The DFCCIL JOURNAL

ISSUE IV, SEPTEMBER 2019

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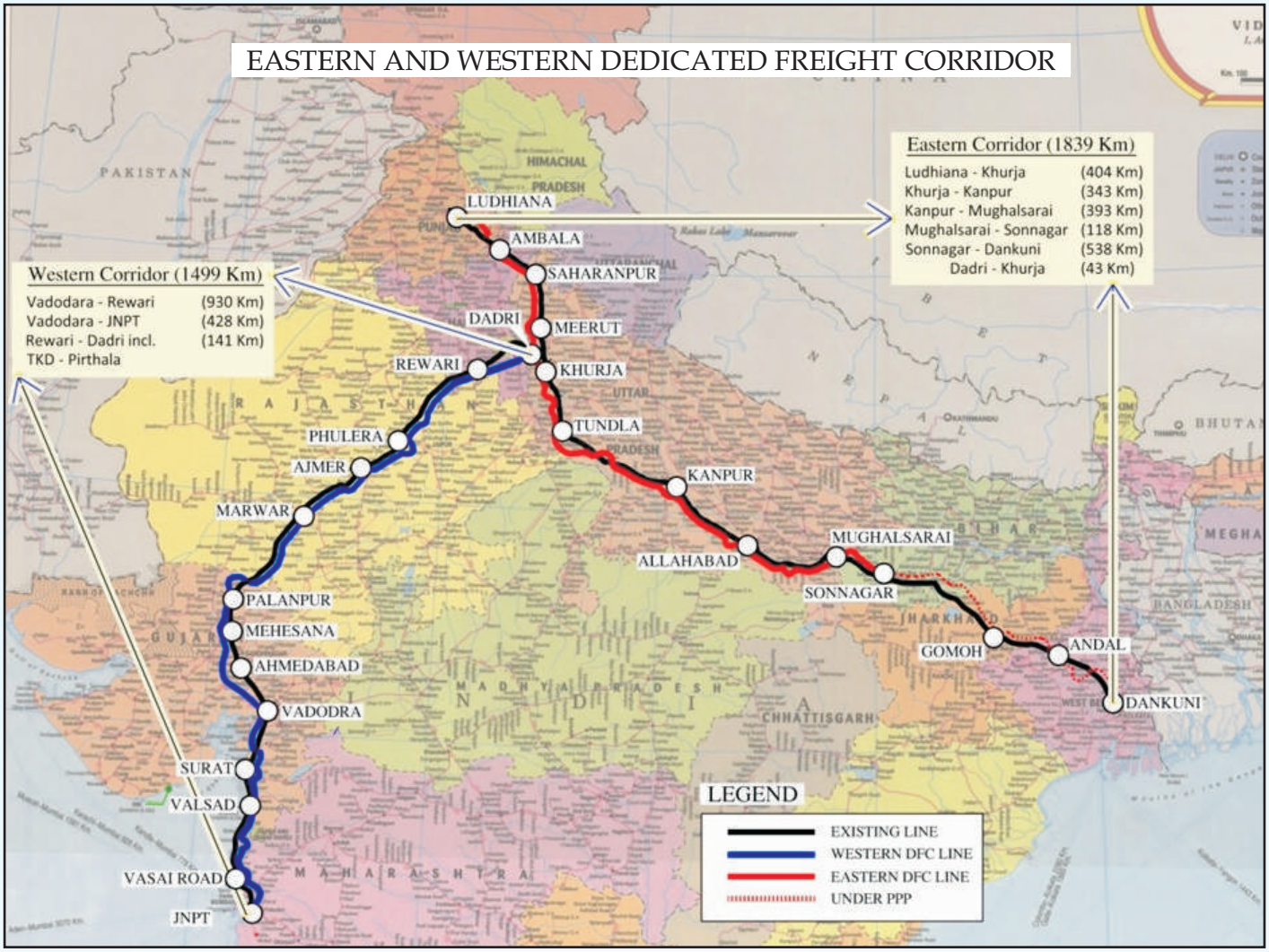


Targets

Western Corridor

SN	Sections	Targets
1.	Ateli-Phulera (190 Km)	August – 2018 (completed)
2.	Rewari-Madar (306 Km)	December – 2018 (completed)
3.	Madar-Palanpur (335 Km)	March – 2020
4.	Entire WDFC	2021

Eastern Corridor

SN	Sections	Targets
1.	Khurja-Bhadan (200 Km)	November – 2018 (completed)
2.	Bhadan-Bhaupur (143 Km)	November – 2019
3.	Bhaupur-Mughalsarai (402 Km)	December – 2020
4.	Entire EDFC	2021

Anurag Kumar Sachan
Managing Director, DFCCIL

FROM THE EDITOR's DESK

After a grand success and overwhelming response to our earlier publication of three issues of the periodical "DFCCIL Journal" in Dec 2018, March 2019 and June 2019, I feel privileged and proud in communicating with all the employees and stakeholders through the publication of periodical "DFCCIL Journal"-Issue-IV, September 2019, on quarterly basis, the official mouthpiece of DFCCIL.

It is very satisfying that in the month of September, Freight operations saw a big development. DFCCIL has successfully completed the trial run of a Heavy Haul Train comprising a total of 103 wagons on Eastern Dedicated Freight Corridors (EDFC) 194 Km long Bhadan – Khurja section. The wagons of the Heavy Haul Train carried finished steel and coal weighing approximately 9,000 tons. With the successful trial run of the Heavy Haul Train on EDFC corridor, the count down for commercial run has gathered momentum.

It's a matter of pride for DFCCIL that, on 09-09-2019, University of Wollongong (UoW), Australia signed a Memorandum of Understanding (MOU) to establish a mutually beneficial collaboration with DFCCIL, paving the way for a wide range of research, teaching and consultation activities. With this, DFCCIL has officially recognised the key role of UoW in meeting India's urgent need for additional rail freight transport capacity.

DFCCIL has also achieved an important milestone by charging the first traction sub-station (TSS) of 63 MVA (Mega Volt Ampere) at Biruni near Tundla on the Khurja-Bhaupur section of Eastern Dedicated Freight Corridor (EDFC). Along with this, 2x25Kv overhead equipment (OHE) from Biruni to Dariyapur of a length of 66 Kms. has been charged. This is an important milestone which will pave the way for operation of freight trains pulled by electric locomotives on that section.

It gives me an immense pleasure that DFCCIL Stall at the 64th Railway National Function & Exhibition-cum-Rail Mela 2019 at Ambala was adjudged as the best stall.

In this current DFCCIL Journal, we bring to our readers well researched, & suitably illustrated (with quality Pictures & Diagrams), informative Articles across a wide range of interesting subjects like Train Protection and Warning System, Turnouts, Mechanisation in Electrification work, Enhanced GIS based Project Management Information, NTC working, Survey, Design and Setting out of Alignment. I sincerely hope that you would find the DFCCIL Journal-IV, intellectually stimulating.

This publication includes very useful articles and case studies which will definitely inspire Engineers and Professionals alike and enrich them with fruitful knowledge and information. I wish that the DFCCIL team will continue to share rich repository of knowledge amongst Engineers, academicians, professionals etc. by publication of "The DFCCIL Journal".

Enjoy reading.

Anurag Kumar Sachan
Managing Director, DFCCIL

CONTENTS

Trial run of a Heavy Haul Train comprising of 103 Wagons on EDFC

Front cover picture

Trial run of Electrified Sections between New Bhadan to New Khurja of EDFC

Back cover picture

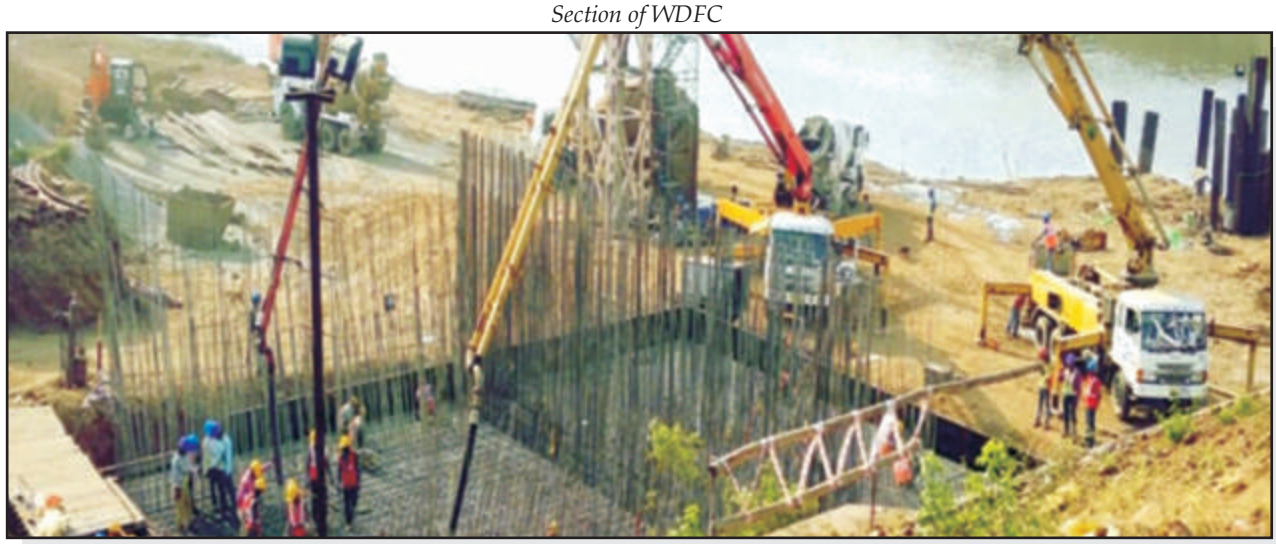
ISSUE IV, SEPTEMBER 2019

PHOTO

View of Yard at Station 'New Daudkhan' in 'Bhadan-Khurja' section.

Construction of Traction Sub-station building at Station Karanjade near Panvel

Painting of RFO Girder of Bridge no-136 in Rewari-Dadri Section of WDFC



Concreting in progress for well cap of Abutment (A2) at Bridge No. 60 on River Par

GALLERY

Curing of the Pier Cap of Bridge No. 19 over Damanganga

CTP-13: Soil Testing Laboratory set up by contractor in WDFC

Construction work in progress at Bridge No. 240 on River Tapi

CTP-14: Construction work in progress at Viaduct No. 92

CTP-14: Tunnel work in progress

Pre-tamping survey using Survey trolley and Design Mode tamping using Absolute Profile on DFC Corridors

ABSTRACT

On Indian Railways the measurement and correction of track geometry has been traditionally done through relative measurements through overlapping chords of varying lengths. With the induction of tamping machines, the geometry correction graduated to tamping in smoothening mode where the defects in track geometry are made less pronounced by distribution them over the adjacent lengths. In course of time this was improved to measurement of pre tamping track geometry through surveying instruments and running a surfacing or realignment computer programmes to determine the slews and lifts, which were marked on sleepers and necessary corrections were achieved using track tamping machine. Recent advances in the field of survey equipment have made it possible to generate the absolute profiles using Electronic measuring devices like Total Stations and Differential Global positioning systems (DGPS). Such absolute profile once generated can be used as permanent reference for giving maintenance corrections using combination of equipment and machines like survey trolleys, Electronic Distance measuring equipment and track tamping machines with compatible software. These simple solutions provide a comprehensive and reliable data for all times with reduced time of possession of track. This paper describes the laying of track using GPS co-ordinates and correction of alignment through a pre-tamping survey using Survey trolley which generates the feed for tamping machine for progressive correction the laid track geometry in two or three tamping cycles.

Atul B Khare
CGM/TDL/DFCCIL

Survey System

On Bhaupur-Khurja section the track is laid by mechanised means using a New track construction machine (NTC). A Trimble survey trolley and associated tool sare used for measurement, recording, analysis and rectification of track geometry during construction. It produces high accuracy "Absolute

Position of Rail" and "Relative Track Geometry" to sub 5mm precision using optical instruments. Hardware and software specially tailored for railway tasksstreamlines work in the field and office. The system includes the following:

a) Trimble Trolley: One or two rail mounted trolleys can be used for measurement of pre-tamping profile of laid track. These trolleys have a gas pressurized gauge sensor to measure gauge, a calibrated inclination censor to measure cant, a positive braking system, and an internal 2.4 GHz radio communication system. The trolleys can be adapted to work with different gauges, are light weight (20kg) and can be easily removed from the track to stay clear of tamping machines, construction equipment and moving trains. When two trolleys are used the instrument trolley has a high precision 1" total station mounted on an adjustable levelling tribrach and the prism trolley has a handle mounted Trimble controller unit and a Trimble track prism. The controller unit displays real time comparison of measured data to design while walking with the trolley.

b) Tamping Machine with compatible software which takes the slews and lifts from controller unit of survey trolley and use it on the tamping machine to bring the initially laid track to desired absolute profile progressively in two or three tamping cycles.

Fig -Trolleys- One with robotic total station and other with prism and controller unit

Fig- Controller Unit

The system produces absolute and relative geometry by measuring to a high precision control network established close to the track at intervals of 150 to 200m. The control network achieves not only the initial project quality requirements but also a legacy tying in absolute track geometry for future maintenance giving the Railway a much more sustainable network and asset longevity.

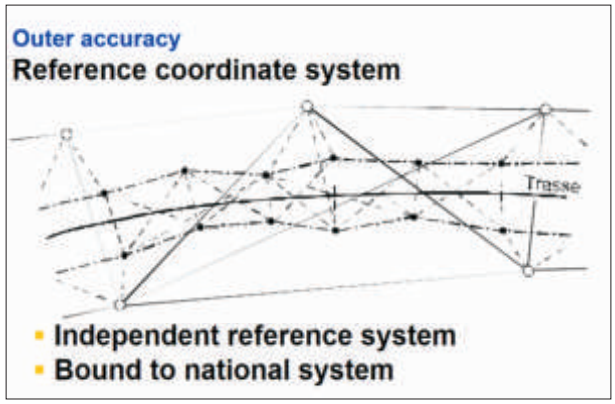
Establishing Control Network

Topographic Survey is an essential preliminary step for civil engineering design and construction works. The topographic surveys are carried out from whole to part to establish horizontal and vertical control over proposed project site. The Bhaupur- Khurja project spreads over 350 km in length and following surveys were carried out to establish the reference points:

- Differential Global Positioning System (DGPS) Survey using DGPS instruments and conversion to Cartesian co-ordinates using WGS84 system
- Horizontal Traversing between established GPS points to transfer co-ordinates to control points at 200m interval
- Vertical traverse to connect to Grand Trunk Survey (GTS) Bench marks around the site and transfer of level to the control points at 200m interval
- Topographical ground/land survey by triangulation traverse using "Total Electronic Station" instruments and contour map along the entire length of the alignment

With the said surveys, the Design alignment of track is produced in XML format with X, Y and Z co-ordinates.

This alignment is fed into total station of survey trolley as target alignment.



Pre-Tamping Measurements

The measurement of Pre-tamping profile can either be undertaken using either two or one trolley.

a) Two Trolley Measurements

In this system two trolleys are used. The instrument trolley has a high precision 1" total station mounted on an adjustable levelling tribrach and the prism trolley has a handle mounted Trimble controller unit and a Trimble track prism. The controller unit displays real time comparison of measured alignment to design while walking with the trolley.

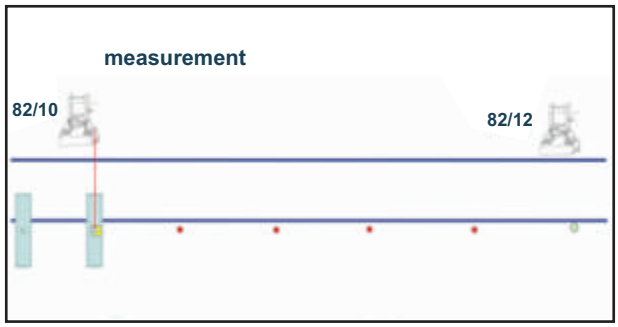


Fig: Measurement to first control point

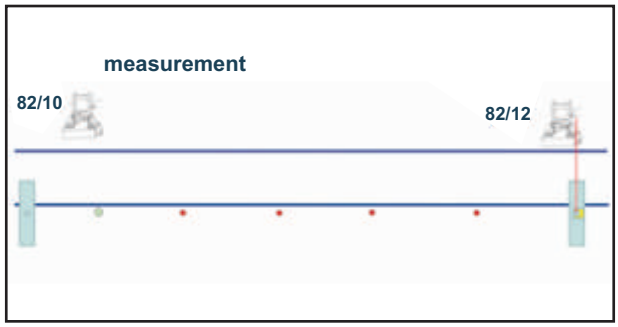


Fig: Measurement to second control point

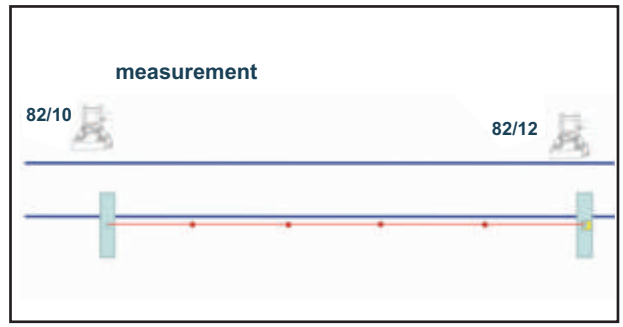


Fig: Measurement of alignment by moving prism trolley

The instrument trolley mounted with total station instrument is positioned and locked, using the braking system, perpendicular to a control station and takes a measurement to a prism held on the control station. It is then pushed up to the next control station, positioned and locked, and a measurement taken to the control station as before. The prism trolley is then positioned and locked perpendicular to the first control station and a measurement taken to it by the instrument to define the long chord. The prism trolley is then pushed towards the instrument trolley and the total station measures the co-ordinates continuously, recording them at predetermined interval of normally 5 meter. While the prism trolley is being pushed the Controller unit, containing preloaded alignment files, displays real time comparison to design, chainage, uplift on left and right rail, slew values, gauge, cant and main alignment points for marking and synchronization of tamping machines.

b) Single Trolley Measurements

In this measurement, the robotic total station is positioned by the side of track. Measurements are taken at least on three control points to obtain thepositionof instrument through resection. The measuring trolley with Controller unit and prism is moved on the track for about 150 m. The robotic total station consciously moves around its vertical axis sighting the prism on measurement trolley and records measurements at pre-determined interval which is generally 5 m. While the prism trolley is being pushed the Controller unit, containing preloaded alignment files, displays real time comparison to design, chainage, uplift on left and right rail, slew values, gauge, cant and main alignment points for marking and synchronization of tamping machines.

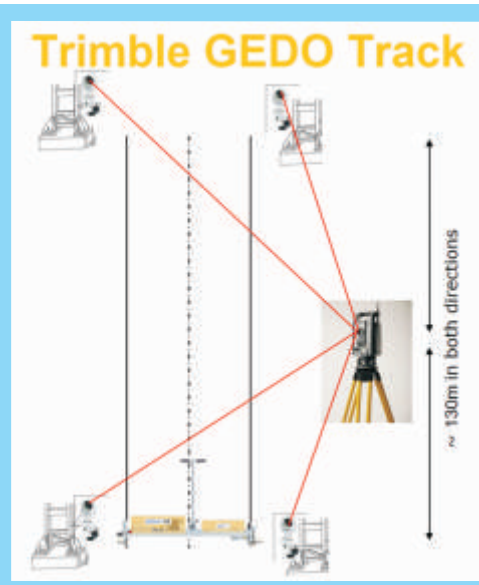


Fig: Measurements with Single trolley

The two trolley measurements are recommended for speed and accuracy, as some time is wasted in resection after every 150 m when one trolley is used.

Output

The measured data through trolleys is downloaded to the desktop computer and processed through a software to generate the following output:

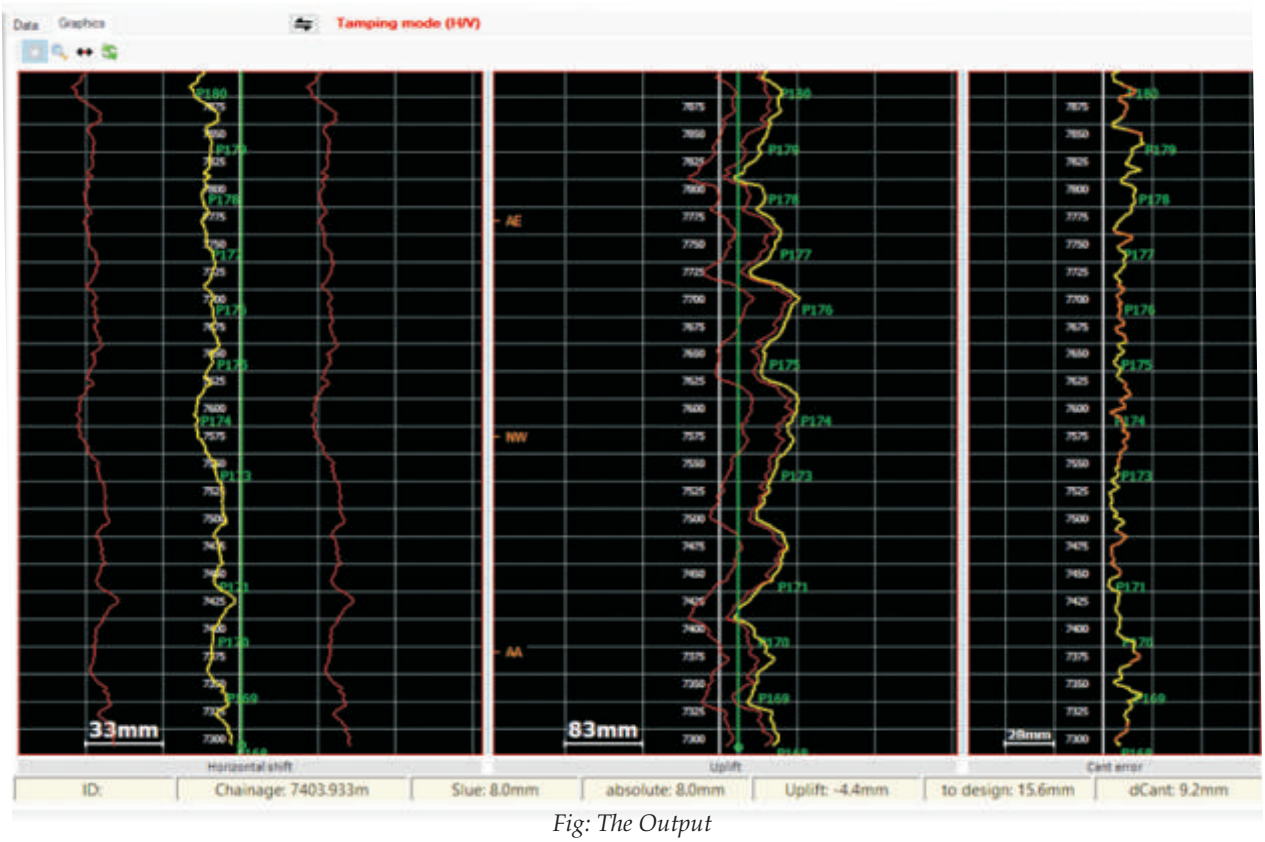


Fig: The Output

This output in further processed to ALC format and transferred to tamping machine for design mode tamping. The following are the pre and post tamping parameters of track:

	Design Data				Measured Pre-Tamping data				
CH	Des. Eastimg	Des. Northing	Des. Elevation	Des. Cant	Meas. Elev Left	Meas Ref Right	Meas. Cant	Lateral (m)	Twist
12663.413	205498.285	3089128.133	193.518	0	193.418	193.411	0.007	-0.016	-0.002
12668.545	205499.1	3089133.201	193.529	0	193.433	193.423	0.011	-0.016	-0.002
12673.913	205499.952	3089138.501	193.541	0	193.439	193.434	0.005	-0.021	0.003
12679.277	205500.804	3089143.797	193.554	0	193.455	193.453	0.002	-0.018	0.002
12684.621	205501.653	3089149.073	193.566	0	193.481	193.477	0.005	-0.01	-0.002
12689.959	205502.5	3089154.343	193.578	0	193.488	193.483	0.005	0.006	0
12695.278	205503.345	3089159.595	193.59	0	193.489	193.475	0.014	-0.015	-0.005
12700.562	205504.184	3089164.812	193.601	0	193.496	193.491	0.005	-0.031	0.005

	Design Data				Measured Post-Tamping Data					
CH	Des. Eastimg	Des. Northing	Des. Elevation	Des. Cant	Meas. Elev Left	Meas Ref Right	Meas. Cant	Lateral (m)	Twist	Mease Gauge
12663.413	205498.285	3089128.133	193.518	0	193.434	193.424	0.01	-0.008	-0.001	1.678
12668.545	205499.1	3089133.201	193.529	0	193.445	193.438	0.007	-0.008	0.002	1.676
12673.913	205499.952	3089138.501	193.541	0	193.459	193.451	0.008	-0.008	0	1.676
12679.277	205500.804	3089143.797	193.554	0	193.475	193.468	0.007	-0.01	0	1.677
12684.621	205501.653	3089149.073	193.566	0	193.485	193.48	0.005	-0.012	0.001	1.677
12689.959	205502.5	3089154.343	193.578	0	193.494	193.488	0.006	-0.014	0	1.677
12695.278	205503.345	3089159.595	193.59	0	193.51	193.5	0.01	-0.013	-0.002	1.678
12700.562	205504.184	3089164.812	193.601	0	193.522	193.512	0.01	-0.015	0	1.679

Key Benefits

The following are the key benefits of using the survey system:

- Light weight (20kg) and easily removed from track in less than ten seconds.
- Reduced tamping time and costs with rapid delivery of data to the tamping machine.
- Reduced track downtime for construction and maintenance.
- 3D track co-ordinates of track captured in a single operation.
- Self-contained trolley provide flexibility and reliable results.
- Permanent repository of track alignment can be created for maintenance corrections.
- Reduced tamping efforts by effective utilisation of tampers.

Conclusion

There is need for full mechanisation of track laying to achieve consistent quality and efficiency. The initial quality of laying of track determines not only its life but also affects the frequency of maintenance interventions. With the routes getting saturated the track possession is becoming increasingly challenging for the maintenance Engineers. Through measurement of absolute profiles and using design mode tamping the maintenance inputs can be delayed. Further absolute track geometry provides a permanent reference for future maintenance giving the Railway a much more sustainable network and asset longevity. These operations demands precise measurements of track geometry. The survey trolleys are cost effective and easy to implement solutions for such needs.

Pioneering Train Protection and Warning System (TPWS) for Freight Trains on WDFC

Madhusudan
GGM/S&T/MC-I

ABSTRACT

Western Dedicated Freight Corridor (WDFC) will be providing Train Protection and Warning systems (TPWS) on its Network. Spread over 1502 Route Kms, this will become one of the biggest implementation of the TPWS specifications in the world. The TPWS system which is similar to the ETCS-1 system of ERTMS solution and is further augmented by provision of Infill Balises for quicker updating of the Signaling information. TPWS on WDFC will be the first of its kind designed to meet trailing load requirementsranging from 6650T to 13000T/15000T.it is heartening to note that the Balise cable with drum length of 3.5 kms is being developed indigenously. Type tests for Track side Equipment (Balise and LEU) have been completed in Japan. Field installation is in progress. On Board design near finalization. This paper also covers the Interoperability aspect of ETCS 1 and ETCS 2 systems. When the system is completed, TPWS on WDFC will be first of its kind both in magnitude and Design spread.

Train Protection and Warning System (TPWS) is one of the Automatic Train Protection system, being implemented in Indian Railways, based on European technology called ERTMS with including functionalities suiting to train operations in Indian conditions.

What is ERTMS?

The European Rail Traffic Management System (ERTMS) is a European cab-based signalling and train control system that offers significant capacity through more efficient traffic management and performance benefits, as well as further enhancing safety beyond the capability of legacy ATP systems. ERTMS includes two basic components:

- ETCS, the European Train Control System, which makes it possible not only to transmit permitted speed and movement authority information to the train driver but also to monitor constantly the driver's compliance with these instructions
- GSM-R based on standard GSM (900MHz) but using frequencies specific to rail as well as certain advanced functions. It is the digital radio system used for exchanging voice and data information between the track and the train.

Brief History of ERTMS

- Following the decision taken by the European Transport minister in December 1989, the EC embarked upon a project to analyse the problems relating to signaling and train control.
- The project framework included a new on-board equipment based on open computer architecture (EUROCAB), a new discontinuous system for data transmission, (EUROBALISE) and a new continuous transmission system (EURORADIO).
- At the end of 1993, the EU council issued an Interoperability Directive and a decision was taken to create a structure to define the Technical Specification for Interoperability.
- At the beginning of the 4th Framework Programme, in 1995, the EC defined a global strategy which described a "Master Plan of Activities" describing the development and validation phase with the objective of performing full scale tests on sites located in different countries (France, Germany and Italy).
- In the summer of 1998, UNISIG, comprising of six European Signaling companies was formed to

finalise the specifications. With the final signature on ERTMS specification, Class 1, on 25th April 2000, ERTMS has finally arrived providing substantially higher performance levels for the railways.

Objectives of ETCS

- Higher Line Capacity is achieved through higher speed and greater train density. This imposes a demand to maintain at least the same level of safety.
- The primary objective of ETCS is to support this increase in Line Capacity by providing additional safety support on top of the existing system.
- ETCS ensures safety of the train with its ability to apply the brake in a reasonable time before a hazard. This is done by continuous supervision of speed and distance.
- This is accomplished by allowing the train to move within a speed profile derived from
  - ➢ Train data – braking capacity, brake type, train length etc.
  - ➢ Line data – signal aspect with corresponding movement authority, gradient, adhesion condition etc.

Why the need of ERTMS / ETCS?

Assists Railway Operators to meet their safety and modernisation goals by

– Providing a safety protection mechanism against reduced headway of the trains for increasing line capacity

– Eliminating human errors leading to:
  - Signals passed at danger
  - Over speeding

The advantages are,

– Enhanced Safety beyond the capability of legacy ATP

– Significant capacity improvement with reduced headway

– Providing a widely accepted standard

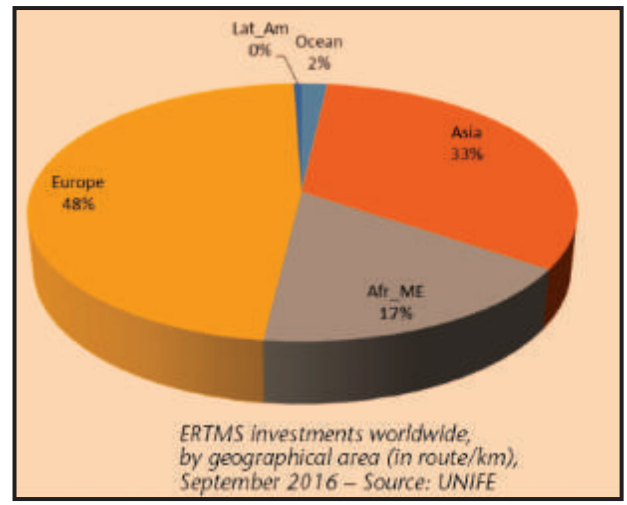
– Accommodating multiple vendors and interoperability

– Providing a robust platform for technology upgradation in future

– Permitting customisation to meet Indian Railway's needs

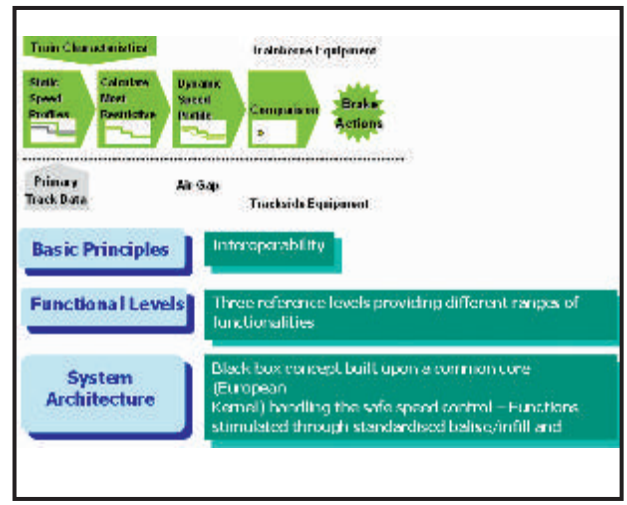
Worldwide Deployment of ERTMS

ERTMS investments outside Europe represent more than 50% of the global ERTMS investment worldwide. Countries such as diverse as South Korea, Saudi Arabia, the Unites Arab Emirates, China, Taiwan, Libya, Indonesia, Malaysia, New Zealand, Australia, Kazakhstan, Turkey, Algeria, Morocco, Brazil, Mexico, Chile and India have all launched major investments program to install ERTMS on their railway networks, Other major countries such as Argentina, and even USA are also showing an interest in this technology, with several pilot lines planned in different countries.



ERTMS investments worldwide, by geographical area (in route/km), September 2016 – Source: UNIFE

ERTMS Concepts



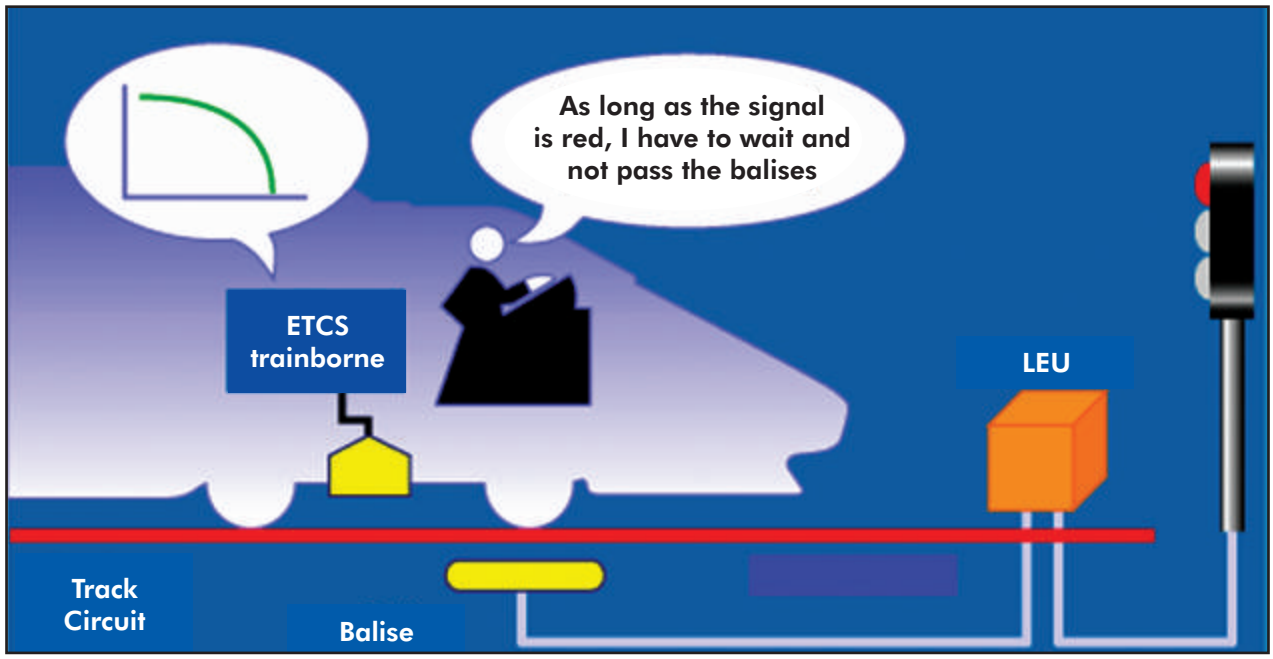
The ERTMS Levels

LEVEL	TRACK SIDE	ON BOARD
Level 1	• ERTMS system superposed with the line side signalling • Authorisation to run given by the beacons / balises on the track side	• Continuous control of the speed with intermittent transmission
Level 2	• Authorisation to run given by Radio • Balises used for location referencing • Line side signals can be suppressed	• Continuous control of the speed with continuous transmission
Level 3	• Authorisation to run given by Radio • Possibility of moving block sectioning • Absence of track circuits	• Continuous control of the speed with continuous transmission • Self-train location • Train integrity

Basic Functionalities of ERTMS Level 1

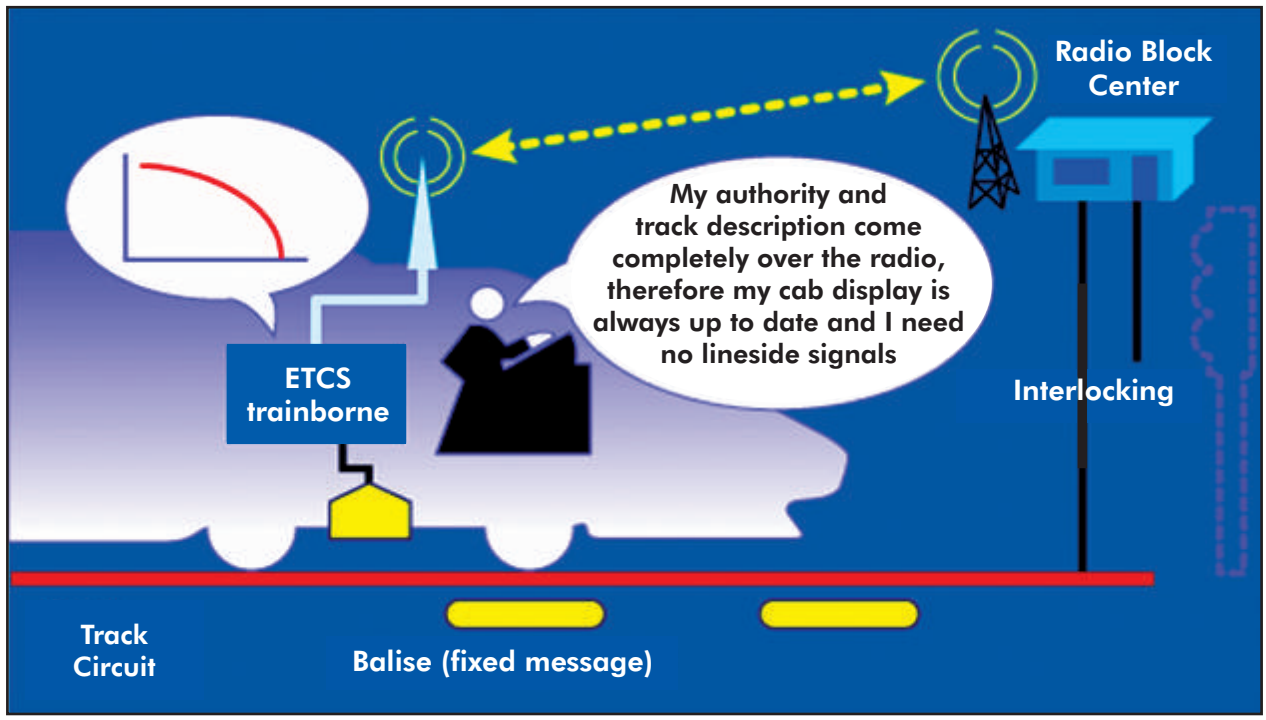
- In a 'fixed block' system, each train runs within its own exclusive section of track, demarcated by lineside signals.
- Level1 is the simplest form, consisting of trackside equipment which 'reads' the signals and passes this information to the train via track-mounted transponders (balise and radio infill). This enables an on-board computer to determine the train's limit of movement authority and supervise the speed.
- Its main features are:
  - ➢ Possible Overlay to a pre-existing signalling system
  - ➢ Movement Authorities and position reference through Eurobalise.
  - ➢ Train Integrity & Position by Track Circuit.

Characteristics of ERTMS Level-1



- Level-2 is also a fixed block system and as with Level 1, provides full Automatic Train Protection. The difference is the use of radio to connect the on-train computer with signalling centres. The radio system chosen for the European Railways is GSM-R, in the 900 MHz frequency band.
- A continuous stream of data informs the driver of traffic and signals status on the route ahead, allowing the train to reach its maximum speed within its block while maintaining safe braking distance.
- Track based detection systems are maintained but lineside signals are optional, though may be retained for 'fallback operation'. Eurobalise normally provides fixed information such as position reference.
- Its main features are:
  - Conventional train detection supports train detection, interlocking and automatic block functions
  - Movement Authorities are provided through GSM-R
  - Train Position is calculated on-board from Eurobalise information
  - Trackside optical signals can be minimised or eliminated (subject to operating rules)

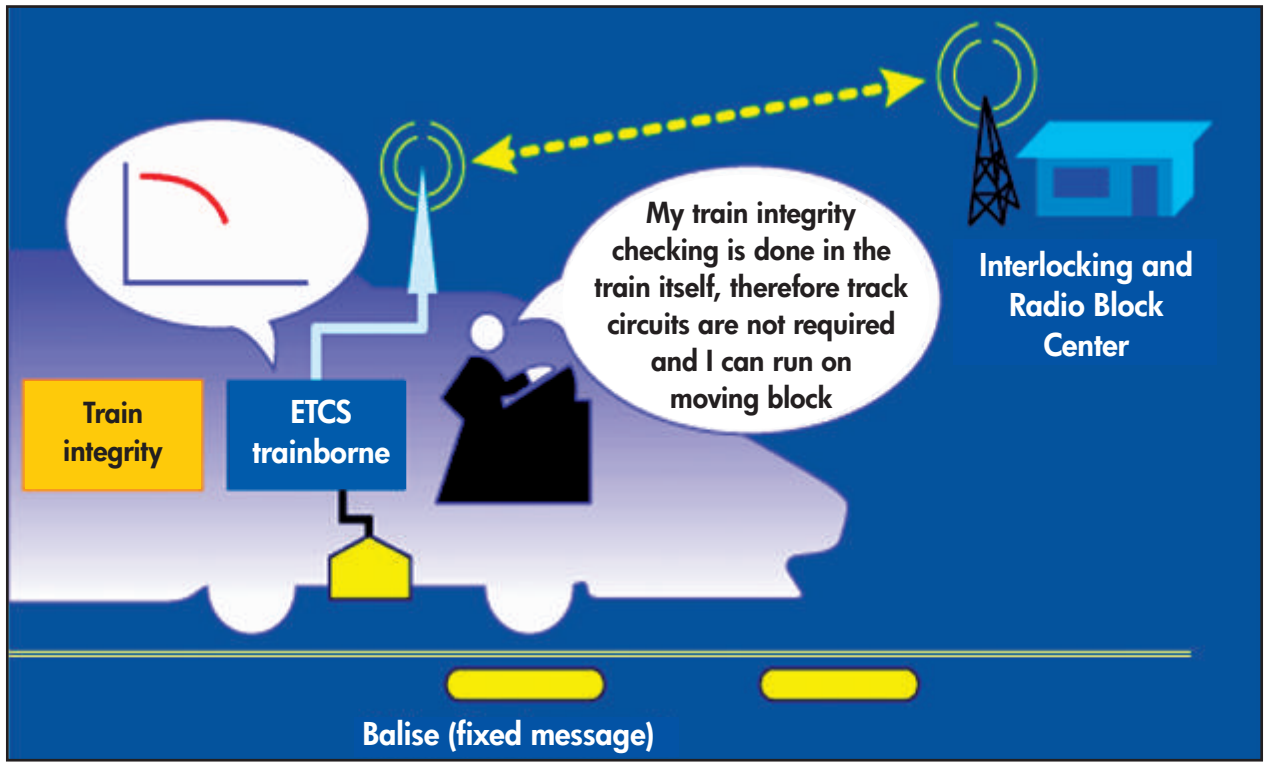
Characteristics of ERTMS Level-2 with Eurobalise + Euroradio (GSM-R) + Radio Block Center



Basic Functionalities of ERTMS Level-3

- Accurate and continuous position data is supplied to the control centre directly by the train, rather than by track based detection equipment.
- At this Level there are no trackside signals, and the train driver views all speed and signalling information on in-cab monitors only.
- Level 3 systems need not involve fixed blocks, but could instead operate on a 'moving block' principle.
- Train position through GPS

Characteristics of ERTMS Level-3 - Futuristic



Implementation of ERTMS in Indian environment

What is TPWS?

TPWS-Train Protection and Warning System. Colloquialism used by Indian Railways.

- It applies to the ERTMS Level 1 concepts and the UIC/UNISIG specifications
- Meets ERTMS/ETCS specification
- SUBSET-026-v2.3.0d for SRS

TPWS implementation in Indian Railways

1. Southern Railway

Section	:	Chennai Central - Gummidipoondi
ERTMS Level	:	1
Total Track Length	:	104 Kms.
No. of Trains	:	42
Supplier	:	ANSALDO STS

2. Northern & North Central Railway

Section	:	New Delhi - Agra
ERTMS Level	:	1
Total Track Length	:	384 Kms.
No. of Trains	:	35
Supplier	:	ANSALDO STS

3. Kolkata Metro

ERTMS Level	:	1
Total Track Length	:	23 Kms.
No. of Trains	:	35
Supplier	:	SIEMENS

4. Southern Railway

Section	:	Chennai – Arakkonam
ERTMS Level	:	1
Total Track Length	:	132 Kms.
Supplier	:	THALES

Challenges faced during TPWS implementation in Indian Railways

Indian Railways while implementing TPWS in their Mainlines and suburban sections, have faced lot of challenges to adopt the system in Indian operating conditions. However, through the team work and collective efforts by Technical experts from OEMs, Application Engineers from India and the technical

officials of India Railways, TPWS was implemented successfully in Indian operating conditions. Few of the challenges experienced by Indian team and the solutions found thereof, are described below.

- **Odometry**

Most of the failures were of intermittent nature coming from disturbances in odometry signal lines. Extensive trials by creating track slippery conditions were carried out to fine tune the slip / slide parameters. Also to mitigate the misalignment between train axle and speed sensor shaft, a flexible coupling (made of elastomeric material) was introduced.

In the case of Kolkata Metro project, the speed sensor is installed on trailer coach axle ends to ensure the safe operation of odometry system.

- **EMI / EMC**

The nature of Electro-magnetic Interference (EMI) in Indian locomotives are very high compared to European locomotives and so a detailed EMI assessment was undertaken to mitigate the interferences by introducing shielding of cables, earthing of car body with the bogie etc.

- **Back EMF from inductive loads**

It was found that the back emf from the brake valves and application relay coils were very high. These issues were resolved by incorporating freewheeling diodes.

Brake Interface Unit

Separate brake interface unit was developed by the brake system supplies to interface TPWS brake commands with E70 Brake system on WAP5 and WAP7 locomotives.

With this brake interface, the loco pilot can apply more intensive brake during service brake application by TPWS and also the problem of extensive speed reduction during TPWS service brake application was eliminated.

Space availability for Onboard equipment

As TPWS onboard equipment is installed as retrofit basis, only limited space are available for TPWS fitment there is a necessity for splitting the onboard cabinet to suit the space.

- **Temperature**

Ambient conditions in India have provided a number of challenges compared to Europe. Issues have been identified and engineering solution like double wall arrangement for the trackside location boxes for better ventilation and cooling.

- **Trackside Power supply**

Due to BROWN Out of input power, there were interruptions in the internal power supply of LEU. Capacitor based power supply was introduced to resolve this momentary power interruption problem.

TPWS Implementation in Western Dedicated Freight Corridor

Scope of TPWS

The Western Dedicated Freight Corridor (WDFC) TPWS Project comprises Approx. 1337 Kms. of double line 2 x 25KV AC Overhead electrified railway between Rewari and JNPT. The total 1337 Kms. line trackside system will be commissioned in 2 phases.

Phase 1

From Rewari to Makarpura covering 31 stations and 30 block sections

Phase 2

From Makarpura to JNPT covering 12 stations and 12 block sections

TPWS Onboard system will be installed on 120 locomotives in Phase 1 and 80 locomotives in Phase 2

Uniqueness of TPWS in WDFC

System Configuration

- TPWS is equipped for Freight locomotives for the first time in India aiming at safe, Reliable operations and effective utilization of infrastructure.
- TPWS is being implemented in 1.5 Kms. long haul freight trains with heaviest trailing load (15000T).
- LEUs are located at centralized location and balises are driven upto 3.5 Kms. distance.

Functional

- Interoperable with existing TPWS on IR.

Installation

- Onboard TPWS system will be installed at OEM premises itself by Loco builder.
- 3.5 Kms. long balise cables are passing through bridges and culverts.

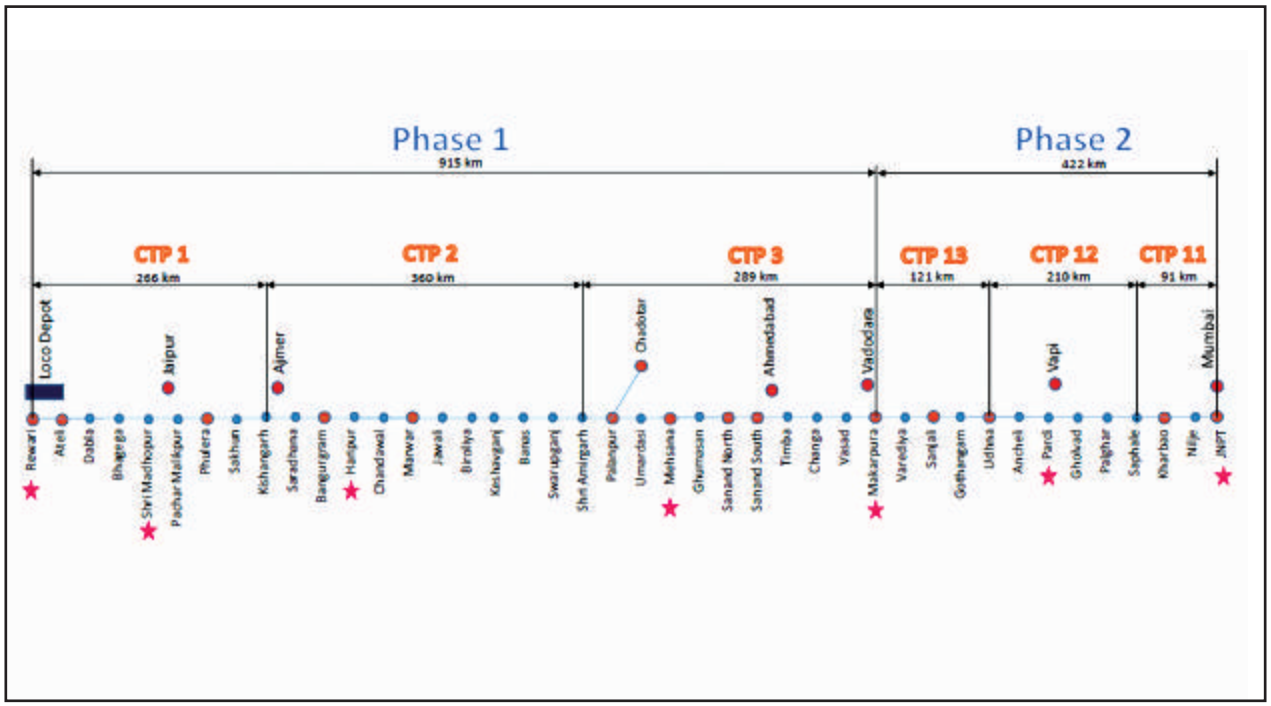
Maintenance:

- Remote health monitoring of LEUs through TMS which will enhance the maintenance capability.

Additional features:

- Stop in Shunting - TPWS on-board equipment will apply emergency brake to stop the train when passing the defined border of the shunting area (e.g., Block Section Limit Board).
- Overrun Protection – This function will stop the train when entering into the overrun section by applying emergency brake and prevents the train hitting the buffer stop.

WDFC Section Detail



SYSTEM DESCRIPTION

a. Purpose of the System

(1) Enhancement of safety in train operation

In traditional operation without a TPWS, a driver recognizes the signal aspect by visual confirmation and controls the brake manually following the operational rule.

In such case, the crew and passengers are exposed to a potential hazard, when the driver is violating the operational rules or occurrence of inability, e.g. sudden illness. In the worst case, this hazard may lead to critical accidents, such as train collision and derailment.

TPWS essentially works as an automatic backup of the driver, which sufficiently enhances the safety by eliminating the hazard under consideration.

Important Functions of TPWS are,

- Prevent Signal Passing at Danger Monitoring of train speed (SPAD)
- Indication and warning to the driver
  - Brake application
  - Management of train operation mode
  - Monitoring and logging system condition

(2) Interoperability

Proposed TPWS provides functions and interfaces that conform to the RDSO's TPWS specification so that interoperability with IR TPWS is ensured.

Also, major equipment of proposed system are developed by following EU Regulation, Technical Specification for Interoperability and ETCS Specifications, which ensure the technical interoperability with equipment from other major suppliers, such as UNISIG members. This is demonstrated by the NoBo certification issued by Notified Body, e.g. Lloyd's Register and ATKINS.

b. Outline of Functions

The system offered conforms to the RDSO specification RDSO/SPN/183/2012 Ver. 2.3, UIC/UNISIG ETCS SRS Ver. 2.3.0d and provides the functions mentioned below.

(1) Prevention of the occurrence of SPAD

For the safety operation described above, it is important for the system to ensure that the train does not pass a signal when its aspect orders the train to stop. The TPWS prevents the occurrence of SPAD even if the driver does not command the brake. The TPWS gives warning to driver by audio and visual indications in case of over speeding and controls brakes to bring the train to a halt automatically if the driver does not react to the warning.

(2) Monitoring of train speed

The system continuously compares the current speed of the train with the permitted speed at all locations.

(3) Indication and warning to the driver

The system displays the necessary information such as train speed, operation mode, system condition etc. for the driver on the DMI. It gives audio and visual indications and warning in unexpected situations when intervention of the system is necessary.

(4) Brake application

The system issues service brake commands to force the train to operate in a safety status under the permitted limitation. It also issues emergency brake command to completely halt the train

(5) Management of train operation mode

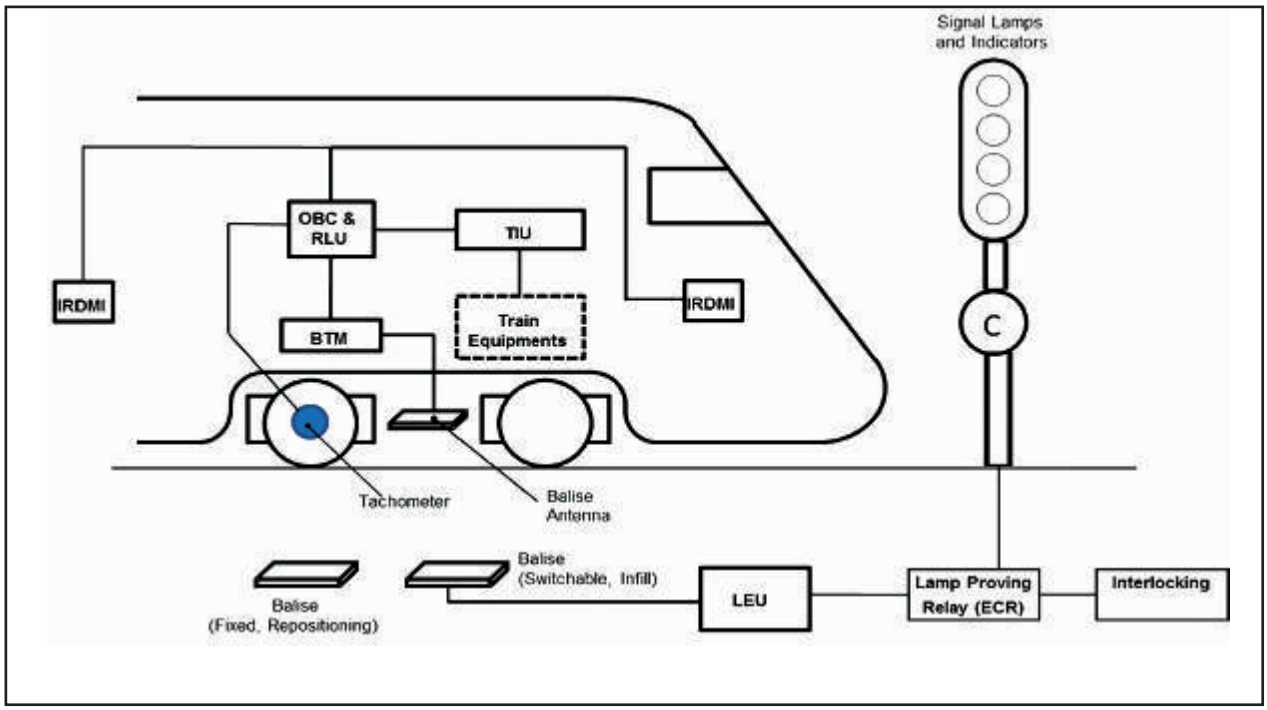
The system manages the train to operate at an appropriate mode for each expected or unexpected operational scenarios.

(6) Monitoring and logging system condition

The system monitors its condition continuously and executes necessary processing such as output of warning in case of system error or malfunction, and also records the event log for the purpose of diagnostic and maintenance.

c. Overview of System Configuration

An overview of TPWS configuration is shown below;



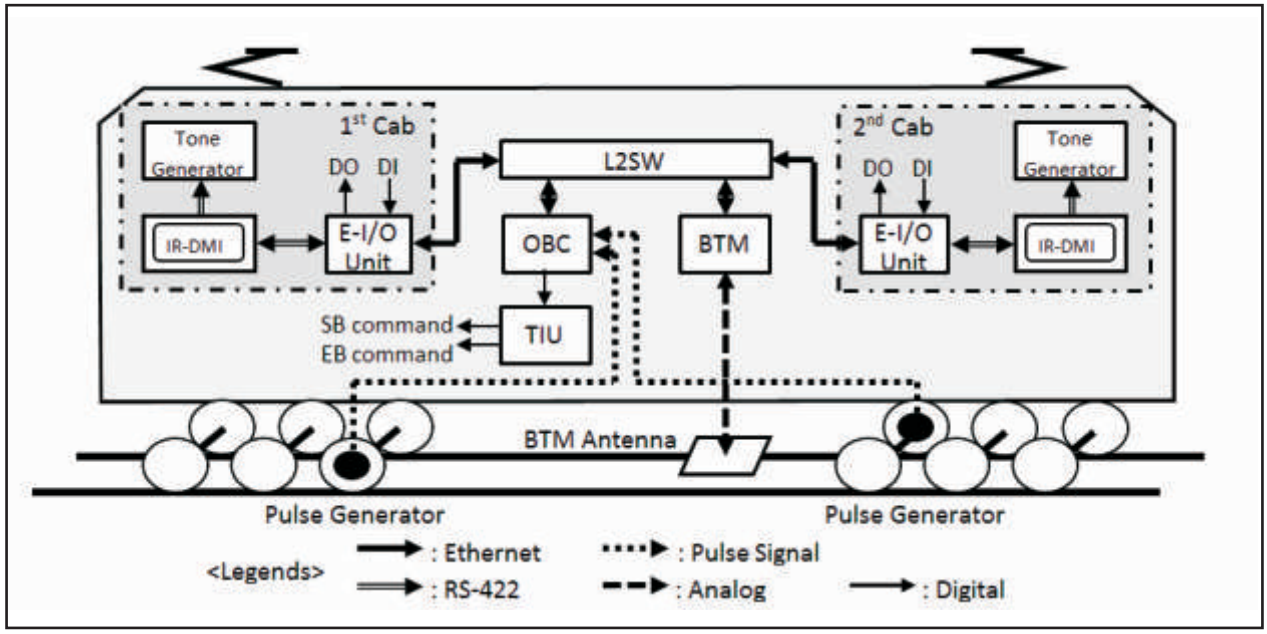
The ETCS functionalities are implemented using the following

- Reception of Eurobalise Telegrams
- Calculation of train speed and distance travelled
- Speed supervision based on movement authorities received from the trackside and speed and distance information determined on-board
- Brake application
- Display of information to the driver and input of commands.

d. On-board System Components

On-board TPWS system is comprised of

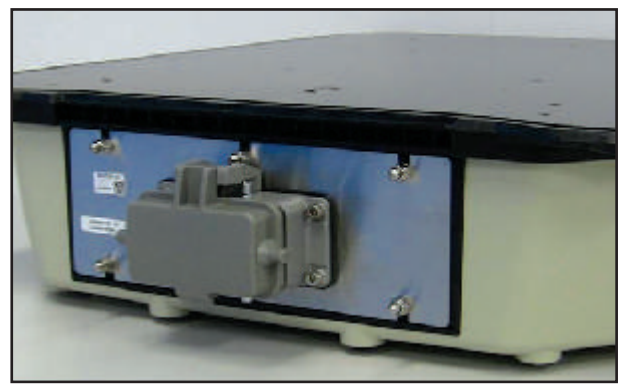
- Onboard Computer (OBC)
- Balise Transmission Module (BTM)
- Balise Antenna
- Train Interface Unit (TIU)
- Pulse Generator (PG)
- E-I/O Unit
- Driver Machine Interface (DMI)
- Tone Generator



System Configuration of TPWS On-board subsystem

Balise Transmission Module (BTM) and Balise Antenna

Balise interface equipment comprises the Balise antenna and Balise transmission module (BTM). The Balise antenna is installed under (in the lower part) the locomotive and it receives telegrams from Balises. The BTM processes the telegram received by the antenna and sends it to the On-board computer (OBC).

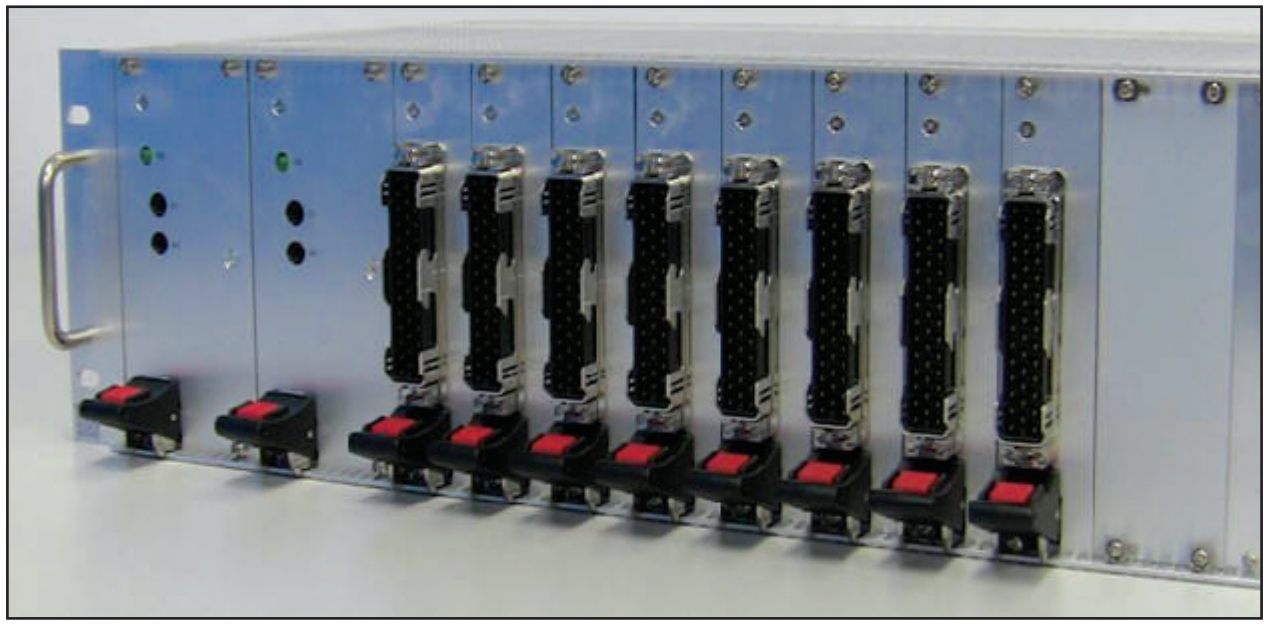


OBC (On-board Computer)

The OBC determines train control according to telegram received from balise, current train speed, input from the driver's cab, system condition etc. and delivers output control commands to train equipment. The CPU board of the OBC has 2oo2 architecture where output data from each CPU is compared to ensure fail-safe train control. OBC also drives the driver-machine interface (DMI) to display various movements and track related information and to receive driver's commands and inputs to the system. Hitachi OBC also has data logging capability for diagnostic purpose.

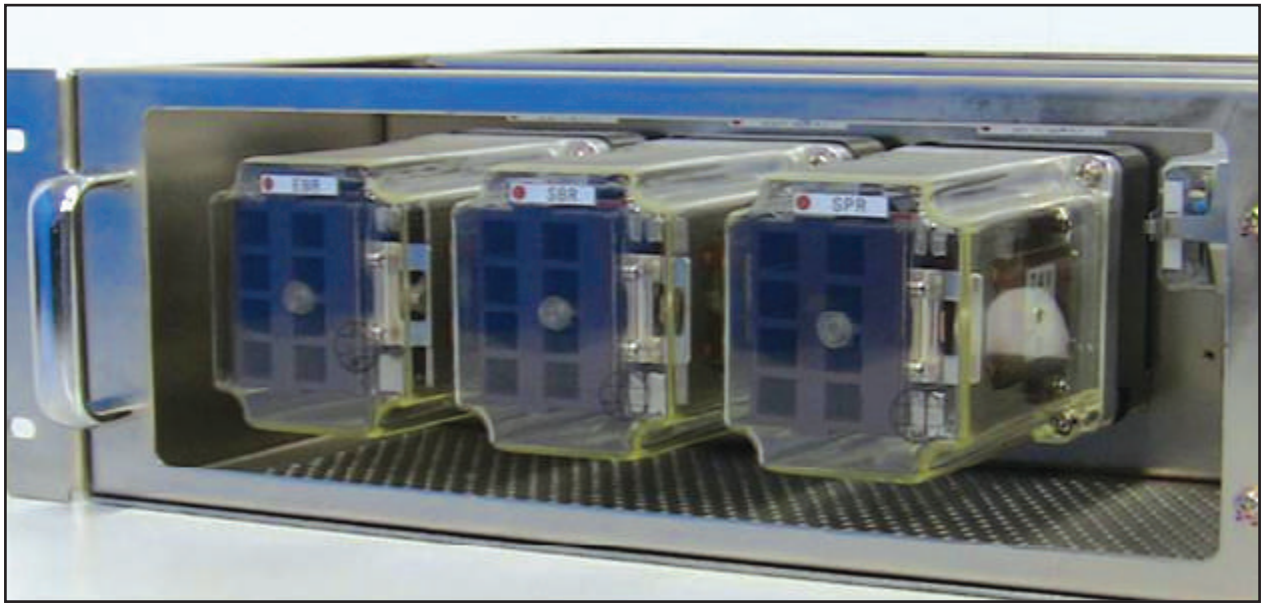
RLU (Relay Logic Unit)

This unit has a relay logic or sequence for interfacing with train side



TIU (Train Interface Unit)

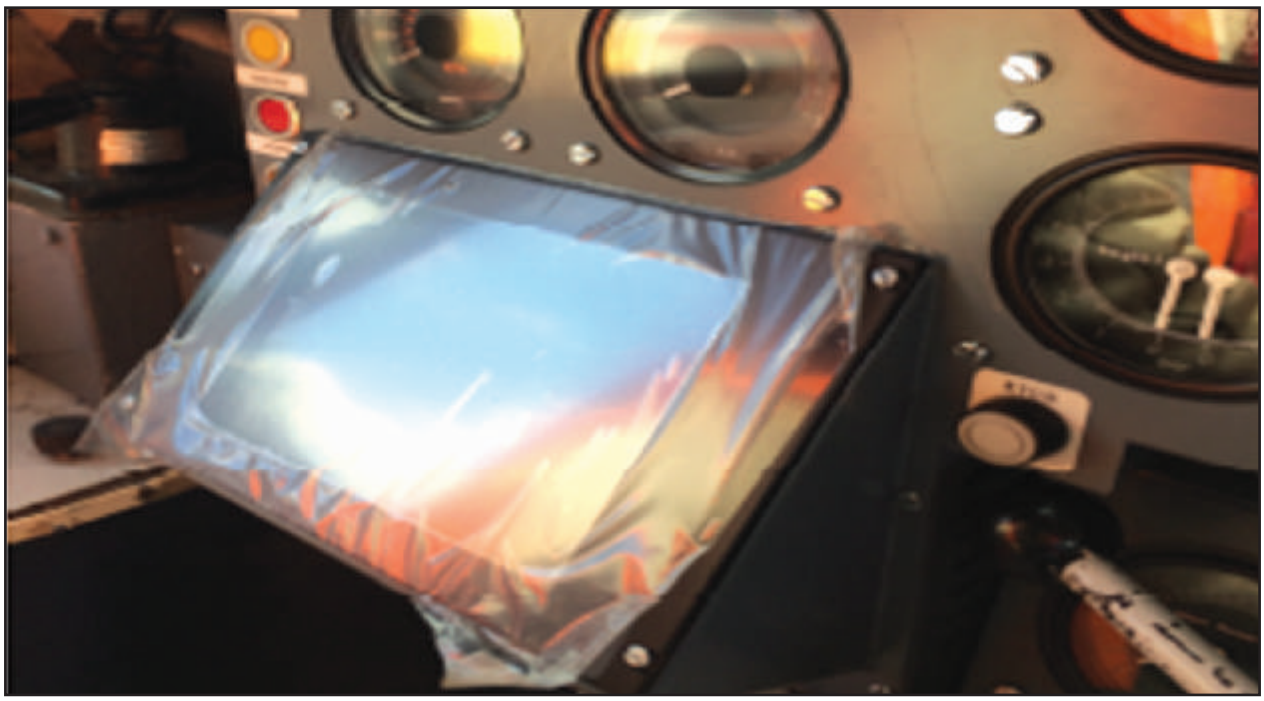
The TIU is input/output equipment interfacing with brake controls (for both Service and Emergency Brakes)



IRDMI (Indian Railways Driver-Machine Interface)

The DMI receives various information such as current train speed, target speed, distance to go, system condition, operation mode, warnings etc. from the OBC and displays it to the driver. The DMI is equipped with a speaker so that it can give the driver not only visual indications but also audio indications.

The IRDMI shall be based on soft key version of CENELEC DMI with simplification of display area by inhibiting certain areas of display not required for IR, like planning area. There would be some fixed train types and driver can select one of them using drop down menu, it will require just two/ three steps for start of mission.

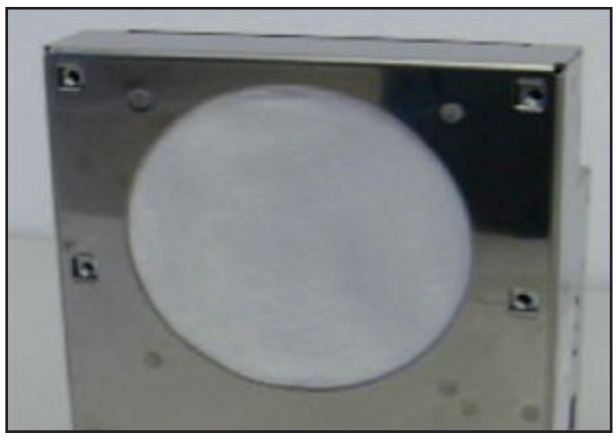


Pulse Generator (Odometry)

Two numbers speed sensors provided at different axels of locomotive will provide train speed information to OBC

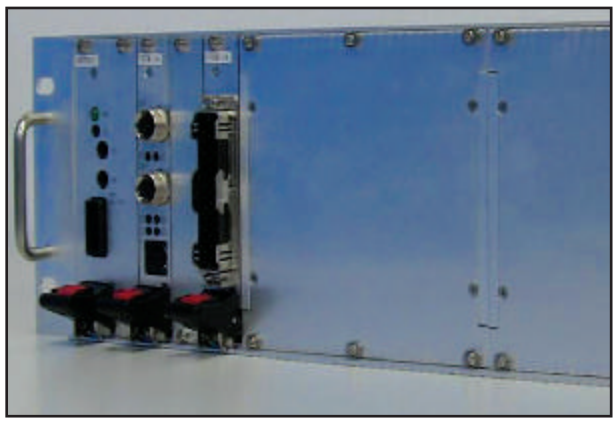
Tone Generator

Tone Generator generates the necessary warning / alarm sounds for the ETCS system to alert the driver of the operation of various TPWS functions.



E - I/O Unit

Electrical Interface Unit interfaces with all the Train inputs



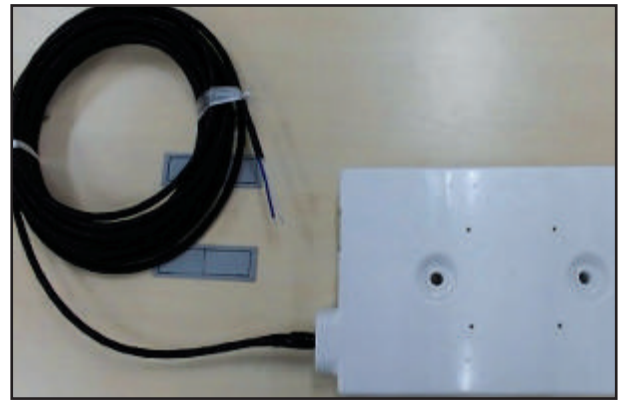
e. Trackside System Components

LEU (Lineside Electronic Unit)

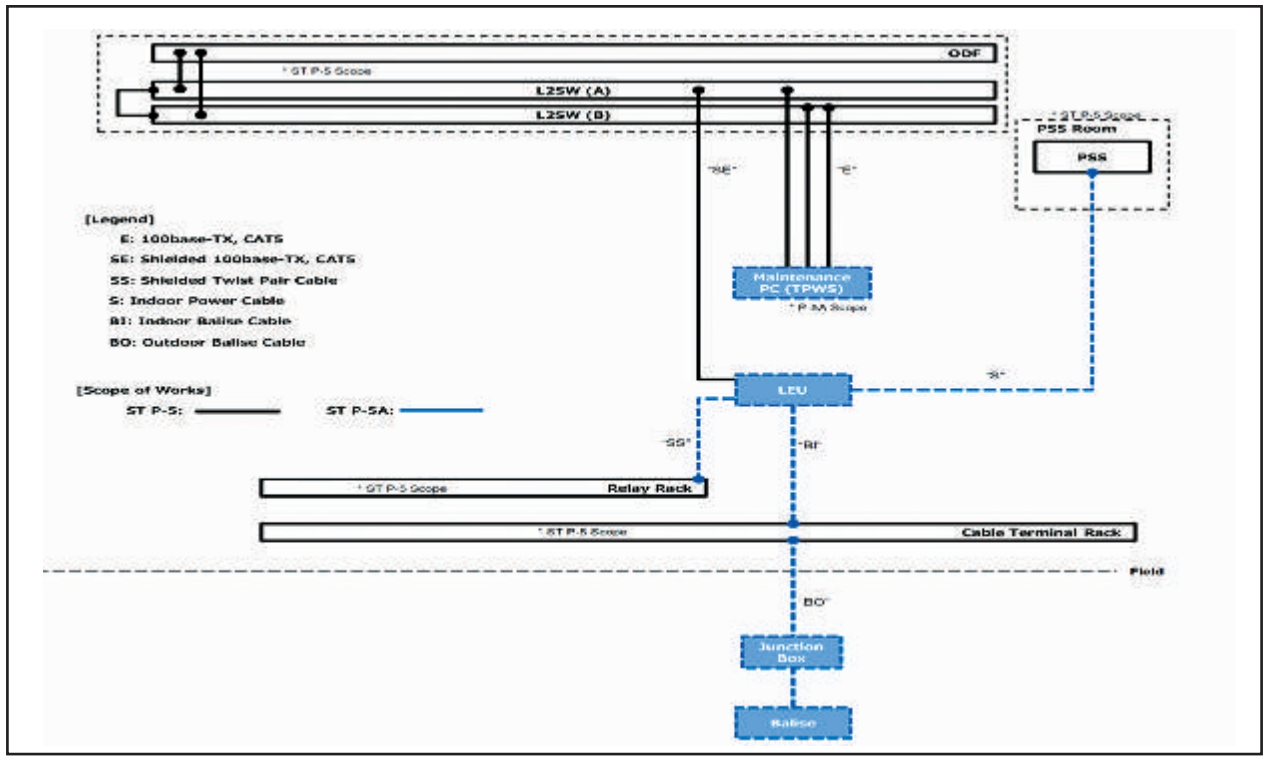
LEU takes the aspect information from the lineside signals and /or route indicator through potential free contact of ECR relay and sends the train control information to the switchable balise.

Balise

Balise is a contactless information transmission device to transmit the train control information from trackside to onboard equipment.



System Configuration of TPWS trackside sub-system is shown in figure below



TPWS Functioning

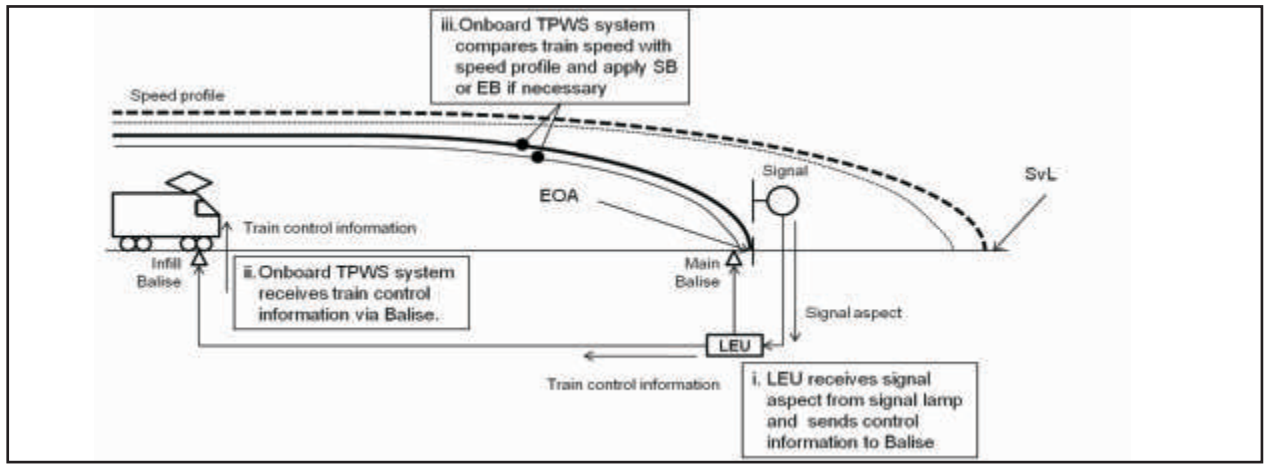
Basic Control Process

Flow of Train Control

(1) The trackside equipment (LEU) recognizes the signal aspect and sends train control information according to the signal aspect to onboard TPWS equipment.

(2) Trains receive the control information through Balises.

(3) Onboard TPWS equipment controls the train speed according to calculated braking curve. Braking curve is the relationship between the train speed and the train location until stop position, and the onboard equipment continuously compares it with current train speed and applies brakes if train speed exceeds the curve.



Flow of Train Control

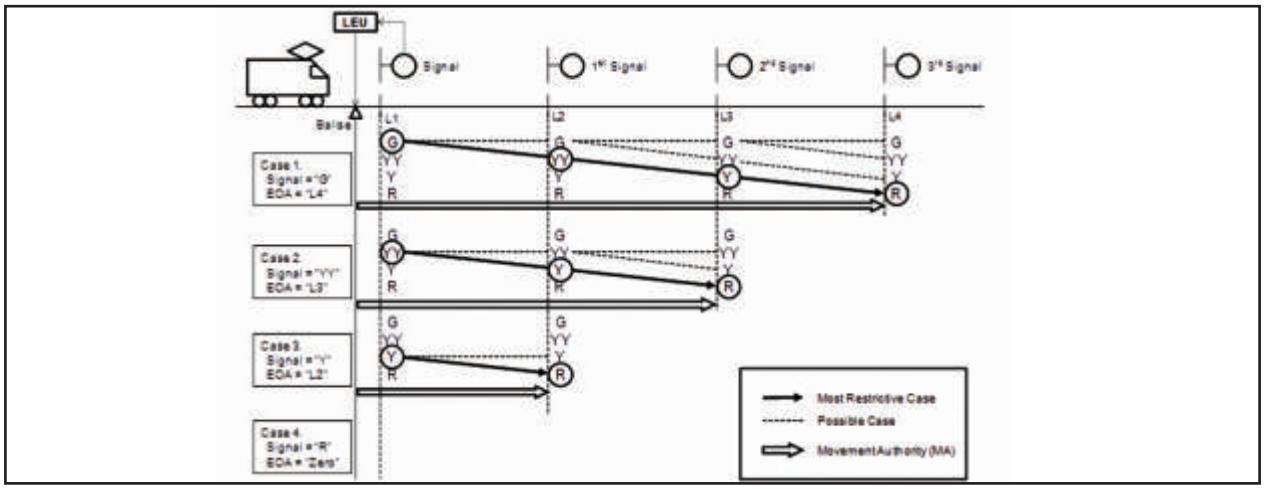
Transmission of Information

Representative transmission items between trackside and onboard side for train control are listed below. The information listed below is transmitted from the trackside to the onboard equipment through the Balise.

No.	Item	Data Functionality
1	Movement Authority (MA)	Permission for a train to move to a specific location with supervision of speed. Trackside TPWS equipment informs the movement limitation (MA) to Onboard TPWS equipment, which is used for train movement supervision, e.g. Prevention of SPAD (i.e. Signal Passed at Danger).
2	Trackside condition profile	Provide the speed restriction profile and the gradient profile according to the current interlocking status.
3	Operation-level transition	Issue commands for management of operating modes of onboard TPWS system
4	Other control and operating	informationInformation used for train control or operation event required by specific application

Signalling Principle of TPWS system is aligned with the most restrictive situation assumed from the main signal aspect. Therefore, the relationship between the main signal aspect and train control information (Movement Authority and End of Authority) is shown below

No.	Main Signal Aspect	1st Signal Aspect	2nd Signal Aspect	3rd Signal Aspect	End of Authority (EOA)
1	G	YY	Y	R	At the 3rd signal from the main signal
2	YY	Y	R	-	At the 2nd signal from the main signal
3	Y	R	-	-	At the 1st signal from the main signal
4	R	-	-	-	At this main signal (Immediate application of the emergency brake in case of signal passing)



Typical Situation assumed from the Main Signal Aspect

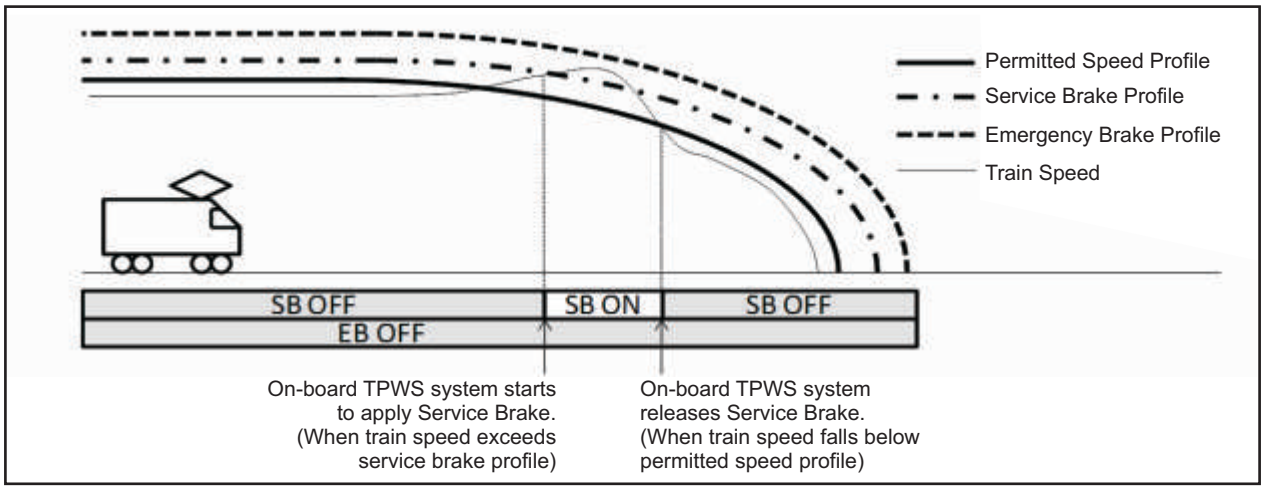
Brake Control

The types of brake controlled by onboard equipment are described below

(1) Service Brake (SB)

If the train speed exceeds the speed limit of Service Brake profile, On-board TPWS equipment applies Service Brake (SB). The SB is released when the train speed decelerates lower than the permitted speed. The following Figure 3 shows the application of the Service Brake.

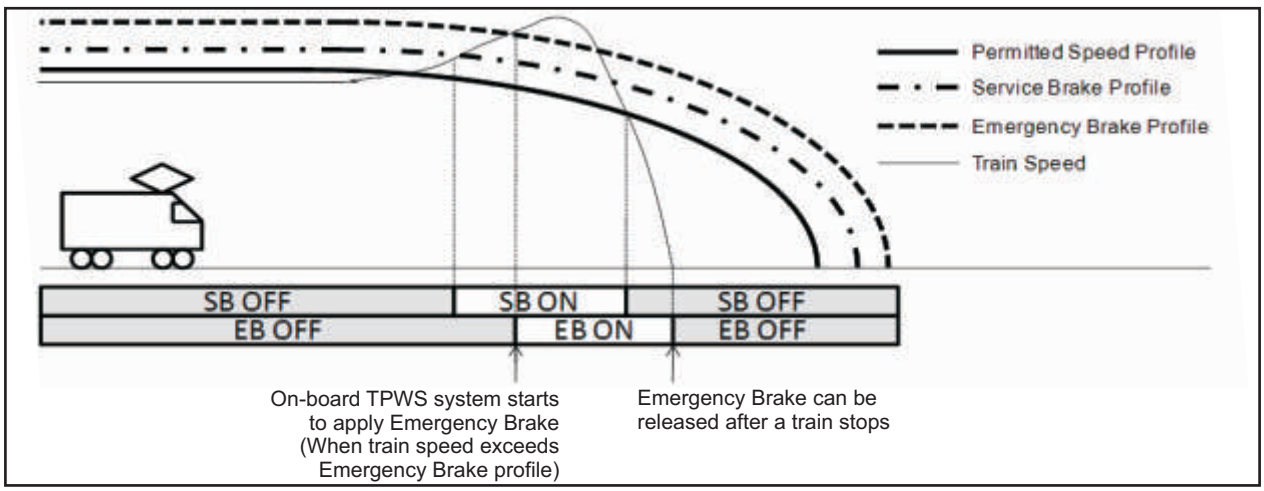
The application of this function depends on the braking interface of wagon.



Application of the Service Brake

(2) Emergency Brake (EB)

If the train speed exceeds the speed limit of Emergency Brake profile, onboard TPWS equipment applies Emergency Brake (EB). On-board TPWS equipment continues to output EB until the train stop, or until the train speed decelerates to below the speed limit, and after that, EB can be released. The following figure shows the application of emergency brake.



Application of the Emergency Brake

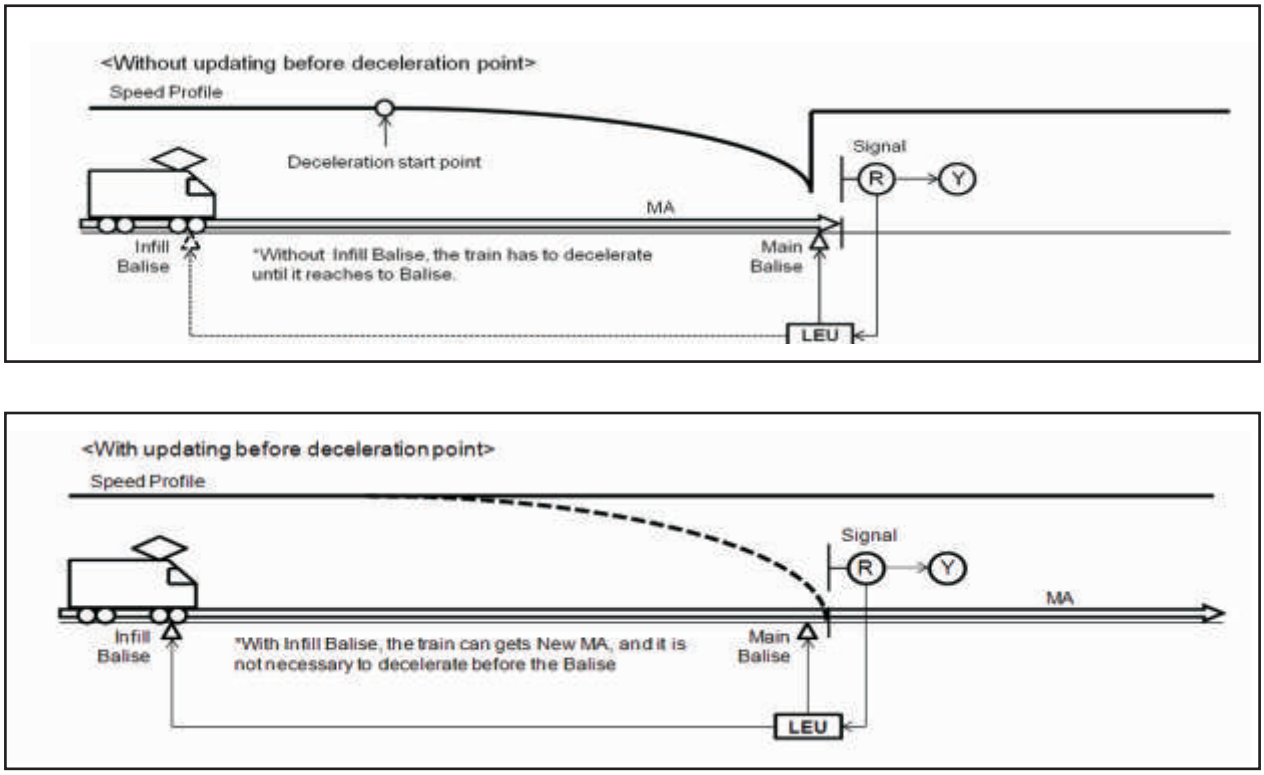
Action against Over-speed

This TPWS system decides where the train should stop and continuously monitors whether it is exceeding the speed limit of the profile or not. If the train exceeds the limit, TPWS system executes the necessary processing such as output of warning and brake control depending on the degree of excess.

Update of Movement Authority (MA)

Movement Authority of the onboard TPWS system is updated by transmission of MA information from each main Balise which is installed just before the main signals.

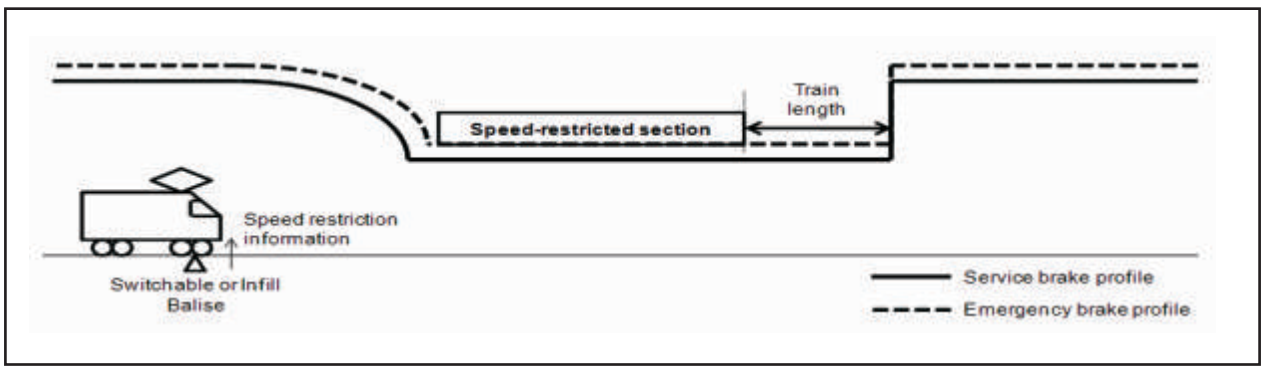
In addition to the main Balises which are placed just before the main signal, this TPWS system also employs infill Balises, which are installed at the middle of blocks between two consecutive main signals, to provide the latest Movement Authority.



Update of MA at middle of Signals

Static and Temporary Speed Restriction

This TPWS system can enforce static speed restriction (SSR) and temporary speed restriction (TSR). SSR is enforced by static speed profile because of curves and/or gradients. TSR is enforced by installing two fixed Balises at the start/end of the speed restricted section. The following figure shows an example of a speed profile in a speed-restricted section.



Example of Speed Profile in a Speed Restriction Section

Basic Function

Brake Control

(1) On-board TPWS system has two kinds of brake command as follows;

(a) Service Brake command

(b) Emergency Brake command

(2) The brake commands by onboard TPWS system have an interface with the brake system of locomotive, by a relay contact output with feedback. Also, when onboard TPWS system outputs a brake command, the traction will be cut off.

(3) The driver can apply the brakes above and over TPWS control.

(4) In case of train trip, driver confirmation is necessary to release the emergency brake after the train stops. Records in the form of EB counter, which uses a non-resettable electro-mechanical counter, are provided with the system. This is not affected by an interruption of the power supply to the system.

(5) It is impossible to cancel the brake application by interrupting the power supply to the system.

Calculation of Speed

On-board TPWS equipment calculates the train speed accurately by inputs from two independent speed sensors (two channels per speed sensor) that are installed at two independent axles. The accuracy of speed calculation is ± 2 km/h for speed lower than 30 km/h, then increasing linearly up to ± 12 km/h at 500 km/h.

Calculation of Speed Profile

The controller of onboard TPWS equipment calculates the static and dynamic speed profile for the anterior track section according to received data from Balises and to the train's characteristics.

Calculation of Permitted Speed

Permitted speed is maximum speed at which a train / shunting movement can run without warning and / or brake intervention.

This TPWS system calculates the permitted speed, warning speed, service braking curve, and emergency braking curve for the train for all locations in the section, based on all relevant data (available on board and as received from Balises).

Release Speed

Release speed is maximum speed at which a train is allowed to reach the end of its Movement Authority.

The release speed can be determined at the trackside or calculated on board. It is possible:

(1) To receive a value from the trackside, as part of the MA or

(2) To calculate the value on board

Monitoring Speed

(1) Onboard TPWS equipment continuously compares the current train speed with the permitted speed at all locations and in all modes in which speed monitoring is required. However, in case of release speed monitoring, the description in Clause 1.3.7 (2) applies. A warning is informed to the driver to enable to react and avoid intervention from the onboard TPWS equipment before the application of the service brake. The actions listed below are taken by the onboard TPWS equipment depending upon the difference in the current train speed and the permitted speed.'

Sl. no.	Current train speed exceeds the speed permitted at the moment, by	Warning to the driver	Command for traction cut-off	Braking/Brake command	Event logging
1	Up to 5 Kmph	Intermittent audio and visual warnings that stop once the train speed decreases to the permitted speed	No	No	No
2	More than 5 Kmph & up to 10 Kmph	Continuous audio and visual warnings	Yes	The TPWS applies the service brake. The	Yes

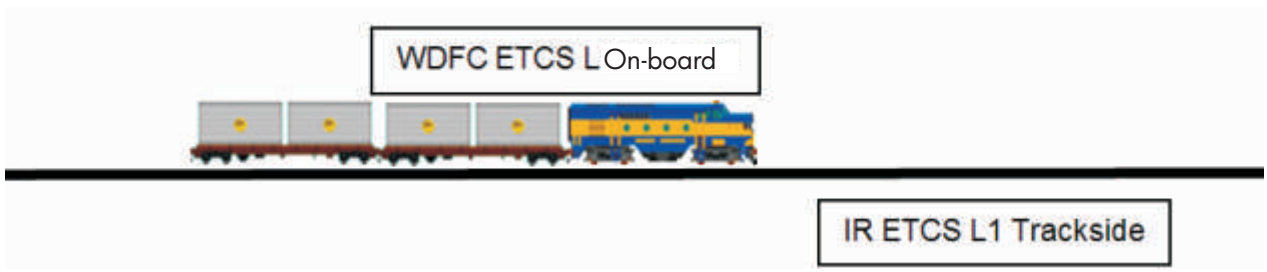
				service brake command will be withdrawn only when the current train speed decreases lower than the permitted speed.	
3	Over 10 Kmph	Continuous audio and visual warnings	Yes	The TPWS applies the emergency brake. There are the following two programmable options for the release of the emergency brake (a) When the current train speed is reduced to the permitted speed or below (b) When train comes to a halt	Yes

Train operation on WDFC section and Indian Railways section with ETCS as ATP

Operation of WDFC Locomotive fitted with ETCS L1 system

a) WDFC Locomotive fitted with ETCS L1 On-board will operate on WDFC section with ETCS L1 system.

b) WDFC Locomotive fitted with ETCS L1 On-board will operate on Indian Railways existing TPWS (Level 1) sections with ETCS L1 system.

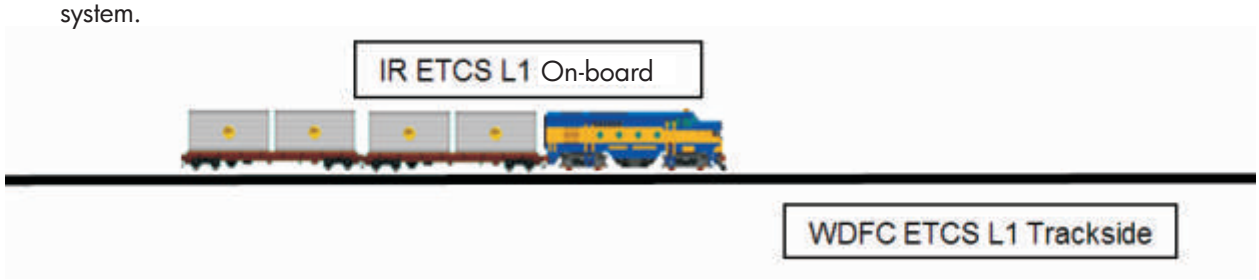


Interoperability between IR and DFCCIL with various system configurations:

Operation of Indian Railways Locomotive fitted with ETCS L1 system

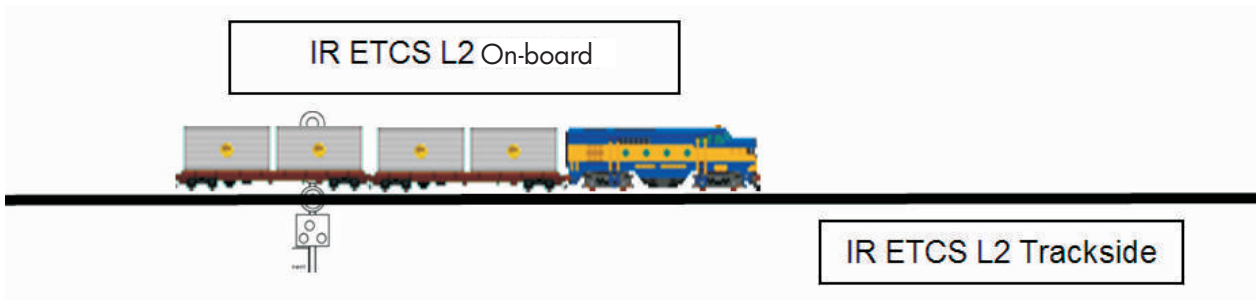
a) Indian Railways Locomotive fitted with ETCS L1 On-board will operate on Indian Railways section with ETCS L1 system.

b) Indian Railways Locomotive fitted with ETCS L1 On-board will operate on WDFC section with ETCS L1 system.

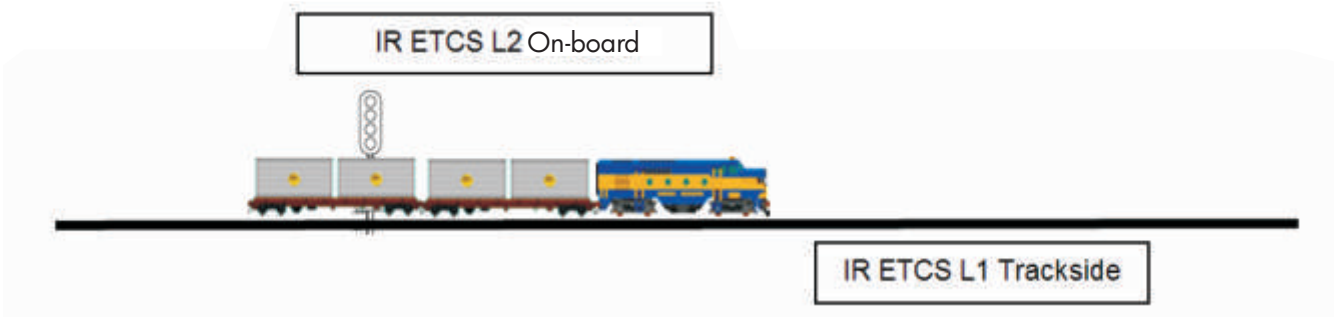


Operation of Indian Railways Locomotive fitted with ETCS L2 system

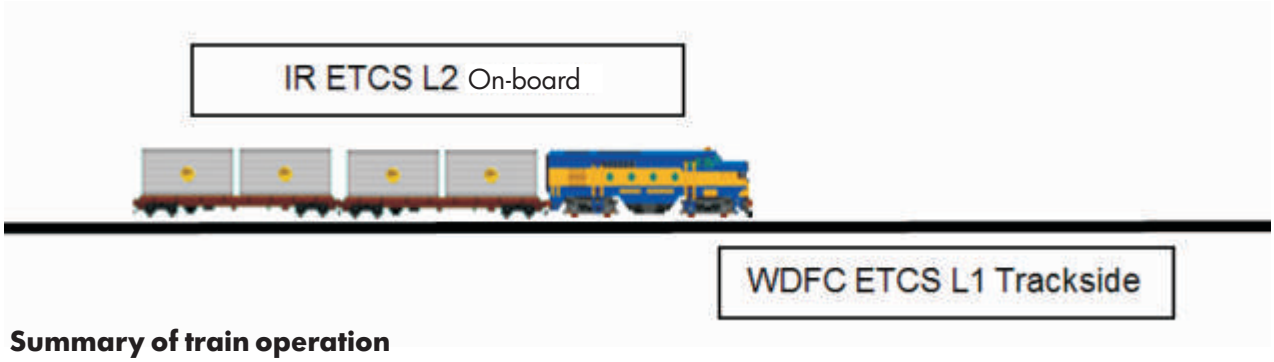
a) Indian Railways Locomotive fitted with ETCS L2 On-board will operate on Indian Railways section with ETCS L2 system.



b) Indian Railways Locomotive fitted with ETCS L2 On-board will operate on Indian Railways existing ETCS (Level 1) sections with ETCS L1 system through automatic level transition in onboard (trackside data will be read by BTM antenna).



c) Indian Railways Locomotive fitted with ETCS L2 onboard will operate on WDFC section with ETCS L1 system through automatic level transition in onboard (trackside data will be read by BTM antenna).



Summary of train operation

	WDFC Section with ETCS L1 Trackside	Indian Railways existing ETCS L1 Trackside	Indian Railways Section with ETCS L2 Trackside
WDFC Locomotive with ETCS L1 On-board	ETCS L1 ATP	ETCS L1 ATP	On-board will operate in UNFITTED mode (Ceiling speed of train will be monitored)
Indian Railways Locomotive with ETCS L1On-board	ETCS L1 ATP	ETCS L1 ATP	On-board will operate in UNFITTED mode On-board (Ceiling speed of train will be monitored)
Indian Railways Locomotive with ETCS L2 On-board	ETCS L1 ATP	ETCS L1 ATP	ETCS L2 ATP

Conclusion

Train protection and warning system (TPWS) in WDFC will ensure the safety for freight train operation which is long haul oriented. Therefore, it is highly essential to implement TPWS in WDFC train operations. This has become all the more necessary with heavier axle loads of 25T to 32.5T (in future) and longer Braking distances. This will be a pioneering effort as the Freight Locos will be equipped with TPWS for the 1st time.

Panagiotis Amerikanos
Project Director, Systra

TECHNICAL PAPER ON TURNOUTS IN EDFC 2

ABSTRACT

On Dedicated Freight Corridors Corporation of India Ltd. (DFCCIL) Project from Mughalsarai Jn. to New Bhaupur, modern turnouts and derailing switches are to be used with speed potential of 100 Kmph on main lines and 15 Kmph on sidings with dead ends. To fulfil the contractual requirements, canted turnouts with thick web switches are adopted.

Technical background

In Indian railways at present 1 in 12 over riding switches are used with operating speed of 30km/h. These turnouts are isolated from continuing LWR through them due to susceptibility of weak track structure in turnouts. No special arrangements made to withstand LWR forces. The turnouts designed for Axle load present in Indian Railways is 22.5T. Due to increase in axle load from 22.5 Tonnes to 25 Tonnes in DFCC project and requirement of passing LWR through turnouts, these should be capable to withstand lateral and longitudinal movements. The turnouts should have higher speed potential to reduce operating Time. The turnouts and their fastenings should be robust enough to withstand LWR forces and dynamic forces caused by heavier axle load and able to be fitted with elastic fittings for ease of construction and minimum maintenance thereby reducing operational and maintenance costs in the long run. Since longer loop lengths are envisaged in DFCC yards, passing traffic with higher speeds is feasible.

Based on above assumptions tangential turnout with thick web switches and weldable CMS crossings are considered for design. Keeping in view the requirement of land in proposed DFCC yards to as minimum as possible, 1 in 12 turnouts with 441m radius with high speed potential have been considered.

The design of turnout suitable for LWR has been studied for geometric requirements of layout, reducing angle of attack at toe of switch, ensuring complete housing of switch and maintaining required opening at JOH by providing either SSD or back drive, feasibility of carrying out welding in crossing portion, geometry of stock and tongue rails.

Design Requirements of Turnouts and Derailing switches

1.	Gauge	1676mm
2.	Crossing Angle (on main lines and loop lines)	1 in 12
3.	Rail profile	60 kg (UIC 60 kg/m)
4.	Speed potential on the main lines	100km/h
5.	Speed on sidings with dead ends	15 km/h
6.	Axle load	25 tonne
7.	Designed Annual Traffic	>50 GMT
8.	Type of Web	Thick web
9.	Tangential entry and the switch entry angle	$\leqslant$ 0º-20'-00''
10.	Maximum Cant deficiency	75mm

11. The left hand and right hand turnouts shall be designed with common concrete bearers (PSC fan-shaped layout) and shall have provision of anti-creep fastenings and other relevant fastenings and fixtures. Steel/cast iron bearing plates shall be provided on the common concrete bearers with fixtures on bearing plates ensuring the right orientation of the rails.
12. The turnouts shall meet with all the provisions set out in para 12.40 of chapter XII of Indian Railways Signal Engineering Manual.

13. For manufacturing stock, lead, intermediate sections and closure rails, 90 UTS (UIC60 Kg/m) section to be used.
14. For switch rails, thick web section manufactured out of asymmetrical rail section shall be used. Both switch & stock rails shall be of special grade steel (minimum 880 grade as per IRS: T-12-2009) and have hardened heads for better life.
15. The crossings shall be fixed nose, 1 in 12 weldable cast manganese steel. Shall have welded leg extensions of 60 Kg (60UIC) 880 grade rails.
16. Drilling of holes not permitted except for connecting the interlocking arrangements.
17. Check rails in all turnouts shall have the facility for adjustment of check rail clearances up to 10mm over and above the initial designed clearance.
18. Elastic fastenings suitable for 25T axle loads compatible with main line rail to sleeper fastening system.

Based on above design requirements the design has been analysed for the following parameters:

I. Geometrical sufficiency

i. The turnout curvature designed as simple curve extending from TTS to beginning of crossing without any straights in between. The radius worked out for design speed of 50 Kmph is 441360mm.

ii. Length of turnout worked out considering tangential entry at toe of switch and toe of crossing.

iii. Design of switch angle at toe of switch. This feature will ensure reduction of lateral acceleration on track components as well as reduced jerk in rolling stock. Thus, minimising maintenance costs to a great extent.

iv. Stress analysis has been done by FEM analysis.

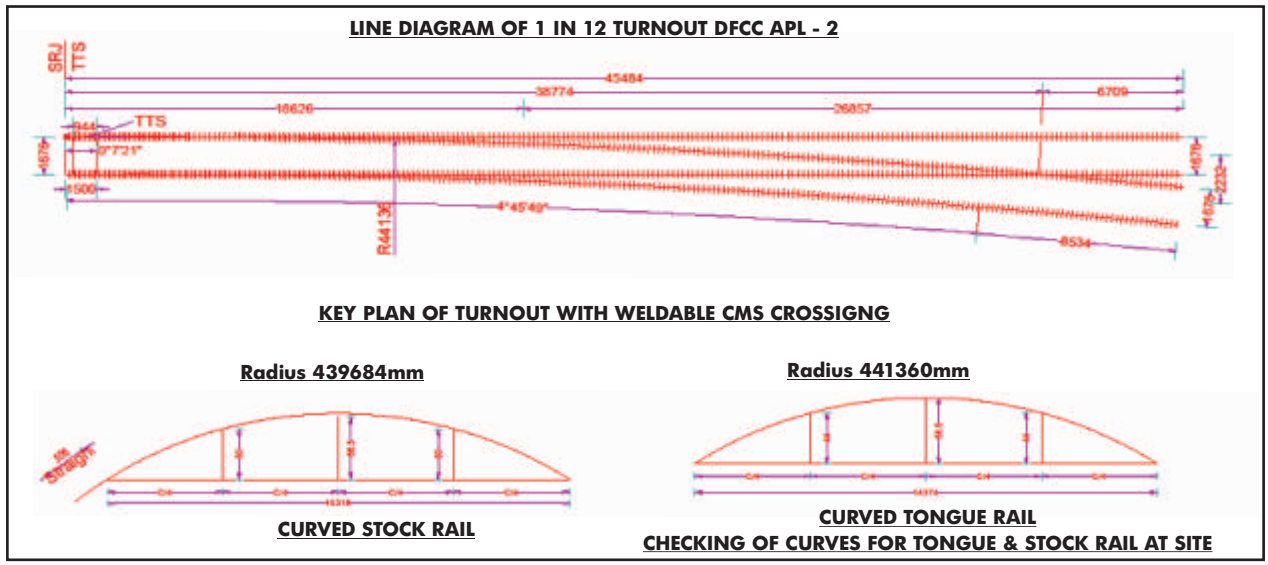


Exhibit 1

II. Design of Stock and Tongue Rails

i. Stock rails have been designed to have longer service life by using head hardened rails.

ii. 1 in 20 cant maintained in turnout portion also which will eliminate twist at both ends of turnout portion and result in improvement in riding comfort and safety.

iii. Tongue rails have been provided as thick web switches from asymmetrical rail section of ZU-1-60 with forged end towards lead portion to be enabled to get welded. The tongue rail is tangential at switch entry resulting longer lengths of stock and tongue rails.

iv. Both tongue rails connected with clamp lock and Drive bar to the Electric point machine. This will ensure Housing of Tongue rail with Stock rail and simultaneous locking of both Tongue rails. The Point machine designed for maximum stroke of 220mm thus ensuring throw of switch minimum 160mm as compared to 115mm in over riding switches.

v. Both Tongue rails have very thin head thickness at toe and geometry designed for housing under the stock rail fully for not coming in contact with Wheel. The geometry allows contact of wheel loads with Tongue rail only after adequate thickness is achieved.

III. Design of anti- creep device

Anti-creep device along with high strength friction bolts have been provided to withstand residual stress due to long welded rails which are combined sharing with other components of track i.e., ballast, sleepers, elastic rail clips and Rubber pads.

Exhibit 2

IV. Design of fastenings for fixing rail with sleeper

The bearing plates have been designed to cater 1 in 20 cant in both stock and tongue rails.

The bearing plates have been checked for plate thickness, welding of components and dimensional analysis for maintaining track in required gauge 1676mm.

The stock rail fixed to slide chairs/bearing plates using ER clips on one side and leaf spring and wedges on the other side thus avoiding drilling holes in stock rail portion.

The slide chairs are provided with anti-corrosive coating to improve movement of tongue rail and reducing maintenance.

The tongue rails have been fixed to bearing plates using ER clips and also suitable fastening clip.

V. Provision of Back Drive

Mechanical back drive has been provided in switch portion. The back drive consists of system of bell cranks and shafts, fixed at sleeper no. 3 & 4 and sleeper no. 13 & 14 which transmits force from driving rod to rear lock bar provided between sleeper no 13 & 14. The first lock bar of back drive is connected with driving rod of electric point operating machine. The second lock bar of back drive is connected to LH & RH tongue rails. This arrangement is very simple and efficient in ensuring proper housing of tongue rail with stock rail from ATS to JOH. This operation acts in sync with point operating machine. This back-drive system will not require any additional power and is compatible with 220mm stroke machine.

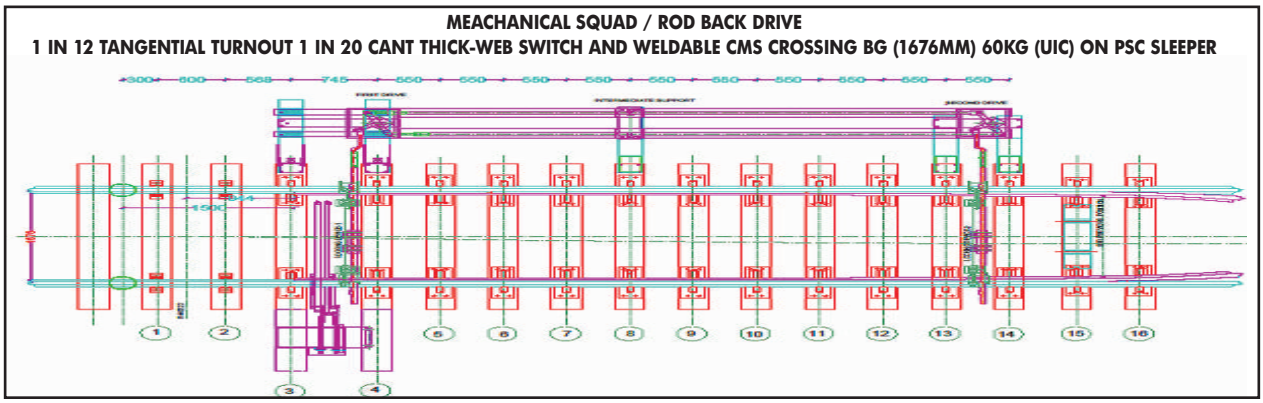


Exhibit 3

VI. Provision of Point Machine

Electric point machine (RDL-2) non-trailable point machine is provided at sleeper no. 3 & 4. This machine is designed to operate high speed turnouts with thick web switch along with external clamp point lock.

Technical Data

Throw of Point Machine	Time of Operation (max)	Current Consumption	Test Voltage	Test Load on Throw bar	Slipping Load	Stalling Load (min.)
220mm	5.5sec	⩽5.5 Amp	110VDC	550kg	⩽700kg	1000kg

VII. Design of Lead Portion

Lead portion designed for less handling/maintenance and sturdy track structure. The sleepers are designed for fan shaped layout with modified CI inserts to accommodate 1 in 20 cant in rails CGRSP and metal bearing plates provided in between inserts. The rails can be fixed to sleeper with the help of Elastic Rail fastening provided in main line track. This will ensure fixed curvature of lead portion without any disturbance.

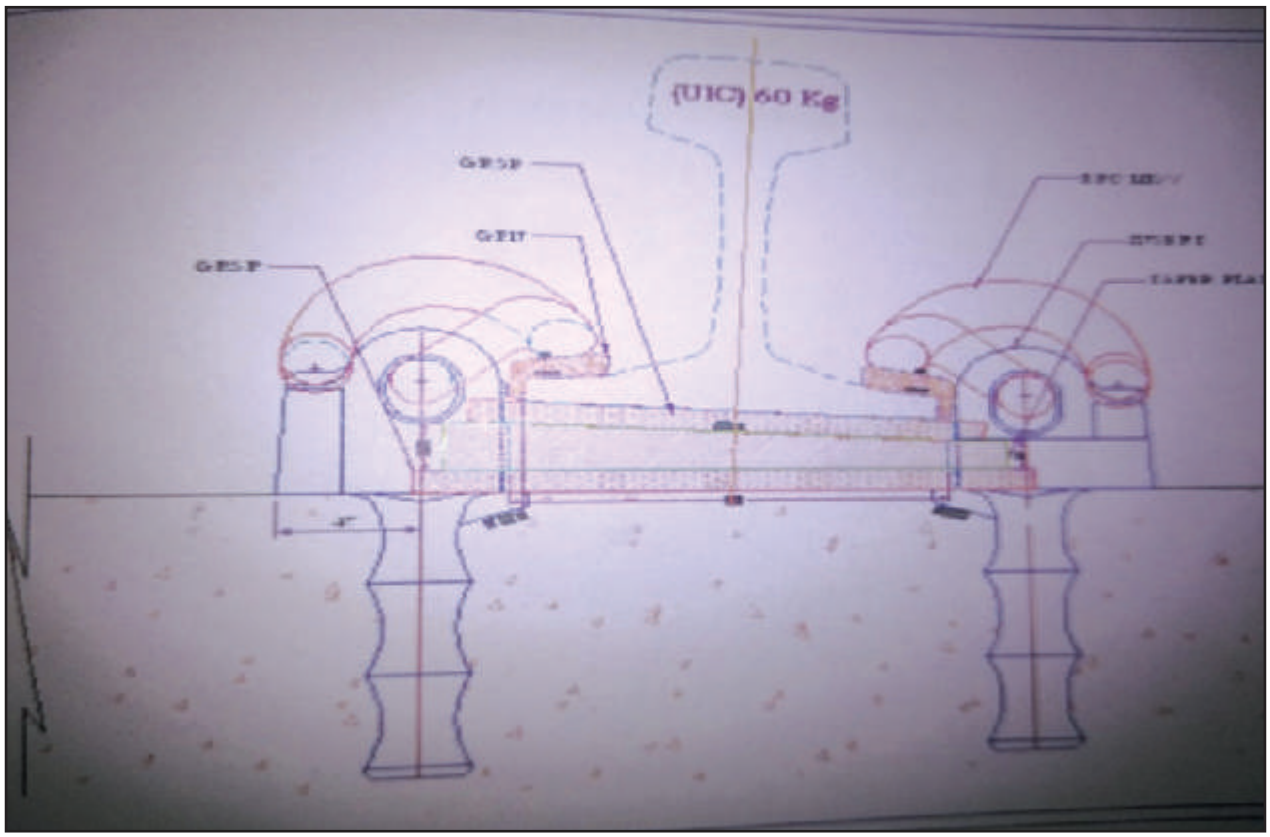


Exhibit 4

VIII. Design of crossing Portion

Crossing portion designed as fixed nose crossing with canted rail profile. The crossing is welded with extended legs so as to carryout AT welding at site. Thereby totally nullifying drilling of holes. Sturdy CMS crossing with extended legs in crossing portion will act like monolithic structure and thus nullify the LWR forces coming from adjoining track.

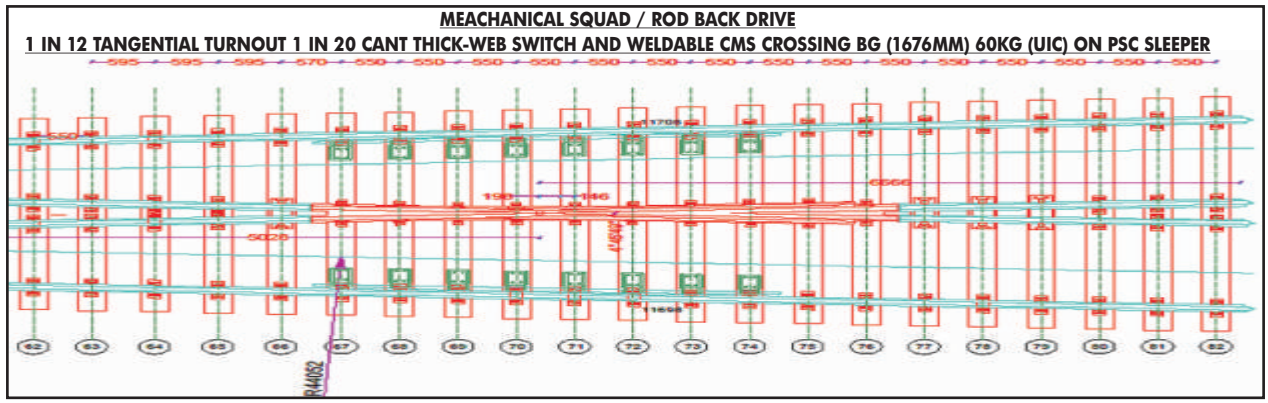


Exhibit 5

IX. Check Rail Portion

Check rails provided with normal 60 Kg UIC rail connected to sleepers by bracket arrangement. No drilling in main line track required to fix check rails. Check rail clearance designed for adjustment of 10mm over designed clearance and also 25mm above the running surface of main line thus avoiding possibility of wheel taking different routes at nose of crossing.

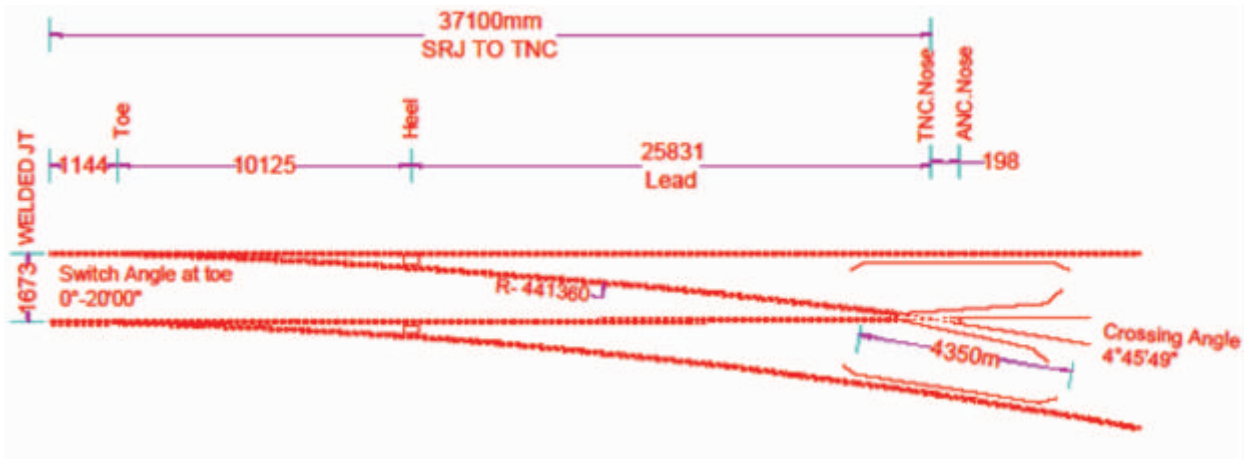
Conclusion

The turnouts used in DFCC have a better usability as compared to the traditional IR turnouts. A comparative study of both is as follows

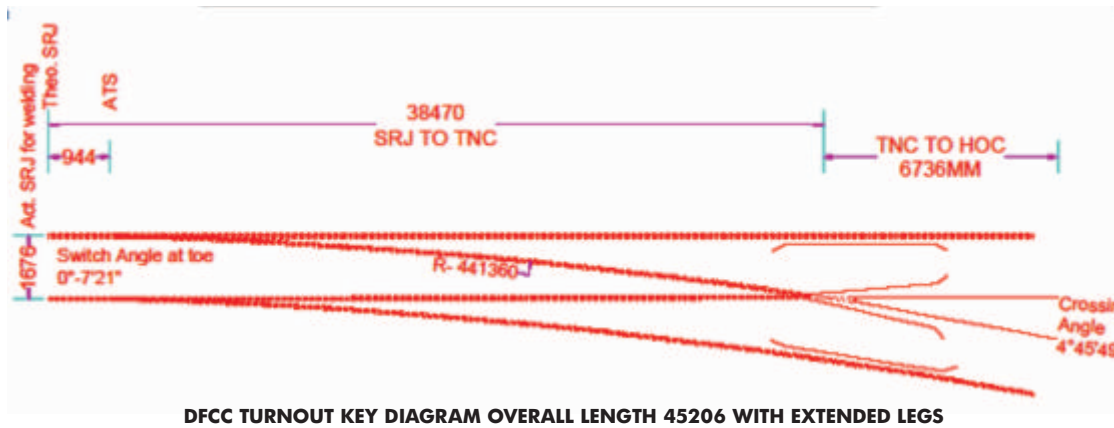
Comparison between IR Thick Web Switches and DFCC turnout in APL2

S No	Item	IR Turnout	DFCC Turnout APL2
1	Type of Turnout	Intersecting	Tangential
2	Gauge	1673mm	1676mm
3	Switch Entry Angle	0º20'00"	0º7'21"
4	Radius of Lead Curve	441360mm	441360mm
5	Operational speed on loop lines	30 Kmph	45 Kmph
6	Rails-Stock	60 Kg UIC 880 Grade	60 Kg UIC 880 HH
7	Rails-Tongue	Thick web ZU-1,60	Thick web ZU-1,60
8	Top Table of Rails	Flat	1 in 20 Cant
9	Layout	Fan Shaped	Fan shaped
10	Operating system	Elect. Point machine with Spring Setting device	Elec. Point Machine with synchronized Back Drive System
11	LWR forces	Not suitable	Suitable to take CWR forces.
12	Anti-Creep Device	Not Provided	Provided
13	PSC sleepers	Fan shaped fit for 22.1 T axle Load	Fan shaped Modified with 25 T Axle Load

14	Approach sleepers at Entry and Exit Points	Required	Not Required
15	Crossing	1 in 12 ,Fixed nose, Fish plating Required	1 in 12, Fixed Nose with Extended Legs, welding can be done with Lead portion.
16	Fittings	Elastic	Elastic, allowing 1 in 20 Cant
17	SRJ to TNC	36.902m	38.470m
18	Overall Length	40.000m	45.206m



IR TURNOUT KEY DIAGRAM OVER ALL LENGTH 40000



DFCC TURNOUT KEY DIAGRAM OVERALL LENGTH 45206 WITH EXTENDED LEGS

Exhibit 6

Exhibit 7

Exhibit 8

Codes and References used in the Design & Materials used in 1 in 12 canted Turnout

1.	Contract Agreement HQ/EN/EC/D-B/Mughalsarai - New Bhaupur/CP-201&202
2.	Layout calculations by IRICEN Pune.
3.	Indian Railway PWAY Manual
4.	Indian Railway LWR Manual
5.	IRS -T12-2009
6.	IRS -T10- 2000
7.	IRS-T23-1967
8.	IRS-T31-1992
9.	IRS-T44-1995
10.	IRS-T29-2000
11.	IRS-T1-2012
12.	IRS-T42-1988
13.	IRS-T46-1996
14.	IRS-T39-1985
15.	IRS-T16-1981
16.	IRS 10mm Thick GRSP RDSO M&C/RP-200/ 2007(Provisional)

17.	IRS 6mm Thick GRSP RDSO M&C/RP-198/ 2006(Provisional)
18.	IS-2062-2006
19.	IS-210-1993
20.	IS-1148-1992
21.	IS-1875-1992
22.	IS-2016-1981
23.	IS-3063-1991
24.	IS-4072-1975
25.	IS-1148-1992
26.	IS-2074-1992
27.	IS-2875-1992
28.	IS-3073-1992
29.	IS-5571-1993
30.	IS-104-1979
31.	IS-117-1998
32.	IS-1153-2000
33.	IS-55S7 Gr42
34.	IS-6649
35.	BS-EN-13232-1 to 9

Mechanization in Electrification Works over Western Dedicated Freight Corridor

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ABSTRACT

The electrification works over IR had so far being executed at a slow pace mainly on account of execution of important activities like foundation, mast erection, wiring, cantilever adjustments etc. on manual basis. Western Dedicated Freight Corridor (WDFC) is currently implementing the project having a route length of 1504 Kms. with double line tracks from Dadri in Uttar Pradesh to Jawaharlal Nehru Port Trust (JNPT) in Maharashtra with lot of emphasis on mechanization cum automation of critical and time consuming activities as mentioned above. This article describes the highlights alongwith key machines being deployed to expedite the pace of electrification over the corridor. The salient features, key equipment used alongwith their capacities, the extent of saving in time etc. are also explained in detail.

Introduction

The Dedicated Freight Corridors have been planned in India with a prospective in mind that they are designed to act as high capacity rail transit corridors with several merging and demerging nodal points on the Indian Railways (IR) network. The Western Dedicated Freight Corridor (WDFC) is currently undergoing its project implementation in India. The project, partly financed by Japan International Cooperation Agency (JICA) at an estimated cost of 470 Billion Indian Rupees (INR), has the unique feature of being the world's first electrified dedicated freight corridor suitable for running of double stack containers having a height of 7.1 metre from the rail level. This requirement of running double stack containers of height 7.1 meter on WDFC shall create the need for developing the traction contact lines at 7.54 meter height, which leads to several challenges in construction stage of electric traction system. WDFC has adopted 2X25kV system, which in itself poses several challenges in construction due to additional feeder wire and Aerial earth wire running along the OHE masts/portals.

The electrification over IR has so far being executed using conventional means of casting of foundations, mast erection, wiring, droppering, adjustment of cantilevers etc. primarily on manual basis to a great extent. It has led to avoidable delays in execution of the projects, thereby, leading to inefficient system of working mainly due to slow progress being achieved inspite of deployment of huge labour. WDFC has kept all the challenges being faced by IR in mind and accordingly, tried to adopt the mechanization to a great extent (depending on the site conditions) for all major and critical activities involved in electrification works.

WDFC has adopted mechanisation mainly for time consuming activities like digging of holes for foundation, mixing of concrete in batch plants, transfer of concrete to site through transit mixers, casting of foundations directly from transit mixers, mast erection, wiring and auto tensioning, droppering, cantilever adjustment etc.

These mechanization activities alone have led to a sharp reduction in execution time, saving in no. of staff deployed for various activities and thus have led to fast execution rate followed by better quality/consistency during execution. The details of activities being mechanized and the machines deployed for these tasks are explained in detail in next section.

Mechanization of Important OHE Activities

High levels of mechanization in electrification works has already been introduced over worldwide by different Railways, which has helped in cutting down

the execution time mainly due to adoption of efficient, standardized and fast installation methods. The mechanisation of these activities will ensure faster project execution, improved quality of services, more efficiency and accuracy in operations and also improve the working conditions of railway staff. The details of mechanization adopted in various activities is elucidated below:

A. Foundations

Indian Railways had so far been using only conventional/rectangular foundations during electrification works using digging of holes by the labour manually. The activity of foundations becomes the most time consuming activity, if conventional methods are adopted for its execution. Moreover, this is the first activity and the progress of the project depends to a great extent on rate of execution of foundations. Therefore, there is a prime requirement of mechanization of this activity to the extent possible.

Apart from above, the major area of Phase-I in WDFC is having hard rocky strata as shown in Figure 1, which increases the problem many fold as far as the foundation activity is concerned.

In order to facilitate mechanized excavation of foundations, to cause least intervention to the sub-soil track formation and for an expeditious execution of the project in a time bound manner, cylindrical foundation design has been adopted by WDFC for first time in India for all types of catenary structures. Further, the cylindrical foundations also offer advantages in terms of lesser space requirement, lesser concrete alongwith lesser execution time as the design of cylindrical foundations matches with shape of drilling with mechanized augur (used for digging of holes for foundations) followed by better service life of foundations. The details of different mechanization means adopted for foundation activity are as given below:

Fig.-1 Typical rocky strata over WDFC

(I) Mechanized Augering

WDFC has adopted complete mechanization in excavation and casting of foundations with the help of deployment of different machines as given below:

a. Tractor mounted guided augers

b. Excavator mounted guided auger with rubber padded crawlers – Manufactured by Colmar, Tescar etc.

c. Rail Road Versatile (RRV) excavator mounted guided augur RRV- Manufactured by Colmar, Tescar, Palfinger etc

d. Rail based augering equipment

These machines have been deployed at different locations depending on the site conditions. Rail based

Fig.-2 Rail based augering equipment

augur shown in Fig.2 is more suitable for locations in yards, as the travel speed of this vehicle is less. One rail augur is capable to carry out excavation for 7-8 foundations per day in yard. For mainline foundations, the fast moving vehicles are preferred, as these may need to travel large distance to reach the site of casting of foundations. The tractor based augur machine is suitable to drill portal foundations of size 900 to 1200mm diameter with 5000 mm depth in 20-30 minutes as against 10-12 hours working by 3-4 labour staff manually. However, around 20-25 nos of mast foundations can be executed on per day basis by this machine.

The details of different machines deployed for augering purpose in terms of their capacity and productivity for foundation activities is summarized below:

Sr. No	Machine	Usage	Capacity per machine per day	Machine deployed
1	**Tractor Augers**	Pre Ballast stage	8-12 Nos.	
2	**Track Mounted Augers**	Track based augering	7-8 Nos.	
3	**RRV Auger Make: Palfinger**	Track based augering	20-25 Nos.	
4	**Crawler based RRV**	Semi hard rock area, suitable for more than 4m implantation	40-50 Nos.	
5	**Crawler based RRV Make: Tescar**	Rail cum road augering	15-20 Nos.	

These machines are suitable for excavating of foundations under different conditions like tractor auger is suitable for pre ballast stage construction i.e. where blanketing has been done and track not laid. On the other hand, the track mounted augers and RRV of make Palfinger crane can be utilized in areas, where the track has also been laid and the vehicles need to move on the track due to non-accessibility/non availability of suitable and convenient approach by road.

(ii) Hard Rock Foundations

There are large no. of stretches in WDFC project, where rocky strata is encountered. This in itself poses a great challenge in augering, thereby, leading to slow progress of foundation activity, if manual methods are adopted. Thus, to expedite the progress of foundation activity, crawler based RRV Tescar/Colmar as shown above has been used for augering in the rocky strata, in case the track has already been laid. In case of hard

rocks encountered during digging, special JCB breakers have been deployed to cut the rocks. The use of HILTI TE AVR Breaker as shown in Fig.3 has been made for smoothening of rough holes drilled by Tescar/Colmar/JCB breaker to save time. With the help of one set of above arrangement, it has been possible to achieve 1 foundation per day in hard rock areas, which otherwise would not have been feasible to execute manually with the available resources of manpower as well as time schedule.

Fig.-3 HILTI TE AVR Breaker for augering

(iii) Mechanized Concrete Mixtures/ Batching Plants

To expedite the foundation activity and for a better quality control/proper mixing of constituents, different equipment used for concreting operation are as given below:

a. RRV concrete mixer

b. Ready mix concrete batching plant

c. Transit Mixer (RRV)/vehicle suitable for road

d. Concrete vibrator

e. Wheel barrow

Fig.-4 Ready mix concrete batching plant and transit mixture

As shown above, no. of mechanized concrete mixture batching plants as shown in Fig.4 have been installed at designated places along the corridor. Industrial R.O. plants have been commissioned alongwith batching plants to ensure the quality of concrete mixture, as the raw water quality varies from place to place. To have proper record and history, computer generated batching slip is generated by the plant after the mixing operation. It takes only about 30 minutes to prepare first batch of concrete of around 6 cum quantity, whereas manually, it takes large labour and substantial time to prepare concrete of this much quantity. The concrete of grade M15/M20 is mixed as per IS:456 as per the site requirement. Further, the mixing quality form batching plant is far superior than manual mixing.

From these batching plant locations, the concrete is transported to the foundation sites through transit mixtures, which are able to run on roads as well as on tracks. The material in transit mixtures is consumed within 3 hours of mixing at batching plants after conducting necessary slum test. Apart from above, Fig. 5 shows concrete self loading mixture, which is capable of mixing the aggregates as per site requirement and it is easy to transport to difficult terrain locations. It is capable of mixing aggregates upto 4 cum quantity at a time.

Fig. 6 shows different techniques deployed for pouring of concrete from transit mixtures in the foundations for different site conditions. Accordingly, different methods have been adopted for concrete pouring inside the foundations to result in efficient and expeditious execution. Fig. 7 shows the use of boomplacer for pouring of concrete, which is more suitable for locations in yards or where the foundation locations are at a distance from the transit mixture. In case of non accessibility to site, wheel barrow may be used to move the ready mix concrete to the site of foundation. The mechanized construction of cylindrical foundation as explained above results in achieving faster execution, higher efficiency, reliability & consistency in the construction. The complete activity of augering, centering, alignment, casting and concrete pouring is depicted in Fig.8.

Fig.-5 Concrete self loading mixture

B. Mast/Upright/Boom Erection

The activity of mast, upright, boom erection takes a quite large time, if conventional means are adopted. However, WDFC has utilized mast grabbers for this purpose, which is suitable for lifting/grabbing the mast and placing it in the foundations, thereby, resulting in very fast erection of masts and uprights. Even it is very much easier and useful for erection of masts at critical locations such as on bridges, Earth Retaining Structures, via ducts etc. The main advantages are:

- It leads to safe working while adjacent to live tracks.
- Better and ease in accessibility for embankment areas
- Faster and better precision than conventional methods

Concrete pumping through pipe

Crane bucket pouring method

Fig.-6 Concrete pouring methods

Fig.-7 Concrete pouring using boomplacer

Digging of hole

Centering and alignment

Concrete pouring

Guide chute to pour

Finished cylindrical foundation

Fig.-8 Process of casting of cylindrical foundation

- Higher productivity
- Easier to operate, being self propelled
- Ease in mast erection particularly on bridges and via ducts – faster erection with better accuracy
- Ease in transportation of masts/uprights in yards from one location to other
- No damage to galvanization coating on masts/portals during transportation/erection

Similarly, Palfinger crane fitted on a vehicle with capability to run over the tracks (being self propelled) has been adopted for erection of booms in yards. The reach of the crane has been designed such that it can pick and erect the booms of different heights easily. WDFC has been able to erect as many as 41 booms in a single day in a yard. In case the boom length is more, such as R type, it has been possible to erect the same with the help of two such cranes positioned on two different tracks in a yard as shown in Fig.9.

Mast grabber for mast erection, grouting and palfinger crane for mast erection

Similarly, Palfinger crane fitted on a vehicle with capability to run over the tracks (being self propelled) has been adopted for erection of booms in yards. The reach of the crane has been designed such that it can pick and erect the booms of different heights easily. WDFC has been able to erect as many as 41 booms in a single day in a yard. In case the boom length is more, such as R type, it has been possible to erect the same with the help of two such cranes positioned on two different tracks in a yard as shown in Fig.9

C. Wiring and Tensioning Arrangement

The activity of overhead laying of contact and catenary wires had been done manually over IR so far, which requires large no. of staff alongwith the need of laying catenary and contact wires separately under different traffic blocks. This had led to very slow progress of wiring activity of the order of around 1.5 TKM per day only. The conventional method of wiring is more prone to twists/kinks in contact wires, whose rectification takes longer time during tower wagon checking. WDFC has adopted wiring train shown in Fig.10, which is having facility of adjustable auto tensioning as per the design requirements alongwith necessary instrumentation for ensuring proper tension and uniform rotation of wiring drums. The machine has been procured from OMAC Italy and equipped with capstan unit, main guiding mast, auxiliary mast, motorized reel stands, compensators, guide rollers etc. mounted on a wagon. The wiring train has facility of laying both contact and catenary wire alongwith simultaneous tensioning facility at the time of laying of wires themselves with the help of puller/tensioner. The machine is able to provide tensioning force of upto

Boom erection using two Palfinger cranes

Fig.-9 Mast/Upright/Boom Erection

20KN, while moving at a continuous speed of 5kmph.The manpower requirement too becomes very minimal and the quality of laying of contact as well as catenary wires is far superior than conventional methods. Moreover, it has been possible to carry out wiring with auto tensioning of both contact and catenary wires under around 60 minutes traffic block only, thereby, leading to expeditious progress of the project. WDFC has been able to lay contact and catenary wires of around 25 TKM in a single day by using two wiring trains simultaneously alongwith necessary tensioning of the contact and catenary wires in open line area.

Fig.-10 OHE Wiring activity using wiring train

D. Laying of AEC and Feeder Wire

WDFC has adopted 2X25kV system which necessitates running of (-) 25kV feeder line in parallel to OHE. Similarly, the Aerial Earth Wire (AEW) used for normal current return and fault return current, needs to be laid from mast to mast on country side all along the section with proper clamping arrangement on each mast/portal. The laying of feeder wire as well as AEW has been mechanized to a limited extent with the help of arrangement shown in Fig.11 below. The above arrangement results in fast laying of both types of wires without any distortion/damage on account of manual handling by labour. It is possible to lay feeder wire of one tension length of about 2km in traffic block of about 2.5 hrs.

E. Dropper Manufacturing & Droppering

The droppers used over WDFC are quite different from being used on IR in terms of the fact that the droppers used over WDFC are flexible and current carrying and the same needs to be pre fabricated. Accordingly, the manufacturing of these droppers is very critical in nature. The dropper manufacturing arrangement adopted over WDFC is shown in Fig.12, wherein the droppers are pre fabricated in the workshop as per their schedule and tested accordingly of droppering of OHE is such that it has to be executed immediately after wiring so as to avoid the possibility of damage from theft incidences. This activity is being done on IR using trolley arrangements, which results in very slow progress. WDFC has made use of specially designed multi utility imported VCPs (Vertical Cradle Platform),

Fig.-11 Laying of feeder wire

shown in Fig.13, which are light in weight, compact and easily maneuverable with limited level of noise and pollution. These equipment are self propelled and easy to drive, so do not need any extra resource for its movement.

Fig.-12 Dropper manufacturing arrangement

Fig.-13 VCP for droppering

The activity of droppering of OHE is such that it has to be executed immediately after wiring so as to avoid the possibility of damage from theft incidences. This activity is being done on IR using trolley arrangements, which results in very slow progress. WDFC has made use of specially designed multi utility imported VCPs (Vertical Cradle Platform), shown in Fig.13, which are light in weight, compact and easily maneuverable with limited level of noise and pollution. These equipment are self propelled and easy to drive, so do not need any extra resource for its movement.

The key features of VCPs are as given below

- Equipped with working platform which is adjustable in height & having an articulated boom
- People are able to climb upto 10m height to attend OHE without any risk.
- 3 people can work simultaneously on the VCP, one on the pole and cantilever and 2 on the catenary.
- It can be equipped with lot of options such as generating set, winch, 1 ton trailer etc.
- It can give quite substantial progress of droppering activity with ease and better accuracy.
- VCP can also be used during wiring and for adjustment of cantilevers.

With the help of above VCPs, WDFC has achieved droppering of around 150 spans (each span having 6 droppers) on per day basis.

F. Cantilever Adjustment

The cantilever adjustment, hitherto, being done manually by using ladders, trollies, leads to slow progress on daily basis, as the staff have to move up and down frequently at each cantilever location. Moreover, the above adopted arrangements are not fail proof and the staff (alongwith tools) is also not much comfortable. Therefore, in this project, use is made of two types of equipment i.e. self propelled truck (which can run over rails as well as on road) and

Fig.-14 Rail cum Road cantilever adjustment track

Fig.-15 Rail based cantilever adjustment vehicle

self propelled rail vehicle as shown in Fig.14 and 15 respectively, which are having high rise platforms, where 3-4 staff can stand easily alongwith necessary tools and make adjustments of cantilevers more comfortably, accurately and in a faster manner, as the staff need not go up and down frequently at each location. The movement operation of these vehicles is easily controlled with the help of communication through a pair of walkie talkie set. The daily productivity of cantilever adjustment has increased sharply after using these two equipment in WDFC. With the help of above arrangements, WDFC has achieved cantilever adjustments of around 100 cantilevers or even more on per day basis.

Conclusion

WDFC has adopted no. of mechanization measures to improve the productivity alongwith consistency in design/quality of different electrification activities using various mechanized means in terms of deployment of machines like rail/rail-cum-road based augers for foundations under different geographical terrains, batching plants for better preparation of concrete mix as per design requirements, transportation/erection of masts/uprights/booms, wiring using wiring trains, droppering activity, cantilever adjustment etc. The above mechanization measures/techniques have definitely improved the pace of progress of electrification activities over WDFC to a great extent even with availability of less labour, thereby, reducing the dependency (to a certain extent) on availability of labour, which is crucial these days due to large no. of electrification projects going over IR. By adopting the above mechanization means, DFCCIL would become instrumental in initiating an innovative process, thereby, leading to quantum jump in productivity of execution of electrification activities. It is also expected that it shall open a new era of technology and vast field of opportunities for Indian Railways to expedite the electrification projects by adopting similar mechanization measures.

Enhanced GIS-based Project Management Information System for Responsive and Integrated Monitoring and Evaluation in WDFC Phase-1

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ABSTRACT

Developing countries face unique challenges with the design, construction and operations of Railway infrastructure compared to the nations with mature infrastructure for planning, design, construction and operation of facilities. Due to the large amount of cost involved and steeper project completion timeline, there is a requirement to adopt effective and strong tools for Systematic Project Management by means of PMBOK. The objective of this paper is to demonstrate how Enhanced GIS-based Project Management Information System (PMIS) can perform to satisfy the responsive and integrated construction progress monitoring and evaluation work of Nippon Koei Consortium (NKC) as a real-time and integrated web-based solution. This is an in-house comprehensive open source web-based Project Management Information System (PMIS) integrated with Geographic Information System (GIS) and Global Positioning System (GPS) for the project documentation control and monitoring of works. The entire 922km long Western Dedicated Freight Corridor (WDFC), PMIS provides a graphical representation of railway elements - lines and other assets that can be accurately represented as a map (Cartographic representation) on a monitor (screen) graphic station for monitoring and evaluation. Moreover, the dashboard with a pool of updated data and the maps generated through PMIS enable easy viewing of railway track construction and an easy way to identify an object or a group of objects which are seeking information or that are related to certain activities. To conclude, PMIS integrated with geospatial information systems and geospatial technologies is a highly effective information system that can easily be integrated with multi-disciplinary perceptions covering the fields of social, economic and environment to offer real benefits for the country. The PMIS integrated with GIS is not only be able to communicate considerable amounts of information in an efficient and attention-getting manner for the planners and decision makers, but also caracterized by integrated modeling of freight traffic between major transport hubs and market centers.

Keywords Project Management Information System, Dedicated Freight Corridor, Railway Construction, GIS, GPS, Monitoring and Evaluation

Introduction

In any Construction Project, the project managers face hard times monitoring the projects between site and office owing to a large number of tasks and activities involved in it. The railway is not exceptional as the organizations invest heavily in their track network and related support infrastructure. These networks support the critical movement of goods and services and can often make a key difference in keeping regional and even national economies competitive.

Developing countries face unique challenges with the design, construction and operations of Railway infrastructure compared to the nations with mature infrastructure that follows traditional technology models for planning, design, construction and operation of facilities. Moreover, the large amount of cost involved and steeper project completion timeline often makes the managers confused on what to do next or what would be the changes faced by them in the future. Hence, there is a requirement to adopt effective and strong tools for Systematic Project Management by means of PMBOK. For achieving this objective, the integration between construction project management and the Geographical Information System seems to be the effective.

The Western Dedicated Freight Corridor (WDFC) Phase-1 project area is 922 Kms. long for which inspection by Engineers and compiling the reports showing overall progress may take several days. Moreover, there are seven different contract packages: three Civil and Track Packages, one Steel Bridge Package, one Electrification Package, one Signal and Telecommunication Package, and Procurement of plant and equipment for Maintenance Package under direct construction management practices by the Nippon Koei Consortium (NKC), the Engineer for WDFC Phase-1. Sometimes, these packages will work at the same place and the same time to keep their time schedule which obviously will require better project monitoring, integration and interfacing among the stakeholders. Thus, a comprehensive Information System is essential which can be extended to monitor not only the construction process itself, but also all the supporting activities, including on-site plant and equipment.

To meet this requirement, NKC has introduced an in-house comprehensive web-based Project Management Information System (PMIS) integrated with Geographic Information System (GIS) and Global Positioning System (GPS) for the Project Documentation Control and Monitoring Works and the same is operational since 30th May 2015. The objective of this paper is to demonstrate how Document Control and GIS can be integrated in software tool for construction progress visualization and an integrated information system. In one way, GIS allows project managers and different people involved in project with different backgrounds to get the information about the progress of the project and support decision making. On the other hand, GIS supports a common basis of understanding and communication among the stakeholders and decision makers. Hence, the PMIS integrated with GIS is not only able to create high quality maps, but also communicate considerable amounts of information in an efficient and attention-getting manner for the planners and decision makers.

Objective

The objective of this paper is to demonstrate how Document Control and Geographic Information System (GIS) can be performed in the Project management Information System (PMIS) for railway freight corridor construction as a real-time and integrated web-based solution. This means the goal of this paper is to demonstrate the benefits of using Dashboard and Geographic Information System integrated with construction project management.

Overview and Components of PMIS

To meet the objective mentioned above, NKC has developed the "Real Time" supervision System under the NKC IT System named as PMIS, which is a system with the approach to reduce as much as possible the human errors, the communication gaps among the related organizations and help to solve the technical issues, improve the progress delay as well as to perform risk mitigation. For the entire 922 Kms. long Western Dedicated Freight Corridor (WDFC), PMIS provides a graphical representation of railway elements - lines and other assets that can be accurately represented as a map (Cartographic representation) on a monitor (screen) graphic station for monitoring and evaluation. The dashboard with a pool of updated data and the maps generated through PMIS enable easy viewing of railway track construction and an easy way to identify an object or a group of objects which are seeking information or that are related to certain activities (Figure-1).

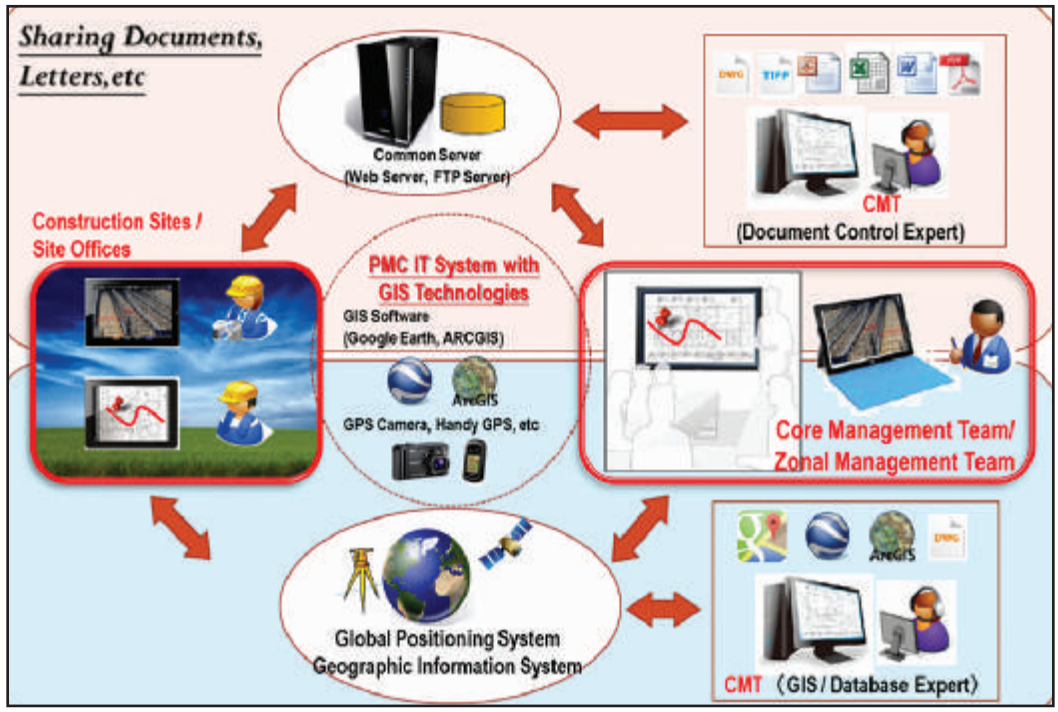

Fig.-1 Overview of Project Management Information System

PMIS assists in

- Control and manage all the data (Design, Survey, Construction Machine, Quality Control, Progress Control data) in one system using the electronics information.
- Real time update and share these latest information among clients, constructors and consultant.
- Providing necessary information e.g. Design Documents, Design Drawings, correspondence Letters for each Package to all concerned stakeholders.
- Visualization of DFC Alignment, Structures and design drawings on GIS Database.
- Visualization of Project Progress with Site Photos on GIS Database.

Document Control

- Incoming /Outgoing letters related to 6 work contracts and 1 PMC contract
- All reports of PMC contract
- Design submission from 6 contracts
- CDP/GFC drawings
- Work Procedure / Method Statement
- NCR, EI, Weekly Site Schedule
- Site photos, etc.

Progress monitoring with GIS

- Alignment data (F.L., G.L, fill/cut)
- Bridge data with approved CDP/GFC
- ROW information
- Earthwork progress with color code
- Bridge/building progress with color code
- Track progress with color code
- Site photos

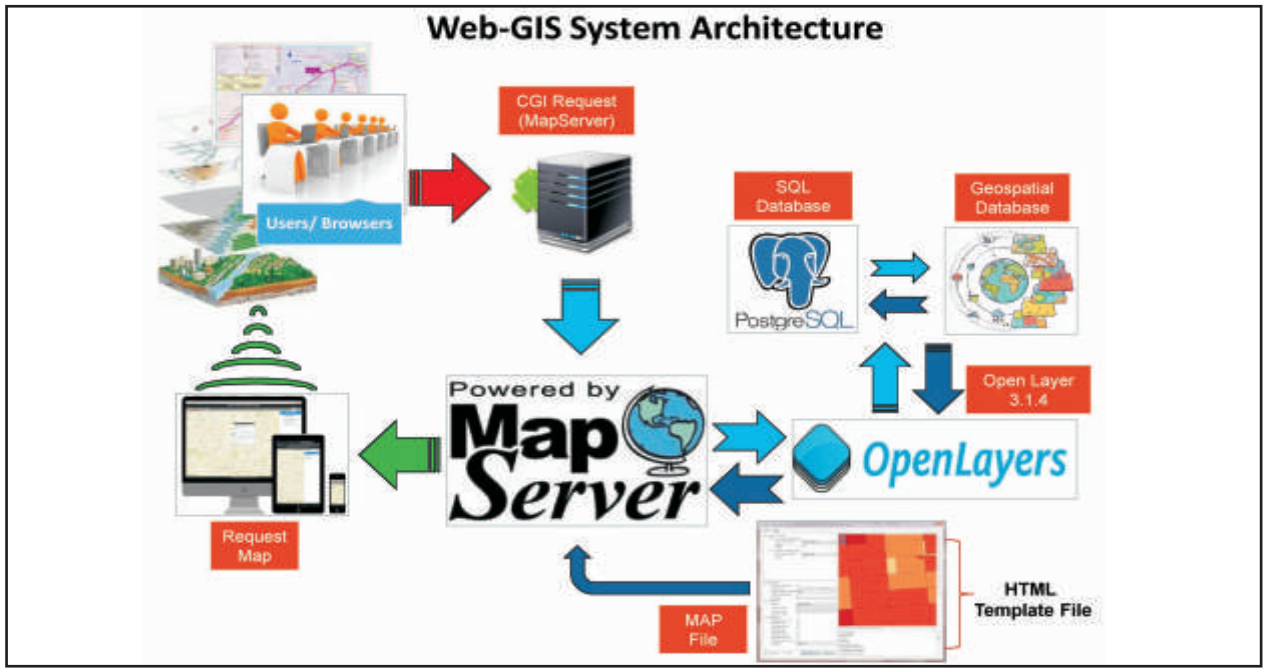

Fig.-2 Modules of PMIS (left) and Architecture of GIS web-system (right)

- Improving the communication among all concerned members of the project by developing the tool for top down and bottom up communication.

PMIS has two distinct components (1) Dashboard – to Control of all incoming and outgoing communications in the form of letters and submittals and (2) GIS module- to view and analyse the actual work progress at site (Figure-2).

It should be kept in mind that geospatial solution is not a simple map, because a GIS map involves much more than a data "engine" for processing spatial characteristics. After overcoming the visual border, GIS map becomes a remarkable collection of alphanumeric data (attributes) and geographical (positioning elements) which usually are the result of workflows performed by personnel from various functional departments of the institution. Management and maintenance of railway infrastructure using GIS allows administrators to rapidly identify and resolve infrastructure problems caused by any disruptive factors in DFCCIL system.

Technologies Used

The PMIS is a highly secured web-based platform based on the latest technologies that represents the state-of the-art progress monitoring practices in WDFC Phase-1. The PMIS website can be accessed through https://nkc-pmc1-wdfc.co.in/NKCWebProd using secured user id and password issued by NKC. Another significant feature is that the website can be accessed through mobile and tables while at a construction site.

The Dashboard module is based on ASP.NET MVC and MSSQL database while the GIS module is based on Map Server, PostgreSQL database and Open Layer Plugin (Figure-3). The security permission has been endorsed at various levels such as a) normal users, b) admin users and c) system admin

- NKC Web Application is rich in user's maps/ layers/ documents safety, security and permissions
- Admin can set permissions at different level of users/group
- Permissions determine who can view, download, edit and manage layers, maps and documents ('system admin' has the master control and 'admin users' can upload/ download data while 'normal user' has view only permissions)

GIS is both a database system with specific capabilities for spatially referenced data, as well as a set of operations for working with the data. Geographically referenced data separate GIS from other information systems. Let us take an example of

road. To describe a road, we refer to its location (i.e. where it is) and its characteristics (length, name, speed limit etc.). The location, also called geometry or shape, representing spatial data, whereas characteristics are attribute data. Thus, a geographically referenced data has two components: spatial data and attribute data.

Key Features and Functions

Dashboard

The main window of Dashboard system comprises of four main features 1) Latest construction updates, 2) Helpful links, 3) Construction physical progress at a glance and 4) Documents search (letters, submittals, drawings) (Figure-3)

1) **Latest Construction Updates:** This feature presents the site construction photographs along with descriptions. The photographs are geotagged (latitude/ longitude) ones, i.e. taken using cameras having GPS facility. These photographs when opened in GIS website or Google Earth shows the exact location where it was captured on a particular date and time. This helps the stakeholders to know about the stages of construction at the site as on date and find the impedances faced by Site Engineers. This also helps in approving requests for investigation (RFI) that act as an evidence for approving the interim payment certificate (IPC).

2) Helpful Links: The helpful link in the dashboard is the link that provide instant access to useful details about the project and the process, e.g. PMS member list with contact details, Site hut locations and manager in-charge, schedule and progress charts.

3) Construction Physical Progress: This

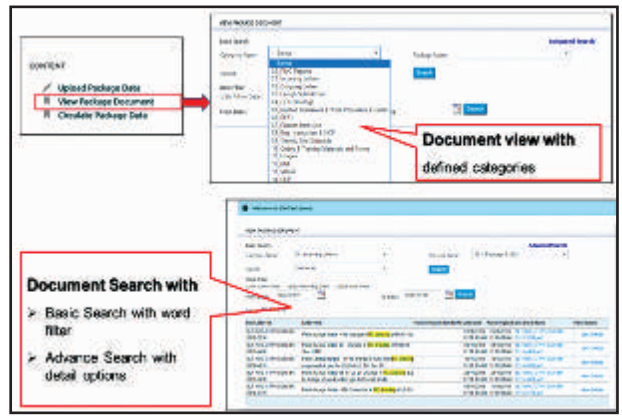

Fig.-3 PMIS Dashboard module (left) and document search system (right)

section provides the construction physical progress at a glance based on cost centres defined in the Contract, e.g. the Global progress presents the overall construction progress % considering all the contract packages on WDFC Phase-1.

4) Document Search: The PMIS is a storehouse of past communications/ documents in the form of letters, submittals, drawing and designs. It comprises of a searchable database in MSSQL that helps the users to find any past documents either Incoming (received from Contractors/ Client) or Outgoing (sent to Contractors/ Client). The user can search this record by Packages, Date, Document number, Document title, etc. Even the users are provided with the option to search the geotagged photographs that represent the site work progress (Figure-3).

5) KML Upload and Search: The .KML files containing the alignment and structural details for overlay in Google Earth Viewer are being uploaded in the PMIS. This inventory of .KML files are searchable and user can select the required section using the "Advanced Search" option.

GIS Module

The main function of web-based GIS monitoring system are geo-referencing of the alignment on WGS 84 coordinates, capture and upload of geo-referencing coordinates of the assets into GIS and monitoring of project progress online. This is a State-of-the-art GIS system developed for the WDFC Phase-1 project. With GIS technology, the development of new infrastructure will follow new technology models eliminating data redundancy, construction, and operation of

infrastructure data in Dedicated Freight Corridor Construction and Maintenance. The geotagged assets will be of high importance in developing an asset management database for future business, integration and planning (Figure-4).

Using the above Map Window, the users can interactively select the packages, sections and then the

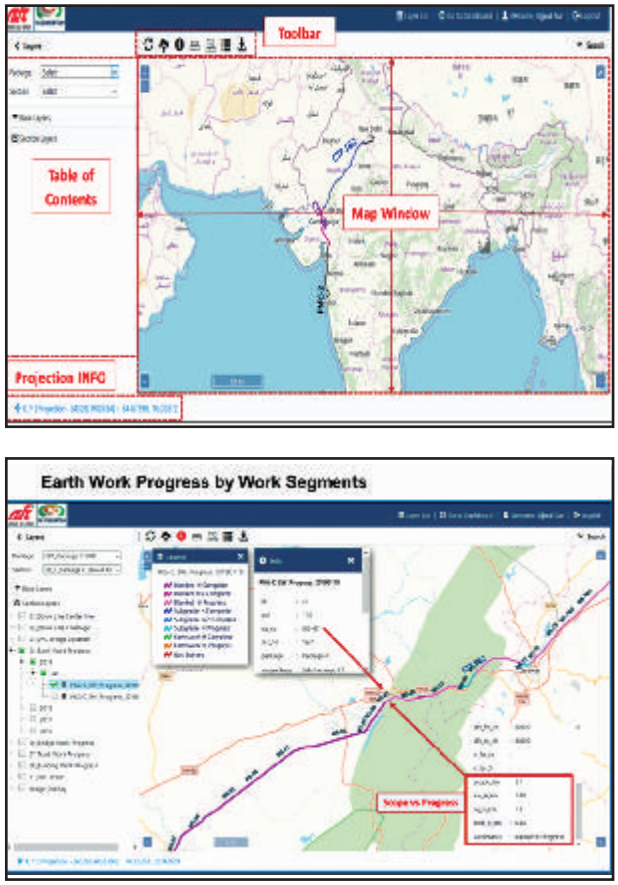

Fig.-4 Web-GIS module map-viewer (left) and earthwork progress monitoring (right)

progress parameters. The NKC PMIS is equipped with map elements such as Legend/ Master Legend, Scale Bar and Map Projection System and can export maps directly from the web-system for a particular area. The construction designs and drawings can also be viewed by their locations overlaid on Open Source Maps (OSM). Even the construction stage at different time frame can be compared easily to view the overall quantitative progress over a period of time (Figure-5).

The GIS module is well capable of visualizing and analyzing the construction work progress of various

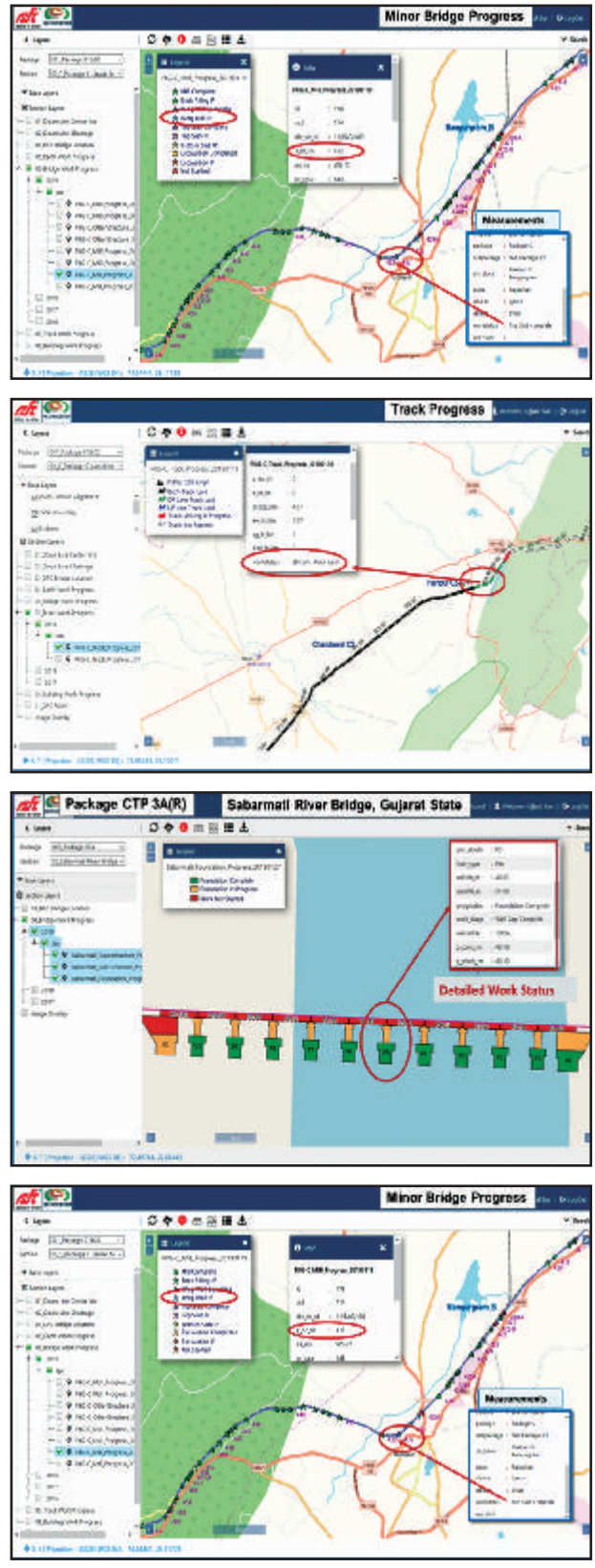

Fig.-5 Web-GIS modules (from top left in clockwise direction) Progress monitoring of Bridges, Track skeleton, Geotagged site photographs and work progress of Steel Bridge

activities such as monitoring of bridges, buildings, tracks, E&M works and S&T works by construction phases. Another unique feature of the PMIS is visualizing work progress on GIS maps. This is done by importing the geotagged site photographs in GIS. This helps to view various sites related issues that may delay the overall construction of railway assets or, interface issues.

Benefits and Limitations of PMIS

Some of the key benefits of the PMIS are-

- Highly accurate coordinates of DFC alignments and structures
- Secured storage of project information (letters, submittals, drawing and designs)
- Periodic update of construction progress using available online maps, drone videos and satellite images
- Real time geo-tagged site photographs showing Work Progress
- A Global Reach – can be accessed from anywhere over internet
- Better cross-platform capability
- Integration of data - Analysis and planning
- Cost Effective Technology
- Diverse Applications and handing over of information to clients

The current PMIS GIS module is based on open source solutions. Though this helps NKC to go for a cost effective solution, however, there are certain functions that could be easily applied using the licensed versions of the software.

Going forward, the georeferenced Assets of WDFC will be captured and uploaded in PMIS GIS module every asset can be mapped and in future, they can be integrated with the Enterprise Resource Planning (ERP) comprehensively. Moreover, the performance of PMIS depends on internet data speed and a high-end server may speed up the process faster. Hence, with more and more data being uploaded in the PMIS, there is a need to enhance the Server configuration and capacity for optimum result. The advance integration of mobile application that may help to include the site data directly into the web-server may be taken up in the next version of the web-system based on specific requirements.

Conclusion

The study specifies that the PMIS is well capable of providing data, and allow iterative design/data collection procedures without exchanging data files of differing formats, version, and content. Due to superior spatial data handling capabilities, Geographic Information System (GIS) technology is increasingly being considered for implementation in many infrastructure projects.

As presented above the features and functions of PMIS is an integrated part of the Project management Consultancy which provides effective and efficient support in construction of dedicated freight corridors for DFCCIL. The information stored in digital form and analysis and monitoring using GIS interface is a unique feature in the context of new railway line construction. The GIS map becomes a remarkable collection of alphanumeric data (attributes) and geographical (positioning elements) which usually are the result of workflows performed by personnel from various functional departments of the institution. Management and maintenance of railway infrastructure using GIS allows administrators to rapidly identify and resolve construction related problems caused by the disruptive factors.

The upcoming Dedicated Freight Corridors of India are characterized by a concentration of freight traffic between major transport hubs and relatively long distances. These Green transportation corridors will reflect an integrated transportation concept where short sea shipping, rail, inland waterways and road transport will complement each other to enable the choice of environmentally friendly transport (Litra, 2014). To conclude, a PMIS integrated with geospatial information systems and geospatial technologies is a potential information system that can become a more effective and can easily be integrated with multi-disciplinary perceptions covering the fields of social, economic and environment to offer real benefits for the country.

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STATUTORY PROVISIONS AND RBI DIRECTIONS RELATED WITH BANK GUARANTEE IN RELATION TO RAILWAY CONTRACTS

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ABSTRACT

Bank Guarantee is an important instrument of our contract Management. We take BG for various purposes in the contract. There are many important provisions related with the Bank Guarantee which an official dealing with Contract matters in the project should know. The purpose of this article is to apprise the readers on various aspects of the Bank Guarantee.

Introduction

Bank Guarantee means a comfort, which is being given by issuing bank, to a party (Beneficiary in whose favour the guarantee is issued) of losses or damages if the Client (on whose behalf the guarantee is being issued) fails to complete or conform to the terms of agreement.By issuing the guarantee, the issuing bank is assuring payment of the certain amount of money (as specified in the bank guarantee) to the beneficiary in case of non-performance of a certain contract or default according to the terms and conditions contained in the same.

The Bank Guarantee has an implied commitment to fulfil the terms and conditions of the agreed contract. In

case of failure to comply the same, the bank will honour them. It is a guarantee against loss on honesty, sincerity and authenticity of that party.

A contract of guarantee is thus a secondary contract, the principal contract being between the creditor and the principal debtor themselves. If the promise or liability in the principal contract is not fulfilled or discharged only then the liability of the surety arises.

Bank Guarantees are issued for some purpose and for a tenure which automatically get revoked on fulfilment of such purpose and/or completion of such specified period or vice versa. For example, a bank guarantee might be revoked by the beneficiary when the contractor fails to fulfill the obligations contained in the contract. In such a situation, the bank pays the beneficiary to the extent of the amount of Bank Guarantee. Issuance of Bank guarantee is a secured transaction as the client needs to mortgage the properties and cash in the form of FDR for issuing of same. The bank will not give guarantee without securing itself. Bank Guarantee is shown as contingent liability in the notes of account in balance sheet.

Bank Guarantee under the Law

Section 126 of Indian Contract Act, 1872 defines a contract of guarantee as a contract to perform the promise, or discharge the liability, of a third person in case of his default. The various definitions in this context are reproduced as below:

Contract of guarantee

A 'contract of guarantee' is a contract to perform the promise, or discharge the liability, of a third person in case of his default.

Surety

A person or entity who undertakes an obligation to pay a sum of money or to perform some duty or promise for another in the event that person fails to act, is called 'Surety'. Surety is a guarantor of payment or performance if another fails to pay or perform, such as a bonding company which posts a bond for a guardian, an administrator, or a building contractor.

Principal Debtor

The person in respect of whose default the guarantee is given is called the 'principal debtor'.

Creditor

The person to whom the guarantee is given is called the 'creditor'. The creditor is an individual or entity to whom an obligation is owed because he or it has given something of value in exchange.

According to Section 126 of Indian Contract Act, 1872 a Guarantee may be either oral or written. For example, A takes a loan from a bank. B promises to bank saying that if a does not repay the loan "then I will pay". In this case A is the principal debtor, who undertakes to repay the loan; B is the surety, whose liability is secondary because he promises to perform the same duty in case there is default on the part of A. The bank, in whose favour the promise has been made, is the Creditor. The object of a contract of guarantee is to provide additional security to the creditor in the form of a promise by the surety to fulfill a certain obligation, in case the principal debtor fails to do that.

In every contract of guarantee, there are three parties, the creditor, the principal debtor, and the surety. Firstly, the principal debtor himself makes a promise in favour of the creditor to perform a promise, etc. Secondly, the surety undertakes to be liable toward the creditor if the principal debtor makes a default. Thirdly, an implied promise by the principal debtor in favour of the surety that in case the surety has to discharge the liability on default of the principal debtor, the principal debtor shall indemnify the surety for the same.

The contract of guarantee is no doubt tripartite in nature, but it is not necessary or essential that the principal debtor must expressly be a party to that document. In a contract of guarantee, the principal debtor may be a party to the contract of implication. Thus, there is a possibility that a person may become a surety without the knowledge and consent of the principal debtor. In such a case, the rights of the surety are given in sections 140, 141 and 145 of Indian Contract Act, 1872 viz, the right of subrogation, right to securities with the creditor and the right of indemnity

against the principal debtor, respectively.By virtue of Section 126 of Indian Contract Act, 1872, every bank guarantee is a tripartite contract between banker, the beneficiary and the person at whose instance the bank issues the guarantee.

Bank Guarantees are given by Suppliers/ Contractor's Bank in favour of the Principal for following purposes

a) Towards earnest money deposit;

b) As security against performance of the contract;

c) As security against initial and stage payment made by the Buyer to the Supplier;

d) Towards liquidated damages in exceptional cases of large value contracts;

e) Towards guaranteeing specified operational parameters of the equipment;

f) Towards meeting warranty claims in respect of equipment; or

g) Towards performance of maintenance during a specified period (usually one year) in respect of Civil Works Contracts

Types & Purposes of Bank Guarantees

There are broadly two types of Bank Guarantees:

(I) Unconditional Bank Guarantee - In an unconditional bank guarantee, the bank/guarantor has to pay the guarantee amount to the beneficiary in whose favour the bank guarantee has been issued on demand, irrespective of any pending disputes;

(ii) Conditional Bank Guarantee - In a conditional bank guarantee, the bank/guarantor has to pay the guarantee amount to the beneficiary in whose favour bank guarantee has been issued on demand, only after the specific conditions for invocation in the contract are fulfilled.

These are in general Sub-divided into two types of Bank Guarantee namely direct bank guarantee and indirect bank guarantee. Direct Bank Guarantee is a guarantee which is issued by the bank of the account holder directly in favour of the Beneficiary. Indirect Guarantee is a guarantee which is issued by a second bank in return for a counter-guarantee.

A financial institution can provide bank guarantees in different forms. These include the following:

a) Performance Guarantee (or Performance Bond) – These are the guarantees that act as collateral for any loss suffered by the beneficiary in case of non-performance or the performance below par.

b) Advance Payment Guarantee – This is to ensure the safety of any advance payment made by the beneficiary party to the party in case the party is unable to deliver the service or can't get his money back.

c) Payment Guarantee – This guarantee is provided to the client, ensuring payment by a predetermined date.

d) Conditional Payment Undertaking – This is an instruction to the bank from an account holder to pay a sum of money to a creditor on completion of certain conditions. This bond is a post contract instrument that is used to pay off agents and contractor on completion of a project.

e) Guarantee Securing Credit Line – This surety is given to a creditor on claims against the debtor in case a loan is not repaid as per the terms of the agreement.

f) Order and Counter Guarantee – This is a surety given by the debtor to the creditor, to protect against the failure to fulfill an obligation as contracted. In case of default, the creditor can demand the payment back.

Essential features of guarantee

Whether it is a financial guarantee, a performance guarantee or a letter of credit established by a bank, it is a contract under section 126 of Contract Act 1872 to perform the promise or discharge the liability of a third person on that third person's default. In the case of non-

performance or short performance of obligations by its constituents, the bank will be called upon to make good the monetary loss arising out of non-fulfillment of the guarantee obligations to the extent stipulated in the guarantee, to the beneficiary.

The essential features or elements of a valid contract of Guarantee are as under:

a) There must be some liabilty, which should be recoverable.

b) There must be three parties' i.e. principal debtor, creditor and surety.

c) The contract of Guarantee may be either oral or written.

d) There must be a distinct promise, oral or written, by the surety to pay the debt. In case of default, committed by the principal debtor.

e) There should be no misrepresentation or concealment of any material facts concerning the transaction.

f) Sometimes a contract of Guarantee is implied also from the Special Circumstances. For example, the endorser of a bill of exchange is liable to pay the amount of the bill to the payee in case of the acceptor of the bill defaults to fulfill his promise.

g) The principal debtor must be primarily liable. Surety's Liability arises only in case of default of the principal debtor.

h) There should be some consideration. Benefit to the principal debtor is sufficient consideration.

i) The liability under Guarantee must be legally enforceable.

j) The Contract of Guarantee must have all the essentials of a valid contract.

Benefits of Bank Guarantee

Reduction of financial risk:

The need for bank guarantees arose because of the increased defaults by the buyers/Contractors. Sellers/beneficiaries/Clients were not willing to supply goods to unknown buyers without having payments received. A sense of mistrust was present. Bank guarantees solved this issue by acting as an assurer to the beneficiary. The sellers, after obtaining bank guarantees, are ready to supply goods. It brought down their financial risk to a substantially low level.

Increased opportunities

By having bank guarantees with itself, a business can grasp opportunities in the market which were earlier not available to it. A public perception would be developed that a bank stands with a particular business. Having a bank as a partner is always a sign of the inherent strength and faith towards the business.

Small fees

The fees charged by the banks are also very nominal. It ranges from about 0.5% – 1% of the amount guaranteed by the bank. Due to its nominal nature, the fees do not have a significant impact on the profits of the business.

No need for advance payments

Advance payments to the sellers have become a thing of the past. It means that the buyer can defer his cash outflow to a later date. By deferring payments, the available funds can be utilized currently to fuel extra growth.

Increased credibility

Banks exercise extensive credit monitoring. They have specialized staff and tools which can accurately assess the financial health of a business. Hence, the credibility of the entity enhances as it is backed by the banks. The banker's trust would reflect that the performance of the business is great and that there is no risk of default.

Less documentation

In bank guarantees, lesser documentation is required. Only the information about the concerned parties, the details about the transaction about which guarantee is

sought, financials of the applicant are generally demanded by the banks. The level and extent of documentation may change depending on the lender's policy and period of credit.

Operative clause in bank guarantees

All commercial banks apply following limitation clause standardized by Indian Banks' Association (IBA) as a concluding para of the guarantee. This is to avoid ambiguity if any in the body of the guarantee agreement in respect of banks liability under the guarantee and its validity period.

"Notwithstanding anything contained herein: (i) Our liability under this guarantee shall not exceed Rs. ..... (AMOUNT) *(ii) This bank guarantee shall be valid up to .....*(DATE OF EXPIRY) OF THE GUARANTEE) *(iii) We are liable to pay the guarantee amount or any part thereof under the bank guarantee only and only if you serve upon us a written claim or demand on or before .....* (DATE OF EXPIRY OF GUARANTEE OR DATE OF EXPIRY OF CLAIM PERIOD IF ANY CLAIM PERIOD IS PROVIDED IN THE GUARANTEE AGREEMENT TO INVOKE THE GUARANTEE AFTER DATE OF EXPIRY OF GUARANTEE)"

The time limit for raising any dispute or claim by the beneficiary in case of guarantee contracts is generally 3 years from breach of contract. The Section 28 of Indian Contract Act prohibits the parties to an agreement to substitute their own periods of limitation in place of the periods laid in the act. However, the third exception to Banking laws (amendment) act 2012 brings following exception to the statute book.

"This section shall not render illegal if a contract in writing by which any bank or financial institutions stipulate a term in a guarantee or any agreement making a provision for guarantee for extinguishment of the rights or discharge of any party thereto from any liability under or in respect of such guarantee or agreement on the expiry of a specified period which is not less than one year from the date of occurring or non-occurring of a specified event for extinguishment or discharge of such party form the said liability."

This exception to the banking law provisions enables banks and financial institutions to limit the validity period of the guarantee. The beneficiary of the guarantee shall invoke the guarantee as per clause of the bank guarantee in order to honour his /her claim.

Though, the above standard exposure and time-limit clause neither extinguishes rights nor prescribes a period within which any suit has to be filed, however, it clearly makes a distinction between the creation of an enforceable right and the extinguishment of such right, satisfying provisions of Section 28 of the Indian Contract Act, as well as the third exception to Banking Laws (Amendment) Act 2012.

As per the amendment made by the contract (Amendment) Act, 1996 in Section 28 of the Indian Contract Act, 1872, if a beneficiary of a bank guarantee invokes the bank guarantee with the claim period, for a default committed by the debtor during the validity period, then the bank will not make payment, the beneficiary may file suit against the bank within the period mentioned in the Limitation Act, 1963 and any clause restricting the bank's liability will be illegal and void ab initio.

Therefore, the bank should obtain the bank guarantee duly cancelled by the beneficiary or a certificate from the beneficiary that there is no claim under the guarantee. If the guarantee, duly cancelled or certificate is not obtained from the beneficiary, the bank should retain the security of the debtor and cash margin till the expiry of the limitation period under the Limitation Act, 1963.

The various courts have observed in numerous cases that the liability of the bank under the guarantee is absolute and they would not generally interfere with the contractual obligations of the banker by issuing any injunction against the payment when the guarantee is validity invoked. In enunciating the general principle of non-intervention by the

courts in respect of the guarantees and letter of credit the courts intend that trade and commerce should function smoothly without interference from the judiciary. At the sometime, the courts expect businesses to honor their respective commitments and maintain business honesty.

Revocation of Guarantee

So far as a guarantee given for an existing debt is concerned, it cannot be revoked, as once an offer is accepted it becomes final. However, a guarantee for a future debt or continuing guarantee can be revoked for future transactions. In that case, the surety shall be liable for those transactions which have already taken place.

Important provisions and observations in the latest RBI guidelines over Bank Guarantee

RBI has issued latest Guidelines on the Bank Guarantee vide Ref. RBI/2015-16/76, DBR. No. Dir. BC.11/13.03.00/2015-16 dated July 1, 2015. Important provisions are stated as under:

a) General

No bank guarantee should normally have a maturity of more than 10 years. However, in view of the changed scenario of the banking industry where banks extend long term loans for periods longer than 10 years for various projects, it has been decided to allow banks to also issue guarantees for periods beyond 10 years. While issuing such guarantees, banks are advised to take into account the impact of very long duration guarantees on their Asset Liability Management. Further, banks may evolve a policy on issuance of guarantees beyond 10 years as considered appropriate with the approval of their Board of Directors.

b) Precautions for averting frauds

At the time of issuing financial guarantees, banks should be satisfied that the customer would be in a position to reimburse the bank in case the bank is required to make payment under the guarantee. In the case of performance guarantee, banks should exercise due caution and have sufficient experience with the customer to satisfy themselves that the customer has the necessary experience, capacity and means to perform the obligations under the contract and is not likely to commit any default.

c) Model Form of Bank Guarantee Bond

The Government of India have advised all the Government departments/ Public Sector Undertakings, etc. to accept bank guarantees in the Model Bond and to ensure that alterations/additions to the clauses whenever considered necessary are not one-sided and are made in agreement with the guaranteeing bank. Banks should mention in the guarantee bonds and their correspondence with the various State Governments, the names of the beneficiary departments and the purposes for which the guarantees are executed. This is necessary to facilitate prompt identification of the guarantees with the concerned departments. In regard to the guarantees furnished by the banks in favour of Government Departments in the name of the President of India, any correspondence thereon should be exchanged with the concerned ministries/ departments and not with the President of India. In respect of guarantees issued in favour of Directorate General of Supplies and Disposal

d) Payment of invoked guarantees

Where guarantees are invoked, payment should be made to the beneficiaries without delay and demur. An appropriate procedure for ensuring such immediate honoring of guarantees should be laid down so that there is no delay on the pretext that legal advice or approval of higher authorities is being obtained.

e) Delays on the part of banks in honoring the guarantees when invoked tend to erode the value

of the bank guarantees, the sanctity of the scheme of guarantees and image of banks. It also provides an opportunity to the parties to take recourse to courts and obtain injunction orders. In the case of guarantees in favor of Government departments, this not only delays the revenue collection efforts but also gives an erroneous impression that banks are actively in collusion with the parties, which tarnishes the image of the banking system.

f) The top management of the banks should bestow their personal attention to the need to put in place a proper mechanism for making payments in respect of invoked guarantees promptly, so that no room is given for such complaints. When complaints are made, particularly by the Government departments for not honoring the guarantees issued, the top management of the bank, including its Chief Executive Officer, should personally look into such complaints.

g) In this regard, the Delhi High Court has made adverse remarks against certain banks in not promptly honoring the commitment of guarantees when invoked. It has been observed that a bank guarantee is a contract between the beneficiary and the bank. When the beneficiary invokes the bank guarantee and a letter invoking the same is sent in terms of the bank guarantee, it is obligatory on the bank to make payment to the beneficiary.

h) The Supreme Court had observed [U.P. Co-operative Federation Private Ltd. versus Singh Consultants and Engineers Private Ltd. (1988 IC SSC 174)] that the commitments of the banks must be honoured, free from interference by the courts. The relevant extract from the judgement of the Supreme Court in a case is as under:

"We are, therefore, of the opinion that the correct position of law is that commitment of banks must be honoured free from interference by the courts and it is only in exceptional cases, that is, to say, in case of fraud or any case where irretrievable injustice would be done if bank guarantee is allowed to be encashed, the court should interfere"

h) In order to avoid such situations, it is absolutely essential for banks to appraise the proposals for guarantees with the same diligence, as in the case of fund based limits, and obtain adequate cover by way of margin so as to prevent the constituents to develop a tendency of defaulting in payments when invoked guarantees are honoured by the banks.

i) Any decision not to honour the obligation under the guarantee invoked may be taken after careful consideration, at a fairly senior level, and only in the circumstances where the bank is satisfied that any such payment to the beneficiary would not be deemed a rightful payment in accordance with the terms and conditions of the guarantee under the Indian Contract Act, 1872.

j) Where the bank is a party to the proceedings initiated by Government for enforcement of the bank guarantee and the case is decided in favour of the Government by the Court, banks should not insist on production of certified copy of the judgement, as the judgement/ order is pronounced in open Court in presence of the parties/ their counsels and the judgement is known to the bank.

k) In case the bank is not a party to the proceedings, a signed copy of the minutes of the order certified by the Registrar/ Deputy or Assistant Registrar of the High Court or the ordinary copy of the judgement/ order of the High Court, duly attested to be true copy by Government Counsel, should be sufficient for honouring the obligation under guarantee, unless the guarantor bank decides to file any appeal against the order of the High Court.

l) The Government, on their part, have advised the various Government departments, etc. that the

invocation of guarantees should be done after careful consideration at a senior-level that a default has occurred in accordance with the terms and conditions of the guarantees and as provided in the guarantee deed.

Legal and judicial course

Legitimacy of invocation of bank guarantees has always been a bone of contention between the parties who have entered into commercial arrangements. While the general view of the courts in India has been that invocation of bank guarantee should generally be not interfered by the courts when challenged, as it will defeat the purpose of such guarantees in commercial contracts. However, there is no dearth of judicial pronouncements against invocation of bank guarantees albeit in exceptional circumstances.

The law with respect to the grant of injunction against invocation of bank guarantee has been settled by catena of judicial pronouncements. Courts have consistently held that an unconditional bank guarantee, which is an independent agreement between beneficiary and the Bank, can be invoked by the beneficiary, regardless of the disputes between the beneficiary and principal obligation (i.e. the party on whose behalf the bank guarantee has been given).

It is a settled position that invocation of unconditional bank guarantee cannot be stayed by the courts except (i) in case of fraud which would destroy the very purpose for which such bank guarantee was issued and (ii) in a case where encashment of the bank guarantee would result in irreparable harm or injustice to one of the parties concerned.

In view of the aforesaid settled position, a party seeking stay against invocation of the bank guarantee used to find it very difficult, nay impossible, to obtain favourable order. However, in its recent pronouncement, the Hon'ble Supreme Court of India seems to have made a paradigm shift by holding that each case of injunction against invocation of the bank guarantee has to be decided with reference to the facts involved therein.

The Apex Court in Gangotri Enterprises v. Union of India held that while there can be no quarrel to the proposition laid down in the cases pertaining to encashment of bank guarantees, the same would not be applied in every case. Holding that the in the case in hand, law laid down in the case of Union of India Vs. Raman Iron Foundry was applicable, the apex court reversed the judgment of Allahabad High Court which declined to grant injunction against invocation of bank guarantee by beneficiary party.

The judgement suggests that invocation of bank guarantee is not justified merely because the party invoking the bank guarantee has some claim of damages against the party who furnished the bank guarantee. It has been held that a claim for damages is not a crystallised or ascertained amount or a sum due and payable in praesenti (meaning 'at present'), therefore invocation of bank guarantee would not be justified on the basis of such claim which are yet to the decided by the competent forum.

This judgment has to some extent diluted the position that an unconditional bank guarantee can be invoked regardless of the dispute between the beneficiary and the principal obligation. The Supreme Court in some ways has supplemented to the line of authority of judgments against invocation of bank guarantee by beneficiary like the Hindustan Construction Co. Ltd. v. State of Bihar, which held that the invocation of bank guarantee will have to be strictly in accordance with the terms of the contract/Bank guarantee deed.

This judgement of Gangotri Enterprises will certainly come to the rescue of litigants, primarily contractors executing work under contracts awarded by government agencies and the said agencies were exercising unbridled discretion in the matter of encashment of bank guarantees furnished by the contractor.

A general belief that bank guarantees can be encashed irrespective of the main dispute between the contractor and the department, or for covering the claims for damage, which are yet to be crystallized, has been set right but this judgement. Therefore,

whenever any party would seek to encash the bank guarantees provided by other party to the contract on the basis of their claims of damages, such an attempt would not be successful as a claim of damages is not a sum due and payable in present. Similarly, bank guarantee given for one contract cannot be encashed for breaches/disputes concerning to another contract.

In a recent judgment in Classic KSM Bashir JV vs. Rites Ltd. and Ors. (2018 SCC OnLine Del 9056) case, wherein, the appeal was made by challenging the order of the learned Single Judge which had declined the grant of interim relief under Section 9 of the Arbitration and Conciliation Act, 1996 (hereafter 'the Act'). In the instant case, the date of completion of the work was extended several times until the appellant was aggrieved by the termination of the contract on September 20, 2017. The grievance of the appellant was threefold - i) the invocation of performance guarantee, ii) mobilization of advance bank guarantee and iii) the alleged unlawful termination of the contract by Rail India Technical and Economic Service (hereafter 'RITES').

The Single Bench Court vide order dated October 13, 2017, restrained the HDFC Bank, who has been impleaded, from taking any steps in relation to the encashment of the bank guarantee. However, RITES had already invoked the bank guarantees submitted by the appellant vide its invocation letter dated October 05, 2017. The learned Single Judge stated that invocation of the performance guarantee could not be prohibited in view of the settled principles of law. However, he granted limited relief to the appellant with respect to the invocation of the mobilization advance, holding that the invocation was not in terms of the bank guarantee.

Legal propositions were upheld by the division bench. The division bench stated that it could not be accepted that the performance guarantee cannot be invoked at all in a case of undetermined or inchoate sums claimed on the principal on account of damages. The Division Bench upheld that the bank cannot adjudicate as to whether the claim by the beneficiary was in fact determined by it in accordance with the underlying contract between it and a third party in order to invoke the bank guarantee. Furthermore, emphasis was laid on the fact that the guarantee is an independent contract and that a contract of guarantee is divorced from the obligations of the parties towards each other, in their bilateral enforcement.

Conclusion

Bank guarantee has its own merits and demerits. The decision of obtaining bank guarantee must be thoughtful keeping in mind the risks involved and the procedures. One should be conversant with the various features and laws related to the Bank guarantee as it involves a huge financial risk. We should take immediate action in the matter of Bank Guarantee as there are instances of court judgements which can affect the encashment of it.

Reference

1. Article written by Mr. Ravi Singhania, Singhania & Partners LLP by referring Supreme Judgment in the case, Gangotri Enterprises v. Union of India
2. Judgment of the case, Gangotri Enterprises v. Union of India
3. Judgment of the case, Classic KSM Bashir JV vs. Rites Ltd. and Ors. (2018 SCC Online Del 9056)

The Engineer's role in Claims Process as per FIDIC conditions

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ABSTRACT

The Employer appoints the Engineer to carry out the duties assigned to him in the Contract. The Employer undertakes not to impose further constraints on the Engineer's authority. While carrying out duties or exercising the authorityas per FIDIC conditions, it is expected that the Engineer's staff/assistants are competent to carry out these duties. Likewise, it is expected that the Contractor's & Employer's personnel would be familiar with the provisions of Contract as well as FIDIC conditions. The Engineer's role in Claims process has been elucidated in the article with a view to guide the Engineer's assistants in this crucial activity. If this role is not discharged properly, it would not only lead in sowing seeds of dissatisfactionin the Contractor but could become root cause of dispute between the Employer and the Contractor. It is also felt that abundant precaution would be required on the part of the Contractor as well as the Employer to enable the Engineer to discharge role.

Background

The Federation Internationale Des Ingenieurs Conseils (FIDIC) is an International Federation of Consulting Engineers founded in 1913, now with over 100 member countries. FIDIC publishes various standard contracts to be used for construction works, large scale machinery supplies,infrastructure projects, consultancy services etc. Each contract applies to a specific area and is characterised by an individual colour label. The contracts aim at distributing liabilities and risks on the relevant parties but these are not "agreed documents" per se. Dedicated Freight Corridor Corporation of India Limited (DFCCIL) has awarded "Build & Design" contracts for which 1999 Yellow Book is applicable. Due to lack of awareness of various provisions in this book, the contract professionals are struggling to deal with the various aspects in the Contract Management according to their own understanding which not only leads to wastage of time and efforts but also results in dissatisfaction amongst various stake holders. The article deals with one aspect namely, the Claim process in the Contract Administration which is critical to successful completion of project. The purpose of article is to spread awareness amongst the contract professionals.

Introduction

"Major projects give rise to major risks, which have to be dealt with if they occur. In these events, the claims procedures are specified so as to provide the degree of formality considered necessary for proper administration of a project. Complying with these procedures and maintaining a co-operative approach to the determination of all adjustments should enhance the likelihood of achieving a successful project"

-FIDIC Guide Page 88-89.

Claim is a contractual mechanism thatformally structures request for and determination of adjustment in the completion time and contract value in the case that risks eventuate.

Claim mean a request or assertion by one party to other party for an entitlement or relief under any Clause of these Conditions or otherwise in connection with, or arising out of,the contractor the execution of works.

Claim could either be for Extension of Time (EOT) of the various milestones in the Contract or for cost adjustment on account of deletion of some work or addition of new work from the original scope of work due to change in specification/size of structures to be executed as per the instruction issued by the Engineer/Employer during the course of execution of work.

Claim is generally made by the Contractor thus termed as"Contractor's claim" in FIDIC conditions.

Sometimes, the Contractor in its communication with the other party or the Engineer create confusion by using the term "Dispute" in place of "Claim" or vice versa. Therefore, as a word of caution, the term should be used in an appropriate manner in the context of Contract administration.

To remove the ambiguity in the minds of the readers, it would be worthwhile to explain the term 'Dispute'which means any situation where

a) One party makes a claim against other party (which may be a claim as defined in these conditions or a matter to be determined by the Engineer under these conditions or otherwise);

b) The other party (or the Engineer under subclause 3.5 of 1999 FIDIC Yellow Book {Engineer's determination}) rejects the claim in whole or in part; and

c) The first party does not acquiesce (by giving Notice of Dissatisfaction {Dissatisfaction with the Engineer's Determination} or otherwise),

Provided however that a failure by the other party to oppose or respond to the claim, in whole or part, may constitute a rejection if, in the circumstances, the Dispute Adjudication Board (DAB) or the Arbitrators, as the case may be, deem it reasonable for it to do so.

The entire process right from the stage of giving notice ofthe Claim by the Contractor as well as the time frame for sending the fully detailed Claim by the Contractoris

prescribed under clause 20 of 1999 FIDIC Yellow Book.

Similarly, the Engineer's role indealing with theClaim after its receipt till its disposal is prescribed in the Clause 20 & Clause 3 of 1999 FIDIC Yellow Book which provides clear focus of action required and time frame.

The Engineer is required to agree or determine the Claim. Most important part in this process is to act in a "neutral" and "time bound" manner.

Clause 3.5 "Determinations" of FIDIC Yellow Book does provide for "Consultation" by the Engineer with each party. This could be held jointly or separately. During the consultation, end eavour should be made to encourage both the parties to reach an agreement which should be written and signed failing which Engineer is required to make a fair determination in accordance with the Contract, taking due regard of all relevant circumstances within 42 days after receiving a claim.

One of the biggest hurdles while dealing with the Claim is submission of the Claim without proper scrutiny by the Contractor&without proper details/documents. Under these circumstances, the Engineer makes repeated request to come forward. If situation persists, the Engineer has no other option but to issue determination by way of closing the case.

Quite often, during the consultation process, the two Sine Qua Non namely "Neutral " and "Time bound" become casualty due to push and pullexerted which must be guarded.

Endless rounds of discussion are being held with the Contractor in order to convince him to agree to the proposed determination by the Engineer.

Many a time, the Engineer is being asked to share the draft assessment on the Contractor's claim before consultation process can be concluded.

The particular condition which limits the power of the Engineer to issue determination up to a particular value is also acting as an impediment in the timely issue of determination by the Engineer in those cases where the Employer's approval is being sought by the Engineer for exceeding the limit mentioned above before determination is issued by the Engineer.

If no "Notice of Agreement" or"Determination" is issued within time, the Claim should be deemed as rejected and "matter" deemed to be a Dispute and may be referred to the DAB."Notice of Disagreement" is not required to be issued by the Engineer in case the Claim is not agreed to.

Conclusion

Engineer's role in claim process has been robustly defined in the 1999 FIDIC Yellow Book. It should be endeavour of all the stake holders to enable Engineer to carry out its role and discharge its duties consistently as defined in these Conditions which will go a long way in pushing the project towards the goal of timely completion and without many disputes.

Survey, Design & Setting out of alignment in Rewari -Dadri Section of WDFC under CTP-14 Contract Package

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ABSTRACT

In present time almost all Linear Projects (Rivers, Transmission Lines, Water Pipe Lines, Roads, Railway lines) prefer, survey work in Grid coordinates system based on WGS84 datum. This is a better way of surveying to collect the required survey data in global coordinate system at project site thus to complete the survey effectively with more accuracy in minimum time with the help of DGPS observation in Static & RTK mode.

The Grid coordinate system helped the aforesaid CTP-14 project alignment to match with the alignment of adjacent section in CTP-1 & 2 project, thus accelerating the design of the alignment and saving time in implementation of the whole project by integration of survey data.

DFC Project Overview

The Western Dedicated Freight Corridor alignment consists of double line electrified track with 2x25 kV AC, 50 Hz. Overhead Catenary System capable of operating at a maximum train speed of 100 Kms./h, from JNPT to Dadri (1500 Km).

Brief of DFC Rewari-Dadri under CTP-14

M/s Sojitz - L&T has been awarded the integrated contract to construct the Proposed Railway line in CTP-14 Contract Package from Rewari (Haryana) to Dadri (U.P.) (128 Kms). This project is located totally in detour passing through seven districts namely Rewari-Alwar-Mewat-Gurgaon-Palwal-Faridabad-GB Nagar in the states of Haryana, Rajasthan & Uttar Pradesh. Project area falls in geographically difficult terrain of Arawali hills consisting of 1 Kms. Tunnel, Deep cuts up to 30 Mtr depth, High embankment with bank height up to 25 Mtr., Viaducts having height up to 25 Mtr. and aqueducts & syphon.

The Project is an Integrated Package involving design and construction of Civil, Buildings, Track, Electrical & Mechanical and Signaling & Telecommunication

Works with an initial design axle load of 32.5 MT for Formation & bridge structures and for25 MT for Track structure.

The Project connects with CTP1&2 (Rewari-Iqbalgarh) section of WDFC (Phase-I) at Rewari on one end & CP-302 (Khurja-Dadri) section of EDFC at Dadri, on the other hand.

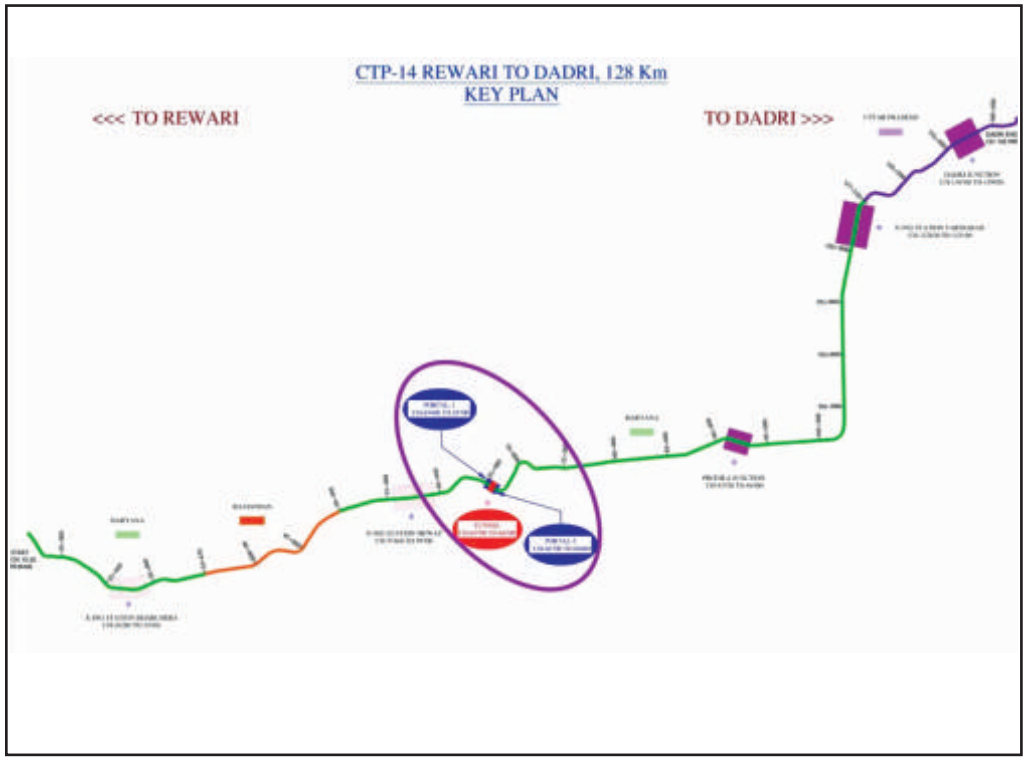

Fig-1 Key plan of Rewari-Dadri Section

Brief of adjoining DFC Projects

(I) CTP 1&2

CTP1 &2 is a Civil, Building and track contract for double line , situated in Phase - I of WDFC between Rewari to Iqbalgarh (661Kms.) awarded with initial cost of Rs 6699.5 crore. Presently this contract is being administered by CGM/Jaipur & CGM/Ajmer unit of DFC& connects CTP-14 Project at Rewari.

(ii) CTP 15-C

This is steel girder bridge contract consisting 03 girder bridges one at River Yamuna, one at River Hindon & one RFO over Delhi - Mathura line of IR. This contract was awarded with initial cost of 214.11 crore. These steel bridges are situated between CTP-14 chainages. Presently this contract is being administered by CGM/Noida unit.

(iii) CP-302

CTP -302 is a Civil, Building and track contract for double line, situated between Khurja - Dadri (46 Kms) on EDFC awarded with the initial cost of 511.30 crore. Presently this contract is being administered by CGM/Meerut unit of DFC& connects CTP-14 Project at Dadri.

4. Survey work of CTP-14

The Survey in DFFCIL CTP-14 Project from Rewari to Dadri was carried out throughGlobal Positioning System (GPS). Itwas based on grid system(WGS-84)on UTM coordinates,comprising various activities like Prime triangulation to establish Bench Mark for horizontal control point along the alignment through DGPS, Close level survey for integration with Survey of India (SOI) GTS bench Marks to establish vertical control point along the alignment, validate the survey data as provided by

the Employer, ROW Validation, collecting Topographic Survey details, Joint Alignment Verification with connecting DFC Project, Alignment Verification report, Setting Out etc.

(i) WGS-84

WGS 84 is the standard U.S. Department of Defense definition of a global reference system for geospatial information and is the reference system for the Global Positioning System (GPS). It is compatible with the International Terrestrial Reference System (ITRS).

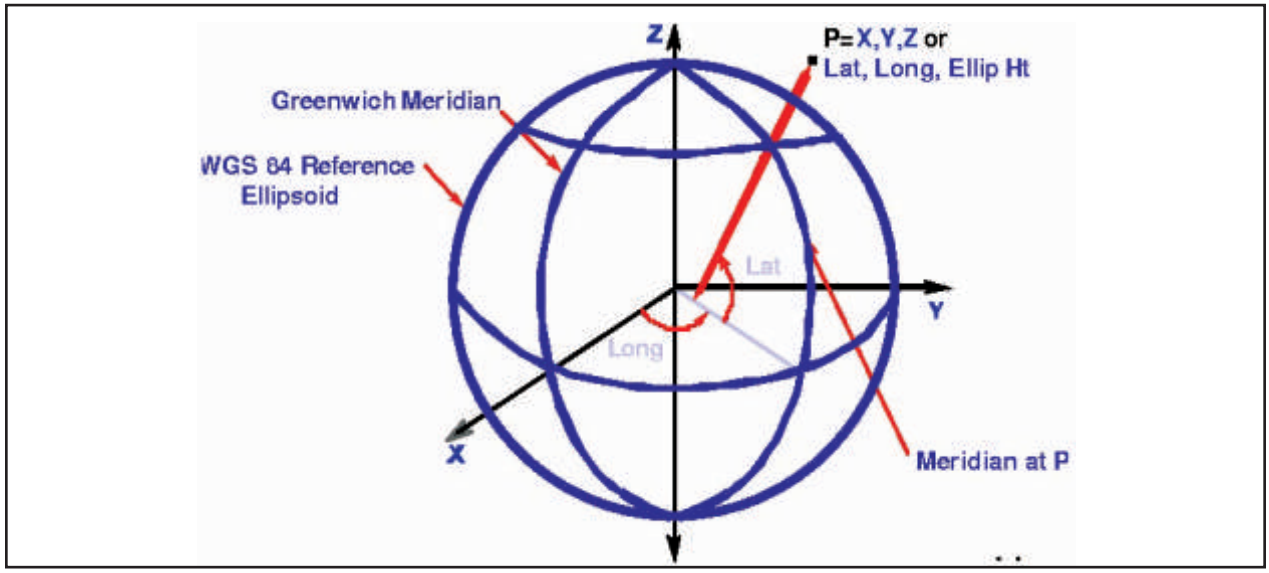

Fig-2WGS-84 system

(ii) UTM

The Universal Transverse Mercator (UTM) is a system for assigning coordinates to locations on the surface of the Earth. Like the traditional method of latitude and longitude, it is a horizontal position representation, which means it ignores altitude and treats the earth as a perfect ellipsoid. However, it differs from global latitude/longitude in that it divides earth into 60 zones and projects each to the plane as a basis for its coordinates. Specifying a location means specifying the zone and the x, y coordinate in that plane.

The UTM system divides the Earth into 60 zones, each 6° of longitude in width. Zone 1 covers longitude 180° to 174° W; zone numbering increases eastward to zone 60, which covers longitude 174°E to 180°. The Polar Regions south of 80°S and north of 84°N are excluded.

Each of the 60 zones uses a transverse Mercator projection that can map a region of large north-south extent with low distortion. By using narrow zones of 6° of longitude (up to 668 Kms.) in width, and reducing the scale factor along the central meridian to 0.9996 (a reduction of 1:2500), the amount of distortion is held below 1 part in 1,000 inside each zone. Distortion of scale increases to 1.0010 at the zone boundaries along the equator.

(iii) GPS

GPS stands for Global Positioning System and it allows users to determine their location on land, sea, and in the air around the Earth. It does this using satellites and receivers. There are currently 24 satellites in orbit operated by the US Department of Defense that provide worldwide coverage 24 hours a day, 7 days a week, in all weather.

How the system works is, by the satellites sending information to receivers. This information includes time, position, and satellite strength among other things. The receivers pick up this information and use it to determine the users location. Using the signals from at least 4 satellites, a receiver can determine latitude, longitude, and elevation. Some receivers can then convert the latitude and longitude into other coordinate system values.

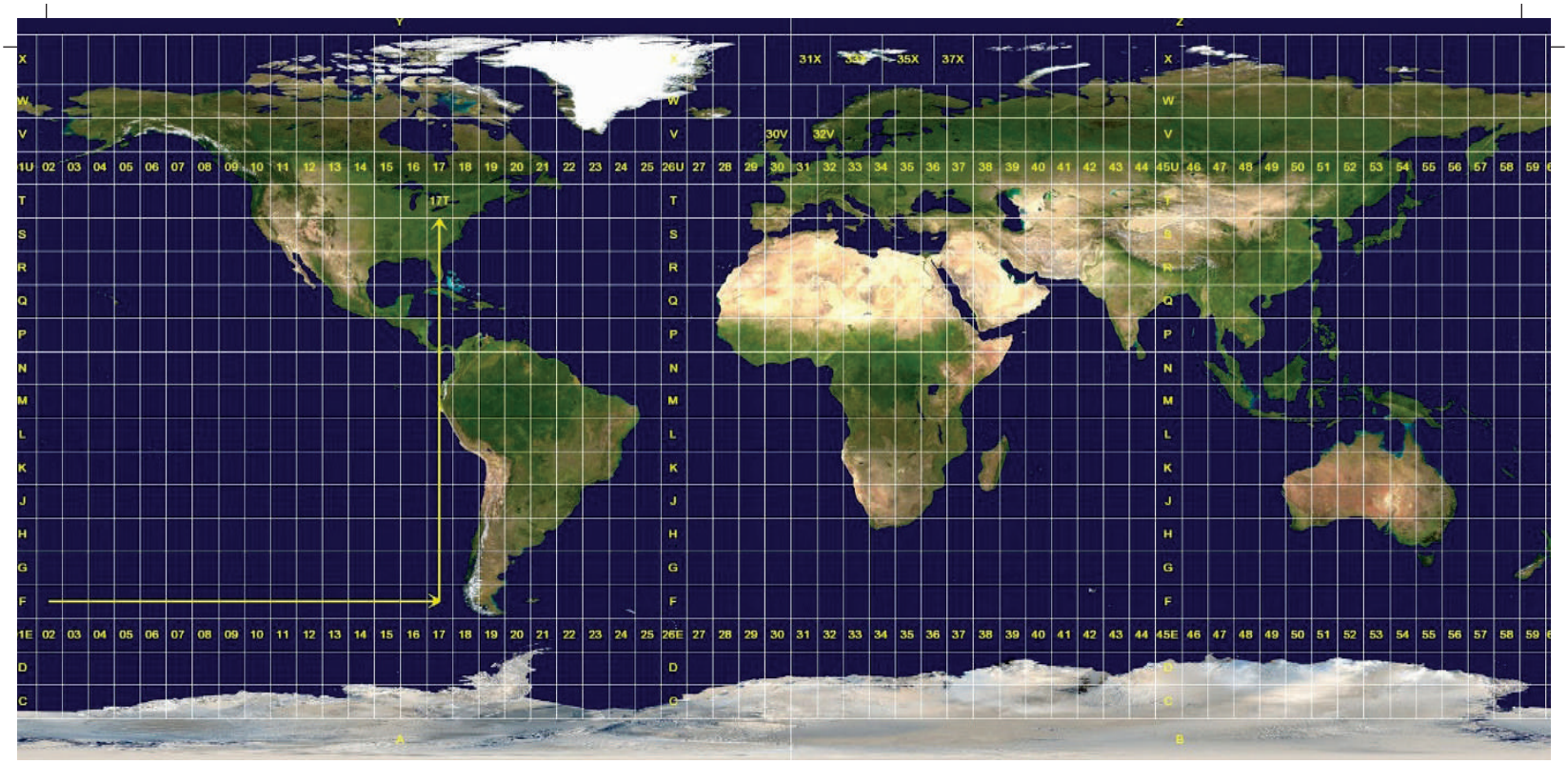

Fig.-3 UTM coordinate system

The accuracy of GPS depends on several factors such as which receiver is being used, the surroundings it's being used in, and Selective Availability. Selective Availability is the Department of Defense deliberately interfering with the satellite signals to reduce positional accuracy to around 30m - 100m. With Selective Availability receivers are divided into two types: precise positioning systems (PPS) and standard positioning systems (SPS). PPS receivers are used by the military and are not affected by Selective Availability. Currently there are efforts under way to end the use of Selective Availability with the aim to reduce the effect of positional accuracy.

(iv) DGPS

Differential GPS uses position corrections to attain greater accuracy. It does this by the use of a reference station. The reference station (or base station) may be a ground based facility or a geosynchronous satellite, in either case it is a station whose position is a known point. When a station knows what it's precise location is it can compare that position with the signals from the GPS satellites and thus find the SA error. These corrections can then be immediately transmitted to mobile GPS receivers (real time DGPS), or the receiver positions can be corrected at a later time (post processing).

The use of DGPS can greatly increase positional accuracy (in general, the better it is the more expensive it is). Some surveying systems can give sub-centimeter readings. There are a lot of different differential providers that supply real time and post processing corrections, many are private companies. The availability of these services varies greatly depending on what part of the world you are in. Presently US companies are the leading companies to provide these services.

DGPS APPLICATIONS

Now a days DGPS technique is widely being used in Civil Engineering for making reconnaissance survey, detailed survey, fixing of alignment, for layout of structures to be build. It is of great use to fix alignments for very long linear projects such as Railway lines, Canals, Roads, Transmission lines etc.

In DGPS control survey following methods are used for Survey

(I) Static GPS Control surveying

(ii) Real Time Kinetic (RTK) Mode GPS control surveying

(i) Static GPS Control Surveying

In static GPS surveying the receivers is stationary for a long period (6-10 hrs). Static survey can be independent of some of the things that have created problems in survey works in the past by other survey methodology (such as Theodolite survey, compass survey, Plane table survey etc) in the past. However, there are some things that need to be considered—overhead obstructions, access between points, and so on.

Static GPS surveying is a relative positioning technique which employs two (or more) stationary receivers simultaneously tracking the same satellites. One receiver, the base receiver, is set up over a point with precisely known coordinates such as a survey monument. The other receiver, the remote receiver, is set up over a point whose coordinates are unknown. This method of surveying is based on collecting simultaneous measurements at both the base and remote receivers for a certain period of time, which, after processing, yield the coordinates of the unknown point. This type of survey is primarily used to create control where no control exists to very high accuracies.

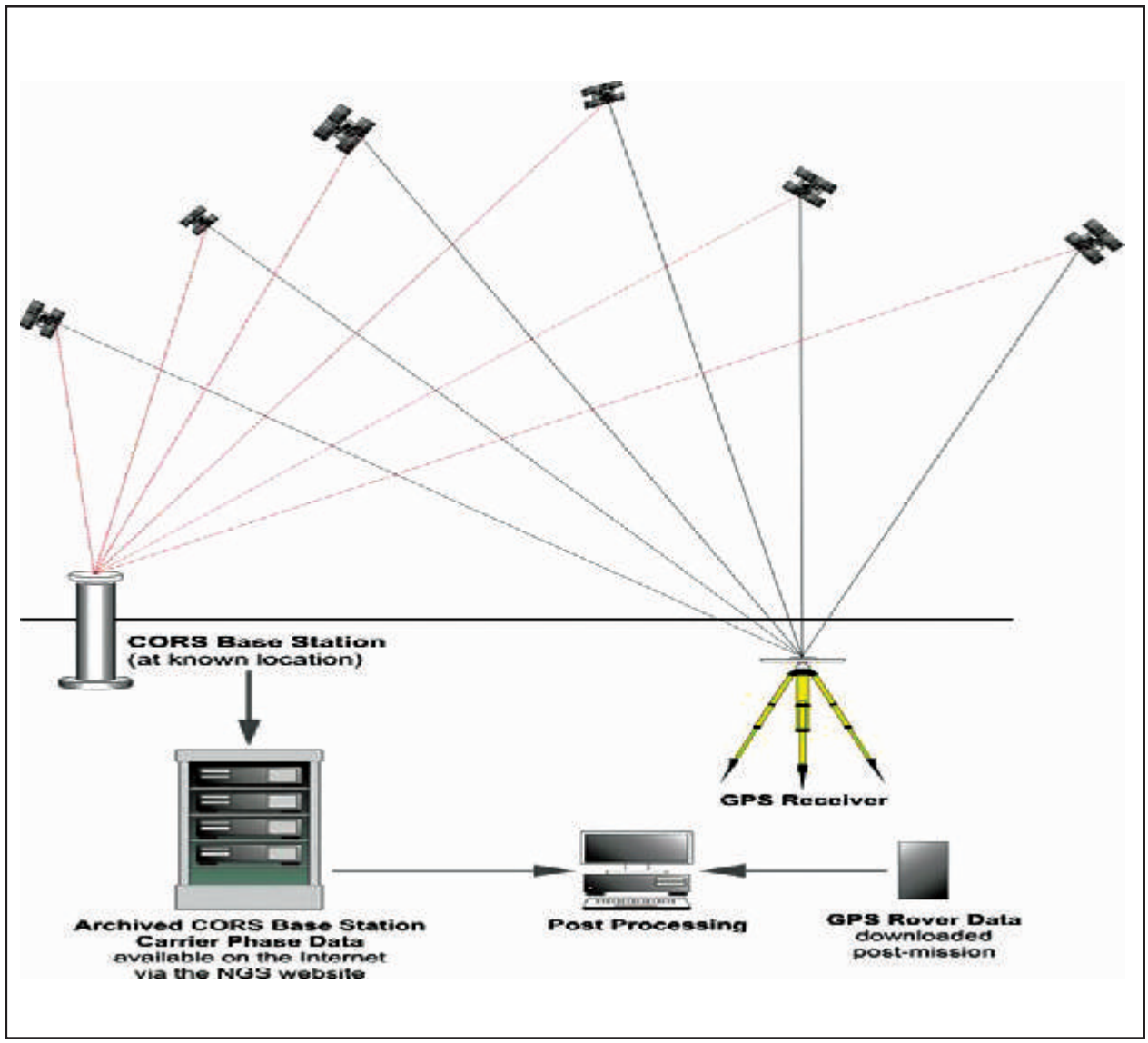

Fig.-4 Static survey methodology

Static GPS surveying typically uses a network or multiple baseline approach for positioning. It may consist of multiple receivers, multiple baselines, multiple observational redundancies and multiple sessions. A least squares adjustment of the observations is required. This method provides the highest accuracy achievable and requires the longest observation times; from less than an hour to five hours or longer. Project control points are nearly always set using this type of survey.

(ii) Real time Kinematic (RTK) mode GPS control survey

It involves the use of at least one stationary reference receiver, the base station, and at least one moving receiver, (the rover). All the receivers involved observe the same satellites simultaneously. The base receivers are stationary on control points. The rovers move from project point to project point across, stopping momentarily at each new point, usually briefly. The collected data provides vectors between themselves and the base receivers as shown in Figure 3 in real-time.

Real-time kinematic is done by carrier phase ranging. It must track five satellites minimum. The reason for the five satellites is basically to have one spare so that you're absolutely sure that you will have a position all the time. The base station is set up on a known point there is a transmission antenna associated with it through which a radio transmitter sends corrections to a rover. The baselines are typically at 10 to 20 Kilometers, which is considerably shorter than DGPS's effective range.

RTK also requires a real-time wireless connection be maintained between the base station and the rover. The radio receiving antennas for the rovers will either be built into the GPS antenna or be present as separate units. The position of the transmitting antenna affects the performance of the system significantly. It is usually best to place the transmitter antenna as high as is practical for maximum coverage, and the longer the antenna, the better its transmission characteristics. It is also best if the base station occupies a control station that has no overhead obstructions, is unlikely to be affected by multipath, and is somewhat away from the action if the work is on a construction site. It is also best if the base station is within line of sight of the rovers. If line of sight is not practical, as little obstruction as possible along the radio link is best.

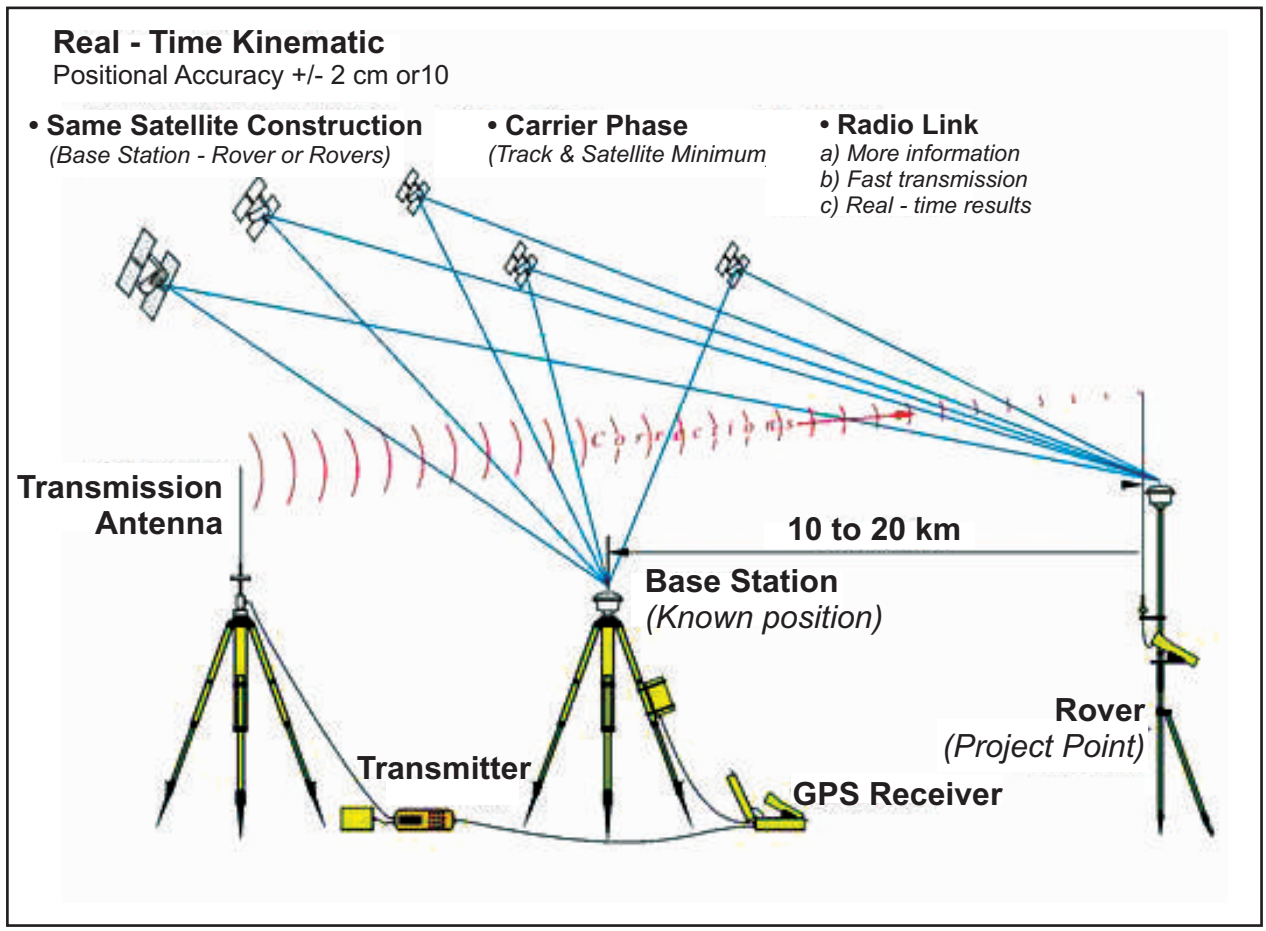

Fig.-5 Real time Kinematic survey

It is also important to note that it takes some time for the base station to calculate corrections, and it takes some time for it to put the data into packets in the correct format and transmit them. Then the data makes its way from the base station to the rover over the data link. It is decoded and must go through the rover's software. The time this takes is called the latency of the communication between the base station and the rover. It can be as little as a quarter of a second or as long as a couple of seconds. And since the base stations corrections are only accurate for the moment they were created, the base station must send a range rate correction along with them. Using this rate correction, the rover can back date the correction to match the moment it made that same observation.

As mentioned earlier, RTK is at its best when the distance between the base station and the rovers is 6-12 miles or less. However, the baseline's length may be further limited by the effective range of the radio data link. why most radio data transmitters used in RTK allow the user several frequency options within the legal range.

It is vital, of course, that the rover and the base station are tuned to the same frequency for successful communication. The receiver also has an antenna and a demodulator. The demodulator converts the signal back to an intelligible form for the rover's receiver. The data signal from the base station can be weakened or lost at the rover from reflection, refraction, atmospheric anomalies, or even being too close. A rover that is too close to the transmittermay be overloaded and not receive the signal properly, and, of course, even under the best circumstances, the signal will fade as the distance between the transmitter and the rover grows too large.

Adopted procedure for Survey in WDFC Project from Rewari-Dadri

Project Survey The Survey in the project comprised the following activities at the Site.

- Establishment of horizontal & vertical control points.
- Matching the alignment coordinates with interface connecting DFCC corridors
- Validation of the survey data provided by Employer.
- Verification of the actual location of Right of way (ROW) on ground as per Land Plan.
- Stacking of alignment on ground.
- Verification of topography survey details as per depicted ground profile.
- Design of the horizontal & vertical alignment.
- Setting out of the central line for formation & structures work as per approved Plan & Profile drawing.

Establishment of Horizontal & Vertical control points

Survey:-For establishment of Horizontal & Vertical control following survey activities were done.

(i) Reconnaissance survey of project area was carried out to ascertain location of starting point, end point, reference point & appropriate location for establishment of control points. Locations for fixing of DGPS for triangulation were also identified.

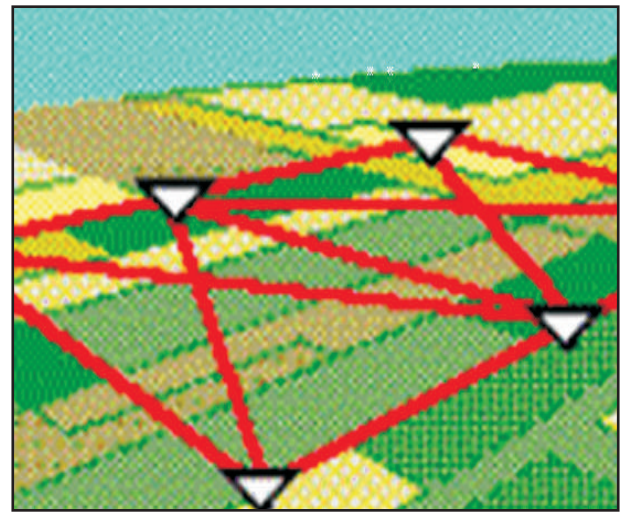

Fig.-6 Triangulation through Static survey methodology

(ii) The Prime Triangulation survey by DGPS observation was commenced, at the points identified along the network by taking 20 Kms. baseline with 8 Nos. DGPS survey equipment's to determine the co-ordinates (Geographical & UTM) of the DFC Benchmarks by common time long observation in static mode(8-10 hours of DGPS observations).

(iii) These identified points for DGPS observations includes control points of CTP-1 & 2 (D-9) located at Rewari (starting point of CTP-14), Control point of CTP-15C at RFO site, Yamuna & Hindon (intermediate points of CTP-14) and Survey of India triangulation stations situated at Rewari (Starting point), Faridabad, Jewar (Intermediate point) & control point of EDFC CP-302 (end point). Thus by considering these 08 known control points, prime triangulation survey was done along the alignment from Rewari to Dadri to form a base line of Prime triangulation. Vertex of the triangulation taken away from alignment, for formation of well-formed triangle.

(iv) Control survey was carried out through DGPS to verify the coordinates for horizontal control (X,Y) and for vertical control(Z) for verification of Bench Mark established by DFC & also cross verified by GTS bench marks established by Survey of India.

(v) Raw data of Prime Triangulation survey as well as control survey was downloaded from the DGPS equipment and processed by Lieca Geo Office software. During processing the raw data of DGPS observation, approved coordinates of CTP-1 & 2 control point were taken as base controlfor synchronization of CTP-1,2& CTP-14 alignment. After processing raw data, it was found that actual Geographical Coordinates (X,Y) of Survey Of India Bench Mark at Rewari, Jewar & Faridabad were matched.

(vi) After triangulation and matching of data at starting, Intermediate and end points, the DGPS observations on TBM initially fixed by the Employer was taken and final coordinates of DFC Benchmarks to be fixed at each 5 Kms. was calculated.

(vii) By DGPS Triangulation Survey linear accuracy of 1 in 250000 could be achieved, which was more than permissible limits of 1 in 100000.

(viii) During triangulation survey, all the network of triangles were set-up along the alignment on triangulation stations and DFC Benchmarks were identified on map (these points were transferred to a permanent structure on the ground) using the datum WGS84 and coordinates were determined by UTM projection.

Establishment of Horizontal Control at 5Kms., 1Km. &200 M Interval

After triangulation and fixing the Coordinates, according to base control (CTP-1&2), the next step was to verify the TBMs fixed by the Employer (at random locations along the alignment), and thereafter, Benchmarks (Horizontal & vertical control) at every 5 Kms., 1 Km. and 0.2 Km. interval were fixed along the alignment for verification of ROW and setting out of work.

Static mode DGPS observations were commenced again to determine the coordinates at 5 Kms. interval for pairing of control points (along the alignment) which were fixed by the agency along the ROW from Rewari to Dadri. In this observation every 5Kms. control points were fixed along the base line length with long time observation (4-6 hours). Secondary loop control points @1Km. interval (fixed by the agency between 5Kms. control points) were also connected. Thereafter the DGPS observation raw data was processed with the coordinates of 5 Kms. control points at both end and the network was adjusted by least-squares method.

After fixing of 5Kms. & 1 Km. control points,TBMs at 200 mtr interval were fixed with the help of DGPS in RTK mode.

Fig.-7 DGPS observation in Static mode at 5Kms. interval Bench Mark Pillars

Establishmentof Vertical Control

The Vertical Control system was established by connecting existing GTS Bench Marks to the TBMs fixed by the agency, by running a closed loop level survey with the help of total station/Auto Level.

The Closing error of loop was not allowed to exceed $12\sqrt{K}$ in mm, where K is the circuit length in Kilometre(K should not exceed 5 Kilometres).Even if some error was found in the closing with in permissible limit,the same was distributed in 5 Kms benchmarks.

The temporary vertical control points were also established at important locations such as bridge approaches, road crossings, canal crossings, river crossings, So that, Level can be transferred to required location from nearest reference pillars to ensure accuracy in construction work.

Around 5 Kms. area between Rewari-Dadri between Kms. 65/000 to 70/000(Tunnel & High Bank/Deep cut location) was found inaccessible due to Arawali Hills. The same was surveyed through Drone (UAV, Unmanned Ariel vehicle). Automated Photogrammetry using UAS Modern software's, was done to create orthomosaics and generating topographic lines. This orthomosaic was based on the GPS position of the camera taking photograph. Automated aerial triangulation and parallax measurements were calculated to generate an elevation for each point. To draw accurate topographic lines, ground control points established from DGPS survey were used. The longitude, latitude, and elevation value for each ground control points were then manually assigned using the software to the corresponding pixel where the GPS shot was taken.

The Digital Terrain Model (DTM) was created by combining topographical and drone data and thus vertical alignment was designed accordingly.

These vertical control points (Z coordinates) were periodically checked by Digital/Auto level and corrected/rectified wherever errorwas found beyond permissible limits.

Method of Fixing the survey Control points

(I) RCC Pillars of 30cm x 30cm x 80cm (15 cm above the ground) was fixed with a 5cm X 5cm x 6mm metal plate on top of thepillar with a punch mark in the center. The RCC pillars were fixed in 1:3:6 concrete at 5 Kms. interval on both sides of alignment within ROW.

(ii) A thin metal plate was provided on all sides of the pillar above the ground. The entire exposed surface of pillar was painted with red color enamel paint.

(iii) Each pillar was protected by barbed wire fencing or other similar measures to keep it safe.

(iv) A unique code was also assigned to each RCC pillar as per the DFC Chainage. The code was also written on the top of pillars.

(v) Similarly RCC Pillars of size 20x20x60cm (15 cm. projected our ground) were fixed at 1KM and 200 Mtr intervals with in ROW on one side of the alignment.

(vi) These pillars were painted with blue paint and a unique code was also assigned as per DFC chainage.

Fig. 8- Fixing of Bench Mark at 5 Kms. interval with Fencing

Fig.-9 Fixing of Bench Mark at 1Km. interval

Fig.-10 Fixing of Temporary Bench Mark at 200m interval

Matching the alignment coordinates with Interface connecting DFCC corridors

Co-ordinates of control points of adjacent DFC corridor were re-verified with respect to our project control points at the start, in the middle and at the end.

Validation of Survey data Provided by the Employer

After fixing of Horizontal & Vertical control points, the next step was to do topographical survey and validation of survey data provided by the Employer. This validation was done through DGPS in RTK mode or through Total Station and date was collected.

The collected data matched with the survey data provided by the Employer at most of the locations. In case of deviation at some locations, necessary coarse correction was done in consultation with Engineer/Employer before moving to the next stage of design.

Coarse correction The Joint alignment verification was done at following interface location with connecting DFCC project.WDFC CTP-1 &2,WDFC CTP-15C project at proposed RFO, Yamuna & Hindon bridge location and EDFC CP-302 project at Dadri end.

CTP-1&2 and CTP-14 coordinates system were same, but CTP-15C & EDFC CP-302 did not match when connected with CTP-14 Bench marks coordinates system. Joint alignment verification was therefore done with the adjoining CGM unit.

The Joint Alignment verification was done as per following stages

CTP-15C& CP-302 approved alignment coordinates were staked out on ground by their established Bench Marks coordinates system so that exact location of the alignment on ground can be found.

Coordinates of these stacked out points on ground were thereafter picked up by taking reference from CTP-14 survey system. These points were thereafter again stacked on the ground by CTP-14 survey system and it was found that they were falling on ground at same location.

Verification of Right of Way (ROW) on Ground as per land Plan

The Employer staked the Right of Way (ROW) pillars on either side of the alignment at site. Co-ordinatesof all ROW pillars were recorded through DGPS observation in RTK mode & drawing was prepared.

This ROW pillars drawing was superimposed on geo referenced land plans. Slight variation at some isolated location was observed. The variation locations were identified and noted down. At these locations Joint marking of land on ground was again done with the help of District revenue authorities and in consultation with affected local farmers & the revised coordinates of the latest marking on ground were recorded. The earlier coordinate were slightly modified in consultation with Engineer & Employer at site as per newly recorded coordinates based on actual ground situation. DFCC ROW width as per Employer requirement/ authenticated Land plan was ensured during this whole

process. The verified ROW Drawing based on finalized ROW validation coordinates was used to design the Plan & Profile of DFCC alignment in WDFC CTP-14 project.

The missing ROW stakes were staked at ground to confirm the Right of Way (ROW) as per ROW validation coordinates(X, Y) which was verified by Engineer or Employer.

Missing ROW pillars were fixed. These RCC precast pillarwere of 15cm x 15cmx 125cm, M-15 grade concrete fixed 75cm below ground level with CC 1:3:6. The Pillars were painted with White paint/Red paint and the DFC chainage marked with black paint.

Fig-11: DGPS observation in RTK mode for ROW validation

Staking of Horizontal Alignment

The Horizontal Alignment (in x,y Co-ordinate system) was fixed at centre of down main line from Rewari-Dadri at 20 mtr. interval in addition to TS, SC, CS, ST points along the proposed Alignment using DGPS in RTK mode observation or Total Station equipment.

Topographic Survey & its Verification (using DGPS in RTK mode and preparation of 3-D plan)

Topographical details were collected through DGPS in RTK modealong the proposed alignment (River Bridges, Water ways, ROB & RUB locations etc., were considered for taking additional data as per Employer's requirement), these details were taken w.r.t horizontal and vertical reference TBMs already established at the site.

Picking up of natural and man-made features covering the entire section of CTP-14 (DFCC ROW on either side of proposed alignment) was done.

Spot levels were taken along the alignment to depict ground truthfully; distance between two adjacent points along the alignment was 20 m and at 5 mtr. interval across the alignment.

Survey report based on the detailed survey of the entire stretch within ROW was prepared.

3-dimensional topographic plan on Auto CAD 2012, showing center line of proposed alignment along with all features and spot levels, was prepared thereafter.

At structures location, topography survey was conducted as per following details:

S. N.	Structure	Topography survey
1.	Major Bridge	Spot levels were taken 1.5 Km. in Upstream side and 1 Km. on downstream side.
2.	Minor Bridge 300m	Spot levels were taken on both sides
3.	RUB	In case of roads, cart track etc. (min.200m) topography on either side of alignment
4.	RFO/ Major ROB	Levels were taken up to from ROW Boundaries 300m

Fig.-12 DGPS observation in RTK mode for Topographic Survey

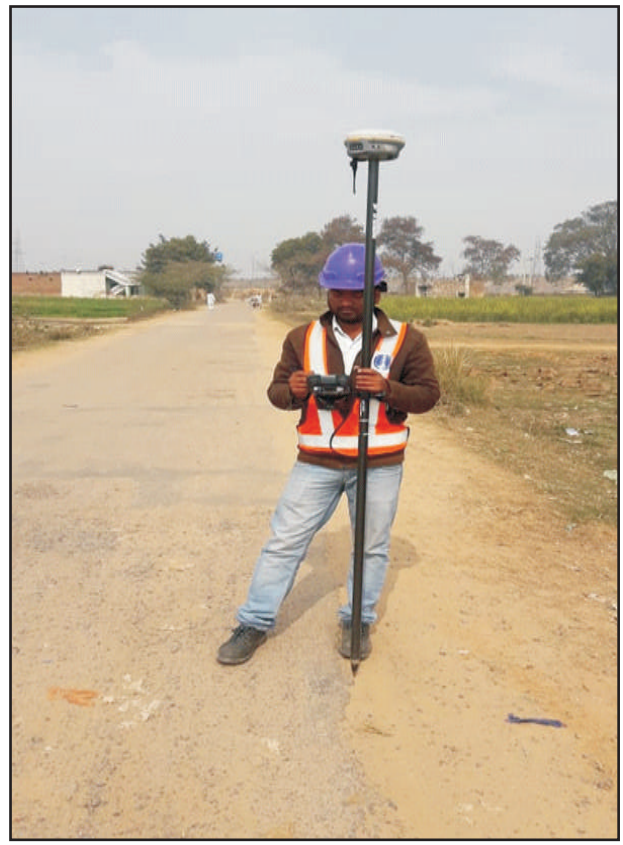

Fig.-13 DGPS observation in RTK mode at existing road crossing

Verification of Topographic

- The Verification of Topographic survey data was done at every existing crossing on DFC alignment such as National Highways, State Highways, Village Road, Bitumen Road, Cart Track, Cement Concrete Road, Existing Rail line at 15C RFO and RFO at Delhi-Alwar line, Minor Canal, Asaoti Rail Track, Yamuna & Hindon Bund, Noida-Greater Noida expressway, DMRC track, ICD Rail track & Dadri Rail track at end of CTP-14 alignment.
- DGPS in RTK mode, Total Station & Auto Level survey equipment's were used as per situation for this verification.

Alignment Verification Report (AVR)

The coordinates of Horizontal & Vertical alignment were staked on the ground at 20m interval with the help of DGPS observation in RTK mode by uploading the alignment coordinates in the DGPS instrument. Coordinates of the Toe line of the embankment & ROW were staked on ground to check feasibility of the alignment design at every 20m interval by marking with wooden pegs or lime powder.

During Alignment verification, some permanent obstructions were found within verified ROW. Their coordinates were recorded in DGPS RTK mode and based on it, alignment verification report were prepared. If anywhere ROW width was not found sufficient as per height of the embankment or due to some obligatory point or due to some design constraints, Earth Retaining Structure (ERS) were proposed to limit the construction with in available ROW at all such locations. Service road space (as per employer's requirement), was also shown in Plan & profile. The Alignment Verification Report along with alignment coordinates at 20m interval, details of obstruction & proposed ERS location was thereafter by the Agency to the Engineer /Employer for further review & approval.

Design of Horizontal & Vertical Alignment

The vertical alignment was designed conforming to design manuals, bridge manuals, structures requirement and keeping in view clearances for all the future and existing utilities such as HT Lines. RFO clearances on Delhi Alwar & Delhi-Mathura IR

line, Connections of (Asawati and ICD) track in yard and siding has been done following all the technical specification. Availability of ROW width as per proposed embankment height was also considered. The optimization of quantity wasdoneto minimize the earthwork and earth retaining structure.

SETTING OUT

- The setting out for all the permanent works including, but not be limited to the bridges(Important Bridges, Major Bridges, Minor Bridges, Road over Bridges, Road under Bridges) Pedestrian Sub-ways, buildings in the Junction and Crossing Stations and Earth Retaining Structure, was done on ground for unhindered execution of civil works.
- The layouts of the structures were marked on ground after the completion of the technical design of Bridges, Pedestrian Sub-ways, buildings in the Junction and Crossing Stations and Earth Retaining Structure.
- The established approved Bench Marks coordinates were used for setting out work for the Foundation Plan & Substructure plan at the Site.
- After completion of Setting out, the Construction Design Package Drawings were prepared for further construction.
- The Total Station survey equipment's was used for Setting out at site.

Lessons Learnt

Land acquisitions were carried out as per land plans prepared on the basis of Revenue Maps and Ground Measurements. This data was at later stage converted in to ground/Local coordinates and these coordinates were made part of tender documents. Some conversion error or mismatching of base point coordinates led to confusion & resistance by the local farmers at execution stage due to land measurement issues, leading to confrontations and project execution delays. To counter this situation, the land should be cross verified with the land plan before staking the alignment on ground. The contractor should also employ some person (Preferably local retired Revenue Official) having idea of land measurements in order to avoid conflicts on land measurement issues at the time of execution of work.

The Tender alignment drawing & Final approved alignment drawing should be in same coordinates system for easy validation for survey data like Bench Mark & ROW Validation. It is better to adopt UTM Grid coordinate system for easy site survey verification and for better co-ordination with Project, So that the alignment coordinatescan be kept in same uniform system.

List of Abbreviations used

DGPS	–	Differential Global Positioning Systems
GPS	–	Global Positioning Systems
UTM	–	Universal Transverse Mercator
WGS	–	World Geodetic System
UAV	–	Unmanned Aerial Vehicle
RTK	–	Real Time Kenematic
DTM	–	Digital Terrain Model
GTS	–	Great Trigonometrical Survey
GCP	–	Ground Control Point
TBM	–	Temporary Bench Marks
ROW	–	Right of Way
AVR	–	Alignment Verification Report
ST	–	Straight to Transition
TC	–	Transition to Circular
CN	–	Crown
CT	–	Circular to Transition
TS	–	Transition to Straight

A PRACTICAL APPROACH ON CONSTRUCTION DUST CONTROL & MANAGEMENT TO 'BEAT AIR POLLUTION' IN DFC PROJECT

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ABSTRACT

This paper discusses one of the key environmental issues on the construction sites and the most practical mitigation approaches to minimize or reduce its environmental impacts. Construction dust emissions is regarded as one of the major contributors to air pollution and therefore, requires systematic and effective pragmatic approaches for improving air quality in and around the construction sites.

In recent years, violation of dust norms during construction and demolition activities and open dumping of concrete waste has been inviting varying degree of strict actions on the project proponents from the National Green Tribunal (NGT), regulatory authorities, and other enforcement agencies. Contractors and sub-contractors are regularly directed and enforced to implement environmental protection measures on sites to comply with mandatory and contractual provisions as well as evolving guidelines and norms on construction dust control and mitigation.

Providing that construction operations form a multifaceted set of activities, there is not a single option, but a multiple option needs to be adopted for controlling dust pollution on construction sites. This paper has attempted to provide more insight into the best available practical techniques to reduce dust impact in the sphere of sustainable construction.

Although, there are some general approaches to dust control but more efficient and cost effective pragmatic approaches for improving air quality in and around the construction sites depends on – (1) Identification of significant dust emission sources on every site, (2) Prioritizing such sources that needs to be tackled more prudently, (3) Weighing various practical and cost effective options for controlling the dust emissions from different sources, and (4) Sincerely implementing and managing such appropriate actions.

Even the theme of the World Environment Day 2019 has been selected by UN as "Air Pollution". There is no doubt that construction dust control has now become new challenges for the construction activities in any large-sized infrastructure developmental project. The need of the hour is to intensify sincere efforts towards control of air pollution and enhanced compliance level for control of dust pollution.

INTRODUCTION

"Beat Air Pollution" -
The Theme of World Environment Day 2019

'We can't stop breathing, but we can do something about the quality of air that we breathe'

Air pollution is increasing day-by-day representing a serious environmental problem, and seriously affecting our health as well as impacting economic activities and ecosystem. As per UN, nine out of ten people worldwide are exposed to levels of air pollutants that exceed WHO safe levels. Around 7 million people worldwide die prematurely each year from air pollution with about 4 million of these deaths occurring in Asia-Pacific. Among all air pollutants, the health risks associated with particulate matter smaller than 10 and 2.5 microns in diameter (PM10 and PM2.5) are of particular public health relevance.

Dusts from various construction and other civil engineering activities contain a wide range of particle sizes (including PM10 and PM2.5) and material types, such as silica, and recognized as one of the major contributors to air pollution in India. Construction dust emission originates from many types of on-site activities such as earth work, excavation work, rock blasting & drilling, bulk material transportation, loading and unloading of dusty materials, open-air material storages, concrete production, stone crushing, cutting and filling, movement of equipment and vehicles, etc. Owing to their small sizes, they are carried from sites even in light winds and may therefore have an adverse effect on the local environment, on the health of local residents, construction workers as well as on others working on the site. Blowing dust on construction site is also considered a potential safety hazard.

In recent years, impact of dust pollution is becoming worse in extreme summer and winter conditions in India. The deteriorating situation every year has been forcing the National Green Tribunal (NGT) and other regulatory authorities to frequently issue various directives, guidelines, and actions to construction projects to strictly follow all laid down rules and regulations to control dust pollution [Box-1]. Violating prescribed rules by projects are resulting in punitive actions including ban on carrying out their site activities.

The Government had also notified "Construction & Demolition (C&D) Waste Management Rules, 2016 which had been an initiative towards effectively tackling the issues of pollution and waste management. Taking note of the increasing air pollution, host of other guidelines and action points have been laid down making dust mitigation measures in infrastructural projects and demolition activities mandatory. It is expected that such approach would help in keeping the dust under control to reduce air pollution.

Although, there are some general approaches to dust control, such as sprinkling water every day to suppress the suspension of dust at the construction sites; covering debris and materials when stored or when they are being taken; barricading along the perimeter of construction or demolition sites; use shade nets, tarpaulins or plastic sheets for staging, etc. but more efficient and cost effective pragmatic approaches for improving air quality in and around the construction sites depends on – (1) Identification of significant dust emission sources on every site, (2) Prioritizing such sources that needs to be tackled more prudently, (3) Weighing various practical and cost effective options for controlling the dust emissions from different sources, and (4) Sincerely implementing and managing such appropriate actions.

The DFC project has been giving due considerations to such aspects and has laid down adequate provisions in its contractual documents as well as in monitoring & supervision mechanisms. It strictly requires different contractors and sub-contractors to adopt appropriate dust reduction measures as per stipulated norms in the contractual and mandatory provisions while carrying out various construction activities for the development of freight corridor.

[Box-1]

One-day deadline to act on dust pollution

NGT Tells Delhi, UP & Haryana To Follow Construction Rules

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New Delhi: Elaborating on its order to curtail air pollution due to dust, National Green Tribunal (NGT) on Friday issued directions to the governments of Delhi, Haryana and UP to stop any construction in NCR, which violates its rules or 2010 guidelines of the MOEF. It issued a deadline of Saturday for taking action, saying that the governments and departments concerned would be held liable if constructions continued in violation of the rules.

The tribunal also asked six court commissioners to inspect various sites to check on compliance with its order.

Meanwhile, the commissioners were told to submit a report on their inspection of various entry points into Delhi. In a drive that started on Thursday following NGT's order, traffic police impounded 363 vehicles between midnight and Friday morning.

File photo

MESSY BUSINESS: A PWD work site in Greater Kailash-I, New Delhi

On Friday, the Delhi government pleaded with NGT to allow essential services such as fire trucks, ambulances and vehicles carrying food items into the city, saying that six months would be needed to replace the existing fleet of diesel vehicles. NGT said the government could file an application in this regard and as long as its intent to follow the orders was clear, the court would not penalize it unnecessarily.

The tribunal will now take up the issue of air pollution in phases. On Friday, it focused mainly on dust-related pollution. In the next hearing it will take up matters related to pollution caused by open burning of waste.

NGT's order effectively makes the 2010 MoEF guidelines on construction compulsory to follow. Occupancy certificated will only be issued if this order is complied with. Delhi has been told specifically to increase its tree cover.

"Most of what NGT has been saying during the hearings is part of the MoEF guidelines. By virtue of being guidelines, it was not necessary that they be followed. The order makes that compulsory. In fact, the court specified that its order overrides any permission or clearances that a project has been granted. If there are violations, the construction has to stop," said a source.

The city, which has a single facility for processing its construction and demolition waste, has been told to immediately increase its capacity. "Delhi is producing around 4,000 MT of C&D waste each day and only 10% of this is being processed. The government needs to expand its capacity to process C&D waste," said Swatanter Kumar, NGT chairperson.

Source: The Times of India, April, 2018

MAJOR SOURCES OF CONSTRUCTION DUST EMISSIONS IN DFC PROJECT

The most significant sources of dust generation during the project construction works are:

- Stockpiles;
- Exposed areas during earthworks and excavations;
- Cement Handling and Concrete Batching Plants; and
- Vehicle movements on haul roads and site roads.

Since, DFC Project is a linear project, dust pollution sources along with their associated major issues are divided into three categories based on the main activities being carried out in the project and it includes - (1) Stationary sources, (2) Mobile sources, and (3) Area sources.

(1) Stationary Sources

a) Concrete Batching Plant –

- Overall operation of Batching Plants
- Improper and irregular maintenance of cement silo vent air filters
- Uncovered aggregate bins
- Improper dust covering arrangements for conveyor belt and hopper
- Uncovered and unsecured cement feeding hopper area

b) Cement Go-down –

- Poor housekeeping
- Untidy and open storage of bundles of empty cement bags
- Poor ventilation air arrangement

- ➲ No PPEs to workers to prevent inhalation of cement dust particles

c) Pre-stressed Concrete Sleeper Plant –

- ➲ Unprotected loading point at aggregate bins
- ➲ Uncovered and unsecured cement feeding area
- ➲ Unsecured and unprotected storage of rejected or broken concrete sleepers

d) Stone Crushing Unit and Pug Mills –

- ➲ Overall operation of stone crushers and pug mills

e) Rock Drilling and Blasting Operation –

- ➲ Fugitive silica dust pollution during drilling of blasting holes
- ➲ No wet drilling to contain dust emissions
- ➲ No PPEs to workers to prevent inhalation of harmful dust particles

(2) Mobile Sources

f) Vehicle and Construction Equipment –

- ➲ Movement of vehicles / dumpers at site and haul roads without water sprinkling
- ➲ Working of excavators for rock breaking at blasting site without dust suppression
- ➲ Vehicles carrying loose construction materials like soil, sand, stone chips without cover

(3) Area Sources

g) Overburdened Material and Muck Piles –

- ➲ Storage of overburdened material and muck piles

h) Construction and Demolition (C&D) Waste –

- ➲ Accumulation of construction and demolition waste
- ➲ Dumping waste all over the site

i) Storage of Aggregate Materials –

- ➲ Storage of coarse and fine aggregate materials without dust suppression

j) Site Road Conditions –

- ➲ Damaged and non-compaction conditions of internal site roads

k) Storage of Unsuitable Material at Site –

- ➲ Accumulation of unsuitable spoil material stockpiled within RoW

REVIEW OF MAJOR LEGISLATION / MANDATORY REQUIREMENTS OF DUST CONTROL MEASURES

Previously, there used to be no specific regulation prescribing preventive measures to be taken for the management of dust, especially C&D dust that arises during construction. However, taking note of the increasing air pollution in recent years and to keep dust material under control - regulatory authorities, enforcement agencies, National Green Tribunal (NGT), etc. are regularly issuing various guidelines, action points & mitigation measures, notifications, etc. and has made dust mitigation measures mandatory in infrastructural and large construction projects, which would help to keep the dust under control to reduce air pollution.

Defying these directives have recently resulted in - hefty penalties including ban on construction activities; issuing of legal notices against project implementing agencies; issued stopping orders have major detrimental impacts in progress of works; and other strict actions.

In this paper, following major Guidelines and Legislative Directives on Dust Pollution have been considered for collating mandatory action points and mitigation measures:

1. Environmental Impact Assessment Guidance Manual for 'Building, Construction and Area Development Projects', 2010;
2. Central Pollution Control Board (CPCB) 42 Action Points to Mitigate Air Pollution;
3. National Clean Air Programme, 2019;
4. NGT Order OA 21 dated 04-12- 2014;
5. NGT Order OA 95 dated 10-04- 2015;
6. MoEF Dust Mitigation Measures Notification 25-01- 2018; and
7. CPCB Guidelines on Dust Mitigation Measures in Handling Construction Material and C&D Wastes, 2017

Notable among these collated action points are summarized below: **[Box-2]**

S. No.	Collated Mandatory Action Points & Mitigation Measures for Dust Control
a.	The dust emissions from the construction site should be completely controlled and all precautions taken in that behalf.
b.	➲ Control dust pollution at construction sites through appropriate cover. ➲ The construction material of any kind that is stored in the site should be fully covered in all respects so that it does not disperse in the Air in any form. ➲ Material storages / warehouses – Care should be taken to keep all material storages adequately covered and contained so that they are not exposed to situations where winds on site could lead to dust / particulate emissions. Fabrics and plastics for covering piles of soils and debris is an effective means to reduce fugitive dust. ➲ No loose soil or sand or Construction & Demolition Waste or any other construction material that causes dust shall be left uncovered. ➲ Mount dust barrier sheet ex tarpaulin / plastic on scaffolding around the construction / demolition building – particularly side facing residential areas.
c.	Undertake control measures for fugitive emissions from material handling, conveying & screening operations through water sprinkling, curtains, barriers and dust suppression units.
d.	➲ Ensure carriage of construction material in closed / covered vessels. ➲ The vehicles carrying construction material and construction debris of any kind should be cleaned before it is permitted to ply on the road after unloading of such material. ➲ All the construction material and debris shall be carried in the trucks or other vehicles which are fully covered and protected so as to ensure that the construction debris or the construction material does not get dispersed into the air or atmosphere, in any form whatsoever. ➲ No uncovered vehicles carrying construction material and waste shall be permitted.
e.	Ensure DG sets meeting the standards only be allowed to operate
f.	Every worker working on the construction site and involved in loading, unloading and carriage of construction material and construction debris shall be provided with mast to prevent inhalation of dust particles.
g.	➲ Wind breaking walls around construction site. Wind breaker of appropriate height shall be provided. ➲ Raise barricade along the perimeter depending on the nature of adjoining regions.
h.	No excavation of soil shall be carried out without dust mitigation measures in place.
i.	Compulsory use of wet jet in grinding and stone cutting.
j.	Water sprinkling system shall be put in place.
k.	➲ Reducing the speed of a vehicle to 20 Kmph can reduce emissions by a large extent. ➲ Speed bumps are commonly used to ensure speed reduction. ➲ In cases where speed reduction cannot effectively reduce fugitive dust, it may be necessary to divert traffic to nearby paved areas.
l.	➲ Locally found gravel may be applied to access roads as it adds a protective layer over the exposed soil and helps control dust generation in some situations. It is important that gravel contain a minimal percentage of fines and clean gravel be added periodically, as the fines migrate to the surface and create dust.

m.	Construction material and waste should be stored only within earmarked area and roadside storage of construction material and waste shall be prohibited.
n.	Selective mechanization (deployment of construction / demolition) of handling material / wastes helps in better management and reduction of dust generation at site.

CONTRACTUAL REQUIREMENTS AND PENALTY PROVISIONS IN DFC PROJECT

In DFC project, adequate provisions have been laid down in the contract documents, but together with the above listed mandatory requirements, it gives adequate information to the contractors and sub-contractors to control dust pollution on their construction sites. These contractual provisions are listed below –

- The Contractor shall water all unpaved roads in all construction sites at least thrice daily in dry weather to reduce dust; and shall apply the same watering regime to areas of exposed soil during dry and windy weather.
- All fine-grained loose material (soil, sand, etc.) shall be covered with secure tarpaulins when stored on site and when carried on- or off-site on trucks.
- Vehicle speeds on all construction sites shall be limited to a maximum of 20 kmph at all times.
- Wheel washing facilities shall be provided and used by all vehicles at all site exits prior to travelling on public roads.
- Crushers and any other machinery likely to produce significant dust shall be located at least 1 km from the nearest inhabitation, downwind of the predominant wind direction. Permission/NOC shall be obtained from the State Pollution Control Board for installing and operating all crusher units. The Contractor shall provide the Engineer with copies of relevant certification to show that all such machinery is fitted with appropriate dust reduction/ extraction equipment.
- Watering of site roads and other exposed soil during the dry season to suppress dust, with water tankers permanently available for this purpose.
- Removal of topsoil before excavation; and storage for future use, with measures to prevent erosion or dust production from stockpiles.

In case, the dust control measures are not practiced on site, the penalty amounts to Rs 10,000 per single violation and compounded to a maximum of Rs 50,000 at any single instance.

Additionally, there is a strong mechanism of "Construction Dust Monitoring and Inspection" inbuilt in the DFC Project. Regular environmental monitoring for ambient air quality and source emissions, and regular meetings among all stakeholders to monitor implementation of environmental management are some of the key success factors in the DFC Project.

TYPICAL WORK AREAS AND REQUIRED CONSTRUCTION DUST CONTROL & MITIGATION TECHNIQUES

Some typical work areas and activities along with required construction dust control and mitigation techniques are briefly summarized below:

1. Exposed Dust Generating Stockpiles & Excavated Soil

Exposed stockpiles such as fine and coarse aggregates, concrete waste, excavated soil, etc. on worksites require appropriate dust control and mitigation techniques to prevent dust emissions during wind blowing and other site disturbances.

Some typical control methods include ➔

- Exposed stockpile and excavated soil should be dampened using water sprinkler system for dust suppression.
- Such exposed surfaces should be covered entirely by impervious sheets.
- Such materials should be stored away from the site boundary and downwind of residential areas.
- Storage time should be minimised on site.
- Height of stockpiles should be reduced to manage it and applying dust suppression methods.
- Stockpiles of dusty materials should be temporarily stored in an allocated locations.

2. Concrete Production

For production of concrete in captive batching plants, various dust prevention measures are required to be taken.

Some typical control methods include ➔

- Debagging area or cement feeding hopper area should be in a secured enclosure.
- Silo exhaust vent air should be exited only through arrangement of bag filter assembly with a mechanism of either auto cleaning or air injection cleaning.
- Empty cement bags should be temporarily stored in a covered area and timely removed from the site.
- Ventilation air from cement go down should be through ducting arrangement followed by either bag filter and wet suppression system.
- All loose cement collected at the bottom of silo hopper should be collected in bags and in no case left in open.

3. Belt Conveyor System

Belt conveyor system in batching plants, pug mills, stone crushing units, etc. requires dust prevention measures for controlling fugitive dust emissions on work sites.

Some typical control methods include ➔

- Conveyor belts should be covered on top and two sides all along its length.
- All transfer points between belt conveyors should be covered.
- The unloading area, such as storage bin, should be covered on top and three sides.

4. Loading and Unloading of Dusty Materials

Loading and unloading of dusty materials on-site is considered as one of the significant sources of dust pollution and requires appropriate dust prevention measures.

Some typical control methods include ➔

- All dry dusty materials should be sprinkled with water for dust suppression immediately prior to loading and unloading operations.
- Cover the dusty materials loaded in trucks, dumpers, etc. with impervious sheeting before leaving the site.
- Provide wheel washing facilities at places where the transit mixers, dumpers, trucks etc. have to travel the roads passing through residential areas or the carriageways are meant for regular road traffic.

5. Good Housekeeping

Good housekeeping is one of an effective technique in controlling dust pollution at construction work sites.

Some typical control methods include ➔

- All surplus earth and debris are removed / disposed off from the working areas to officially designated dumpsites in a timely manner.
- No waste, scrap of any kind should be allowed to build-up on worksites.
- Empty cement bags, other stocked iron pipes, accessories, etc. should be either kept in a covered area / store or if in open, they should be appropriately covered with a tarpaulin / plastic sheet.

6. Haul Roads and Access Roads

Regular movement of construction vehicles and machineries, site vehicles, etc. on haul roads, access roads, and site internal roads leads to significant dust pollution and requires sincere efforts to control the dust emissions.

Some typical control methods include ➔

- Most traversed roads should be compacted and sprayed with water for dust suppression to maintain the entire road surface wet.
- Limit the speed of vehicles to 15-20 Kms./hr.
- The portion of any road only leading to a construction site that is within 30 m of a vehicles entrance or exit should be kept clear of dusty materials.

WDFC SITE EXAMPLES – GOOD PRACTICE VS. BAD PRACTICES

Recognizing the importance of reducing dust air pollution on construction sites, the DFC project has taken / is taking multiple initiatives on its various construction sites to minimize the impact of dust on the surrounding environment as well as to comply with

various conditions as stipulated in mandatory provisions. Some of these mitigation measures which has resulted in controlling dust pollution to a great extent on different construction sites in the project are briefly summarized below in the form of 'Good Practices' vs. 'Bad Practices' and are indicative of sound environmental management practices being integrated during implementation work:

GOOD PRACTICES	BAD PRACTICES
1. Housekeeping	
	
	
Good housekeeping, storing outside stacking and other material in an enclosed area or store area, covering with tarpaulin/plastic sheets, timely disposal of scrap materials from site, etc. has resulted in controlling dust pollution and preventing settled dust from re-appearing into the atmosphere during wind blowing.	Poor housekeeping, stacking of scaffolding and other materials outside cement go-down area has resulted in accumulation of cement dust & fine soil dust, which acts as a potential source of dust pollution during wind blowing and other site disturbance.

GOOD PRACTICES

2. Excavated Soil

Taking measures such as spreading out dredging soil and excavated soil for site development, filling low lying areas with soil and compacting it, preparing proper soil disposal plan, etc. has resulted in controlling dust pollution.

3. Ventilation Air

Controlling cement dust emissions from cement go-down area by providing ducting arrangement at the outlet of all exhaust fans and connecting them to the wet suppression dust extraction system has resulted in much dust free environment in the surrounding area.

BAD PRACTICES

Poor management, open dumping, and improper stacking of dredging soil from piling work & excavated soil on worksite without having sufficient plan for its disposal or reutilization. On drying, such pile up of soil in open acts as a source of dust pollution.

Poor ventilation arrangement at cement go-down / bagged cement store causes emission of cement dust laden exhaust air in the ambient air and also fine cement dust settles down and accumulates on the vegetation and ground in the surroundings, which reappears into the atmosphere during wind blowing and causes dust pollution.

GOOD PRACTICES

4. Silica Dust Emissions during Rock Drilling

Adopting wet drilling operation through a "Water Injection Arrangement" and carrying out both drilling and blasting operation in a controlled manner leads to control of dust pollution and preventing potential environmental & health hazard to both workers and surrounding villagers.

5. Health Protection of Workers

Good quality of Environmental PPEs - disposable particulate respirators (3M N95 8210) with at least 95% filtration efficiency of "Nose Mask" for protecting operators / workers from high level of both respirable, inhalable silica dust; "Ear Muffs" to deal with high decibel noise exposure of 120-140 dBA; and "Eye Goggle" to protect eye from Silica dust during drilling and blasting operation are provided.

BAD PRACTICES

Rock drilling operation without following precautionary measures leads to excessive dust pollution rich in crystalline silica content. Such dust not only emitted out into the ambient air, but also accumulate on the surrounding rock surface. This has the potential to become airborne during wind movement, thereby causing both environmental & health hazards to workers engaged in drilling & blasting work as well as propagate in the surrounding village areas.

Workers engaged in drilling operation are not equipped with proper work specific Environmental PPEs to protect themselves from high level of both respirable and inhalable silica dust concentration as well as high decibel noise.

GOOD PRACTICES

6. Stockpiling of Coarse and Fine Aggregates

- Sprinkling of water / fine spray from nozzles on the heap of coarse aggregates to suppress dust and avoid dust pollution.
- Covering fine aggregates with tarpaulin and other suitable sheets.
- Material is stored in demarcated areas to act as wind barriers so that dispersion of pollutant in the atmosphere is minimized.
- Storage of aggregates are kept in a low height i.e. not exceeding 3 m height for effectively applying dust suppression measures.

BAD PRACTICES

No (or insufficient) dust suppression method applied to stockpiled area of both fine and coarse aggregates, thereby leading to significant dust pollution during wind blowing and affecting the surrounding residential colonies.

GOOD PRACTICES

7. Handling of Dusty Material

Dust protection during transportation is done through three measures:

- Avoiding overloading above tail and side boards.
- Covering top with tarpaulin sheet and securing it properly.
- Cleaning the outer surface of dumpers before leaving the borrow pit, such as removing lumps of loose soil on the running board, etc.

8. Haul Roads & Site Roads Dust Emissions

Adequate water sprinkling is applied to at least 3-4 times per day or as per actual site conditions so as to keep fugitive dust emissions constantly under control. Speed limit of all vehicles is restricted to 15-20 km/hr on both haul and inter site roads and accordingly, drivers are instructed.

BAD PRACTICES

Dumpers or trucks carrying borrow earth, quarry materials, and other dusty materials either without any cover or partial cover leads to dust pollution during transportation as well as spillage on roads.

Excessive dust emission generates, particularly during dry and windy season, due to continuous movement of heavy vehicles and other site bound vehicles. But activity is being carried out with no (or insufficient) water sprinkling on dusty roads or no restriction on speed of vehicles.

GOOD PRACTICES

9. Gaseous Emissions from DG Set Operations

Adequate height of stack is provided as per CPCB norms –

$H = h + 0.2 \times \sqrt{KVA}$, where

H = Total height of stack in metre

h = Height of the building / shed in metres where the generator set is installed

KVA = Total capacity of the generator set

The stack is above the roof level of the canopy (i.e. acoustic enclosure) in order to avoid the build-up of pollutants or smoke at the normal inhalable level restricting harmful exposure to site staff and workers.

10. Storage of Empty Cement Bags

Though proper covering has been provided, but in order to enhance effectiveness, the outside stacked materials should be removed in a timely manner from the site, since cement go-down area is a vulnerable location and a potential source of dust pollution.

BAD PRACTICES

DG sets kept in a covered shed with tin sheet roof but stacks provided are inadequate / improper and not following CPCB norms. This leads to emissions of harmful gases in the surrounding atmosphere.

Bundles of empty cement bags lying in open outside the cement go-down area, which acts as a potential source of cement dust pollution during wind blowing.

GOOD PRACTICES

11. Aggregate Bins and Conveyor Belt

Green net arrangement is provided at aggregate bins as well as all along the length of conveyor belt on both sides to control fugitive dust emissions. At some locations, water sprinkler arrangements are also provided to control dust emissions during loading in aggregate bins.

12. Handling of C&D Waste at Site

In order to minimize dust pollution, various measures are applied:

- Temporary storage of concrete waste is stored in a demarcated and designated area on worksite.
- Stop dumping of such waste at all over the site.
- Applying dust suppression measures for such waste by either keeping it moist or covering it with a tarpaulin sheet.
- Reutilize such waste as much as possible for filling low lying areas on the site and covering it with soil and compacted.
- Build-up of such waste should be avoided on the site and needs to be regularly disposed on the authorized locations.

BAD PRACTICES

Aggregate bins and conveyor belt for sand and aggregates are not covered to control fugitive dust emissions during loading and conveying process in the captive batching plants.

Waste concrete and debris are dumped at site without following dust protection measures. Such type of waste dumping not only leads to soil contamination but also acts as a potential source of dust pollution due to wind dispersal.

CONCLUDING REMARKS

This paper has mapped various practical control and management measures for different construction activities for controlling dust pollution in and around the construction sites in DFC project. In recent years, it has become mandatory to control construction dust emissions in order to avoid penal actions from the regulatory and enforcement authorities. Contractors and Sub-contractors are regularly instructed and monitored to address issues of dust pollution in their work activities not only as per contractual provisions but also to comply with relevant directions and guidelines issued by the government or NGT from time to time.

In order to maintain dust emissions from all types of sources, viz. stationary, mobile, and area, within the acceptable limit, considerable efforts should be made to continuously improve the effectiveness of all of the identified measures. It is worth to mention here that not an individual approach, but a combination of measures is required to be implemented.

Dust control is becoming a new challenge for the construction projects in India. Systematic and effective approaches need to be integrated with the good construction practices to control air pollution and environmental impacts. It requires increased awareness and change of mindset among contractors and its sub-contractors. It has to be understood that there are implementation risks in the form of stoppage of work or hefty penalties in case of non-compliance and non-adhering to the stipulated norms causing delay in timely execution of projects.

TOP DOWN CONSTRUCTION OF DEEP CUT BRIDGES

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ABSTRACT

In present time of Infrastructure boom, construction industries are focusing more on Smart work along with Hard work. Smart work in the form of Project planning, Construction Strategy, Advanced Methodology & Technique, Enhanced Machineries, Skilled workmanships and so on.

In tender stage, the deep cut bridges in CTP-14 package were considered as PSC I-girder spans with piers resting over deep cut. In this method, the bridge work must be initiated only after completion of Deep cut excavation works, since all the foundations shall start below deep cut level. Moreover, Construction of foundations, sub-structures, superstructure from a deep cut level of average 18m & also the erection of superstructure in the excavated terrain is risky & more time-consuming.

Considering the strict timeline of project completion, the smart work adopted here is the construction Strategy, i.e. Top-down construction for the span type bridge structures over the deep cut region.

This strategy of top-down construction is changing the complete dynamic of the construction activities – Foundations & Substructures can be can be completed over the existing NGL without starting excavation; Superstructures can be constructed cast-in-situ over the existing ground level & traffic movement can be resumed over the new bridge before start of excavation. These, ultimately reducing the overall duration of construction due to Ease & proper access to all the activities.

INTRODUCTION OF PROJECT

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 Kms./h, from Rewari to Dadri (128 Kms).

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 Kms.) 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 Kms. 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 Top-Down Construction Strategy for constructing Span type bridges in the Deep cut profile of CTP-14 project.

CONSTRUCTION STRATEGY

Inside the 128 Kms. long alignment of CTP-14, there is a deep-cut stretch of approx. 5 Kms. in length & the depth of cut varying from 4m to 32m. Within this stretch, there are a total of 6 Span-type structures: 5 Nos. ROBs & 1 No. Major bridge.

Below were the Bridge configurations proposed during tender:

Sl. No.	Bridge Type	Bridge No.	Span Configuration during tender	Superstructure Type	Approx. depth of deep cut
1	ROB	80B	1x12.2m + 1x24.4m + 1x12.2m (5m wide)	PSC I-Girder	8.5m
2	ROB	81	1x12.2m + 1x24.4m + 1x12.2m (5m wide)	PSC I-Girder	9.7m
3	ROB	82	1X25.0m (7.5m wide)	PSC I-Girder	11.1m
4	ROB	85	1X25.4m + 1X24.4m + 1X25.4m	PSC I-Girder	24.4m
5	Major Bridge	85A	1X2mX2m + 1X13mX9.2m + 1X2mX2m	RCC Box	27.2m
6	ROB	86	1X26.5m + 1X24.4m + 1X26.5m (7.5m wide)	PSC I-Girder	28.9m

Since all these structures are in Deep cut sections, the activities involved in Construction are:

- Deep cut Excavation up to an average depth of 18m & further below for constructing Foundations.
- Construction of foundations at an average depth of below18m from NGL.
- Construction of Sub-structure at that depth from NGL.
- Erection of superstructure from inside the deep cut with average depth of 18m.
- Construction of deck-slab from within the excavated Deep cut.

For the complete construction activities of these bridges, it is very difficult to get all the machineries at such excavated level from NGL. Moreover, for initiating structural activities, the deep cut excavation & slope stability need to be fully completed

For overcoming these difficulties, a relevant method of construction has been adopted – the Top Down construction method..

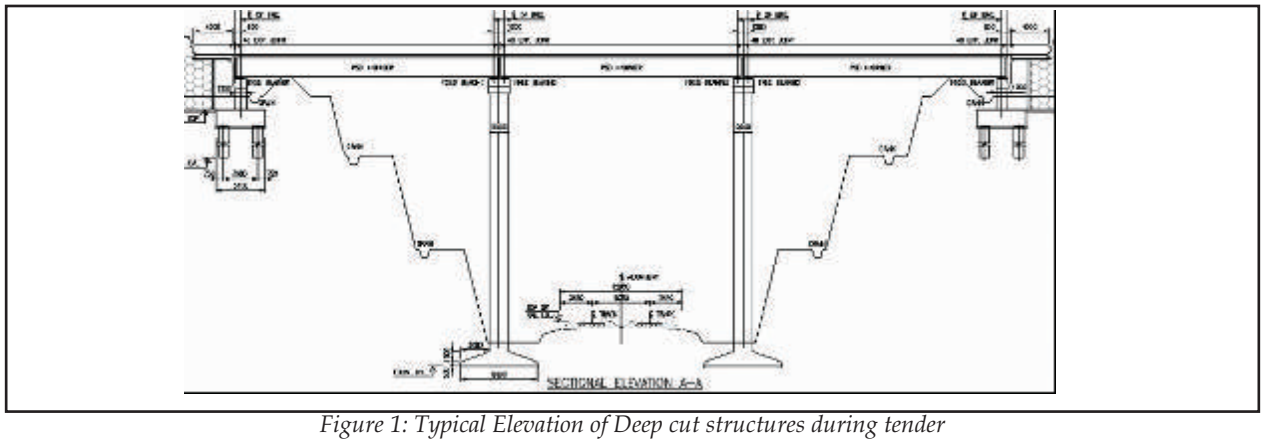


Figure 1: Typical Elevation of Deep cut structures during tender

Following are the advantages of adopting Top Down construction

- The foundations are converted to Pile only & the Pile cap will work as the Sub-structure. Piles shall be constructed directly from NGL without any excavation. Also, the Pile cap can be constructed with minimum excavation till pile cap bottom. This is advantageous, since all the activities will be performed from NGL itself with proper access & with more efficiency.
- For constructing new bridge, road diversion will be easier over the NGL than compared to diversion over excavated Deep cut.

- The Superstructures are converted into Voided Slabs / Solid slabs / Box Girders. These will be constructed directly over the ground, making it easier to access & work effectively.
- Structural Work need not be held till completion of deep cut excavation.

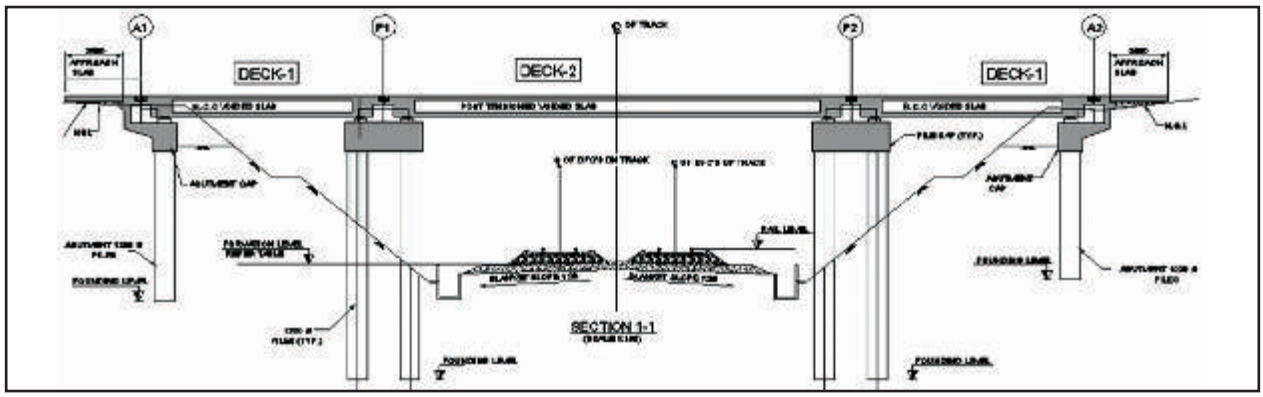


Figure 2: Typical Elevation of Deep cut structures in Top down construction

Below are the modified Span configuration & Type of Superstructures

Sl. No.	Bridge Type	Bridge No.	Span Configuration after modification	Superstructure Type
1	ROB	80B	1x13.78m + 1x25.6m + 1x13.78m (7.5m wide)	Voided Slab
2	ROB	81	1x14.8m + 1x28.5m + 1x14.8m (7.5m wide)	Voided Slab
3	ROB	82	1X25.0m (10m wide)	Voided Slab
4	ROB	85	3X50m	PSC Box-Girder
5	Major Bridge	85A	1X21.5m + 2X27m + 1X25m + 1X17.1m	Beam/Flat slab
6	ROB	86	3X33.1m (12.5m wide)	Voided Slab

The advantages of changing the superstructure type into voided slabs

- Voided slabs enormously reduce the superstructure self-weight.
- Due to reduced superstructure self-weight, it attracts much lesser seismic forces & thus reducing the seismic design loads.
- The reduced superstructure weight also results in design load reduction for substructures & foundations.
- It also brings opportunity in quantity reduction & thus cost saving can be considered.
- Also, it becomes easy and simple for construction of slabs, rather than constructing PSC-girders & deck slabs/diaphragms separately.

Construction Methodology

- STAGE-1: The existing road/crossing shall be diverted from the bridge location as per proper diversion plan. Clear & proper diversion barricades & signages shall be provided to maintain safe working condition.

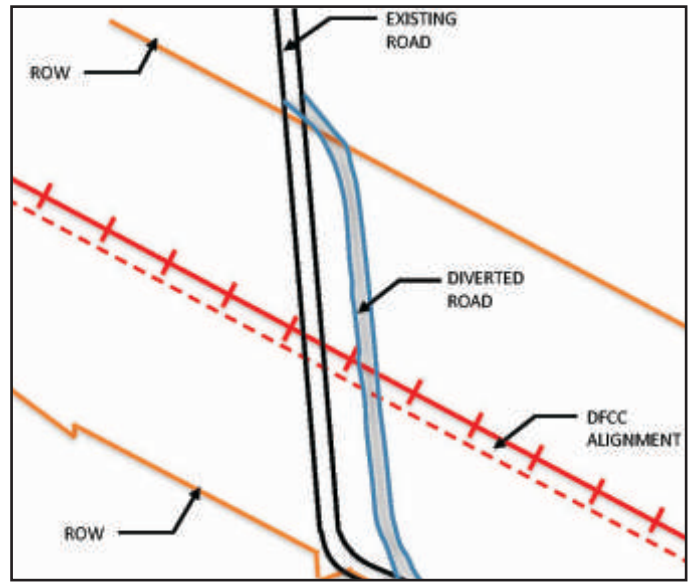


Figure 3: Existing road diverted for commencement of Bridge work

- **STAGE-2:** After diversion, Bridge location with foundations shall be marked as per the GAD co-ordinates. The foundations/piling locations shall be marked to start the piling work

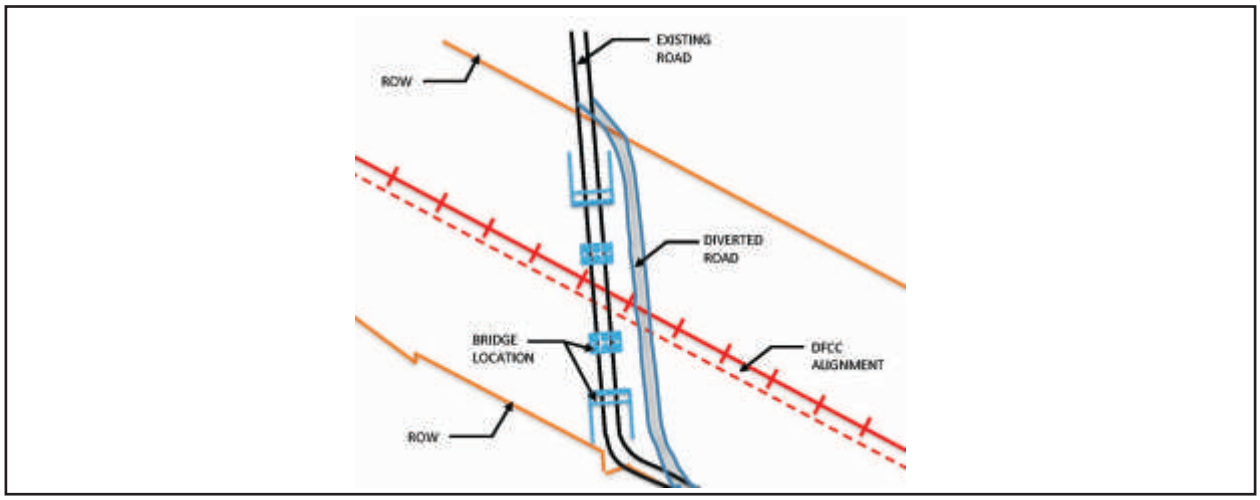


Figure 4: Bridge locations marked as per co-ordinates

- **STAGE-3:** Now, piling shall be started over the NGL & as per the marked co-ordinates. Permanent steel liners are provided till the excavation depth to prevent it from exposed environment.

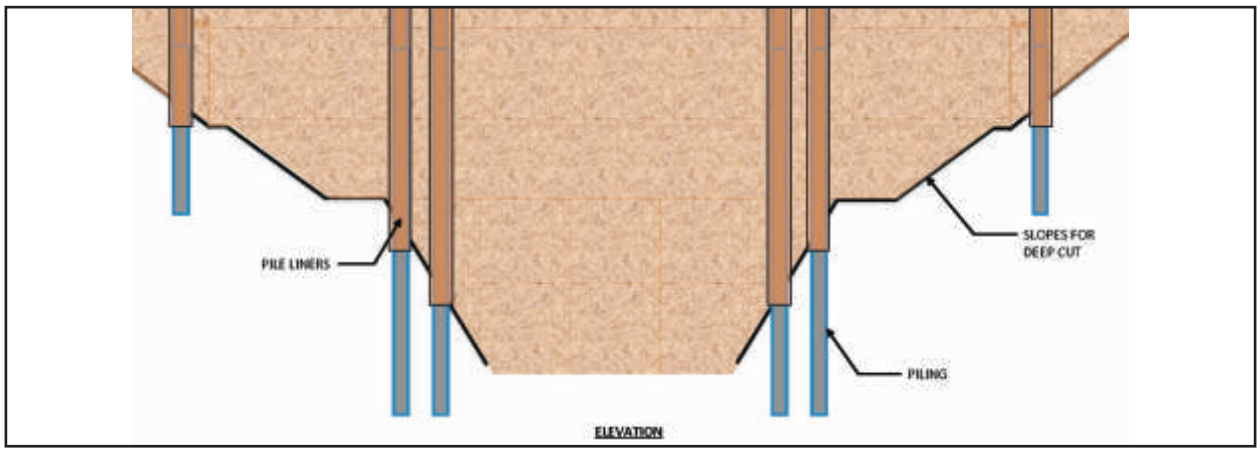


Figure 5: Elevation showing completed Piling work

- **STAGE-4:** After piling is completed, excavation shall be done for constructing the pile caps. Piles shall be chipped off till cut-off level & pile cap construction shall be completed.

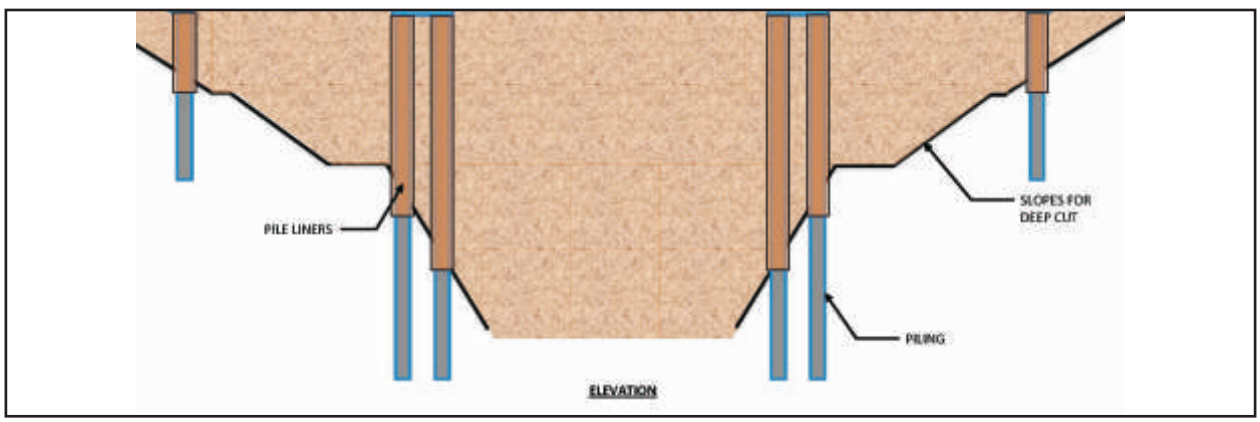


Figure 6: Elevation showing completion of pile caps

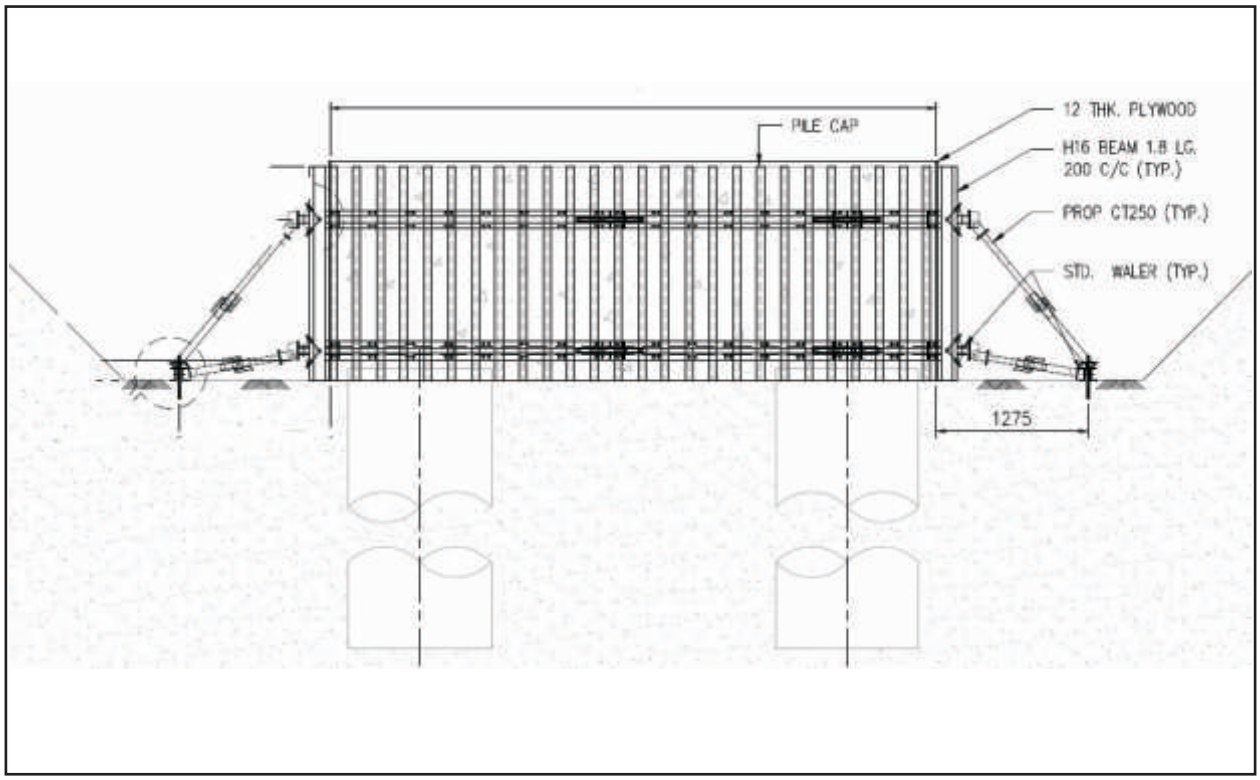


Figure 7: Elevation showing Pile-cap supporting arrangement

- **STAGE-5:** After Pile-cap construction is over, superstructures shall be constructed over the existing ground level.
  - o For superstructure, the ground level shall be compacted properly after excavation till the required depth.
  - o PCC shall be done to support the voided slab soffit.
  - o Then formwork shall be assembled for supporting the vertical face & the cantilever decks.

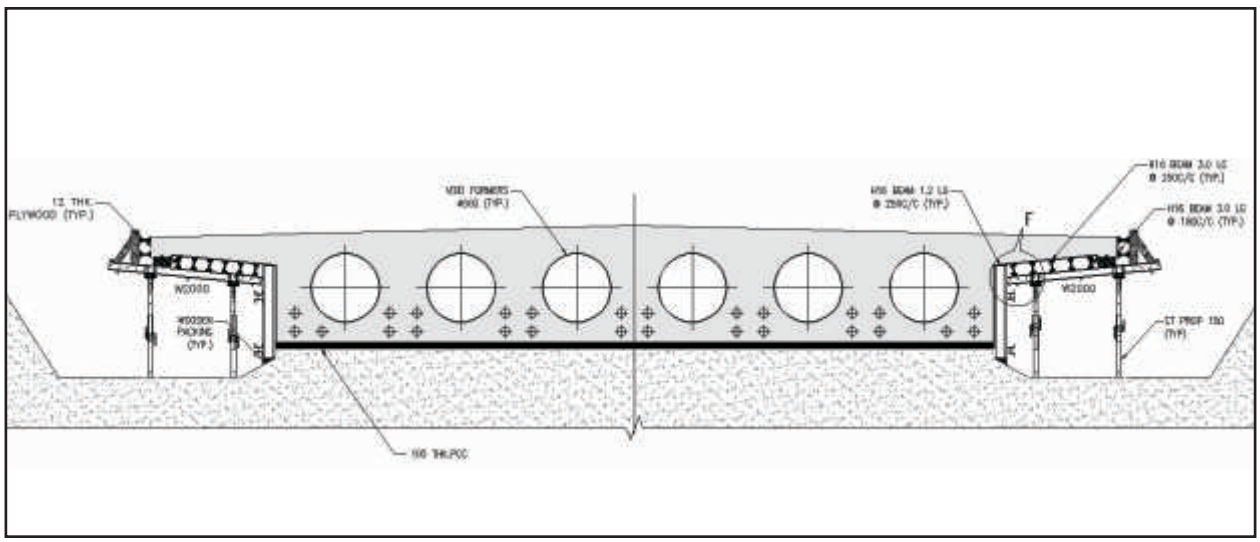


Figure 8: Cross section showing Bed PCC,Vertical face & Cantilever supporting

- Reinforcement for the superstructure shall be tied over the PCC & assembled formwork.
- Void formers of GI materials shall be placed in position as per the approved drawing.

Figure 9: Tentative void former arrangement

- End shutters with post-tensioning anchor cones shall be fixed & profiling of sheathing ducts shall be completed as per the approved post-tensioning drawings.

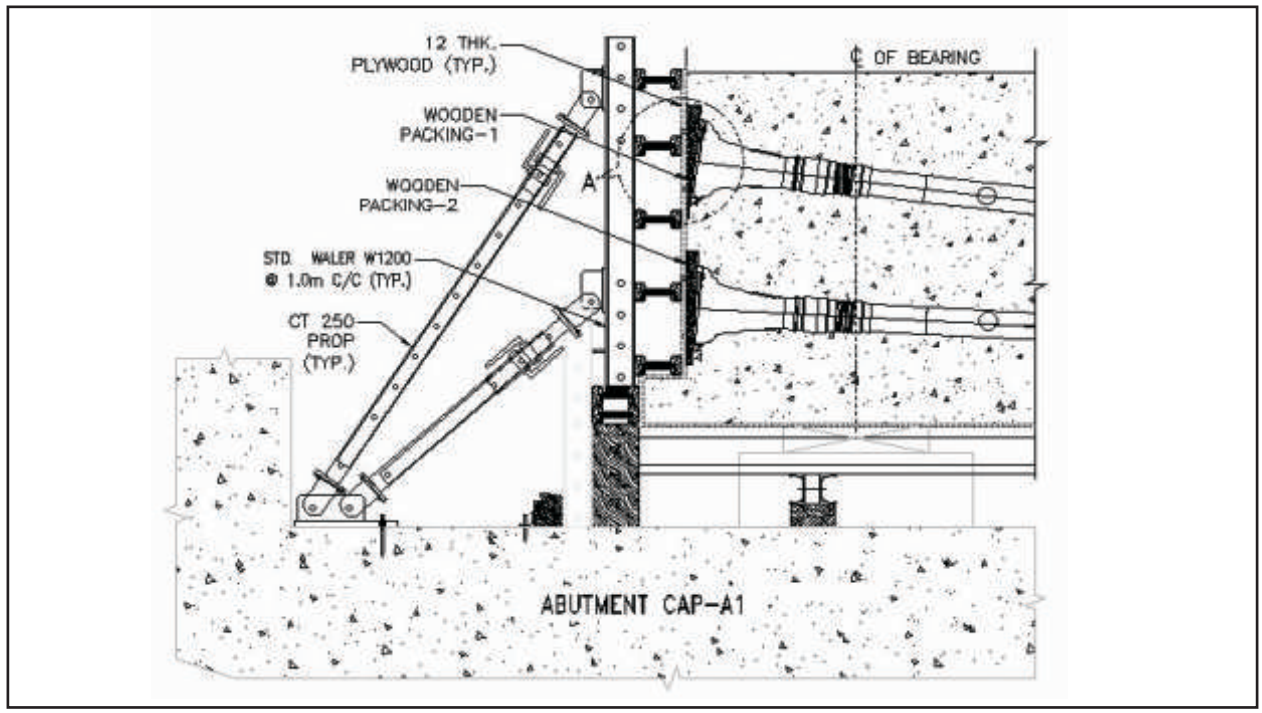


Figure 10: End shutter with Post-tensioning system

- Concreting shall be completed for the superstructure.
- Post-tensioning shall be done as per the approved drawing after 21 days of casting.
- The superstructures shall be lowered over the pier cap bearings

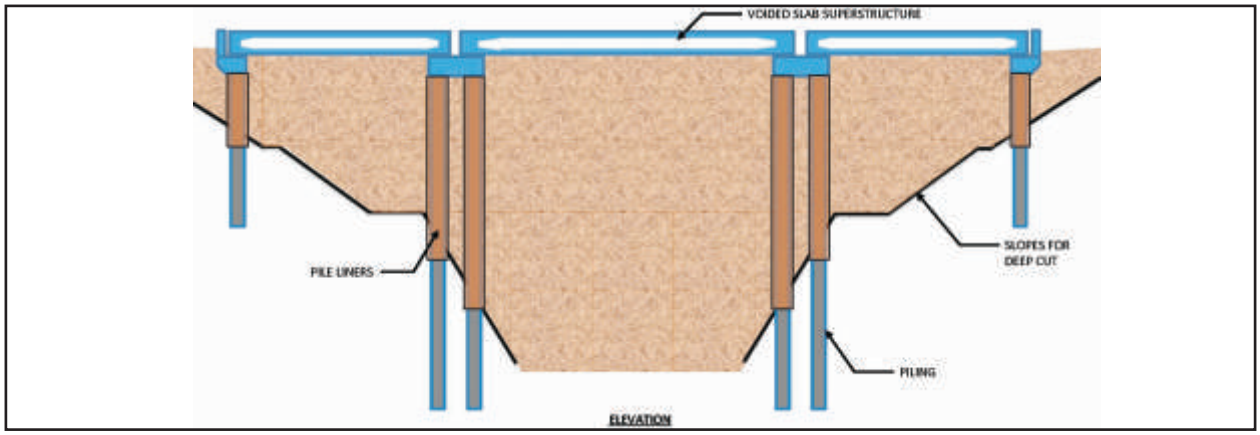
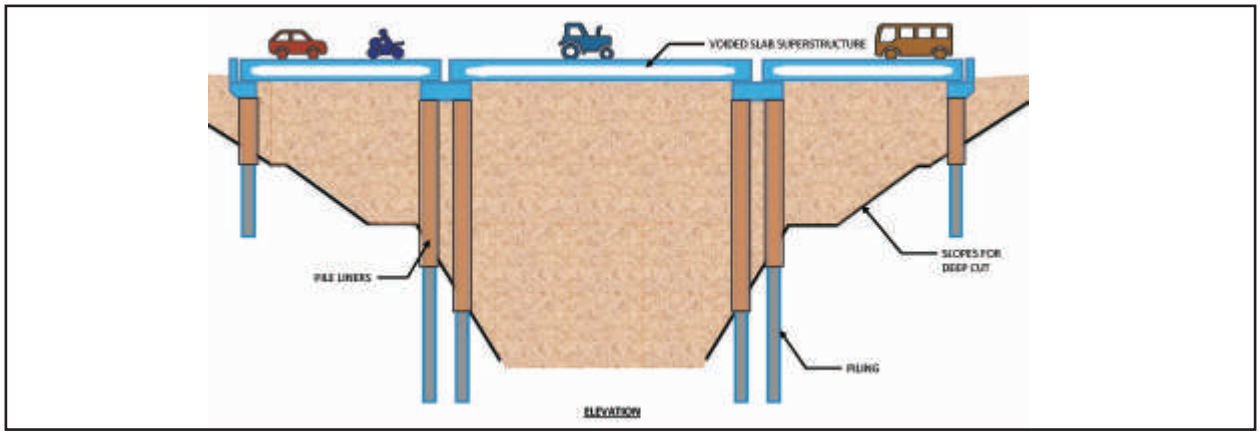


Figure 11: Elevation showing completed superstructure

- STAGE-6: Once superstructure is completed, the diverted traffic shall be redirected over the newly constructed bridge



- STAGE-7: Now excavation shall be started for the deep cut & shall be carried on till the required depth..

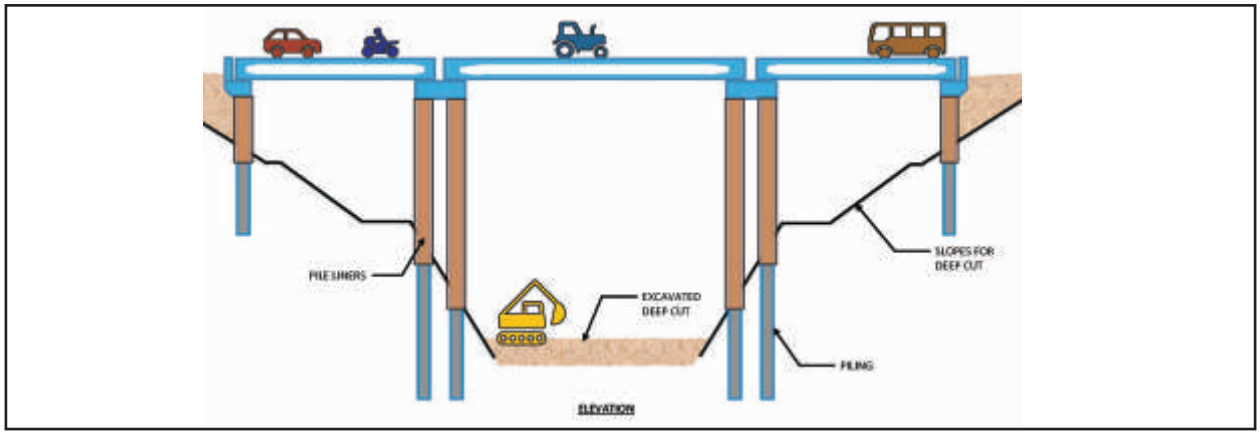


Figure 13: Excavation completed below the constructed bridge

- STAGE-8: Track work shall be done over the excavated pit as per the approved alignment & track drawings

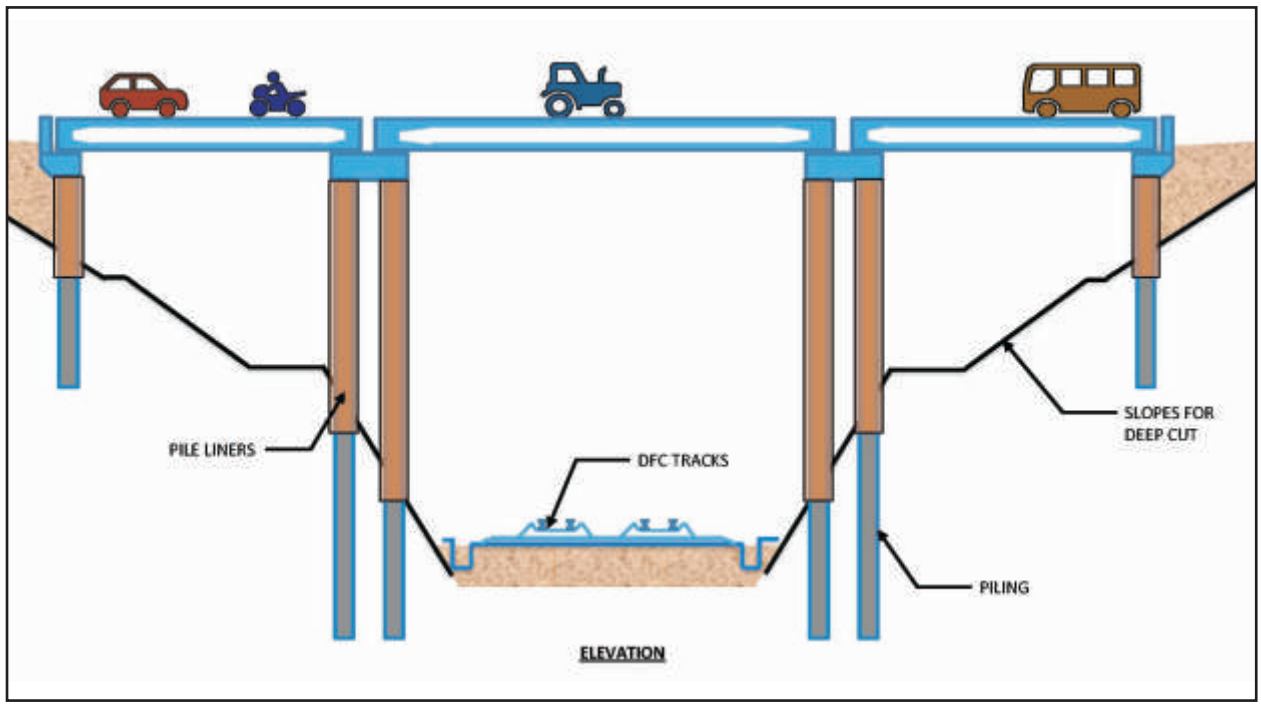


Figure 14: Track work completed for DFCC tracks

Conclusion

By analyzing the strict timeline of Project deliverables, the Contractor & DFCCIL officials have worked out the Innovative Top-Down construction method & adopted the same as the perfect solution for the described terrain condition.

Following conclusions may be drawn from the Top-Down construction system:

- With this method, bridge construction work can be carried out without Deep cut excavation.
- Pile cap is designed to act as the substructure, thus enhancing the pace of construction.
- Voided Slab superstructure reduced the self-weight of overall bridge, thus attracting lighter forces for complete structure design.
- It also brought opportunity in reducing structural quantity, thus saving cost as well as time of completion.
- Voided slab construction as superstructure became simpler & more effective compared to construction of PSC I-girder with deck slab & cross girders.
- One complete bridge construction duration can be reduced by approximately 2 months.

In a larger scale, this method not only facilitated the Bridge construction work before even start of deep cut excavation, it also reduced the overall construction duration by providing ease & proper access to all the construction activities, thus increasing the efficiency and workability of all resources.

Vision of DFCCIL Development of Heavy Haul Railway Research Institute (HHRI) by DFCCIL

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The Dedicated Freight Corridor Corporation of India Limited (DFCCIL), an SPV under the administrative control of Ministry of Railways, is engaged in implementing the Dedicated Freight Corridor Project, the largest rail infrastructure Project of India costing currently about INR 81,459 crores, by way of providing separate rail link for, only, Freight traffic across the Indian Railways' Golden Quadrilateral formed by four metropolitan cities of Delhi, Mumbai, Chennai and Howrah with 16% of the highly saturated rail route & currently carrying with more than 52% of the passenger traffic & 58% of Goods Traffic.

DFCCIL aim is to build a sustainable, efficient and safe rail freight corridor, and through implementing the latest innovative technologies, enable Indian railways to regain its market share of freight transport to railway (environmentally friendly transport model), creating additional capacity, and guaranteeing reliable, safe and affordable options for the mobility of freight to its customers.

The entire project of DFCCIL i.e. Eastern Dedicated Freight Corridor (EDFC) and Western Dedicated Freight Corridor (WDFC) scheduled for completion during Dec. 2021, the Project would revitalize the Indian Railways by becoming First Indian Heavy Haul operation wherein Goods trains @ 25 MT Axle Load would running at 100 Kmph MSS to a pre-decided time table.

In view of various tangible benefits, accruing out of fast evolving Heavy Haul Technologies based upon the continued research in Heavy Haul Research institutes, located all over the world, a pressing need was felt in DFCCIL to, develop a similar Heavy Haul Research institutes (HHRI), at par with the Best of such HHRIs. In agreement with the DFCCIL aforesaid Vision, Railway Board, advised the DFCCIL to go ahead with setting up of a Heavy Haul Research Institute (HHRI) as 'not for profit entity', along the lines of similar research institutes, globally.

In DFCCIL, to expedite the Project of setting up and operationalizing the HHRI, a Project Implementation Team (PIT), was constituted and tasked with planning, developing, constructing, commissioning and operationalizing a similar Heavy Haul Research institutes (HHRI) at par with the Best of such HHRIs.

To put the HHRI project on fast track mode, the first step should be to create the building infrastructure for HHRI along with certain associated track facilities so as to conduct certain research/test or studies. In this direction, DFCCIL has decided to construct the HHRI Building at Sector-45, Noida adjacent to the "Integrated Office cum Residential Complex at Noida" which is very near to Dadri DFC Yard where no. of tracks spurs are also being constructed which are to be utilised of various research and development activities of HHRI.

DFCCIL Integrated Office cum Residential Complex at Sector 145, Noida

It is the well-known fact that Australia has heaviest and longest heavy haul trains in the world and pioneering several world firsts, such as remotely located train control centres, rail infrastructure management and driverless heavy haul trains. Australian Rail Industry bodies and research centres are actively involved in developing products and solutions for the Industry.

The DFCCIL leadership team has visited at Monash University's Institute of Railway Technology (IRT), which is the largest university in Australia and the youngest member of Australia's Group of Eight, an alliance of elite Australian universities recognised for their excellence in teaching and research. Monash University has a reputation for excellence in Railway Research, particularly in Heavy Haul Railway System which may assist the DFCCIL for setting up of the HHRI as well as to provide the support with conducting High-end railway research.

DFCCIL has also contacted with the representatives of another Australian University i.e. University of Wollongong, and also held meetings and video conversations in regard to development of HHRI. The main points of discussion were i) Knowledge sharing regarding various facilities for HHRI, ii) Operation of HHRI, iii) How both of us can enrich ourselves in the field of Heavy Haul Operation and research, iv) Establishing a long term relationship in the field of Inspection, Maintenance, Monitoring and Operation of Heavy Haul, v) Adoption of New Technology and Innovations, vi) Developing a pool of experts in the Field of Heavy Haul, vii) Organizational structure of HHRI.

The need of transport infrastructure to perform for long periods of time is best shown by the way heavy haul transport networks are expected to withstand higher speeds and heavier axle loads. As per the discussion held with the Representatives of University of Wollongong, it is learnt that to enhance track performance results on large-scale laboratory tests, computational modelling and field measurements are required.

DFCCIL is also working to deploy the "Instrumented Revenue Vehicle" (IRV) concept developed by IRT in one of its recently completed dedicated freight corridors in India. IRV will provide us with the ability to detect "hot spot" track locations, where high dynamic responses can be recorded, thus enabling a rapid risk mitigating process to reduce damage and risk to rail infrastructure and for its users. The IRV will also assist with corrective and future maintenance planning.

The following instrumentation will be installed on the carriage:

i) Suspension travel transducers on one bogie to identify long wavelength vehicle dynamics (this also provides a direct measure of the vertical loading going through the side frame and hence is a measure of dynamic vertical wheel load).

ii) High frequency vertical accelerometers to assess the rail condition (in particular impact associated with IRJ's, welds, turn-outs, rail corrugations, etc). The data from these accelerometers is also used to determine rail running surface profile.

iii) Tri-axial accelerometers mounted within the passenger compartment to measure ride comfort. The locations of these accelerometers will be decided after consultation with DFCCIL and IR. Cabling will be provided to ensure that these locations can be adjusted with minimal rework to the system.

iv) Bolster mounted roll rate sensors to assess curvature, superelevation, twist and bogie instability.

v) Differential GPS to accurately monitor speed and location to sub-metre accuracy allowing discrimination between adjacent tracks.

vi) Wheel counting system to establish the position and speed of the carriage while in tunnels.

vii) Self-diagnostic capability.

Once the system has been bedded down, additional sensors (e.g. strains, temperatures, door response) may be added to reflect operational issues identified and to assist with ongoing improvement programs.

The University of Wollongong, Australia has already in the process of drafting an Industry Linkage proposal for the Australian Research Council to come up with the proposal titled; 'Field Data Based Predictive Maintenance and Enhanced Track Design Procedure' which may be beneficial for the DFCCIL. Already Companies like SMEC, Sydney Trains, MTM and ARTC are happy to support this Project.

Finally, after lot of discussions and knowledge sharing with the representatives of University of Wollongong, a Memorandum of Understanding (MoU) between DFCCIL and University of Wollongong, Australia has been signed on 09.09.2019. The purpose of this MOU is to establish, develop and expand the co-operative relationship between the parties. By signing this MOU, the Parties intend to facilitate discussions regarding the establishment, development and management of Activities which are mutually beneficial to the Parties and their staff.

News and Views from all over

Kowloon-Shenzhen Express Rail Link: Will open for revenue services on September 23 and has brightened the working of Hong Kong Operator MTR Corporation. MTR has overcome the construction problems due to variations in the agreed designs. This line is being rebuilt as an interchange between the north-south and east-west corridors. While the Contractors are legally responsible for quality control, the client has kept in place in robust quality management regime to ensure correct process is in place. This is possible with effective supervision. Having almost doubled the size of Hong Kong's rail network over the past two decades, MTR has further six extensions in pipeline for completion by 2027. At the same time MTR has taken several mainland Chinese cities as well as pursuing operating opportunities as far apart as Sweden and Australia (RGI Sept '18 pp3).

TGV of the Future: The board of SNCF confirmed an order for 100 Alstom Avelia Horizon High Speed train sets. This is the first build of the next generation of high speed train sets which is being developed under the TGV of the Future programme launched by Alstom and SNCF in 2016. Deliveries are planned to run for 10 years from 2023. The double decker train sets will cost Euro 25 million each which SNCF said is 5 million euros less than the list price for the current TGV duplex design. The train sets will share the short wheelbase power or design developed for the Avelia Liberty train sets which Alstom is supplying to Armtrack. SNCF said this is most eco-friendly TGV design in history with the adaptation of regenerative braking contributing to a 20% reduction in energy consumption. They will be fitted with real time condition monitoring tools with the aim of reducing maintenance costs by more than 30%. (RGI Sept '18 pp7).

High speed service in Africa: Africa's first high speed Railway is expected to open for traffic by end of 2018. The LGV Maroc 183 Kms. high speed line between Tanger and Kenitra with 137 Kms. of ungraded conventional line from Kenitr to Casablanca is sutible for speeds upto 220 Kmph. The brand name of the high speed service is 'Al Boraq'. The railway overcome obstacles like aread of subsidence over a 3 km section of the alignment caused by geological issues. Speeds upto 367 Kmph were achieved during trial runs which is a new African rail speed record. Training of 600 staff in partnership with SNCF is also in course. On June 19, formal approval was granted for testing to move into the simulated operation phase with a view to a team of auditors signing off the railway as fit for operation in accordance with UIC standars. (RGI Sept '18 pp7).

Moscow freight terminal: The Vostochny freight terminal near Elektrougli station 36 Kms. east of Moscow was opened on July 31. Traffic in the first year is expected to be 200 000 TEU growing to 600 000 TEU per year when the second and the third phases are completed. (RGI Sept '18 pp7).

IRP buys its first short line: International Rail Partners has made its first short line acquisition, buying Grenada Railroad from Iowa Pacific Holdings and taking over operations on August 2 under a lease-purchase agreement with the North Central Mississippi Regional Railroad Authority which owns the infrastructure. (RGI Sept '18 pp8).

700-coach framework agreement: Austrian Federal Railways and Siemens Mobility signed a five-year framework agreement on August 17 covering the supply of up to 700 coaches. With a potential total value of €1.5bn, the deal includes an option to extend the agreement beyond 2023. OBB has placed

an initial firm order for eight nine-car rakes to replace EuroCity stock which cannot be used on routes to Italy from 2021 because of changes to fire regulations. The order also includes 13 seven-car rakes to replace or augment vehicles currently uses on Nightjet overnight services. The coaches from Siemens' Viaggio family will be produced at the manufacturer's Wien plant for entry into service from 2022. The coaches will have LED interior lighting, Air-conditioning and a fresh air supply regulated by the CO2 content in the interior air. (RGI Sept '18 pp8).

Leo Express expands: Czech open access operator Leo Express ran its inaugural service from Prague to Krakow on July 20, saying it had become the first private operator to be certified to operate long-distance services in Poland. (RGI Sept '18 pp10).

Driverless operation study: East Japan Railway Co has set up a team to develop plans for driverless operation, which it envisages could help to mitigate staff shortage arising from the ageing workforce and also reduce costs on loss-making rural lines. Pilot schemes are proposed for the Yamanote Line in Tokyo, which does not share tracks with other services, and the Tohoku Shinkansen. Trains would initially run with an On-board supervisor able to intervene in the event of an emergency, but in the longer term unattended operation is envisaged. This would require the development of improved obstacle detectors, grade separation and the installation of platform screen doors at stations, as well as legal changes. (RGI Sept '18 pp10).

CAF to develop Spanish test track: Spanish infrastructure manager ADIF has approved the award of an extendable 20-year concession for CAF to develop and operate a Railway test centre and Corella, 92 km from Pamplona and around 100 Kms. from the supplier's existing research and testing facilities at Zaragoza. (RGI Sept '18 pp10).

€1.6bn regional DMU framework: Trenitalia has awarded Hitachi Rail Italy a framework contract for the supply of up to 135 regional DMUs. The operator said the tender had attracted interest from the most important rolling stock suppliers, and the winner had been selected on the basis of the most economically advantageous offer. (RGI Sept '18 pp10).

UZ locos under construction: GE Transportation has rolled out the first of 30 TE33A Evolution Series locomotives which it is building for Ukrainian Railways at its Erie plant. The final 10% of assembly work as well as painting is to be undertaken in Ukraine under a localisation agreement. The locomotives are expected to offer improved reliability, lower emission, longer maintenance intervals and lower life-cycle costs than UZ's legacy diesel fleet, 90% of which is estimated to have exceeded its planned service life. (RGI Sept '18 pp12).

Thailand Government approves 323 km line: Funding of 85.3bn Baht for the construction of 323 Kms. railway from Den Chai in Northern Thailand to Chiang Rai and Chiang Khong on the border with Laos was approved by the Thailand Government on July 31. There would be 26 stations plus a freight terminal at the border. Traffic is estimated at 5600 passengers/day and 2.2 million tonnes of freight a year. (RGI Sept '18 pp13).

Cascadia high speed rail study: Washington State Department of Transportation has appointed WSP to prepare a business case analysis for an 'ultra-high speed ground transportation system' connecting Vancouver, Seattle and Portland. WSP will be assisted by Steer, EnviroIssues, Paladin Partners and Transportation Solutions. The proposed high speed railway would be between 435 and 475 Kms. long and designed for speeds of 400 km/h, with the aim of offering a 1hr journey time from Seattle to Vancouver or Portland. (RGI Sept '18 pp14).

S-Bahn tunnel resignalling completed: A three-year €100m project to re-signal the heavily-used S-Bahn tunnel linking Frankfurt's Hauptbahnhof, Lokalbahnhof and Muhlberg was completed when a new electric Interlocking was brought into use on August 6. The 65 Kms. tunnel is used by eight S-Bahn Rhein-Main routes and carries upto 24 trains/h in each direction. Replacement of the 40-year old relay-based equipment was undertaken by DB Netz, Siemens and Leonhard Weiss. This included installing 20 signals, modifying 48 existing signals and laying 70 Kms of cables, as well as removing 190 km of redundant cable and 100 obsolete signals. (RGI Sept '18 pp17).

(compiled by: **K.Madhusudan GGM/S&T/WC-I)**

We Can Work Better If We Work Together

Running is ultimately the most universal physical activity because it involves a true passion for fighting challenges, encourages people to consistently get out of their comfort zone & defy themselves.

DFCCIL Noida Unit organized a Mini Marathon of 6 kms. on 25.8.19 which was actively participated by employer, PMC & the contractor, Purpose of the run was twofold i.e. one for awareness for individual health & the second one is that "We Can Work Better if We Work Together" similar to the one which is undoubtedly true "We Can Run Better if We Run Together". Running helps an individual in myriad ways like;

Run Away from Diabetes

There is no denying that exercise and weight loss can cut diabetes risk. A study found that by losing 7 % of body weight by exercising for 150 minutes each week and adopting low fat, lower calorie diet, one can lower his blood glucose level and reduce their risk of developing diabetes by 58% over a three year period.

Good Run = Clear Head

Got a problem you need to solve? Go for a run & you will be impressed by how much clearer your head feels afterwards. When we exercise, blood pressure and blood flow increase everywhere in the body, including the brain. Move blood means move energy and oxygen which makes our brain perform better. "It is a no brainer"

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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	

डेडीकेटेड फ्रेट कारीडोर कार्पोरेशन ऑफ इंडिया लि.
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