High frequency shutter vibrators for better compaction of the wall concrete, which consists very dense reinforcement.
- After completion of 2 lifts of wall, the deck slab casting shall be done along with the remaining part of wall, measuring about 50 Cum. The end diaphragms shall not be casted over pre-cast bed, since it will obstruct the inner shutter to come out. Vibrating needles used for compaction of the top layer of concrete.
- End diaphragms shall be casted after shifting the girders over stacking beds.

Figure 17: Girder Concreting Finishing work

1.7 REMOVAL OF FORMWORK & DE-TENSIONING:

- First, outer shutters shall be removed by lowering it with the mechanical screw jacks. Once lowered, the outer shutters along with outer trusses shall be shifted sideways over the tracks laid.

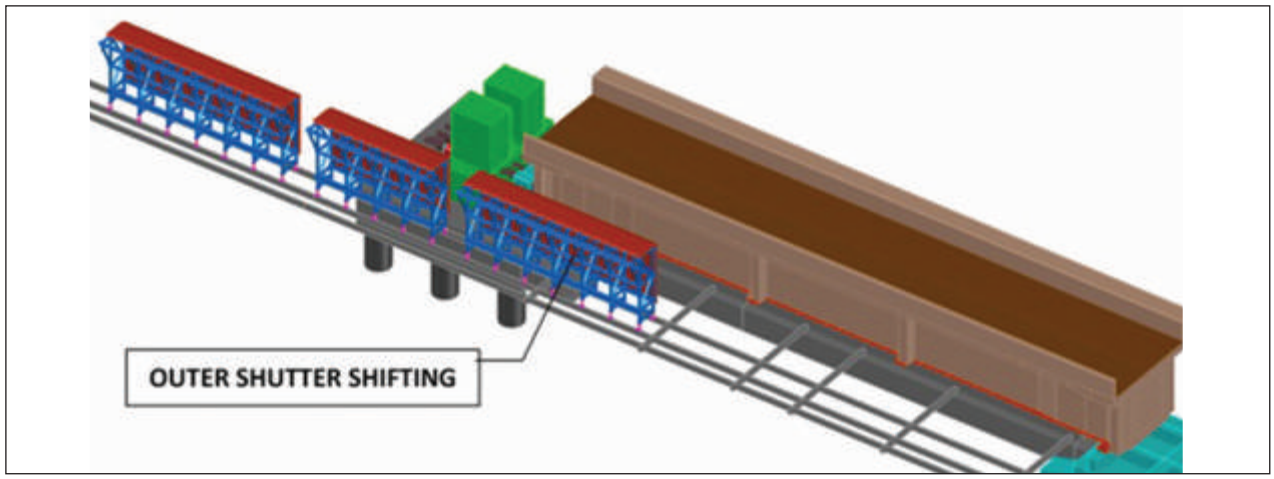


Figure 18: Perspective view of Outer shutter shifting

- After removal of outer shutters, de-stressing activity can be taken up provided girder strength achieves 40MPa strength.
- For de-stressing of soffit level strands, same tensioning Jacks of 300MT capacities shall be used, and for top layer strands, mono strand jacks shall be used.
- After de-tensioning, the strands shall be cut using diamond bit saw or similar equipment and the exposed ends of the strands shall be covered with epoxy coating.
- Once girder is taken out of casting bed, the inner shutter shall be moved out over the shifting rails, and also can be handled with the Gantry crane.

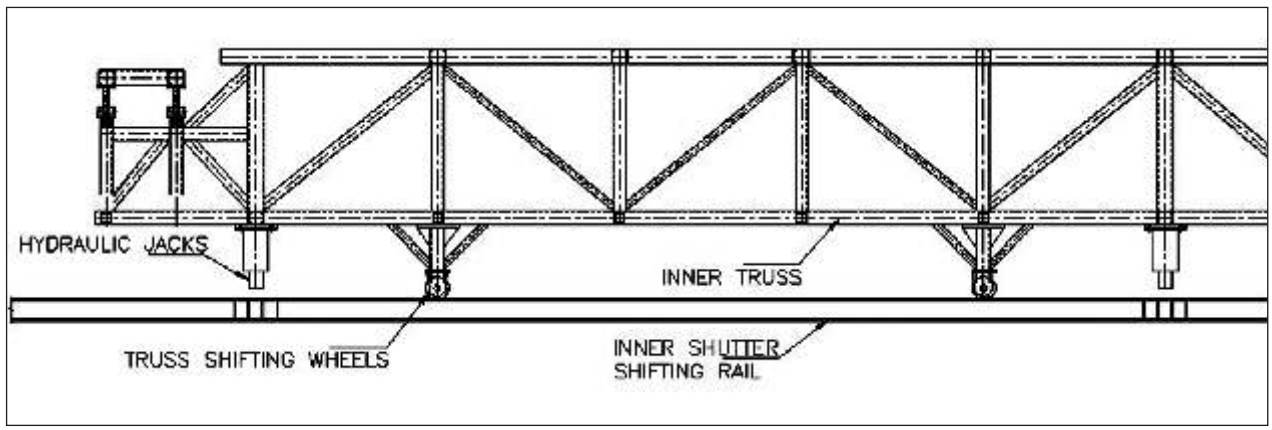


Figure 19: Sketch showing Inner truss & shifting rails

1.8 CURING ARRANGEMENT:

Stages of Girder Curing:

- Once concreting is complete, ponding shall be done over the top slab of girder for curing of top slab.
- Till removal of shutters from walls, water shall be sprinkled over the shutters to maintain the temperature of girder.
- Curing compound shall be applied to the wall faces of girders immediately after removal of shutters from the face of the girders.

Figure 20: Ponding over casted Box Girder

- Ponded water level over the deck slab of girder shall be maintained till the required duration of curing even after shifting the girder over the stacking beds.
- Diaphragm walls & ballast retainers shall be cured with curing compound once casted.

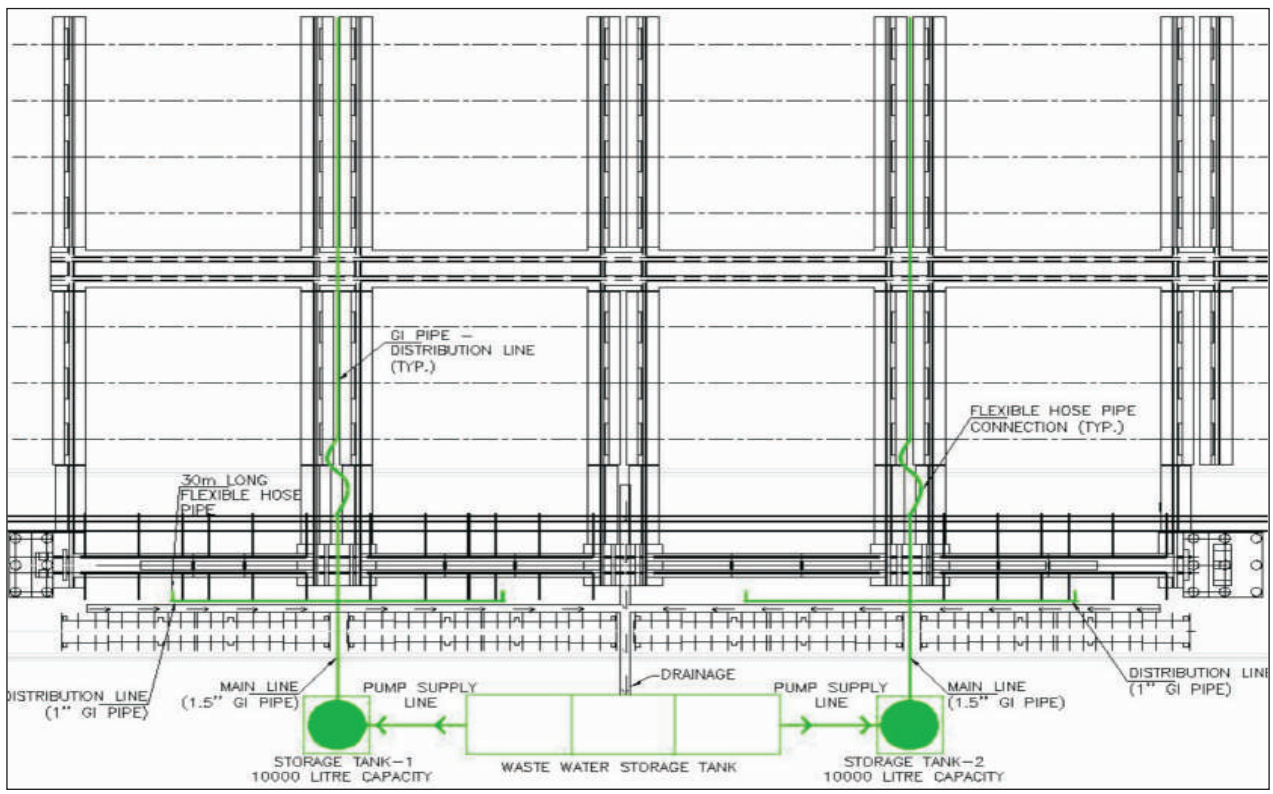


Figure 21: Sketch showing Curing arrangement with Hose pipe layout

2. SHIFTING & STACKING OF GIRDERS:

For stacking of Box girders, approx. 50 nos. stacking places are available in the complete yard. The stacking location of 210 nos. girders are planned as per the erection sequence of the same.

The Shifting of girders from casting bed to stacking locations & from stacking beds to feeding location are not feasible with gantry cranes in terms of operation as well as cost. The shifting needs to be in both transverse & longitudinal directions, and operation with Gantry will not provide a suitable solution. Thus, the complete shifting activities are planned with a set of motorized power trolleys of capacity 360MT, having 4 nos. 120MT hydraulic jacks with 150mm stroke length for height adjustment, and the wheel bogies are such designed that it can be rotated 90 degrees during shifting from transverse to longitudinal direction.

Figure 22: View of girder shifting trolley arrangement

2.1 Technical Parameters of Shifting trolley:

Grade of Mechanism	=	M5	Power Supply	=	Cable drum
Capacity	=	360MT	Rail type	=	80x40 Flat
Wheel Diameter	=	Ø350mm	Control mode	=	Remote
Each Wheel Pressure	=	24MT	Each Jack capacity	=	120MT
Speed of trolley	=	0-9 m/min	Each Jack stroke	=	150mm

2.2 Operation sequence of shifting trolley:

- For shifting of girder from casting bed, the trolley shall be brought below the casted girder, and jacked up with 4 nos. 120MT hydraulic jacks to separate the girder from the bed.
- Once the girder is free from bed, both the units of shifting trolley shall be operated from a single remote and shall be moved outside the casting bed over the side-shifting tracks to reach the dedicated stacking location of the girder.
- Once girder reaches stacking location, the jacks shall be lowered to rest the girder over stacking pedestals.
- For girders to be shifted from stacking bed to the feeding location, the trolley shall be brought below the girder & shall jack up the girder from stacking bed.

- Then, the trolley along with girder shall be moved to the junction of side-shifting & longitudinal shifting tracks.
- Once the girder reaches the junction, the girder shall be supported temporarily by 4 nos. 120MT capacity hydraulic jacks at the girder jacking locations.

Figure 23: Stacked Girder over stacking pedestals

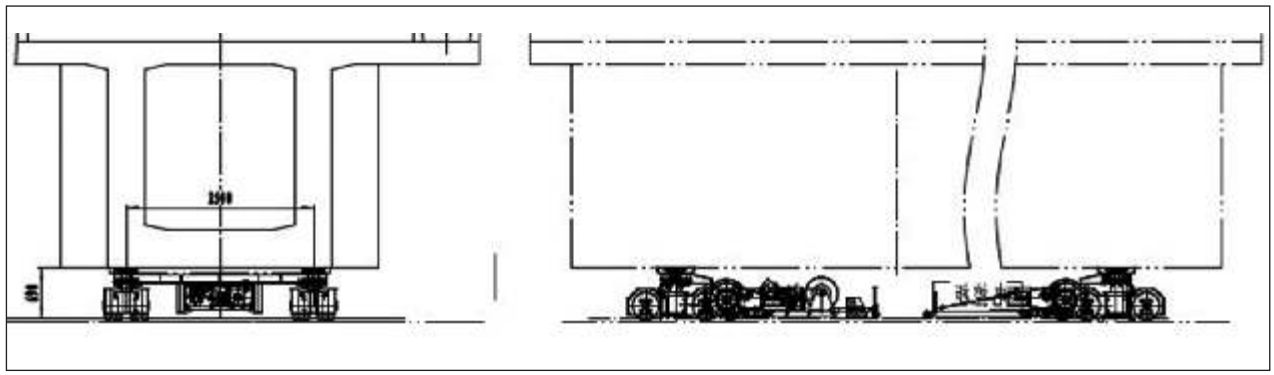


Figure 24: Cross section & Elevation of girder while temporarily supported

- As the trolleys become free, temporary stools shall be inserted below the shifting trolley legs, to support it from bottom.

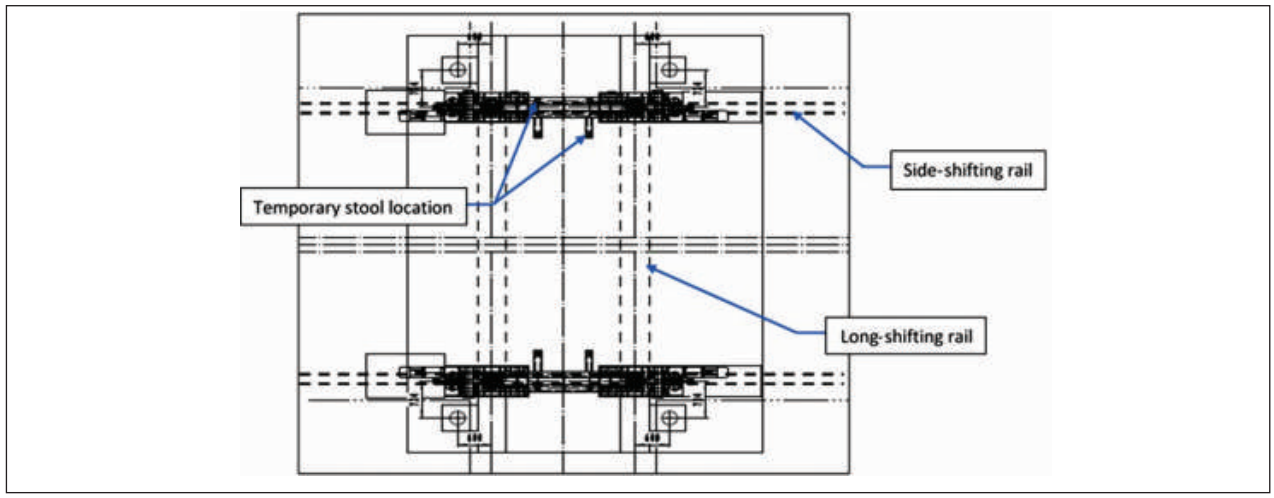


Figure 25: Trolley plan during side shifting

- Once the trolley is ground supported, the jacks shall be retracted to free the wheel bogies & rotate the wheel bogies by 90 degree.

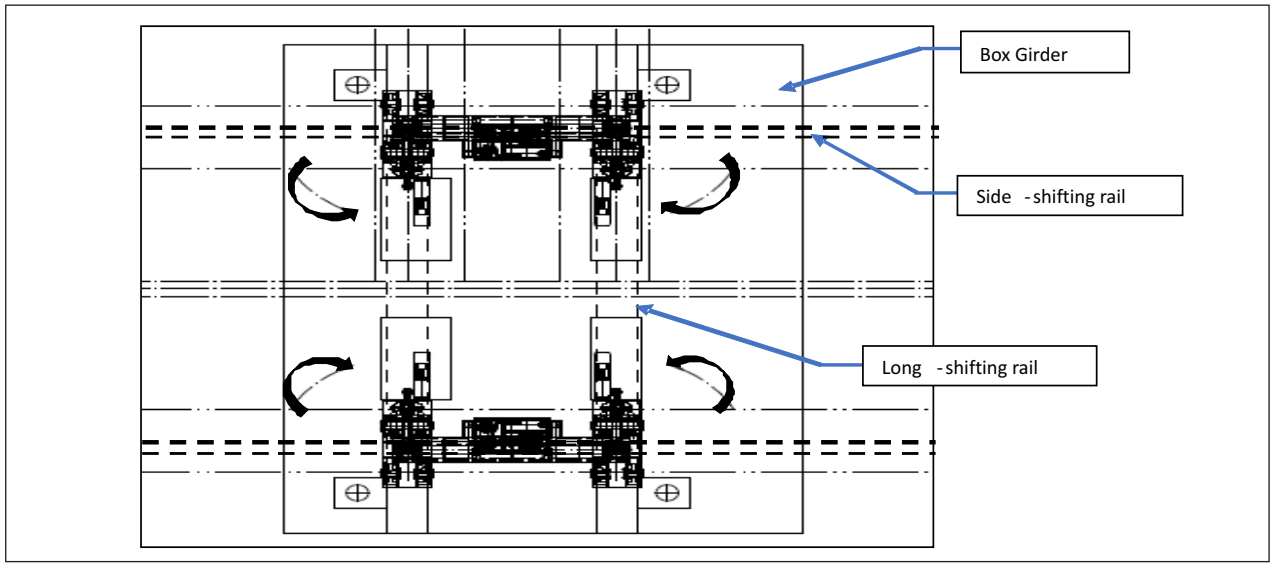


Figure 26: Trolley plan during longitudinal shifting (after rotation)

- After rotating the wheel bogies, the jacks shall be stroked out to rest the trolley over the rail. Next, the girder shall be lowered from the temporary jack supports to rest it over the trolley again.
- Then the girder shall be shifted in longitudinal direction and shall reach the girder feeding point.

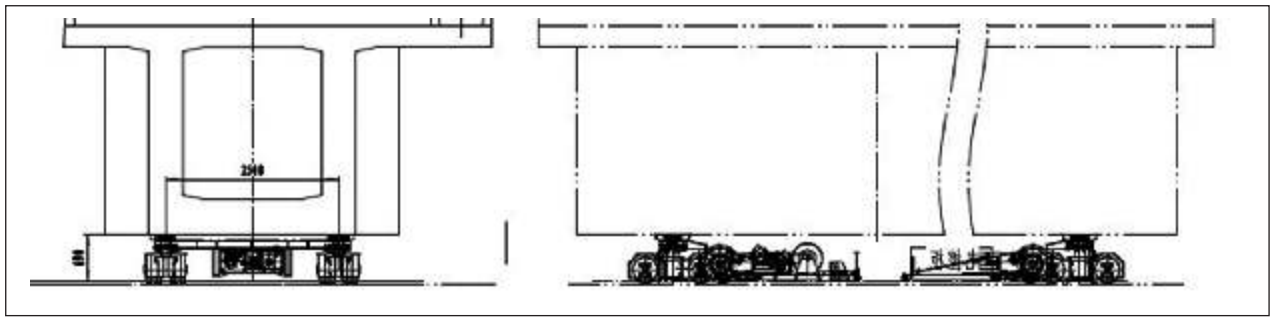


Figure 27: Trolley Cross section & Elevation during long shifting

3. TRANSPORTATION & ERECTION OF BOX-GIRDER:

Once the girder reaches the feeding location, it shall be lifted over the Erected girder, which is at an elevation of approx. 22m from Ground level. The lifting of girder is planned with 2 nos. Gantry cranes of 180MT capacity. The Gantries shall place the lifted girder over Tyre-transporter of 360MT capacity, which shall run over the erected girders till the erection location. Then the girders shall be erected to it's position with the help of Launching Girder of 360MT capacity.

Below are the arrangements & Technical parameters of Gantry crane, Tyre transporter & Launching Girder.

3.1 Portal Gantry arrangement:

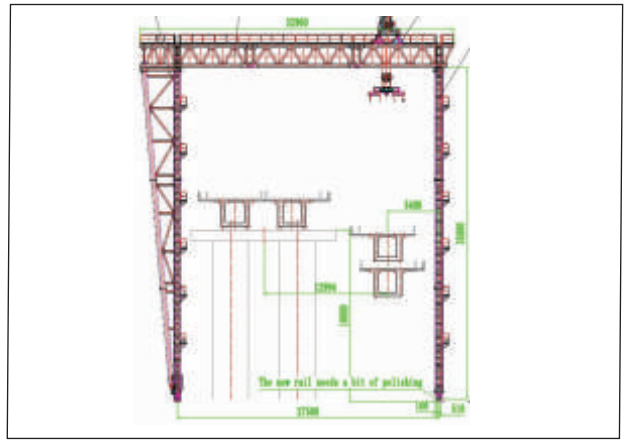


Figure 28: General arrangement of Portal Gantry crane

3.2 Technical parameters of Gantry crane:

Grade of Mechanism	=	M5	Working class	=	A4
Capacity	=	180 MT	Hoisting speed	=	0-1 m/min
Span of Gantry	=	27.5m	Travelling speed	=	0-8 m/min
Lifting Height	=	35m	Slope of operation	=	< 1%
Number of wheels	=	8 Nos.	Wheel pressure	=	220 KN
Power supply	=	415V 3P 50Hz	Environment temperature	=	-100~ +500 C

3.3 Tyre Transporter arrangement:

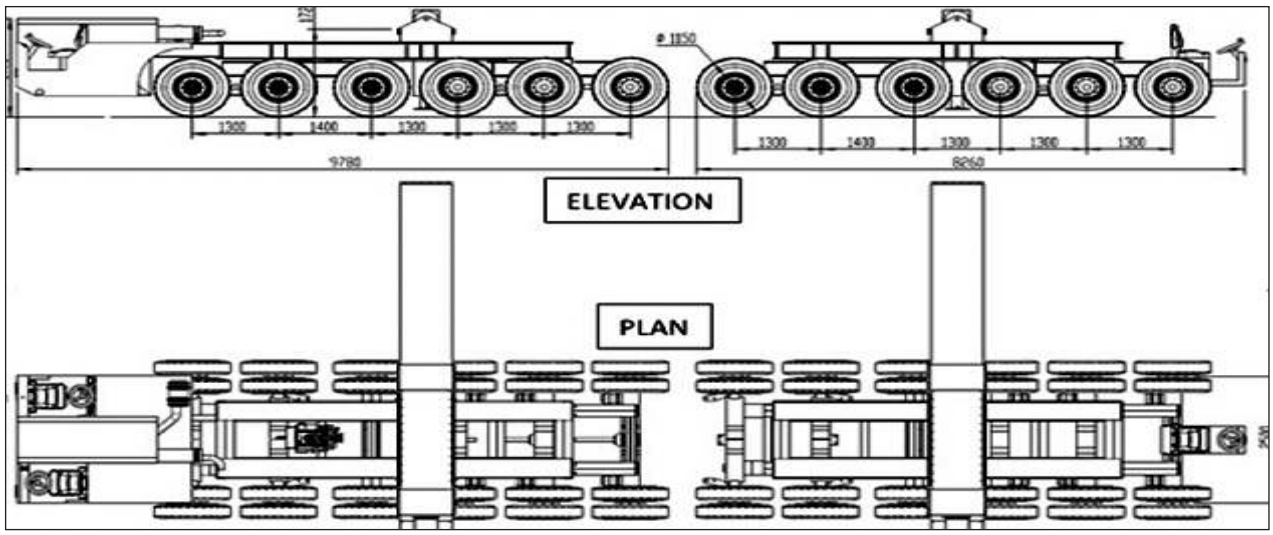


Figure 29: General arrangement of Tyre Transporter

3.4 Technical parameters of Tyre Transporter:

Capacity	=	360 MT	Dead Weight of trolley	=	33 MT
Rated Speed of engine	=	2200 r/min	Shaft Number	=	6X2 = 12
Power of engine	=	247 Kw	Driving Speed	=	(3.5 - 300) m/min
Adaptive slope	=	5% (Hor.), 3% (Ver.)	Front wheel steering	=	200 max.

3.5 Launching Girder (LG) arrangement:

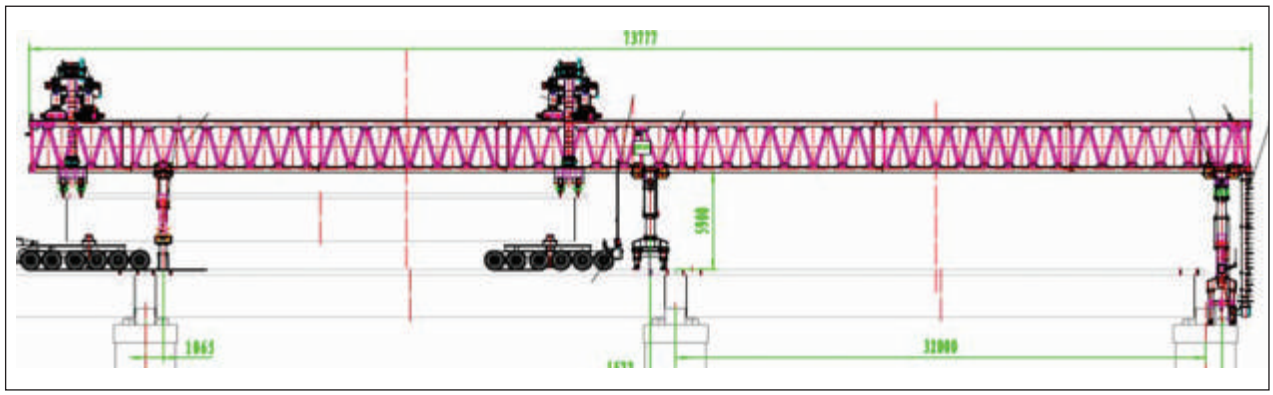


Figure 30: General arrangement of Launching Girder

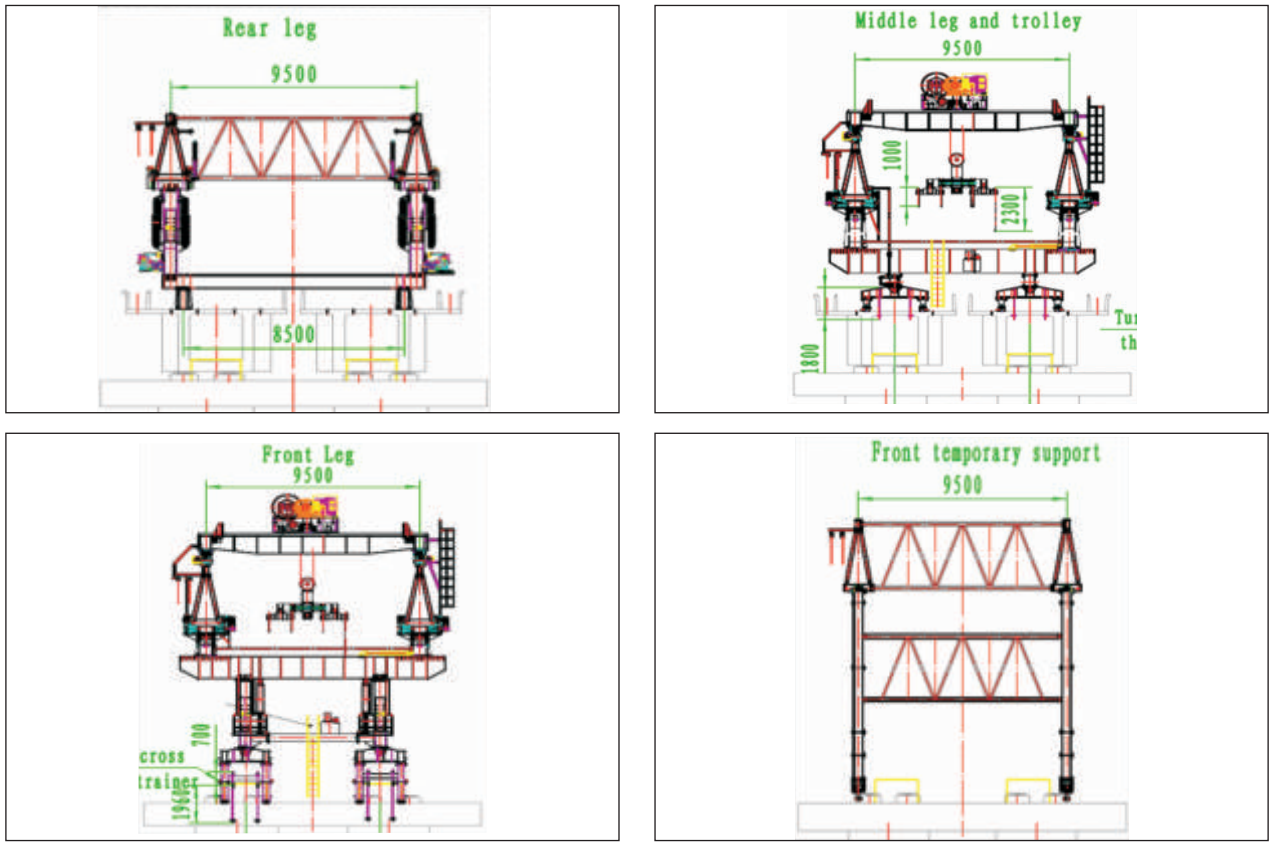


Figure 31: Support legs of Launching Gantry

3.6 Technical parameters of Launching Girder:

Length of LG	=	74 m	Span to be erected	=	32 m
Lifting Arrangement with	=	2 no. Winches	Load capacity	=	2 X 180 MT
Weight of Girder	=	330 MT	Grade of Lifting bars	=	1030 grade
No. of Lifting bars	=	2 X 8 nos.	Dia. Of Lifting bars	=	32 mm
Travel speed of winch trolley	=	5.0 m/min	Power	=	120 KW
Hoisting speed of winch	=	0.7 m/min	Negotiable Longitudinal Slope	<=	0.02
Equipment Launching speed	=	0-3 m/min	Minimum negotiable curve	=	600m

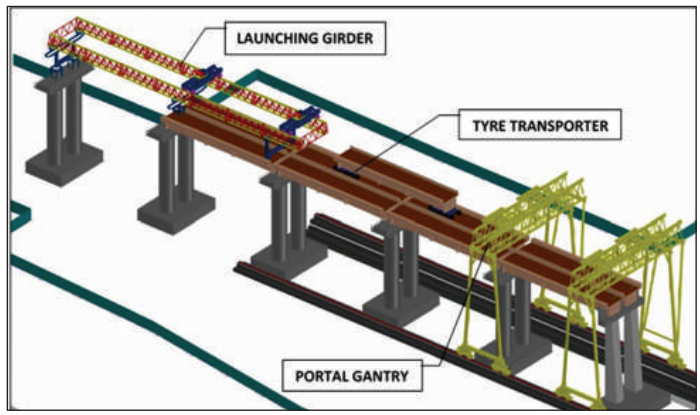


Figure 32: Perspective view of Launching Girder, Tyre Transporter & Portal Gantry

3.7 Procedure for Girder feeding, Transportation & Erection:

- First, the gantries shall be assembled over the 1st span of the viaduct.

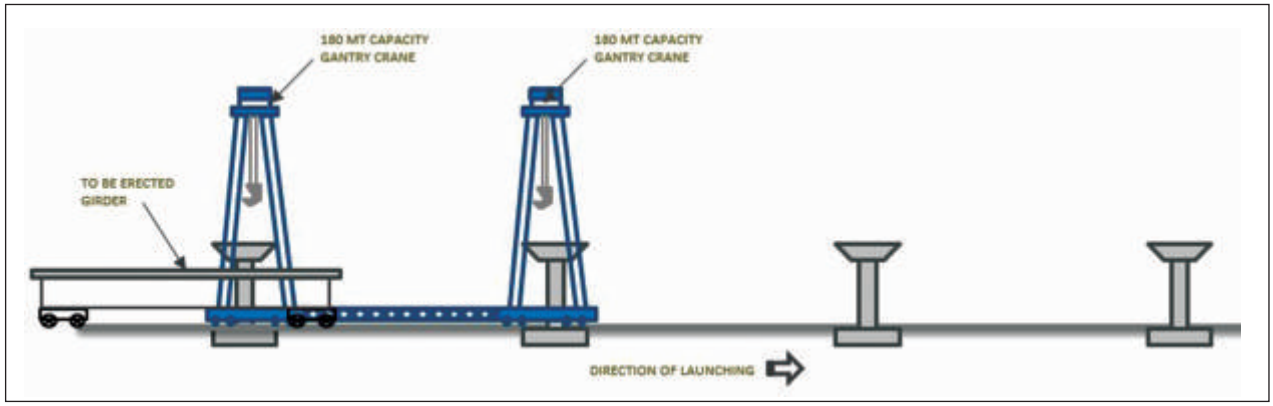


Figure 33: Gantry assembly at first span

- The first span girders shall be erected with the Gantries and the gantries shall be marched and parked in the next span.

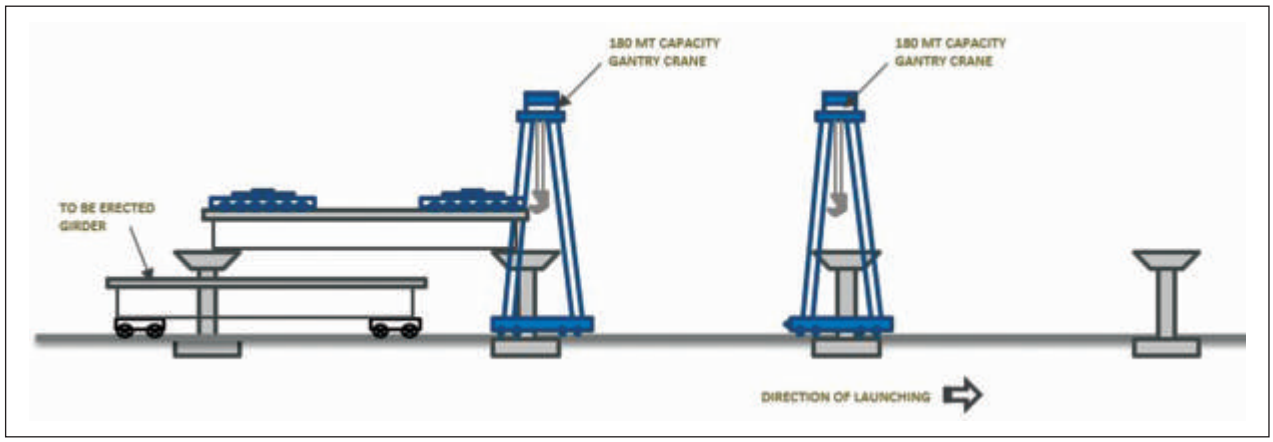


Figure 34: 1st span girders erected with gantry

- Similarly, the 2nd & 3rd span girders shall be erected with the Gantry cranes.

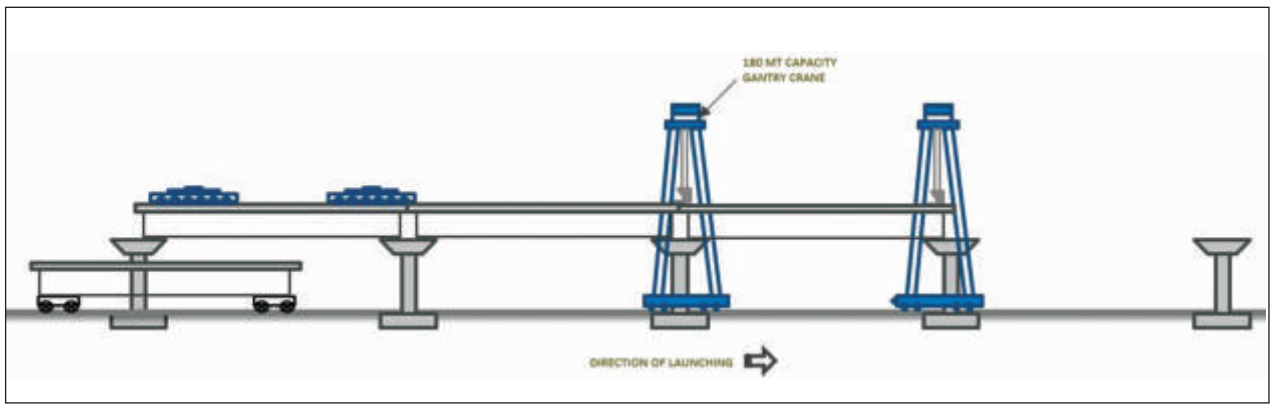


Figure 35: 2nd & 3rd span girders erected with gantry

- Assemble the Launching Girder with all its support legs & winches over the 2nd & 3rd span with the help of Gantry crane.

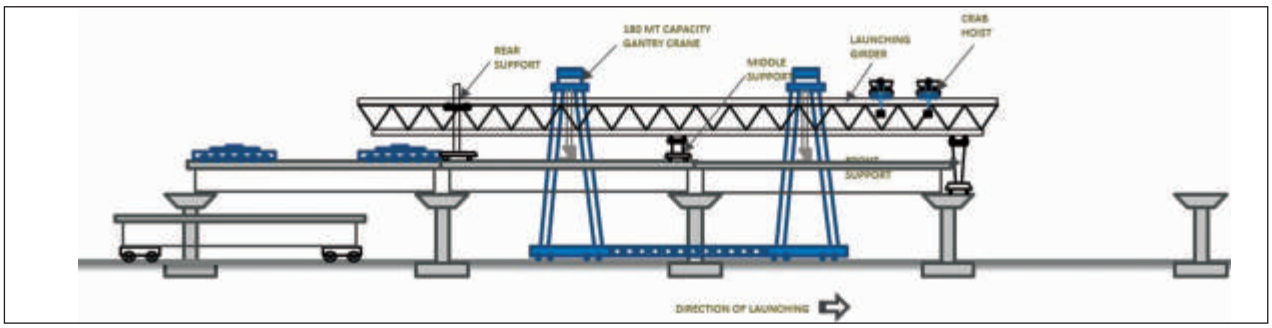


Figure 36: LG assembly with Gantry crane

- Once the LG is assembled completely, it shall be auto-launched with the help of motorized rollers present over the support legs and shall reach to next span for erection. Also, the Tyre-transporter shall be assembled over the first span & the next span girder shall be placed over it for transportation.

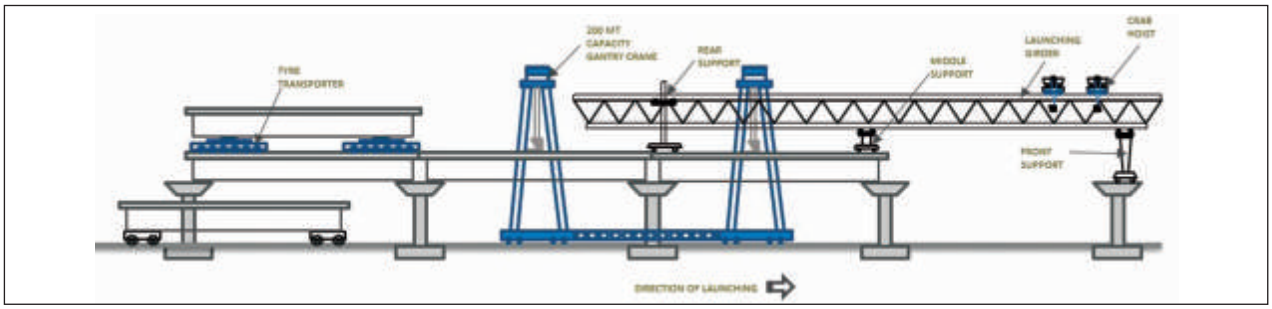


Figure 37: LG assembly with Gantry crane & Tyre-transporter loading

Next, the rear support shall be temporarily deactivated, to allow the transporter to move below the LG along with girder to be erected.

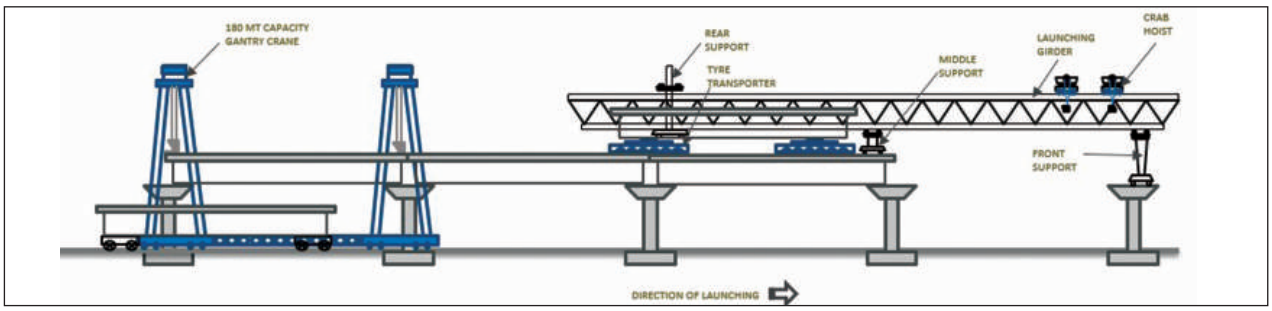


Figure 38: Transporter moved below LG

- Then, the rear support shall be activated again once the girder arrives below LG, and the winches shall be brought to the lifting locations of girder.

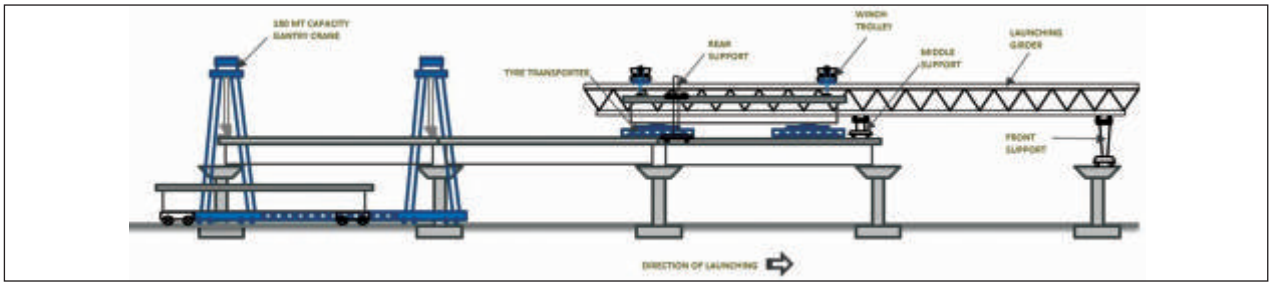


Figure 39: Rear Leg activation & movement of winch trolleys

- Now the winch trolleys shall lift the girder from transporter and bring it over the pier caps for erection. The Lifting of Girder shall be done with total 16 nos. 32mm dia. Stress bars of 1030 grade.

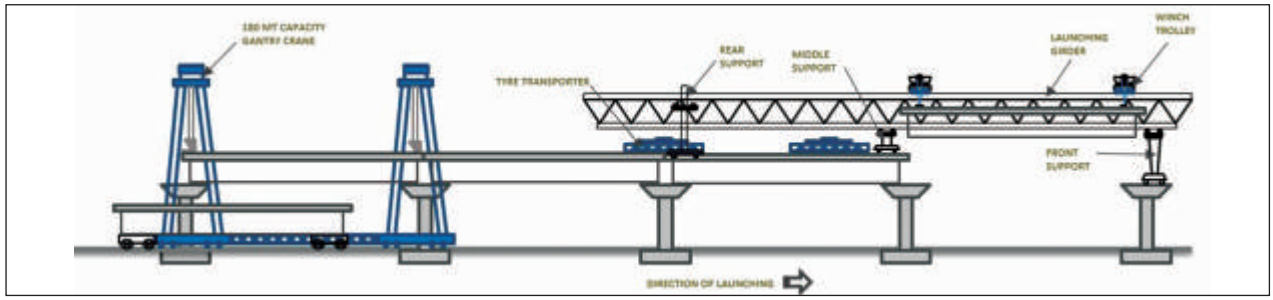


Figure 40: Lifting of Girder

- The girder shall be placed at its actual location. Once the girder is released from winches, the winches shall move to the front of LG & the rear support shall be deactivated again to allow the transporter to move out and bring the next girder for erection.

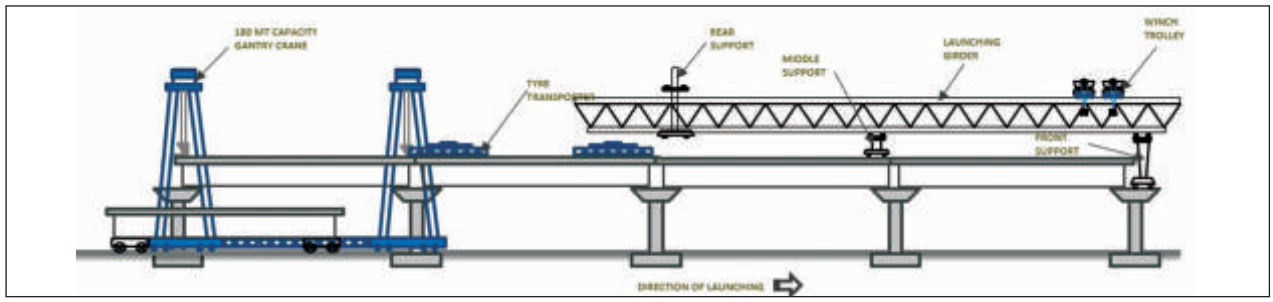


Figure 41: Placement of Girder & Transporter moving out for next girder

- Similar steps shall be followed for further erection of girder & auto-launching of LG.

CONCLUSION:

Looking into the stringent timeline of Project deliverables, the Contractor with DFCCIL officials have adopted the above-mentioned Innovative techniques as the perfect solution for the need of the hour. Following conclusions may be drawn from the overall construction system:

- Pre-casting of Full span pre-tensioned Box girders in 4+2 nos. beds reduced the overall casting duration from 18 months to 12 months.
- Motorized Shifting trolleys for Box-girder shall reduce the travel time during shifting and avoids installation of Heavy or high capacity gantries, which is an innovative solution towards smooth handling of Box girders.
- For erection, single point feeding of girders & transportation above the already erected girders shall enhance the process and operation time as the transportation of girders will be free from local traffic movement and safer.
- With full span Launching girder, the cycle time for any single span can be expected to be finished within 2.5 days in average. Hence, enhancing the overall erection time and the complete erection can be finished within 10 months.

Mainly the long span Viaducts/Bridges located in Aravalli Hills were in critical path of project completion and needed special techniques for on time accomplishment. With introduction of the above technologies, the completion of these critical bridges is now planned within 18 months' time with highest safety & quality compliances.

GAS INSULATED SWITCHGEAR BASED TRACTION SUB-STATION AT KHARBAO-MUMBAI

Sanjay Phulwaria
General Manager/EL/Mumbai/S/DFCCIL

Introduction

Existing CR 100/25KV AC TSS at Kharbao is infringing with the proposed DFC alignment and is located on the north east of the Kharbao station. New DFC TSS220/54 KV was also required to be located near the Kharbao station. As per the DPR the proposed DFC TSS and new CR TSS were planned to be constructed on the North West of the station. However, in the field survey later the proposed location was not found suitable as it had many constraints.

- Portion of the hillock needed to be flattened to construct the TSS of IR, DFC and the MSEB LILO. This would have involved huge expenditure.
- CR plans to run suburban EMU trains in future in this section. Construction of TSS on the west side would have restricted the expansion of existing station for the purpose.
- There was no road connectivity available for transport of construction machinery and equipment to the proposed site. A temporary LC needed to be constructed which would have hampered the smooth train operation.

In order to overcome these issues it was proposed to construct an integrated 220 KV GIS (Gas Insulated Switchgear) based TSS instead of conventional AIS (Air insulated switchgears) based sub stations being used in IR. Same was proposed near the existing CR TSS site only to utilise the existing land optimally. GIS is a new technology and has many advantages over AIS based conventional substations.

Major advantages are as given below:

- **Compact Design**

  The installation space that is required is about 1/10~1/20th than that of conventional air insulated substations which makes it possible to install GIS within a building. Preferred solution where land availability is restricted and cost of land are high as in Metros and big cities.

First GIS based TSS on Indian Railways by DFCCIL

- **Safety**

  High degree of safety for operating personnel due to Enhanced insulating properties. Personnel safety is ensured by an earthed enclosure, numerous interlocks, and lockout devices. Greater stability is provided during earthquakes and the perfect enclosure protects from loss or damage from salt, dirt, weather, and lightning. While the SF6 gas insulation prevents deterioration, the partition of the gas prevents accidents from occurring.

- **Superior Reliability**

  High level of availability

- **Installation & Transportation**

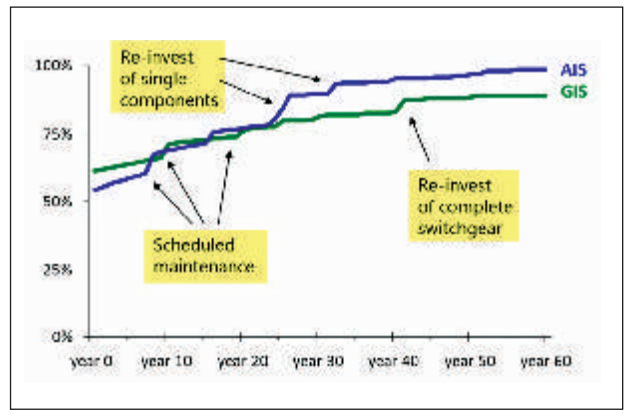
Short planning, delivery and installation periods. Installation time and costs are reduced since the system is shipped in a completely assembled bay or by unit.

- **Easy extension and up gradation.**
- **Advance in-built fault detection system.**
- **Elimination of Periodic Maintenance and Economical cost of operation.**

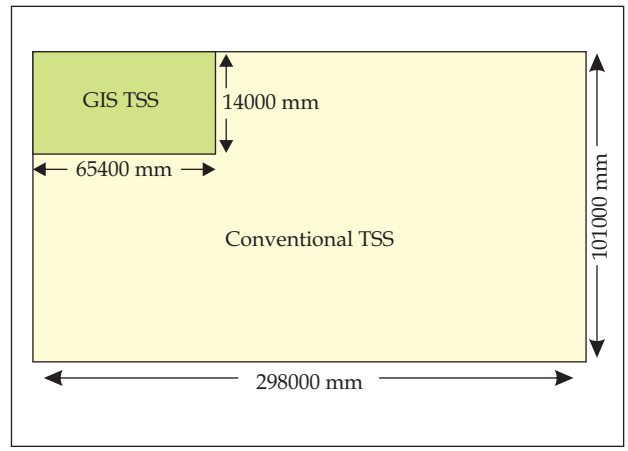
  Minimal maintenance efforts. Virtually eliminates long term maintenance costs and contamination of critical components by means of SF6 gas filled metal enclosures, automatic monitoring of operating mechanisms, and the SF6 gas system. Long operating life > 50 year.

- **Other Drivers for the Application of GIS-Solutions:**
  - o Factory pre-assembled and tested units
  - o Protection from aggressive environmental conditions
  - o Impervious to wind and ice
  - o Low earthquake-sensitivity due to low centre of gravity
  - o Customer-tailored solutions due to modular design
  - o Extension / Refurbishment of AIS under restricted space availability or during operation
  - o Fast and easy erection of pre-assembled bays or bay sections
  - o Only a few foundations are required for outdoor-GIS (low civil work efforts).

Life Cycle Cost Comparison AIS Vs GIS



AIS / Gas-Insulated Switchgear 145 kV - Indoor Comparison of Space Requirements 30:1



Design of Kharbao GIS TSS

Methodology:

After a detailed site survey and discussions with industry experts it was found that there was enough land available near the existing TSS for constructing an integrated GIS based traction substation taking care of both IR and DFC requirements. There was an abandoned DC TSS building at the south of MSEB 100 KV LILO substation. Railway land was available behind the abandoned DC TSS. A few GIS based substations of Tata Power and Reliance Infra were visited by field officers to study and assess the GIS TSS proposal. Based on these studies a proposal was made to construct integrated 220 KV GIS TSS at Kharbao. Proposed Technical scheme, layouts, SLD were drawn and were discussed with CR and MSETCL officers and their consent and approval was obtained. Draft specifications for GIS were drawn and sent to RDSO and Railway Board for approval.

Same was obtained and were incorporated in EMP-16 Package.

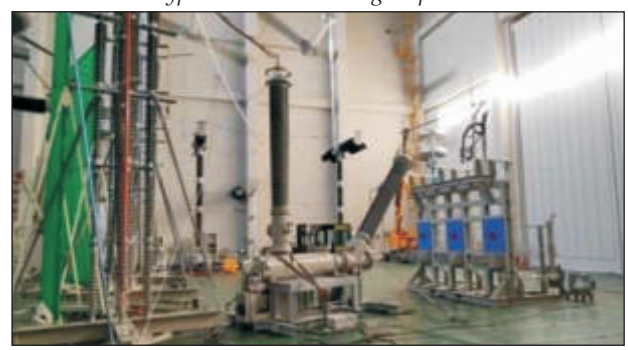
The main features of the proposed integrated GIS based TSS are as follows.

- DFCCIL would first construct Control building which will house all the GIS equipments of DFC, CR and MSETCL along with the control panels and other indoor equipments.
- The size of the proposed control building is 100M*80M and it's a G+2 structure with total height of 17 M from the ground level.
- There is a cable cellar below the GIS floor slab for routing of all the cable network of MSETCL, DFC and CR.
- DFC will initially install 220 KV GIS system for availing supply from MSETCL and feeding it to traction transformers of CR.
- MSETCL would lay the 220 KV cables from an existing EHV line to feed the TSS and do the associated works.
- CR TSS will install 25 KV GIS equipment in the common building and balance outdoor equipments like 30 MVA transformers to commission the CR TSS.
- After commissioning of CR TSS, existing MSEB 100 KV LILO and CR 100/25 KV TSS would be dismantled so as to enable installation and commissioning of Balance outdoor equipments of DFCCIL.
- Common Metering will be provided at 220KV point to avail maximum demand tariff advantage. Separate metering would be provided at 25/54KV level also for segregation of traction demands between CR and DFCCIL.
- Power supply for the integrated TSS would be obtained on open access basis to minimise the traction bill.

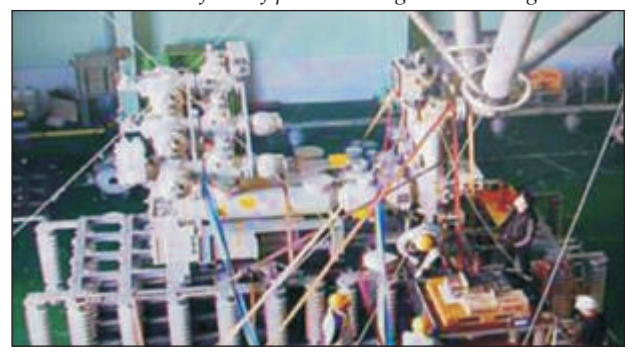
Type Test

Since GIS is being used for the first time on IR it was proposed to carry out Prototype Testing of 220 KV GIS to meet CAC criterion. 66 KV GIS were already type tested as per CAC criterion. Type test of 220kv GIS has been carried out in M/s Korea Electro technology Research Institute (KERI), South Korea from 5th July 2018 to 24th Dec 2018 which has been completely witnessed by Independent agency (Bureau Veritas) and also the critical tests has been witnessed by Engineer along with Employer.

Type test Photos during inspection



General view of out of phase making and breaking test



Preparation for the short circuit making performance test

The original site condition

Prospective Architecture

Technical Requirement:

220 kv GIS

The 245 kv SF6gas insulated switch gear for three phase system shall have double bus bar arrangement with 7 bays (2 nos. 100 MVA transformer bays, 2 no, of 30 MVA transformer bays, 1 no bus-coupler and 2 Nos. feeder bays). Space for 4 nos future bays and jointing plugs shall

be kept in GIS hall for adding future bays and jointing plugs required for connecting GIS of different makes and associated local control panels, control cables, all consumables and hardware etc. as per enclosed SLD and as per the technical specification. The SF gas insulated switch gear rated for 220 kv, 3-phase, 50 Hz shall be of the indoor metal-enclosed type

2x25 kV GIS (DFCIL)

Reason for selection of 66 kv GIS switchgear: As phase to phase voltage in 2x25 kv system is 54 kV and

phase to earth voltage is 27 kv. So 3-pole (though the actual system is 3 pole, we will use 2 pole only) 66 kV GIS switchgear is considered suitable for 2x25 kV system.

The 66 kV SF6 gas insulated Switchgear for three phase system shall have double bus bar arrangement with 11 bays (2 nos. Transformer I/C bays from 100MVA Transformer, 1 no. bus VT, 4 Nos of Auto Transformer bay,2 Nos of PFC feeder bays and 2 no's of future I/C. Space for 2 Nos future bays shall be kept in GIS hall for adding future bays and jointing plugs required for connecting GIS of different makes and associated local control panels, control cables for consumables and hardware etc. as per enclosed SLD and as per the technical specification. The SF6 Gas Insulated Switchgear rated for 66kV, 2-phase, 50Hz, 31.5kA fault level for 3 sec shall be of the indoor metal-enclosed type.

25 kV GIS (IR)

The 66 kV SF6 gas insulated double pole Switchgear shall have double bus bar arrangement with **13** bays (2 nos. Transformer I/C bays from 30 MVA Transformer, 1 no. bus-coupler, 10 nos. feeder bays with spare of 2 Nos future bays shall be kept in GIS hall for adding future bays and jointing plugs required for connecting GIS of different makes and associated local control panels, control cables for consumables and hardware etc. as per enclosed SLD and as per the technical specification. The SF6 Gas Insulated Switchgear rated for 66kV, 1-phase, 50Hz, 31.5kA fault level shall be of the indoor metal-enclosed type,

Design features:

The SF6 gas insulated metal enclosed switchgear shall be totally safe against inadvertent touch of any of its live constituent parts.

It should be designed for **indoor application** with meteorological conditions at site **(winter 30C to 140C and summer 310C to 460C seismic zone:IV).** All part of the switchgear should be three phase enclosed for **220kV GIS.**

The arrangement of gas sections or compartments shall be such as to facilitate future expansion of incomer bay with any make on either end without any drilling, cutting or welding on the existing equipment. To add equipment, it shall not be necessary to move or dislocate the existing switchgear bays.

The design should be such that all parts subjected to wear and tear are **easily accessible for maintenance purposes.** The equipment offered shall be protected against all types of voltage surges and any equipment necessary to satisfy this requirement shall be deemed to be included.

The GIS assembly shall consists of separate modular compartments e.g. Circuit Breaker Compartment, Bus bar compartment filled with SF6 gas and separated by gas tight partitions so as to minimize risk to human life, allow ease of maintenance and limit the effects of gas leaks failures and internal arcs etc. These compartments shall be such that maintenance on one bus bar/compartment may be performed without de-energizing the adjacent bus bars/feeders. These compartments shall be designed to minimize the risk of damage to adjacent sections and protection of personnel in the event of a failure occurring within the compartment. Rupture diaphragms with suitable deflectors shall be provided to prevent uncontrolled bursting of pressure developing within the enclosures under worst operating conditions, thus providing controlled pressure relief in the affected compartment.

Gas Insulated Switchgear (GIS)

Gas Insulated Switchgear (GIS) refers to the general equipment of a substation in a metal enclosure filled with high insulation SF6 gas and connected to the ground, which includes a circuit breaker, disconnecting switches, earthing switches, and peripheral devices (e.g., current transformer, voltage transformer, and lightning arrester). It can be installed in a small space in cities or buildings. Ensuring reliable and stable operation and good maintainability, it is especially suited for polluted and/or salty seashore areas. GIS ensures reliable and stable operation along with simple maintainability.

Breaking Performance Analysis

Low current breaking performance: analyze changes in SF6 gas density cause by arc heat generated Between the poles of the circuit breaker by the charge current of transmission line.

High current breaking performance: analyse changes in SF6 gas density by the high arc heat which is Generated when the circuit breaker blocks the abnormal current. For maximizing the breaking Performance, phoenics and fluent, the arc analysis

tools, are used for analysing the SF6 gas density and flow.

Circuit Breaker

GIS circuit breaker uses superior arc quenching performance and the insulation characteristics of the SF6 gas and adopts the puffer type, which has a simple operation principle and structure. With the double trip coil, it guarantees reliable circuit breaking and its few parts allow for simple maintenance.

Assembly of Disconnecting Switch & Earthing Switches for GIS

Disconnecting switch is a device used to segment the charge current section partitioned by the circuit breaker. It is operated by an electric motor; however, it can be manually operated for maintenance tests. In addition, the user can check the switch status since the switch status display is connected to the control shaft in the control box. **Earthing Switches**

The earthing switch is classified into two types according to its role.

The earthing switch is classified into two types according to its role.

1 Device earthing: manually and electrically controlled for maintenance

2 Line earthing: controlled at high speed. It has an input capacity even when the line is energized. For preventing any unforeseen accidents, it is interlocked with associated circuit breaker and disconnecting switches.

Busbars

Most busbars up to 362kV use three phase batch tank for reducing the number of parts and installation period. The conductors are automatically connected via the tulip contactor when the housing of the busbars is assembled. The expansion or shrinkage of conductors due to temperature changes can be compensated.

The required overall parameters of GIS are as follows:

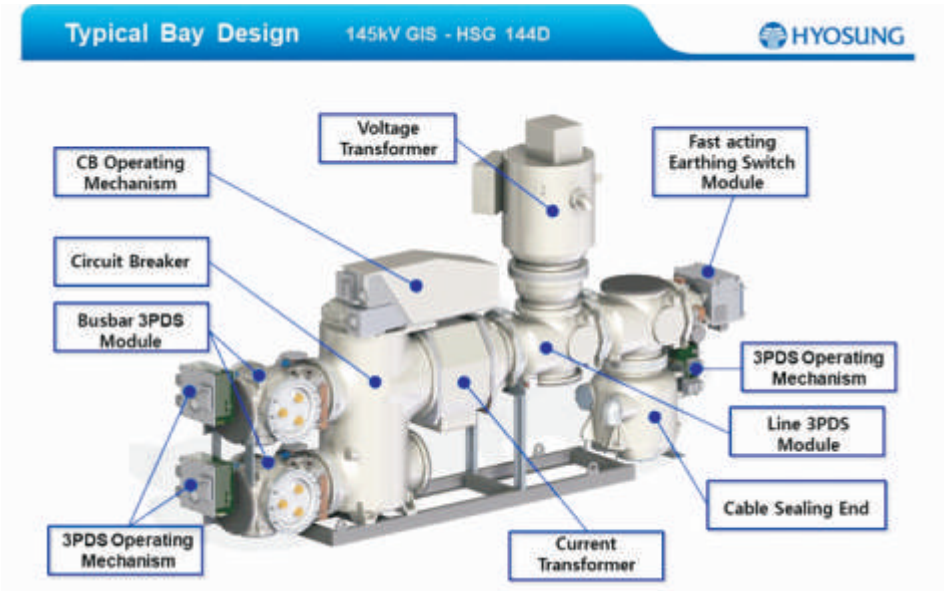
No.	Technical Particulars	220kV System	66 kV System
1	Rated Voltage	245 kv (rms)	72.5 kv (rms)
2	Rated frequency	50 HZ	50 HZ
3	Grounding earthed	Effectively earthed	Effectively
4	Rated Power frequency with stand voltage (1 min) line to earth	460 KV (rms)	170 KV (rms)
5	Impulse withstands BIL 1.2/50/mic.sec) line to earth	1050 kv p	325 kv p
6	Rated short time withstand current (1sec)	40 KA (rms)	31.5 KA (rms)
7	Rated peak withstand current	100 KA (peak)	80 KA (peak)
8	Guaranteed maximum gas losses or complete installation as well as for all individual sections in %.	As per IEC-62271-203	As per IEC-62271-203
9	Seismic level	Zone-IV, as per IS-1893, Year-2002	Zone-IV, as per IS-1893, Year-2002

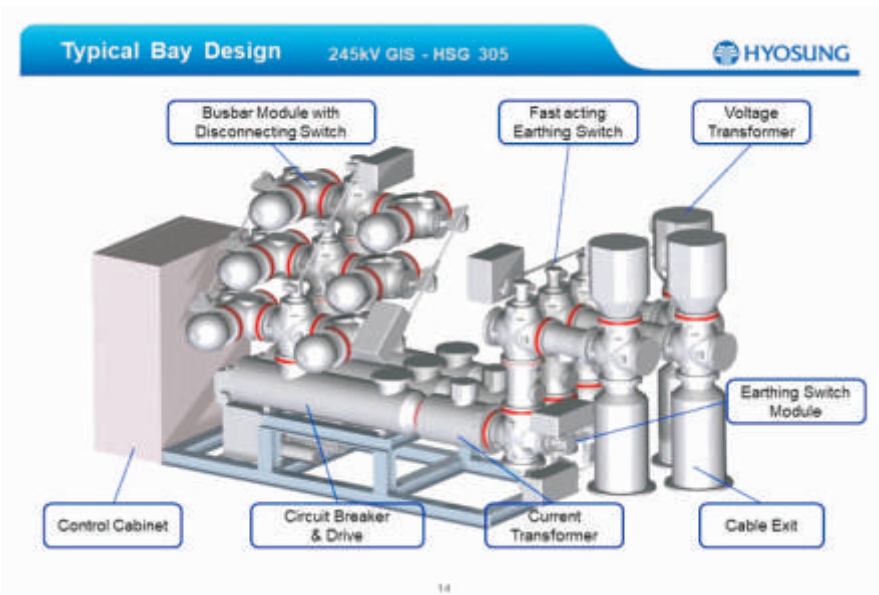
Reference Standards:

The metal enclosed gas insulated switchgear, including the operating devices, accessories and auxiliary equipment forming integral part thereof, shall be designed, manufactured, assembled and tested in accordance with the IEC-62271-203/IEC-62271-200 publications including their parts and supplements as amended or revised to date.

- IEC 62271-203 – Gas insulated metal-enclosed switchgear for rated voltages above 52KV.
- IEC 60376-New Sulphur hexafluoride
- IEC 62271-100 High voltage alternating current Circuits breakers
- IEC 60694-Common clauses for high voltages Switchgear and control-gear standards
- IEC 62271-102 – Alternating current disconnectors (isolator) and earthing switches.
- IEC 61128 – Alternating current disconnectors. Bus-transfer current switching by disconnectors.
- IEC 61129 – Alternating current earthing switches. Induced current switching

- IEC 66044-1 – Current transformers
- IEC 66044-2 – Voltage Transformers
- IEC 60137 – Bushings for alternating voltages above 1000 V
- IEC 60859 – Cable connections for gas-insulted switchgear
- IEC 60480 – Guide to checking of Sulphur hexafluoride taken from electrical equipment
- IEC 60099-1/4 - Non-linear resistor type arresters for AC systems
- IEC 60439 – Factory- built assemblies of low-voltages switchgear and control gear.
- IEC 60427- Report on synthetic testing of high –voltage alternating current circuit breaker.
- IEEE 80 (2000) – IEEE Guide for Safely in AC Substation grounding.
- CIGRE-44 – Earthing of GIS application guide. (Electra no. 151, Dec'93)





GIS Typical Bay Design.

Conclusion:

Kharbao TSS would be the first GIS based TSS on IR and DFCCIL and flag bearer of this path breaking innovative technology. Integrated TSS would be commissioned in phases. In first phase CR TSS would be commissioned along with charging of 220 KV LILO for MSETCL. It's targeted for completion by June 2019. In second phase DFCCIL 2x25 TSS portion would be commissioned by March 2020. 220 kV and 66 kV GIS are being procured from M/s Hyosung India whereas CR 66 kV GIS are procured from m/s CGL India. With the commissioning of first GIS based TSS at Kharbao, DFCCIL would thus become instrumental in initiating a quantum jump in innovation and technology in the field of Traction Sub-Stations in India.

LEVERAGING TECHNOLOGY FOR MANAGEMENT OF RAIL STRESSES IN CTP 1&2 CONTRACT OF WESTERN DEDICATED FREIGHT CORRIDOR

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GGM/WC-I

ABSTRACT:
With the advancement in technology and quality for track components in terms of heavier rails and PSC sleepers and continuous welded track having ballast cushion in the range of 300 mm, the only challenge left to track maintainer is management of rail stresses. Rail fractures have been the cause of worry, giving sleepless nights to Pway supervisors and senior Railway officials. Efforts have been made to address this issue rightly in CTP 1&2 Contract of WDFC by way of meticulous destressing of track and ensuring rail stress free temperature of the CWR track by use of Super Pullers and Verse equipment. The paper gives an insight into working and use of these two Equipments in CTP 1&2 Contract.

1.0 Destressing with Holland F.B. Welding Machine & 160T Super Puller

For destressing of track in WDFC (Phase-1), Holland F.B. welding machine with 160T super puller has been deployed.

Use of this machine, obviates the need for destressing of the CWR without waiting for the specific temperature range, so long as the ambient temperature is below the destressing temperature and has many more advantages as under.

i. No need to cut the track in advance.

ii. Uniform extension of rail with mechanical pullers.

iii. Calculates the extension of rail at the ambient temperature.

iv. Welds the closure joint along with destressing and thus no subsequent welding of the joint required.

v. Calculates the overall extension considering rail consumption in weld and thus recalculates the actual destressing temperature.

Holland's 160T rail puller's high capacity, extended working stroke, compact design and custom control features allows to provide rail welds in applications that were not possible before. By eliminating the need for a separate puller carrier and power source, closure welding has become more cost effective, more productive and much easier.

a. Features and Benefits:

- 160T (145 MT) pulling force provides power for all applications.
- 15 inch (38 cm) stroke available for closing long rail gaps and pulling rails.
- 4 independently control hydraulic jacks designed to allow easy & precise rail alignment.

b. Sequence of operations for machine working:

- Enter operator name.
- Enter location – Geographical, Track km, chainage, etc.
- Select rail size (EN60E1)
- Input neutral temperature for the area.
- Input actual rail temperature.
- Input length of unclipped rail.
- Cut rail end to provide required gap.
- Move rail after cut to plugged end.
- Pre-align the rails by puller.
- Lower welder on rails and complete weld.
- Keep rail clamped in puller for about 8 minutes till weld temperature will become (370°C).
- Lower rails on sleepers and clamp.
- Generate welding chart from PC on completed destressing work.

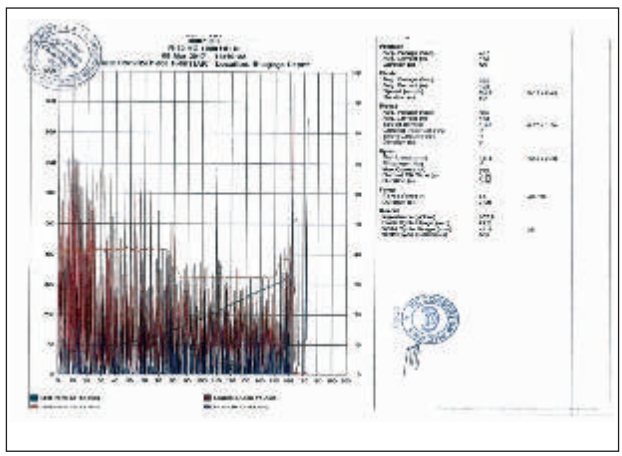
c. Sample input & output data:

i. Sample input data:

- Planned neutral rail temp - 41°C
- Prevailing rail temp - 26°C
- Total unclipped length - 1250m
- Calculated rail gap -175.6mm
- Calculated rail pull - 215.6mm

ii. Sample output data:

- Rail pull up - 159.1mm
- Total rail pull - 198.3mm
- Total pull force (t) - 85
- Holding time (s) - 480
- Achieved neutral temp (°C) – 39.8



d. Procedure of distressing and closure welding:

- It is done when prevailing temperature is less than stress free temperature.
- The operations starts from j1-j2 panel.
- Anchor length is calculated as 2.5 (to-tp) which is j1-A and fastening of J1-A will remain intact.
- Marker pillars are erected on either sides at the location A & B of the track and the marking shall be transferred on the rail foot at A.
- The fastening of panel J1-J2 are removed starting from J2 and proceeding towards A.
- Panel J2-A is mounted on the roller starting from J2 & proceeding towards A.
- FBW com destressing machine is stabled at J2 end of the panel J2-J3.
- Extension required for the length J2-A is calculated by FBW cum destressing machine depending upon the stress free temperature, prevailing temperature, length of the panel to be destressed and considering the rail to be consumed during welding for which the required input details is fed into the machine.
- The required gap calculated by super puller will be provided at J2.
- Clamp rails in puller pull rails together several times and release to stretch unclipped rail section for correcting misalignment etc.
- Calculated stretch force by the machine is applied by the super puller on panel J2-A and flash bitt welding is done at J2.
- Unmount the panel A- J2 and fasten rails to the sleepers.
- If any movement is noted at A (anchor length) necessary corrective action will be taken for increasing the anchor length.
- Marking at B shall be transferred to the rail foot.
- Now the destressing of panel A-J2 is complete.
- Destressing of J1-A (Anchor length+ 100m) shall be done at the time of welding of J1 after destressing of switch & crossing / adjoining track.

- After the destressing of A-J2 is completed, the destressing of the next panel J2-J3 shall be taken up and is as below:
- Track in rear of B will be marked as anchor length and marker pillar will be provided.
- The FBW com destressing plant shall be shifted to J3 of the J3- J4 panel.
- The necessary gap at j3 shall be created as explained above in point no. 8 but the length to be destressed considered is B-J3.
- The above stated steps are repeated and welding of J3 is done. This process continues till the end of the block section.
- Before doing the calculation of extension it is kept in mind that if the movement at marker pillar of anchor length is noticed, corrective action shall be taken.
- *The Destressing of one rail is done at a time for J1 – J2 panel and after completion of above explained process for J1- J2 panel, the other rail i.e. panel J1-J2 is destressed in the similar manner. Similar process is followed for the subsequent panels.*

Super puller +Weld head arrangement

Pulling operation

Ready for the closure weld

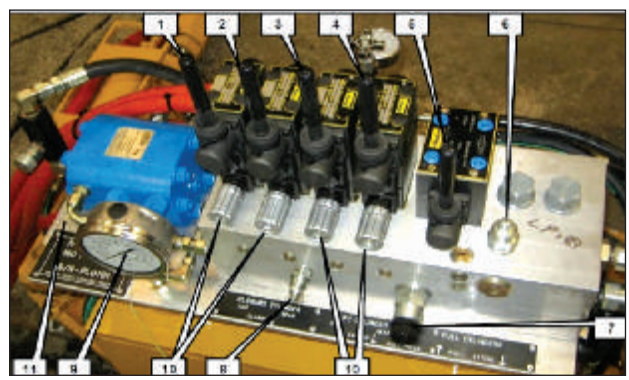
Welder display unit

e. Sequence of Operation 160-Ton Puller Line

i. General

When making closure welds, the drag force from the rail increase during the welding cycle. If a welder head alone is being used to close the gap between the rail ends, the drag force would increase to a point where it would prevent the welder head from pulling the rail ends together and the welding process would stop.

The Holland Puller Lite offsets the increasing drag force. The result is that the welder head experience no drag force during the entire weld cycle.



Puller controls

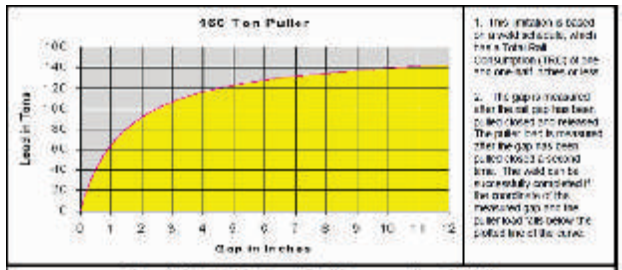
ii. Closure Welding Guidelines

a) The recorder must be properly calibrated.

b) When making welds, t**he welder head force at the point of upset (drag force) must be below the drag limit for the rail.** Any weld made with the welder head force exceeding the drag limit will be considered out of specification. The weld must be cut out.

c) Arrangements must be made to ensure the drag force remains below the drag limit of a rail and puller must be used to complete the weld. The drag force limit for six-inch wide base rails is 25 tons.

d) The capacity of the puller to complete the weld must be evaluated. Use the **160-tons rail gap versus puller load limitations chart.**



Graph A – TRCG (Total Rail Consumption Guide)

e) Never pull a closure weld gap closed until the immediately preceding plug weld has cooled to below 700**º** F (371.1**º** C) or the release temperature designated by the railroad.

f) Never release a puller until the closure weld temp has dropped to below 371.1º C.

g) After a rail gap has been closed and before the welding process has been started, **the free rail must be examined for anything that could prevent the rail from moving in the direction of the weld.**

2. Verification of Stress Free Temperature by "VERSE Equipment"

Every railway engineer knows that rail should be at the correct stress Free Temperature (SFT) . Whilst care is normally taken to ensure that new track is laid in this condition, there are many factors which can cause local changes over time.

i. Rail outside of its SFT limits is at risk of:

a. Buckling in hot weather

b. Fracturing in cold conditions

c. Pull-in on curves when cold

d. In addition it is possible for the left and right rails to develop a different SFT which can produce uneven loads with unpredictable results, as has been found in some case studies.

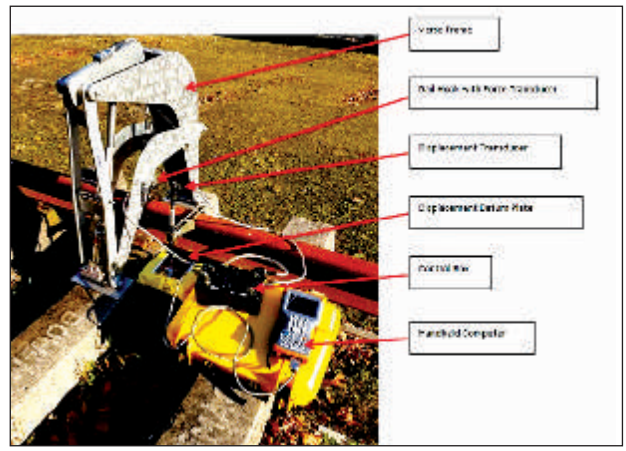
e. Anyone of these track failure will, at best, cause considerable disruption to the network and in the worst case, cause catastrophic de-railment of a high speed trains.

As a thumb rule temperature 10**º**C rise in rail temperature creates a compressive force of 18 tons.

The fact that buckles and fractures are prevalent, is in many respects due to the absence of a cost effective and practical method of checking SFT.

In view of the above, CTP 1&2 Contract provides for a non- destructive, cost effective and practical method for checking SFT with the means to measure the network, determine the change and rate of change of SFT and its causes, identify high risk sites and plan pre-emptive measurement and de-stressing programmes.

a. Some features of VERSE Equipment



- **Non-destructive-** No need to cut the rail unless SFT check proves re-stressing necessary.
- **Quick & easy-** only 20 to 30 minutes per measurement depending on type of rail clip.
- **Low cost-** less than 5% of the cost of performing the traditional cut, measure and re-weld method.
- **Accurate-** excellent reproducibility with a mean error of 0.2**º**C and standard deviation of 1.3**º**C so you can be confident in the result.
- **Versatile-** suitable for all rail profiles

- **Instant result-** follow on – screen instructions on hand held computer for easy measurement and instant result.
- **Database-** files from the hand – held can be downloaded into a PC database to produce a record of our whole rail network
- **Portable-** supplied in a convenient carry case which will fit into small and or estate car.
- **VERSE** delivers a direct SFT result without needing to know any residual stress history of the rail.
- **VERSE** measurement is made whilst the rail is in tension, at an ambient temperature lower than the existing SFT of the rail.
- Only one measurement at one ambient rail temperature is required.

b. VERSE Site application

- One VERSE test determines the SFT on up to 1500m of straight track (750m on either side of the lift point) and curved track of 3000m radius and above. For curved track between 3000m radius and 500m radius, one VERSE test is required for every 400m (200m on either side of the lift point).
- The site test limits should be no closer than 30m to any P&C.
- The 30m test lengthy should be free of welded joints. If this cannot be achieved, then the lift point for the VERSE should be positioned centrally between two welded joints
- The rail within the test section (30m) shall be of uniform section.
- Both rails of a track should be VERSE tested to validate the 'SFT achieved' .
- If the VERSE data meets the criteria, the represented track site is considered acceptable and no further testing for that section is required.
- If the VERSE data from a site shows the SFT of the rail is not within the allowable, or if it is not within +/- 2ºC of the stressing certificate for sites, then an additional test site within the 400m of track of either side of the failed test site should be VERSE tested to determine if the failed site is an isolate section of track. Sites with VERSE results having an unacceptable shall be de-stressed.
- if there VERSE data from the additional test sites is acceptable, the reminder of the represented site is considered to be acceptable.

c. Environmental conditions limiting use of VERSE

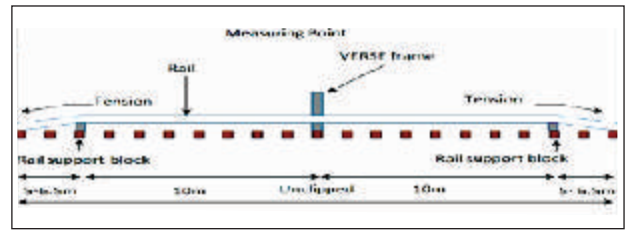
VERSE should not be carried out in the following conditions, as the resulting data will be indeterminate:

d. The rail is undergoing rapid changes of temperature (1ºC in 15 minutes or greater).

e. Where the rail temperatures are/or could be at above the actual SFT.

f. Procedure for measurement

- Measurement entails unclipping approximately 30 metres of rail.



- At points 10 metres each side of the centre point, the rail is lifted onto a rail support spacer. This leaves a 20 metres length of freely suspended rail.
- The VERSE equipment is positioned over the central point, and the rail is jacked steadily to a load of 10 KN and monitored by a load transducer. Displacement is simultaneously monitored for each increment of load to another transducer attached to the rail.
- The output from both transducer is sent to a hand held computer
- The software menu prompts the user to enter certain site specific data such as ambient rail temperature, rail profile and actual rail height.
- The software then calculates the SFT directly. VERSE equipment is self-calibrating for each lift and the software is able to check the validity of each measurement. Time on site is between 20 and 30 minutes per rail depending on the type of rail fastening.

g. The Software

- The hand held computer software guides the user through the measurement procedure, logs certain site specific data and produces a track side SFT result. The rail profile is easily selected from a drop down menu.

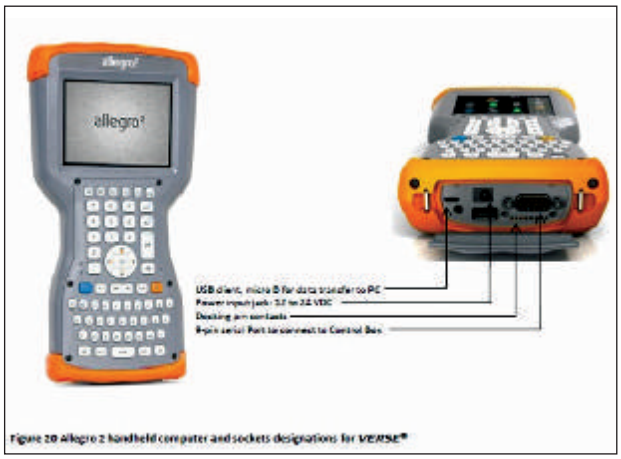


Figure 28 Allegro 2 handheld computer and sockets designations for VERSE®

- Data sets for each measurement can subsequently be uploaded to the VERSE PC software and stored in a database as a permanent record of rail network measurement and can be interrogated at any time.
- Data can also be exported an analysed with other databases such as MS Excel or MS Access types where it can be integrated with other track data for maintenance management decision making.

3. Conclusion

While performance of any asset primarily depends upon close monitoring and proper handling and maintenance of the asset, it can be better managed and maintained by Leveraging of Technology. With the advancement of technology and in this digital age, efforts have to be made for minimising the dependence on human interface. Adoption of the above two technology in Rewari - Iqbalgarh section of WDFC will help immensely for construction and maintenance of Continuous welded rails and planning preventive maintenance.

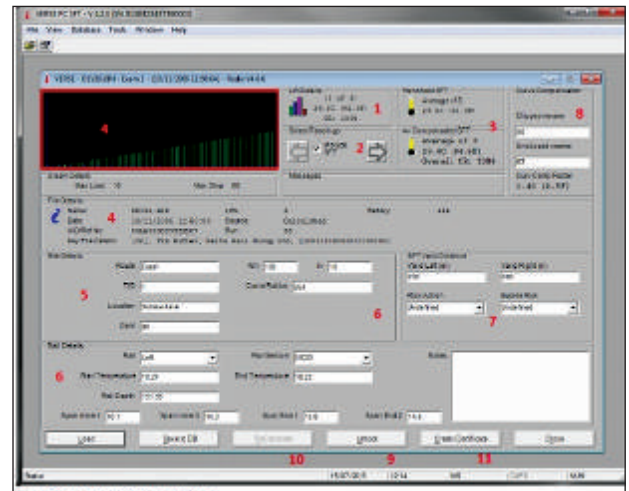


Figure 53 VERSE - Lift results, example

1. The Lift Details are shown in a box, and the lower panel gives the details of the .BIN file, the time and data of the measurement, the serial number of the Radix, the number of lifts recorded and the run number

4. References

i. *Quality Assurance Programmes for welding and distressing for CTP 1&2 section.*

ii. *Data and details collected from site.*

FAST TRACK MODULAR CONSTRUCTION OF PIER CAPS AT YAMUNA AND HINDON RIVERS

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SYNOPSIS:
Many construction industries prefer working only with the well-established / believed ways of construction - all involved activities to be executed in series only i.e. creation of huge ground supporting system, huge working platforms (with temporary structures), lifting & fixing of each and every rebar at the cast in situ site concluded to be old conventional methods. However, the need of the hour is to complete the works efficiently in minimum time by keeping the quality and safety in the project at par, which has necessitated adoption of an innovative method such as the modular construction method. The modular method of Pier Cap construction eliminated the complete ground supporting system (GSS), reduced a number of resources, eliminated critical safety challenges, kept quality of rebar cage at par and finally saved the time of 30 days in each pier cap construction. This method separates various activities into sub-activities that was executed in parallel sequence thus accelerating the comprehensive schedule of construction, which subsequently helped in saving of sufficient time in implementation of the whole project.

1.0 Introduction:

Noida unit of DFCCIL Western Dedicated Freight Corridor showed ambitious interest in developing alternative pioneering ways to accelerate the ongoing construction activities without compromising the quality and safety in the project. After going through in circumstantial planning with the Contractor (IIS –L&T Consortium) of various ways for construction of pier cap bypassing the conventional method, Noida unit came up with an innovative thought of executing the binding & fixing of pier cap works not at the top of the pre-constructed two no's of pier, but right at the ground surface for saving precious construction time period. However, the major apprehension arrived was the scheme for providing the bottom support to the pier cap, need of specially designed jigs & fixtures required for assembly of reinforcement cage at ground, procedure for lifting & placing the whole 35MT reinforcement cage of pier cap at place (call for - specially designed lifting gears, reaction arrangement, lift plan) with utmost accuracy at top of the two piers. It was also kept in mind that any error while lifting and placing the cage of pier cap, would invite severe complications as well as time impact to the project schedule. The ZMT 4 team

(Field PMC team) and PMC design team looked into various constraints of this solution and suggested various mitigations required for execution and supported this method. IIS-L&T Consortium with the help of its technical expertise successfully completed the lifting and placing of the rebar cage at pier top with the help of two no's of 75 MT heavy-duty crane, both working in tandem lift. This modular construction method of pier cap is a perfect example of "Value Engineering" without compromising with the quality & safety of the work. It can be used as a case study for the budding civil engineers.

2.0 Project Details

Design & Construction of 03 special steel bridges over existing railways & across rivers Yamuna &Hindon, involving Bridge structure, Approaches in Embankments, Guide bunds & protection works including Testing & Commissioning on Design-Build Lump Sum price basis for Rewari - Dadri section of Western Dedicated Freight Corridor (Phase-2) – (Special Steel Bridge Works Contract Package – 15C, ICB No. CT P-15C)

Task:

Construction of 13 Nos of Pier Cap in WDFC – CTP 15 C Project

1. 10 Nos at Yamuna River - Bridge No. 180
2. 03 Nos at Hindon River - Bridge No. 188.

Brief Technical Details of Pier Caps

1. Final Dimensions: 19 x 3.0 x 2.0 in Meters
2. Concrete: M-40, Quantity = 110 CUM
3. Reinforcement Weight = 35 MT
4. Shuttering = 124 Square Meter

3.0 Construction Methodology

3.1 Conventional

Cast in Situ Type – Normally, in all the construction projects, the conventional method is followed for construction of pier caps through GSS in which huge supporting systems (with temporary structures) is created from ground for fixing of bottom shutters and for working platforms. Each individual rebar is lifted from ground &is fixed in cast in situ location above the casted piers at height. **This method requires almost 45 days** for this activity. It involves a lot of resources, no. of critical safety challenges & quality concerns. All the activities in this method being executed in series only which itself has high direct & indirect cost.

3.2 Innovative

Modular Assembly Type - By innovative thinking, the complete reinforcement cage was assembled at ground at respective pier location in **specially designed jigs & fixtures.** All the activities in this method being executed in parallel mode (i.e. cage of pier cap is ready as both the respective piers being casted). The entire reinforcement cage comprises of 35 MT having a length of 19 Meter which was lifted and placed into its position with 02 No's of 75MT crawler cranes in tandem lifting. It was lifted through **specially designed lifter** and with various **unique lifting gears** as per the approved lift plan. The lifting operation was conducted under the stringent supervision of officials of all departments *(especially safety)* with proper planning. This modular method of Pier Cap construction eliminates complete ground supporting system (GSS), reduces no of resources, eliminates critical safety challenges, kept quality of rebar cage at par and **finally saved the time of 30 days in each pier cap construction.**

4.0 Challenges Encountered

1. Meticulous planning and preparation of the complete scheme with the Contractor keeping in mind the resources available at ground level. *(Execution – Safety – Quality – Erection – P&M).*
2. Detailed Review of whole scheme by PMC & its Design Team in-depth coordination with Site Team.
3. Detailed study of drawings and applicable codal provision necessitating modifying the reinforcement drawings to suit the above mentioned innovative technique.
4. Bringing about of specially designed Jigs & fixtures to assemble the reinforcement cage at the ground.
5. Review Design & Preparation of specially designed lifter.
6. Since it is the first of its kind in railway projects, on suggestion of DFCCIL special rigging team had been mobilized and trained about this lifting technique.
7. Proper monitoring of lifting the entire reinforcement cage (weight = 35 MT) with two Nos of 75 MT crawler cranes in tandem lifting operation as per approved lift plan.

8. Proper monitoring of Placing & lowering of entire reinforcement cage into the dense dowels of casted piers.
9. Proper monitoring of Protection of the entire reinforcement cage during lifting & placing.
10. Ensuring appropriate dimensions of entire reinforcement cage during placing into its final position

5.0 Advantages

This construction methodology not only saves the time of approximately one month as both the activities i.e. casting of piers, bottom shuttering for pier cap works and preparing of entire reinforcement cage of pier cap at the ground was done simultaneously as well as eliminates works of the lifting of rebars. Thus, 45 days cycle for in situ works compressed by adopting this methodology to about 12-15 days. Thereby saving about 30 days of time in each pier cap construction. Additionally – Following are the direct cum indirect benefits from this methodology.

1. Complete Elimination of GSS (Ground Supporting System).
2. Creation of Parallel Activities - Simultaneous works on pier construction as well as fixing of bottom shutter for pier cap as well as assembly of complete pier cap cage.
3. Critical challenges of safety stands eliminated.
4. Workers can work easily at the ground during fixing and handling of bulk reinforcement (35 MT).
5. Minimisation of various types of resources
6. Quality Standards is at par by fixing the dense reinforcement at the ground, which is quite difficult during working at height.
7. Temporary structures/platform required to work at height was significantly reduced.
8. Engagement of workforce for reinforcement work was substantially reduced.

6.0 Methodology: Sequence of Construction

a. **Beam Erection:** During the construction of Pier, special 10 no's of holes of 70 mm were made in each pier. **Macalloy bars** were inserted in those holes a week after pier casting. B1-Beams (02 Nos) were erected on both sides of the piers across the alignment of the bridge and attached to macalloy bars with set of nut-bolt& washers. Inserted **macalloy bars stressed up to 75 MT** from each end with special hydraulic system. After stressing both B1 beams with pier, it act as a single entity with same pier for transferring the load of pier cap to the foundation / ground. Further horizontal beams and vertical trusses being erected to support the bottom shutter, as the base of Pier cap is not uniform. The base shutter was placed over this arrangement and required working platform for shuttering were made with the support of these beams.

b. Jig Fabrication: This process starts simultaneously and independently along with the construction of piers and as well as with the beam erection part. A structural base cage was fabricated at the ground level near the pier location. It acts as a base cum jig & fixture for assembly of rebar cage.

Figure 1: Jig assembly for reinforcement cage fabrication

c. Assembly of Rebars: On the base structure, the rebar activity starts with the tying of rings, bottom reinforcement top, stirrups, and various miscellaneous reinforcement to complete the pier cap case in all respect for erection on the piers.

Figure 2: Beam Assembly and completed rebar cage

d. Lifting Arrangement: After the completion of the above activities, **specially designed lifter** was placed at the top of assembled rebar cage. This lifter was connected with whole reinforcement cage at **28 location** through specially designed lifting gears coupled with **embedded heavy-duty (horizontally & vertically fixed) pipes,** which helps in uniform lifting of the cage without pressure on a particular point in cage.

Figure 3: lifting assembly and lifting hook attached with the rebar cage

e. Lifting Operation: Assembled cage was lifted from the jig with two no's of heavy duty 75 MT Crawler Cranes in tandem lifting as per the **approved lift plan.** The cage was lifted slowly and placed it over the fixed bottom shutter. This process takes around 3 hours. It is one of the most critical activity in this modular construction.

Figure 4 : Cage Lifting Operation started in Tandem lifting

Figure 5: Lifting Operation in Progress

Figure 6: Placing of Cage

Figure 7: Adjustment of the cage with Pier Reinforcement

Figure 8 : The Rebar Cage successfully placed in its position

Figure 9 : Dismantled lifting arrangement

f. Balance Reinforcement: Once the cage is placed over the bottom shutter, the balance reinforcement is completed and miscellaneous rebar requirements of bearing pedestal, OHE mast etc. are inserted. This balance reinforcement is mainly on sides.

g. Shuttering: Meanwhile, side shuttering started from the center of the pier cap after competition of pier cap reinforcement case.

Figure 10 : Shuttering arrangement in process

Figure 11: Concreting of Pier Cap

h. Concreting: After the completion of formwork, we started pouring of concreting after engineer and employer completed all checks. The total volume of concrete is 110 cum.

i. De shuttering: After casting of pier cap, all formworks removed and curing was done as per the approved methodology.

Figure 12 :Completed Pier Cap

7.0 Conclusion

Fast paced construction is the need of the modern construction industry. Dedicated Freight Corridor project is a flagship project of Government of India and as such lot of emphasis has been accorded for timely construction so as to reap the benefit early and boost the GDP growth of the country. For timely completion of such a mega projects, DFCCIL has adopted various innovative methods and advanced technologies for the fast paced construction of the project. The above discussed method is one of the several others, which has been employed for the speedy construction of a mega project of the size of Dedicated Freight Corridors, which has resulted in optimizing the timelines while ensuring high quality standards.

ENVIRONMENTAL JURISPRUDENCE – ANALYSIS OF SPECIFIC CASES ACTED AS DETERRENT OR CATALYST DURING CONSTRUCTION WORK OF THE DFC PROJECT

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ABSTRACT:

This paper has reviewed and analyzed some of the major judicial orders issued by the Hon'ble Supreme Court of India and National Green Tribunal (NGT)on different environmental issues as well as changes in environmental legislations during the course of implementation work of the DFC project between 2013 and 2018, which resulted in mixed "Time and Cost Impacts" (adverse or beneficial) on its construction activities.

On the one hand, intermittent blanket ban on construction activities, revision of environmental rules, conflicting interpretation of the Central and State Environmental Regulations, etc. created a scarcity of resources (natural construction materials, etc.) thereby affecting the progress of work, whereas on the other hand, technological inputs, timely interventions and discussions at the policy and inter-ministerial levels did help in construction works of some of the major project components.

In recent years, there has been a significant change in the judicial approach towards environmental aspects and impacts associated with the construction activities. Many unexpected and unforeseeable orders have been issued in favor of environmental protection, which ultimately became project deterrent over a short and long term. Some of these major legal orders, issued mostly in the form of blanket ban, ensured that construction activities proceed in compliance with legal obligations related to sustainable supply of natural construction materials, air pollution, solid waste management, eco-sensitive areas, EIA, etc. Most of these cases have been due to exacerbated situations of non-compliance by other project proponents (not by DFC), state governments, sand miners, construction projects in general, other sectoral and sub-sectoral projects, etc., which led to harsh judicial interventions and decisions.

Though the intention behind many of such judicial orders appeared good from a long-term perspective, but a blanket ban stopping all construction activities actually had a negative impact on a timely completion of large-sized railway infrastructure projects and many other government sponsored schemes. Such type of "New Environmental Risks and Challenges" are now becoming an integral part of the construction activities in any large-sized infrastructure developmental project.

1.0 INTRODUCTION

"The Supreme Court has held that the right to life as enshrined in Article 21 means something more than survival or animal existence and would include the right to live with human dignity. It would include the right to minimum subsistence allowance during suspension and all those aspects which go to make a man's life meaningful, complete and worth living."

Environmental Protection and Sustainable Development have been the cornerstones of the policies, procedures, laws and rules, codes and guidelines, etc. governing the developmental activities in India. The Ministry of Environment, Forest and Climate Change (MoEF&CC) is the nodal regulatory body of Government of India and is mandated to formulate policies, laws and rules related to environment, and issuing Environmental Clearance (EC) for any developmental project, as in the Schedule of the Environmental Impact Assessment (EIA) Notification, dated 14th September 2006 under the Environmental (Protection) Act, 1986.

Railway projects are excluded from the Schedule of the EIA Notification 2006 and as such does not require any Environmental Clearance (EC). But there are certain activities pertaining to construction works, such as extraction of sand and gravel from the river bodies, mining of masonry stones for aggregates and ballast material from quarry sites, excavation of ordinary earth for embankment from borrow areas, etc. which are regulated and done with adoption of required environmental safeguards as per EIA Notification and subsequent amendments. Ensuring availability of construction materials is vital for the smooth working for the development of any large-sized railway infrastructure development project.

Though the MoEF has taken several policy initiatives and enacted environmental and pollution control legislations to prevent indiscriminate exploitation of natural resources and to promote integration of environmental concerns in developmental projects, but there are always issue of low compliances, violations of environmental norms, poor enforcement, attempt to dilute environmental principles, etc. These have resulted in the Indian Judiciary to take a lead in terms of actual immediate effects in the matters of the environment.

For example, in one of the recent orders on pollution control, when the air quality in Delhi and NCR began to deteriorate in early November 2018, the Hon'ble Supreme Court appointed Environment Pollution Control Authority (EPCA) banned all construction works in the pollution hotspots two to three times over a short period, which also affected the activities of all major projects.

To comply with ever growing environmental challenges, there is a need of balancing act between the legislative and judiciary system to effect measures for improving and protecting the quality of environment.

2.0 LEGAL IMPLICATIONS OF ENVIRONMENTAL ISSUES IN THE DFC PROJECT

The following six typical case examples have been reviewed and analyzed in this paper that somehow resulted in direct or indirect impacts (negative or positive) on the construction activities of the DFC project.

These selected case examples covering either legal orders for blanket ban on construction activities or changes in environmental legislations aimed at to promote integration of environmental concerns in large-sized infrastructure developmental projects and others.

These are:

Negative Impacts *(but impacts were reduced through mitigation strategy)*

- Due to stay order issued by the Hon'ble National Green Tribunal (NGT)on Environmental Clearance (EC) process for stone quarries and borrow areas in the State of Rajasthan for non-compliance between 2013 and 2015.
- Due to Hon'ble Supreme Court order on banning of mining / extracting river sand in the State of Rajasthan from November 2017 till date.
- Ban on construction activities due to non-implementation of solid waste management rules in August-September 2018.
- Ban on construction activities due to severity of air pollution and smog conditions in Delhi and other NCR Districts – Intermittently between 2017 and 2018.

- Unavailability of Borrow Pits due to Change in Law within 10 km radius of Declared Jawai Bandh Forest Area as Panther Zone in Pali District, Rajasthan between Marwar and Iqbalgarh stretches of the DFC Project between 2013 and 2017.

Positive Impacts

- Due to changes in EC law for borrow areas for mining of ordinary earth (soil) applicable to the DFC projects in February 2017

3.0 CASE EXAMPLE – 1:

Stay Order by Hon'ble National Green Tribunal (NGT) on Environmental Clearance (EC) process for stone quarries and borrow pits in the State of Rajasthan

Environmental Issue:

As per the Central Law, the requirement of prior EC for minor minerals with a lease area less than 5 ha became effective after the MoEF's Office Memorandum (OM) dated 18th May 2012. However, the State of Rajasthan implemented the requirement of prior EC for minor minerals with a lease area less than 5 ha after the issue of Gazette Notification by MoEF dated 09th September 2013. Additionally, the categorization of projects as "B2" as per MoEF's OM dated 24th December 2013 got implemented by the State Mining Department in the State of Rajasthan by issue of guidelines on 08th January 2014.

There was a persistent conflict between the State Regulations and the Central Notifications during the period between 27th February 2012 and 09th September 2013 i.e. the bridge period. It was recorded by the State of Rajasthan that mining leases for minor minerals were granted to all the private respondents till 2013 as no EC was required in the State for such activity. All such confusion led to delay in EC for obtaining masonry stone and ordinary earth.

The State Government recorded in the NGT proceedings that after the operation of the MoEF's OM dated 24th December 2013 and the guidelines issued by the Government of Rajasthan dated 08th January 2014 was stayed by the NGT on 06th June 2014, the State did not give effect to any of the OMs issued by the MoEF on the subject. Due to this, the EC process got affected in the State of Rajasthan until the stayed order got vacated on 13th January 2015.

This situation was unexpected and beyond the control of the Contractors. This resulted in delay in obtaining EC for already submitted applications for masonry stone quarries before 06th June 2014 and new applications for borrow areas after 06th June 2014. However, subsequent to the issue of Notification by the Government of Rajasthan on 26th November 2014 for depth up to 1.5 meters, the contractor commenced work from borrow areas.

Various orders issued by the Central and State Govt. / Court / Tribunal focussed mainly on two important aspects – a) Requirement of Prior Environmental Clearance (EC) for mining of minor minerals on a lease area of less than 5 ha as mandated by the Hon'ble Supreme Court of India in its order dated 27th February 2012; b) Delay in EC due to NGT order dated 06th June 2014 in the State of Rajasthan.

Quarry Area for Stones in Rajasthan

The chronological events in the matter are mentioned below:

27th February 2012	The Hon'ble Supreme Court in its judgment dated 27 February 2012 ordered that "leases of minor minerals including their renewal for an area of less than five hectares (5 ha) be granted by the States / Union Territories only after getting Environmental Clearance from the MoEF".
18th May 2012	In compliance to the direction of the Hon'ble Supreme Court in para 29 of the said judgement (as mentioned in pt. above), MoEF issued an Office Memorandum (OM) dated 18 May 2012. In this OM, it was decided by MoEF (as Competent Authority) that – a) All the mining projects for minor minerals including their renewal, irrespective of the size of the lease would, henceforth, require prior EC. b) Wherever the area was less than 5 ha, they would be treated as category 'B' projects in terms of EIA Notification of 2006.
09th September 2013	MoEF in exercise of its powers under the Environment (Protection) Act and Rules of 1986 amended the original Environment Impact Assessment (EIA) Notification of 2006 by issuing Gazette Notification and amended the entry 1(a) with a clause saying the requirement of EC for mining lease of minor minerals less than 50 ha is to be categorised as 'B'.
20th November 2013	The Rajasthan State Pollution Control Board (RSPCB) issued letter to the contractor that their submitted applications on 11th November 2013 for 'Consent to Establish' and 'Consent to Operate' for 'Short Term Permits' for minor minerals less than 5 ha cannot be considered unless they obtain EC as per MoEF Notification dated 09th September 2013.
24th December 2013	MoEF on 24 December 2013 issued OM for consideration of proposals for grant of EC for minor minerals with a lease area less than 5 ha regarding further sub -categorisation of Category 'B' projects into Category 'B1' and 'B2'.
08th January 2014	The State of Rajasthan implemented MoEF's OM dated 24th December 2013.
28th March 2014	The Hon'ble NGT stayed the operation and effect of the MoEF's order of OM dated 24th December 2013 as this OM was found to be not in conformity with the order of the Hon'ble Supreme Court, order of the NGT in other cases, and the Notification dated 09th September 2013 issued by the MoEF itself. This stay applied both to "Masonry Stone Quarries" and "Borrow Areas".
06th June 2014	The Hon'ble NGT issued order that the Government of Rajasthan cannot be permitted to proceed as provided under the MoEF's Office Memorandum dated 24th December 2013, granting permission to mine. It further directed not to proceed pursuant to the guidelines issued by the Government of Rajasthan on 08.01.2014.
26th November 2014	The Government of Rajasthan issued Notification for amending mining rules by virtue of which mining of earth up to a depth of 1.5 meters from the adjoining ground level was excluded from the scope of mining, thereby implying that such activities were exempted from environmental clearance.
13th January 2015	The Hon'ble NGT pronounced its final judgment on its stay on 06th June 2014 in the State of Rajasthan.

Impacts on Construction Activities:

Due to constraint in the procurement of construction materials, the progress in the work got impacted till the time the stay order was vacated on 13th January 2015.

Mitigation Strategy:

Due to somewhat complex situation on the legislative requirements at the State level followed by NGT ban, there were limited options available in the project. However, all NGT proceedings after ban were closely monitored and even representations were made to the NGT for granting interim relief to the DFC project as being the project of a great National importance. Continuous persuasion and advocacy resulted in the State Government to come out with a new Notification on EC exemption for borrow areas up to a depth of 1.5 m, which gave much intended relief to the project.

4.0 CASE EXAMPLE – 2:

Blanket Ban by the Hon'ble Supreme Court on Mining / Extracting River Sand in the State of Rajasthan

Environmental issue due to non-compliance of Environmental Clearance (EC) norms by sand miners:

River sand is one of the key ingredients for civil construction. The technical specification allows river sand as one of the constituent materials (fine aggregate) for the permanent works viz. concrete and blanket.

The extraction of river sand has been guided by the MoEF's comprehensive document on "The Sustainable Sand Mining Management Guidelines, 2016" to ensure sustainable sand mining and environment friendly management practices in order to restore and maintain the ecology of river and other sand sources. However, there has been continued mining of river sand ('bajri') unabated in the State of Rajasthan without any environmental clearances and replenishment studies.

Pursuant to the judgement by the Hon'ble Supreme Court of India dated 16.11.2017, the supply of river sand in the State of Rajasthan came to a standstill from 16.11.2017 and thus impacted the construction activities of the DFC project due to non-availability of sufficient supply of river sand. In the Judgement dated 16.11.2017, the Hon'ble Supreme Court cited the following –

"We restrain all the 82-mining lease / quarry holders from carrying out mining of sand and bajri unless a scientific replenishment study (siltation study) is completed and the matter is fully and dispassionately considered by the Ministry of Environment, Forest and Climate Change and an environmental clearance is granted or rejected. This order will come into force with immediate effect."

The Hon'ble Court took a strong view in the matter considering there was a total non-compliance of rules framed by MoEF by the State of Rajasthan and its mining department. It was noted that none of the state miners took any environmental clearance and conducted any scientific replenishment study since the directives issued by the State High Court in 2013.

River Sand Mining

The Supreme Court directed the Chief Secretary of the State of Rajasthan to file an affidavit in the matter and in the meantime directed that no mining activities for river sand should continue. The court also directed the MoEF to consider the applications for Environmental Clearance to be either granted or rejected.

Impact on Construction Activities:

The Contractor had been procuring river sand from some of these 82 sources (approved by the Engineer) for use in the work since as per the practices followed in the State of Rajasthan, the lease for mining and supply of river sand was assigned to 82 parties / agencies.

This direction by the Hon'ble Supreme Court had an adverse impact to the execution of work in the locations, where the river sand has been used as a component for construction of permanent work in the DFC Project, particularly for sleeper plants and permanent works for bridges. Contractor was constrained to suspend the key and critical activities

due to unforeseeable circumstances, which involved usage of river sand and invoked contractual clauses on entitlement to extension of time for completion of milestones and associated additional cost to be added to the contract price.

Mitigation Strategy:

Initially, the ban was expected to be temporary issue, but due to prolonged ban period with no sign of any early solution and no relief by the Hon'ble Supreme Court, the Contractor worked on revised mix-design for concrete and blanket using crushed / manufactured sand as an alternative to river sand. Further options for procuring washed sand from other unaffected sources were also explored.

At one point of time, it appeared that the delays due to non-availability of one of the important construction materials, if not arrested, would lead to massive time and cost overrun of the project, but timely actions and continuous discussions involving technological solution and acceptance of alternative materials helped in overcome of the situation in spite of non-existence of any policy on use of manufactured sand in the State of Rajasthan.

The river sand mining is still on hold in compliance of the Hon'ble Supreme Court orders. In hindsight, the use of manufactured sand is the only feasible option in the future.

5.0 CASE EXAMPLE – 3:

Changes in EC law for Borrow Areas applicable to the DFC Projects

Environmental Issue due to continuous amendments in EC law for Borrow Areas:

In February 2000, Ministry of Mines included ordinary earth used for filling or levelling purposes in construction of embankments, roads, railways, buildings in the definition of 'Minor Minerals'. Subsequently, MoEF&CC made environmental clearance mandatory for lease of minor minerals including their renewal irrespective of the area of lease through their Office memorandum (OM) dated 18th May 2012 and Notification dated 09th September 2013.

MoEF&CC on 24th December 2013 issued another OM for consideration of proposals for grant of EC for minor minerals with a lease area less than 5 ha regarding sub-categorization of Category "B" projects into Category "B1" and "B2".

Further, the State Government of Rajasthan issued state-level Notification for amending mining rules by virtue of which mining of earth up to a depth of 1.5 meters from the adjoining ground level was excluded from the scope of mining, thereby implying that such activities were exempted from EC.

To meet enormous demand of ordinary earth for construction of embankments for DFC project through large number of small-sized (less than 1 ha) borrow areas, the stringent and conflicting EC requirements started impacting the sufficient supply of earth, as huge procedural delays were being encountered by contractors of DFC project in securing clearance of Mine Plan (from concerned Mining Department of State Government) and approvals from concerned District Impact Assessment Authorities.

Mitigation Strategy:

Timely interventions by the railway authorities at the policy level and at inter-ministerial level facilitated the process for exemption from obtaining environmental clearance for excavation of ordinary earth from borrow pits for DFC projects.

Railway projects were already exempted from prior environmental clearance in the EIA Notification dated 14.09.2006. In further amendments to the EIA Notification, certain exemptions from environmental clearance were also provided to certain activities for excavation of soil for:

Borrow Area for Mining of Soil

"Community works like desilting of village ponds or tanks, construction of village roads, ponds, bunds undertaken in Mahatma Gandhi National Rural Employment and Guarantee Schemes, other Government Sponsored Schemes and community efforts."

Recognizing that DFC projects also fall under "Government Sponsored Schemes"as per said provisions, petition was filed with the MoEF & CC for granting similar exemption from EC for excavation of ordinary earth (soil). On 28th February 2017, MoEF & CC communicated that above mentioned provisions were also applicable to the DFC projects and thus, exempted the project from EC requirements. It gave much incentive to the project in expediting the embankment work by removal of major obstacle on the arrangement of sufficient supply of construction material.

6.0 CASE EXAMPLE – 4:

Ban on Construction Activities due to non-implementation of Solid Waste Management Rules, 2016

Environmental Issue:

In another legal case on environmental non-compliance, the Hon'ble Supreme Court order dated 31st August 2018 imposed a blanket ban on construction activities in a few states including Maharashtra until the framing of a policy under the Solid Waste Management(SWM) Rules, 2016 by them. The court took cognizance of the situation that vector-borne diseases were on rise due to poor management of solid wastes in the country.

The MoEF had notified the updated Solid Waste Management Rules on 08th April 2016. The SWM Rules deal with management of municipal solid waste generated, segregating it from other kind of wastes. Different rules for management of plastic waste, construction and demolition waste, bio-medical waste, hazardous waste and e-waste were also notified under the Environment Protection Act, 1986.

The SWM Rules provides for waste segregation at source, generator fee and fines for people who burn, litter or bury solid waste generated on streets, or public spaces outside their premises.

Mitigation Strategy:

It was only after assurance by the State of Maharashtra and other states on solid waste handling and submitting solid waste management policy that the ban was lifted on construction activities on 05th September 2018.

Although, the ban was for a very short duration, but the message behind it cannot be ignored. For ensuring compliance with the SWM Rules, it requires strict adherence to the requirements under SWM Rules, 2016 on all construction sites. Though these requirements are part and parcel of the contractual documents of the DFC project but normally not followed so diligently. Such legal orders are indicative of type of associated environmental risks existing on the construction sites, and if the prescribed norms are not followed, it can hamper the progress due to stoppage of work.

7.0 CASE EXAMPLE – 5:

Ban on Construction Activities Due to Severity of Air Pollution and Smog Conditions in Delhi and other NCR Districts

Environmental Issue:

The Hon'ble Supreme Court appointed Environment Pollution Control Authority (EPCA) and National Green Tribunal (NGT)by their various orders in peak summer and winter season of 2017 and 2018imposed ban on all construction activities involving excavation, civil construction (excluding internal finishing / work where no construction material is used) in Delhi and other NCR Districts for different period of time, such as for 10 days from Nov 01-10, 2018, for 3 days from Dec 24-26, 2018, etc.

Further stoppage order was also issued to all stone crushers, hot mix plants generating dust pollution. The local government / authorities also banned the movement of heavy vehicles, cargo movement and logistical movement across the whole of the NCR Region. These actions had a major detrimental impact in progress of works during the banned period. Concreting has been badly affected due to the banned movement of RMC, bulk materials, cement, etc.

The smog conditions resulted in extremely poor visibility levels. Site works at night had to be abruptly discontinued as visibility neared zero-meter levels. This has caused the hindrance in the movement of cranes, other heavy machinery and people on site, drastically hampering the rate of physical progress.

The EPCA imposed ban on construction activities mostly in Delhi, Faridabad, Gurugram, Ghaziabad and Noida in view of the national capital's "severe" air quality.

Mitigation Strategy:

Only a few options were available after blanket ban on construction activities. However, to avoid any risk on stoppage of work during non-ban period by the

competent authorities in case of non-compliances, the DFC project took stringent measures on all construction sites to comply with the stipulated norms and standards. Some of these measures included –

- **Control of dust pollution at construction sites through appropriate cover such as:**
  - o Provision of ducting arrangement at the outlet of all exhaust fans & connecting to the suitable-type dust extraction System in cement godown;
  - o Removal of all loose cement dust settled at the bottom of the bag filter system and the bag filter to be operated & maintained properly, especially the cleaning of filter bags to avoid pressurization of silos thereby causing fugitive emissions from leakages etc. in concrete batching plant;
  - o Provision of adequate covering arrangement at aggregate bin to control dust emissions into the atmosphere; & Cover conveyor belt from sides throughout with tin sheets and/or green nets to avoid fugitive dust emissions.
- **Several Control measures was under taken at sites for fugitive emissions from material handling, conveying and screening operations through water sprinkling, curtains, barriers and dust suppression units:**
  - o Water sprinkler is provided for coarse aggregates, to cover entire stockpile;
  - o Water sprinkling arrangements in haul and service roads has been made though water tanker. The frequency of water sprinkling is done as per actual site conditions so as to keep fugitive dust emissions constantly under control.
  - o Provision of green net beside at approach road.
- **Ensured carriage of construction material in closed vessels:**
  - o As per NGT Orders and directions from the Pollution Control Boards, dust emissions during movement of construction vehicles within construction sites is controlled at all the times. Further, green net / tarpaulin sheets are provided in dumpers carrying soils.

8.0 CASE EXAMPLE – 6:

Unavailability of Borrow Pit in the Extended Area due to Declaration of Jawai Bandh Panther Zone as Protected Area

Environmental Issue:

The State Government of Rajasthan took a decision in early 2012 to declare the Jawai Bandh forests in Pali District as a "Conservation Reserve" and thereafter, started the process for notifying the area.

The State Government of Rajasthan issued Notification on 27.02.2013 under the Wildlife (Protection) Act, 1972 to declare 19.7858 sq. km of area within five villages of Pali District, as "Jawai Bandh Conservation Reserve". In the notification, the notified area was clearly mentioned with Khasra (Plot) no., area in ha, category of land, and ownership which was mainly government land belonging to the Forest Department and the Irrigation Department. The category of land was primarily either of hilly nature or water holes. Most of the plots were categorized as "Recorded Forest Area".

The State Government issued corrigendum on 03.07.2013 to the previously issued Notification of 27.02.2013 for renaming "Jawai Bandh Conservation Reserve" as "Jawai Bandh Leopard Conservation Reserve".

Subsequently, the Office of the Deputy Conservator of Forests, Pali District issued a letter on 10.02.2014 to the Mining Department, Sojat informing about the proposal on expanding the area of "Jawai Bandh Leopard Conservation Reserve".

The letter mentioned that the Mining Department prior to issue permit for mining lease on "Government Land" of 10 villages should seek permission from the Conservation Reserve Management Committee.

Mitigation Strategy:

Though no formal Notification has been issued, but the ban on doing any type of mining activity continued in the "Panther Zone Conservation Area" and affected the adequate supply of borrow earth material.

Recognizing the ground reality, more borrow areas were continuously identified in the adjoining villages falling in the non-conservation zone to ensure supply of sufficient quantity of construction material.

9.0 CONCLUDING REMARKS

This paper has focused on nature and duration of impacts during the construction work of the DFC project resulting due to continuous changes

happening in the environmental regime of the country, either at the National or State Level, on account of non-compliances, violation of environmental norms, environmental emergency situations, etc.

It cannot be denied the facts that such frequent events happening on the environmental issues are now becoming "New Environmental Risks and Challenges" for the development of any large-sized railway infrastructure development project or others. The project has to either live by it or in-built "environmental risk assessment, mitigation and management" concepts and measures in moving forward independent of negative impacts and at the same time comply with the stringent conditions being imposed by the regulatory authorities from time to time.

It is also true that most of these judicial orders normally come like a 'bolt from the blue' in the project, but at the same time, it also requires adequate preparation, identifying the critical issues, and provision of enough resources to address weaknesses or opportunities associated with them without affecting the progress of construction activities for timely completion of projects.

PIONEERING NEW VISTAS IN DFCCIL – INDEPENDENT SAFETY ASSESSMENT OF ELECTRONIC INTERLOCKING (EI) FOR WDFC-I

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SYNOPSIS:
Electronic Interlocking (EI) is the current state of art and the de facto standard of Interlocking. On IR, EI Equipment of the vendors pre-approved by RDSO are installed and commissioned. However on Western Corridor of DFCCIL which is funded by JICA, the requirements of the STEP items supplied as part of the tied Japanese loan that includes Electronic Interlocking are different. This necessitated chalking out a path hitherto un travelled. DFCCIL was required to handle the entire gamut of activities which is being handled by RDSO for IR. DFCCIL prepared and established a 'Cross Acceptance/Approval Policy for Software embedded systems like the EI, finalise the Contractor for the Project, prepared guidelines for the ISA, finalise the agency for taking up the Independent Safety Assessment (ISA) work and subject the Equipment being supplied by the Contractor to the Safety assessment by ISA. DFCCIL also initiated another pioneering step in preparing the Terms of Reference (TOR) for Safety assessment of the Signalling system Project by the Independent Safety Assessor. The work although is gigantic, DFCCIL rose to occasion and with a systematic approach formalised the required rules, Policies and procedures for taking up assessment work as well as the Nomination of the ISA agency. Hence DFCCIL chalked out a new path for others to emulate in times to come. This also laid a strong reference frame work for handling future freight corridors too. Hence DFCCIL pioneered the entire Procedure and policy for subjecting the Product as well as Project to the scrutiny of the Independent Safety Assessor (ISA). This is being done for the first time on IR establishes the credentials as well as confidence of DFCCIL in taking such similar steps in future.
In this paper, an attempt has been made to trace the path which culminated in finalisation of the DFCCIL policy suitable for Equipment being supplied under STEP tied loans, the issues faced and the processes involved in fixing the Independent Safety Assessor (ISA). The paper also traces the interesting path of the ISA processes in validating the design – both hardware and software which finally culminated in according provisional clearance for use of Hitachi EI on DFCCIL

Introduction:

In order to execute Signalling works in DFCCIL Project, Railway Board has permitted introduction of New technology in S&T items vide Board's letter No. 2007/Infra/6/8 dated 9/7/2010, which mentions EI, MSDAC and TPWS as new technology items. Hence RDSO specifications and acceptance of these Signalling items by RDSO is not mandatory on DFCCIL project. Further the Board observed that the equipment being submitted under STEP component will not be able to meet the proven ness criteria as their modified equipment are not deployed for commercial service anywhere.

Further Railway Board vide their letter 11/Sig/G/7/DFC dated 4/9/2014 advised DFCCIL that "DFCCIL may have to consider appointment of experienced **Independent Safety Assessor (ISA)** of repute for Safety Evaluation and Certification of Signalling items included in the STEP (Specific Terms for Economic Partnership) components or any other new Technology Signalling items permitted in DFCC project. Based on the Safety certification by ISA, DFCCIL with the recommendations of their consultants may approve such STEP Components or new technology Signalling items before commissioning of the Product/System.

DFCCIL committee to finalise the scope and TOR of ISA:

A Committee consisting of three senior S&T officers was formed in April 2015 to finalise the scope of work and conditions for engagement of Independent Safety Assessor (ISA) for S&T works. The Committee reviewed the RDSO's Cross Acceptance/Approval Policy for Software Embedded Electronics system and New /Imported Technology products for Railway Signalling and deliberated whether to have one ISA for the Signalling Generic Products Assessment and another for Signalling Project Assessment or separate ISA for each

assessment. The Committee also deliberated on carrying out Type Tests and/or field trials and the officials who will carry out/witness the same. Since the details of the Generic Product to be supplied for Signalling project will be known only after finalisation of the Signalling Contracts, it was consciously decided to start the tendering process for engagement of ISA agency after the Signalling bids were finalised. It is worthwhile to note that the committee in its deliberations mentioned that the Assessment of product by an ISA is a tedious process taking anywhere from 1 to 2.5 years in general. The Committee also deliberated whether the Safety Certification by the ISA appointed by the Signalling Contractor can be accepted or not, whether Option to have their products approved by RDSO or DFCCIL ISA, how to deal with products that have undergone minor hardware/Software modifications (having proven ness for earlier version) and apprehensions regarding time taken for Cross approval adversely affecting project timelines.

The Committee observed that the Cross approval/acceptance of Signalling equipment under RDSO's cross approval policy is primarily for Equipment which are already in use on a passenger carrying service anywhere in the world at speed more than 100kmph. Committee also observed that the RDSO Cross approval of Signalling items involves two important aspects:

a. Safety Case Clearance.

b. Trials.

What is a Safety Case: Specification IEC 62425 defines a Safety Case. The Safety Case documents the Conditions that are required to be satisfied in order that the Safety related Electronic Railway System/Equipment can be accepted as adequately safe for its intended application. The Conditions are:

a. Evidence of Quality Management: It should be demonstrated that the quality of the system, sub system or equipment has been and shall continue to be controlled by an effective Quality management system throughout its life cycle. Basic purpose is to minimise the human errors at each stage of the Life cycle.

b. Evidence of Safety Management: At this stage it should be demonstrated about availability of robust Safety Management system consistent with IEC62278.

c. Evidence of functional and technical safety: This shall explain the technical principles which assure the safety of the design including supporting evidence. Section 3 of this Evidence deals with effects of the faults and the technical measures taken to reduce the consequent risk to an acceptable levels. This section also details the requirements of mitigating the risk due to single or multiple faults.

All these conditions are required to be satisfied at equipment, sub-system and system levels before the Safety related system is concluded as adequately safe. The documentary evidence that these conditions have been satisfied shall be included in a structure safety justification document known as Safety Case.

Safety case can be for Generic Product, for Generic Application or for Specific Application Safety case.

Keeping all the above in view, the Committee finalised their recommendations which was issued as "Procedure order for Cross Acceptance/ Approval of Software Embedded Electronics Systems and new/Embedded technology products for Railway Signalling for DFCCIL". The Committee also finalised the Terms of Reference (TOR) for ISA

which essentially covers the Assessment requirements of the Signalling Project being undertaken on DFCCIL, in this case the WDFC-I Project.

In retrospect the Committee although consisting of Indian Railway S&T officers not very familiar with the new path being adopted, came out rather exceptionally well in finalising the not only the Cross Approval Procedure order for Cross Acceptance /Approval of Software embedded Electronic Equipment but also the Terms of Reference (TOR) for Independent Safety Assessment of Signalling Project. These two historic documents made the role and responsibilities of the Independent Safety Assessor crystal clear there by chalking out a smooth path for the ISA to adopt leading towards Certification of the Product as well the Signalling Project.

Salient features of the DFCCIL Procedure Order for Cross acceptance/approval of Generic products.

a. it shall be applicable only for EI, MSDAC and TPWS supplied under Japanese STEP loan conditions.

b. the supplier shall submit Safety Case of the product to the ISA containing details as mentioned in the Policy.

c. Evaluation of the Cross acceptance shall be in compliance to the relevant specifications. (this para includes not only the RDSO specifications for the Generic

product being assessed but also the technical stipulations laid down in the Bid documents to be complied by the Vendor of the Product.

d. The proveness criteria for various Equipment has been defined as follows:

	Equipment/System	Min. no of Equipment	Equipment hours in use
1.	MSDAC	50	4,32,000
2.	TPWS On Board	25	2,16,000
	TPWS Track side	100	8,64,000
3.	EI	25	2,16,000

Further the following three notes have been added to cater to the specific status of the Equipment consciously eliminating any duplication of processes and at the same time respecting the Safety nature of the product without cutting any corners.

Note 1: For all the above items, atleast 20% of the equipment/system with a minimum of 10, should be in continuous operation for a minimum period of 720 days.

Note 2: If the offered equipment has undergone minor hardware/software up gradation to improve functionality/Safety of the equipment, the utilisation of the earlier version can be considered for proven ness criteria. However in such cases, a minimum 10 upgraded Equipment should be in continuous operation for a period of 180 days.

Note 3: If equipment is not deployed for commercial service any where, it shall be subject to Type tests and field trial as detailed in the procedure order.

e. The ISA at every stage is required to prepare assessment report giving his permission /clearance for

i. Type test and trials (based on the assessment of the Safety Case).

ii. Field trials (based on the assessment of the Type Test results)

iii. Use on DFC (based on the assessment of Safety case, Type tests and field trials and the ISA's own Test witnessing audit).

f. The Type tests where carried out shall be as per the tests laid down in Annexure to the Procedure order.

g. The Type Tests shall be carried out in manufacturer's premises to be witnessed by DFC/Engineer/ISA as per Cross Acceptance Responsibility matrix. This matrix clearly lays down the responsibility of Contractor, PMC, ISA and the Employer, ensuring Independence of the ISA.

h. Further it was stipulated that the Type tests can also be carried out in independent test house of repute.

i. The field trials shall be carried in Rlys/DFC. The

field trials can be proceed simultaneously with Type Tests. (This is to save on Project time without any way sacrificing the requirements).

i. The duration and number of equipment to undergo field trials have been mentioned in the procedure order for various class of equipment.

Salient features of the Terms of Reference(TOR) for ISA:

a. The TOR supplements the Cross acceptance Procedure Order and essentially covers the methodology for Safety assessment of the Signalling system to be adopted by ISA for his assessment.

b. The ISA shall assess both the hardware and software components of the Signalling system.

c. To assess the adequacy of the Safety management processes undertaken by the Contractor during various stages of the project.

d. Shall carry out Safety audit of the Design offices and Project site offices.

e. Shall carry out document review as per the standards.

f. Shall issue Interim ISA reports and observation management and tracking log.

g. The deliverables of the ISA are to be submitted in terms of reports as follows:

1. Report 1 to include initial safety assessment plan and the assessment of Contractor's plans issued during design phase.
2. Report 2 to include Design assessment of the Contractor's design offices. This also details the documents on which ISA shall focus.
3. Report 3 pertains to Manufacturing and Installation Audit and Assessment which pertains to manufacturing and installation phase.
4. Report 4 pertains to ISA's site audit of the Project site offices.
5. Report 5 pertains to Testing and Commissioning Audit and Assessment.
6. Report 6 pertains to Engineering Safety validation case Safety assessment.
7. Report 7 pertains to assessment of Operation and maintenance processes.
8. Report 8 pertains to assessment of Trial running tests.

h. The ISA shall submit monthly progress reports for Signalling products and Quarterly reports for Generic products.

At the end of the above assessments the ISA shall issue

a. Final safety assessment report for Generic Products and

b. Final Safety assessment report for Signalling System.

Experience of WDFC-I in processing for finalising the Independent Safety Assessor for WDFC-I Project:

1. RDSO vide their letter STS/E/ISA-Approval dated 16/9/2013 issued its first panel listing the firms who are eligible to undertake Independent Safety Assessment (ISA) of Signalling Generic products, Signalling project and for Metro projects. One of the important criteria is ISA should have accreditation under ISO/IEC17065. RDSO issued the revised panel of ISA vide letter no STS/E/ISA-Vol-III dated 7/12/2015 containing 5 firms for Metro Projects, 10 firms for Main line projects and 9 firms for Railway Signalling Generic products.
2. The ISA panel list issued by RDSO is separate for Main line Generic Products and for Main line Signalling project. As mentioned earlier, the Committee took a decision to subject both the generic products as well as the Signalling Project to the scrutiny of ISA. As per RDSO's Panel, 10 firms were empanelled for Main line Signalling Project services and only 9 firms were eligible for Safety assessment of the Signalling Generic Products. However as the RFP for ISA for WDFC-I was common for both the services (Generic as well as the Signalling Project), it was ensured that no firm suffers due to combining of both the services by introduction of appropriate Eligibility Criteria. Hence the Eligibility Criteria mentioned in the RFP stated that "Only firms borne on the RDSO panel for Main line Signalling AND for Generic Products used in Railway Signalling products used in Railway Signalling either as sole firm or JV/Consortium". The Eligibility criteria was applicable to the lead member of the

JV/Consortium only. This clause ensured that no firm will be at disadvantage due to combining both the assessment services.

3. As it is noted that out of the 9 to 10 firms on the RDSO panel, some of the firms were noted to be dormant. To ensure serious participation, further Eligibility criteria was included in the ISA RFP which includes inter alia

a. The tenderer should have valid accreditation under the scope of ISO/IEC 17065 as on the date of submission of the offer.

b. The tenderer should have carried out at least TWO works of Independent Safety assessment /audit of Train control and Signalling system in the past 7 years. (In case of JV/Consortium it is sufficient if the lead member is satisfying this Criteria).

4. Since most of the firms are located outside India, to avoid any difficulties that may be associated with Local taxes, it was stipulated that local taxes and cess shall be borne by the Client. (The RFP was finalised in the pre-GST regime).

5. To ensure true Independence of the ISA, it was stipulated that the ISA should not have associated with the given Generic products either for Product or for Project. (Conflict of interest).

6. Minimum Qualification Criteria was stipulated for the Assessment experts. (Lead assessor, Dy Assessor and System Expert).

7. Bidders are free to quote up to a maximum of Two foreign currencies.

S & T Packages for WDFC-I Project

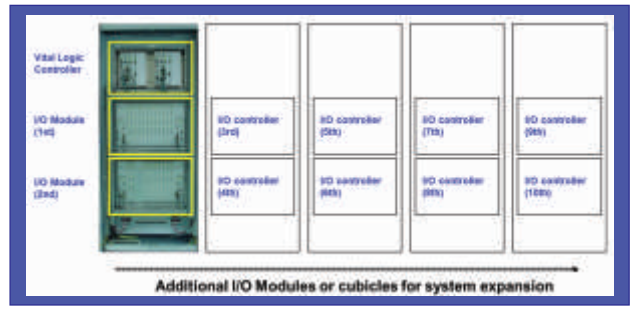
STP5 (Signalling project contract for WDFC-I): M/S. SAFE Consortium consisting of M/S. Hitachi, M/S. Mitsui and M/S. Texmaco were awarded the Contract package for the S&T work in Rewari-Makarpura section of WDFC-I. The Electronic Interlocking (EI) of Hitachi make is being supplied as a STEP component under this Contract.

STP5A (TPWS Project for WDFC): M/S. IN Signal Consortium consisting of M/S.Hitachi, M/S. Mitsui were awarded the contract for provision of TPWS Equipment in Rewari-Makarpura-JNPT section of WDFC.

The Hitachi EI being supplied under STP5 package and the TPWS being supplied under STP5A package are required to be subjected to the Procedure Order for Cross acceptance/Approval.

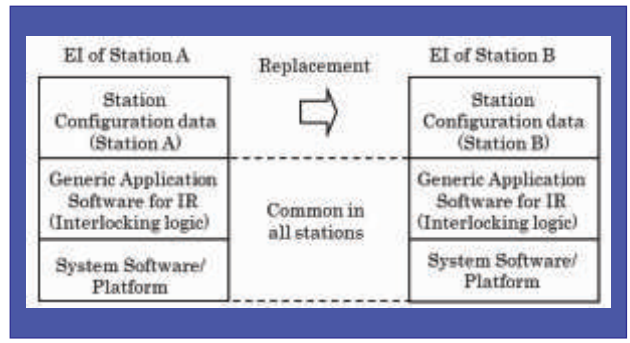
Salient features of Hitachi EI:

Hitachi's Electronic Interlocking is consisting of a main system and a hot standby system. The 2 out of 2 hardware architecture is applied to both of the main and the standby system, where twin CPUs are implemented. Hitachi EI system comprises of two vital modules; The VLC (Vital Logic Controller) is the central module of EI system where vital interlocking logic is processed and I/O Module interface with field gears via relays. I/O module also having 2 out of 2 duplicated hardware (main and hot standby) architecture. I/O Modules can be added to expand the system as shown in figure below.



Serial interface (without relays) between EI and Multi Section Digital Axle Counter System (Frauscher make FAdC R2) is implemented in this project first time on IR/DFC.

Interlocking logic is realized by Generic Application software first time on mainline project of IR/DFC, and it operates in the linked data created from the RCT and the station-specific constant table (Bit chart, Point Configuration, Track Section Configuration, etc.). By the replacement of the linked data, it is facilitated to correspond to the station of different control conditions without changing software of the interlocking logic.



Station specific data is generated from selection table of each station, then uploaded to VLC. While generic application software that contains interlocking logic, is common for all stations. This kind of software architecture provides high level of safety because human errors in preparing interlocking logic for every station is eliminated.

Appointment of ISA for WDFC-I: As it was consciously decided to initiate action for finalising the ISA agency after the agencies for the S&T packages were decided, the tendering process for finalising the agency for ISA started as soon as the packages STP5 and STP5A were finalised. ISA bid documents were prepared on Two Packet bid system. The first packet was opened on 2/9/2016. Due to certain technical reasons, the bids were refloated and the revised technical bid was reopened on 28/11/2016 and the price bid was opened on 19/12/2016. The Letter of Acceptance (LOA) was issued to M/S ItalCertifer S.p.A Italy on 2/1/2017. **As can be seen the two packet bid was finalised within a period of 35 days.** The Integrity Pact with the ISA was signed on 30/1/2017 and the Contract Agreement for the first ever Contract for Independent Safety Services (ISA) on DFCCIL was signed on 31/1/2017. The Completion period of the ISA Contract is FOUR years dovetailing with the completion periods of the STP5 and STP5A Contract packages.

Brief on Hitachi EI: The original Hitachi EI was modified for complying with RDSO specifications for EI and the modified Equipment was not deployed for commercial service anywhere. Hence as per the DFCCIL Cross approval policy, the equipment was required to undergo the Type Tests as well as Field trials. Initially the Contractor submitted certified **Safety Case** for the original base equipment for evaluation by ISA. Also the Type Test Plan for carrying out Type Tests on the EI equipment as mandated by RDSO/SPN/192 EI Specification) and RDSO/SPN/144 (Safety and Reliability requirements of Electronic Signalling Equipment). The ISA issued Detailed Technical Note (DTN). The Technical note contained the various issues that need more information/documentary supplement by the Contractor. The First DTN issued on 15/2/2017 had 17 open issues. Through a number of video conferences/ teleconferences, the issues were closed convincingly. The ISA submitted their Assessment report on Safety case as well as on the Type Test Plan for EI in August 2017 giving clearance for carrying out Type Tests. The Type Plan included both Hardware as well as Software Type Tests as mandated in the RDSO specifications.

Type Tests of EI Hardware and Software: The Hardware Type Tests began in September 2017 and were conducted in Hitachi Works Ibaraki , EMI/EMC tests in Hitachi Test house Kanagawa, Vibration, Temperature tests in TUV Osaka etc. The Type Tests were conducted in Japan for a period of 3.5 months. The Type Tests as per the Cross approval policy were witnessed by both Employer and Engineer. The Hardware Type Tests were completed in January 2018. The Software type tests were completed by March 2018. The Type Test results were submitted to ISA. The ISA after issuing various DTNs (Detailed Technical Notes) submitted his Assessment report on the Type Test results giving clearance for carrying out Field trials.

The field trial plan was then submitted to ISA which was cleared for conducting Field trials. While clearing the equipment for field trials, the ISA mentioned that he will be conducting random tests for which Test audit protocol will be issued.

Field Trials of EI: As per the Cross acceptance policy, the field trials are required to be conducted on One equipment for a period of 6 months. However field trials were started at two stations on DFCCIL– New Shrimadhopur and New Dabla stations. They were conducted from April 2018 to October 2018. The ISA issued Field trial audit protocol, attended the site and conducted random tests on the Equipment undergoing field trials at New Dabla station. It is of interest to note that the tests conducted by him were truly random as the routes to be tested were picked up by the ISA assessor randomly at the site and he recorded his findings in pen on the test format. This 'as it is' formed the part of the Test Witnessing Audit Report. The Field Trial test results were submitted to the ISA The ISA sought clarifications which were addressed.

Software versions: Initially a Generic application software on which the required features of DFCCIL/IR were tested as part of the Software Type Tests. This was called Version 1.0, based on the observations, the software was modified vide version 2.0. As demanded by ISA, the supplier submitted the non regression and impact analysis for the two software versions to the satisfaction of the ISA.

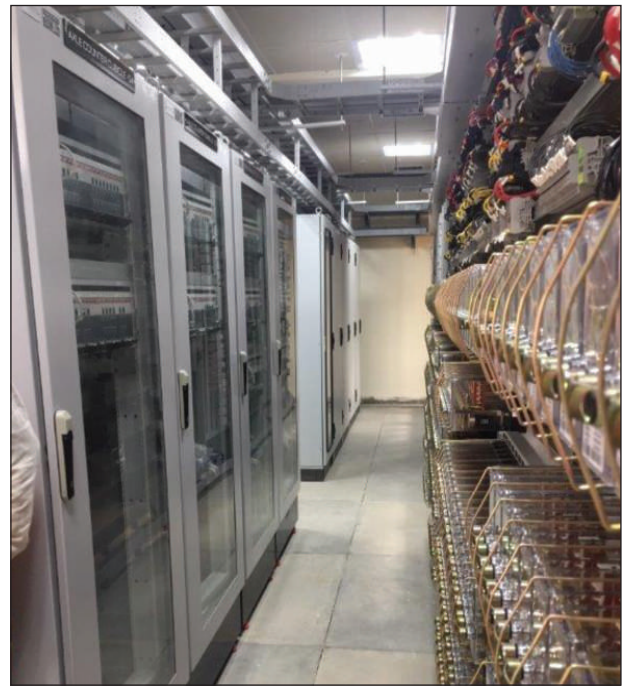
ISA's certification of Hitachi EI for use on DFC: The ISA after going through the Safety case, version 1.0, version 2.0 software, the non regression analysis for the software, Hardware and software Type test results,

the field trials results, the test witnessing session report, gave his assessment report dated 24/12/2018 which concluded that **" Italcertifer regards that Hitachi Electronic Interlocking Baseline version 2.0 identified in 4.8 of this report can be permitted for use on DFC".** This completes a major mile stone in progress of STP5. The Final Safety assessment report will be issued by ISA after the receipt of the internal certification by M/S.Hitachi.

The total time taken to complete the process from appointment of ISA till the Certification was around 22 months.

Conclusion:

Railway Board in their wisdom gave a new direction to DFCCIL - a nascent company to take the path of ISA for certification. Although this direction divergent from the current method of certification on IR, DFCCIL took up this direction in right earnest, set up internal mechanism to tackle the gigantic task of chalking out the new path and came out successful while ensuring all the laid down processes and policies are adhered to in toto. The path shown by DFCCIL in preparing the Cross acceptance/approval policy for Signalling Generic Products, Terms of Reference (TOR) for Safety assessment of Signalling Project and laying down the path for the ISA to adopt that ultimately resulted in the Cross Approval/Certification of the EI to be commissioned on WDFC-I by an Internationally accredited ISA within a short span of 22 months. This augurs well not only for DFCCIL but will also provide the needed impetus for other organisations contemplating to tread on the path laid by DFCCIL



Hitachi EI Installation at New Ateli Station of WDFC-I.

USE OF TURN TABLES FOR OPTIMIZATION OF NTC ON EDFC2

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ABSTRACT:
On Dedicated Freight Corridors Corporation of India Ltd. (DFCCIL) tracks are to be laid by New Track Construction (NTC) machines. During layout of tracks by NTC the prime requirement is of continuous availability of ready formation which at times is difficult due to various challenges like incomplete bridges, discontinuous embankment, lead from the depot etc.
This involves mobilizing the NTC wherever the continuous stretch of work front is available so as to save time and also to avoid idling of NTC and associated resources. To achieve this either the machine is to be lifted or turned 1800 as soon as the obstruction is struck.
This could be achieved by an indigenous use of an old/scrapped Turntable. This paper describes the efficient use of the same to achieve cost optimization and time saving.

1. Background:

Easter Dedicated Freight Corridor – 2 (EDFC2) project of Dedicated Freight Corridor Corporation of India between Bhaupur near Kanpur and Pandit Deen Dayal Upadhyaya junction (earlier called Mughal Sarai junction) includes laying of 435 km of double line track. The Civil Engineering work is being delivered by joint venture of GMR Infrastructure Limited and Sew Infrastructure Limited (GIL-SIL JV). The Signalling and Telecom work and Electrification are being delivered by Chinese Railway Signalling and Communication Company (CRSCD) and L&T-INABENSA joint venture. Project Management Consultancy is being provided by joint venture of Systra and Mott McDonald.

2. Methodology and Scope of Operations:

The laying of track is being done using New Track Construction (NTC) machine. Two sets of NTC machines have been procured – one each for Bhaupur – Allahabad section and Allahabad – Pandit Deen Dayal Upadhyaya junction section. Two depots have been set up for the NTC machines – at Ramwa between Bhaupur and Allahabad and at Pahara between Allahabad and Pandit Deen Dayal Upadhyaya junction. The NTC machine was planned to work in both directions from its respective depots in order to be lay the track. This required reversing of the NTC machine depending upon direction of work. The reversing could be achieved either by laying a track triangle or turntable.

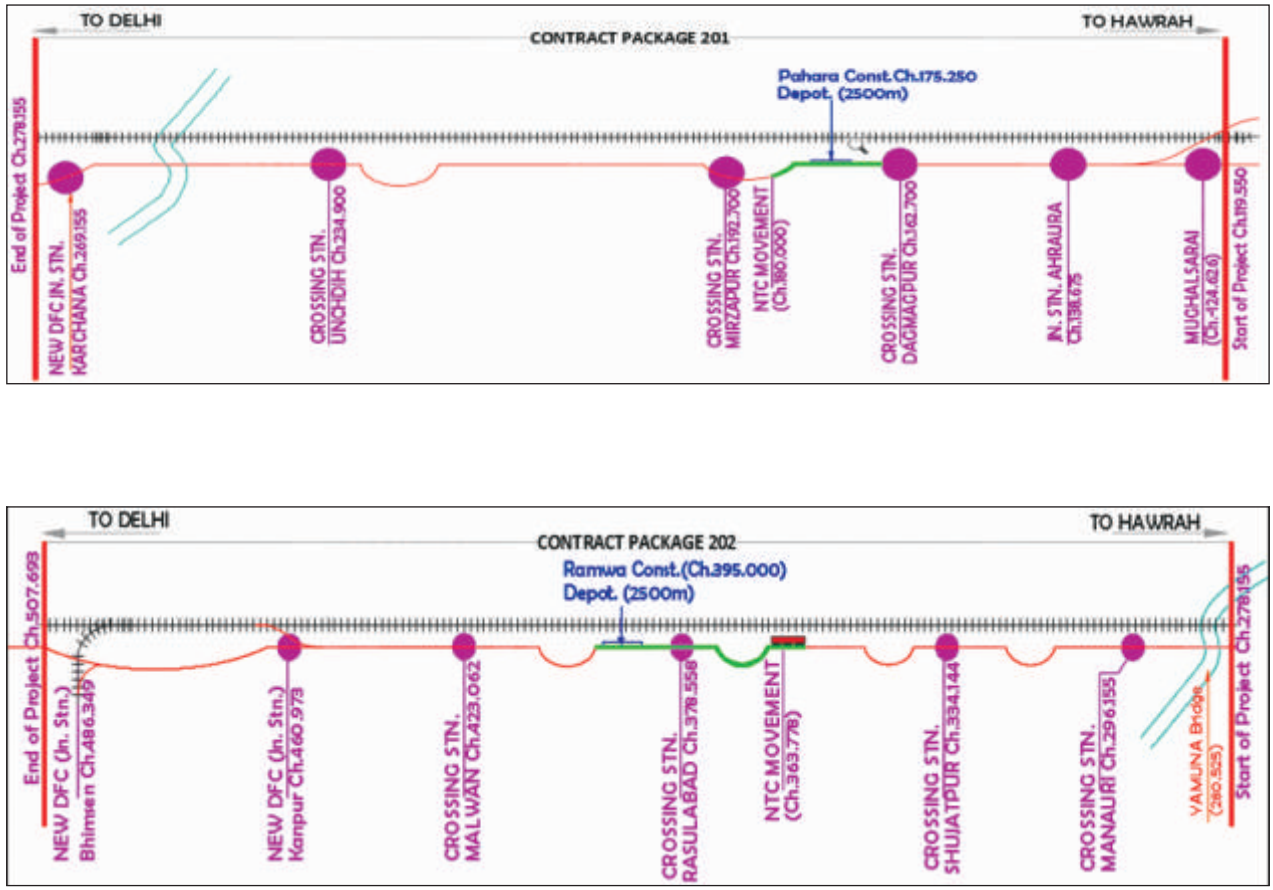

Exhibit: 1 – Layout of APL2 showing locations of Depots and NTC

3. Issues regarding operation of Turntables:

Laying a triangle to reverse NTC would have required a large amount of free and non-undulating land. Since such required land was not available it was decided to explore another option. During a casual visit to NCR (Zonal Railway HQrs) it came to knowledge that two number DS8 (Scrap) turn tables of 75 feet diameter and 37.5 tons each weight at Chunar and Naini near Prayagraj (earlier Allahabad) were being auctioned. It was decided by the Project Team to explore the use of these turn tables for reversing the NTC. A preliminary study revealed that these can be used to reverse the NTCs and thus save time and cost in their operations.

DFCCIL – Allahabad team extended support to obtain necessary approvals from Indian Railways. There was also some interesting discussion about monetary value of these turn tables as well as disposal of these once the project would be over. Project Team was able to settle terms and conditions with Indian Railway at a total cost of Rs 21,71,804 +18%GST). The turn tables were out of use for a very long time and therefore were not in working order. Project Team started to restore these turn tables and arranged spare parts. Mr. Vinay Srivastava, GM-Track-GIL-SIL JV developed the spare parts with local vendors and workshops and thus the Project Team was able to restore these turn tables. Concrete pit for the turn table was constructed locally. The turn table is operated manually using hand lever to move the bridge forward or backward. The turn tables have since been installed at Ramwa and Pahara depot and are giving satisfactory service.

Due to efficient use of these turntables the movement planned for the NTC could be optimized viz a viz the availability of work fronts.

Graphs showing the optimization of NTC are as follows:

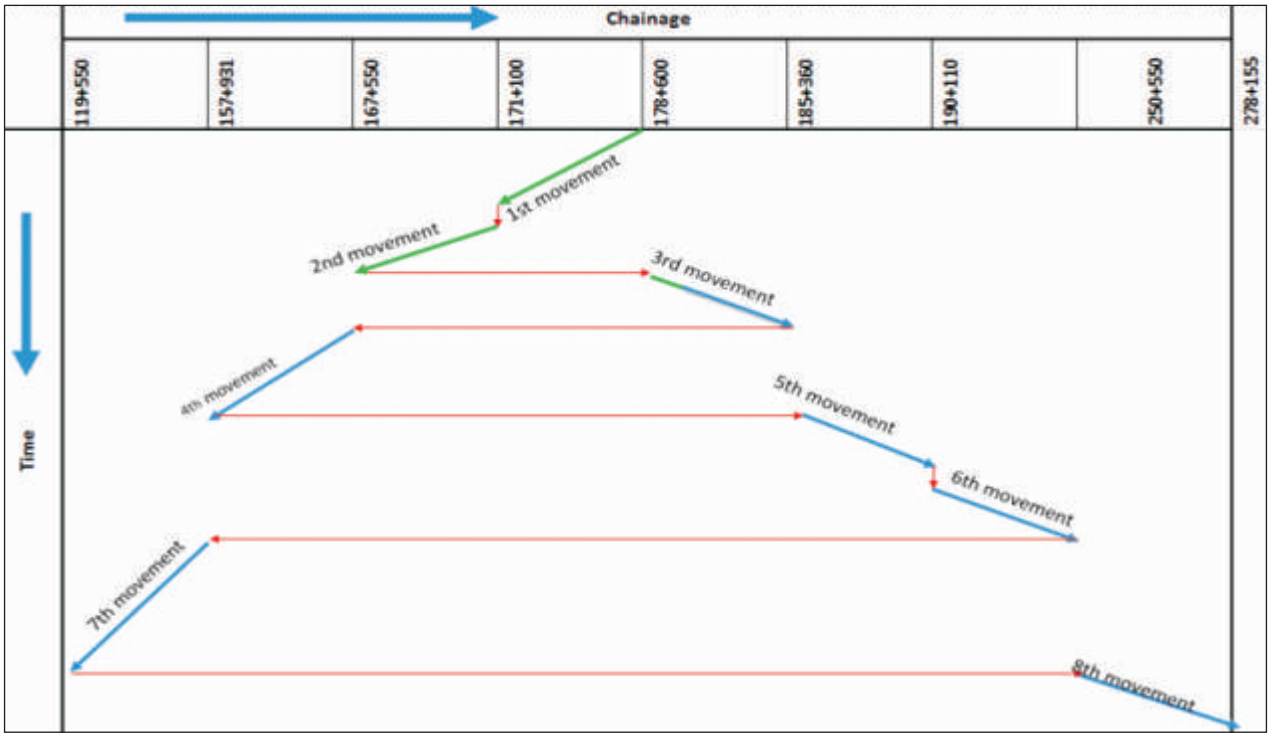

Exhibit -2 – CP-201 - NTC Movement= 12.5 Route Kms. (Track Laid)

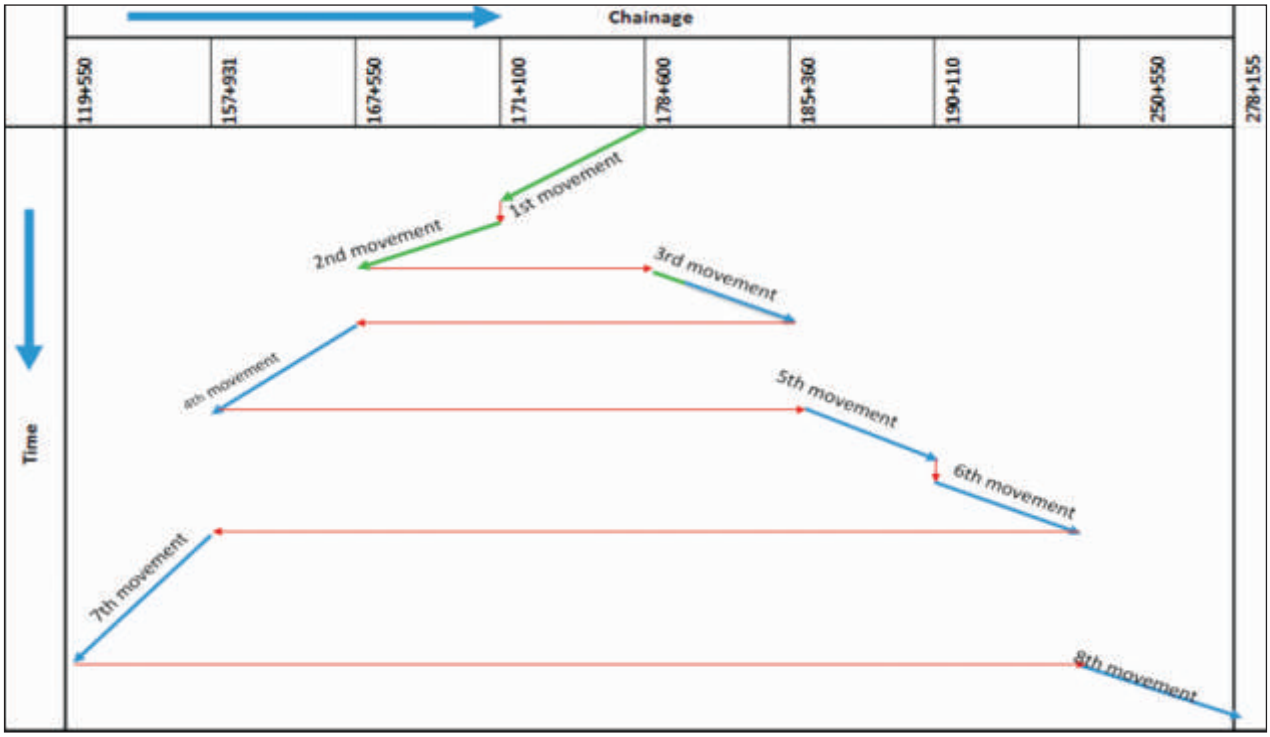

Exhibit -3–CP-202 - NTC Movement= 35Route Kms. (Track Laid)

Exhibit -4 – Turn Table installed at RAMWA Depot

Exhibit –5– Turn Table installed at RAMWA Depot

Exhibit -6 – Turn Table installed at RAMWA Depot

Exhibit -7 – Turn Table installed at RAMWA Depot

4. Conclusion:

By using this old turn tables, the project was considerably able to shrink the timelines as well as optimize the use of NTCs. The credit for this goes to the Employer (DFCCIL), Contractor (GIL-SIL JV) and the team of Engineer (Systra – Mott JV).

Complex project always throws up complex challenges, but these also provide innovative solutions. Project Managers must always look beyond the standard solutions and be innovative in their approach.

ADOPTING GREEN PRACTICES WHILE CONSTRUCTION OF CORRIDOR WITH THE AIM OF SUSTAINABLE DEVELOPMENT: UNDERSTANDING OUR ENVIRONMENTAL AND SOCIAL RESPONSIBILITIES

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ABSTRACT:
This paper focuses on various practices being integrated as part of Construction Methodologies to Safeguard Natural Ecosystem and to minimize the negative impact of construction activity on surrounding vicinity and existing baseline environment. DFCCIL has Dedicated Social and Environment Management Unit (SEMU) at Head Office. Role of SEMU unit is to formulate Corporate Environment Policy, Environmental Management Framework for Eastern Corridor as Eastern Corridor being funded by World Bank, in line with Funding agencies Environment Safeguard Policies.
The key inputs from SEMU unit focuses on ensuring Environmental Safeguard Performance by formulating necessary Guidelines/Policy, providing all Technical Support, formulating Environmental Management Framework, Environment Impact Assessment study and continuous Monitoring of Performance Indicator at Site Level.

1.0 INTRODUCTION

Dedicated Freight Corridor Corporation of India (DFCCIL) was incorporated in October 2006 under Indian Companies Act 1956, is a Special Purpose Vehicle set up under the administrative control of Ministry of Railways. DFCCIL adopts a corporate environment policy, to adopt not only an environment friendly mode of transport system but also takes initiatives in each aspect of its working to foster growth and sustenance of healthy environment. The freight corridor projects taken up by DFCCIL are range from medium to large scale infrastructure projects. Such projects have a potential of causing environmental and social impacts.

The Railway projects may have negative impacts on some parameter of environment on short term basis but in long run it will have positive impact on environment. As an environmentally aware and socially responsible corporation, DFCCIL is cognizant to the need to mitigate and minimize the negative environmental and social impacts of projects in its portfolio and has adopted Environmental and Social Policy (ESP) and developed procedures that ensure minimization of such impacts.

2.0 DFCCIL Corporate Environment Policy

The Environment Policy of DFCCIL is guided by its commitment to integrate environmental protection and social development in its mandates, in a proactive manner, to contribute towards sustainable development. To achieve the fine balance among developmental imperatives and environmental wellbeing, DFCCIL gives due importance to environmental considerations in adopting the projects to minimize adverse impacts and risks to the environment and people that may be affected. This policy statement emphasizes DFCCIL's sensitivity and concern to environmental issues, commitment towards compliance, and responsiveness towards environmental requirements of its projects. The Environment Policy is implemented through a well-structured Environmental Management Framework (EMF) for sustainable development approach.

At the onset of construction activity for constructing corridor, at the beginning with the aim and approach for Sustainable Development, DFCCIL has formulated its Corporate Environmental Policy and in year 2011 it got approved and embedded in all technical documents.

DFCC

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CORPORATE ENVIRONMENT POLICY

Sustainable development for inclusive growth as the key objective of the national economy in India would call for rapid growth of infrastructure. Rail transport is one of the major components of vehicle for growth of Indian economy. DFCC is a major initiative in this direction to acquire the quantum jump in Rail transport capacity in the Pan India Network by providing high capacity, high efficiency backbone connecting the major economic hubs of the country.

It is natural DFCCIL adopts a corporate environment policy to adopt not only an environment friendly mode of transport system but also takes initiatives in each aspect of its working to foster growth and sustenance of healthy environment. The corporation is thus committed towards compliance of all regulations and guidelines relating to environment. It is also our endeavor to adopt -

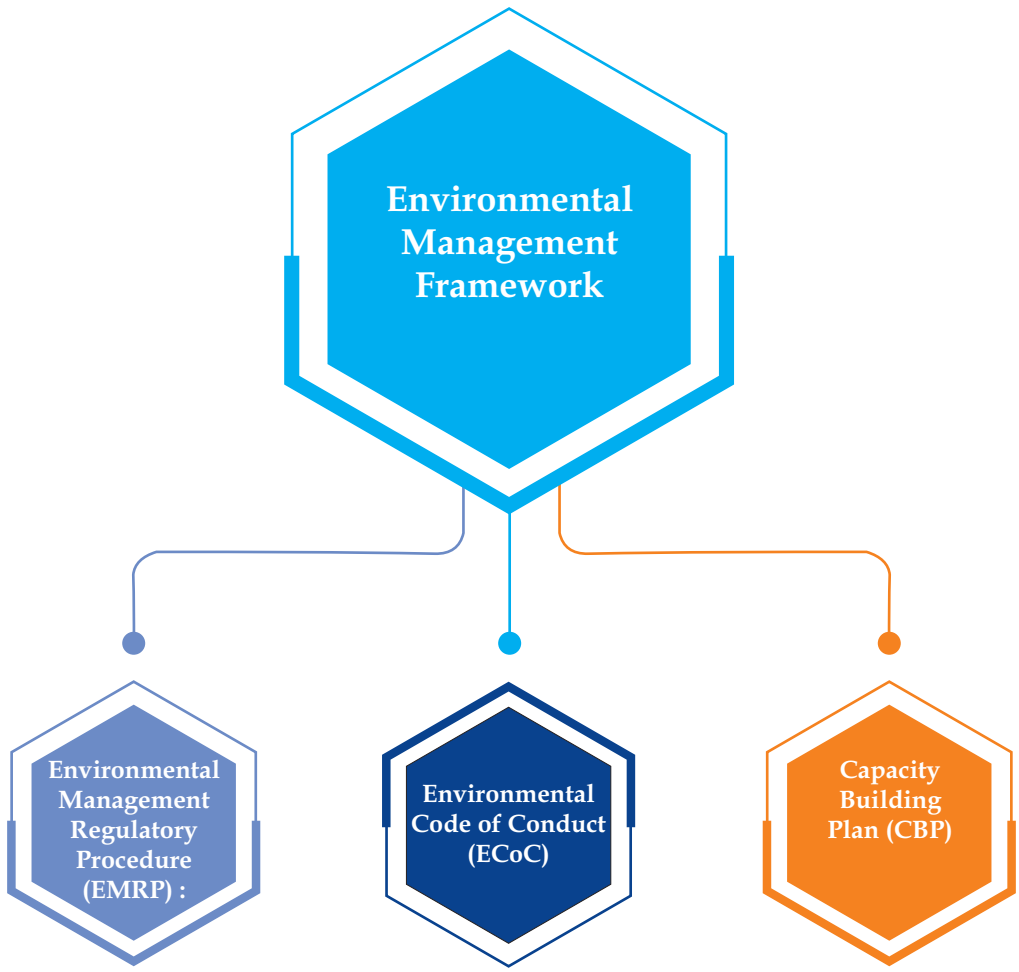
- Integrated Environment Management and Practices.
- To exhibit sensitivity towards environmental responsibilities and conduct our activities accordingly.
- Efficient utilization of energy resources.
- Associate in direct activities towards environmental improvement through development of green belt and conservation of water resources.
- Make efforts for preservation of ecological balance & heritage.
- Mitigation measures for noise, vibration and waste pollution.
- Sensitize human resource of the corporation towards environmental needs.
- Sustain improvement of environmental performance of the organization.

3.0 Environmental Management Framework

The Environmental Management Framework addresses following key issues

- to avoid and to minimize adverse environmental impacts/risks due to project,
- to ensure that adverse environmental impacts/risks are well-mitigated/minimized to achieve applicable environmental standards and objectives,
- to comply with applicable GOI state laws and regulations, and environmental safeguards requirements of development partners,
- to provide guidance to its own staff in conducting subsequent monitoring & reporting, and in undertaking corrective actions;
- To develop and exercise mechanisms for effective supervision by DFCCIL during implementation.
- Guidelines for the DFCCIL in terms of for environmental regulations and its implementation for future projects.

For better understanding the Environmental Management Framework, EMF is divided into three parts



4.0 Sustainable Development

Striving to be a responsible corporate citizen, DFCCIL tries to find a balance between the often-competing demands of the technical, economical, and environmental commitments. The corporation is committed to protecting and enhancing the natural environment in all its operations as far as possible and aim to go beyond compliance with environmental legislations. DFCCIL endeavors to achieve sustainable development through

integrating sustainable development construction methodologies and approaches in its all construction bid documents and implementing framework at the onset of construction chain phases.

5.0 Our safeguard Practices during Construction Methodologies

Our developmental activities have minimal environmental and social impact owing to very nature of construction methodologies that minimize disposal of any pollutant in land, air or water nor it involve large scale excavation which may result in soil erosion. In spite of that DFCCIL, which is committed to achieve the goal of Sustainable Development had realized that given the scale of its operations, it is inevitable that there is some impact upon both natural environment and communities that it helps to support. To address such issues, DFCCIL has integrated environmental and social management procedures into its corporate operations by enunciating Environmental Policy & Environmental Management Framework.

Approach

Alignment of DFC have been meticulously selected & finalized to avoid or minimize intrusion & acquiring of sensitive environmental features like forest land, water body etc. This is to ensure negligible / minimum damage to the flora & fauna. Wherever, it becomes unavoidable, statutory clearance from the Competent Authority are being obtained before undertaking construction work. Re-plantation will be undertaken against trees felled within project affected area and prior permission of the Competent Authority will be obtained. For every corridor, as part of our company policy EIA study has been conducted, So far EIA studies have revealed negligible impact on the habitat of water bodies, wildlife, flora & fauna. Mitigation measures have been identified and recommended in the Environmental Management Plan. Mitigation measures for anticipated air, water, soil pollution, dust control during construction stage have been suggested. Wherever necessary noise barrier has been recommended. Regarding vibration mitigation, measures are proposed during design stage itself.

EIA studies have revealed negligible impact on the habitat of water bodies, wildlife, flora & fauna, ambient air quality, soil and not significant noise & vibration pollution due to DFC. Suitable mitigation measures and Environment Management Plan have been recommended in the reports. Cutting of trees to clear Right of Way (RoW), compensatory tree plantation and silicosis exposure reduction strategy have been adequately addressed in the EIA reports.

Environmentally proactive approach of DFCCIL is reflected from the initiatives taken in the field of energy conservation at the corporate and field level offices. GHG Emission evaluations and the positive impact that DFC will have as a contribution from rail transport sector to the carbon mitigation scenario of the country.

Some of the practices briefed at this juncture, which are consistently being tracked at all construction sites during construction phase of Eastern Corridor wherever optimum possibility hit upon tominimize the effect of construction activity on surround ecosystem.

5.1 Top Soil Preservation

While conducting construction operations at sites special care has been taken care to preserve precious top soil .Top soil being rich in organic nutrients that fit for plant growth and survival. Following practices are being done to avoid wastage.

- Top soil is collected and preserved at designated place in situ with the help of Tarpaulin.
- The stockpiles being designed such that the slope does not exceed 1:2 (vertical to horizontal) and the height of the pile to be restricted to 2 m.
- After borrowing of earth material, preserved top soil is spread over the borrowed land to restore its productivity.
- The top soil being utilized for redevelopment of borrow areas, landscaping along slopes, incidental spaces etc.
- Incorporation of suitable and effective contractual clauses for rehabilitation and restoration of borrow areas and other temporary works and landscaping it with surrounding area immediately after its use.

In Eastern Corridor, alignment being passing through the agricultural land of U.P. Haryana, Punjab State. Top soil have being stockpiled and stored carefully and being rehabilitated for landscaping purposes and borrow area reclamation.

"Top soil is the top layer of soil, in which all plants grow. Topsoil is so important because it contains all the nutrients that plants need to survive".

Top soil Stockpiling

Top Soil Stacking

After Backfilling Topsoil Closed Borrow Area

5.2 Protection of Agricultural Land while movement of construction vehicle on haul road

For suppressing the effect of generated dust on standing crop due to movement of construction vehicle on haul road, along with regular water sprinkling Green Net along agricultural farm is also being provided.

Extra precautions are being taken care of as second layer of protection to safeguard the effect of dust generated on agricultural land from vehicle plying on road.

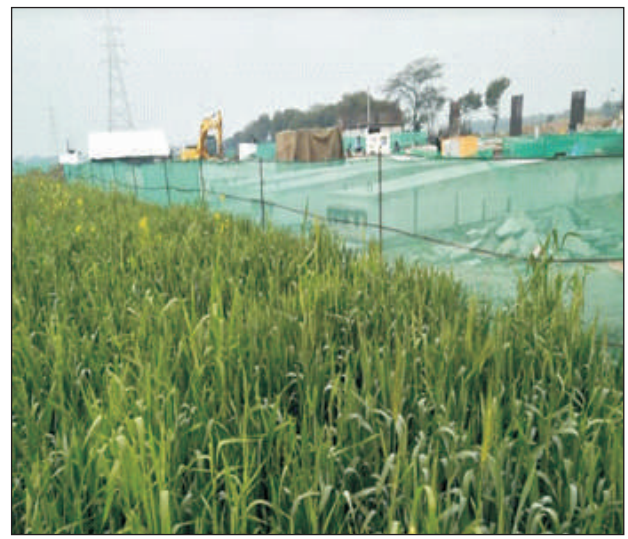
Haul Road Definition

"A Haul road is a term for roads designed for heavy or bulk transfer of construction materials by haul trucks in the vicinity of railway project.

5.3 Avoiding ecologically sensitive areas while routing lines

There has been tremendous reduction in forest involvement for development of rail corridor. Environmentally proactive approach of DFCCIL is reflected from the initiatives taken that DFC alignments have been selected carefully to avoid or minimize damage to the environment by avoiding of sensitive forest land and passing through wild life sanctuary.

In the eastern corridor total land requirement is 5664 Hectare out of which 4611 hectare is private land

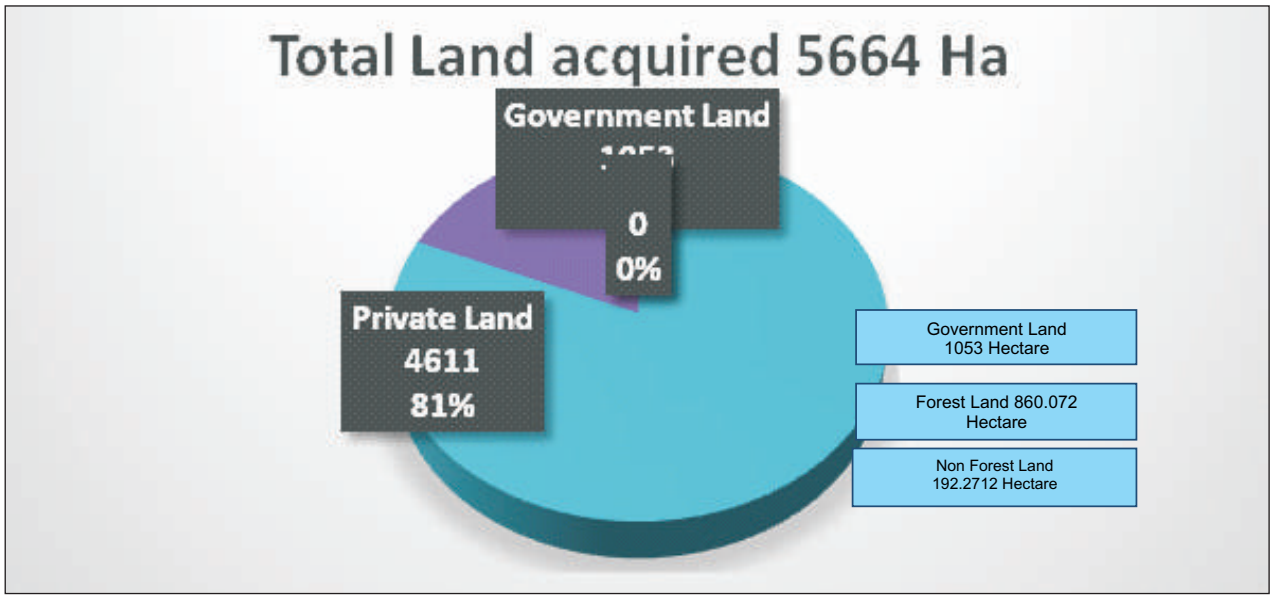


Green Net near agricultural land

Water Sprinkling to suppress dust

(which is 81.40% of total land acquisition) and 1053 ha. (Which is 16.60 % of total land acquisition) is falling under Government Land (Forest Land = 860.7288 ha.&Non Forest Land 192.27 ha.). Where unavoidable all regularity Clearances from forest and wildlife Dept. are being obtained and compliance are regularly being taken care off.

Total Land Acquire 5664 Ha.	Pvt. Land 4611 Ha.	Pvt. Land 4611 in Ha.
	Govt. Land 1053 Ha.	Forest Land 860.7288 Ha.
		Non forest Land 192.2712 Ha.



5.4 Green Initiatives

The project integrate various options in its design and project implementation to improve energy performance

At construction site reduction in specific energy consumption was accomplished through various measures, such as

- Water conservation procedures being adopted in staff quarters & stations.
- Rain water harvesting implemented in staff quarter complex, stations.
- Harnessing of solar energy being fruitfully implemented in staff quarters, station & substation buildings for street and site security lightening.
- Low sulphur High Speed Diesel to run DG sets

in emergency situation only on account of power failure.

- Use of only LED lights reduces consumption load

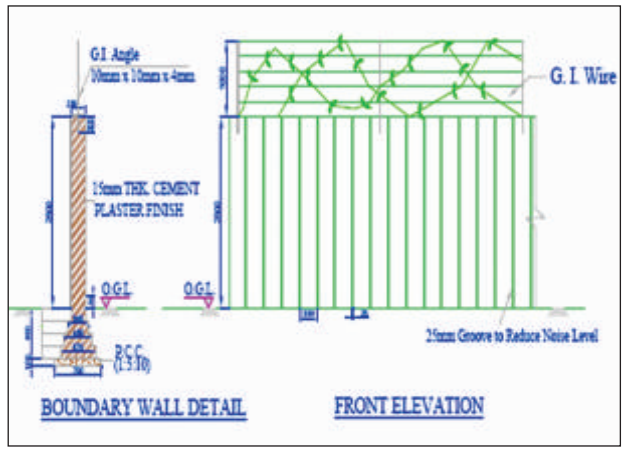
5.5 Vermicomposting

Providing vermicomposting pit at satellite offices, to manage the quantum to biodegradable waste on surrounding. DFCCIL has taken an initiative to implement vermicomposting facilities at all satellite offices to treat the kitchen waste as an initiative towards management of Biodegradable waste at site and generated compost has been used for in-house landscaping Vermicomposting facility at satellite office

5.6 Installing Noise barrier near Sensitive Receptor

School, Hospitals, Mandir, Masid close to the track (within 20 m from ROW) are the primarily susceptible site for high noise level. DFCCIL has taken initiative to safeguard sensitive receptor from high noise. Noise mitigation measures in form of noise barrier at sensitive receptors have been planned during operation phase of freight corridor also a thick canopy of green belt as green belt along the corridor has also been proposed to mitigate balance impact of High Noise.For attenuating the impact of noise on sensitive location while operation of rails , Noise barrier have been provided to attenuate the impact of crossing train noise and vibration on the sensitive receptors Contractually there is a provision of installing noise barrier at sensitive receptors.

Schematic drawing of noise barrier wall is given below:



5.7 Bottom Sediments

Silt fencing being provided to avoid runoff into the river and to save water quality of water body.

Construction activity should be taken in dry season to avoid spreading of construction material and minimize impact on water quality.

Silt Fencing while carrying construction near river

Conclusion

Contractually fostering all illustrated practices also sets mandate for Sustainable Development. Social and Environment Management Unit (SEMU) being setup to administer strict implementation of Environmental Safeguard at work site. Based on Environment Impact Assessment study (EIA) and Environmental Management Framework (EMF) various safeguard practices for "Sustainable Development" have been integrated during Construction Phase with the methodologies involved for construction. Sustainable Practices which are compatible for least degradation of Natural Environment have been adopted and being practiced. All necessary steps are being taken to safeguard the natural ecosystem. All endeavors and necessary tools will be incorporated in future too.

SALIENT FEATURES FOR SELECTION OF CONSULTANTS UNDER WORLD BANK LOANS

Ajay Kumar
ED/EDFC

Preface

Eastern Dedicated Freight Corridor from Mughalsarai to Ludhiana is being funded by World Bank. Loan agreement require DFCCIL to use World Bank documents for procurement of Works and Consultancies. Guidelines issued by World Bank for Selection and Employment of Consultants under IBRD loans and IDA Credits & Grants by World Bank Borrowers issued in January, 2011 has been adopted for Engagement of Consultants. As per Project Appraisal Document DFCCIL should engage General Consultant for preparation of PQ document, Bid document as well as to assist DFCCIL in Bid Process Management. For project management Independent Engineer as Project Management Consultant is also required to be engaged. Quality and Safety Audit Consultant has also been envisaged in DFCCIL project to report directly to World Bank and DFCCIL corporate office regarding Quality and Safety issues. Consultants are also required to be engaged for issues related to Land Acquisition , Environment and Social matters. Loan component also include Technical Assistance Component where Consultants were engaged for conducting study related to Institutional Strengthening, Energy Optimization, Commercial aspects of DFCCIL project, Operational and Maintenance Philosophy for Freight Railway, Heavy Haul Institute for Freight Railway etc. Hence, Engagement of Consultants is one of the important activity for EDFC Project. Guideline issued by World Bank deals with all aspects related to Engagement of Consultant. Some of the issues related to eligibility of applicant, preparation of short list, transparency, conflict of interest dealing with complaints etc. are slightly in variance from the procedure applicable in Indian Railway and are detailed in this paper for appreciation by DFCCIL officials which are dealing with procurement of Consultancy Contract funded by World Bank. Although, effort has been made to reproduce the content of guidelines in its perspective but it is recommended that Guideline should be referred to while acting on the provision of Guidelines.

The Borrower is responsible for preparing and implementing the project, and therefore responsible for selecting the consultant, and awarding and subsequently administering the contract.

Main considerations for selection of consultant are.

(a) the need for high-quality services,

(b) the need for economy and efficiency,

(c) the need to give all eligible consultants an opportunity to compete in providing the services financed by the Bank,

(d) the Bank's interest in encouraging the development and use of national consultants in its developing member countries, and

(e) the need for transparency in the selection process.

Quality- and Cost-Based Selection (QCBS) is the most commonly recommended method for selection of Consultants.

Consultant should provide professional, objective, and impartial advice and at all times hold the client's interests paramount, without any consideration for future work, and that in providing advice they avoid conflicts with other assignments and their own corporate interests.

A consultant shall submit only one proposal, either individually or as a joint venture partner in another proposal. If a consultant, including a joint venture partner, submits or participates in more than one proposal, all such proposals shall be disqualified. This does not, however, preclude a consulting firm to participate as a sub-consultant, or an individual to participate as a team member

Fairness and transparency in the selection process require that consultants or their affiliates competing for a specific assignment do not derive a competitive advantage from having provided consulting services related to the assignment in question.

To foster competition consultants (firms and individuals) from all countries to offer consulting services are permitted.

Government-owned enterprises or institutions of the Borrower's country may participate in the Borrower's country only if they can establish that they (i) are legally and financially autonomous, (ii) operate under commercial law, and (iii) are not dependent agencies of the Borrower/Sub-Borrower.

A firm or an individual sanctioned by the Bank shall be ineligible to be awarded a Bank-financed contract.

Consultants may associate with each other in the form of a joint venture or of a sub-consultancy agreement to complement their respective areas of expertise, strengthen the technical responsiveness of their proposals.

All members of the joint venture shall be jointly and severally liable for the entire assignment.

Once the short list is finalized, and Requests for Proposals (RFP) are issued, any association in the form of joint venture or sub-consultancy among short listed firms or from non short listed firms shall be permissible only with the approval of the Borrower.

For prior review Consultancy Services all stages of procurement are reviewed & No objection to proceed provided by World Bank.

The Bank does not finance expenditures under a contract for consulting services if the Bank concludes that such contract: (a) has not been awarded in accordance with the agreed provisions of the Loan Agreement (b) could not be awarded to the consultant otherwise determined successful due to willful dilatory conduct or other actions of the Borrower resulting in unjustifiable delays, or the successful proposal being no longer available, or the wrongful rejection of any proposal; or (c) involves the engagement of a representative of the Borrower, or a recipient of any part of the proceeds of the Loan, in fraud and corruption.

In such cases, whether under prior or post review, the Bank will declare mis-procurement, and it is the Bank's policy to cancel that portion of the loan allocated to the services that have been mis-procured.

The RFP and the proposals shall be prepared in English Language.

QCBS uses a competitive process among short listed firms that takes into account the quality of the proposal and the cost of the services in the selection of the successful firm.

The selection process shall include the following steps:

(A) preparation of the TOR;

(B) preparation of cost estimate and the budget, and short listing criteria;

(C) advertising;

(D) preparation of the short list of consultants;

(E) preparation and issuance of the RFP [which should include: the Letter of Invitation (LOI); Instructions to Consultants (ITC); the TOR and the proposed draft contract];

(F) receipt of proposals;

(G) evaluation of technical proposals: consideration of quality;

(H) public opening of financial proposals;

(I) evaluation of financial proposal;

(J) final evaluation of quality and cost; and

(K) negotiations and award of the contract to the selected firm.

The Borrower shall be responsible for preparing the TOR for the assignment. TOR shall define clearly the objectives, goals, and scope of the assignment to facilitate the consultants' preparation of their proposals.

Cost Estimate (Budget)

The cost estimate shall be based on the Borrower's assessment of the resources needed to carry out the assignment: experts' time, logistical support, and physical inputs. Costs shall be divided into two broad categories: (a) fee or remuneration and (b) reimbursable items, and further divided into foreign and local costs. The RFP shall indicate the estimated level of experts' time inputs or the estimated total cost of the contract.

Advertising

For all projects the Borrower is required to prepare and submit to the Bank a General Procurement Notice. The Bank will arrange for its publication in UN Development Business online (UNDB online) and on the Bank's external website. GPN shall include list of expected consulting assignments in the Project. REOI (A request for expressions of interest) is published on Client Website, National Newspaper (Hindi and English) as well as on UNDB online. For Consultancy of bigger Value, REOIs should also be published in an international newspaper or a technical or financial magazine.

UNDB online. For Consultancy of bigger Value, REOIs should also be published in an international newspaper or a technical or financial magazine.

Minimum 14 days from date of posting on UNDB online shall be provided for responses, before preparation of the short list. The late submission of a response to a REOI shall not be a cause for its rejection unless the Borrower has already prepared a short list, based on received EOIs.

Short List of Consultants

Short lists shall comprise six firms with a wide geographic spread, with (i) no more than two firms from any one country unless there are no other qualified firms identified to meet this requirement and (ii) and at least one firm from a developing country, unless no qualified firms from developing countries could be identified.

Exceptionally, the Bank may agree to short lists comprising a smaller number of firms.

Preparation and Issuance of the Request for Proposals (RFP)

The RFP shall include (a) a Letter of Invitation, (b) Instructions to Consultants and Data Sheet, (c) the TOR, and (d) the proposed type of contract. Borrowers shall use the applicable standard RFPs issued by the Bank with minimal changes, acceptable to the Bank. Any such changes shall be introduced only through the RFP data sheet.

Letter of Invitation (LOI)

The LOI shall state the intention of the Borrower to enter into a contract for the provision of consulting services, the source of funds, the details of the client and the date, time, and address for submission of proposals.

Instructions to Consultants and Data Sheet (ITC)

The ITC shall contain all necessary information that would help consultants prepare responsive proposals, and shall bring as much transparency as possible to the selection procedure by providing information on the evaluation process and by indicating the evaluation criteria and factors and their respective weights and the minimum passing quality score. Consultants, however, shall be free to prepare their own estimates of experts' time to carry out the assignment and to offer the corresponding cost in their proposals.

Receipt and Opening of Proposals

The Borrower shall allow enough time for the consultants to prepare their proposals. During this interval, the firms may request clarifications about the information provided in the RFP. The Borrower shall provide these clarifications in writing and copy them to all firms on the short list .If necessary, the Borrower shall extend the deadline for submission of proposals. The technical and financial proposals shall be submitted at the same time. To safeguard the integrity of the process, the technical and financial proposals shall be submitted in separate sealed envelopes. A committee of officials from the relevant departments (technical, finance, legal, as appropriate), shall open all technical proposals received by the deadline for the submission of proposals at the designated place stipulated in the RFP.

Opening of technical proposals is done in the presence of consultants wishing to attend, the Borrower shall neither reject nor discuss the merits of any proposal.

All proposals received after the deadline shall be declared late and rejected and promptly returned unopened.

The committee shall read aloud the names of the consultants that submitted proposals, the presence or absence of duly sealed financial envelopes, and any other information deemed appropriate. The financial proposals shall remain sealed and shall be deposited with a reputable public auditor or independent authority until they are opened as per provision of RFP.

Evaluation of Proposals: Consideration of Quality and Cost

The evaluation of the proposals shall be carried out in two stages: first the quality, and then the cost. Evaluators of technical proposals shall not have access to the financial proposals until the technical evaluation, including any Bank reviews and no objection, is concluded.

Financial proposals shall be opened only thereafter. The evaluation shall be carried out in full conformity with the provisions of the RFP.

Evaluation of the Quality

The Borrower shall evaluate each technical proposal through evaluation committee of at least three, and normally not more than seven, members including qualified specialists in the sector of the assignment under consideration. Each member of the committee shall not be in a conflict of interest` and certify to that effect before participating in the evaluation.

The technical evaluation shall take into account the criteria and the sub-criteria included in the RFP. The RFP shall describe each such criterion and sub-criterion along with their relative maximum scores and disclose the overall minimum technical score below which a proposal will be rejected as non-responsive.

The indicative range for the overall minimum technical score is 70 to 85 out of 100.

The criteria for Technical Evaluation shall include:

(a) the consultant's relevant experience for the assignment,

(b) the quality of the methodology proposed,

(c) the qualifications of the key experts proposed,

Only the key experts should be evaluated. Since they ultimately determine the quality of performance, more weight shall be assigned to this criterion if the proposed assignment is complex.

The individuals Key Expert shall be rated in the following three sub-criteria, as relevant to the task:

(a) general qualifications: general education and training, length of experience, positions held, previous assignments as team expert, experience in developing countries, and so forth;

(b) adequacy for the assignment: education, training, and experience in the specific sector, field, subject, and so forth, relevant to the particular assignment; and

(c) experience in the region: knowledge of the local language, culture, administrative system, government organization, and so forth.

Borrowers shall evaluate each proposal on the basis of its responsiveness to the TOR. Technical proposals containing any material financial information shall be declared non-responsive.

The members of the evaluation committee shall evaluate proposals in accordance with the evaluation criteria specified in the RFP, independently of each other, and without any external influence from any person or entity.

A proposal shall be rejected if it fails to achieve the overall minimum technical score specified in the RFP. At the end of the evaluation process, the Borrower shall prepare a Technical Evaluation Report using the Bank's standard form of evaluation report. The report shall substantiate the results of the evaluation and justify the total technical scores assigned to each proposal by describing the relative strengths and weaknesses of the proposals.

Opening of Financial Proposals and Evaluation of Cost

After the Technical Evaluation Report is completed (and for prior review contracts after the Bank has issued its no objection), the Borrower shall inform consultants whose proposals did not meet the minimum qualifying technical score or were considered non-responsive to the RFP and TOR that their financial proposals will be returned unopened after the signature of the contract.

In addition the Borrower shall inform each of the above consultants of their overall technical score as well as scores obtained for each criterion and sub-criterion if any.

The Borrower shall simultaneously notify the consultants that have secured the minimum overall technical score of the date, time, and place set for opening the financial proposals.

The opening date shall be set allowing sufficient time for consultants to make arrangements to attend the opening of the financial proposals.

The financial proposals shall be opened in the presence of representatives of the consultants who choose to attend (in person or online).

The name of the consultant, the technical scores, including the break-down by criterion, and the offered total prices shall be read aloud and recorded when the financial proposals are opened.

The Borrower shall also prepare the minutes of the opening and a copy of this record shall be promptly sent to the Bank and to all consultants who submitted proposals.

The Borrower shall then evaluate and compare the financial proposals in accordance with provision in RFP.

Prices shall be converted to a single currency selected by the Borrower (local currency or fully convertible foreign currency) as stated in the RFP.

The Borrower shall make this conversion by using the selling (exchange) rates for those currencies quoted by an official source (such as RBI).

The RFP shall specify the source of the exchange rate to be used and the date of that exchange rate, provided that the date shall not be earlier than four weeks prior to the deadline for submission of proposals.

For a lump-sum contract, the consultant is deemed to have included all prices in its financial proposal, so neither arithmetical corrections nor price adjustments shall be made, and the total price, net of taxes, included in the financial proposal shall be considered as the offered price.

For the purpose of evaluation, the offered prices shall exclude local identifiable indirect taxes on the contract and income tax payable to the country of the Borrower on the remuneration of services rendered in the country of the Borrower by non-resident experts and other personnel of the consultant. In exceptional circumstances, when indirect taxes cannot be fully identified by the Borrower when evaluating the financial offers, the Bank may agree that prices, for the purpose of evaluation only, include all taxes payable to the country of the Borrower. The offered total price shall include all consultants' remuneration and other expenses such as travel, translation, report printing, or secretarial expenses. The proposal with the lowest offered total price may be given a financial score of 100 and other proposals given financial scores that are inversely proportional to their prices.

Combined Quality and Cost Evaluation

The total score shall be obtained by weighting the quality and cost scores and adding them. The weight for the "cost" shall be chosen, taking into account the complexity of the assignment and the relative importance of quality. The weight for cost shall normally be 20 points out of a total score of 100. The proposed weightings for quality and cost shall be specified in the RFP. The firm obtaining the highest total score shall be invited for negotiations.

Negotiations and Award of Contract

Negotiations shall include discussions of the TOR, the methodology, Borrower's inputs, and special conditions of the contract. These discussions shall not substantially alter the original scope of services under the TOR or the terms of the contract, lest the quality of the final product, its price, and the relevance of the initial evaluation be affected.

The selected firm should not be allowed to substitute key experts, unless both parties agree that undue delays in the selection process make such substitution unavoidable or that such changes are critical to meet the objectives of the assignment.

If this is not the case and if it is established that key experts were included in the proposal without confirming their availability, the firm may be disqualified and the process continued with the next ranked firm.

The key experts proposed for substitution shall have qualifications equal to or better than the key experts initially proposed.

Financial negotiations shall include clarification of the consultants' tax liability in the Borrower's country (if any) and how this tax liability has been or would be reflected in the contract. In the case of time-based contracts, payment is based on inputs (experts'

time and reimbursables) and the offered price shall include experts' rates and an estimation of the amount of reimbursables.

When the selection method includes cost as a factor in evaluation, negotiations of experts' rates shall not take place, except in special circumstances, like for example, experts' rates offered are much higher than typically charged rates by consultants for similar contracts.

Consequently, the prohibition of negotiation does not preclude the right of the client to ask for clarifications, and, if the fees are very high, to ask for their change, after due consultation with the Bank.

Reimbursables are to be paid on actual expenses incurred at cost upon presentation of receipts and therefore are not subject to negotiations.

However, if the client wants to define ceilings for unit prices of certain reimbursables (like travel or hotel rates), they should indicate the maximum levels of those rates in the RFP or define a per diem in the RFP.

If the negotiations with the highest ranked consultant fail the Borrower shall inform the concerned consultant in writing of all pending issues and disagreements, and provide them a final opportunity to respond in writing.

Contract negotiations shall not be terminated only for budget considerations.

If there is still disagreement, the Borrower shall inform the consultant in writing of its intention to terminate negotiations. Negotiations may then be terminated after obtaining the Bank's no objection, and the next ranked consultant invited for negotiations.

The Borrower shall furnish to the Bank for review the minutes of negotiations and all relevant communications, as well as the reasons for such termination.

Once negotiations have commenced with the next ranked firm, the Borrower shall not reopen the earlier negotiations. After negotiations are successfully completed and the Bank has issued its no objection to the initialed negotiated contract, the Borrower shall promptly notify other firms on the short list that they were unsuccessful.

Publication of the Award of Contract

The Borrower shall publish information on UNDB online for all contracts when the short list included any foreign firm and all single source selection contracts awarded to foreign firms, and in the National press all contracts where the short list comprises only National firms and all single source selection contracts awarded to National firms.

Such publication shall be within two weeks after receiving the Bank's no objection for award of the contract for contracts subject to the Bank's prior review, and within two weeks of successful negotiations with the selected firm for contracts subject to the Bank's post review.

Publications shall include the following information as relevant and applicable for each method: (a) the names of all consultants in the short list, specifying those that submitted proposals; (b) the overall technical scores and scores assigned for each criterion and sub-criterion to each consultant; (c) the prices offered by each consultant as read out and as they have been evaluated; (d) the final combined scores and the final ranking of the consultants; (e) the name of the successful consultant and the total price, duration, and summary scope of the contract. The same information shall be sent to all consultants who have submitted proposals.

The Bank will arrange the publication of the award of contracts under prior review on its external web-site upon receipt from the Borrower of a conformed copy of the signed contract.

Debriefing by the Borrower

In the publication of contract award ,the Borrower shall specify that any consultant who wishes to ascertain the grounds on which its proposal was not selected, should request an explanation from the Borrower.

The Borrower shall promptly provide in writing an explanation of why such proposal was not selected. If a consultant requests a debriefing meeting, they shall bear all their costs of attending such a debriefing meeting.

Rejection of All Proposals, and Re-invitation

The Borrower will be justified in rejecting all proposals only if:

(i) all proposals are non-responsive because they fail to respond to important aspects of the TOR or present major deficiencies in complying with the TOR

(ii) all proposals fail to achieve the minimum technical score specified in the RFP;

(iii) if the offered price of the successful proposal is substantially higher than the available budget or a recently updated cost estimate.

In the later case, as an alternative to re-invitation, the feasibility of increasing the budget, or scaling down the scope of services with the firm should be investigated in consultation with the Bank. However, any substantial reduction in the scope of services will not be acceptable and will require a re-invitation. If cost is a factor in the evaluation for a time based contract, the number of person-months proposed by the consultant may be negotiated, provided that it does not compromise quality or adversely affect the assignment.

Before all the proposals are rejected and new proposals are invited, the Borrower shall notify the Bank, indicating the reasons for rejection of all proposals, and shall obtain the Bank's no objection before proceeding with the rejection and the new process.

The new process may include revising the RFP, including the TOR, the short list and the budget. These revisions shall be agreed upon with the Bank.

Confidentiality

Information relating to evaluation of proposals and recommendations concerning awards shall not be disclosed to the consultants who submitted the proposals or to other persons not officially concerned with the process, until the publication of the award of contract.

If the Borrower receives complaints from consultants, it shall promptly send to the complainant an acknowledgment, and to the Bank for review and comments a copy of the complaint, the Borrower's comments on each issue raised in the complaint, and a copy of the proposed response to the complainant.

One conformed copy of the contract shall be furnished to the Bank promptly after its signing and prior to the submission to the Bank of the first application for withdrawal of funds from the Loan Account in respect of such contract.

Action by the Bank

If consultants wish to raise issues or questions about the selection process, they may send the Bank copies of their communications with the Borrower, or they may write to the Bank directly when the Borrower does not respond promptly or when the communication is a complaint against the Borrower.

All such communications should be addressed to the Task Team Leader for the project, with a copy to the Country Director for the borrowing country and to the Regional Procurement Manager.

Communications received by the Bank from short listed consultants prior to the closing date for submission of the proposal shall be, if appropriate, referred to the Borrower with the Bank's comments and advice, for action or response.

NON-VIBRO STONE COLUMN FOR SOIL IMPROVEMENT - SAFE CONSTRUCTION NEAR RUNNING TRACKS

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Dy CPM/Mumbai/S/DFCCIL

ABSTRACT:
The authors through this paper intend to introduce the non-vibro technique of ground improvement by stone column, being used for the first time in India under the Western Dedicated freight Corridor in Mumbai area. New 2x25 KVA double line dedicated freight corridor tracks, capable of carrying 32.5-ton axle load are proposed to be built on this stretch. The patches in question are of marine clays & running parallel to existing Railway tracks, on JNPT-Panvel-Vaitarna section and have problems with bearing capacity and stability, and where excessive settlements may occur due to the heavy axle loads. The article details the site soil conditions, design philosophy, construction methodology by avoiding the existing various types of utilities, the advantages of the method for fast and safe construction and the results of the use of this method for the ground improvement. The quality of stone column was better and the settlements were lesser than that calculated using the conventional formulae. Further, the modified method ensured ground improvement without disruptions to Railway traffic or the nearby utilities and avoided imposition of crippling speed restrictions in the treacherous stretch of Mumbai sub-urban. The method can thus be used with considerable benefits in sensitive locations with fast paced construction.

1 INTRODUCTION

Ministry of Railways (Govt. of India) is constructing the highly ambitious 2x25 KV electrified double line Western Dedicated Freight Corridor carrying heavy haul(HH) freight tracks for a length of about 1500 km between Mumbai and Delhi. A stretch of about 100 km in the state of Maharashtra runs parallel and close to the densely worked suburban tracks of Mumbai, along the coastal area. In this stretch, various long patches totalling to around 22km are having marine clay of depths varying from 6m to 19m. The bearing capacity of the soil in these stretches is very less with Standard Penetration Test (SPT) values of 0-5, undrained shear strength less than 25kPa and EV2 (Elastic modulus of 2nd step plate load test) less than 20MPa. The strength of these soils are quite less and need to be improved by suitable method in terms of GE:0014(2009) issued by RDSO.

During initial planning, several methods of ground improvement like stage construction, Sand drains,

Wick drains, Geocell, Stone column etc. were evaluated. Taking into consideration, the depth of soft soil, existence of underneath bearing strata, area to be covered, proximity to Indian Railway tracks (limiting large consolidation settlements) and the time period of construction, it was decided to carry out the ground improvement of the patches parallel to the tracks by stone column method.

Stone columns can be constructed by displacement method, non-displacement or the vibro-replacement method. The type of method selected is based on the sensitivity of the soil, the loads& type of structure to be supported, ground water conditions, and the effect of the method on surrounding structures. The most prevalent method is the vibroflot method which involves compacting the stone column by means of a rammer. This method, however, generates vibrations in the ground, which may affect the stability of adjoining structures, tracks etc. Hence, while looking for the solution to this problem, Non-VibroGround Improvement method, as developed and patented by Jaron McMillan of New Zealand, was incorporated in the DFCCIL project for Mumbai area. This method was developed in 2011, after the Christchurch earthquake, when Jaron McMillan looked to solve issues associated with conventional methods specially to do ground improvement next to landforms and structures that could not have any detrimental effects put on to them as a result of ground improvement vibrations. The method was further developed by him in coordination with Casagrande and has been adopted in United States and Germany with considerable success.

2 GENERAL DESCRIPTION

2.1 General Geology and site conditions

The soils of Maharashtra are residual, derived from the underlying basalts. In the semi-dry plateau, the regur (black-cotton soil) is clayey, rich in iron, but poor in nitrogen and organic matter; it is moisture retentive. Mainly three types of soil are found in Thane District – regur soil, red soil and brownish black soil. Laterite and lateritic soils cover most of the part of Panvel and Urban tehsils of Raigad District. These soils are practically devoid of calcium carbonate, acidic in reaction (pH 5.0 to 6.5) and sandy clay loam to clayey in texture. The sesquioxides consists more than 95% of the total chemical constituents. Kaolinite is the dominant clay mineral which is sometimes associated with illite. These are normally classified as Haplustalfs, Plinthustalfs and Ustochrepts. These soils are sandy clay loam to clay in texture. The soils are susceptible to erosion.

In order to ascertain the nature of soil in the stretch under consideration, sub-soil investigation was carried out at every 500m on normal formation stretch, one at each minor bridge location and one bore hole at every third pier location for major bridges. In this paper, the example of soil in JNPT area of Navi Mumbai has been considered for elaboration of this non-vibro stone column method.

Based on the boreholes,as listed in Table 1, the soil observed at top is soft clay followed by weathered to hard rock. The soil profile is also shown in the *Figure 1* below. To determine the in-situ soil strength, Standard penetration test (SPT) at various depths are carried out in each borehole. The observed SPT-N Values are presented in Table 2.

Sr. No.	Structure	Borehole No.	Chainage	Co-ordinates		R.L. (m)	Borehole Termination Depth (B.G.L.) (m)	Water Level (B.G.L.) (m)
				Northing	Easting			
1	Minor Bridge 13	BR-13	2+933.07	2091584.965	288217.769	2.729	14.00	1.80
2	Embankment Fill 3000	BH-3000	3+000	2091483.362	288469.093	3.692	16.00	1.00
3	Embankment Fill 3500	BH-3500	3+500	2091561.773	288947.143	1.812	15.10	0.55
4	Minor Bridge 15	BR-15	3+562.83	2091591.253	289000.308	1.210	16.50	0.00
5	Minor Bridge 16	BR-16	3+801.95	2091708.933	289212.535	1.317	12.00	0.00

Table 1. Soil profile from DFC CH 2.9 to 3.8 km in various boreholes

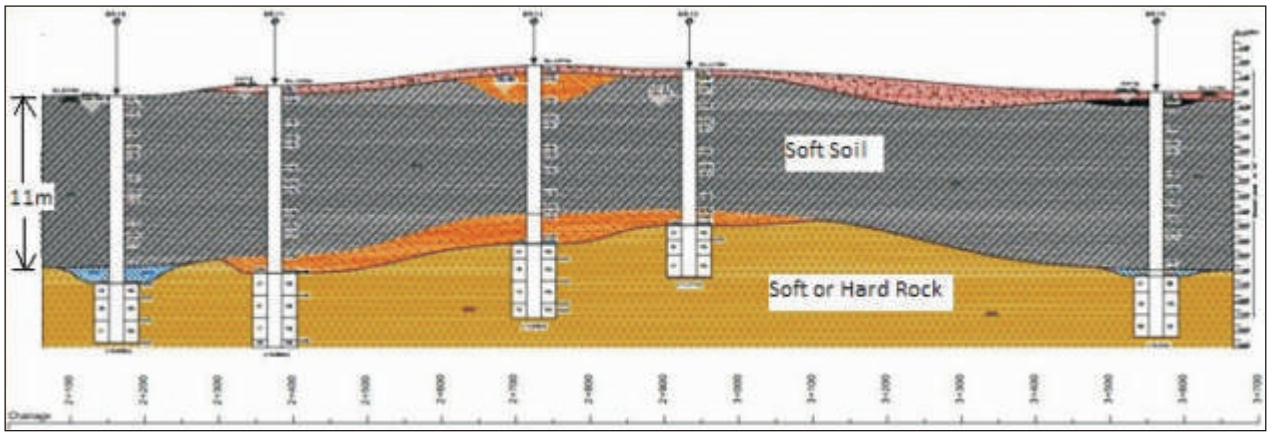

Figure1. Soil Profile at DFCCIL Chainage from 2.100 to 3.700 km in JNPT area

BH No.	BH-13	BH-3000	BH-3500	BH-15	BH-16	BH-17
Chainage	2933.07	3000	3500	3562.83	3801.95	4040.25
GL	2.729	3.692	1.812	1.21	1.317	2.01
GWT		1.8	1	0.55	0	00
Depth(m)		**SPT-N Values**				
1.5	8	5	5	10	3	2
3	5	7	0	0	0	2
4	-	2	0	1	0	-
6	5	2	3	0	3	1
7.5	-	2	3	0	2	
9	5	2	3	3	100	38
10.5	56	5	4	2	100	100
12	100	15	32	7	100	100
13.5	100	38	100	100		
15		53	100	100		
16.5		100		100		

Table 2. Field SPT values at various depths in different bore holes

From the above details, it is clear that the depth of soft soil (having SPT values less than 5) is considerable in the stretch. The maximum depth of soft soil observed in some other bore holes was up to 19m.

2.2 Utilities and other hindrances

The area where ground improvement is to be carried out is having various types of public and private service utilities like IOCL pipe line, Reliance pipe lines, MIDC water pipe line besides the hindrances due to other working contractors of NHAI, Employer's other contractors. The challenge is to carry out the ground improvement of maximum area by co-ordinating with the various contractors working in the area and without disturbing the utilities. The typical layout of a particular location, in this JNPT area, where ground improvement was planned is shown in Figure 3a. The stone column layout as per the design was plotted to the scale showing the adjacent Railway track and the various utilities (as per their surveyed locations). The columns which cannot be executed due to hindrances by various utilities or obstructions were marked with red colour, so that these are not attempted, even by mistake.

3 DESIGN OF STONE COLUMN

3.1 General

The non-vibrostone columns are designed using the IS code15284(Part-1):2003,as being used for the design of column being constructed by the conventional vibroflot method. The spacing of the stone column, as per the design using the codal procedure and the existing soil properties came out to 2.4m centre to centre, while the diameter as 900mm. The design philosophy and procedure is explained below:

3.2 Design Philosophy

The stone column design is performed based on the IS 15284(Part-1):2003. The design methodology involving the following steps is briefed in subsequent paras:

a) Identification of Design Engineering properties of soil strata.

b) Basic input for design parameter of stone column (Diameter, spacing, pattern, equivalent diameter and replacement ratio)

c) Design for ultimate load capacity of column
   i) Capacity based on bulging of column
   ii) Surcharge effect
   iii) Bearing support provided by intervening soil

d) Settlement Analysis

3.2.1 Design parameters for soil

Design soil parameters are obtained from the factual geotechnical report of the stretch under consideration. The basic design parameters considered for the design are summarised below:

Average cohesion value = 22.5 kPa

Average SPT N value = 2.

3.2.2 Design parameters for Stone column

3.2.2.1 Diameter

Depending on soil condition (shear strength), ramming effect and available tool, diameter would be presumed for the analysis. The equipment is able to drill 600mm, 750mm, 900mm and 1200mm dia stone columns. Keeping in view the loading from embankment, effective drainage path for consolidation, number of stone columns from constructability point of view and spacing of stone columns - 900mm diameter stone column is selected. The diameter so taken in the design is developed in field by conducting a few trials.

3.2.2.2 Pattern

Equilateral triangle pattern has been considered for the stone column arrangement (Figure 2).

3.2.2.3 Spacing

Spacing of column (S) is based on loading pattern, column factor, installation technique and settlement tolerance (i.e 2 to 3 times column diameter)

Tributory area (in the form of a hexagon)for column = 0.866 S2,Equivalent Diameter, De = 1.05S ----------For triangular Pattern

Where S = Spacing of column (column pile)

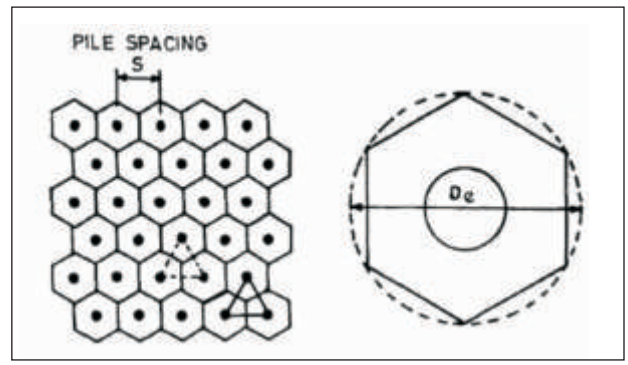

Figure 2. Triangular patter of stone column

3.2.3 Load carrying capacity of the Stone Column

The failure of the stone column is primarily by bulging into the surrounding soil. Hence, the load carrying capacity of the treated ground can be obtained by summing up the contribution of each of the following components, for wide spread loads (in Embankments):

a) Capacity of the stone column resulting from the resistance offered by the surrounding soil against its lateral deformation (bulging) under axial load.

b) Capacity of the stone column resulting from increase in resistance offered by the surrounding soil due to surcharge over it

c) Bearing support provided by the intervening soil between the columns.

The ultimate load carrying capacity of stone column is verified by initial load test.

3.2.4 Settlement Analysis

Settlement for the ground treated by the stone column should be computed by the Reduced stress method as per Appendix B to IS 15284 (Part 1):2003. However, initial load tests (single and three column

group) are performed to evaluate the load settlement behaviour of the stone column system.

3.2.5 Layout of the stone column

As per the contract specifications, the ground improvement is to be done below the proposed bank and up to 3m on either side, so that each column below the Embankment is confined and has bearing capacity as per design. However, in case of existing track bank, the stone column is to be restricted to the toe of the existing bank. The typical layout of the stone column is shown in Figure 3a & 3b.

3.2.6 Stage-loading to achieve required residual settlements:

The allowable residual settlements during the operational time is 100mm. To achieve the 100mm settlement, a suitable stage loading requirement with time period is assessed using the consolidation theory.

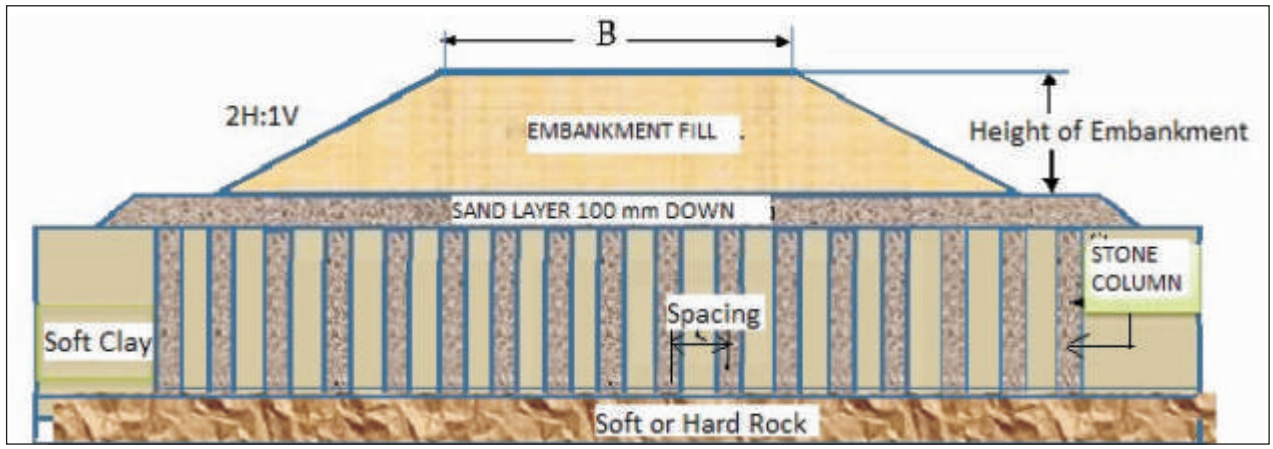

Figure 3a. Typical section of layout of stone column

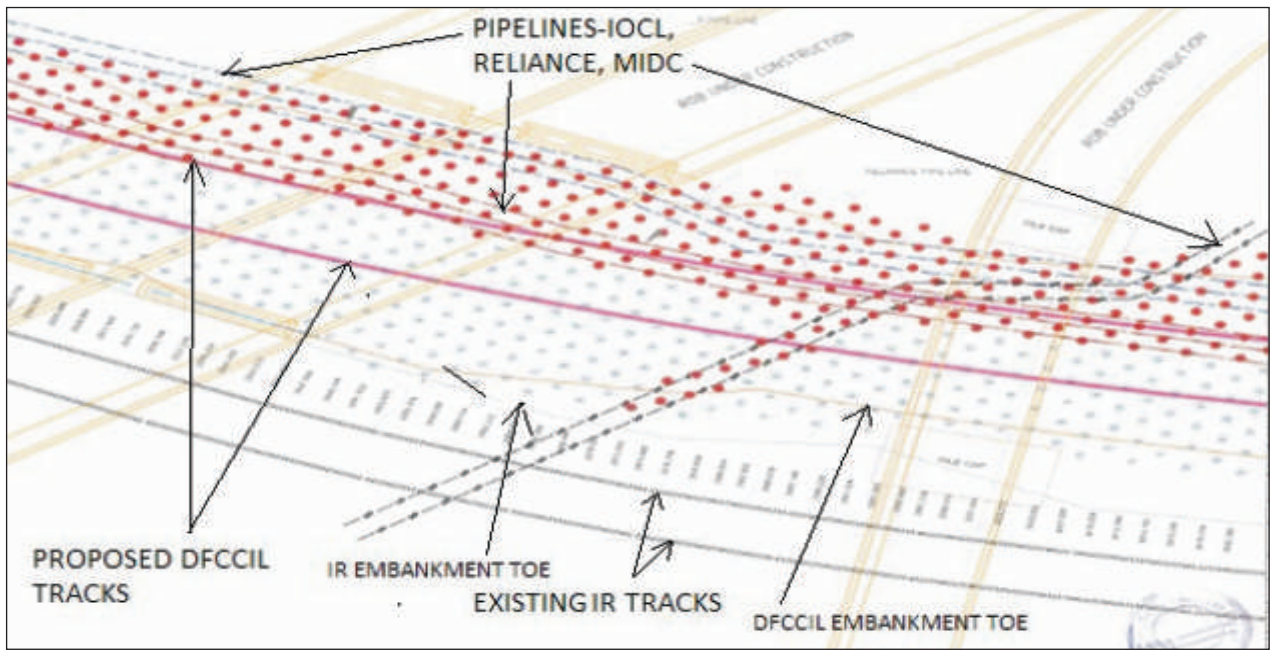

Figure 3b Typical layout of stone column among the utilities

The basis of arriving at the preloading and time period is explained below:

Consider the settlement due to DL+LL = Sset (in mm)

Required settlement before the start of operations = Sreq = Sset – 100 (in mm)

Required preloading to achieve above settlement Seq = iterations done to achieve preloading to limit the consolidation time between 40 to 75 days.

The consolidation theory is used to estimate the time rate settlement to achieve required preloading with

the limited time period. However, this stage loading and time period can be increased or decreased during the execution based on the available time and space as well as the actual observed settlements at site.

3.2.7 Summary of Design of stone columns

3.2.7.1 Stone column Capacity:

The designed stone column diameter and spacing are provided in Table 3.

Chainage	Stone column Dia(m)	Spacing of stone columns(m) - Triangular Grid	Depth of soft clay below NGL(m)*	Design Heigh to fembankment (m)	Maximum intensity from Embankment (kPa)	Load carrying capacity of improved ground (kPa)
CH2+800 TO CH4+000	0.9	2.4	8.5to14	2.500	56.4	64.02

Table 3. Summary of Ground Improvement

Stone column capacity=32.5MT

The stone column depth varies based on the hard stratum/rock availability. The soil profile and typical cross section of this stretch are shown in Figure 1 & 3a respectively.

3.2.7.2 Settlement summary:

Settlements are estimated for not treatedground and treated ground as per IS: 15824 (Part 1) and are summarized in Table -4:

Chainage	Stone column Dia(m)	Spacing of stone columns(m)	Clay layer thickness(m)	Settlement Before treatment (mm)	Settlement after treatment (mm)
CH2+800TOCH4+000	0.9	2.4	12	1903	1376

Table4: Summary of Settlement Analysis

Required surcharge load is estimated with the time required to maintain the surcharge loading to obtain the residual settlement of 100 mm as per contractual requirements. The details are given in Table 5.

Chainage	Stone column Dia(m)	Spacing of stone columns (m)	Stage1stage platform loading (SQ1*) (m)	Time period for Stage1 (days)	Stage 2 Loading- 0.6m (S and/10 mm down stone agree gate)+ SQ1fill + Sub grade (m)	Time Period for Stage 2 Loading to attain 100 mm residual settlement (days)
CH2+800TOCH4+000	0.9	2.4	0.6	38.0	0.6+1.4=2.0	60.0

Table 5: Summary of Pre loading and Time required to arrive at the residual settlement

However, for settlement, monitoring instruments shall be installed to monitor the actual settlements at every 250m interval. Using the Asaoka method, the final settlements are estimated based on the observed field settlements.

Settlement monitoring instruments are installed immediately after stone column installation and continuous monitoring records are maintained.

Final embankment levels are arrived based on the observed settlements. The tops ubgrade layer is to be removed to accommodate 0.6m of blanketing.

3.2.7.3 Stability Analysis

Maximum Embankment height for the stretch Ch2+800 to Ch4+000 is 2.40m. Stability analysis for untreated ground and treated ground are computed using the slope/Wsoftware.

Summary of the Factor of safety values are tabulated below in Table 6.

S. No.	DFCC Chain age	Embankment Fill Height	Proposed Slope	Factor of Safety Static Case	Factor of Safety Seismic Case
1	3+000to6+300 (No treatment)	2.7m	2H:1V	0.838	0.562
2	3+000to6+300 (with treatment)	2.7m	2H:1V	1.970	1.267

Table 6. Slope stability analysis summary

4 CONSTRUCTION OF NON-VIBRO STONE COLUMN

The step by step procedure for the construction of non-vibro stone column is as follows:-

a) The stone column construction assembly, also called as Rig, consists of concentric cylinders, the outer cylinder having an enlarged lower section with flights. The various components of the assembly are shown in Figure 4.The outer diameter of the outer drilling assembly is 380mm.

b) A working platform is prepared by dumping the SQ1 soil of about 0.5 to 1.0 m depth for movement of the driving assembly.

c) The base of the embankment, where ground improvement is to be done, is marked and the stone column construction is started from Railway bank or sensitive structure location to the outer side.

d) The assembly is forced into the ground using high torque equipment, displacing the soils primarily in the lateral direction. During installation, the base of the assembly is blanked off.

e) Upon reaching target depth, a hydraulic cylinder opens the base of the assembly, exposing the internal stone aggregate feeding mechanism, and engaging a gearbox that rotates the centre stone feeding mechanism.

f) Stone aggregates are loaded into the upper stone bin (Figure 5), and is fed out of the base of the assembly as the tooling is extracted from the ground.

g) The stone aggregates are compacted by pressing with the rotating screw assembly (Figure 6). The compaction is achieved both vertically and horizontally and the degree of compaction is monitored by real time torque output on the Rig's computer screen.

h) As the required torque value is achieved, the assembly is raised by anticlockwise rotation of the screw assembly, building a continuous compacted column. The continuous torque values are visible on the monitoring screen. Figure 7&8 show torque applied during boring (in blue colour) and during compaction of column (in orange colour) respectively. The torque applied during compaction should be greater than the torque applied during initial boring to ensure proper compaction. This is ensured if the orange strip of the torque values completely cover the blue torque values.

i) The volume of stone aggregate installed is monitored by the number of buckets of stone aggregates fed during the column installation. The complete process is shown in Figure9.

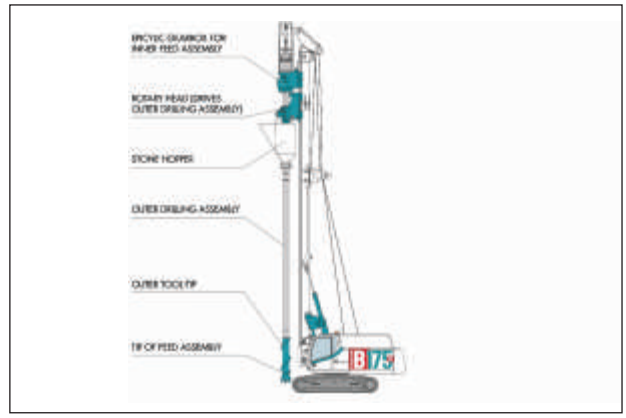

Figure 4. Assembly for non-vibration stone column

Figure 5. Loading of stone aggregates into the bin

Figure 6. Rotating screw assembly

5 LOAD TEST

The initial load test on single stone column as well as three column group was conducted in terms of clause 13 of IS 15284. As per this clause, the load test should be considered acceptable if it meets the following settlement criteria:

i) 10 to 12 mm settlement at design load for a single column test, and

ii) 25 to 30 mm settlement at the design load for a three-column group test.

The initial load test values for single column test was obtained as 3mm, while for three column group as 7mm, which is much below the stipulated values, as given above.

The routine load tests is performed at a frequency of 1 test per 625 m2. The results of the routine load tests showed almost similar values of settlements.

6 ADVANTAGES OF NON-VIBRO STONE COLUMN METHOD

This method provides the following benefits over traditional vibrating stone column installations:

a) The method is vibration free so it can be used immediately next to sensitive sites or neighbouring buildings. (Works within 1.5m of existing buildings & pipe lines and at the toe of Railway banks have been completed.)

b) The method is fast to set up, and column installation can begin within 3 hours of the equipment arriving at site, depending upon which base machine is used.

c) Only two pieces of plant are required at each site -the stone column machine and a loader (Stone aggregates are delivered by truck to working site), as compare to conventional vibrof lot method which requires, power pack, water pump, crane, welding set etc apart from the Virator & Follower pipe assembly.

d) The equipment involves less high pressure and high wear hydraulic components, and is subsequently more reliable.

e) This method allows the introduction of cement, to create cement stabilised columns, providing increased load transfer properties, and ground improvement for building constructed on the boundary.

f) Graded filter selected materials can be used so columns are more resistant to clogging in

Figure 7. Torque applied during initial boring of column

Figure 8 Torque applied during column compaction

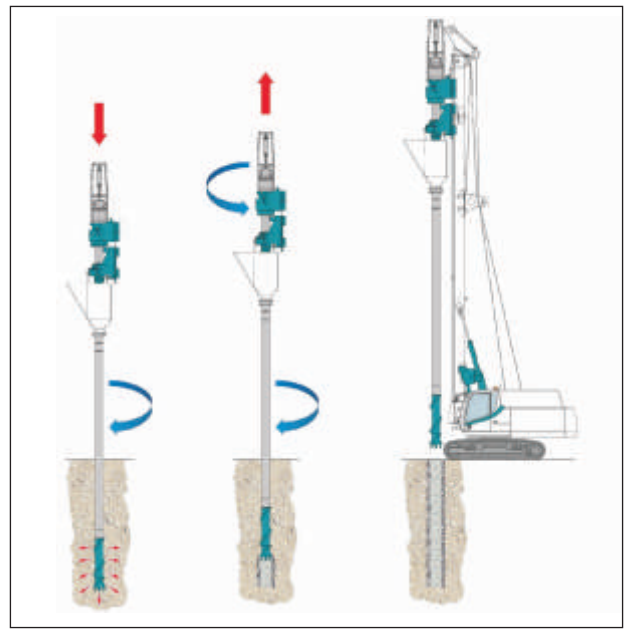

Figure 9. Process of installation of stone column (Courtesy: Jaron Lyell McMillan)

liquefaction events. Columns remain effective for multiple events.

g) No introduction of high-pressure water or air required so relatively mess free. Sites immediately adjacent to sensitive environments have been completed.

h) The method builds complete columns at all times, so there is no-void space introduction to allow column contamination at any time, unlike methods where a plunging motion is used such as in vibro-float method.

i) The size of the column developed is more or less uniform with very less over-breakage of surrounding soil in contrast to vibro-float method, where over-breakage occurs both during wash water upward flow & dropping of aggregates through the annular space along the side of vibroflot. Thus, the quantity of aggregates used is also less than conventional methods.

j) The tooling is a hybrid drilling assembly. This allows tool penetration through hard layers and removes the requirement for predrilling, that is often required for vibrating tool.

k) Proposed method does not induce liquefaction therefore can be installed with high water table and not create undermining problems. In the majority of cases no working platform is required. This is a potential time and cost saving.

l) Method opens up new foundation possibilities, where previously stone columns/ground improvement could not be considered due to vibrations and nuisance such as parallel to sub-urban tracks or in vicinity of high rise buildings.

m) The system can be attached to a conventional rotary piling rig, thus a truly multi-purpose machine that can be converted back to other techniques is possible. Only 1 day is required to change over.

n) The increase in diameter of initially drilled hole from 380 mm to 600 - 1200mm(as per design) results in much more increase in strength of the surrounding soil than the conventional method, in which the enlargement is from intial hole of around 750mm to final stone column of 900mm.

o) The settlement values observed are much less than the designed values. This can considerably reduce preloading time and thus ensure faster construction of the structure above.

7 QUALITY CONTROL IN NON-VIBRO METHOD

In order to ensure proper quality control of the column formed during the non-vibro method, following methods may be adopted: -

a) The gradation range of the stones being used should be fixed so that the same strength of the column and degree of compaction is achieved as during the initial trial. The grading is to be checked every week as is done in concrete aggregates.

b) The strength of the column also depends upon the diameter of the column formed and its compactness. In order to ensure this, continuous observation of the torque applied during the compaction of columns is done. This applied torque during compaction should be more than the torque required during the driving of the rig during penetration. This ensures penetration of aggregates into the surrounding soil after compaction of the annular aggregates.

c) The total quantity of the aggregates used in the column is approximately determined by the number of buckets used to fill the feeding hopper. This can be further cross checked at regular intervals by the quantity of aggregates received at the site by comparing with the total aggregates required to complete the corresponding number of columns.

d) The diameter of the stone column formed can be physically measured by opening the surrounding top soil. This may be done once per day.

e) The depth of the column achieved during the drilling operation is displayed on the monitoring screen. This can be tallied with the depth of the soft soil, as obtained during the soil investigation.

f) The initial load test is to carried out on single stone column as well as on the group of three stone columns. This ensures the determination of load bearing capacities of the stone columns to greater precision.

g) The number of routine tests recommended by IS 15284 (Part-1):2003 is 1 per 625 sqm. This seems to be quite high for the work of around 22 km in a continuous width of around 20m. However, to

determine the quality of the new method, it is thought prudent to follow the same in the project.

8 PRE-REQUISITES FOR THE NON-VIBRO METHOD

In spite of the above-mentioned advantages of the non-vibro method, there are certain limitations of the method. There are as follows: -

a) In case of presence of hard material and boulders in the top layers (either due to backfill or in the soil used to make platform for moving the machine), the tip of the tool in not able to penetrate. The hard material need to be removed for proper functioning of the non-vibro tool.

b) The maximum torque achievable for compaction is around 100KNm. Hence only soft soils can be improved by this method.

c) The tool is patented by Jaron Macmillan and thus has to be imported. This delays the start of the work and extra tool cannot be deployed for increasing the progress, in between, unless pre-planned.

d) The upgraded method has not been corelated with the theory and the standard design procedure as for conventional method is being used. This results in over safe design.

9 CONCLUSION AND RECOMMENDATIONS

The non-vibro stone column method is being used in India for the first time under DFCCIL project. The method is still in its initial stage of development. However following conclusions may be drawn from the foregoing details:-

a) Use of the latest technology of non-vibration method of driving stone column not only avoids any danger of settlement to the existing tracks or nearby structure and utilities but also leads to higher bearing capacities and lesser settlements.

b) The contamination of aggregates and over-breakage of surrounding soil is less which gives better and uniform quality of stone column.

c) The test results show that the settlement values for the stone column by this non-vibro method is much less than the conventional method, while using the same formula. This is due to increased compaction of soft soil, as 380 mm dia hole is enlarged to 900mm. Hence the existing formulae or the parameters taken in the formulae can be modified for the non-vibro method so that the design corelates with the actual observed values.

d) The observation of actual settlement versus time such as in Asaoka method can help modifying the settlement calculations for the method and bring it closer to the actual observed values. This can thus reduce preloading time and can lead to faster construction after soil improvement.

Based on the experience gained with the use of non-vibro stone column method for ground improvement following recommendations can be made:-

a) The non-vibro stone column method is particularly useful when used adjacent to the existing railway banks, utilities and sensitive structures etc as these are not disturbed during the process.

b) Being compact in nature, the machine can be used in locations where heavy machineries for conventional stone column are inaccessible.

c) The method gives better quality of the stone column and higher displacement of the surrounding soil. Hence particularly useful for carrying higher loads with lesser settlements such as in DFCCIL.

d) Till now, the actual observed values of settlement versus time (Asaoka method) has been used to assess the actual settlement values, and revise the loading cycle and final settlements. This need to be co-related with theory as well.

10 ACKNOWLEDGMENTS

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11 REFERENCES

Asaoka, A(1978). Observational Procedure of Settlement Prediction. Soils and Foundations, Vol. 18, No. 4, Dec 1978, Japanese Society of Soil Mechanics and Foundation Engineering.

GE:G-1(2003) Guidelines for Earthwork in Railway Projects. Geotechnical Engineering Directorate Lucknow : RDSO

GE:0014(2009). Guidelines and Specifications for Design of Formation for Heavy Axle Load. Geotechnical Engineering Directorate. Lucknow: RDSO

HQ/EN/PWC/PHASE-II PKG-11/D&B/9/Express Freight Railway Consortium. Contract Agreement, Package CTP-11 Civil, Building and Track Works(JNPT-Vaitarna Section)

IRS Bridge and sub-structures & Foundations code:2013. Code of Practice for the design of sub-structures and foundations of bridges. Lucknow: RDSO

IS 15284 (Part1):2003. Design and Construction for Ground Improvement-Guidelines. New Delhi: BIS

Jaron Lyell McMillan(June 14, 2016). Patent No. US 9,365,997 B2. United States Patent.

SIMPLIFICATION OF WORK IN KOSAMBA YARD UNDER VADODARA DIVISION, WESTERN RAILWAY

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ABSTRACT:

This paper is primarily focused on simplification of yard modification at Kosamba Yard under Vadodara Division, Western Railway. The Kosamba Junction of Vadodara division falls in parallel alignment of Western Railway and the proposed alignment of WDFC under CGM/Vadodara. It is a typical yard having connectivity of both Broad Gauge (B.G.) line as well as Narrow Gauge (N.G.) line in the same yard wherein, the DFCCIL Lines are proposed to be laid in parallel to the IR lines, warranting yard modification and necessitating change in station interlocking. As the interlocking system was old conventional Panel Interlocking (PI) system and there was space constraint in relay room, a complete new Electronic Interlocking (EI) along with complete yard involving construction of station building was required as a part of utility shifting works to accommodate the proposed DFCCIL alignment. This article details the simplification process adopted to curtail/minimize the need of yard remodeling thereby saving money, time and efforts.

A. Introduction

"The Railway Utility Shifting"

Who better than the DFCCIL team can understand the pain involved in acquiring land for the construction of this Mega Project – "The Dedicated Freight Corridors"? In initial phase, all the departments were primarily involved in the land acquisition which is a time-consuming activity and requires great efforts. In order to minimize the acquisition of land, the instructions were issued by Railway Board to utilize the land already available with the Indian Railways and further acquiring the land required in excess of it. Though this step was remarkable in minimizing the time, energy and money involved in the Land Acquisition, but on the other side, it warranted for another big chapter known as "Railways Utility Shifting Works", involving Civil – Permanent Way (P. Way) & Works, Electrical – Traction Distribution (TRD) and Power, Signal & Telecommunications. The Railway utility shifting work is yet another major task to be taken up by DFCCIL which was no lesser than the land

acquisition as safety of running train movement comes into picture now.

The Railway Utility Shifting work involves various phases such as –

i. Joint Verification of Railway Utilities by Railways & DFCCIL,
ii. Preparation of estimate by Railways,
iii. Verification and Sanction of the estimate by DFCCIL,
iv. Release of funds by DFCCIL,
v. Calling of Tender(s) by Railways,
vi. Finalization of Tender(s) by Railways,
vii. Execution of Work by Railways,
viii. Completion & Closure of work by Railways,
ix. Final fund adjustments and settlement between Railways and DFCCIL,
x. Closure of Work Account by DFCCIL.

Though it appears to be a simple 10-step process but in actual it is a herculean task and it becomes a critical related safety matter when involving interlocking is involved as a part of S&T utility shifting work.

The S&T utility shifting work can be sub-divided into:

a. S&T utility shifting in Block Section – involves trenching & laying of Signaling cables, OFC cables, Quad cables, casting of termination of Location boxes & signal posts, Level crossings. Interlocking is only limited to Level crossings.
b. S&T utility shifting in Station section – involves trenching & laying of signaling cables, OFC cables, Quad cables, casting and termination of Location boxes & signal posts, installation of Train detection devices, Relays, Points, modification or installation of EI / PI / RRI. The Interlocking involved is for whole station.

The utility shifting in Station section is far more critical as compared to that of block section because of the following major constraints:

i. Limited land availability in yard for laying of new cables.
ii. Installation of train detection devices on point zone etc.
iii. Limited space for installation of location boxes / Junction boxes within station area.
iv. Constraints in space availability at Battery Rooms.
v. Constraints in space availability at Relay Rooms.
vi. Constraints in space availability at Station Master Rooms.
vii. Constraints due to limited track crossings availability in station yard.
viii. Continuous Train Operations during execution of work.
ix. Risk of disturbing the existing interlocking / equipment.
x. Risk of damage to already existing working cables during execution.
xi. Disturbances due to passenger activities.
xii. Presence of civil structures such as Station building / residential buildings etc.
xiii. Installation or modification in Telecom devices such as STM, GPS clocks, Public Address systems etc.
xiv. Non-Mechanized mode of working due to vicinity of trains & passengers and restricted access to machines.

Interlocking works generally involve Non-Interlocked (N.I.) working during Testing & commissioning of S&T works, which is the most critical part during train operation as the interlocking arrangement is completely bypassed and whole safety of operation is to be ensured manually by the Operating and S&T department staff.

Efforts are always made to avoid Non-Interlocked working as it involves –

a. Ensuring safety manually by person on duty as the interlocking using signaling systems is bypassed,
b. Obtaining the desired NI period from Operating department,
c. Requires huge manpower during NI period,
d. Causes delay in train operations,
e. Disruption in normal working of trains.

In case, it is not possible to avoid NI working, then it is always desired to minimize the NI duration.

Thus, it can be judged from the above reason that the utility shifting in yards tend to be more difficult than that of the block sections.

B. Background

Kosamba Junction falls on the main Mumbai - Delhi

Rajdhani route on Western Railways under Vadodara Division. The station is 4 Line Broad Gauge station with Class-B, Standard - III Interlocking. A Narrow Gauge (N.G.) yard exist adjacent to this the main line junction which caters to the 61 Km Narrow Gauge route from Kosamba to Umarwada with 9 intermediate halt stations. The station yard is a congested area surrounded by market from both the sides.

The yard layout of Kosamba station before modification is depicted in Figure 1.

It can be seen from yard layout that the existing IR UP Goods siding No. 2 and Trans-shipment platforms are infringing the proposed DFCCIL Lines. It was not possible to accommodate the DFCCIL alignment in the East of these lines due to land constraints in congested station area. Hence, the siding lines at goods trans-shipment platform and the UP goods siding no.2 lines involving points 202, 203, 204 and TP205 were required to be dismantled. The best thing about this portion was that these were non-track circuited. So, its disposal would not affect Interlocking Arrangements of the yard. Vadodara Division agreed for dismantling of these 4 points and associated tracks being goods siding with poor utilization. Even after dismantling of these lines, there was another infringement just 1 m to DFCCIL alignment due to curved sand hump at point no. 117 (1 in 8.5) on UP common loop line.

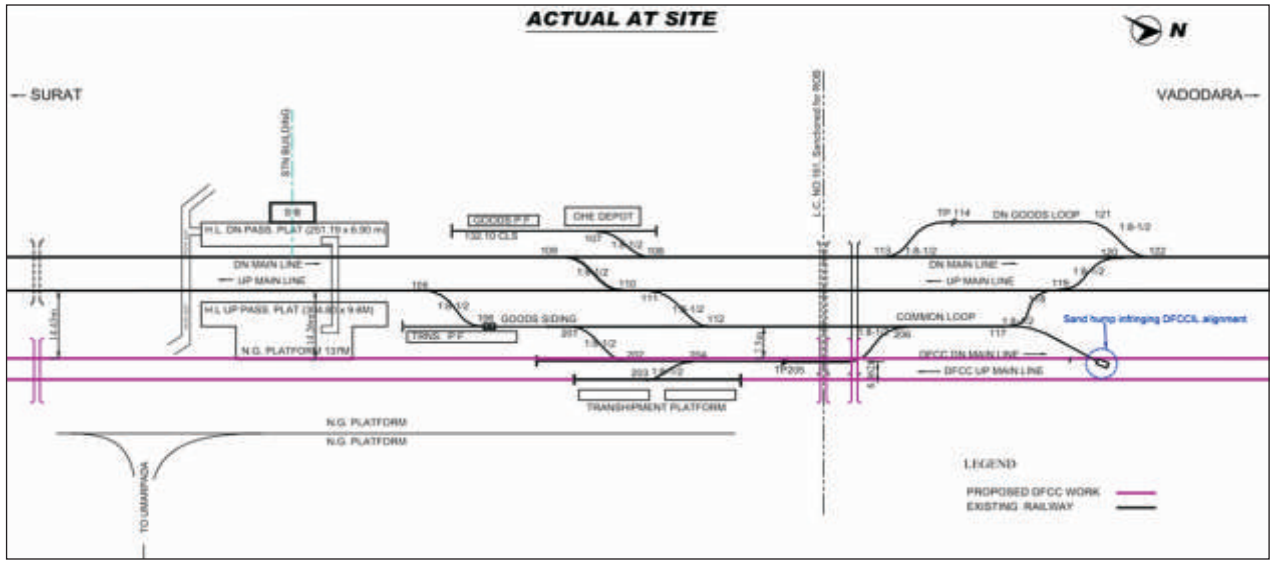

Figure 1: Kosamba Yard before Modification

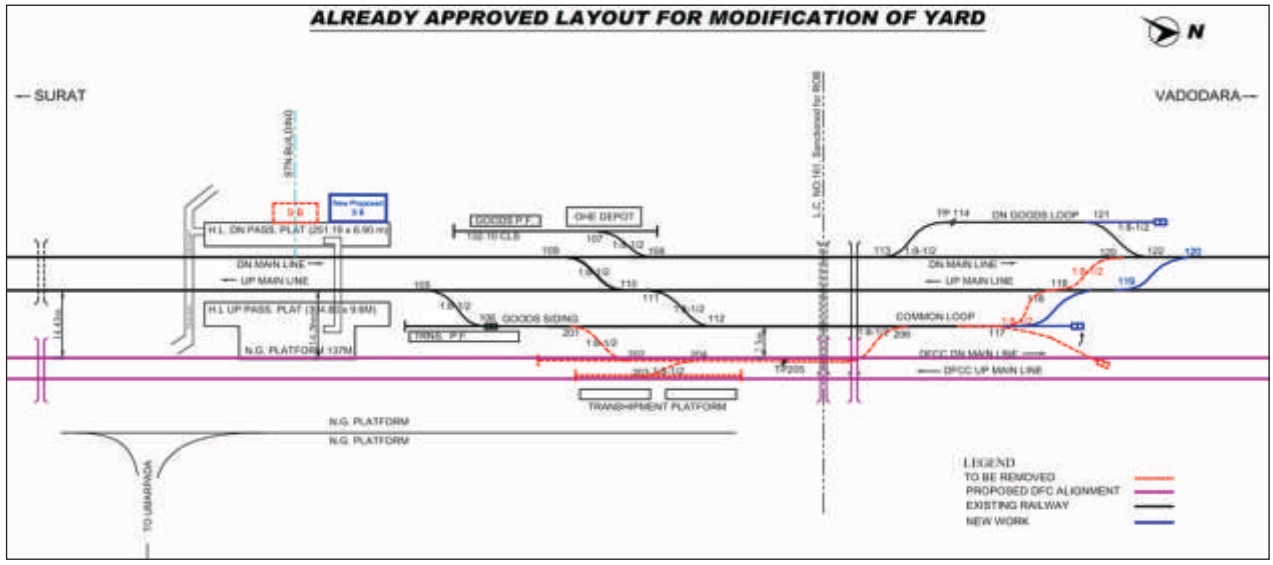

Figure 2: Kosamba Yard Modification proposed and already approved by Railways

C. The Problem

To clear the infringements, WR has approved the Engineering Scale Plan as shown in Figure 2.

In this plan (ESP), infringement of 1 m due to the infringement by one symmetrical layout at point no. 117 to DFCCIL alignment was proposed to be removed by replaced this point by 1 in 12 turn out by WR, which triggered of shifting of the crossovers 119-120 resulting into change in yard lard layout requiring change in interlocking also.

The existing interlocking at the yard was Panel Interlocking (PI) using ABB relays (Metal to Metal type). Being an old installation using discrete relays, the size of Relay room was insufficient to cater for the modification necessitated due to change in interlocking.

Hence, this space constraint in existing relay room gave rise to requirement of new relay room. But further, it was highlighted by the Division that the Panel Interlocking at Kosamba is nearing its codal life and is required to be phased out by new Interlocking mechanisms and thus, demand of new Electronic Interlocking emerged for Kosamba yard. Based on this new yard geometry, WR submitted the estimate incorporating for new Electronic Interlocking in lieu of existing Panel Interlocking which again required a new Station building.

As per the ongoing trend, new yard commissioning as per Railways practice requires around 30 months period to complete. Hence, DFCCIL would be in a position to get the encumbrance-free land from WR at least after 30 months' time.

After going through the proposal of WR for modification of complete Kosamba yard, it was realized that the time required for completion of the work is too long which might affect the DFCCIL Civil & Track work, apart from handing over of encumbrance free land. This would have been a setback to DFCCIL target of commissioning.

In the nutshell, an infringement of sand hump by 1 m to the DFCCIL proposed tracks is resulting into Kosamba yard remodeling, whole new Electronic Interlocking and complete Station Building etc. requiring:

a. Estimated expenditure of roughly Rs. 10.66 Cr. as per abstract estimate.
b. Physical completion period of the said work to be no lesser than 30 months.
c. Non-Interlocked working.

It was very difficult to digest, that such as petty work of straightening of a sand hump would call for such a huge expenditure and cumbersome exercise.

Hence, the issue was re-examined in all dimensions to explore some optimized solution.

D. The Solution

"When there is a will, there is a way"

The solution was perceived in a different way. It was felt that instead of shifting the crossover towards Vadodara end, it may be shifted towards Surat end, so that the yard geometry remains intact and no modification in interlocking is required.

But this was leading to another problem of reduction of Clear Standing Length (CSL) of the Common Loop line by 11 m of clear standing room (CSL) of this Common Loop line which was unlikely to be agreed by Western Railway.

Hence, site inspections were carried out by DFCCIL officials to find out a solution. It was discovered that the existing starter no. 16 was at a distance around 51 m from the SRJ of point no. 112, as against the distance requirement of 6 m to 16 m (after implementation of Railway Board guidelines of regarding shifting of starters up to 3 m from glued joints).

So, if starter no. 16 is shifted towards SRJ of point no. 112, then the CSL for Common loop line can be increased by more than 55 m considering all other margins. Now, this increased length of CSL for Common Loop line can compensate for the reduction of 11 m of CSL and accommodate the proposed crossover no. 117-118 of 1 in 12 (Refer Figure 3 for the proposed changes suggested by DFCCIL). Figure no. 4 depicts the Common Loop line CSL affected by changes proposed by DFCCIL.

While the above concept fine and workable but convincing the Railways and getting the work executed from them as per proposal of DFCCIL was another tough task.

E. The Final Chapter

"Convincing the Railways"

This proposal was prepared and discussed with the Divisional Officers of Vadodara Division one by one. First, Sr.DSTE/Vadodara was convinced for shifting of Starter no. 16 along with Axle counter Detection Point (DP) towards SRJ of Point no. 112 as it would require minimize the expenditure for execution of

this work. It was further highlighted to Sr.DSTE/Vadodara that as the Panel Inter-locking at Kosamba was commissioned in 2003, and it has a codal life of 25 Years, hence is not due for replacement and can still serve.

There is a LC no. 161 running in between the station yard of Kosamba and diving the Common Loop line in two parts. Sr.DOM/Vadodara was highlighted that the common loop is having two CSL (i.e. 100.23m for Surat end CSL, and 469.11 m for Vadodara end CSL) due to existence of LC no. 161. While the DFCCIL proposal shall reduce the Vadodara end CSL by 11 m, it would increase the Surat end CSL by 45 m (due to shifting of starter) which would more than compensate for reduction in the Vadodara end CSL. It was also highlighted that that Road Over Bridge (ROB) is sanctioned at LC-161 and is likely to be commissioned in 2 to 3 years. So, these two CSLs shall merge and shall become 750.98m which is higher than the extant rule of IR of 750m, which is not the case with the existing proposal by WR. As per the approved layout of WR, the CSL would have been 707.98m which was lesser than the standard prescribed by Railway Board.

DFCCIL officials put forward their proposal with the following strong arguments:

i. There would be minimum alteration required in the yard,

ii. There would be minimum disturbance to the traffic operations.

iii. There would not be any Non-Interlocked working, which could be highly unsafe on Mumbai-Delhi main Rajdhani route.

iv. The work can be planned on disconnection on the Goods line, without disturbing mainline operations.

The above arguments were enough to convince Sr. DOM/Vadodara.

The matter was then taken up with Sr. DEN/Vadodara and it was clearly spelt out that DFCCIL shall not bear any additional expenditure beyond one-to-one replacement and strictly in terms of Joint Procedure Orders and Railway Board Instructions.

After convincing all branch officers, finally the proposal was discussed by CGM/DFCCIL/

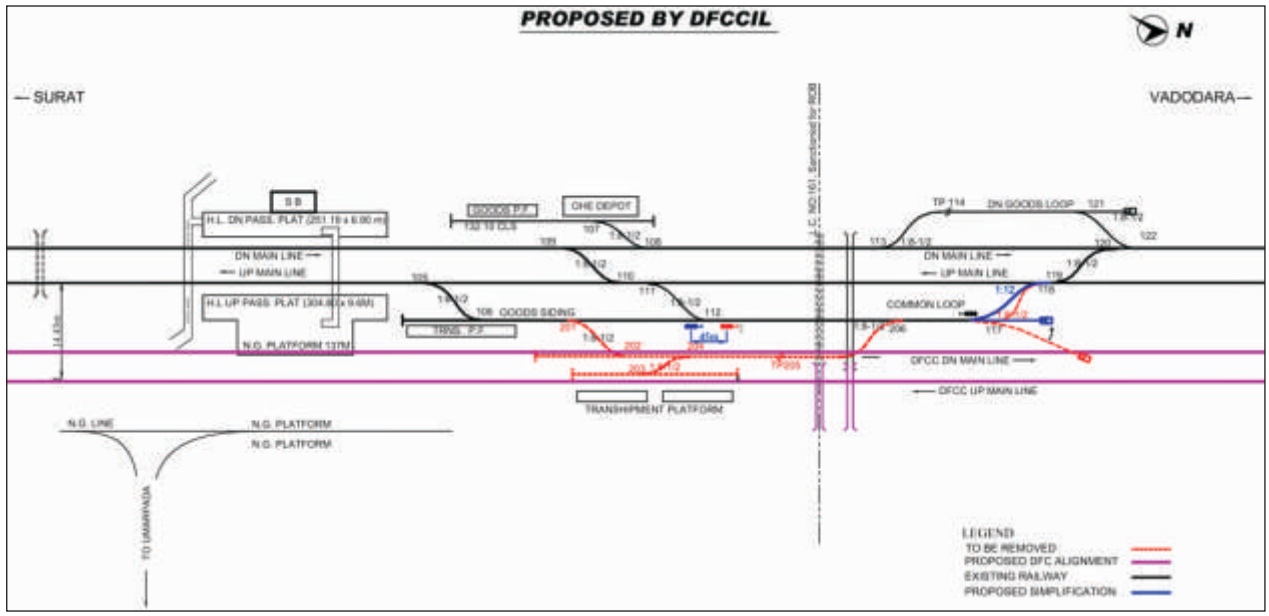

Figure 3: Simplification proposed by DFCCIL for Kosamba Yard in order to retain original layout to avoid any change in Interlocking arrangement.

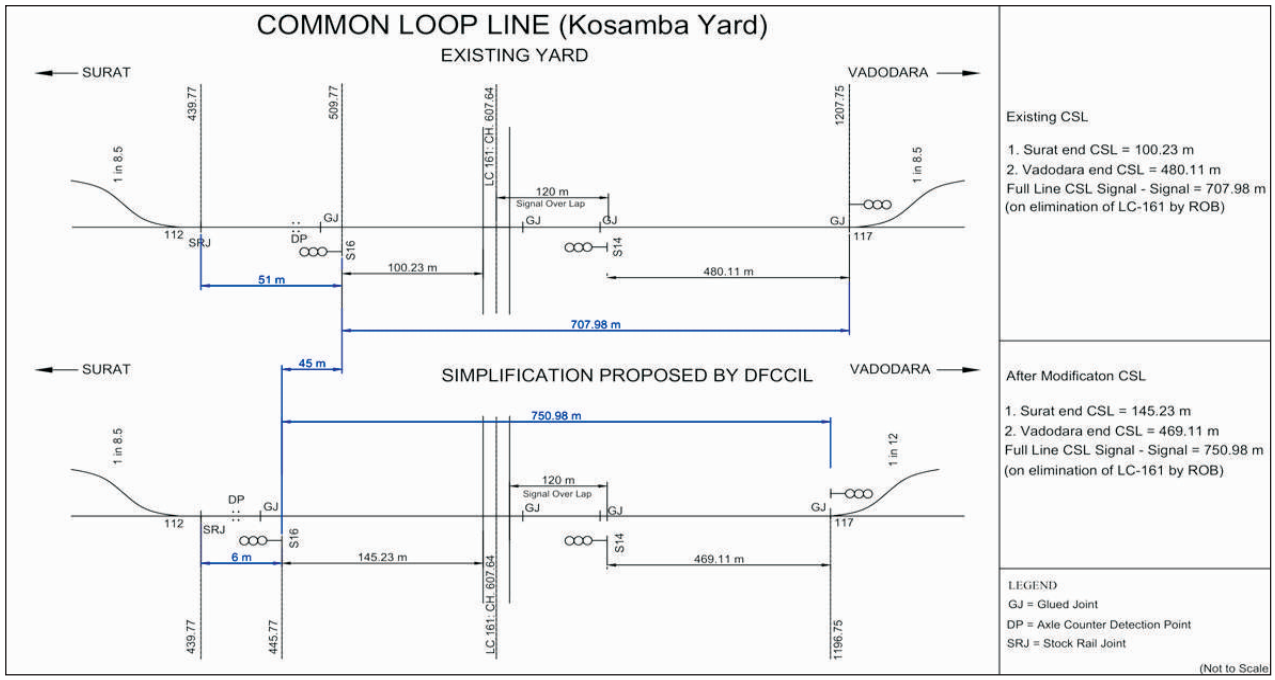

Figure 4: DFCCIL proposal of shifting of Starter S16 to increase CSL of Common Loop line which shall be beneficial to WR

Vadodara with DRM/Vadodara, who was convinced and appreciated the logic behind DFCCIL's proposal and agreed for initiating the proposal of new P. Way plan as proposed by DFCCIL. The whole exercise is summarized in a nutshell as given in Table no.1. Hence, the plan was revised as per DFCCIL proposal depicted in Figure 3, and was approved by various departments of Western Railway HQ, by convincing the officials across the table thereby cutting delays that may have crept in absence of chasing and communication. Finally, the ESP was approved and new estimate was agreed amounting less than a Crore duly saving roughly Rs. 9 Crores. Further, this work was executed with in a period of 6 months.

F. The Result

"If you care enough for a result, you will most certainly attain it."

Because of the new proposal by DFCCIL for Kosamba yard, the Right of Way (RoW) in Kosamba station was cleared and encumbrance-free land could be handed over to CTP-13 (Civil & Track Work Package) contractor M/s Express Freight Consortium. In addition to saving in expenditure, roughly 2 years were also saved. So, both Time and Money were saved for DFCCIL which is very crucial for commencing the execution of construction activities of DFCCIL.

TECHNICAL PAPER ON THE CONSTRUCTION OF WELL FOUNDATIONS ON TAPI RIVER BRIDGE NO. 240 NEAR SURAT CITY

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CGM/MUMBAI/N/DFCCIL

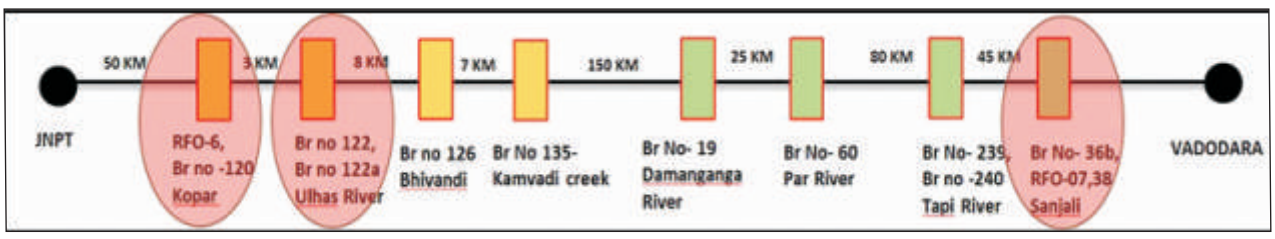
A. K. Diwakar
Dy CPM/SURAT/DFCCIL

SYNOPSIS:

Construction of well foundation for important bridge is a challenging job in the perennial river and especially when rock is encountered in the well foundation which was unforeseen during initial GTI investigation. This paper highlights and give overview of the difficulties and delays experienced in the field execution due to mismatch in the GTI investigations done before execution of work and actual soil encountered during execution. The document will help in taking utmost care during GTI investigation for important projects.

1. Preface

The work of Design and Construction of 8 Special Steel Bridges over Water Mains, Railways, Creek and Rivers (Ulhas, Damanganga, Par and Tapi rivers, RFOs) including Bridge Structure, approaches, formation of Embankments, Guide Bunds and river protection works with testing and commissioning is part of 15A Contract package of WDFC. The contract was awarded to IIS-L&T consortium on Design-build lump sum price basis.



Bridge no. 240 across the River Tapi in Surat – Vadodara Section is an important bridge of WDFC-Phase II which is a part of 15A package, is a special steel bridge (Open web through type truss) located on outskirts of Surat City consisting of 15 spans of 48.5 metre, with overall length of 727.50 meters. The scope of work also covers embankment construction of 200 metre on either side of the bridge &guide bund towards Vadodara side.

Did you know?

The Tapti River (or Tapi) is a river in central India between the Godavari and Narmada rivers. It flows westwards over a length of 724 km (449.9 mi) before draining through the Gulf of Khambhat into the Arabian Sea. It flows through Surat, and is crossed by the Magdalla ONGC Bridge.

On August 7, 1968, before the construction of the Ukai Dam to bring its waters under control and provide hydroelectric power, the Tapti River overflowed its banks during heavy rains during the monsoon season. The city of Surat was submerged beneath 10 feet of water for several days.

The stretch of river Tapi where bridge is located is proposed to be classified as Class-III waterway for which horizontal clearances of 50 m. and vertical clearance 6 m. above NHFL is required.

2. Introduction of Bridge No.-240

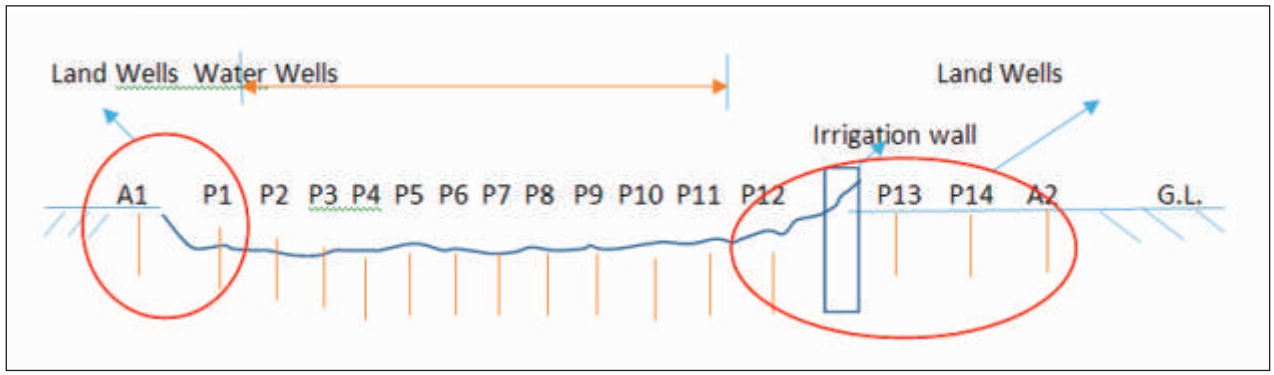
Bridge No. 240 at Tapi river consists of 16 well foundations, out of which 10 nos. were originally designed as water wells and 06 nos. as land wells. As per the GTI data & approved GIR reports, the land wells were designed for 11.50 m diameter up to a depth of 40 mtr (avg) and water wells were designed for 16 m diameter up to a depth ranging between 16-20 mtr, maintaining the required embedment within rock.

About Bridge no. 240

- Type of Bridge - Important Bridge.
- Foundation - 16 well foundations;
- Substructure - 2 abutments, 14 piers
- Super structure - Open web through truss type; 15 X 48.5 mtr
- Standard of loading - 32.5T DFC loading
- Formation level - 24.039
- Rail level - 24.811

➢ Concrete - 46000 cum
➢ Structural steel - 5000 MT
➢ Reinforcement steel - 4200 MT

Line Diagram of Bridge: -



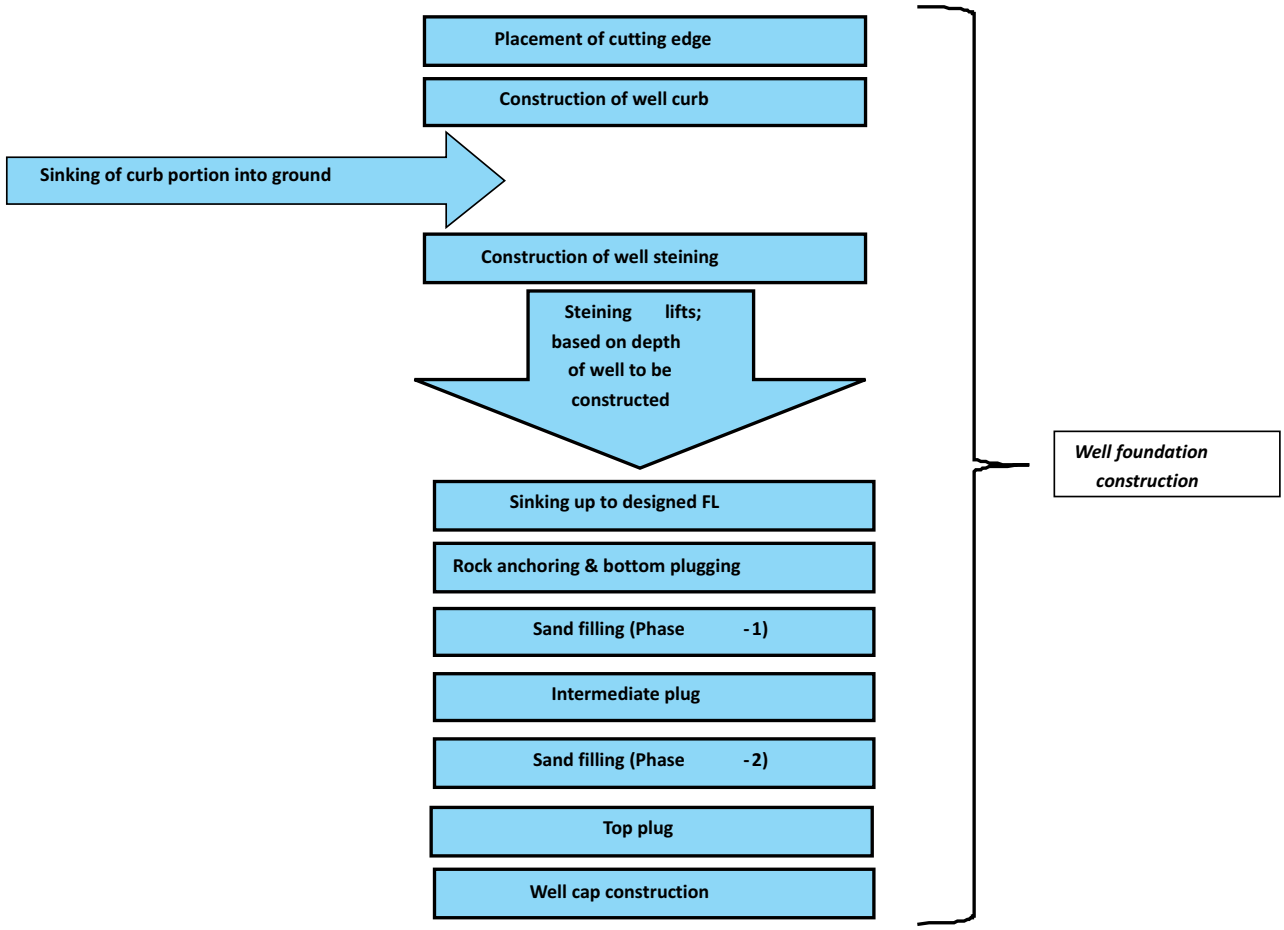
At beginning: Overview of Tapi River at Bridge site

3. Conventional Method for Well sinking:

- Dredging by Grab bucket.
- Chiselling by heavy weight Chisel.
- Water and Air jetting.
- Jack Down method.
- Pneumatic sinking.
- Use of Explosives.

All above methods are used in India for sinking of wells to reach up to founding level.

4. Well foundation: Construction methodology



5. Well sinking: A major challenge in the path of progress

As per the GTI conducted at site, data collected thereafter & approved GIR reports, the land wells were designed up to a depth of 40 metre (average) and water wells were designed up to a depth ranging between 16-20 metre, maintaining the required embedment or more within hard strata.

However, during execution, anomalies were found between the bore log data and the stratum encountered at site in case of **land wells.** The sinking of well progress was very poor due to soft rock encountered in the well. Several site visits by DFCCIL, design and geotechnical experts from the engineer as well as contractor side were conducted and it was decided to re-investigatethe soil for the land wells. During the re-GTI, it was found that the bore log data, so obtained, differed from that of the previous reports and the data was thoroughly analysed by the designer as well as Geo-tech experts.

Following these analysis and re-investigation, founding level and design were modified all the 6 land wells, which meant starting from zero again.

This anomaly in the GTI data could be attributed to the boring methodology **(i.e. – Single core type barrel)** used during the initial GTI conducted at site. Thus, for conducting re-GTI, **3-core barrel type boring machine** was deployed at site.

Initially at design stage, bore hole recorded as **REFUSAL.** Which does not indicate about type of rock encountered, how much the **RQD** found at particular intervals of level/depth. Hence, the Geotech experts decided the founding levels of wells.

The comparative statement for both GTI reports as below: -

- UCS value reported in 1st GIR at founding level –Considered as soil.
- UCS value reported in 2nd GIR at founding level - 12.85 MPa.
- UCS value observed at founding level site- 22.38 MPa.

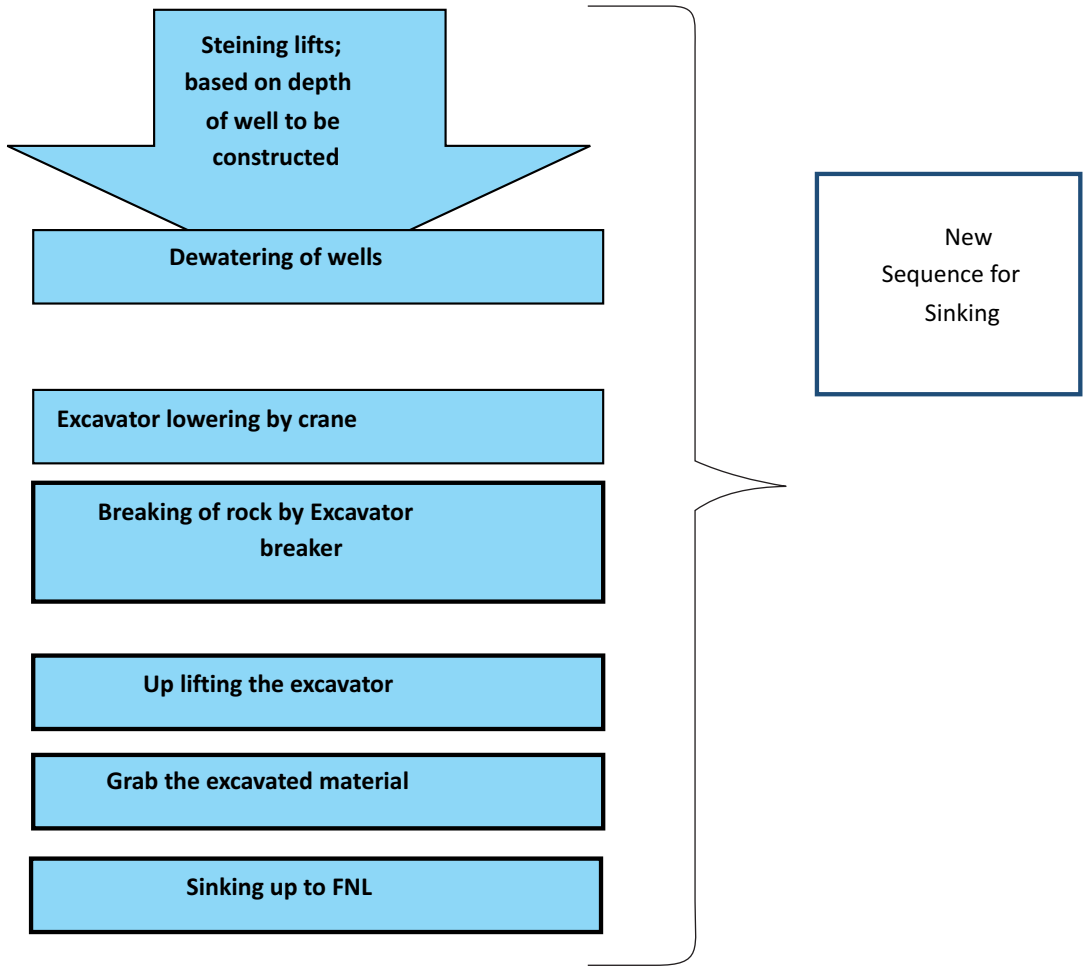
Based on designed FNL, execution team started the work and found that after well sunk up to the depth 20 mtr the encountered strata were not matching along with bore log sheet. The execution team decided that re-GTI to be conducted by 3-core barrel type boring machine. For taking this decision and approval from Geotech and Design experts the work at such wells were standstill. The work delayed due to hard strata (i.e.- Conglomerate Rock) encountered, which was not dredged by any conventional methods as mentioned above, because the wells were originally designed for soil/friction type. Thus, the sinking of wells was so difficult up to designed depth.

Although the scope of sinking in the six land wells viz., A1, P1, P12, P13, P14 & A2, were revised and reduced, the fact that these foundations were originally designed for soil strata could not be ignored. For sinking the well foundations at Tapi Bridge site, the conventional method of grabbing and chiselling proved to be an ineffective exercise after the initial sinking of 8-9 metre. Hence, to tackle the issue, the contractor engaged excavators with rock breaker arrangement to break the rock inside the well. In order to facilitate this, complete dewatering of well had to be done. Thus, dewatering pumps were deployed for dewatering the wells and excavators were lowered inside the foundation to break the rock and to further sink the well.

6. Innovative method for sinking:

- Since sinking the well through the strata encountered at site seemed impossible with the conventional sinking methods, after several brain storming sessions, the project team conceptualised a different method **– *Engagement of chain mounted excavators with rock breaking arrangement.***
- **Suggestions from experts: -**
  a) To avoid sand blow-The experts suggested to provide the coffer dam by sheet pilling. But its time taking job and has financial repercussions cost also.
  b) Use of explosive-It is not feasible due to the fact that design of such wells were not designed for using explosives, and no protection were provided in well curb and steining inner surfaces.
- This method, though effective, comes with its own package of risk and safety concerns.
- The progress of sinking by this method is very slow due to several sequence of work for achieving small depth of sinking of well.
- A huge mass of hard strata, when broken by the excavator, has the tendency to sink the well with a sudden impact, thereby injuring the workers and damaging the equipments inside the well. Also, the risk of damage to cutting edge due to sudden impact could not be ruled out.
- In order to ensure quick response in such condition of impending risk, the project team ensured that at every location where such activities were in progress,a dedicated crane with man basket is stationed along with all other necessary safety arrangements viz. lifebuoys, life jackets, etc.
- Emergency rope ladder is also suspended from the top of well so that workers could be rescued even in case of crane breakdown.

  Now after adopting different method for sinking, the following operation sequence was followed:



Excavator Lowering inside the well

7. Challenges Encountered for Implementing Innovative method for sinking

- Sand blow: In case of water wells, which were designed for sinking through hard strata itself, continuous seepage of sand and water from the surrounding area was disrupting the activity to a large extent. In order to lower the excavator, dewatering of the well was compulsory. As soon as a well is dewatered, and where there is a presence of fracture between the cutting edge & the underlying strata, blow is inevitable. This impend a major safety hazard if various safety precautions are not adopted and followed strictly. During such sudden seepage of sand and water into the well, the water level abruptly rises thereby posing a threat to the life of the excavator operator & labour inside the well. In order to enable a quick response in the event of unforeseen sand blow, a crane was always placed in position for removing the labour & machinery.

  Such incidents of sand blow aren't restricted to the water wells. It has been observed in land wells such as P1 & P12 also.

  In the event of sand blow, a huge mass of soil/ sand seeps inside the well (approx. around 30 cum) which eventually resulted in repeated cycle of grabbing and dewatering. This affected the overall productivity at site and also had financial repercussion due to deployment of heavy machinery and materials. A gist of resources deployed for dewatering and further breaking of 1 well foundation is as below:

- Dewatering pumps (25 Hp) – 4 nos. with starter
- Delivery hose pipe, pipe jointers/ connectors
- TFC crane 75 MT – for lowering pumps, excavator & man basket
- Power generator – as per capacity of pumps to be used
- Diesel for excavator & DG
- Staff & labour
- Other allied attachments & arrangements

❑ **Loss of productivity:**

- Even though adequate resources were deployed at site for efficient sinking at site, the progress of sinking through the hard strata was negligible. Thus, the productivity of labour and machinery was very low.
- Ineffective exercise of grabbing due to sand blow inside the well.
- Ineffective utilisation of resources leading to idle time and low utilisation rate (Crane has to be placed in position near well when excavator is lowered due to safety concerns)
- Repeated cycle of grabbing & dewatering causing rework & increased cost
- Low productivity (even after engaging excavator with breaker arrangement) – leading to labour payment issues

Due to the issues enlisted above, it was difficult to work out a cycle time for sinking the well within hard strata/ or just above the hard strata as most of the efforts made for sinking goes in vain due to repeated sand blow and damage to the structure.

'This has a major impact on the progress of the project and thereby, any strategy related to resource allocation, management and utilisation fails drastically.'

❑ **Damage of cutting edge and concrete surface in inner surface of well curb:**

- Even through this innovative method for sinking, due to hard strata and sudden sinking of well, the cutting edge and well curb inner surface was damage. This challenge was also faced by execution team. Due to damaged cutting-edge, sinking work was also very tough specially in the encountered hard strata. The execution team referred the case to design & Geotech experts for giving better solution for sinking.

  The experts suggested that the damage of cutting edge should not be the concern of field team and recommended that, the damaged concrete surface shall be repaired by non-shrink material (i.e.- GP-2 or epoxy grout).

  After applying the suggested method, bottom plug of well was cast successfully.

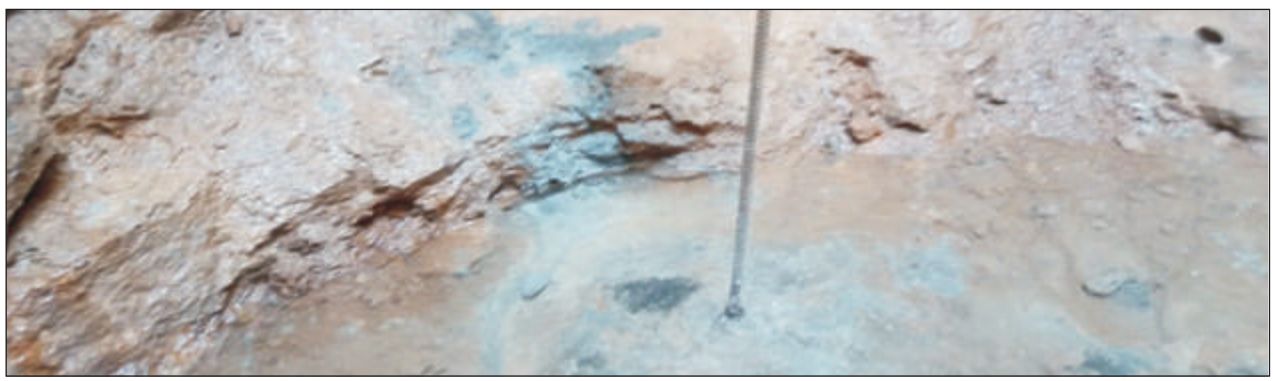
Damaged Cutting Edge

Repair of Cutting Edge

Soil/ sand caving in from the area around the well

Rebar anchoring on Rock strata at FNL.

Damaged Well curb concrete repaired by GP2



Rock breaking by excavator inside Well

8. The case of A-2 well foundation (land well).

Activity details of A2 well: -

Activity Name	Date of start	Date of Finish	Sinking in mtr.	Remarks
Placing of cutting edge	-	22/08/2017	-	
Concreting of well Curb	-	21/09/2017	-	
Casting of 1st lift of steining	-	10/10/2017	-	
1st phase Sinking by traditional method	14/10/2017	20/10/2017	3.506	Avg. sinking 0.584 metre/day
Casting of 2nd lift of steining	-	26/10/2017	-	
2nd phase Sinking by traditional method	30/10/2017	03/11/2017	2.867	Avg. sinking 0.716 metre/day
Casting of 3rd lift of steining	-	11/11/2017	-	
3rd phase Sinking by traditional method	15/11/2017	18/11/2017	2.394	Avg. sinking 0.798 metre/day
Casting of 4th lift of steining	-	27/11/2017	-	
Casting of 5th lift of steining	-	07/12/2017	-	
Sinking after rock was encountered				
4th phase Sinking by New method	08/12/2017		18/12/2017	1.770Avg. sinking 0.177 metre/day
Casting of 6th lift of steining	-	23/12/2017	-	
5th phase Sinking by New method	26/12/2017	09/01/2018	3.768	Avg. sinking 0.269 metre/day
Casting of 7th lift of steining	-	16/01/2018	-	
6th phase Sinking by New method	20/01/2018	24/03/2018	4.247	Avg. sinking 0.067 metre/day
7th phase Sinking by New method	23/08/2018	28/08/2018	1.479	Avg. sinking 0.295 metre/day
Casting of 8th lift of steining	-	08/09/2018	-	-
8th phase Sinking by New method	18/09/2018	30/10/2018	2.851	Avg. sinking 0.067 metre/day

- In case of A2 well, a sinking of 14.115 metre was required to be achieved as per revised FNL. After continuous effort to sink the well by resorting to grabbing & chiselling, it was decided to dewater the well with 4 nos. – 25 Hp pumps.
- Also, as the well wasn't resting on uniform hard stratum, sand blow used to disrupt the activity of rock breaking every alternate day. Thus, sinking productivity, after dewatering the well and engaging excavator and other resources was adversely affected.
- After dewatering the well, excavator was lowered for rock breaking. Excavator was engaged continuously for 3 months but avg. sinking was observed about 67 mm. per day.
- This period was very crucial as it was working season and no satisfactory productivity observed at site. The execution team were conduct the re-GTI and got approvals based on results.
- The work was idleduring this phase when GTI was conducted and re-decision of FNL was approved by design and Geotech team.

Cracks developed over the ramp surface due to sand blow inside the well

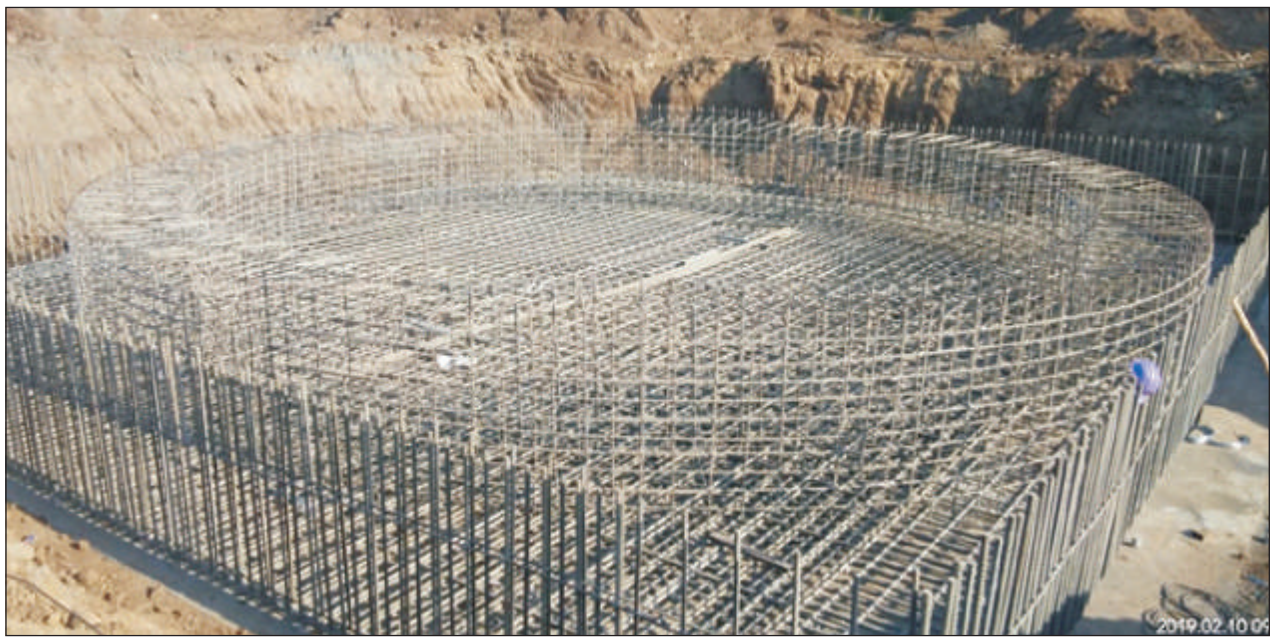
Soil/ sand seepage inside the well thereby submerging the pumps & excavator

Inspection of Well foundation by Experts

- Finally, after reaching at Founding level at A2 well, the further work of bottom plugging, anchoring the rebar as mentioned in drawing for rock anchoring, repairing all the damaged surface by non-shrink grout was completed.

Progress at Tapi: Amidst the hardships due to sinking

- At present, all the work fronts at Tapi site have been initiated.
- 3 land wells have reached the founding level, out of which, top plugging has been done in 2 wells and 2 other wells are almost nearing the founding level.
- Rebar works of well cap have commenced in one of the wells
- 75% sinking has been completed in well foundations till date.



A2 Well: Rebar tying for well cap

News and Views from all Over

Blurring the distinction between transporters: "….the distinction between mobility on roads and on rails will no longer exist in the way it does today. Multi-modality will be engrained: car sharing to the railway station, rail for the inter-city leg, completing the journey by cycle sharing. Target audience will also change. We may no longer talk about 'rail users' as a group, as travellers select their mode flexibly and according to their circumstances at the moment. This may mean the dominant operators become less important over time. The traveller will not care which provider they are using or whether they are on a train or aircraft, but solely whether the door-to-door journey chain is best for them… (RGI 09/2018 pp162).

Heat film to beat heat on Non AC coaches: DB Regio is applying heat protection film to the windows of the Type DBuz non air-conditioner double decker coaches. Expected to reduce temperatures by 4 degrees C. (RGI 09/2018 pp156)

Brake Inspection Software: Software developer Heartwood 3D has launched a 3 D training tool which will simulate training on brake inspection one of the core skills that newly recruited drivers and conductors must learn. Conventional training involves on site sessions walking along a train of wagons to learn the various components and operating conditions involved. The 3D app is intended to reduce this practical work (RGI 09/2018 pp155).

High Endurance rails: A Russian steel producer is offering high endurance rails

With wear resistance rate upto 25% greater than standard designs. They are found better in fatigue strength, endurance limits and fatigue crack propagation. These are also well suited for curves with a radius less than 650m. (RGI 09/2018 pp150).

Multi functional rail profile measuring device: This patented measuring method is intended to ensure accuracy independent of external factors such as the rail surface. The device can also evaluate track gauge, super elevation and rail cant directly calculating the twist in order to detect irregularities on site. (RGI 09/2018 pp146).

Also British steel is offering high performance rail products having high wear resistance with low residual stress to minimise the risk of foot fatigue. (RGI 09/2018 pp142).

Remote Condition Monitoring (RCM): For bogies and wheelsets using wireless and self powered solution is being offered. RCM will lower maintenance costs an increased availability. The impact of digitisation in rail industry is a hotly discussed topic and Digitisation not just an option but a necessity. (RGI 09/2018 pp140).

Track defect recognition technology: Automatic video recognition technology which can identify potential track defects before they occur is being offered. It uses video monitoring, track expertise coupled with data analytics technology. (RGI 09/2018 PP138).

Pandrol Connect: Mobile App for monitoring rail fastenings, aluminothermic welding. The app enables data capture for traceability. (RGI 09/2018 pp136).

Smarter track machine maintenance: The smart recording car features an inertial track geometry measurement system combined with a novel optical fixed point procedure and GNSS geo reference data. This machine can capture absolute track geometry at speeds of 100 kmph or higher. It can also transmit data on absolute track geometry via cloud computing

directly to a track maintenance machine. (RGI 09/2018 pp132).

ETCS-II in Italy: Firenze (Florence) area will be one of the three hubs to be equipped with ETCS- level 2 high density as part of the introduction of European Rail Traffic Management System (ERTMS).

Virtual Reality: Spanish Railways introduces 3D Virtual Reality facility in their training centre. This VR suite enables students to explore different types of equipments, undertake immersive training exercise away from potentially dangerous locations. (RGI 09/2018 pp83).

The UK: The National Skills Academy for Rail (NSAR) has developed a Skills Intelligence model to try to quantify recruitment challenge. The model indicated that UK rail sector will need 50,000 recruits from different skills from those tradition-ally associated with rail. A further 50,000 existing staff will need to be up skilled. NSAR feels that the future Railway will look different to the one we see today. It will be highly digitised with much shorter product development cycle. Advances in computing and data analytics will combine physical systems. A data driven railway will support a array of enhancements to customer service, real-time information and integration with other modes. (Shamit Gaiger RGI 09/2018 pp79).

Fuel Cells: Europe's first two hydrogen fuel cell powered trains are expected to begin operating regular passenger services in Northwest Germany. They are effectively Co2 neutral. Initially the Hydrogen gas will be supplied from existing sources – Hydrogen is currently the by product from chemical industry, the production of Chlorine. This would gradually be replaced by 'Green' hydrogen produced using electricity from wind farms. Development of more efficient fuel cells which would offer longer life cycle and higher power density are being taken up under Fuel cell technology innovation program (Dink Flege RGI 09/2018 pp67).

ETCS-II in Germany: The Halle/Leipzig-Ecfurt-Nurnberg high speed line is the first longest distance route in Germany to be equipped solely with ETCS level II. (RGI 09/2018 pp62)

Compiled by:
K.Madhusudan GGM/S&T/WC-I

डीएफसीसीआईएल के निर्माण कार्यों को त्वरित रूप से पूर्ण करने के लिए नवीनतम तकनीकों का उपयोग

नवीन आधुनिक तरीकों और प्रौद्योगिकी के सभी क्षेत्रों में विश्व तीव्र गति से विकास कर रहा है। शिक्षा के क्षेत्र में तेजी से वृद्धि, प्रौद्योगिकी से संबंधित नवीन आधुनिक तौर–तरीकों और अनुप्रयोगों की उच्च दर, अभी तक के सबसे तेज और सस्ते संचार साधनों ने राष्ट्रीय और अंतरराष्ट्रीय सीमाओं को समाप्त कर दिया है, जो निर्माण उद्योग में भी गुणवत्ता एवं संरक्षा मानकों से समझौता किए बिना परियोजनाओं के तीव्र गति से कार्यान्वयन में उत्प्रेरक सिद्ध हो रहे हैं।

इस लक्ष्य को प्राप्त करने में पारंपरिक निर्माण पद्धति प्रभावी साबित नहीं हुई हैं। तीव्र गति से निर्माण कार्य करने में मशीनीकरण और समानान्तर कार्य प्रणालियां (Parallel Working) महत्वपूर्ण मंत्र रहे हैं। पर्याप्त योजना और बेहतर समझ के बिना तेजी से निर्माण कार्यों को करने में गंभीर बाधाओं का सामना करना पड सकता है और अधिकांशतः मामलों में ऐसे कार्यों को पुनः भी करना पड़ सकता है। इसलिए प्रौद्योगिकी, संस्था, सूचनाएं, शिक्षा, नवीन आधुनिक तरीके और उत्पादक कौशल क्षमता आदि को विकास के भविष्य की दिशा में एक महत्वपूर्ण निर्णायक भूमिका निभाने के लिए माना जाता है। एक परियोजना के लिए निर्माण कार्य पद्धति को पहले से तय करने की आवश्यकता होती है, जिसको ध्यान में रखते हुए ही संरचना की डिजाइन तैयार की जानी चाहिए। कार्य निष्पादन के दौरान, की जाने वाली गतिविधियों को तय करने में, योजनाबद्ध मशीनीकरण और नवीन आधुनिक तौर–तरीके एक महत्वपूर्ण भूमिका निभाते हैं।

पूर्व–इंजीनियर्ड घटकों का उपयोग, बडी मात्रा में कंक्रीटिंग, स्व–चालित ट्रैक बिछाना, ओएचई मास्ट इंस्टॉलेशन, ओएचई की स्वचालित वायरिंग, गुणवत्ता जांच के आधुनिक तरीके, रिएंफोर्समेंट फेब्रिकेशन के आधुनिक तरीकों, परियोजनाओं में उपयोग की जाने वाली स्वयं की उत्पादन सुविधाएं, स्लिप और जंप फॉर्म शटरिंग का व्यापक उपयोग, मॉड्युलर डिजाइन, थ्रेडेड कप्लर्स का उपयोग और असेंबली लाइन पद्धति के माध्यम से पूर्व–इंजीनियर्ड घटकों का उत्पादन आदि परियोजना कार्यान्वेयन में तेजी लाने के साथ–साथ उच्च गुणवत्ता मानकों को बनाए रखने में बहुत प्रभावी सिद्ध हुए हैं।

इस दिशा में, डेडीकेटेड फ्रेट कोरीडोर कॉर्पोरेशन ऑफ इंडिया लिमिटेड (डीएफसीसीआईएल) ने दो डेडीकेटेड फ्रेट कोरीडोर अर्थात पश्चिमी और पूर्वी हैवी हॉल रेल फ्रेट कोरीडोरों के कार्यान्वयन में तेजी लाने के लिए अत्याधुनिक तकनीक और विभिन्न नवीन आधुनिक तकनीकों को अपनाने का एक बडा कदम उठाया है। परियोजना कार्यों में तेजी लाने की संकल्पना, डीएफसीसीआईएल ने निविदा के प्रारंभिक चरणों में ही कर दी थी जिसके कारण ठेकेदारों को परियोजना के निष्पादन के दौरान प्रत्येक चरण में विभिन्न उन्नत प्रौद्योगिकी और नवीनतम तौर–तरीकों को अपनाने में कोई कठिनाई नहीं होती है।

फॉर्मेशन का तैयार करना किसी भी बड़ी अवसंरचना परियोजनाओं की नींव है, जिसमें सामग्री को भारी मात्रा में रखने के साथ–साथ और परियोजना निर्माण की गति को धीमे किए बिना इसकी गुणवत्ता को सुनिश्चित किया जाता है जिसके लिए मृदा विरूपण (Soil deformation) एवं सामर्थ्य (Strength) के आंकलन हेतु, जांच के आधुनिक द्रुत तरीकों, जैसे कि स्ट्रेन मोड्यूलस (EV-2) नापने के लिए परीक्षण और न्यूक्लियर मॉइस्चर डेंसिटी गेज (NMDC) का प्रयोग, डीएफसीसीआईएल द्वारा व्यापक रूप से किया जा रहा है।

350 टन प्री–स्ट्रेस्ड / प्री– टेंशन्ड कांक्रीट बाक्स गर्डर (Pre-stressed / Pre-tensioned concrete Box Girders) जैसी संरचनाओं को तेजी से बनाने के लिए एक लांग लाइन मैथड (Long line Method), जो कि एक साथ 04 (चार) ऐसे कांक्रीट खंड (Segment) को ढालने (कास्ट) की क्षमता रखता है, का उपयोग किया जाता है जिसमें कि औसतन 18 ऐसे खंड, उच्च गुणवत्ता मानकों एवं उच्च गुणवत्ता वाली वाह्य पृष्ठ पूर्णता (High Quality Surface Finish) के साथ निर्मित किए जा सकते हैं। इन बॉक्स गर्डर्स के फास्ट ट्रैक लॉन्चिंग के लिए बहुत ही उन्नत उपकरणों का उपयोग आरंभ किया गया है, जो एक माह में औसतन 25 गर्डरों को लॉन्च कर सकते हैं। इन कार्यों को तेजी से पूरा करने के लिए, प्रारंभिक चरणों में ही कास्टिंग और लॉन्चिंग यार्ड की समुचित योजना सुनिश्चित की जाती है।

पीयर कैप (Pier Caps) के मॉड्यूलर निर्माण (Modular Construction) का व्यापक उपयोग किया जाता है जिसमें, रिएंफोर्समेंट केज को भूमि पर ही जोड़ा जाता है तत्पश्चात, संपूर्ण केज को उच्च क्षमता वाली क्रेन की सहायता से उठाकर पीयर टॉप पर रख दिया जाता है तथा बडी मात्रा में कंक्रीटिंग (Large pour concrete) की जाती है। इस तरह के नवीन निर्माण के तरीके से कार्य अवधि में परंपरागत विधि की तुलना में तथा पूर्ण संरक्षा अभिकल्प तथा गुणवत्ता मानकों को सुनिश्चित करते हुए लगभग 30 दिन तक की बचत की जा सकती हैं।

डीएफसीसीआईएल जैसी परियोजनाओं में, कंक्रीट स्लीपरों का घरेलू उत्पादन महत्वपूर्ण हो जाता है जिससे कि स्लीपरों की निर्बाध आपूर्ति सुनिश्चित की जा सकती है। विभिन्न घटकों जैसे कंक्रीट आई–गर्डर के भिन्न–भिन्न आकार, सीमित ऊँचाई के सब–वे घटकों, रेन वाटर हार्वेस्टिंग घटकों, रिटेनिंग वॉल घटकों, कंक्रीट नाली घटक आदि की पूर्व–कास्टिंग विभिन्न गतिविधियों के कार्यों में तेजी लाने में क्रांतिकारी परिवर्तन सिद्ध हुए है।

जैसे ही फार्मेशन तैयार होता है, वैसे ही तेजी से रेलपथ बिछाने का कार्य अत्यंत महत्वपूर्ण हो जाता है क्योंकि पूर्व में ये एक श्रम आधारित गतिविधि थी जो कि बेहद धीमी तथा निर्धारित मापदण्डों से निम्न स्तरीय होने जैसे दोषों से युक्त थी। डीएफसीसीआईएल में, रेलपथ निर्माण के विशेष उपकरणों का उपयोग किया गया है। जो कि उच्च आरंभिक रेलपथ बिछाने के मापदंडों को सुनिश्चित करते हुए 1.5 ट्रैक केएम प्रतिदिन रेल बिछाने में सक्षम है। मेरा यह दृढ़ विचार है कि इस प्रकार का ऑटोमेशन नयी निर्माण परियोजनाओं के लिए आवश्यक है जो न केवल तेजी से निर्माण कार्य निष्पादन को सहज बना देता है बल्कि रख–रखाव प्रयासों को, उच्च प्रारंभिक रेलपथ मापदंडों द्वारा परिभाषित किए जाने के फलस्वरूप, किफायती बना देता है।

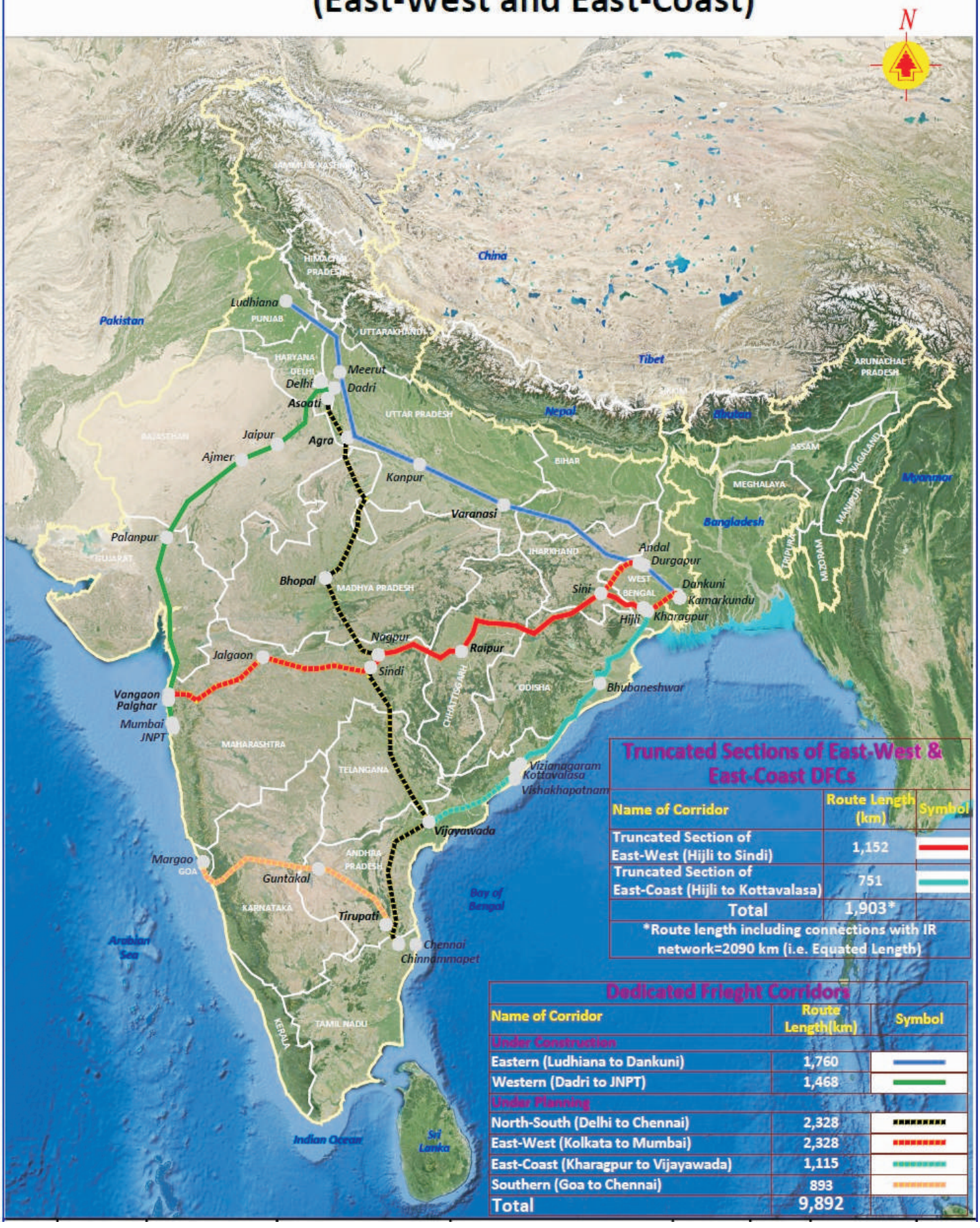
जब विशेष उपकरणों के साथ एक बार ट्रैक बिछा दिया जाता है, तो इसके पश्चात एल.डब्ल्यू.आर / सी.डब्ल्यू.आर की स्थापना एक और बहुत महत्वपूर्ण गतिविधि है। डीएफसीसीआईएल ने लंबे पैनल वाले रेलों के डिस्ट्रेसिंग के लिए 160 टन के सुपर पुलर के साथ उन्नत ऑन–साइट फ्लैश बट वेल्डिंग मशीन को उपयोग में लिया है। उपरोक्त उपकरण डेटा लोगर के साथ है जो वेल्डिंग और डिस्ट्रेसिंग की गतिविधियों के प्रत्येक और हर पैरामीटर को रिकॉर्ड करता है जिसके माध्यम से किसी भी दोष / असंगतता, यदि कोई हो, का पता लगाया जा सकता है और सुधारात्मक कार्रवाई की जा सकती है।

रेलवे के बुनियादी ढांचे में एक और महत्वपूर्ण गतिविधि ओवर हेड उपकरणों की स्थापना है, जिसमें विभिन्न गतिविधियाँ शामिल हैं जैसे कि मास्ट इंस्टॉलेशन, केन्टिलवर इंस्टॉलेशन और इसके समायोजन तथा कैटेनरी और कांटेक्ट तारों की वायरिंग। डीएफसीसीआईएल ने विभिन्न आधुनिक तरीकों और प्रौद्योगिकी को अपनाया है जैसे कि ओएचई की स्व–चालित औगरिंग, मास्ट फाउंडेशन, मास्ट ग्रैबर, फाउंडेशन कंक्रीटिंग के लिए कंक्रीट ट्रेन, कैंटिलीवर इंस्टॉलेशन और इसके समायोजन तथा एक पूर्ण स्वचालित वाइरिंग ट्रेन के लिए रेल–कम–रोड उन्नत मशीनरी। इसके परिणामस्वरूप, उच्च गुणवत्ता और संरक्षा मानकों को सुनिश्चित करते हुए ओएचई स्थापना के कार्य में 6 ट्रैक किमी. प्रतिदिन की प्रगति हुई है।

मेरी राय में, उपर्युक्त विभिन्न तकनीकों को अपनाने से निर्माण कार्यों में तेजी के साथ–साथ उच्च संरक्षा गुणवत्ता मानकों को बनाए रखने में सफलता को सुनिश्चित करते हुए परियोजना पूर्ण करने की कुल अवधि को कम किया जा सकता है।

योगदानः प्रवीण कुमार, समूह महाप्रबंधक / प्रापण / पश्चिमी कोरीडोर

Truncated Sections of Dedicated Freight Corridors (East-West and East-Coast)



Truncated Sections of East-West & East-Coast DFCs

Name of Corridor	Route Length (km)	Symbol
Truncated Section of East-West (Hijli to Sindi)	1,152	
Truncated Section of East-Coast (Hijli to Kottavalasa)	751	
Total	1,903*	

*Route length including connections with IR network=2090 km (i.e. Equated Length)

Dedicated Frieght Corridors

Name of Corridor	Route Length(km)	Symbol
Under Construction		
Eastern (Ludhiana to Dankuni)	1,760	
Western (Dadri to JNPT)	1,468	
Under Planning		
North-South (Delhi to Chennai)	2,328	
East-West (Kolkata to Mumbai)	2,328	
East-Coast (Kharagpur to Vijayawada)	1,115	
Southern (Goa to Chennai)	893	
Total	9,892	

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डेडीकेटेड फ्रेट कारीडोर कारपोरेशन ऑफ इंडिया लि.

Dedicated Freight Corridor Corporation of India Limited

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