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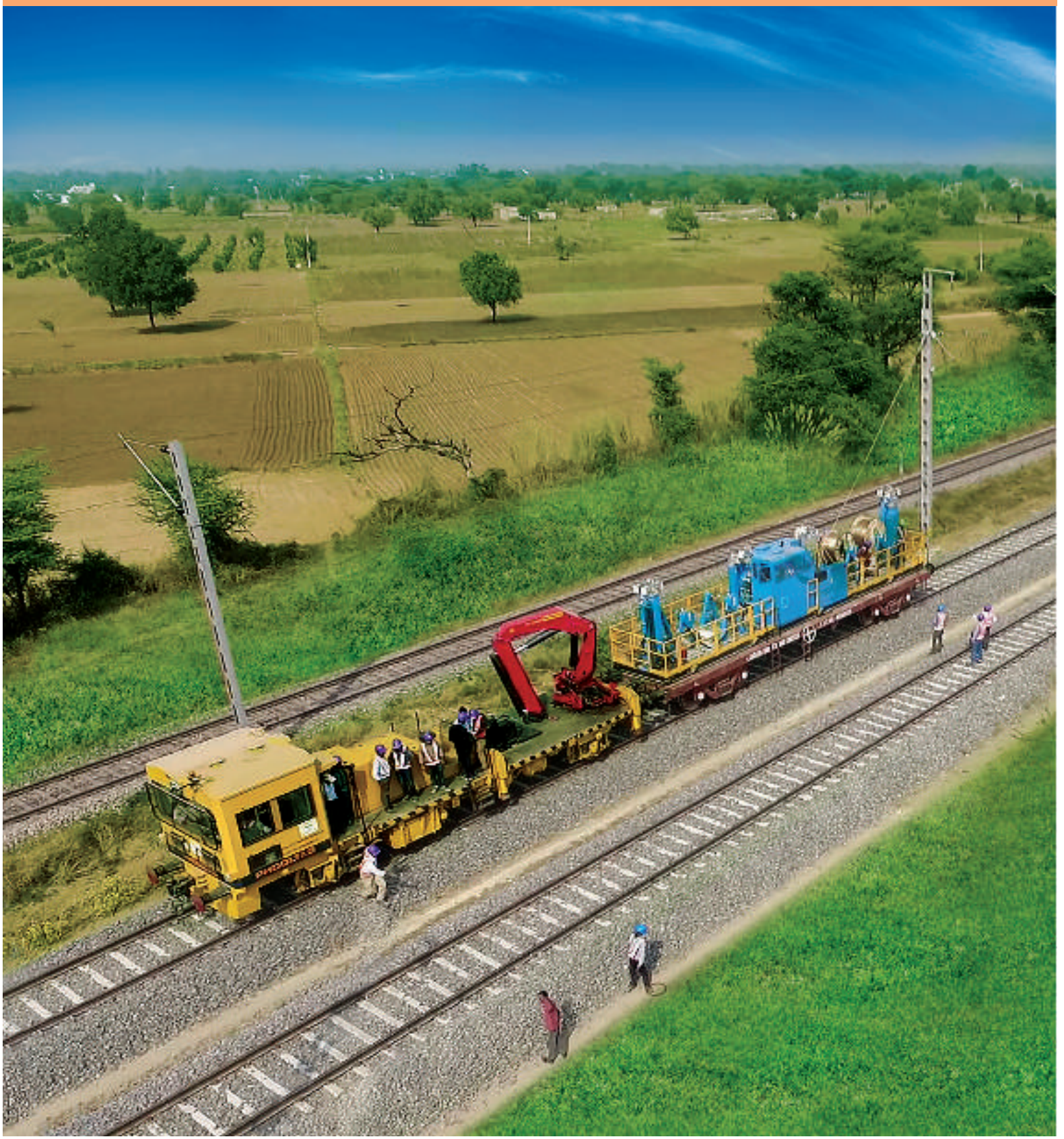

Targets

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

Dear Readers,

I welcome the readers to another edition of the DFCCIL Journal.

DFCCIL is rapidly moving along the envisioned path of attaining excellence in achieving our goals. Our sustained efforts have started showing results in shape of new railway landscape at many places . The ribbons of well laid dual tracks, the OHE structure, signalling set up & our aesthetically planned and utilitarian station buildings have all been constructed to superior quality standards with state of art technology. DFCCIL intends to provide international quality Railway Freight Transportation infrastructure to the nation. The team at DFCCIL is keenly looking forward to dedicating this mammoth and vital infrastructure to serve the country.

In this current DFCCIL Journal-Issue-III (June-2019), we bring to our readers well researched & suitably illustrated (with quality Pictures & Diagrams) articles from a wide ranging subjects of Forest Clearance, Drone based Photogrammetry, Land acquisition, Tilos software, Electric Traction system, Friction Buffers, GSM-R, Earthwork in mega project & Well Steining.

Since, we interacted last in Issue-II-March-2019, we have observed following international days which, being laden with significance in current context deserve a brief mention. These events signify the symbiotic relations that DFCCIL has with the larger ecosystem as well as the different stakeholders. 1st May is observed as the 'International Labour Day' and carried the theme "Uniting Workers for social and Economic Advancement". The worker's contribution in implementing this project has been immense and DFCCIL will like to emphasize further on their safety, health and insurance. I convey my appreciation to all personnel who are currently engaged in and are working hard for successful DFCCIL Project completion.

5th June is the 'World Environment Day' and carried the theme "Beat Air Pollution". Over the past few years the increasing levels of air pollutants has become a serious health hazard. We, at the DFCCIL have environment issues of "Energy Performance" and "Climate Change Mitigation" embedded in our Mission Statement & Energy Management policy. It will be constant endeavour of DFCCIL to reduce greenhouse gas emission and help improve the quality of air by adopting more and more of energy efficient and eco-friendly initiatives.

I acknowledge, with sincere gratitude & appreciation, the warm response given to the contents of DFCCIL Journal-Issue-II-March-2019, by perceptive readers. Buoyed by your response and feedback, we, at DFCCIL, strive to live up to your enhanced expectations from this Journal.

I take this opportunity to thank our diligent contributors for the knowledgeable & insightful articles, contained in this issue. Your diligence, in painstakingly drafting, well researched scholarly articles, goes a long way towards making us all more informed & enriching us intellectually. It also provides the authors of these articles to undertake research and present their perspectives to a larger audience.

Your valuable suggestions would help us in making DFCCIL Journal a more informative publication.

I sincerely hope that you would find this issue of DFCCIL Journal informative.

Enjoy reading.

Anurag Kumar Sachan
Managing Director, DFCCIL

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Front cover picture

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Back cover picture

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Aerial view of Well locations at Bharuch in WDFC

completed Minor Bridge in Khurja-Bhaupur section of EDFC

Construction of ROB at Ringus Near Jaipur in WDFC

Completed Road Over Bridge of Bhadan – Khurja section of EDFC.

GALLERY

Newly constructed 1.1km long viaduct at Renwal near Jaipur of WDFC section

Preparation before blocking of IR Track in Rewari – Iqbalgarh section

Steel girder launching on ROB at Ringus of WDFC section

Girder launching started for ROBs in Ahmedabad

Construction of a major bridge at Maonda of WDFC section

DRONE BASED PHOTOGRAMMETRY FOR TOPOGRAPHIC SURVEY

Dr. Y. Pari,
Head, GeoSpatial Technologies,
L&T Construction

SYNOPSIS:

Geospatial technologies include all technologies that are used to acquire, manipulate, store, analyze and present geographic information. In construction business, all construction activities are being constructed on or under a geographical location. All engineering and construction professionals need reliable geographic data for planning, design, execution, as-built, operation and maintenance purposes. Acquisition of such geospatial data requires proper technology and effective methodology. Recent developments have seen Unmanned Aerial Vehicles (UAVs) or drones as one of the go-to tool for geospatial data acquisition platform as it captures photos with 3X times faster than conventional survey methods. Combining with photogrammetry techniques, all 2D and 3D features of the project site can be collected and measured accurately. With the usage of well-established ground control points, accuracy can be improved proportionally in centimetre level.

This article aims to prove how drones can effectively be used for topographic survey in engineering and construction industry and thereby making it one among a promising tool for geospatial data acquisition.

Keywords: Drone, Photogrammetry, Topographic survey, GeoSpatial, GIS

All project design requires a topographic survey in order to know the characteristics of the terrain to properly design the project. Many sensitive decisions, proposed alignment, earth works, environmental preservation, building green certifications etc., highly depends on the topographical data. Topographic Survey includes collection of data about the natural and man-made features of the land, as well as its elevations. It is 'a routine process for surveyors, engineers, and construction professionals.

In this process, instruments such as 'Total Station' (Evolved from Theodolite) are widely used. In India, this is the dominant form of surveying. In principle, total station works in point by point based data collection and very labour intensive. Taking an example of a typical road, a section of 100 Km will take up to 2 months of surveying and this will end in giving discrete points at an interval of 50 m. Hence, the resultant topographical model is not continuous and points in between are interpolated. As the survey includes high manual intervention, the resultant data is error prone and oversight is required for every work.

Geospatial technologies offer multiple 3D Scanning solutions which scans the geography of the project site with the different platforms. Recent technological advancement has seen the development of Unmanned Aerial Vehicles (UAVs) or Drones as one of the geospatial platform from which aerial photos over large scales at high spatial and temporal resolution is captured. These photos are used to generate digital terrain models and orthophotos from which topo features can be extracted. Hence, drones are fast becoming the end user's go-to tool for aerial data capture.

The extent of data collected from drone is proving to be a game changer with respect to speed of data delivery, cost of data capture and the products that can be created or derived from the captured data. Data, possibly for the first time, is now accessible to the industry at a more frequent and cost effective manner than ever before. Further topographic features can be accurately identified, located and measured from drone results. In this present article, application of drone based topographic survey is examined with a case study executed at CTP 3R project site.

2. PROJECT AREA

CTP 3R is a prestigious project for L&T's Transportation and Infrastructure IC. The project scope includes laying railway track for 343 running Km. This created needs to have deep understanding about the existing topo features and terrain elevation. Contour maps and spot levels are essential data for engineering design purposes. For effective understanding, unmanned aerial vehicle platform was chosen for 10 km of project stretch.

3. METHODOLOGY

a. Equipment Used for Topographic Survey

- DJI Phantom 4 Pro UAV was used to capture aerial images of the project site. It carries a camera with a 1'' CMOS 20M Megapixel sensor and a modified camera lens with a focal distance of 30 mm.
- To determine positions of ground control points 3 DGNSS Units of Trimble R8 (Static & RTK) was used.
- For transferring the level from GTS Bench Mark, Sokkia C32 Auto level was used.

Figure 1 Equipment used for Topographic Surveying

b. Survey Work flow

The entire workflow of drone based photogrammetry is broadly classified as follows:

- Establishment of Ground Control Points (GCP)
- Mission Planning and Drone Flying
- Photogrammetry Processing

Figure 2 Work flow of drone based photogrammetry

Establishment of Control Network Survey

The control network survey acts as the backbone of any type of geospatial survey activity. It includes the establishment of both horizontal and vertical control. The horizontal control surveys coordinate horizontal position while vertical control surveys determine elevation with respect to mean sea level for which leveling instruments and SOI benchmarks are used. For the successful registration and alignment of photos collected from any UAV platform, an accurate and precisely located network of Ground Control Points (GCPs) must be acquired. Ground Control Points are points of known coordinates in the area of interest. Its coordinates are measured with Differential Global Navigation Satellite System (DGNSS) with high accuracy. It increases significantly the absolute accuracy of the project. GCPs are also used as Check points to verify the accuracy of the results. Ground Control Points will place the model at the correct location, scale and orient it. Usage of GCPs aid for measurements, overlay analysis, and comparison with previous results. The GCPs were established in well distributed manner and placed homogeneously around the project area.

Figure 4 Placing Target sheet at site for DGNSS survey

The following points were followed while establishing control network survey:

- Master pillar was established with minimum observation of 36 hours and the data was corrected with the nearest AUSPOS / IGS (International GNSS Service) station.
- Primary points are established for every 5 KM using DGNSS and the observation in static mode with leap and frog method with minimum of 1-hour parallel observation.
- GCP was planned at every 250m interval and its coordinates were captured using DGNSS based

RTK mode and base point was connected with the closest point of primary points/pillars.

- All the control network stations were processed using appropriate GNSS post processing software

Mission Planning & Drone Flying

The primary step in any successful drone survey is proper mission planning. There are a few key considerations in flight planning such as flight altitude, wind speed, estimated flight time, ground sampling distance (GSD), survey area, number of photos that will be captured, and number of batteries required for drone flying.

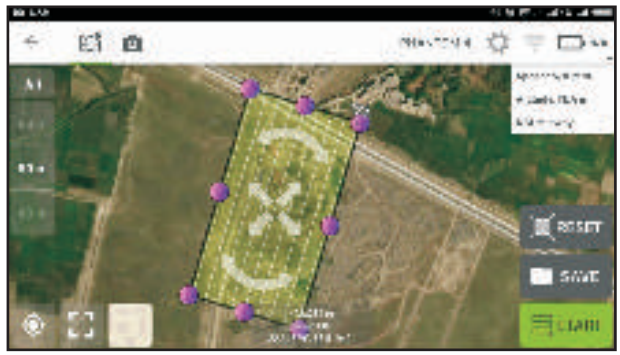


Figure 3 Typical screenshot of Flight Mission Plan

In order to get high accuracy results, a high overlap between the images is required. Therefore, the image acquisition plan was carefully designed in such a way to have high overlap between each image. A minimum of 75% frontal overlap (with respect to the flight direction) and 60% side overlap (between flying tracks) was maintained. Images were captured from 60 to 75m above ground level in a regular grid pattern. The camera was maintained at a constant height over the terrain / object to ensure the desired GSD. PIX4D Capture field software was used for image acquisition. The software allows planning and flying the missions online or offline, to define the altitude in function of the required GSD, camera angle, and overlap and flight speed. At the time of acquisition, the pilot monitors the mission using the map view and camera view. Mapview provides the live telemetry including information like flight altitude and flight speed while Camera view provides the live feed from the camera. The pilot avoids re-flying by reviewing the mission at site itself by checking all the images directly in the app. A bad image acquisition plan will lead to inaccurate results or processing failure and will require acquiring images again.

Before proceeding to drone survey the below mentioned points were considered for uninterrupted survey progress.

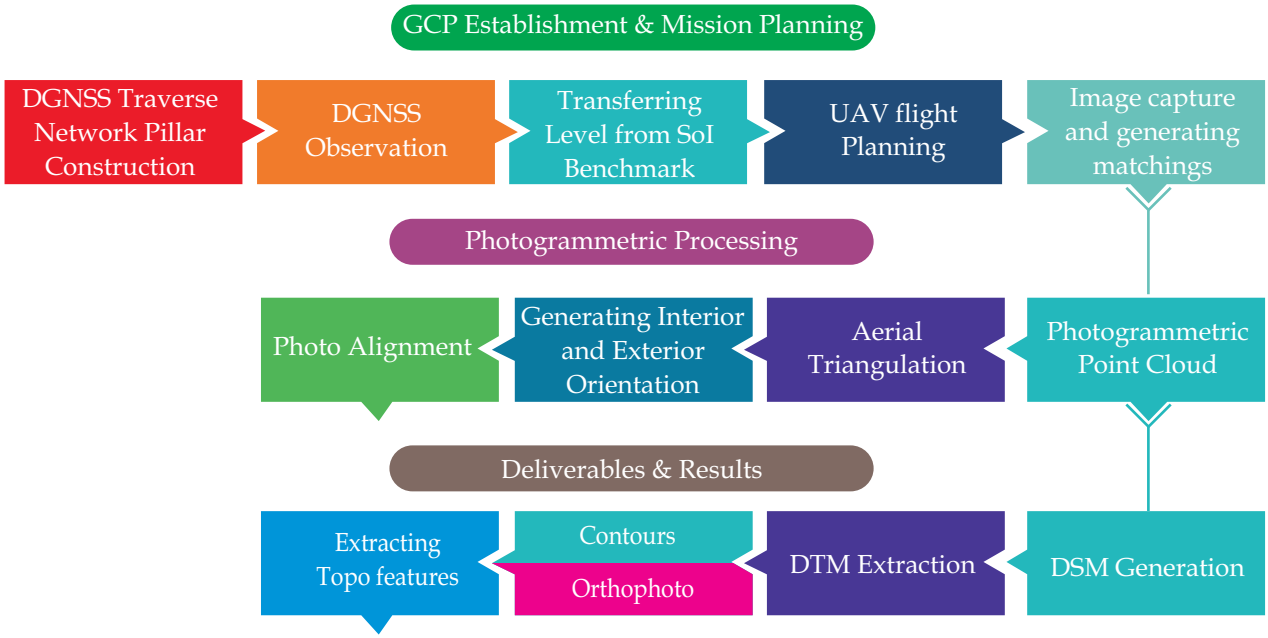
- Drone Flying information to local authorities.
- Required approvals based on the flying height from respective government departments.
- Proper route planning and local support/logistics.
- Avoiding the sensitive zones/forests/hills in route planning.
- Control and monitoring of survey activities.

Drone Based Photogrammetry Processing

The captured aerial images from the drone are transferred into UAV processing software. Drone based photogrammetry processing is based on automatically finding thousands of common points between images. Each characteristic point found in an image is called a keypoint. When 2 keypoints on 2 different images are found to be the same, they are matched keypoints. Each group of correctly matched keypoints will generate one 3D point. When there is high overlap between 2 images, the common area captured is larger and more keypoints can be matched together. The more keypoints there are, the more accurately 3D points can be computed. Therefore, the thumb rule is to maintain high overlap between the images. After aligning the drone photos, the project data was georeferenced which comprises of fixing the ground control points in photographs. This step is vital and plays a crucial role in accuracy. GCPs enables to place the model at the exact position on the Earth. Using traditional photogrammetric principles, stereo models were generated for the overlap region which aided to create break lines and mass points in areas of high undulation. Leica Photogrammetry Suite (LPS) software was used to create the stereo models and

Figure 5 Drone based Stereo Photogrammetry Processing

generating the mass point and breaklines. Mass points are irregularly spaced points, each with x/y location coordinates and z- values used to form Triangular Irregular Networks (TIN). Breaklines define and control surface behaviour in terms of smoothness and continuity. As the name implies, breaklines are linear features. They have a significant effect in terms of describing surface behaviour when incorporated in a surface model.



4. RESULTS & DISCUSSION:

Results of the drone based photogrammetry survey data was validated with the total station based physical survey at random sample locations. By referring the same bench marks established for drone survey, total station based topographic survey was carried out randomly for the same 10 km project stretch and was compared with drone results. Comparison of total station based co-ordinate Vs Photogrammetry based co-ordinate at more than 50 sample locations revealed, at most of the locations values of x, y, z coordinates are harmonised with conventional survey data. However, at few locations maximum of 10 cm difference were observed and this variation in accuracy may be attributed to a number of factors such as ground sample distance (GSD), flying height of the drone, accuracy of geo-referencing etc.,

Subsequent to the validation of the photogrammetry survey below list of deliverables are prepared.

Contours

As the drone flew at a very low altitude above ground level, this flying height combined with high megapixel camera resulted in a ground resolution of 3 – 4 cm per pixel. Therefore, highly precise contours at less than 0.5 m interval were generated for the project site (Fig 7). Contours at highly undulating terrain are generated with better accuracy.

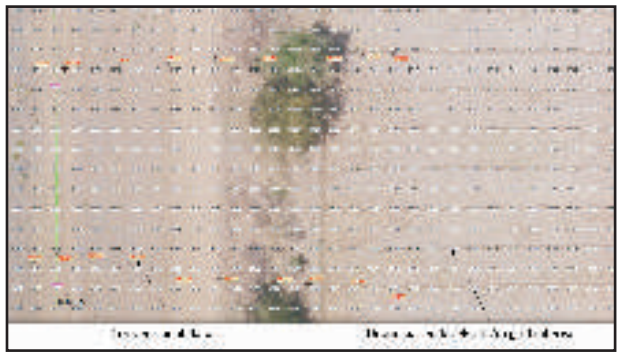


Figure 7 Spot Levels – Drone based vs conventional data

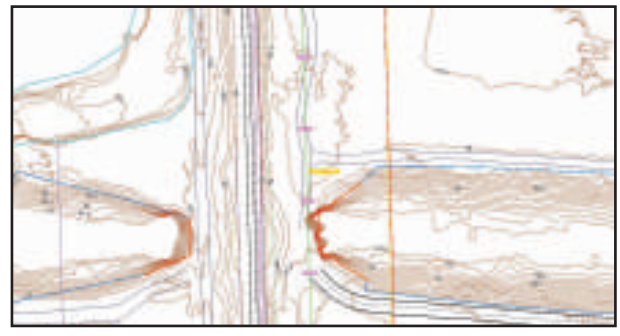


Figure 8 Contour with Topographic Features

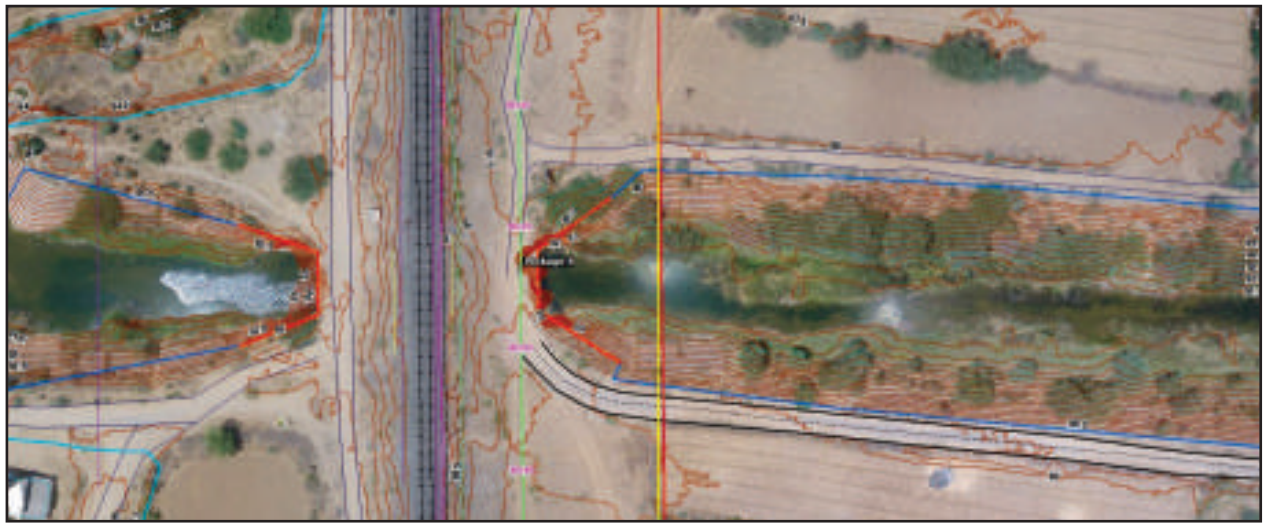


Figure 9 Contour with Drone photo

Topographic Map

A Topographic map in the form of 2D & 3D drawings were produced from original aerial images and point cloud dataset. All topo features such as road, water bodies, buildings, electric lines, etc., were extracted from the orthophotos in standard AutoCAD DWG format for design and engineering analysis.

Orthophoto

The drone captures multiple images from the on-board camera. These images are, georeferenced, combined together, geometrically corrected and a single output image of the project area is produced. Ortho images are measurable and gives the overall view of the project site in a single image.

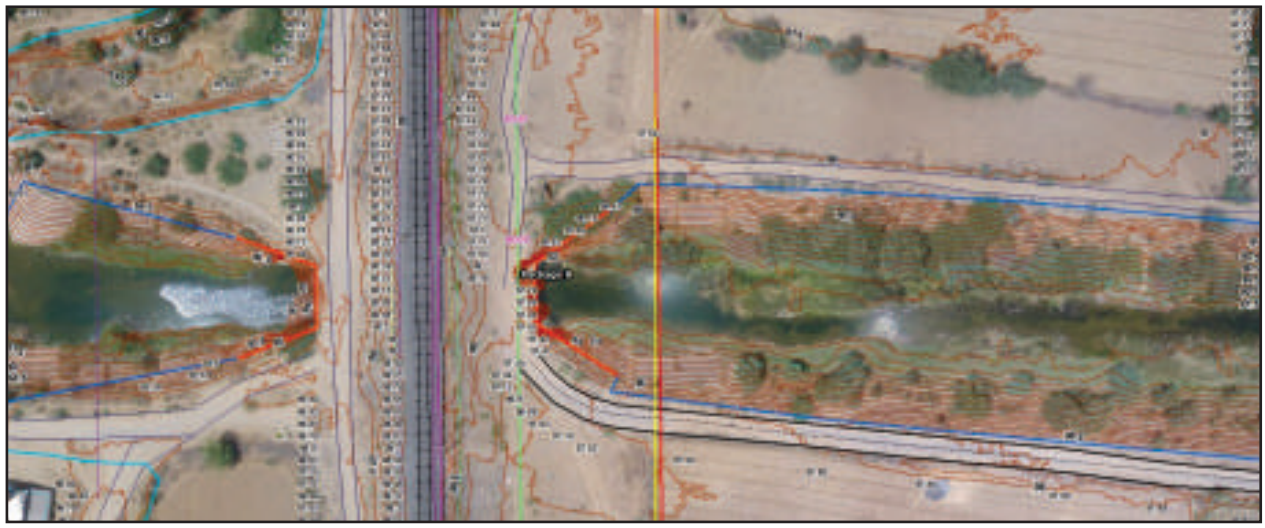


Figure 10 Orthophoto with Contour & Spot levels

5. CONCLUSION

The significant benefit of drone based photogrammetry survey is its high dense continuous point cloud data while total station data is discrete and highly interpolated. With this continuous data, earth work quantities can be precisely estimated. Since the geography of the entire project site is scanned and available in digital photo formats, site visits & engineering redesigns/reworking can be reduced. It also enables the user to measure the dimension of some of existing structures. Periodic execution of the drone based photogrammetry survey assists the users to closely monitor the work progress at the project site.

Unmanned Aerial Vehicle or Drones simply represent a new type of remote sensing platform that is inexpensive, easy to use, and provides users with many new options regarding where, when, and how geospatial imagery and data is collected. As the technology proliferates, it is revolutionizing both spatial data collection and geospatial analysis. This paradigm shift brings new perspectives to a wide range of application fields, and calls for new skills, best practices, regulations, policies, ethics, and more. Further, Geographic information system (GIS) relies upon access to content, and unmanned aerial vehicles are the game changer bringing that content to GIS. The presence of drones in construction means significant changes within the industry. Drones eliminate much of the human error involved in the process and have the ability to capture necessary data in much less time than traditional methods. Further, drones are also used for quantity estimations, quality inspections, progress monitoring etc. at various phases of a project.

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LAND ACQUISITION - A VITAL LINK FOR THE SUCCESS OF AN INFRASTRUCTURE PROJECT

Ashutosh Rankawat,
ED/WDFC

Sanjay Gupta,
CGM/ADI

SYNOPSIS:

Land acquisition is the basic asset needed for any infrastructure project. The doctrine of eminent domain empowers government to acquire private land for public purpose following laid down procedure in Land Acquisition Act without the willing consent of its owner. Land acquisition in India has social, economic, environmental, political and legal connotation. It involves number of sequential activities and the entire land acquisition process takes considerable time. Any mistake/error committed at any stage of land acquisition process may make it legally void and will delay completion of land acquisition resulting in project time & cost overrun. Timely completion of land acquisition is more significant for linear infrastructure projects like Railways/Highways and is critical for their successful and scheduled completion. This paper presents some precautions to be taken in different land acquisition stages for timely completion of land acquisition.

1.0 Introduction:

The government acquires private land for public infrastructure project using the legal powers of eminent domain. Acquisition of land by government has lately drawn resistance in many cases due to inadequate compensation for the land and loss of livelihoods of the affected people, as well as for involuntary displacement without proper rehabilitation. Thus, there is a trust deficit between the government (acquiring body) and land owners, therefore land owners seek assistance of legal counsellors for opposition of acquisition of their land. According to Government of India, 435 infrastructure and highway projects are stuck across the country and pending for completion mainly due to delays in land acquisition. Hence, it is utmost important that all the legal procedures laid down in the Act for compulsory acquisition of private land are strictly followed for timely completion of land acquisition.

DFCCIL is acquiring about 11660 Ha land spread over a length of 3360 Kms in eight states on two corridors presently under construction i.e. Western DFC & Eastern DFC. Land is a State subject but land acquisition is a Concurrent subject. Earlier land acquisition for all Railway projects was being done under The Land Acquisition Act 1894 by the respective State Governments. As railway project normally covers more than one state, sometimes there were delays in land acquisition as different

states have different set of norms and rules for land acquisition. In order to expedite land acquisition for Dedicated Freight Corridor (DFC) project, it was decided to acquire land for the project under The Railway (Amendment) Act 2008 by notifying it as special Railway project.

2.0 Precautions to be taken in land acquisition process:

Land acquisition for Dedicated Freight Corridor, which is a linear railway project is an important & very critical activity. The role of competent authority & land acquisition officers and officials of state revenue department as well as DFCCIL is very important for timely & successful completion of land acquisition for DFC project. It is very important to take due precautions to comply with legal provisions at every stage of land acquisition process so as to avoid any litigations. Some important precautions to be taken during land acquisition process are elaborated below:-

2.1 Activities prior to 20A gazette notification:

Following care should be exercised in the activities that have to be completed before commencement of actual land acquisition process:

- The land acquisition for a railway project under Chapter IVA of The Railways Act, 1989 can be carried out only if it is declared as "Special Railway Projects" by the Central Government through Gazette notification under clause 37 (A) of Section 2 of the Act. Since, Western DFC and Eastern DFC projects have been notified as Special Railway Projects, land required specifically for EDFC & WDFC can only be acquired under Chapter IVA of The Railways Act, 1989.

  There are instances where Zonal Railways have requested DFCCIL to acquire land for their projects, which are not related to DFC project. Any acquisition of land by DFCCIL that is not related to DFC project under Chapter IVA of The Railways Act, 1989 is legally not tenable.

- Central Government has been empowered to acquire land for special railway project under Chapter IVA of The Railways Act, 1989. As per the Government of India (Allocation of business) Rules 1961, the President has allocated conduct of business of the government of India related to Railways to Ministry of Railways. Therefore if an executive officer of Railway Board exercises the power of Central Government for land acquisition under Chapter IVA of The Railways Act 1989, he should be delegated such powers by Minister of Railways through gazette notification.

- "Competent Authority" who is authorized to perform the functions of the competent authority under the Act should be notified in gazette by Central government. Such gazette should also give official address of the competent authority along with area for which he is authorized to acquire land. Any change in the competent authority or official address of nominated competent authority should be notified in gazette.

2.2 20A gazette notification:

20A notification is the first, but the most important, stage of land acquisition. It is foundation of entire land acquisition process and the successful completion of land acquisition depends upon the degree of accuracy of 20A notification. Following precautions should be taken in preparation of 20A notification:

- Latest village revenue plans should be obtained from authorized revenue official and the plan should be authenticated by seal and signature of revenue officer. Land acquisition proceeding initiated on wrong / old village revenue map will eventually render the whole exercise futile.

- If photocopy of revenue map is supplied by the revenue authority it should be ensured that it is photocopied on true scale (100%) without reduction / enlargement, otherwise it will give wrong areas of survey nos.

- Revenue maps in different districts and states are sometimes in different scales. Alignment plan along with right of way should be super imposed on revenue maps after bringing both to same scale. To ensure superimposition of alignment plan on village revenue map in correct orientation, permanent physical features like road, railway line, rivulet etc. on alignment plan, captured during topography survey, should be matched with corresponding permanent features in village revenue map. Assistance of Google map (kmz file of superimposed alignment plan on Google map) may also be taken for proper orientation.

Similarly, revenue maps of two adjoining villages should be properly aligned/oriented using permanent ground features on the boundary of two villages, which are shown on the revenue maps.

Superimposition of alignment plan on true alignment & orientation on village revenue map will ensure correct identification of survey nos. and their approximate areas to be acquired.

- The details of survey nos. and their approximate area to be acquired should be ascertained from land plan and revenue form (i.e. no. 7/12 followed in Gujarat).
- If the survey nos. are illegible due to revenue map being crumpled or torn, it is better to find out correct survey no. from field enquiry or from grass root level local revenue officer (Patwari, Talati etc.) rather than deducing/guessing it from illegible revenue map.
- Since the area of a survey no. in 20 E notification cannot exceed the area notified in 20 A notification, in case of uncertainty in area assessment of any survey no., it is advisable to err on higher side.
- As mentioned in clause 20A (1) Chapter IVA of The Railways Act, 1989, the authority exercising powers of Central Government should record his/her satisfaction that the land which is intended to be acquired is required for execution of special railway project for a public purpose.
- The doctrine of eminent domain empowers government to acquire private land for public purpose, provided the public nature of usage can be demonstrated beyond doubt. Since, clause 20 A (2) of the Act requires to give a brief description the special railway project for which the land is intended to be acquired, hence apart from giving brief description of special railway project, the public purpose which it will serve should be given in detail in 20A notification.

  This will help in defending any court case when the court weighs balance of convenience between public purpose and private interest.
- Since government land is not acquired but transferred, competent authorities in some states do not include government land in 20A notification. If government land required for the special railway project is not notified in 20 A gazette, a person having interest on the government land such as easement right or livelihood will be deprived of his right to object to acquisition of the land. In order to give such person/s opportunity to object to transfer (acquisition) of government land under clause 20 D (1) of the Act, it is advisable that details of government land required for the project should also be included in the 20A gazette notification.
- As soon as 20A gazette notification is issued, state revenue officials should be impressed upon to enter the effect of 20 A gazette notification in revenue records (form no. 7/12) of survey numbers intended to be acquired. This will create "other right" (Bija Hakka) in the revenue records of survey nos. to be acquired for the project and land owner will not be able to change the ownership of the land.

2.3 <u>Clause 20D:</u>

- There should not be abnormal delay in publication of 20A gazette notification in two local newspapers one of which shall be in a vernacular language.
- Minimum period of 30 days from publication of 20A gazette notification in the newspapers should be given to the PAPs to submit objections to acquisition of their land.
- Most of the objections of Project Affected Persons (PAPs) against 20A gazette notification are against alignment and/or project itself. Competent authority, being a non-technical person, sends the objections to acquiring body for remarks. Detailed factual remarks should be given on each objections of PAPs, because competent authority may decide the objections based on the remarks given by the acquiring body.

  However, it should be ensured that competent authority does not simply give reference of or forward the remarks of acquiring body in his order on objections of PAP. Such action will be construed as competent authority acting as subservient of acquiring body and/or incapable to decide the objections.
- Reasonable opportunity of being heard, either in person or by a legal practitioner, should be given to all the PAPs who have objected to the acquisition of their land.

- Competent authority should give detailed reasons (speaking order) for disallowing/ allowing each objections of the PAP and the order should be communicated to the PAP in writing.
- The decision regarding allowing/disallowing of the objections should be communicated to PAPs individually rather than giving a common reply to large number of PAPs, although they may have submitted similar objections (the court may treat it as mechanical exercise by the competent authority without application of mind). Competent authority should give his own reasoned order on the objections based on remarks of the acquiring body.
- Reasonable opportunity should be given to PAPs for submission of objections against acquisition of their land, hearing of their objections and communication of decision on their objections; because in many cases court have viewed that only opportunity available to PAPs to object to compulsory acquisition of their land is under clause 20D of the Act. Any shortcut/mistake committed in following procedure laid down in clause 20D of the Act will make the entire land acquisition proceeding vulnerable to judicial intervention.

2.4 Joint Measurement Survey (JMS):

Joint Measurement Survey is carried out to ascertain exact area of land to be acquired, details of trees, and other structures thereon the land. Joint Measurement Survey becomes basis for area of land to be acquired for declaration under Section 20 E and subsequent preparation of award.

- Advance notice should be issued by Competent Authority giving schedule of Joint Measurement Survey in each village. This notice should be displayed in prominent places of the concerned village so as give wide publicity. Records of such JMS notices should be maintained.
- Before taking up JMS, the land (right of way) to be acquired should be properly demarcated on site by fixing pillars on the ground. This will increase the accuracy of JMS.
- Efforts should be made to associate PAPs in the JMS so that details of all immovable assets on the land like structures, buried pipelines, bore-wells, trees (along with type) etc. can be recorded in the JMS. Survey sheet should be jointly signed by revenue official, official of acquiring body & owner of land. This will reduce post award disputes by PAPs.
- All the immovable properties including trees (nos. if there are large nos. of trees in the survey no.) should be shown on the JMS sheet.

2.5 20E gazette notification:

- Before finalization of acquisition proposal, land plans should be verified with records of grass root level revenue officials (i.e. Patwari, Talati etc.) to know latest survey number which may have got changed due to division of land in a particular survey number. The ownership of survey numbers should be checked with latest revenue records (form no. 7/12).
- Most of the correspondence of competent authority on land acquisition matters is with Chief Project Manager (CPM) of DFCCIL, who is authorized by Ministry of Railways to acquire land on behalf of Railways. However, it should be ensured that report specified in clause 20 E (1) of the Act should be addressed/submitted to Central Government by competent authority and not to CPM/DFCCIL.
- It should be ensured that area of survey number in 20E notification should not be more that the area of survey number published in 20A gazette notification.

2.6 20F gazette notification:

- Valuation of structures, trees and any other immovable property on the land proposed to be acquired must be got done through Govt. approved valuer; for valuation, preference should be given to government departments (R&B/PWD) for structures and forest/ horticulture department for non-fruit bearing/ fruit bearing trees.
- The land compensation award comprises of (i) Compensation of land based on market value and (ii) compensation of assets based on replacement cost. However, it should not be split.
- The amount of land award should be deposited in the bank account of competent authority immediately after declaration of the award or before declaration of award if asked by the competent authority.
- There is no provision of interest on land award compensation for period from initial

notification to date of disbursement of award in the earlier Railway Amendment Act 2008 and for the period after declaration of land award to date of disbursement of award in RFCTLA Act 2013. Hence, efforts should be made to disburse land award compensation to PAPs as soon as possible/immediately after the declaration of land award to avoid any legal issues. In a case, the court has awarded interest on delayed payment of land award.

- There are two parts of compensation in land acquisition (i) cash compensation of land including immovable assets thereon (20F) and (ii) Rehabilitation & Resettlement (R&R) benefits. Efforts should be made to disburse the two compensation simultaneously.
- Mutation: the process of mutation of acquired land to change of ownership in the name of Indian Railways should be started immediately after disbursement of land award. The ownership of Indian Railway on acquired land should also be reflected in other revenue records/forms.

3.0 Government land and forest land:

- Government land: The process of transfer of government land takes considerable time because it also involves obtaining no objection certificate (NOC) from various government departments like R&B/PWD, Irrigation, Inland waterways authority of India (IWAI), Gram Panchayat etc. Hence, the process of transfer (ROW)/right of use (ROU) of government land should also be initiated & completed along with compulsory acquisition of private land.
- Forest land: The forest department under MoEF gives permission for diversion of social/reserved forest land and land of wild life sanctuary and the entire process of obtaining diversion permission from forest department (MoEF) takes significantly long time. Hence, it is important to identify forest/wild life sanctuary land falling on DFC alignment early in consultation with forest department and immediately initiate action for diversion of such land as per the prevalent Acts.

4.0 Conclusion:

Successful completion of any infrastructure project depends upon timely acquisition of land. Large number of infrastructure projects in the country are held up mainly due to delay in land acquisition. The land for public infrastructure projects is acquired through laid down procedures in land acquisition Acts. Since, there is a trust deficit between acquiring body and land owners due to inadequate compensation hence, PAPs strongly oppose acquisition of their land and always look for any lapse/mistake in land acquisition process for challenging it in court, which may delay the land acquisition. The suggested precautions, if followed, will help in smooth and faster acquisition of land for infrastructure projects particularly for future special railway projects.

"DFCCIL has just started its journey with present two under construction corridors (EDFC & WDFC) and it has to go a long way. The experience gained by it in land acquisition, if applied in future corridors, will surely ease DFCCIL's long journey on the path of railway infrastructure development in India".

Use of TILOS in EDFC-2

Sankalp Mishra
Planner & Scheduler

Dhananjay Yadav
Planner & Scheduler

Shubham Garg
Planner & Scheduler

SYNOPSIS:

TILOS (TIme LOcation Software) is being used in Eastern Dedicated Freight Corridor (EDFC-2 project by PMC (Systra Mott JV) primarily for reporting purposes. The use of TILOS in the project enables a distance (location) based view of the project. Progress of activities is also recorded and analyzed linearly. Use of TILOS in scheduling helps in optimized crew movement. This in turn prevents over/under utilization of resources.

This paper focuses on the features of Linear Scheduling, its benefits over traditional Gantt chart schedules and ways in which TILOS can be a useful tool in project scheduling and controlling.

1. Introduction:

Traditional project management tools display schedules in Gantt chart or network diagrams. Creating linear project plans using traditional Gantt software can be cumbersome and inaccurate. Linear projects are the projects which have a definite ROW and repetition of activities.

Road Rail Tunnel Pipeline

Exhibit 1: Linear Projects

2. Advantages of using Linear Project Management Software:

TILOS has its advantages over traditional methods, which are:

- Linear Scheduling provides more information than traditional CPM and bar chart scheduling, it provides a clear picture of when and where activities take place.
- Eliminates planning mistakes.
- Graphically displays the work plan allowing a feel for the distribution of resources and crew movement
- Easily illustrates working limitations such as: stream crossings, utility crossings, topography, ROW acquisition, and lane closures
- Provides maximum flexibility in organizing your plan.
- Much faster creating and updating project plan.
- Easy to understand by all project team.

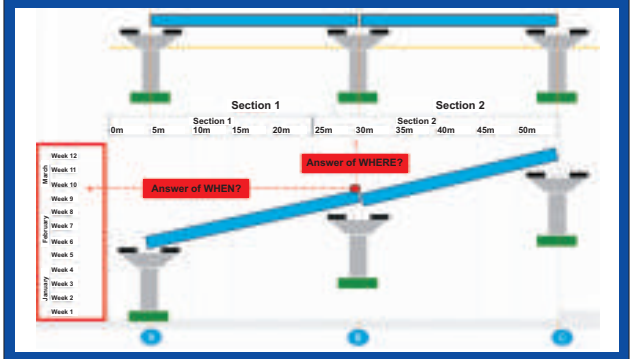


Exhibit 2: Basic of Linear Scheduling

3. Creating Linear Schedule quickly:

TILOS can be used as a standalone planning system or in combination with other planning systems. Either way, TILOS allows quick creating of a linear schedule.

- **Draw your plan:** The time distance diagram in TILOS allows you to draw the activities on the time-distance view like drawing on a piece of paper. The templates for the tasks are pre-defined and can be of a shape, style and colour of your liking.
- **Import your plan:** If the tasks are too many, a simply copy-paste can be used to create the plan and other attributes such as relationships, resource allocations, distance diagram, symbols etc.
- **Easily duplicate repetitive work:** Repetitive work sequence can be copied and pasted on different locations. The new location is identified automatically.

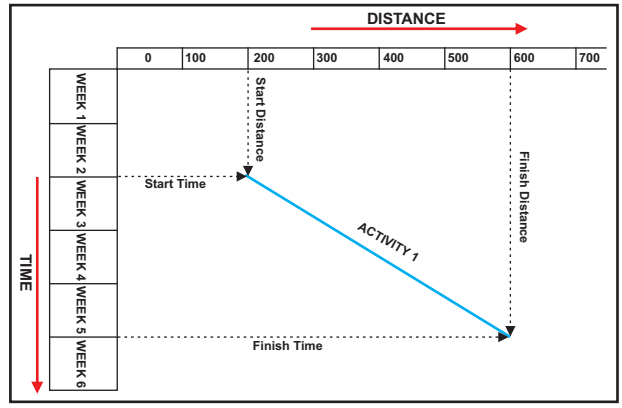


Exhibit 3: Task in TILOS

4. Describe project site details:

Project site details are can be recreated with the schedule. Having risk elements, utilities, lane closures, land hindrances and other features, which can affect the work progress, with the schedule allows you to be proactive and avoid and planning mistakes.

- **Symbols and picture:** Symbols for representation of site utilities can be produced in TILOS and used with the schedule. Actual photographs from the site can also be used for better understanding of project site features. For EDFC-2, symbols for bridges have been incorporated in the accordance to the progress of works. Green for completed, yellow for in progress and red for not started.

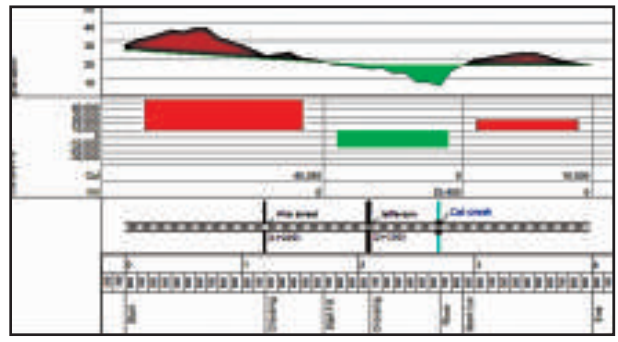


Exhibit 4: Distance Symbols & graphs

- **Distance Graphs:** Graphs can be prepared on the distance axis having land profile data. The topography of the project can be created and viewed with the schedule.

- **Speed Profiles:** Non-linear work rates/ productivity of the activities pertaining to the different sections of the project such as an extremely rocky area shall take more time than a sandy area. Same way profiles for different seasons can also be created. The duration of rainy seasons may have a lower work rate as compared to winter season.

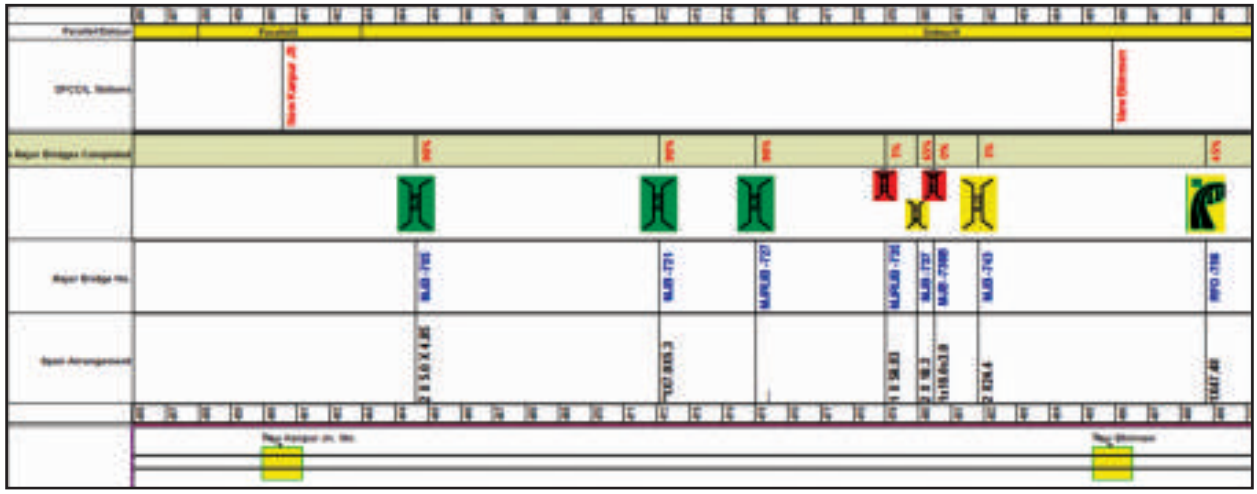


Exhibit 5: EDFC-2 structure details with progress and span arrangement

- **Additional Information:** Any additional information pertaining to site or the project can also be incorporated easily with the schedule.

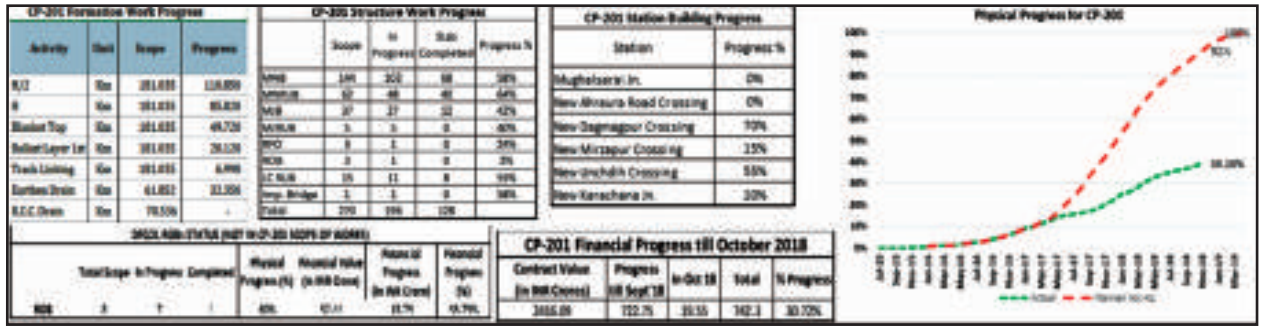


Exhibit 6: Additional Information

5. Keeping my plan up to date:

TILOS allows you to enter progress by percentage (%), distance and quantity as well. For EDFC-2, the progress has been updated on the linear tasks as well as block tasks.

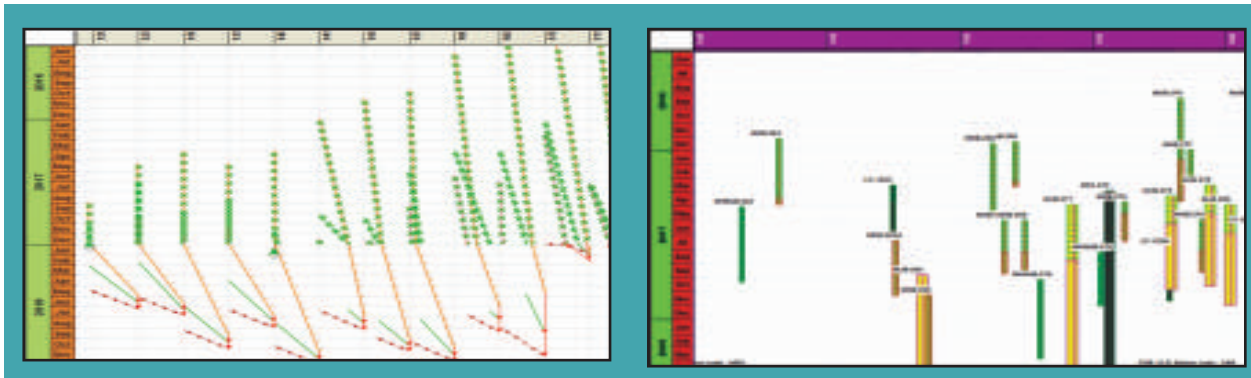


Exhibit 7: Progress Updates

6. Features:

Some of the noteworthy features in TILOS are:

- **Fully customizable Gantt chart:** TILOS automatically creates a Gantt chart in accordance to the attributes in Time distance view. A location based Gantt chart can also be generated. Charts can be grouped on the basis of activities, resources or normal progression of tasks.

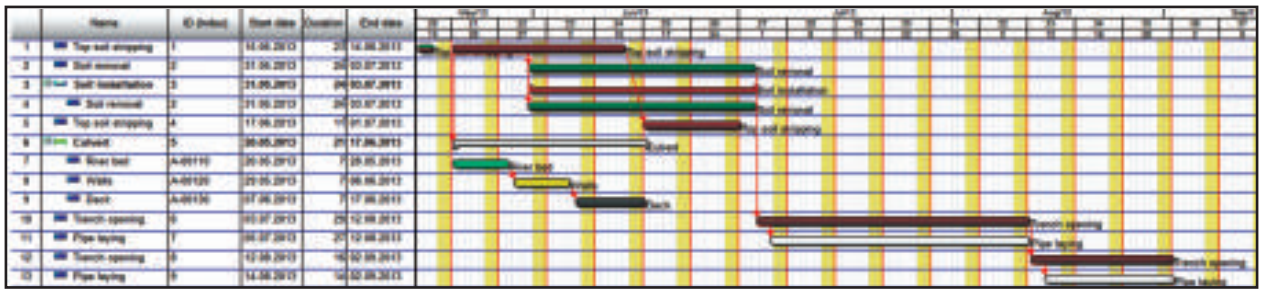


Exhibit 8: Gantt chart view

- **Overlapping of tasks can be detected:** TILOS has feature named as "Clash Detection" which allows the user to detect overlapping mistakes. This is primarily due to a planning/scheduling mistake. Hence, it helps eliminate any planning mistakes.

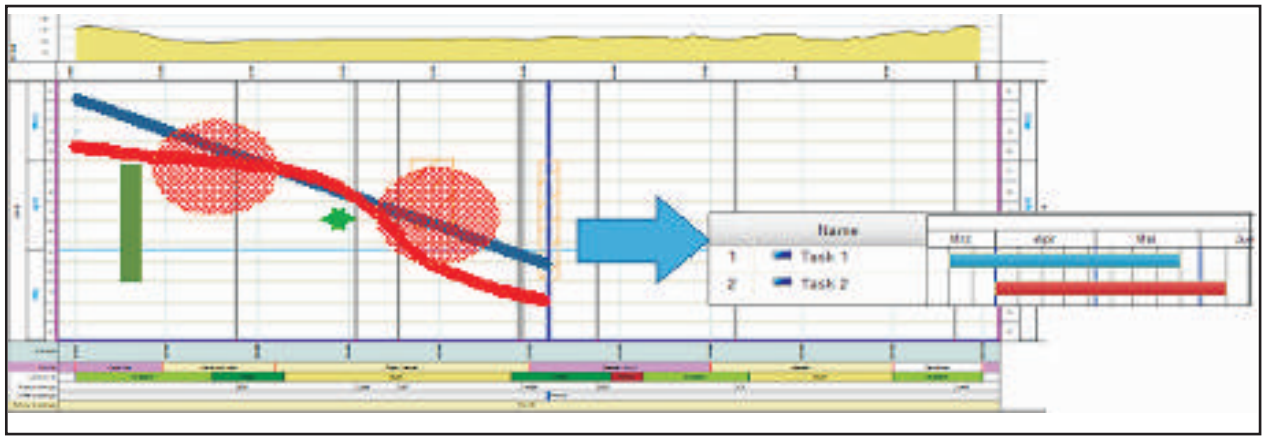


Exhibit 9: Overlapping tasks detected in TILOS

- **One page output:** Schedule, plan & profile, cash flow, resources, site features etc. are visible in a single page output. A 40 page schedule on Primavera can be represented in a single page on TILOS.

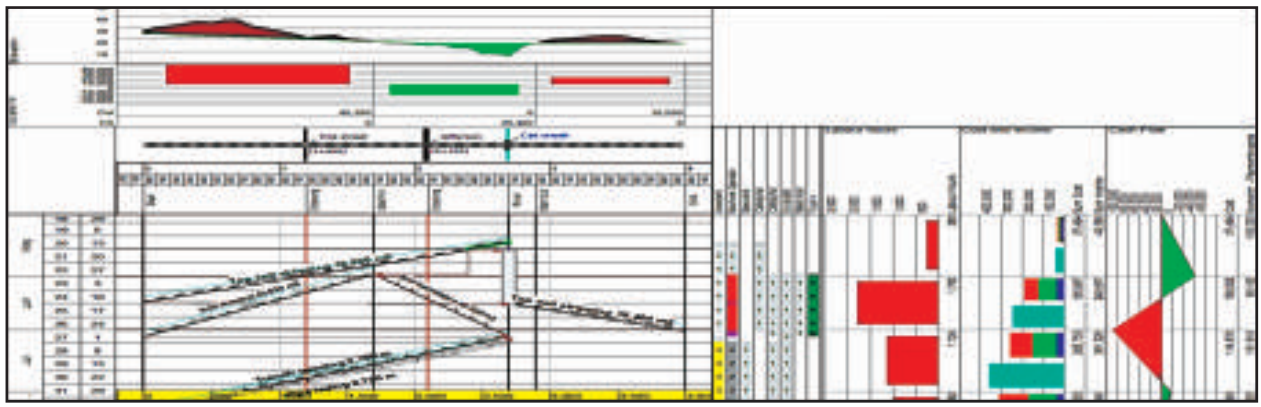


Exhibit 10: Single page output

7. Conclusion:

Use of a linear project management tool as the primary scheduling tool or with any other tool can be very helpful in analysing the location (distance) and time (schedule) together. "Time distance view" is the answer to all the question involving crew mobilization, optimum utilization of resources etc., which is not possible in a traditional project management tool like Primavera. Some of the ways in which TILOS is a better tool than P6 in planning, monitoring and controlling linear projects are:

Sr. No.	Feature	Primavera	TILOS
1	Views	Gantt	Gantt & Time-Distance
2	Ease of creating work schedule	√	x
3	"Draw" to create tasks	√	x
4	Clash Detection	√	x
5	View site conditions	√	x
6	Create land profiles with plan	√	x
7	Fully customizable task shape and colours.	√	x
8	Speed profiles (Non-linear work rates of the activities pertaining to different geographical properties, seasons etc.)	√	x
9	Distance based progress update and monitoring	√	x
10	Output	Single page with all details	Multiple pages with limited information

With increasing number of railway projects in India, presence of TILOS as primary or a secondary planning tool in every project must be mandatory because of its capabilities enabling the scheduler to prepare a realistic work schedule and avoid any planning mistakes.

FREIGHT TRANSPORT IN INDIA AND DEDICATED FREIGHT CORRIDORS

Sh. Biplav Kumar
GGM/BD

SYNOPSIS:

India has a very vast land area with varieties of landscape and topographical features, and extremely long costal boundary throwing a big opportunity and challenges for domestic and international transportation.

The country faces multifaceted challenges in expeditious development and integration of Rail, road, inland waterways, air and Sea-Port infrastructure to meet the freight movement requirement of the country which can serve the remotest parts of the nation and act as catalyst for the boosting of freight connectivity and economic development ultimately.

This article deals with the status of various freight infrastructure in India, achievements, possibilities of progress, approach required and how Dedicated Freight Corridor will embed in the transport system and act as a game changer for Indian freight transportation.

A well planned and coordinated system of transport plays an important role in building and sustaining the economy of a country. A good transport system enables economic growth by providing essential connectivity between available resources, centres of production and the market. It is also an essential factor in promoting balanced regional growth by ensuring the delivery of goods and services to all in the remotest part of the country.

India has one of the most spread transport network on the planet, but it has been plagued by very slow and inefficient movement of passenger and freight. The sector is faced with many constraints and challenges. India's transport demand has grown by almost 8 times since 1980 -more than any other Asian economy. The penetration of the transport network in remote areas and difficult terrains is inadequate. Highways are narrow, congested, and ill maintained, causing sluggish traffic, and a menace of pollution. Frequency of accidents are high, leading to loss of more than 1.5 lac lives every year. A very high percentage of the freight moves on roads even though this is the costliest mode of transport, with the highest pollution burden. Rail transport is cheaper and more environment friendly than road transport but the network is slow and inadequate, while the waterways which are the cheapest and least polluting of the three are very unorganised and meagrely developed. The result of such modal mix is high logistics costs that make our goods non-competitive in the international market.

This picture has, however, started changing in recent times. The government has made it a major priority to build a world class transport infrastructure in the country that is cost effective, easily accessible to everyone, safe, creates minimum load of pollutants and relies on indigenous inputs to the maximum possible extent. This has been possible with strengthening of the available infrastructure by leveraging world class technology, building new infrastructure and modernizing the legislative framework to support this work. Government has embraced partnering with the private sector and intends to achieve enabling environment for such partnership.

Transport has recorded an extensive growth over the years both in spread of network and in output of the system. The most important means of transportation in a country are roads, railways, airways, and waterways. With the vast expanse of India a very large and integrated network of various modes of transport and logistics framework is essential. Although India has completely revolutionized its

transportation system in recent times, much is still needed to be done to adequately meet the demands of this nation. Transport infrastructure at a much higher scale of capacity is imperative to enable India stand in the league of countries like China, USA, Australia etc.

It is desirable to take stock of strengths and weaknesses of different modes of transport in India to reach at the desirable roadmap for concerted and planned development of transport and logistics system and thereby position an efficient and cost effective supply chain network.

Road Transport

India has a vast network of roads, both metalled and unmetalled. However, this means of transport and communication are still inadequate for our needs. Before the advent of railways, roads were the only means of communication for the exportation of surplus produce. With the extension of the railway system, it has become more and more necessary to construct roads to feed the railways.

At present, the economic loss caused by the inaccessibility of many agricultural districts in the rainy season is very great. In sandy, hilly, and forest-covered tracts and in other parts of the country, where railways have not penetrated, road transport still holds an important share of long-distance traffic. The opening of railways has created a demand for road-construction, which must be met by the local and provincial bodies. The question of developing the roads is also of vital importance. We cannot expect any significant progress in our rural economy unless there are good road connections between villages and towns.

India has second largest road networks in the world, spanning a total of 5.5 million kilometres (kms). Production of commercial vehicles increased to 894,551 in 2017-18 from 567,000 in 2009-10 at a CAGR of 5.87 per cent.

The private sector has emerged as a key player in the development of road infrastructure in India. Increased industrial activities, along with increasing number of two and four wheelers have supported the growth in the road transport infrastructure projects. The government's policy to increase private sector participation has proved to be a boon for the infrastructure industry with a large number of private players entering the business through the public-private partnership (PPP) model.

With the Government policy supporting 100 per cent foreign direct investment (FDI) in the road sector, several foreign companies have formed partnerships with Indian players to benefit from the sector's growth. MAIF 2 became the first largest foreign investment in Indian roads sector under Toll Operate Transfer mode worth Rs 9,681.5 crore (US$ 1.50 billion). In May 2018, the Government of India signed US$ 500 million loan agreement with World Bank to provide additional funding for construction of 7,000 km climate resilient roads out of which 3,500 km will be built using green technologies under Pradhan Mantri Gram Sadak Yojna (PMGDY). As of November 2018, total length of projects awarded under Bharatmala Pariyojana (including residual NHDP works) was 6,460 kms for a total cost of Rs 1.52 trillion (US$ 21.07 billion). The total amount of investments* are estimated to reach Rs 1.58 trillion (US$ 2.25 billion) in FY19.

The Ministry of Road Transport and Highways has fixed a target for construction of 10,000 km national highways in FY19. The Government of India aims to complete 200,000 km national highways by 2022. In the coming years, NHAI's increased delegation autonomy along with Bharatmala Pariyojana initiative is expected to enable growth in awarding momentum. The Bharatmala Programme will link border and international connectivity roads, develop economic corridors, intercorridors and feeder routes, improve connectivity of national corridors, build coastal and port connectivity roads, and greenfield expressways.

The road network transports 64.5 per cent of all goods in the country and 90 per cent of India's total passenger traffic uses road network to commute. Road transportation has gradually increased over the years with the improvement in connectivity between cities, towns and villages in the country.

In India sales of automobiles and movement of freight by roads is growing at a rapid rate. In January 2019, more than a million-and-half (1,607,315) new vehicles were bought and registered with various regional transport offices across the country. That comes to an average of more than 51,000 new vehicles bought across India, every single day of January. And according to latest data from the Ministry of

Road Transport and Highways (data till 2016), there were 230 million registered vehicles in India as on March 31, 2016. The total number of registered motor vehicles grew at a compounded annual growth rate (CAGR) of 9.9% between the 2006 and 2016 decade.

Among different category of vehicles, highest CAGR of 10.1% each were recorded by two-wheelers and cars, jeeps and taxis. Goods vehicles and buses recorded CAGR of 9% and 5.9% respectively. While, India's road network (including national highways etc) grew by just about a third in the last decade, vehicle registrations have increased by almost three times. This single statistic should reveal why Indian roads are getting more congested with each passing month and why policymakers need to worry about consequences of this increased congestion: increased vehicular pollution, increase in the number of road accidents and a monumental wastage of money as well as time spent commuting daily. The construction of highways reached 9,829 km during FY18 which was constructed at an average of 26.93 km per day. The Government of India has set a target for construction of 10,000 km national highway in FY19.

Total length of roads constructed under Prime Minister's Gram Sadak Yojana (PMGSY) was 47,447 km in 2017-18.

Key Investments/Developments:

The Union Government aims to boost corporate investment in roads and shipping sector, along with introducing business-friendly strategies that will balance profitability with effective project execution. According to data released by the Department of Industrial Policy and Promotion (DIPP), construction development including Townships, housing, built-up infrastructure and construction-development projects attracted Foreign Direct Investment (FDI) worth US$ 24.87 billion between April 2000 and June 2018.

Some of the key investments and developments in the Indian roads sector are as follows:

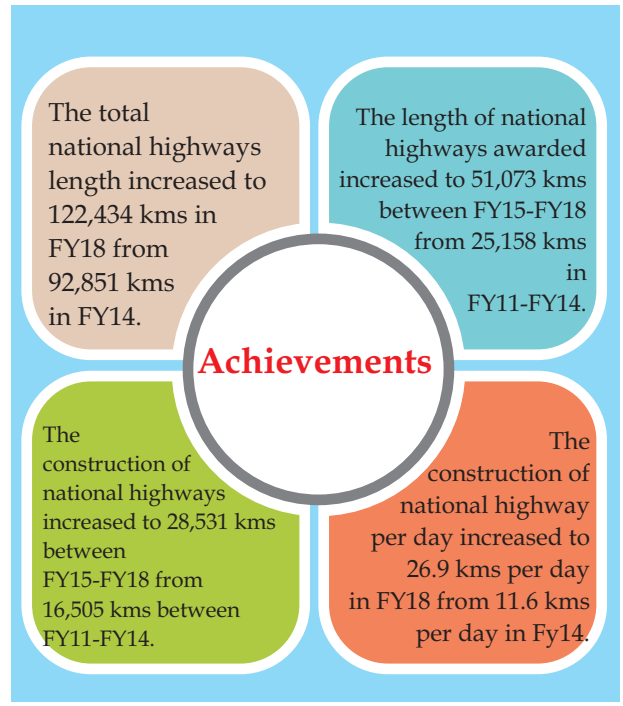
- A total of 892 km and 2,345 km national highway projects were awarded and constructed, respectively between April –August 2018.
- The first phase of construction work of Mumbai's 29.2 km long coastal road began in 2018.

Some of the recent government initiatives are as follows:

- As of October 2018, total length of projects awarded was 6,400 kms under Bharatmala Pariyojana (including residual NHDP works).
- As of August 2018, a total length of 34,800 km road projects have been proposed to be constructed, under Bharatmala Pariyojana Phase-I.
- As of August 2018, Government of India has approved highway projects worth Rs 2 billion (US$ 29.83 million) to improve connectivity among Gujarat, Maharashtra, Rajasthan, Madhya Pradesh and Diu.

Achievements

Following are the achievements of the government in the past four years:



Road Ahead

The government has taken various new steps and is making conducive policies to attract investments at an unprecedented level. Around 200,000 km national highways were planned to be completed between 2017 to 2022.

In total about 295 major projects including bridges and roads are expected to be completed in this financial year.

Apart from adding road lengths , government is also committed to make the highways safe for travel. For this, a multi-pronged approach has been adopted that includes incorporating safety features in road designs, rectifying known accident black spots, proper road signage, more effective legislation, improved vehicular safety standards, training of drivers, improved trauma care and enhanced public awareness.

Under the Setu Bharatam programme all railway level crossings are to be replaced with over bridges or under passes and an inventory with structural rating of all bridges on national highways is being created so that timely repair or rebuilding actions can be undertaken.

Ports

According to the Ministry of Shipping, around 95 per cent of India's trading by volume and 70 per cent by value is done through maritime transport.

India has 12 major and 200 notified minor and intermediate ports. Under the National Perspective Plan for Sagarmala, six new mega ports will be developed in the country.

The Indian ports and shipping industry plays a vital role in sustaining growth in the country's trade and commerce. India is the sixteenth largest maritime country in the world, with a coastline of about 7,517 km. However, installed handling capacity of India's ports is much behind countries like China.

The Indian Government plays an important role in supporting the ports sector. It has allowed Foreign Direct Investment (FDI) of up to 100 per cent under the automatic route for port and harbour construction and maintenance projects.

It has also facilitated a 10-year tax holiday to enterprises that develop, maintain and operate ports, inland waterways and inland ports.

Market Size

During FY18, cargo traffic at major ports in the country was reported at 679.36 million tonnes (MT). In FY19 (up to November 2018) traffic increased by 4.83 per cent year-on-year to reach 461.22 million tonnes. Cargo traffic at non-major ports was estimated at 491.95 million tonnes FY18 and grew at 9.2 per cent CAGR between FY07-18.

The major ports had a capacity of 1,452 million tonnes by FY18 end. The Maritime Agenda 2010-20 has a 2020 target of 3,130 MT of port capacity.

The government has taken several measures to improve operational efficiency through mechanisation, deepening the draft and speedy evacuations.

Investments/Developments

- Essar Ports will invest US$ 70 million in Hazira port by 2020.
- The Indian Minister for Shipping, Road Transport and Highways, Mr Nitin Gadkari, announced a massive investment in India's ports and roads sector, which is likely to help boost the country's economy. The Indian government plans to develop 10 coastal economic regions as part of plans to revive the country's Sagarmala (string of ports) project.
- The zones would be converted into manufacturing hubs, supported by port modernisation projects, and could span 300–500 km of the coastline.

  The government is also looking to develop the inland waterway sector as an alternative to road and rail routes to transport goods to the nation's ports and hopes to attract private investment in the sector.
- Ports sector in India has received a cumulative FDI of US$ 1.64 billion between April 2000 and June 2018.
- Indian ports and shipping sector witnessed three M&A deals worth US$ 29 million in 2017.

  Some of the major initiatives taken by the government to promote the ports sector in India are as follows:
- Net profit at major ports has increased from Rs 1,150 crore (US$ 178.4 million) in FY13 to Rs 3,413 crore (US$ 529.6 million) in FY18 while operating margin increased from 23 per cent to 44 per cent.
- In May 2018, Ministry of Shipping allowed foreign flagged ships to carry containers for transshipment.
- In March 2018, a revised Model Concession Agreement (MCA) was approved to make port projects more investor-friendly and make investment climate in the sector more attractive.

Achievements

Following are the achievements in the past four years:

- Five times more growth in major ports' traffic between 2014-18, compared to 2010-14.
- Increased efficiency has led three times increase in net profits of major ports between FY14-18.
- Turnaround time at major ports reduced to 64 hours in FY18 from 94 hours in FY14.
- Project UNNATI has been started by Government of India to identify the opportunity areas for improvement in the operations of major ports. Under the project, 116 initiatives were identified out of which 91 initiatives have been implemented as of November 2018.

Road Ahead

Increasing investments and cargo traffic point towards a healthy outlook for the Indian ports sector. Providers of services such as operation and maintenance (O&M), pilotage and harbouring and marine assets such as barges and dredgers are benefiting from these investments.

The capacity addition at ports is expected to grow at a CAGR of 5-6 per cent till 2022, thereby adding 275-325 MT of capacity.

Under the Sagarmala Programme, the government has envisioned a total of 189 projects for modernisation of ports involving an investment of Rs 1.42 trillion (US$ 22 billion) by the year 2035.

Ministry of Shipping has set a target capacity of over 3,130 MMT by 2020, which would be driven by participation from the private sector. Non-major ports are expected to generate over 50 per cent of this capacity.

India's cargo traffic handled by ports is expected to reach 1,695 million metric tonnes by 2021-22, according to a report of the National Transport Development Policy Committee. Within the ports sector, projects worth an investment of US$ 10 billion have been identified and will be awarded over the coming five years.

Waterways

Water transport is the oldest and cheapest form of transport. It is one of the most important external and internal means of transport in all the civilized countries of the world. It is useful for the carriage of bulky and heavy goods.

In India, we have many great river systems. However, they are unevenly distributed, some of them are fully utilized for irrigation purposes, and some others are naturally unfit for navigation.

In some parts of India, however, waterways are still extensively used for navigation purposes. Efforts are underway to utilise the navigational potential of India's 7500 km long coastline and over 14,000 km of inland waterways through the Sagarmala programme and by declaring 111 waterways as National Waterways. Sagarmala envisages

developing port as growth engines . The idea is to industrialise the port areas by developing 14 coastal economic zones.

This would be supported by modernisation and augmentation of the port infrastructure, improving connectivity of ports with the hinterland through road, rail and waterways, and development of the coastal community . It is expected that besides saving Rs 35000-Rs 40000 Crores as logistics cost annually ,boosting exports by about USD 110 billion and generating one Crores new jobs, Sagarmala will also double the share of domestic waterways in the modal mix in the next ten years.

In addition, work is on over several waterways including Ganga and Brahmaputra to develop their navigational potential. The world Bank aided Jal Marg Vikas project on Ganga aims to develop the river stretch from Haldia to Allahabad to allow navigation of 1500-2000 tonne ships.

Work on building multi modal terminals at Varanasi, Sahibganj and Haldia and other necessary infrastructure on this stretch is progressing. With this, much of the cargo movement to the eastern and north eastern parts of the country can be done through waterways resulting in lowering of the price of commodities. In 2017, thirty seven more waterways were planned to be developed in the next three years. In India, more navigable rivers and canals should be made. And, a systematic policy for the development of the inland water transport should be pursued.

Air Transport System

Proper attention must also be given at the same time to air transport as another means of national and international communication. India possesses some natural advantages in this respect and they have to be fully exploited for development of airways.

The Government is taking a keen interest in the expansion of civil aviation not only for its importance as a means of transport but also because of its strategic value in the matter of national defense.

Air cargo handled in Indian airports grew by more than 20 times from 0.08 MMT in 1972-73 to 2.5 MMT in 2014-15. During the period 2013-14 to 2017-18 it accelerated sharply and grew with a CAGR of 10.0 %. Cargo traffic in India crossed 2.98 million tonnes in FY2017. International cargo comprises of 60 % of total air cargo tonnes handled in India and grew at 15.6 % in 2017-18.Domestic cargo grew by over 8%, which reflects the skewed modal mix in which roads accounts for over 60% of cargo transportation as compared to the global average of around 30 %. Indian express industry is one of the fastest growing market globally, but with a small share of about 2% of the global market. This industry grew at 17% CAGR over the past 5 years and was estimated to be INR 22,000 Crores in 2016-17.Domestic express industry ,a key constituent of the Indian express industry ,is estimated to be worth INR 17,000crore . International express industry is estimated to contribute INR 5,000 Crores (23% by value) to the Indian express industry. Transshipment cargo which constitutes about 60-70 % of total volumes handled by some of the leading global airport is quite low in India. However, the industry is expected to grow at a CAGR of 17 % for the next five years.

The Indian air cargo industry is poised for significant growth on the back of both the strength of India's economic growth and many other drivers of growth in India's commerce, trade, investment and consumption ,which include significant demand from small and medium B2B segments. Domestically plans are afoot to make metro airports cargo hubs catering to the neighbouring regions. Internationally too, India has significant potential to be a transshipment hub for international cargo movement from other countries. India needs a multi fold approach to development of cargo infrastructure which looks as upgrading existing cargo terminals with advanced technologies, development of new cargo terminals at airports, dedicated cargo airports, and air freight stations.

High dwell time leads to significant transaction costs and operating expenses for the air cargo operators. One way to achieve lower dwell time to match with international standards is air freight stations, which can help to decongest airports and offer value additions.

The magnifier impact of lower air freight costs in India is as yet not seen adequately. High logistics cost in India has also hampered the growth of air cargo logistics industry. A strong boost has been tried through the holistic National Civil Aviation Policy 2016. This includes a number of initiatives for

achieving growth of cargo volumes to 10 Million tonnes by 2027. Open Sky Policy for air cargo and improved international connectivity coupled with expanding cargo - handling infrastructure, both physical and digital have sustained the high growth of air cargo in India in the last few years. As per the Boeing 20 year Forecast, while global air cargo would reach 509 billion Revenue Tonne Kilometers (RTKs) by 2035 i.e. twice that seen in 2015, at an annual average rate of 4.2 %, Asia will lead the growth, with domestic China, intra-Asia, and Indian market expanding at the highest rates of 6.2%, 5.5% and 6.7% per annum respectively .

It is felt that the focus on improvement in the Ease of Doing Business in India coupled with landmark Government of India initiatives like 'Make in India', and 'Digital India', coupled with suitable policy ,logistics, regulatory, and skills regime will all contribute to facilitating accelerated growth in air cargo. Simplication, modernization and harmonisation of export and import processes as well as of the end -to-end domestic supply chains are an important issue. The WTO's Trade Facilitation Agreement (TFA) encompasses several provisions for ensuring expedited movement, release and clearance of goods and sets out measures for effective cooperation between customs, related authorities on trade facilitation and customs compliances. India has adopted a WTO- Plus plan of action to implement the commitments arising from the TFA. Globally, air transport is a highly dynamic industry and in this regard, the industry in India is no different. As markets evolve and customer demands change, air cargo operators must constantly review and update their operations and product offering to ensure that they continue to meet the market need. Accordingly, the Ministry of Civil Aviation has now articulated its vision for the comprehensive National Air Cargo Policy which support the sustainable acceleration of the air cargo industry in India and ensuring global competitiveness with performance benchmarking and monitoring.

An analytic study of the above facts justifies the conclusion that the transport system of India is making good progress. The Government is providing all reasonable facilities for the development of the country's transport. It is for the people to take advantage of the facilities offered and to step up the country's progress in the way we desire.

Millions of tons of raw materials and finished goods have to be transported over long distances and in the absence of transport facilities there will be bottlenecks in the transport of goods leading to undesirable consequences.

To get the most from massive investments, India must adopt a coordinated approach that aligns the development of each transport mode with the country's needs.

Logistics infrastructure is a critical enabler of India's agenda for economic development and urbanization. Despite sizeable investment in logistics sector ,the country's network of roads, rail, and waterways will be insufficient to accommodate a threefold increase in freight movement over the coming decade. This shortfall in logistics infrastructure will put India's growth at risk, concludes a new McKinsey report, Building India: Transforming the nation's logistics infrastructure.

Since a large part of the logistics network that India needs has yet to be built, the country has a chance to add infrastructure optimally to meet the growing demand.

The report finds that to achieve this goal, India must pursue an integrated and coordinated approach that not only closely aligns the development of each mode—railways, roads, and waterways—with the country's needs but also makes better use of existing assets.

This will require increasing the railways' share of logistics infrastructure investments from about 40 percent currently to 50 percent. Building a logistics infrastructure capable of handling rising freight traffic more efficiently presents opportunities for user industries and for infrastructure developers and construction companies, among others, the report finds.

In particular, India must expand its use of rail and realize the potential of its waterways. Given current trends, the share of India's freight transported by rail would decline to 25 percent, from the current 36 percent. By contrast, rail accounts for almost 50 percent of freight movement in China and the United States. The report suggests an approach where India could increase rail's share of its freight to 46 percent by 2020 (exhibit).

Indian Railway :

In India, there are equal number of challenges and opportunities. Rail experts believe that the rail transport systems are six times more energy efficient than road and four times more economical.

The social costs in terms of environment damage or degradation are significantly lower in rail. Rail construction costs are approximately six times lower than road for comparable levels of traffic.

Historically, the Indian railways have played a leading role in carrying passengers and cargo across the country. The Indian railways is one of the largest railway networks carrying about 23 million passengers and hauling nearly 3.18 million tonnes of freight daily. With the current freight system ,there are challenges in the present IR freight handling system leading to inadequate service reliability and higher costs for end users.

These challenges are mostly related to inadequate infrastructure, rolling stock, insufficient line capacity which have contributed to the declining trend in overall rail share.

Railways are the most important means of transportation in India.

The improvement in railway communications in recent times has played a most important part in the internal development of the country. They have brought the different parts of the country closer.

The advent of the railway has been of special advantage to the peasantry. Social and political influences from railway construction have been no less.

Advantages of Railways

- Travelling has become cheaper;
- Defense of the country is less difficult.
- Greater peace and order is maintained in the country, and
- The spirit of nationalism has very greatly developed.
- Freight mobility on rail has major contribution in economic development of India.

The Indian Railways is among the world's largest rail networks. The Indian Railways track length network is spread over 115,000 km, with 12,617 passenger trains and 7,421 freight trains each day from 7,349 stations plying 23 million travellers and 3 million tonnes (MT) of freight daily. India's railway network is recognised as one of the largest railway systems in the world under single management.

The railway network is also ideal for long-distance travel and movement of bulk commodities, apart from being an energy efficient and economic mode of conveyance and transport. Indian Railways has been the preferred carrier of bulk commodities, automobiles and for long distance haulage in general in the country .

The Government of India has focused on investing on railway infrastructure by making investor-friendly policies. It has moved quickly to enable Foreign Direct Investment (FDI) in railways to improve infrastructure for freight and high-speed trains. At present, several domestic and foreign companies are also looking to invest in Indian rail projects.

Market Size

Indian Railways' revenues increased at a CAGR of 9.66 per cent during FY07-FY18 to US$ 27.71 billion in FY18. Earnings from the passenger business grew at a CAGR of 9.90 per cent during FY07-FY18 to reach US$ 7.55 billion in 2017-18P. Freight revenue rose at a CAGR of 9.83 per cent during FY07-FY18 to reach US$ 18.16 billion in 2017-18.

India was among the top 20 exporters of railways globally, as of 2017. India's exports of railways have grown at a CAGR of 27.05 per cent during 2010-2017 to US$ 303.29 million. Exports of railways in 2018* stood at US$ 278.05 million.

Investments/ Developments

Foreign Direct Investment (FDI) inflows into Railways Related Components from April 2000 to June 2018 stood at US$ 920.21 million.

Following are some of the major investments and developments in India's railways sector:

- In December 2018, France-based Alstom announced plans to augment its coach production capacity at its facility in Sri City from 20 cars per month to 24 cars per month. Also, it will set up a new production line to increase capacity to 44 cars per month by the end of 2019.
- In December 2018, the Prime Minister of India laid the foundation stone for the third phase of the Pune metro.

Few recent initiatives taken up by the Government are:

- Government of India is considering a High Speed Rail Corridor project between Mumbai and Nagpur
- As of November 2018, Indian Railways is planning to come out with a new export policy for railways.
- The Government of India is going to come up with a 'National Rail Plan' which will enable the country to integrate its rail network with other modes of transport and develop a multi-modal transportation network.
- A 'New Online Vendor Registration System' has been launched by the Research Designs & Standards Organisation (RDSO), which is the research arm of Indian Railways, in order to have digital and transparent systems and procedures.
- The Government of India has signed an agreement with the Government of Japan under which Japan will help India in the implementation of the Mumbai-Ahmedabad high speed rail corridor along with a financial assistance that would cover 81 per cent of the total project cost.

Road Ahead with Dedicated Freight Corridors:

The Indian Railway network is growing at a healthy rate. In the next five years, the Indian railway market will be the third largest, accounting for 10 per cent of the global market. Indian Railways, which is one of the country's biggest employers, can generate one million jobs.

Indian Railways is targeting to increase its freight traffic to 3.3 billion tonnes by 2030 from 1.16 billion tonnes in 2018.

The major challenges are mixed Traffic with differential speed, heavy congestion on IR routes, inadequate powering of trains, lower priority to freight trains, very low average speed leading to increased wagon turn around time, low utilisation of crew, rolling stock & locomotive, and energy - inefficient locomotives leading to high energy cost.

With the introduction of rail networks exclusive for freight movement, it is expected to provide a solution for efficient and reliable freight operations, with an objective to increase the rail share of freight transportation not only from routine cargo but also attracting non- conventional freight. In order to boost the freight carrying capacity of Indian Railways, the creation of two Dedicated Freight Cortidors has been envisaged in first phase, along the Eastern and Western arms of the golden quadrilateral. DFC is expected to be a long term strategic solution, with a view to increase the declining rail share . This corridor is planned to have high capacity, better infrastructure facilities, scheduled services and premium service offerings like guaranteed transit times, superior asset standards when compared to existing freight system of Indian Railways like axle load, locos, centralized control system , all of which is critical for the shipper in having rail as a preferred mode of transport. The alignment of the freight corridor will be from Ludhiana to Dankuni forming the Eastern Corridor and from Dadri to JNPT forming the Western Corridor of the alignment. Operations in DFCCIL is proposed to be controlled through two tier system with operating officers in Central Traffic Control office at New Delhi, and Centralised Control office at Ahmedabad for WDFC and at Allahabad for EDFC. EDFC and WDFC controls will directly coordinate with IR officers of respective Zones and divisions for routine planning and actual running of freight trains.

DFCCIL, an SPV established as a wholly owned subsidiary of the Indian Railways, will develop, construct, operate and maintain the corridor lines for increasing the capacity of the railway network and enable it, to efficiently carry an enhanced volume of freight traffic. The freight corridors also provide a platform to adopt international best practices in terms of technology, design and business processes which can be inducted on this new freight system.

The cost estimate of Rs, 81,459 Crs. for Eastern & Western DFC including land cost has been approved by the Cabinet Committee on Economic Affairs in June, 2015. This comprises of construction cost of Rs. 73,392 Crs. (including Soft Cost of Rs. 19,390 Crs) and land cost of Rs. 8067 Crs. The cost for the project will be funded by a combination of debt from bilateral/multilateral agencies, equity from Ministry of Railways and Public Private Partnership.

The capital structure of DFCCIL will entail a debt equity ratio of 3:1.

The DFC is part of a broader agenda of reforms in the rail transport sector in India. The specific objectives of the DFC are as below:

- Increase modal share of Railways in the freight transport market by providing customised logistics services
- Create additional rail infrastructure to cater to growing freight transport demand
- Reduction of unit cost of transportation by speeding up freight operations and higher productivity
- Segregation of freight infrastructure for focused approach on both passenger and freight business of railways
- Introducing high end technology and IT packing of freight services.

The freight trains of DFC will boast a 1.5 km length, 3660 mm width, a height clearance of 7.1 meter – the first and only in the world. Moreover, given the reduced time and cost of transporting freight, the DFCs will aid the country in getting a competitive edge in the exports market.

Some technical highlights of DFC: Automatic signalling with 2km spacing between signals will be used for both corridors. The Ludhiana-Khurja segment of the Eastern DFC will additionally feature an absolute block system. Traffic control communications on the two corridors will feature an independent OFC system. A GSM-R communication system will be adopted for mobile train radio communication.

Fully mechanized track laying :
Automated New Track Construction (NTC) machines from Marsco (USA) and Plassers (Austria) are being used for track lying. NTC Machine gives high progress of track linking (upto 3 T-Km per day) with better track geometry as compared to manual lying.

High speed on loop lines :
Canted turnouts have been used to achieve speed potential of 50 Kmph in yards.

Distressing track by super pullers :
Super pullers attached to ash butt welding machines are used for distressing of track. Super puller can carry out distressing at any rail temperature (lower than distressing temperature) along with welding thus obviating the need to wait for attainment of particular temperature range for carrying out distressing.

Indigenization of high technology equipment's used for DFCCIL electric traction.

100 MVA, Scott Connected Power Transformers are being utilized in the Traction Sub-Stations of Western DFC for 2x25 kV power supply. Similarly, Auto Transformers of various ratings are also being used in sub-stations and other switching control posts. These equipment's have been designed, developed and manufactured under patented technologies, by M/s. Toshiba Corporation and M/s. Meidensha Corporation, both of Japan.

Under the 'Make-in-India' initiative facilitated through the respective contracts, the Scott Connected Power Transformer and Auto Transformer are now being manufactured in Toshiba and Meidensha factories in India, under the transfer of technology (ToT) arrangement from the original Japanese manufacturers. These have been types tested in Central Power Research Institute (CPRI), and have been supplied for the Western DFC Project.

To protect and prevent the loss of malfunction of the server data it has been recommended by a business study that servers be located at multiple loacations to cope with loss and malfunction of data in the event of such incidents and use of remote servers such as Cloud has been suggested due to ease of access ,maintenance and reduced costs. Network and internet connectivity for voice and data communication capabilities in addition to LAN /WLAN capabilities have also been suggested as IT support.

It is proposed to run standard trains of 750 m length in the initial phases of the project life cycle. Also a headway of 10 mints between trains and maintenance block of 4 hours per day is envisaged as standard operating parameters. A capacity utilisation of 80% has been considered for estimating the train operation on the DFC corridors which translates into running of 96 trains per day per direction in a section which is equivalent to 96 paths.

Globally running of longer trains is a common feature, with 1.5 to 2.5 km in lengths, for carrying the bulk traffic such as coal from mines or origin clusters. Australia has one of the heaviest and longest heavy haul trains in the world including remotely located train control centres. Sis hen - Saldana, iron ore export line in South Africa has a train length of 4 km, consists of 342 wagons that carry a gross train mass of 37000 tonnes, is hauled by six electric locomotives and runs over a distance of 860 km. Following benefits are there of running long trains :

- Reduction in operational cost per tonne with savings in fuel consumption
- Achieving faster turnaround times
- Lesser congestion on routes facilitating easier freight movement, reduction in detention enroute and increase in speed of rolling stock
- Increase in throughput per train path
- Maximise payload per train path to increase throughput

Density per train will obtain a soaring, in addition to by running of long trains, with heavier trains, which can be achieved also by running double stack container trains. With DFC's operational efficiency offerings, estimated traffic and other growth drivers ,it is essential to strategise handling of EXIM container movement on Western DFC as this corridor is expected to witness EXIM cargo predominantly. It is proposed to operate double stack container trains on the Western DFC, from the day DFC becomes operational, so as to enhance the throughput per train of the container trains, thus reducing the number of paths required so as to realise the goal of service reliability.

Promoting double stack container movement is beneficial from cost perspective as well. However ,operating double stacked container trains also poses certain operational challenges in terms of planning at the point of loading as well as unloading so as to align the container movement with the upstream(port) and downstream (ICDs) handling and logistics planning.EXIM traffic is the major contributor of the estimated traffic with the critical points being New Palanpur,New Mehesana, and New Chadottar. Operating double stack container trains has been proposed from New Palanpur to New Dadri and other identified critical sections from Mundra Port, Pipavav Port, JNPT etc. Further the constraints of running double stack container trains on IR feeder routes will have to be addressed in order to make it more effective, by prioritisation of upgradation of OHE on these feeder routes, connecting to the Western Corridor, to allow Maximum Moving Dimension (MMD) of 7.1 metres. A common user terminal at New Prithala is planned for double stacking, which can address the issue of feasibility of north bound double stack container trains to a great extent. Also connection from New Dadri to Dadri ICD is planned which would be critical as the EXIM traffic volume grows. The key cluster for EXIM container is NCR cluster as origin for up direction movement and destination for down direction movement , with ICDs being located at various places and being operated by CTOs like CONCOR, Gateway, Hind Terminals, Adani, etc. These CTOs can leverage the infrastructure proposed to be provided by DFC. Various CTOs are in process of getting connectivity with DFC network.

Over the years, coal has been the most predominant commodity carried by IR constantly contributing to more than 40% of the total movement. Coal Traffic comprises the principal flow on the Eastern DFC .This is so because a majority of of coal mines in India are located in the Eastern region and coal produced here is transported to thermal power plants located in north i.e, UP, Delhi, Haryana, Punjab, Rajasthan, Himachal Pradesh and, J&K. Some of the coal produced in Chhattisgarh, Orissa and Maharashtra also moves to the north. Movement of the commodity on the DFC in future years is largely dependent on the growth of thermal power generation in the north and the colliery plant linkages, which could also get revised after commissioning of the DFC.

Apart from this, DFC as a new rail network infrastructure presents an opportunity in terms of capacity addition to offer non conventional freight services which have been offered on the IR network on a low scale owing to the capacity constraints. These include RORO services, provision of mini rake services etc. These will be classified as premium service offerings and DFC as a service provider may charge a premium for such services. These services will help in attracting small shipments, reduction in

transit time due to speed efficiency on DFC, saving in fuel, tolls and other variable costs, use of depreciated trucks in RORO, decongestion of roads and reduction in emissions. Ultimately rail share will get a fillip. RORO service is contemplated to operate in a merry go round fashion from point to point and not stopping between two junction stations. The services will be time tabled. JNPT - Gujarat route clusters may be potential starters due to high density of truck movement and projected available capacity on the DFC route.

It is proposed to procure Special Purpose Wagons by IR for movement of freight on DFC to take advantage of the infrastructure provided by DFC by increasing the payload /carrying capacity per unit length of train vis-a-vis tare load of wagon. Increase in payload is expected to reduce energy consumption per net tonne payload and O&M costs, in addition to reduction in number of trains required for freight movement leading to release of line capacity and less congestion on routes. Additional cost incurred on using lighter material like aluminium and its alloy, in place of steel is expected to be recovered faster due to increase in revenue earning potential of these wagons due to high carrying capacity. In US, wagons with carrying capacity of 120 tonnes to 130 tonnes in four axle wagons are being used for freight traffic.

High capacity wagons are capital intensive in nature along with the associated infrastructure required for handling of such wagons. To facilitate private player participation ,IR came up with a policy viz. Libaralized Wagon Investment Scheme (LWIS), wherein a private player, who may also be a shipper, will invest in procuring high capacity wagons and get freight discount of 12 % as per LWIS policy.

It is further considered that brake vans may not be required on DFC network, as the network is proposed to cater to freight only traffic and while forming a long rake, brake van may be a weak link. Internationally, also freight trains are fitted with continuous braking as a result of which brake vans have lost their importance and have been discontinued by many railways.

A recent study on commercial and marketing strategy suggests that in the standard Operating scenario(750 Mtrs train length), both the corridors would reach their capacity in the starting years of operations. In the year FY 21 the projected traffic as per this study are 134 trains in up and 121 trains in down direction on Eastern DFC and 109 trains in up and 128 trains in down over Western DFC. Therefore running long rakes/double stacked rakes is a necessity. Running long trains (1500 mtrs) would help in releasing capacity. If the train length is doubled and if it is assumed that all the trains would be long length trains then number of trains would reduce to half of projected. Studies have suggested that profit margin % for most of the commodities on DFC network will increase by 28% and 12% with long train and with standard train respectively via-a-vis cost on IR with standard train due to its designed efficiencies and efficiency achieved in cost like traction cost, crew cost, and faster wagon turnaround. Further it is estimated that with long rakes and standard headway of 10 mints, EDFC will be saturated in FY 29, and WDFC is expected to saturate in FY 24. After this capacity enhancement can be achieved by reducing headway to 6-7 mints, increasing train speed, bringing uniformity in train speeds and lessening bunching of trains. The studies recommend that based on identified critical sections, the origin junction stations should have a provision to form long rakes and the destination junction station on DFC network should have a provision to break the trains as standard length trains to move on IR network. For this to happen yard at destination junctions should have sufficient loop lengths to form /break trains. For ensuring smooth operations on DFC main lines, it is extremely critical to have seamless operations on IR feeder routes connecting to DFC main line network, as most of the traffic is originating from and destined to IR network. Thus synchronising feeder routes infrastructure in line with DFC main line for seamless operations is extremely critical. To ensure service reliability to shippers it is necessary to minimise speed differential among the trains, timetabling of trains, an efficient operational coordination between IR and DFCCCIL, and a good level of proactive and preventive Infrastructure maintenance regime. Freight market studies indicate that with healthy operations parameters ,rail share within DFC influence area has the potential to reach 47 % and above in FY 21 and beyond with the commissioning of DFC network.

DFC is further working on partnering with 3PL/4 PL logistics players to provide end to end cost effective and reliable services to the industries and for developing, operating and maintaining PFTs and MMLPs along the DFC alignment.

There are around 1835 terminals (Goods sheds, PFTs, ICDs, Pvt Sidings) connected to IR, out of which approx 170 feed traffic to Eastern and Western Corridors. Out of 398 Mn Tonnes traffic projected in FY 21 which will be attracted by DFC ,358 Mn Tonnes will originate from existing IR terminals. Based on terminal analysis it has been suggested by experts to develop terminals at Nilje, Meerut, Mirzapur, Shambhu (for Chandigarh/Shimla/Pantnagar/ Rajpura clusters) and Tundla (Agra cluster) by DFC to optimise tapping of the traffic potential.

In order to capture the market DFC needs to employ a combination of direct and indirect marketing techniques to make the final customers aware of its service offering. International best practices suggest to develop a "Freight Calculator" and make this tool available on the DFCCIL website to allow new customers a quick check for the rail offering. DFCCIL is working on this. Based on customer input on type of freight, origin and destination, total annual volume, frequency of traffic and additional service level requirements the freight calculator provides a quick calculation of availability, transit time, frequency, service levels and carbon footprint compared to other modes of transport. It also provides on an informative basis a freight rate quote to the customer and offers a direct contact to the customer service centre. Such a tool can effectively promote rail as a viable option and a price competitive solution to new customers, which have been reluctant in the past to consider the rail mode.

Commissioning of DFC will offload the freight transportation burden from Indian Railway in a big way and capacity will be released on Indian Railway to run more passenger trains also, thereby easing the passenger demands mainly for long distances which is not addressed fully at present. More DFC Corridors like East Coast and East West Corridors are in the pipeline to be constructed in near future, which hold promising future for freight movement in India in more economic ways and with advance technology. This will herald a new age making the Indian goods more competitive in International market and reduce cost of various products domestically.

Target for commissioning EDFC and WDFC is March 2020. However, it is expected to start commercial runs in some sections like Bhaupur - Khurja, Ateli- Marwar in later half of 2019.

ELECTRIC TRACTION SYSTEM OVER WESTERN DEDICATED FREIGHT CORRIDOR (WDFC)

SYNOPSIS:
Western Dedicated Freight Corridor (WDFC) is currently implementing the project having a route length of 1504 Km with double line tracks. It shall connect Dadri in Uttar Pradesh to Jawaharlal Nehru Port Trust (JNPT) in Maharashtra, near Mumbai. This article describes the highlights alongwith key design parameters of traction system being adopted over this corridor. It gives an insight of 2x25 kV AT fed high rise OHE with contact wire height of 7.54m from rail level. The salient features, key equipment used alongwith their ratings, merits, demerits etc. of the system adopted are also explained in detail.

Dr. Vipin Kumar,
General Manager/Elect./WC-I

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. Since IR has standard train lengths of 750 m, the DFC Corridors are designed as a high density corridors for handling 750 meter length (max 6500 metric tonne) and 1500 meter length (upto 13000 metric tonne) trains over DFC networks. In addition to that, there is also a need for running double stack containers of height 7.1 meter on WDFC, thereby, creating the need for developing the traction contact lines at 7.54 meter height, which in itself poses several challenges in design, construction and operation of electric traction system over WDFC. The salient key features of route of WDFC are given in Appendix 'Á'.

The selection of a single-phase or twin-phase system depends primarily on technical and economic aspects. When the load is relatively low and electromagnetic interference does not impose much constraints, the most commonly used 1 X25 kV system is preferred due to its own advantages in terms of lesser cost, ease in availability of components, standard maintenance practices etc. On the other hand, in case of heavy haul operation, higher power density requirement, lesser availability of space for traction sub stations or where electromagnetic interference become a major constraint in operation, then 2 X25 kV is the adequate option for such corridors.

The electric traction system over WDFC has accordingly been designed to cater for the above requirements along with future incremental loading/trains in the system. The traction system

with 2x25 kV AT fed system has been adopted which has a short time rating of 200% for 5 minutes and 150% for 15 minutes, in order to counter any sudden surge in the train power demand in a particular section for a short duration. The selection criteria of electric traction system alongwith other technical details are presented in the next section.

2.0 Electric Traction Power Supply System

The two most commonly used Power Supply Systems for electrification on use worldwide are:-

- 1x25 kV System or 25 kV system
- 2x25 kV Auto Transformer Fed System

Although IR has got adequate experience in 1x25 kV electric traction power supply system, which is spread over Indian Railways, on the other hand, IR has limited experience on 2x25 kV power supply system, which is available only over a limited section of IR. In 1x25kV system, a substantial portion of return current in the range of 40 to 100% flowing through the tracks and earth can create unwanted electromagnetic interference to the adjoining installations. This may cause electromagnetic disturbances in cables in the vicinity of the line, if no corrective measures are taken. As a consequence, the cables need to be protected by cable sheaths. The maximum line length to be supplied single-ended from a substation is limited to approximately 25 KM to comply with the tolerable voltage drop limits.

Accordingly, to overcome the above shortcomings and in view of the following merits of the system, WDFC has adopted 2X25kV system over its entire network:

A. Higher Power Density

Since low currents flow through tracks and earth for 2x25 kV AC supply system in the sections between the autotransformers, which are momentarily not traversed by trains, the electromagnetic interference will be much lower than in the case of 1x25 kV single-phase supply system. Therefore, higher currents and power can be transmitted which leads to increase in capacity as well as performance of the lines. The voltage drop is also lower for the same power, thereby, enabling up to 50 km or more spacing between adjacent TSSs. The WDFC has accordingly been planned and designed to handle a power density of around 1.5 Mega Volt-Ampere per route KM. The traction sub stations having traction transformers of 100MVA capacity are spaced 50-60 kilometer apart, in order to meet the high power demand over WDFC network, against an average TSS spacing of around 30-40 KM on 1x25 kV system over IR network.

B. Lesser voltage drop

The 2x25 kV configuration utilizes Auto Transformers to supply (+) 25kV to catenary wire and (-) 25kV to negative feeder, thus essentially providing a "boost" to the voltage on the overhead contact system and extending usable reach of the traction sub-stations.

The power is transmitted between the substation and the auto-transformer preceding the section on which the traction unit is collecting electric power from the contact line as in a twin-pole 50 kV line. The lower currents involved with this transmission of power result in lower voltage drops in the overhead contact line network even with heavier load currents, thereby allowing more traffic in the section. The voltage drop in case of 2x25kV system is nearly half as compared to a conventional 25kV system. As per study conducted by UIC, electrical distribution efficiency for 2X25kV system is 97.6% against efficiency of 92.95% in 1X 25kV system due to substantial reduction in losses in the system.

C. Electromagnetic Interference (EMI)

Another major benefit of 2x25 kV Autotransformer fed system is that the EMI emitted due to the load current in the overhead system and running rails is considerably reduced. This is primarily on account of the fact that auto transformers inherently attempt to equalize the current flowing in the two sections of the auto transformers winding. This is also due to the fact that traction power return current in the running rail flowing through the Auto Transformer (-25) kV winding and into the –ve feeder tends to create the required balance. In the section between two auto-transformers, the traction units are fed from both ends, the rails serving as return conductors in the customary manner. The interference with adjacent lines is therefore also lower than in single-ended feeding without auto-transformers. In the section between the substation and auto-transformer, the current flowing in the rails is low due to the almost 180^0 phase shift in the overhead contact line and the negative feeder. The interference with adjacent lines is therefore reduced to a great extent.

Due to this, the current in running rails is much reduced between the train and remote auto transformer feeding the electrical section and very much reduced in adjacent section. The effect of EMI generated in two cases is shown in Fig.1 below:-

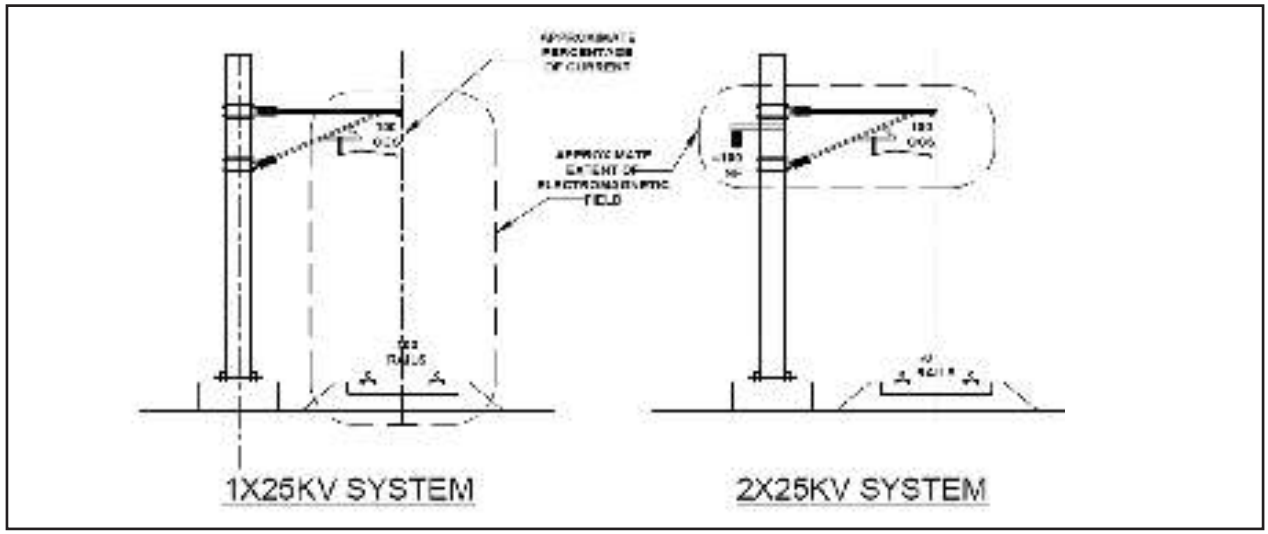


Fig. 1. Effect of EMI in two cases of supply system

3.0 Details of 2x25 kV AT Fed Traction System

To improve transmission properties, the 2x25 kV, 50 Hz system is used for high-performance traffic in worldwide railways. This type of feeding is characterized by additional auto-transformers and a return line at a potential of(-25) KV. In this system, power is fed from the TSS at 50 kV and utilization is achieved at 25 kV by providing Auto-Transformers of adequate capacity and by providing one additional conductor normally referred to as a negative feeder wire. The center point of the Auto Transformer is connected to the earth/rail. This arrangement facilitates +25 kV Voltage between OHE and rail and -25 kV voltage between Rail/earth and the Feeder Wire. The spacing & capacity of autotransformers is decided based on the system design capacity requirements and tolerable limits of the voltage profile, inductive interference levels etc. The traction load is shared by both the adjacent ATs in inverse proportion of respective distances i.e. the AT nearer to the locomotive will share more load than the farther one.

The basic design of this type of feeding along with flow of load current can be seen in Fig.2 given below:

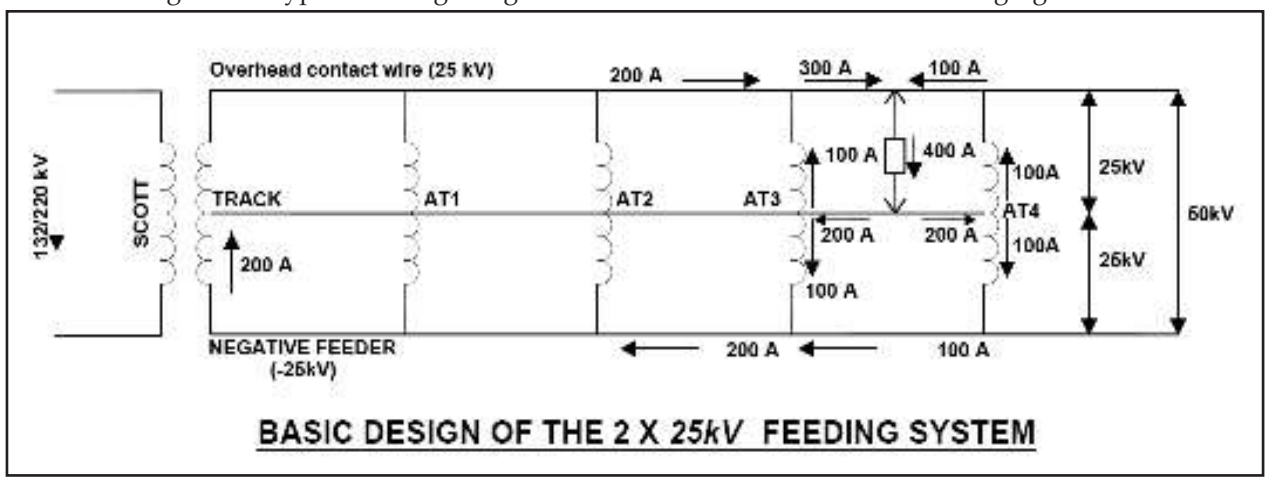


Fig. 2. Basic Design and load current flow in 2X25 kV System

The line supplied by a Scott Connected traction transformer without center tapping. An additional 25 kV feeder line is required between the auto-transformer stations and the traction substations. The voltages between the negative feeder and the rails and between the overhead contact line and the rails are both 25 kV. The potential difference between the overhead contact line and the negative feeder is up to 50 kV. The substations need to be designed for two phases instead of one. Because of this, twin-pole switch gear is required in the overhead line network. Also, the protection of the contact line is more cost-effective because of the double-phase design. Another major advantage is that there is reduced unbalance on the utility transmission network due to usage of three phase traction transformer. The details of major components of the system is as given below:

(a) Scott Connected Traction Transformer

2x25 kV Auto Transformer Fed Traction System has been adopted over WDFC for optimum train operation performance. WDFC has adopted Scott connected, non-center tapped power transformer of rating 60/84/100 MVA based on ONAN/ ONAF/OFAF mode of cooling to feed power to the traction system. The transformers have been manufactured both in Japan as well as in India by M/s. Toshiba Corporation and M/s. Meidensha Corporation respectively under the Transfer of Technology (ToT) from the Japanese manufacturer. The transformer has a voltage input on 220/132 kV, 3 phase, 50 Hz and the output has 2 secondary windings known as main and teaser winding shown below by M phase and T phase respectively in Fig.4. The two windings are identical in voltage (25 kV),

Fig.3. Scott connected transformers and NIFPS system at Ringus TSS

but with 90° phase displacement. The two windings, viz Main & teaser, feed power on either side of the TSS by supplying +25kV to OHE and -25kV to feeder wire, thereby, maintaining rails at zero potential. The neutral sections have been provided in OHE in front of TSS. These traction transformers are also fitted with Nitrogen Injection Fire Prevention and extinguishing System (NIFPS) to prevent tank explosion and fire prevention during internal faults inside the transformer tank.

Fiber optic based temperature measurement of oil and windings has been incorporated in addition to the winding temperature indicators used generally to detect transformer winding hot spots in real time and activate the control of cooling system. Each alternate TSS has been provided with necessary future provisions for installing stand by traction transformer. These transformers have been type tested at Central Power Research Institute (CPRI), Bangalore.

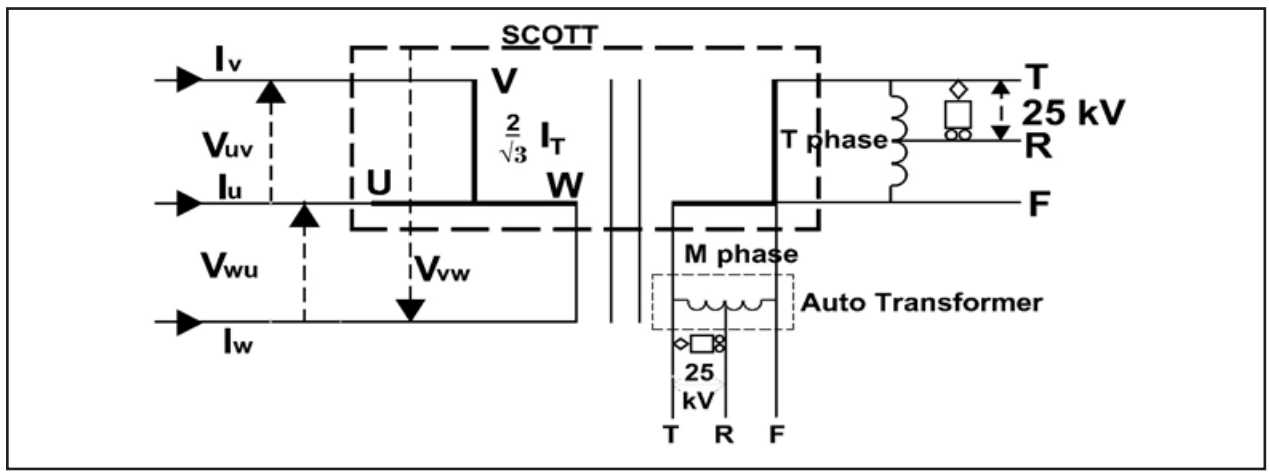


Fig.4. Schematic arrangement of Scott connected transformer alongwith autotransformer

(b) Auto Transformer

The ratings of Auto transformers have been calculated based on detailed simulation studies of complete traction power supply system over Rewari-Makarpura section of WDFC. Accordingly these have suitably been provided at SPs, SSPs, and Auto transformer Stations (ATSs) in order to maintain the designed voltage profile of the Catenary. In addition, because of adoption of non center scott connected power transformer, ATs are also used in TSS for providing rail earth midpoint connectivity at the respective TSS as shown in Fig.4 above. The neutral terminal of the AT is connected to rail. Such AT posts are located every 10 to 20 KMs. The ratings of ATs chosen are 8.0 MVA, 12.3 MVA and 14.3 MVA, 54/27kV and generally operated in ONAN mode of cooling only.

(c) Catenary System

The catenary system consists of a catenary wire made of Copper-Magnesium alloy of 125mm^2, Contact Wire made of Copper-tin alloy of 150mm^2, current carrying flexible dropper of 10mm^2 along with associated jumpers etc.

The negative feeder is 288mm^2 all Aluminum Alloy Conductor (AAAC), which has been strung on separate feeder suspension arrangement on the same mast. The Catenary system has been designed for 940A current level and for a thermal loading of 100o^C.

Fig.5. Modular Cantilever

(d) Cantilever System

A part of Cantilever requirement has been met by modular cantilever system (MCS) (as shown in Fig.5) which have been appropriately designed as per EN-50119 standard and these have been fully type tested for highest structural loading of each member. These cantilevers have been manufactured and supplied by M/s. RIBE Germany. The major advantage of these cantilevers is that these are made of aluminum alloy tubes and aluminum casting fittings. S.S. fasteners have been utilized to give a longer life in field. These cantilevers are so much light in weight that it is very easy to install/replace them in field. However, major portion of the cantilevers are based on the time tested IR cantilever design, made from steel tubes and forged steel fittings. The dimensions of cantilever tubes have accordingly been designed to meet the required level of loadings as per EN-50119 code. The tension in catenary for both the wires has been kept at 12 KN and the same has been regulated through five pulley Auto tensioning devices manufactured by M/s. Arruti Spain.

(e) Buried Earth Conductor

The earthing and bonding system adopted on WDFC is quite different from IR. An Aerial Earth Conductor (AEC) of size 181mm^2 of Aluminum Conductor Steel Reinforced (ACSR) rigidly connected with each metallic mast structure has been provided.

Traditionally, the traction return current from locomotive passes through rail, to the system earthing point of the nearest traction sub-station. A part of the return current also passes through the sub-soil metallic structures, affecting the safety as well as life of such structures, apart from generating electromagnetic interference in nearby communication equipment.

In Western DFC, use of metallic Buried Earth Conductor (BEC) has been adopted to act as a linear earthing throughout the length of the track. The Buried Earth Conductor (BEC) with 20mm diameter galvanized steel wire has been buried under the ground along the DFC track which helps in mitigation of electromagnetic interference on the corridor. The BEC is connected to the rails at approx. every 400 meter apart, thereby, eliminating flow of return current through the rails, thereby ensuring safety too.

(f) Rail Earth Clamp

WDFC has adopted a new technique for effective rail-traction bond connection, by use of a rail-earth clamp, thus completely eliminating the drilling of holes in the rails, or welding on rails. The clamp as

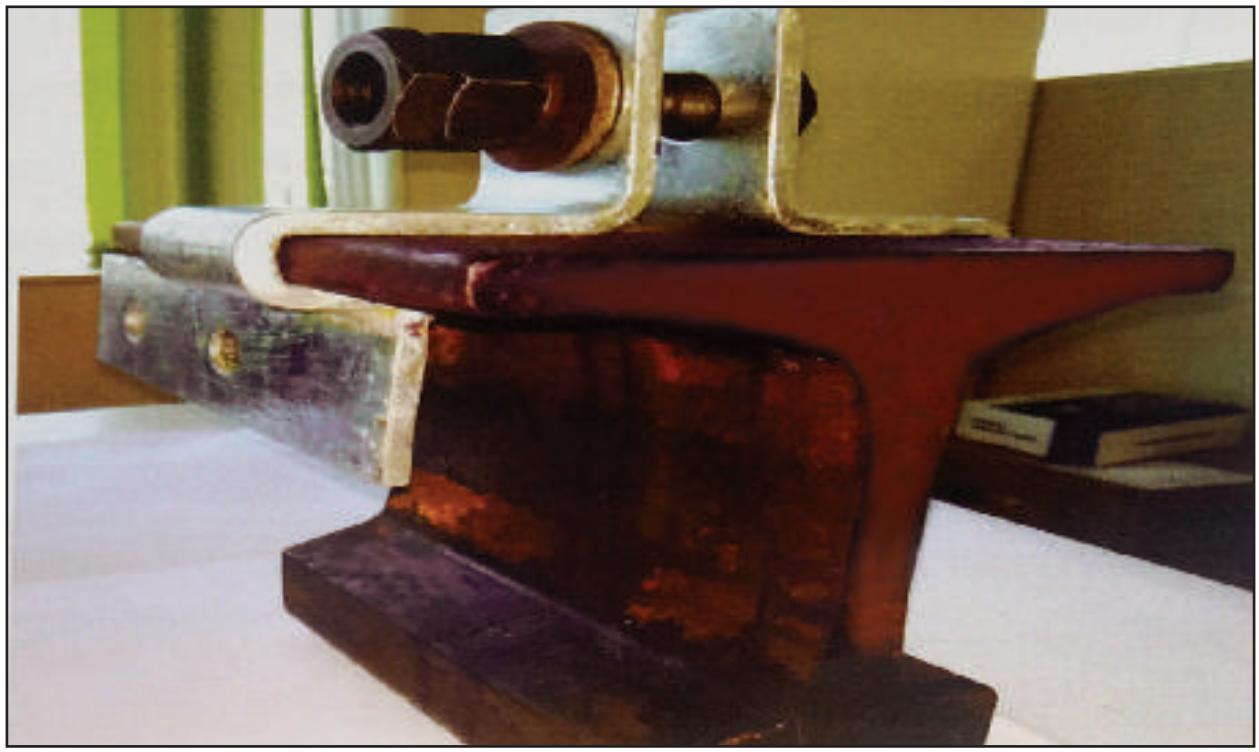


Fig.6. Rail earth clamp

shown in Fig.6 is rigidly fitted to the rails, having sufficient contact surface area for effective passage of the designed short circuit current. The assembly consisting of test piece of rail alongwith the clamping device has been subjected to short time current withstand test at the appropriate value of the short circuit current in Central Power Research Institute. This will ensure safety and reliability of the track structure, while meeting the mandatory requirement of earthing and bonding in AC Traction System.

(g) Auto Fault Locator

The auto fault locators have been provided at TSS and other supply control posts where Auto Transformers have been installed. It helps in fast detection and troubleshooting of the fault in the OHE. When a fault takes place on the OHE, the auto fault locator identifies the location of the fault by collecting the neutral current data of the two adjacent AT posts. The neutral current data of autotransformers is analyzed vis-à-vis the current drawn from the source at the TSS and depending on the ratio, the approximate distance of fault location is calculated. The data so collected can be processed further to arrive at the exact location of the fault. In case of failure of AFL, SCADA is having the facility to test the entire feeding section of a CB that has tripped, to identify and isolate the faulty section.

(h) SCADA

The latest version of Supervisory Control And Data Acquisition (SCADA) System has been adopted over WDFC. There will be one Operational Control Centre (OCC) situated at Ahmedabad, which shall cater for the entire network of WDFC. The SCADA will function as per TCP/IP based open protocol following IEC- 60870-5-104 using dual redundant communication channels. There will also be facility to access SCADA HMI from remote location over internet through necessary Firewall protection for monitoring facility alone for the remote users as shown in Fig.7. The architecture of SCADA system is such that each RTU will be communicating with OCC directly and independently, thereby, giving the advantage that failure of one or more RTUs does not affect the response time of other RTUs.

HUSKY make Remote Terminal Units (RTUs) have been provided over WDFC for acquisition and control of hardwired signals from various equipment at each TSS. These RTUs can be

programmed either locally or remotely using the TCP/IP based communication link. An engineering tool known as Integrated Development Programme (IDE) has been used to configure SCADA offline and also having features of database editing, graphics editing, topology editing, report editing etc, without interfering with the functioning of online systems.

In total, although there are more traction power facilities required for a 2x25 kV Auto Transformers Fed System than for a 1x25 kV systems, but there are fewer traction substations with their associated HV utility circuits, HV transformer, HV switchgears etc. An aerial view of newly created Ateli TSS is as shown below:

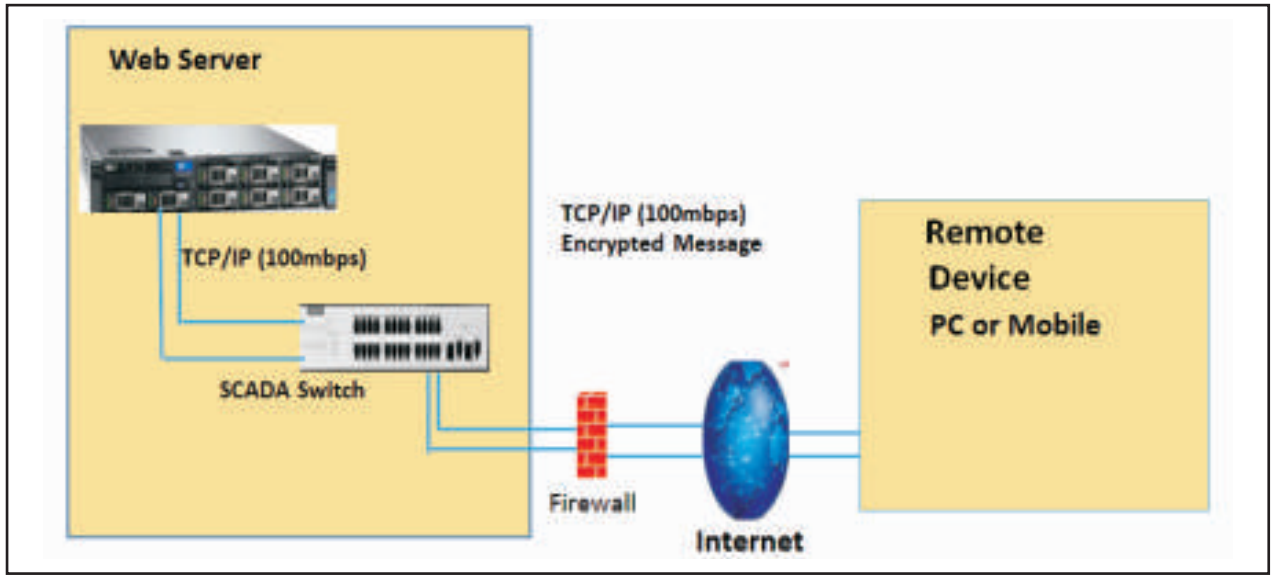


Fig.7. Remote control facility in SCADA system

Fig 8. Aerial view of Ateli TSS

4.0 Comparison of main features of OHE

A brief comparison of main features of OHE adopted over WDFC vis-à-vis being followed over IR is as given below:-

SALIENT FEATURES OF ELECTRIC TRACTION SYSTEM OVER WDFC VIS-À-VIS IR

SN	FEATURE	WDFC 2x25 KV	IR HIGH DENSITY ROUTE 25 KV	IR BINA KATNI SECTION 2X25
1	Power Density per TSS	Around 1.5	Max. 0.6	Max. 0.9
2	TSS Spacing(KM)	60	30	60
3	Traction Transformer (MVA)	Scott Connected 3-Phase input 2-Phase output 100 MVA max capacity Non-earthed secondary	2-Phase input 1-Phase output Maximum 48 MVA One leg earthed	3-Phase input 2-Phase output 54 MVA max capacity Secondary mid point earthed
4	Auto Transformer (MVA)	14.3 MVA maximum capacity	----	8 MVA maximum capacity
5	Catenary Wire	125 sq mm, Copper-Magnesium Alloy (Cu-Mg-0.2%)	65 sq mm Copper Cadmium	65 sq mm Copper Cadmium
6	Contact Wire	150 sq mm, Copper-Tin Alloy (Cu-Sn-0.2%)	107 sq mm HDGC	107 sq mm HDGC
7	OHE Temperature Limit	100°C	80°C	80°C
8	Maximum Current Carrying Capacity	940 A	600 A	600 A
9	Weight of OHE Conductor	2.7 Kg/m	1.6kg/m	1.6kg/m
10	Maximum Implantation	4.85 m	3.5 m	3.5 m
11	Tension in OHE Conductor	1200 Kg	1000 Kg	1000 Kg
12	Height of OHE	7.54 m	5.8 m	5.8 m
13	Height of mast	12 m	9 m	9 m

5.0 Conclusion

Due to higher loading requirements over WDFC, the adoption of 1x25 electrification system would have caused more OHE voltage drop, higher level of electromagnetic interference and higher voltage unbalance in the utility network. Due to less spacing of TSS and more no. of neutral sections, frequent switching ON/OFF of DJ/VCB of locomotive would also have been another drawback. Thus, the adopted system of AT fed 2x25 electrification system is an ideal solution, and most suited for the upcoming Dedicated Freight Corridors in India. This system shall definitely open a new era of technology and vast field of opportunities for Indian industry to manufacture the traction equipment suiting to the requirements of 2x25kV system. This shall prove to be a way forward for future traction systems to be adopted either for high speed rail or higher density traffic routes in India.

Appendix A

1.	Max. ruling gradient	1 in 200 (0.5%)
2.	Max. curvature	2 degree
3.	Max operating speed of goods trains	100 Kmph
4.	Axle Load	25 MT upgradable to 32.5MT
5.	Type of trains	a) Double haul (DH) trains having 1500 meter Train length with max. 13000 MT load (b) Single headed (SH) trains having 750 meter train length with max 6500 MT load
6.	Headway:	(a) 6 minute headway at average train speed of 60 kmph with a combination of 1 DH train for every 2 SH trains in succession all fully loaded. (b) 3 minute headway with 70% loaded & 30% empty trains, 1DH & 2SH combination.

CONCEPT AND PHILOSOPHY OF FRICTION BUFFER STOPS

SYNOPSIS:

Buffer Stops are the important component of Railway System to prevent Unusual occurrence due to overshooting of the Train. Traditionally the Buffer Stop have been designed for very low speed. However, with the advent of higher speed of the loop lines and the higher capacity of the train there is requirement of installation of Buffer stop to handle the increased speed and load.

This article deals with the use of Friction Buffer Stops being provided in the DFCCIL System to handle the increased train load of 6500 MT and with higher Speed of loops of 50kmph. The Friction Buffer stops being provided in DFCCIL have been designed for 6500MT/10kmph parameter. This article deals with the various types of Buffer Stops, its design features, Philosophy and installation & Maintenance. Lately Friction Buffer Stop have been provided in Bhaupur – Khurja Section of EDFCCIL.

Sharad Kumar Jain,
GGM/MA/EDFC-1
DFCC HQ

Veer Narayan,
Vice President,
Project Management,
Rlys and Metro Systra India

1.0 Introduction

Buffer Stops are provided at the end of overrun lines in case a Train load overshoots the signals or the train fails to stop to prevent the train load going further and stopping/slowing down them sufficiently to prevent the damage. Indian Railways traditionally is using fixed buffers stops made of Rails at dead end in Yards which are inadequate and as a result there is the risk that moving train load may collides with other train or overrides the end of platform line or loop line. The use of fixed buffer stops has become unsuitable due to their low resistance and manner of deceleration, which is huge if velocity is high. Fixed type buffer stop are allowed only at those locations where very limited resistance is justified in particular cases such as dead-end tracks in shunting yard, rolling stock depots etc. However these are not sufficiently strong to resist the train loads. It is seen that most of the time these fix end buffers fails whenever an over shooting train hits it with good speed causing lot of damage not only to dead end buffer but also to Rolling stock .

In the past there have been many accidents on account of non-stopping of train load resulting in serious financial losses or even loss of life. In one of the accident in SC Railways, a train load overshot the buffer stop and fell over the Road under bridge leading to loss of lives of road users besides the damage to the bridge structure. In the interest of safety buffer stops of adequate types are required to be installed in the system, else these fixed type buffer stops will always be a safety hazard. With increase in

the speed of loops there is urgent need to install the buffer stops of adequate design to resist the forces coming due to overshooting of train loads. Fitting efficient and effective end stop will protect passengers train and rolling stock in the event of a train failing to stop.

Figure –1: Overshooting of train due to inadequate Buffer stop

DFCCIL will be running the train of 6500 Mt capacity with the loop lines designed for 50 Kmph. Therefore it is necessary to Use high capacity Buffer stops which can dissipate the impact energy safely and without damage. The latest development is to design buffer stops to dissipate the energy by Friction. Sliding Friction buffer stops are the favored construction of buffer stop, mainly due to its high resistance and variations of layout These types of Buffer stops which dissipate the energy of a moving train load by means of friction are called Friction type buffer stops with high resistance and high level of safety. The design of buffer stops varies from the train load and speed with varying train loads and speed. Friction buffer stops have become the preferred constructions at the end of a dead-end track in railway stations abroad (e.g. Switzerland, Germany)

2.0 Different types of End stops:

Depending upon the mechanism to dissipate the kinetic energy of moving train, the Buffer stops are classified into three categories:

a. Sliding friction Hydraulic Buffer stop

The sliding friction end stop is designed to dissipate the impact energy in a controlled manner via the sliding action of the friction shoes fitted between the frame and rail profile in conjunction with hydraulic energy absorption system to provide a recoverable stroke for impact up to 25 km/h and controlled sliding distance for high speeds.

Friction shoes are located within fabricated 'pockets' on the end stops main frame these are fitted around the rail profile secured with three fixings to pre- defined settings to achieve the correct retardation value in relation to the design calculation. Each pair of friction shoes can achieve up to 50KN of braking force, the amount of impact energy to be dissipated will determine the number to be used.

Secondary friction shoes positioned behind the main unit can also be utilised to assist in dissipating the impact energy.

Anti climber shoe assemblies are also fitted to the front of the end stop main frame and clamped around the rail profile to prevent 'uplift' on impact. The friction shoes & anti climber shoe assembles are suited to most type of rail profile and can be reused after an impact – subject to inspection and in accordance with the user manual.

Figure-2: sliding friction end stop

b. Sliding 'friction' end stop – non-hydraulic

Typical used on metro & main line – designed for different Centre impact and side impact with anti climber (if required). Pure friction only, the number of friction shoes will depend on the train mass, impacting speed and required deceleration.

Figure-3: Sliding 'friction' end stop – non-hydraulic

c. Fixed end stop

Fixed and stops are essentially 'end of line' systems with frame fixed directly onto the rails, these type of end stops have no energy absorbing ability unless used in conjunction with hydraulic energy absorption system to dissipate the impact energy. These systems also have the ability to self-reset after impact.

Figure-4: Fixed and stops

3.0 Philosophy of Friction Type Buffer stops:

The sliding friction end stop is designed to dissipate the Impact energy in a controlled manner via the sliding action of the friction shoes fitted between the frame and rail profile. This can be used in conjunction with hydraulic energy absorption system to provide a recoverable stroke for impacts and controlled sliding distance for high speeds. Its manner of deceleration induced upon impact and during the braking makes it smart solution in railway transport safety. The general approach of designing buffer stops is via usage of the kinetic energy and its conversion into work. The main principle of working of Friction buffer stop is to dissipate Kinetic energy of moving train along the braking distance by friction force offered by buffer stop.

When the main braking frame is impacted, the energy is transferred to the Pair of friction shoes in the main braking frame, and the end stop will start sliding along the track to first 2 pairs of trailing friction shoes. If the energy is not totally absorbed at this point, the braking frame and 2 pairs of friction shoe will continue to slide along the track gradually absorbing the energy and reducing the speed. After sliding to the set distance that has been calculated any remaining energy will be absorbed by all pairs of friction shoes installed in the track and brings the train to a complete standstill.

The sliding friction shoe is a mechanical device that clamps onto the rail track. The torque applied to the tightening bolts of the friction shoe determines the amount of clamping force applied to the rail track. In order to move the friction shoe along the trail track the torque induced static friction must be overcome. As the shoe slides along the rail track the dynamic friction of the shoe must be overcome and is typically less than the static friction. The distance that the friction shoe slides is a function of the kinetic energy of the impacting mass. The kinetic energy of the impacting mass therefore is absorbed by transformation of heat energy at the friction faces and subsequently dissipated to the atmosphere.

A friction type Buffer stop consists of three parts:

a. Buffer stop Frame- to resist impact
b. Friction shoes- to provide frictional forces.
c. Length of Railway track- on which frictional shoes move to dissipate Energy.
d. Anti Climber shoe assembly- to prevent uplift of the Buffer stop frame .

2.1 Buffer stop Frame: The frame is designed to withstand the impact load from the moving train and transfers it to the Friction shoes. It is made according to the type of coupler and is designed accordingly. As one of the effect is to overturn, it is fitted with Anticlimber shoe at the front side.

Figure -5: Frame of Friction Buffer Stop

2.2 Friction shoes: These are the main energy dissipating device. It holds the rail and on the force of train load slides with the frictional force between the rail and it. The sliding of friction shoes generates the heat which then dissipated to the atmosphere. The sliding force can vary from 25 KN to 100 KN depending upon the design.

Figure -6: Friction Buffer Shoe with anti climb Stopper

Figure -7: Friction shoes

2.3 Railway track to provide sliding: As the kinetic energy of the moving train is dissipated through the frictional heat energy due to sliding of the frictional shoes, the length of track for sliding has to be kept . the track over which sliding has to be done should be sufficiently stable to handle the longitudinal forces due to slide of the frictional force. Usually the track structure provide is continued for the adequate length.

2.4 Anti-climber shoes: When the main braking frame is impacted, there is uplift force over the frame as the application of force is at some height. This induces the overturning moment which is resisted by the anticlimber shoe (as shown in fig 1) . The anti climber shoe is provided in the front of the frame to anchor the buffer frame against overturning.

A typical layout of a friction buffer stop is as below:

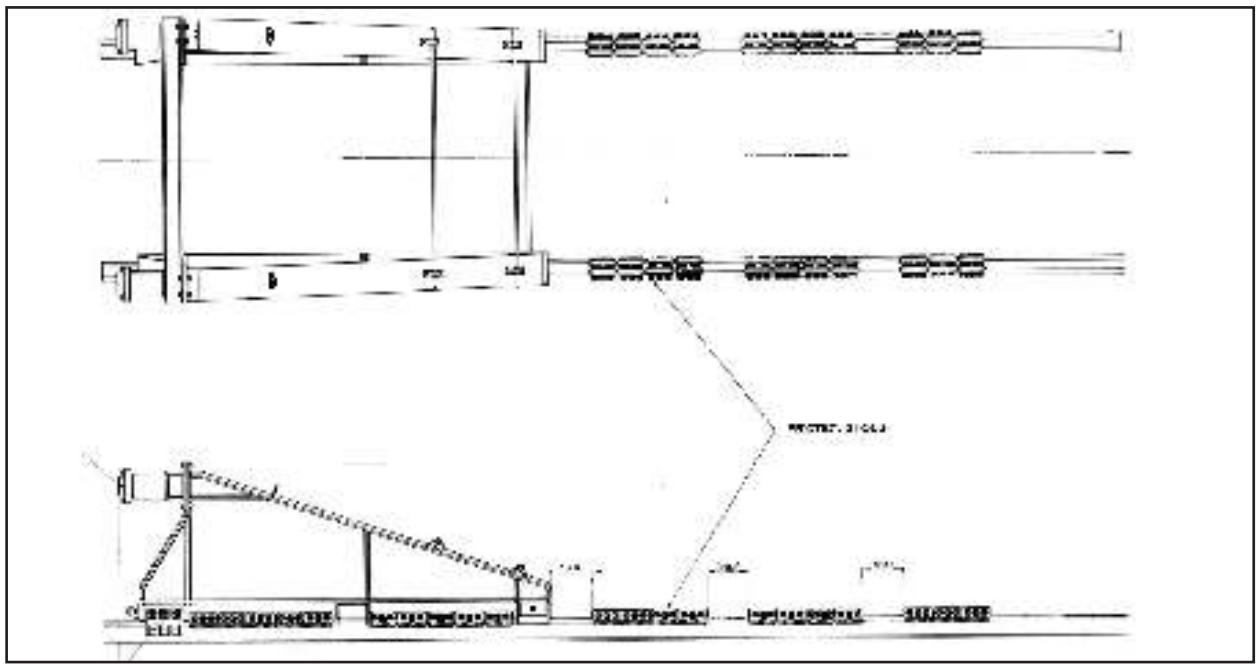


Figure -8: typical Layout

4.0 Design Principles of Buffer stops:

Design principles are being explained to make the readers understand the basic concepts. It is not done into the details of design of each component.

The various parameter that govern the design of Buffer stops are as below:

a. Mass of train
b. Speed of the train
c. Maximum average deceleration permitted
d. Friction Element sliding force

Mass of the train and speed of the train decide the value of the Energy to be dissipated by the Buffer stop. The maximum average deceleration permitted decides the maximum nos of friction shoes to be permitted to be moved as the larger number of shoes will increase the deceleration.

Energy to be dissipated is determined by well known formula of Kinetic Energy of a moving mass which is equal to ½mv2.

Energy dissipated by friction shoes is equal to F*S.

Resistance of a friction buffer stop (work of the buffer stop) could be much higher than a fixed buffer stop, and can be customized for various train mass, trains speeds and acceptable deceleration rates. There is no disadvantage of a friction buffer stop except slight more requirement of space due to its braking distance.

So depending upon the total Kinetic Energy and the frictional force of the slide shoes the distance of sliding is calculated which is provided in the field. As given in the Figure 4 the friction shoes are provided at the spacing to accommodate the sliding.

Deceleration rate could be the limiting parameter when designing number of braking jaws and their braking distances. The most challenging design comes with dead-end track where limited braking distance available Deceleration rate has to be monitored both upon impact and along the braking distance where additional braking jaws could be designed. Fortunately, restriction in deceleration rate applies only to the passenger trains where it should be low from safety point of view of passengers. such is not the case in DFCCIl

The objective is to design the number of braking jaws and their braking distances. There are two possibilities how to design the friction buffer stop:

1. friction buffer stop without additional braking jaws

2. friction buffer stop with additional braking jaws

For better understanding of the deign concept the design followed in one of the Buffer stop in DFCC is explained below.

Mass of the train: 6500 MT or 65,00,000Kg

Velocity : 10 KMPH or 2.78 m/sec

K.E. to be dissipated (½mv2): 2,50,77,160 Nm

Work of the braking jaws can be obtained using Formula work = friction force * distance. Friction force is provided by friction braking jaws & therefore number of jaws can be worked out by knowing friction force provided by one pair of braking jaws. In the friction buffer stops the Friction force of one pair of shoe is designed as 50 KN.

we have provided 10 pairs of jaws in frame followed by 4 pairs of jaws at 30cm and 4 pairs of jaws at 30 cm and finally 3 pairs of jaw at 30cm.

i) During first impact, 10 pair of friction buffer offer resistance for 30 cm(0.3m) of sliding distance.

Energy dissipated- 10*50000*0.3=15000 NM

So balance energy left to dissipate = 25077160-150000=2492760 NM

ii) After first movement of 30 cm , next 4 pairs comes in force & thus 14 pair moves to 30 cm sliding distance

Energy dissipated- 14*50000*0.3=210000 Nm

So balance energy left - 24927160-21000=24717160 Nm

iii) After next 30 cm , 4 more pairs comes in action

Energy dissipated- 18*50000*0.3=27000 Nm

Balance energy left-24717160-210000=24447160 Nm

iv) After next 30 cm ,another 3 jaws comes in action and

Frictional force- 21*50000 =1050000N

Balance Energy to be dissipated- 24447160 NM

So braking distance required to dissipate balance energy of 24447160 Nm- 24447160/105000=23.28 m

so length of track required beyond Buffer point is 23.28 + 0.9=24.18m

Length of 11 pair of buffer @ 210 mm each =2.3 m

Buffer stop structure length =3.2 m

Thus total length of installation required 24.18 +2.3 +3.2 + 29.68 m

Spacing and number of friction buffers can be changed depending upon length available for braking distance beyond location of buffer stop

5.0 Installation and maintenance of Buffer Stops at Site:

Following are the important aspects to be kept in mind while installation and maintenance of Buffer stops at site:

a. Frame must be sufficiently strong to withstand the impact force

b. Anti-climber shoes to have the sufficient anchorage to prevent overturning. Tightness of the bolts to be ensured.

c. Frictional shoes should be ensured to have sufficient frictional forces. Tightness of the bolts to be ensured.

d. Surface of rail should be dry to provide the requisite friction.

e. Buffer stops should not be in down slope direction as it will increase the force to be resisted.

f. Track in advance and rear of the friction buffer should be well compacted and consolidated to provide the resisting force.

g. Formation below the track should be stable as it will finally resist the forces. The high forces induced due to friction of shoes sliding may necessitate the construction of RCC slab to resist the forces coming over the system.

Friction Buffer of capacity 300 MT /10 KMPH have recently been provided in DFCC Khurja-Bhaupur section. Friction buffer stops of higher capacity of 6500 MT/10 KMPH will be provided soon. These are first of its kind in India in terms of its capacity to resist load.

6.0 Conclusion:

The usage of the fixed buffer stops in the railway stations is slowly becoming an anachronism. With the advent of coming of railway systems with high axle loads and higher speeds in main and loop line, there is requirement to design the buffer stops adequate to resist the coming forces to ensure safety of train operations. Friction buffer stops with high resistance and high level of safety meet those criteria. The possibilities of varieties of designing the friction buffer stop is the huge advantage as it can be designed for the range of options from light trains with low collision speed, up to heavy trains with high collision speed. We expect to see more such types of Buffer stops in future in Indian Railways for greater safety.

MoEF&CC: Forest Clearance Demystified

S M J Ahsan
CGM Kolkata

SYNOPSIS:
As Railway projects are running in all parts of the country, it is facing forest land in the midway. Forest (Conservation) Act, 1980 has come into force on & from 25.10.1980. The Act was enacted to save the environmental impact of mindless diversion of forest areas. After enactment, rate of diversion of forest land has come down from 1.50 lakh hectare per annum to 0.38 lakh hectare per annum. After enactment large number of projects got caught for want of forest clearances. Due to non-availability of details and complex structures created in the process for clearances, project controlling authorities are running from pillar to post for getting forest clearances. The instant paper is an attempt to simplify the entire process of forest application and make it simpler for understanding and application in the field. This has demistified the entire process of forest application which prima facie seems to be hard nut to crack.

1.0 Forest (Conservation) Act, 1980 : – Keeping in view the widespread diversions & damage to the forests in the country (diverted at the rate of 1.50 lakh hectare per annum by the various State Gov./UT), Forest (Conservation) Act, 1980 was enacted. It has come into force on the 25th day of October, 1980.

The Act is a unique piece of legislation and a regulatory mechanism that reflects the collective will of the nation to protect its rich biodiversity and natural heritage and permits only un-avoidable use of forest land for various developmental purposes. The remarkable feature of this Act is that it is regulatory and not prohibitory. After enactment of this Act, diversion came down to 0.38 lakh hectare per annum after 1980.

Under the Act, no State Government or other authority can make, without prior approval of the Central Government, de-reservation of any reserved forest; use of any forest land or any portion for any non-forest purpose; lease to private person/ authority/ corporation/agency and clearing of trees grown naturally etc. Any offence under this Act by any authority/person/Dept. of Govt. or any authority shall be liable to be proceeded against and punished accordingly.

2.0 Online Portal:- A portal named as "Pro Active Responsive facilitation by Interactive and Virtuous Environmental Single Window Hub" **(PARIVESH)** has been developed by MoEF&CC for processing of all online applications by the user agencies for seeking forests, environment and wildlife clearances. It has also been mandated that applications for various clearances should be submitted only online. No offline application is being accepted by Forest Authorities. It automates the entire tracking of proposals which includes online submissions of a new proposal, editing/updating the details of proposals and displays status of the proposals at each stage of the workflow.

2.1 OSMEFWC (Online Submission & Monitoring of Environmental, Forests and Wild Life Clearance) is a single window based application developed by MoEF&CC for dealing with online applications for forest & wildlife clearances from all users including Govt. Dept. Screenshot of the Home page of the portal looks like Figure 1.

2.1.1 Overview-

- A workflow based G2G and G2G portal developed for receiving and tracking proposals online submitted by user Agencies for seeking Environmental, Forests and Wildlife clearances.
- A centralized database of proposals submitted to the Ministry from 1980 onwards.
- To be used by User Agencies, DFOs/DCFs, DCs, CF/CCFs, Chief Wildlife Warden, State Forests departments, State Governments, Regional Offices and head quarter of Ministry of Environment & Forests, New Delhi. It will be used by Member Secretaries of SEIAA, SEAC and IA division of MoEF&CC also.

2.1.2 Objectives-

(i) to provide single window for processing;

(ii) to enhance efficiency, transparency and accountability in the forest, environment and wildlife clearance process;

(iii) to reduce time for each activity;

(iv) to enhance responsiveness through workflows automation and availability of real time informations;

(v) to enhance convenience of citizens and businesses in accessing informations and services;

(vi) achieve standardization in processes across regional and state level.

2.1.3 Core Features-

- All submission of projects in single window interface.
- A unique-ID for each proposal for future references.
- On-the-fly generation of all required reports.
- Automatic mailer notifications to take instant action.
- Facilitate Management in effective monitoring.
- Accessible from any PC having internet facility.
- Different privileges/roles for users as per their responsibility.

2.1.4 Stages of Clearances-

- Stage-I Clearance
- Stage-II Clearance

There are two stages conceived in the forest clearance proposals namely, Stage-I and Stage-II. Stage-I is the first clearance to be processed and granted under Forest (Conservation) Act, 1980. At the end of Stage-I process, In-principle approval is granted to the proposal by MoEF&CC.

Stage-II is the second and final clearance to be processed and granted under Forest (Conservation) Act, 1980. At the end of Stage-II process, final approval is granted to the proposal by MoEF&CC.

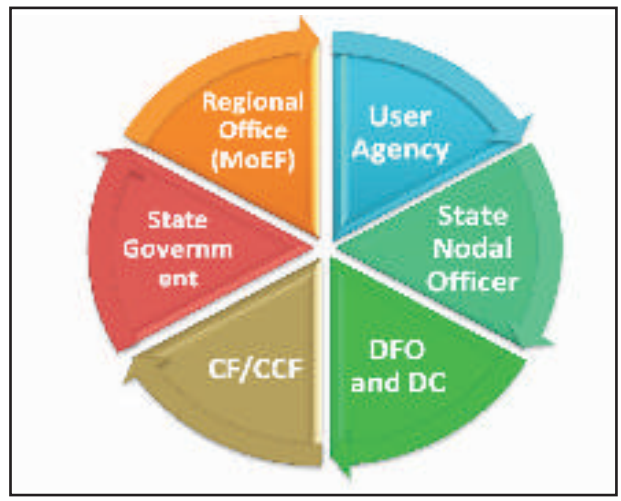
2.1.5 Working Permission-

Stage-I process is an In-principle approval granted to the proposal by MoEF&CC. However, till the process of Stage-II is complete User Agency can seek working permission for working in the forest provided UA agrees to satisfy some conditions as put forward by MoEF&CC through its arm of administration. Working permission once granted gives the right to User Agency for carrying out the work in the forest area for all practical purposes.

2.1.6 Stage-I Clearance-

This is the main/ major process for seeking forest clearance. In the entire process there are various stake holders and each of them are conceived for their part of plays in the process.

2.1.6.1 Roles of Stake Holders- There are six (6) major players in the entire process for forest clearances. These players play their roles in an assigned manner. Stage-I clearance is a synchronized product of the process after playing of roles by each player.



2.1.6.2 Flow of Process- The flow process has been divided into six parts at all levels of stake holders starting from user agency who initiates the process.

2.1.6.2.1 User Agency-

- Registration with the OSMEFWC portal for the credentials. (Ref- Figure 2)
- After registration, User-ID and password will be communicated automatically to the registered email-ID of UA.
- Login to the portal for submission of online application. (Ref- Figure 3)
- Submit application (Form-A/Form-B/Form-C) online.
- Upload relevant documents (polygon of land to be diverted, polygon of proposed CA land etc.) on portal and save it.
- After receiving communication regarding shortcomings (if any) in the proposal, Upload all these details on portal.
- After receiving further communication, User Agency will upload Acknowledgment slip (as a single .pdf file) received.
- If proposal is complete, then UA will receive email regarding acceptance of the proposal from the Nodal Officer.

2.1.6.2.2 Principal Chief Conservator of Forest - Cum-Nodal Officer -

- Complete proposal including all relevant documents sent by UA will be available for viewing.
- Examine the proposal submitted by UA.
- If proposal is incomplete, then Nodal Officer may send communication of shortcomings to UA. The reply along with the additional documents (if any) will be sent by UA to Nodal Officer online.
- If proposal is complete, then Nodal Officer will send a communication of acceptance of proposal to UA along with a request to upload an acknowledgment slip of the submission of a copy (signed) of original proposal to divisions, Districts and Nodal Officer.
- After receiving Acknowledgment slip, Nodal Officer will upload final acceptance on portal and proposal will be forwarded to concerned DFOs and DCs for further processing

2.1.6.2.3 Divisional Forest Officer -

- Complete proposal (Form-A, Part-I) including all relevant documents will be available for viewing.
- Can seek Additional/ Essential details (ADS/ EDS), if required, from UA.
- Process the proposal (Form-A, Part-II) and upload Site Inspection report and Recommendation on portal.
- When Recommendation is uploaded, proposal will move to CF/CCF for further processing.

2.1.6.2.4 Dy. Commissioner/ District Magistrate -

- ❖ Complete proposal (Form-A, Part-I) including all relevant documents will be available for viewing.
- ❖ Upload the details related with settlement of rights under FRA and NOC of Gram Sabhas, if any.

2.1.6.2.5 Conservator of Forest/ Chief Conservator of Forest -

- ✓ Complete proposal (Form-A, Part-I and Part II) including all relevant documents, report from DC and recommendation of DFO will be available for viewing.
- ✓ Can seek Additional/ Essential details (ADS/ EDS), if required, from DFO.
- ✓ Upload Site Inspection Report (if any) and Recommendation.
- ✓ When Recommendation is uploaded, proposal will move to Nodal Officer for further processing.

2.1.6.2.6 Principal Chief Conservator of Forest - Cum- Nodal Officer -

- Complete proposal (Form-A, Part-I to Part-III) including all relevant documents, report from DC and recommendation of DFOs and CF/CCFs will be available for viewing.
- Can seek additional/essential details from CF/CCF (if required).
- Upload Site Inspection Report (if any) and Recommendation.
- When Recommendation is uploaded, proposal will be moved to State Forest Secretary for further processing.

2.1.6.2.7 State Government/ Forest Secretary -

- Complete proposal (Form-A, Part-I to Part-IV)

including all relevant documents, report from DC and recommendation of DFO, Circle and Nodal Officer will be available for viewing.

- Can seek additional/essential details (if required) from Nodal Officer.
- Upload Recommendation.
- When Recommendation is uploaded, proposal will move to either Regional Office or Head Office, MoEF, Delhi as per the flow defined in the system for further processing.

2.1.6.2.8 Regional Office -

- ➢ Complete proposal including recommendations and site inspection reports sent by DFO, CF/CCF and Nodal Officer and recommendation of State Secretary/State Government will be available for viewing.
- ➢ Can seek Additional/Essential details (if required) from State Secretary/SG.
- ➢ SAG/REC recommendations along with Agenda and Minutes of the meeting are uploaded on portal and proposal is forwarded to RO HQ, MoEF, New Delhi for the approval of Competent Authority, if required.
- ➢ Conduct site inspection where forest area to be diverted is more than 100 ha.
- ➢ Upload site inspection reports in cases where in forest area to be diverted is more than 100 ha.
- ➢ Submit the complete proposal to Regional Empowered Committee for deliberation and recommendation where RO is final authority.
- ➢ Issuance of Stage-I clearance for all linear projects etc where RO has been authorized for the same.

2.1.6.2.9 Regional Office (HQ), MoEF, New Delhi -

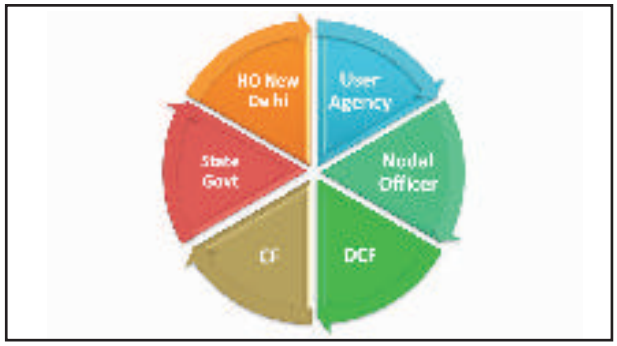
- Complete proposal including recommendations and site inspection reports sent by DFO, CF/CCF and Nodal Officer and recommendation of State Secretary/SG and Regional Office will be available for viewing.
- Can seek Additional/Essential details (if required) from Regional Office.
- Upload Approval of Competent Authority on portal.

2.1.6.2.10 Head Office, MoEF, New Delhi -

- ❖ Complete proposal including recommendations and site inspection reports sent by DFO, CF/CCF and Nodal Officer and recommendation of State Secretary/SG and Regional Office will be available for viewing.
- ❖ Complete proposal including recommendations and site inspection reports sent by DFO, CF/CCF and Nodal Officer and recommendation of State Secretary/SG and Regional Office will be available for viewing.
- ❖ FAC recommendations (along with decision of Competent Authority) and agenda and minutes of the meeting are uploaded on portal and the decision is communicated to all stakeholders.

2.1.7 Stage-II Clearance-

This is second and last major process for seeking forest clearance. Moreover, this is the final clearance in this regard. In the entire process there are various stake holders and each of them are conceived for their part of plays in the process. This stage is more of paperwork and closure of the process initiated by UA.



2.1.7.1 Roles of Stake Holders- There are six (6) players in the entire process for forest clearances. These players play their roles in an assigned manner. Stage-I clearance is a synchronized product of the process after playing of roles by each player.

2.1.7.2 Flow of Process- The flow process has been divided into six parts at all levels of stake holders starting from user agency who initiates the process after Stage-I clearance i.e. In-principle approval is granted and communicated to the User Agency.

2.1.7.2.1 User Agency-

- Upload demand letter for NPV and CA received from forest department.
- After receiving communication regarding shortcomings (if any) in the uploading of demand, resubmit the demand details on portal again.
- After receiving further communication, User Agency will generate online challan for making payment of NPV and CA.

- After generating challan, UA will make payment to the designated account i.e. CAMPA account in the bank.
- Upload status of forest land to be transferred to Forest department.
- Upload compliance to the conditions stipulated in Stage-I Clearance.
- Submission of payment details to DFO through physical payment receipts.

2.1.7.2.2 Principal Chief Conservator of Forest - Cum- Nodal Officer -

- Verify fund demand letter uploaded by User Agency.
- Forward Compliance (to the conditions stipulated in Stage-I Clearance) report submitted by UA to DFO/CFs manually and update status on portal.
- Receive Compliance report from DFO/CFs and update status on portal.
- Forward Compliance report to State Government.

2.1.7.2.3 Divisional Forest Officer -

- Checking the status & physical submission of payments under CAMPA account by User Agency.
- Physical verification of conditions related to boundary posts, GPS Co-ordinates etc.
- Compliance Report submission after forwarding of the same by Nodal Officer.
- Onward forwarding the compliance report along with hard copy.

2.1.7.2.4 Conservator of Forest/Chief Conservator of Forest -

- Checking the status of compliance and field report by DFO.
- Onward forwarding the compliance report with its recommendation along with hard copy.

2.1.7.2.5 Principal Chief Conservator of Forest - Cum- Nodal Officer -

- Compliance report including all relevant documents, report from DFO and recommendation of DFOs and CF/CCFs will be available for viewing.
- Review of compliance of Stage-I conditions as stipulated with In-principle approval.

2.1.7.2.6 State Government -

- Process Compliance Report submitted by Nodal Officer.
- If stage-I clearance is issued by State Government, then issue stage-II clearance otherwise forward Compliance report to Regional Office/HO, New Delhi.

2.1.7.2.7 Regional Office -

- Process Compliance Report submitted by State Government.
- If stage-I clearance is issued by Regional Office, then issue stage-II clearance otherwise forward Compliance report to HO, New Delhi.
- Issuance of Stage-II clearance for all linear projects etc where RO has been authorized for the same.

2.1.7.2.8 Head Office, MoEF, New Delhi -

- Process Compliance Report submitted by Regional Office.
- Issue stage-II Clearance.

2.1.8 Essential Details Sought (EDS) -

Automatic mailer notifications will be triggered for each and every transaction committed in the PARIVESH System. An email/SMS alert will be sent by Forest department to User Agency for the same.

2.1.9 Online Notifications -

The status of proposal will be updated at each transaction and the same would be reflected automatically in the dashboard of the User and reports available in public domain.

2.1.10 Dashboard -

Dashboard has been provided in the portal for overview of all proposals submitted by the User Agency under the same registration. It gives details of all proposals related to environmental clearance, forest clearance, wildlife clearance etc on the same page along with details of proposals under draft stage, process stage along with EDS (Essential Details Sought), ADS (Additional Details Sought) and approvals. (Ref – Figure 4)

3.0 Compensatory Afforestation -

Compensatory afforestation (CA) is one of the most important requirement/ condition for prior approval of the Central Government for diversion of forest land for non-forest purposes. The purpose of compensatory afforestation (CA) is to compensate the loss of 'land by land' and loss of 'trees by trees'. Normally, CA is to be raised on suitable non-forest land, equivalent to the area proposed for diversion, at the cost to be paid by User Agency. The non-forest land for CA is to be identified contiguous to or in the

proximity of a Reserve/Protected Forest to enable the Forest Department to effectively manage the newly planted area. Where non-forest land is available but lesser in extent to the forest area being diverted, CA could be carried out over degraded forest twice in extent of the area being diverted.

4.0 Net Present value –

The concept of Net Present Value (NPV) was introduced by Hon'ble Supreme Court of India by its orders dated 29.10.2002. The Net Present Value (NPV) of forest land diverted for non- forest purposes is also to be recovered from the user agencies, for undertaking forest protection, other conservation measures and related activities. This is payable once demand is raised by DFO after Stage-I clearance is received.

5.0 Status of Forest Proposals under KKK unit –

Out of total nine (9) districts in the unit, forest lands are involved in five (5) districts. Total forest land involved is to the tune of 427.12 Ha which is approximately 35% of total land requirement. The details of the forest proposals with current status are made available in Figure 5. The tabular data in this Figure 5 are:

S. No.	Proposal No.	Proposal Name	Category Name	User Agency (Ha)	Area Applied Received On	Proposal Physically	Proposal Status
1	FP/JH/RAIL/33154/2018	DFC	Railway	DFCCIL	8.6199	18 Apr, 2018	Nodal Officer
2	FP/JH/RAIL/18720/2016	DFC	Railway	DFCCIL	203.803	30 Mar, 2016	IN-PRINCIPLE
3	FP/JH/RAIL/33154/2018	DFC	Railway	DFCCIL	89.688	23 Feb, 2016	IN-PRINCIPLE
4	FP/JH/RAIL/33154/2018	DFC	Railway	DFCCIL	117.584	18 Jan, 2016	IN-PRINCIPLE
5	FP/JH/RAIL/33154/2018	DFC	Railway	DFCCIL	202227	21 Apr, 2015	IN-PRINCIPLE
6	FP/JH/RAIL/33154/2018	DFC	Railway	DFCCIL	1.7936	23 Mar, 2015	IN-PRINCIPLE

Figure 1 - Home page of PARIVESH Portal

Figure 2 - New User Registration page of PARIVESH Portal

Figure 3 - Login page of PARIVESH Portal

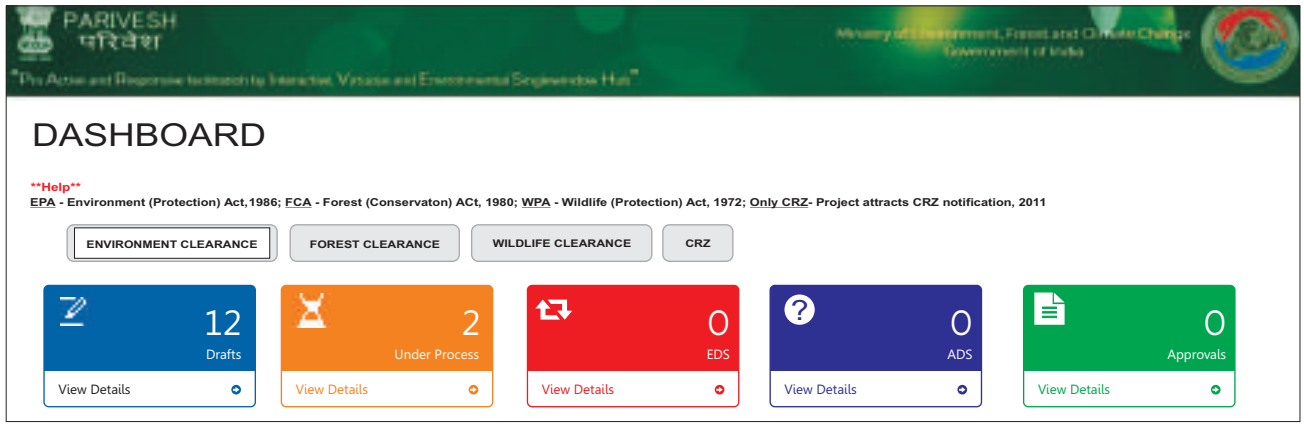


Figure 4 – Dashboard

Figure 5 – View Report of submitted proposals

GSM-R System for Western Dedicated Freight Corridor

K. Madhusudan
GGM/S&T/WC-I

SYNOPSIS:
DFCCIL will be employing GSM-R based mobile Train Radio Communication system which will act as means of Emergency Communication in lieu of the EC socket based Emergency communication. The system will also provide ground to train voice and data communication thus fulfilling the mobile Communication needs of maintenance staff, track side workers, station and ELMD staff, Railway Administration and the DFCCIL Management. The system shall be designed to facilitate immediate relaying of information in case of unusuals and abnormal situations as well as of emergencies in conjunction with other Telecom systems. The system also includes provision of OPH, CAB radios and Shunting radios and related OnBoard systems as part of the Contract. The present paper details the functionalities of the system going to be employed in Western Dedicated Freight Corridor (WDFC), experiences gained during Radio survey, the tools used power budgeting etc.

1.0 History of GSM-R :

The early nineties saw about 35+ railway communication systems being used across Europe. There were wired / cable and analogue radio networks which were not compatible with each other. That's when the European rail companies thought of standardising the communication for the railways.

The concept of Communication system based signalling was being preferred. Railways wanted to adopt a proven technology with minimum modifications. Two potential technology candidates were identified GSM-R and TETRA. In 1990, TETRA was still in the standardisation process whereas GSM-R got an overwhelming support from the GSM industry, thereby, promising to create a wider ecosystem. Being a proven technology with an overwhelming support from the GSM industry, it was chosen as a standard for Railways.

For commercially adapting GSM based standard for railways, the European Integrated Radio Enhanced Network (EIRENE) project was initiated in 1992 by UIC. The aim of the EIRENE project was to develop specifications for a GSM-based railway communication network. The EIRENE project ended in 1995 with publication of Functional Requirements Specification (FRS) and System Requirements Specification (SRS). The EIRENE project was followed by Mobile Oriented Radio Network (MORANE) project, whose goal was to run three GSM-R networks for testing and validating the performance of the technology. This project finished in 2000, with a delivery of the final specifications of GSM-R.

The success of GSM-R is largely attributed to the allocation of spectrum to the European countries allocating the same 4MHz spectrum across Europe (876–880 MHz is the uplink band, while 921–925 MHz is the downlink band). The common band used across the whole EU is one of the important elements allowing for "cross-border interoperability". Later in some countries GSM-R received an additional 3 MHz spectrum (873–876 MHz for uplink and 918–921 MHz for downlink). Thus, a total bandwidth of 7 MHz is available for GSM-R in those countries. Today 60+ countries have adopted GSM-

R as a standard to cater to the basic "Mission Critical" needs of its railway organisations.

GSM-R has become a mature and secure global railway standard. It caters to the basic needs of any global railway organisation namely:

a) Safety
b) Proven technology
c) Standardised for Railway use
d) High Reliability and Availability
e) Communication at high speeds (~500 Km/hr)
f) Cross Border Interoperability
g) Using standardised ecosystem (e.g. transmission, Handsets etc.)
h) Support of Railway specific services
i) Integration of Railways Communication & Signalling systems

2.0 Global Status of GSM-R Today

Wireless technology in commercial networks is taking a giant leap moving from GSM (2G) to 3G to 4G to 5G.On the other hand, globally, railways are a conservative technology adopter due to its Safety concerns and are slow to adopt any technological changes. In the recently concluded INNOTRANS 2018 (Berlin) most of the GSM-R equipment providers have shown their affinity and confidence in GSM-R technology. They are committed to support it at-least till 2030/35. Some Countries as recently as in 2018, floated a tender for countrywide deployment of GSM-R. Poland, Germany, Hungary are some of the nations that have plans for expansion of their existing GSM-R networks. Countries like Saudi Arabia, UAE etc. are in the process of expanding their GSM-R networks. Indian Railways too has awarded multiple GSM-R contracts and is in the process of phased deployment of these projects.

3.0 GSM-R System for Western Dedicated Freight Corridor - Phase 1

The Western Dedicated Freight Corridor (WDFC) Phase-1 Project comprises approximately 915 km of double line electrified railway track with 2x25kV AC, 50Hz overhead catenary system from Rewari to Makarpura. GSMR deployment mandates to provide ground to train voice and data communication and vice versa, thus addressing the mobile communication needs of maintenance staff, track side workers, station and ELMD staff and railway administration and management staff.

The network being deployed has the NoBo certification of EIRENE Standards. It has certified interoperability with the incumbent GSM-R network of Indian Railways.

The network consists of various network nodes belonging to either of the categories

a) Core Nodes.
b) BSS (Base Station Sub System) Nodes.
c) O&M (Operation & Maintenance) Nodes.
d) VAS (Value Added Services) Nodes.
e) User Equipment.

3.1. The WDFC Core Architecture is as shown below:

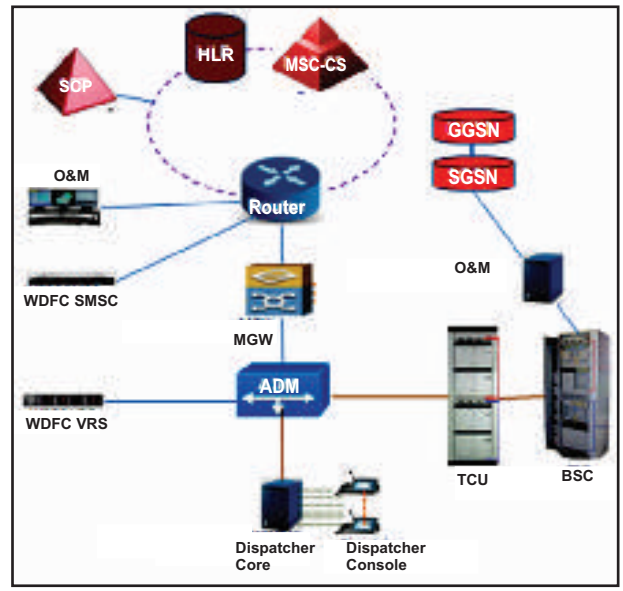


Figure 1:WDFC Core Network

All Core nodes shall be co-located in the OCC building planned at Ahmedabad. The traffic carrying core nodes are carrier grade and fully redundant built on the OEM (Kapsch CarrierCom) technology. This is the first deployment of IP based R4 Core in Indian Railways in the Country.

The core comprises of various nodes like **MSCS (Mobile Switching Centre Server), HLR (Home Location Register), MGW (Media Gateway)** and a very powerful **IN / SCP (Intelligent Network or Service Control Point).** All the core nodes are connected on IP via internal high availability fully redundant LAN (Local Area Network).

MSCS supports the voice switching of the channels and support implementation of all the telephony supplementary features (Call wait, Call Hold, Calling Line {Presentation etc.)

HLR is the fully redundant high availability database that facilitates the creating and storage of profiles of all the subscribers created in the network.

MGW is the gateway that provides connectivity between the Core & the BSS nodes. It facilitates the conferencing facility also. All TDM nodes like EPABX and dispatcher are connected to this node. Provisions have been made to enable connectivity to RBC nodes of ETCS level 2 in the future.

IN/SCP system is the key to implementation of railway specific features like FA (Functional Addressing), LDA (Location Dependant addressing), CSAM (Call Screening and Access Matrix) to name a few.

SGSN & GGSN are key to deploying GPRS functionality in the network. **It is the first deployment of GPRS in any GSM-R network in Indian Railways.** The GPRS along with CSD (Circuit switch Data) is making the core fully ready to support ETCS Level 2 signalling.

3.2 BSS comprises of the following Nodes:

- BSC (Base Station Controller)
- TCU (Transcoding Unit)
- BTS (Base Transceiver Station)
- PCU (Packet Control Unit)

BSC performs various functions like BTS supervision, Radio channel allocation, Radio channel monitoring, Traffic management, TCU management, OMC-R link management, Handover procedures etc.

TCU provides connectivity of the BSS nodes with the core nodes. It manages the TDM (Time Division Multiplexing) between the Core nodes & the BSS nodes. It configures and monitors the PCM links on the A and Ater interfaces. It performs coding / decoding of the speech frames and rate adaptation of data frames.

BTS performs channel coding/decryption. It contains transmitter and receivers, antennas, the interface to the PCM facility and signalling equipment specific to the radio interface in order to contact the Mobile User Equipment. It processes the signalling and speech required for Mobiles in air interface at one side (via antenna) and with BSC in Abis interface (through PCM 2Mb/s in OFC network) at the other side.

BTS network has been designed keeping in view the introduction of ETCS Level 2 in the near future. **It is the only BSS network in the country which will be ETCS Level 2 ready.** The media connectivity between the BSC and the BTS is redundant and in loop architecture comprising of 4BTS per loop. **Overlapping coverage has been designed (discussed in the later section) which has been done for the first time in the country for railways.**

Fully redundant PCU connects the BSC to SGSN on IP to enable GPRS.

BSS Architecture

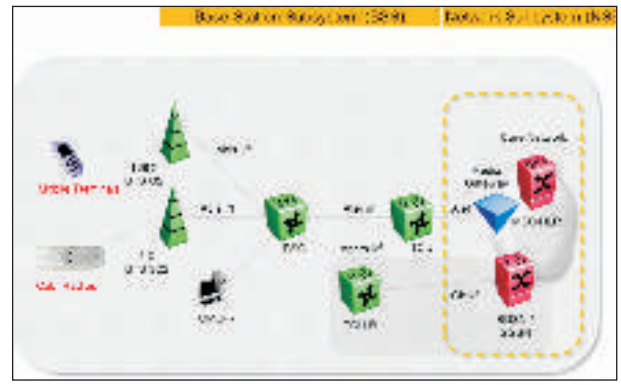


Figure 2:WDFC BSS Network Architecture

3.3 O&M Nodes (Operation and Maintenance)

All the nodes being provided will be centrally monitored from the OCC. OEM has proposed a high availability carrier grade O&M platform with full FCAPS (Fault, Configuration, Accounting, Performance and Security Management) functionality.

3.4 VAS Nodes

SMSC (Short Message Service Centre) has been **planed for deployment for the first time in a Railway GSM-R network in India** for sending messages between various User Equipment.

VRS (Voice Recording System) Voice Recording of all the calls on the GSM-R network is being provided to help the railways in any kind of an unfortunate disaster situation.

Latest state of the art IP **Dispatcher** system is being deployed for railway operations. **IP dispatcher is being deployed for the first time in India in a GSM-R environment.** The system is fully redundant, capable of sending and receiving SMS messages and 100% recording of calls.

3.5 User Equipment

The network is capable of supporting all the certified and interoperable GSM-R devices available globally. **OPH** (Operational Purpose Handsets) are being provided for the operational staff on ground

and On- Board. **OPS** (Operational Purpose Shunting Handsets) are being provided for the shunting teams on the ground. **Cab Radios** are being installed in the locomotives for the ground to On-board loco communication. Cab Radios are 8W radios with high sensitivity which are used by the Loco pilots. For communication with stations **FRT** (Fixed Radio Terminal) with external antennae on the station buildings are being provided.

Figure 3:GPH and OPH

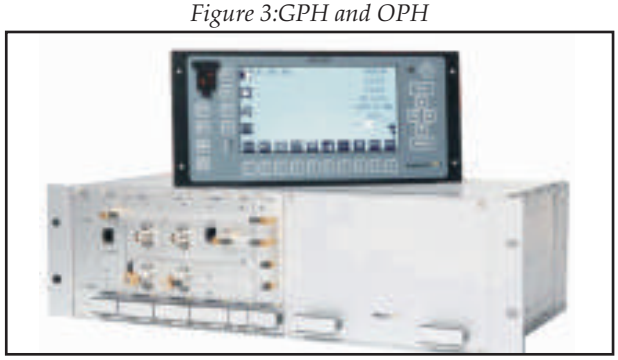


Figure 4:Cab Radio

4.0 Radio Frequency (RF) Design of WDFC's GSM-R Network

The purpose of the Radio engineering activity is to define quantity and locations of radio sites based on project inputs and assumptions. The nominal final number of sites are determined after a complete environment survey and dedicated CW measurements campaign along the lines. Customer specific requirements for sites locations, frequency availability, coverage targets are taken into account before to start the radio design. In addition, local rules, regulations and laws lead to modifications in the site characteristics, including, but not limited to, sites location, height of tower or EIRP. All of these factors will affect performance of the radio sites.

The RF Design process follows a series of steps as detailed below:

- Definition of coverage, traffic and performance objectives
- Acquisition of Digital Terrain Map and Setting up Planning Tool
- Environment Surveys
- CW Testing and Propagation Model Calibration
- Link Budget Definition
- Nominal RF Planning
- Site Acquisition and Build

4.1 Definition of Coverage, Traffic and Performance Objectives

The radio system is based on GSM-R technology as defined in the EIRENE recommendations. DFCC has specified compliance to the EIRENE system requirements and certain radio targets/ specifics. These requirements form the basis for the design. Some of the salient requirements of the Bid are listed below:

- RF coverage along and around 250 m of the railway track along the WDFC alignment from Rewari to Makarpura.
- Maximum inter site distance of 7 kilometres.
- BTS at every junction and crossing station.
- RF signal levels as per EIRENE recommendations (-95 dBm at 95% coverage probability). Further, a signal threshold of -80 dBm has been specified for providing coverage to handhelds considering an in-train penetration loss of 15 dB.
- Overlapping coverage from sites on either side to cater to failure on an intermediate BTS site (fault tolerant coverage) for the case of cab radios inside the locomotive.
- Design maximum train speed of 220 km/hr.
- The radio system to operate in the frequency band 952.8-954.4/907.8-909.4MHz (with eight channel allocations).
- Radio system to be equipped with 15 traffic channels and one control channel or 14 traffic channels and two control channels.
- The network should support point-to-point data communication. The network shall support data rates of at least 2.4 kbit/s.
- Maximum tower height of 40 metres.

4.2 Digital Maps

The RF design tool uses a digital map database created from various source inputs (like SOI topo maps) and updated with high resolution satellite

imagery (20m resolution). The digital maps are created as layers and indicate land use (clutter), terrain (heights) and vectors (roads, railways etc.). The maps have been updated with kmz files provided by DFCC to create the WDFC route. A buffer zone of 10 kms on either side of the DFCC railway track was incorporated into the digital map.

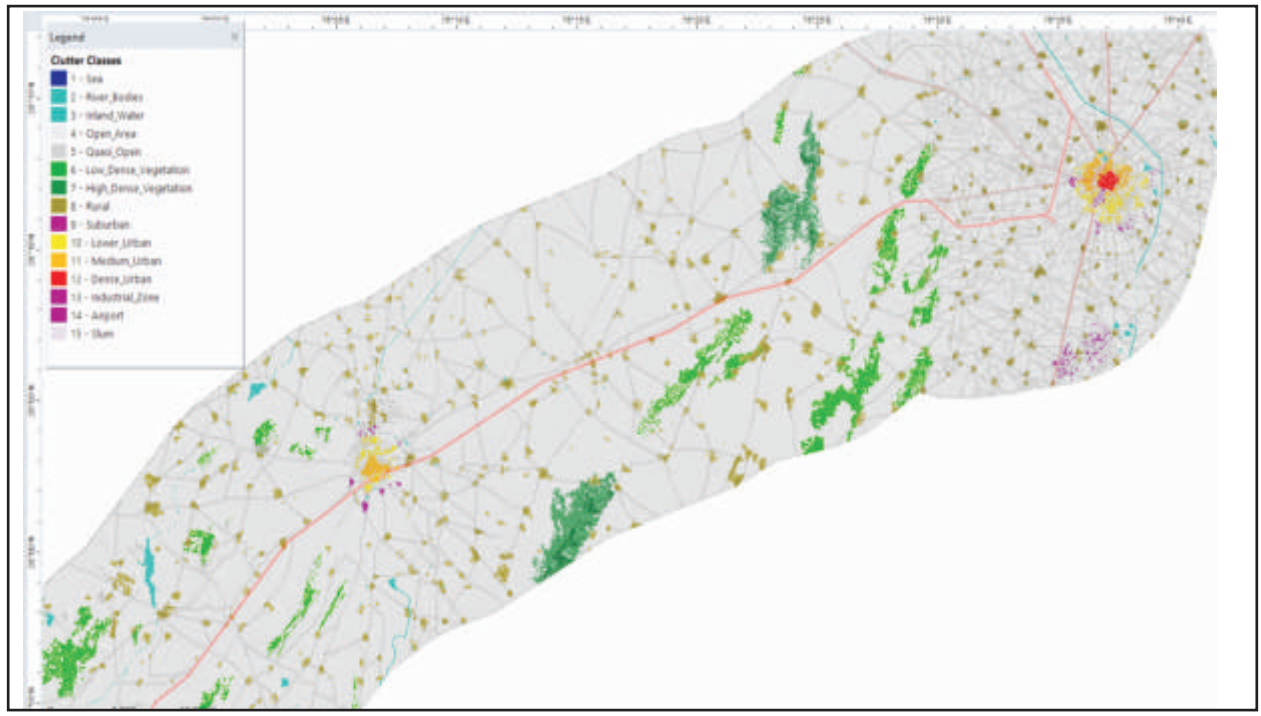


Figure 5: A Sample of She Digital Map Showing Clutter, Vector and Terrain

4.3 RF Planning Tool

The design was performed using a coverage prediction approach using the Atoll tool from Forsk (version 3.2.2). The tool uses various databases like the digital maps, the site database (site coordinates, antenna heights, the antenna patterns, antenna orientations etc.) and the propagation model to calculate the losses at each point in the digital map. These are converted to coverage and interference plots knowing the radiated power from each site. The losses at each point are calculated on the basis of a propagation model which is calibrated for the specific environment.

4.4 CW Testing and Propagation Model Calibration

CW measurements are performed to tune the propagation model so as to provide coverage predictions close to the real world environment. The way the signal propagates varies from environment to the other. The signal propagation will be different within an urban area and than in a rural setting.

Therefore, the first step is to identify the various types of environment that will be primarily encountered in the area of interest. For each representative area, CW measurements are performed at multiple locations along the route for each environment type to collect signal strength samples. All measurements are geo-referenced.

Signal samples so collected for various measurement points are imported into the radio planning tool and used to calibrate the model by tuning the K1, K2… coefficients within acceptable limits of statistical error (RMS mean error close to zero and standard deviation < 8 dB).

The following types of environments were identified along the track:

Open Flat Area: These are environments where the terrain is flat and there is little or no vegetation. There are few obstacles to signal propagation.

Urban and Industrial Zones: The environments in and around cities are classified and urban (low, medium and dense). The industrial areas have typical factory sheds, buildings or warehouses. Buildings close to the railway track create diffraction effects that cab affect signal propagation.

Hilly Areas: These are areas where there are low hills and some vegetation near to the railway track. Diffraction effects come into the play.

On the basis of this, a total of fifteen CW measurements locations all along the track were chosen cover these three environments to develop suitable models. Of these, six were in Open Flat, six in Dense Urban and three in Hilly areas.

The test set up consists of the transmitter connected to an omni-directional antenna on the transmit side. On the receive side, a receiver and GPS are connected to a data logging PC. The receive antenna and GPS antenna are mounted on the rooftop of the vehicle.

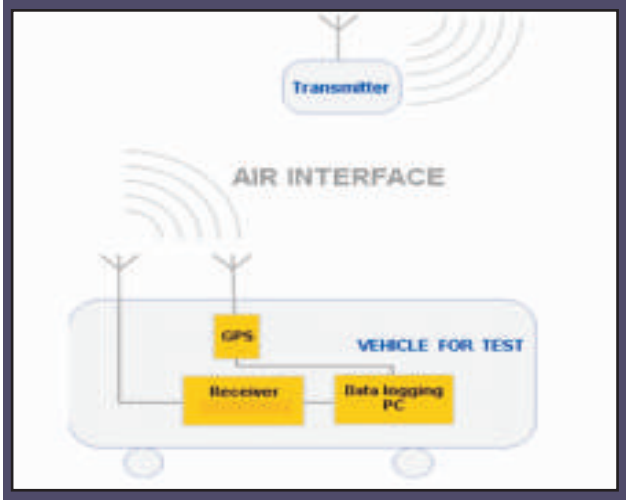


Figure 6:Test Set Up

Transmitter Side Equipment

- Windfreak Signal Generator 34.4 MHz – 4.4 GHz range
- Ophir High Power Amplifier Model 5803021A 500-1000 MHz with 20 watts output
- Laird Omnidirectional antenna with 8 dBi gain
- Commscope CNT 400 RF cable
- Boom Lift

Receiver Side Equipment

- Rohde & Schwarz Spectrum Analyser FSH4
- L-Com Magnetic Mount Antenna 698- 960MHz 3 dBi gain
- LMR 195 Low Loss Cable
- Garmin GPS 18x GPS receiver

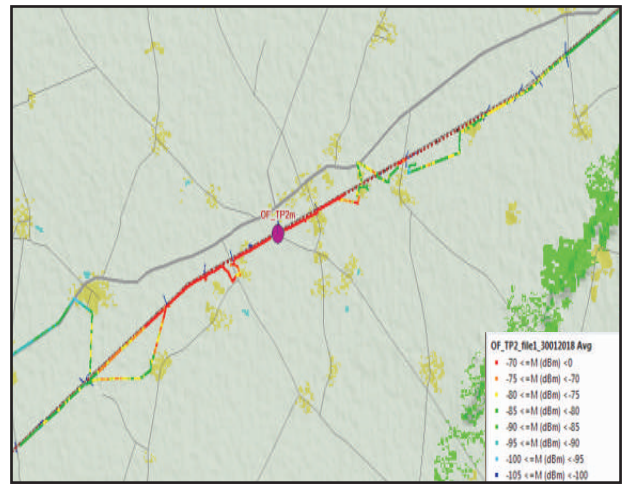


Figure 7: Sample CW Test Data for Measurement Test Point

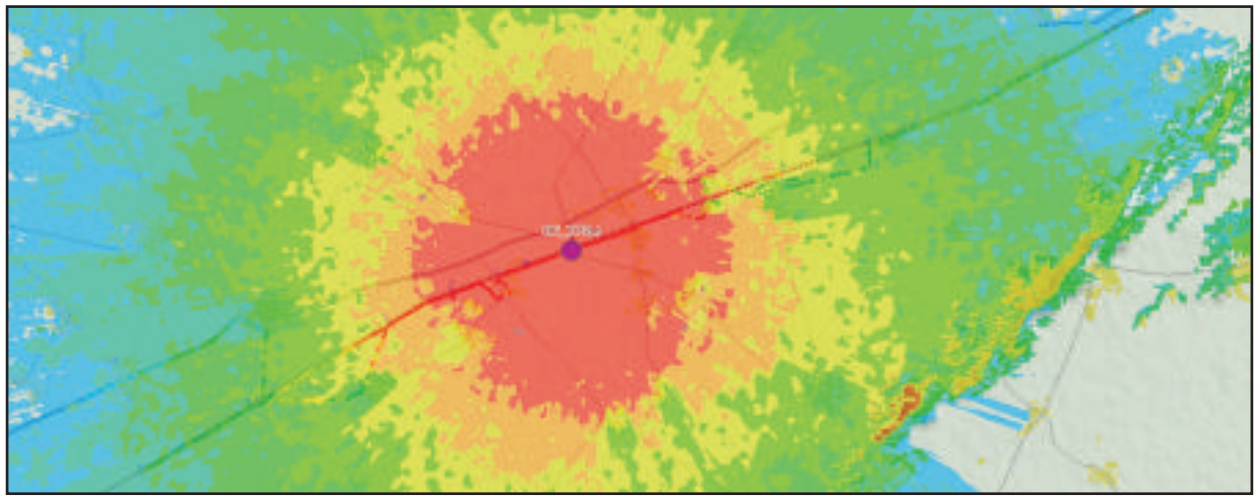


Figure 8: CW Measurements Compared With Predictions with Tuned Model

On the basis of the calibration procedure described above, three tuned models were developed to be used for railway projects in India:

- India_Model_2018_Open_Flat
- India_Model_2018_Dense Urban
- India_Model_2018_Hilly

4.5 Link Budget Definition

The link budget is used to compute the maximum path loss corresponding to a specific equipment configuration and application. It is based on a path loss calculation between the BTS (transmitter) and the mobile (receiver). Two path losses are calculated: the uplink path (Mobile to BTS) and the downlink path (BTS to Mobile).

The inputs needed to perform this calculation are organized in three categories:

- The general parameters (BTS related, antenna heights etc.) that will be independent of the kind of service.
- The parameters that will depend on the kind of service (e.g. mobile type).
- The engineering margins that will depend on the kind of service and the speed of the train and which ensure that the required QoS is met. The design requirements of maximum train speed etc are accounted for considering an overlapping margin herein.

  Useful outputs of the link budgets are the balanced EIRP (based on a link balance being maintained) and the outdoor minimum field required to meet the coverage objectives.

  Typically it is necessary to provide coverage to different types of mobile equipment configurations. In accordance with the equipment types defined and the service to be provided, the worst link budget is calculated and the worst case is considered.

  This means that if we dimension the link budget on the worst case, the requisites of the best case will be, obviously, satisfied.

  Two types of link budgets were developed to cater to the cab radio and handheld case.

4.6 Nominal RF Planning

GSM-R coverage is mostly linear and sites are located close to the railway track, and, at times some of the railway infrastructure is also reused.

The coverage for the entire DFCC track has been planned with a single radio layer with high degree of overlapping (to cater to the fault tolerant coverage requirement).

As mentioned earlier, the coverage design has been performed using Atoll (version 3.2.2). The BTS equipment chosen for the design was the BTS 9000 from OEM. Two types of cross polarised antennae were used for design purposes- a 20 dBi/ 30° beamwidth (80010456v02) and an 17.4 dBi/65° beamwidth (80010306 v02) from Kathrein.

4.7 BTS Coupling

The BTS is connected to a set of 2 sectorized antennas to provide a single cell within a BTS omni configuration. The resulting mono-cellular configuration with sectorized antennas avoids a handover beneath the site and improves the overall quality of service.

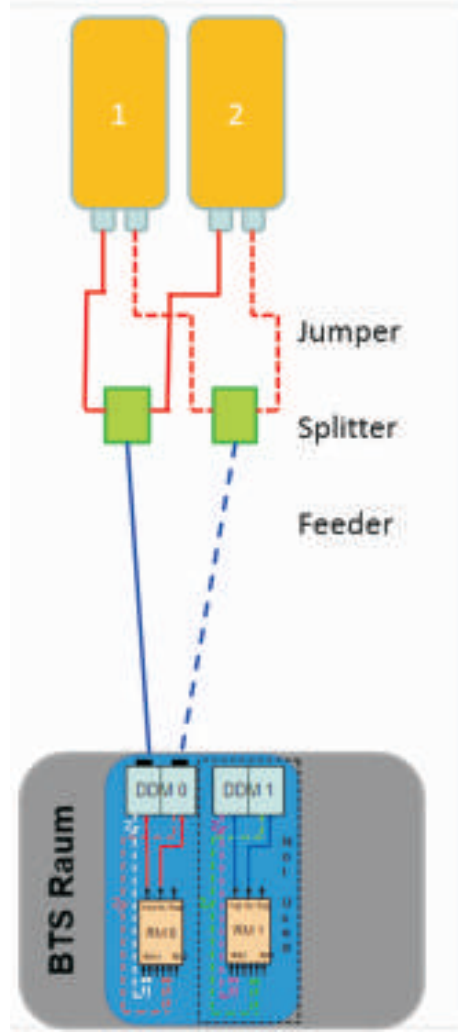


Figure 9: BTS Coupling Scheme

This ensures one unique cell within a BTS omni configuration (O1+1 or O2 with 2 TRX). Cross polarization diversity will be for the coverage of this line. The 2 antennas are set on each side of the tower and are connected to the 2 receiver paths of the BTS to ensure diversity reception (Rx main and Rx diversity).

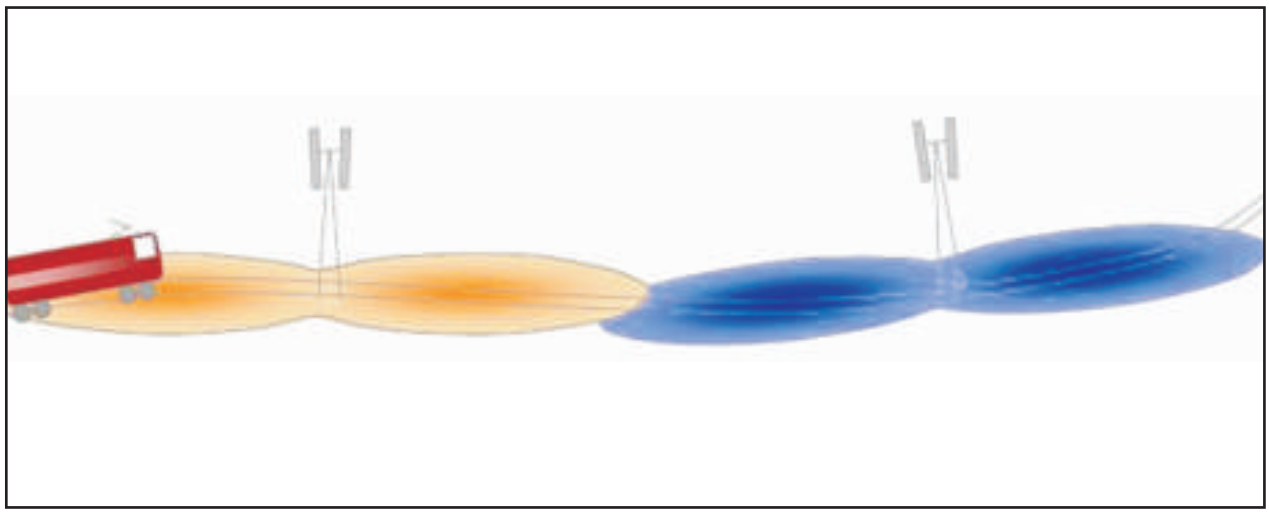


Figure 10: Coverage of Track Using Sectorized Omni Cells

4.8 Coverage Predictions

The design tool uses the digital map database in conjunction with the site database, transmitter database and the prediction model parameters to create an array of predicted coverage per bin for the entire digital map database. User defined variables are the site locations, antenna types and heights, antenna orientations and tilts. A sample of the coverage maps is shown below: it shows the cab radio coverage threshold (in green) and the handheld coverage (in red).

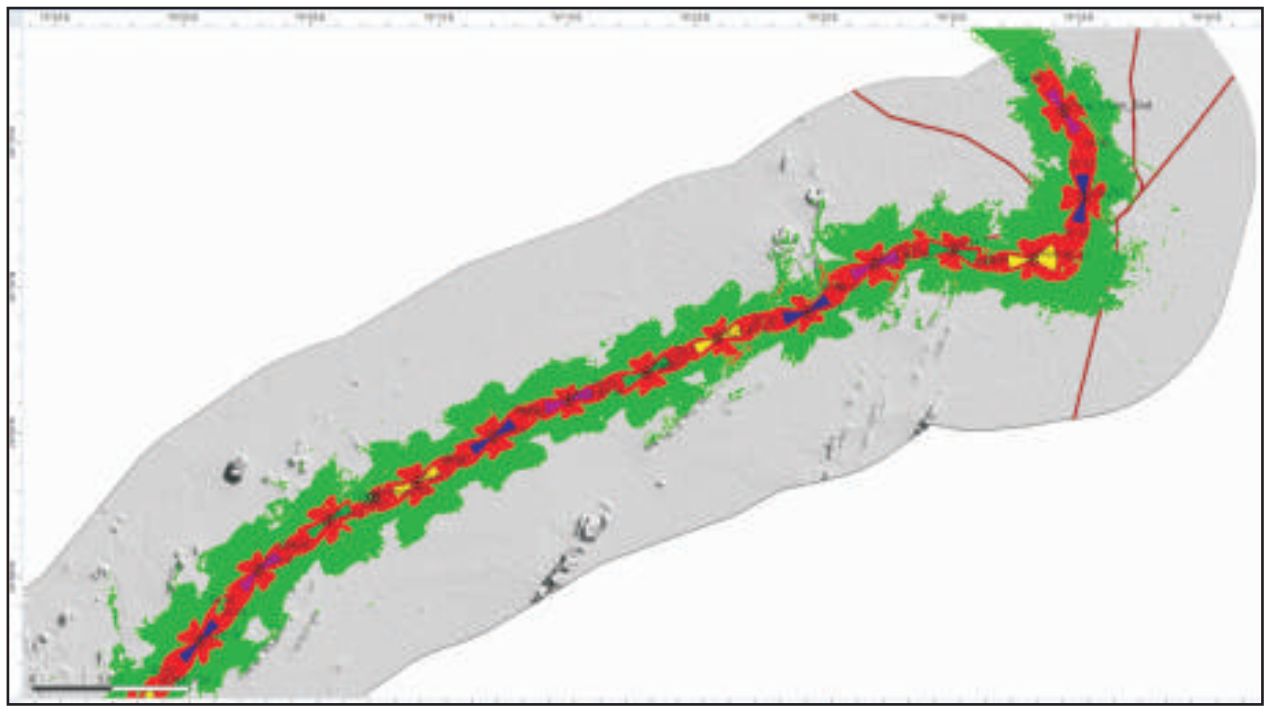


Figure11:Typical Coverage Plot for The WDFC Line

4.9 Frequency Planning

The objective of frequency planning is to allocate the channels in an efficient way to cater to the traffic requirements whilst minimizing the overall co-channel and adjacent channel interference in the network.

The frequency band allocated by the standardization body ETSI to GSM-R is [876 MHz – 880 MHz] in uplink and [921 MHz – 925 MHz] in downlink. The spacing between two consecutive channels is 200 KHz. Therefore 19 channels are dedicated to GSM-R.

As per the spectrum allocated to IR only 8 channels would be available in public GSM 900 MHz band. The goal of the frequency plan is to minimize the level of interference, as the same limited set of 8 radio channels is reused in the entire network.

ARFCN	Uplink	Downlink	ARFCN	Uplink	Downlink
89	907.8 MHZ	952.8 MHz	94	908.8 MHz	953.8 MHz
90	908.0 MHz	953.0 MHz	5	909.0 MHz	954.0 MHZ
91	908.2 MHz	953.2 MHz	96	909.2 MHz	954.2 MHz
92	908.4 MHz	953.4 MHz	97	909.4 MHz	954.4 MHZ

Table 1:DFCC Frequency Allocation

The frequency plan for the DFCC network will have a four cell reuse pattern. The eight frequencies allocated above were be grouped into four sets, with at least 400 KHz separation within a cell and between neighbouring cells. Each cell would have two allocations and hence two TRX's.

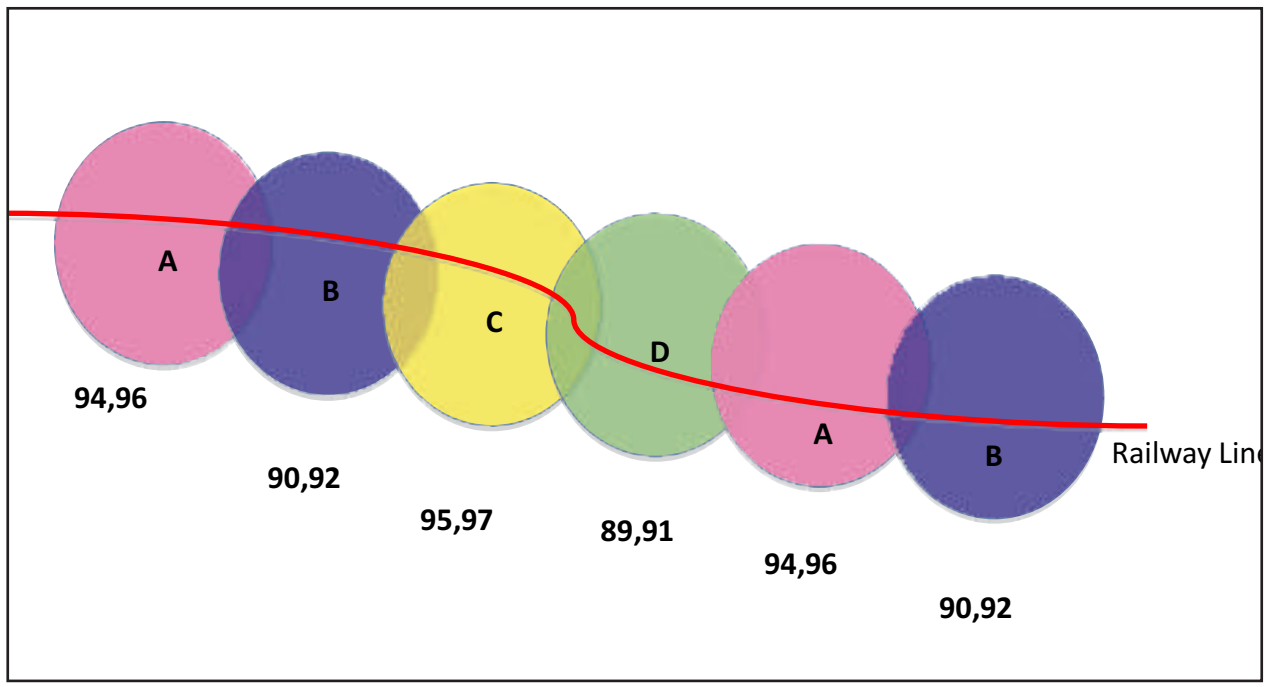


Figure 12: Frequency Reuse Plan

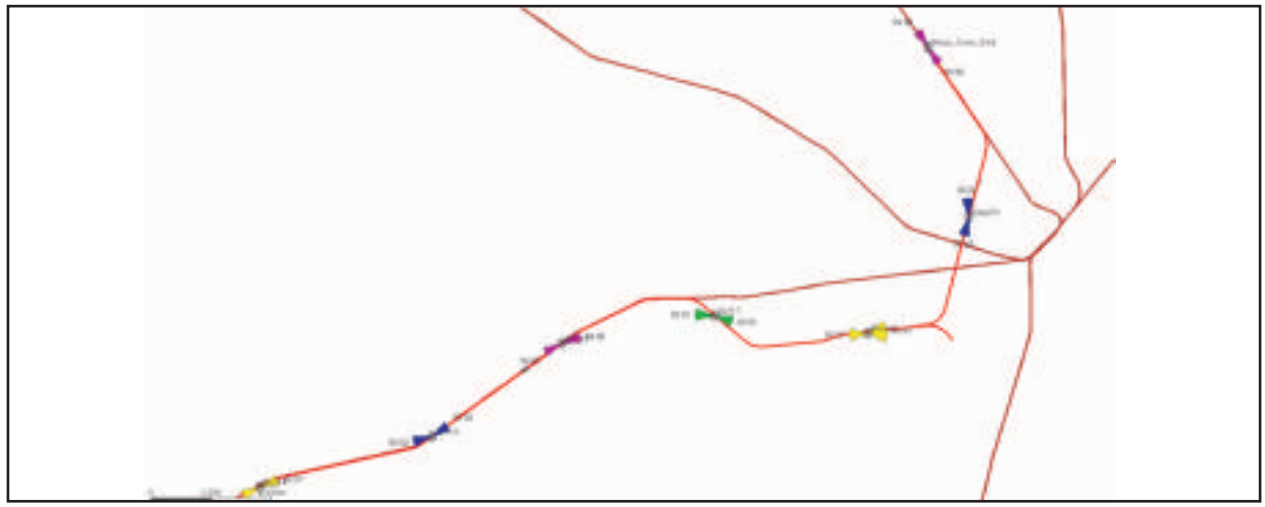


Figure 13: Frequency Plan on WDFC Line

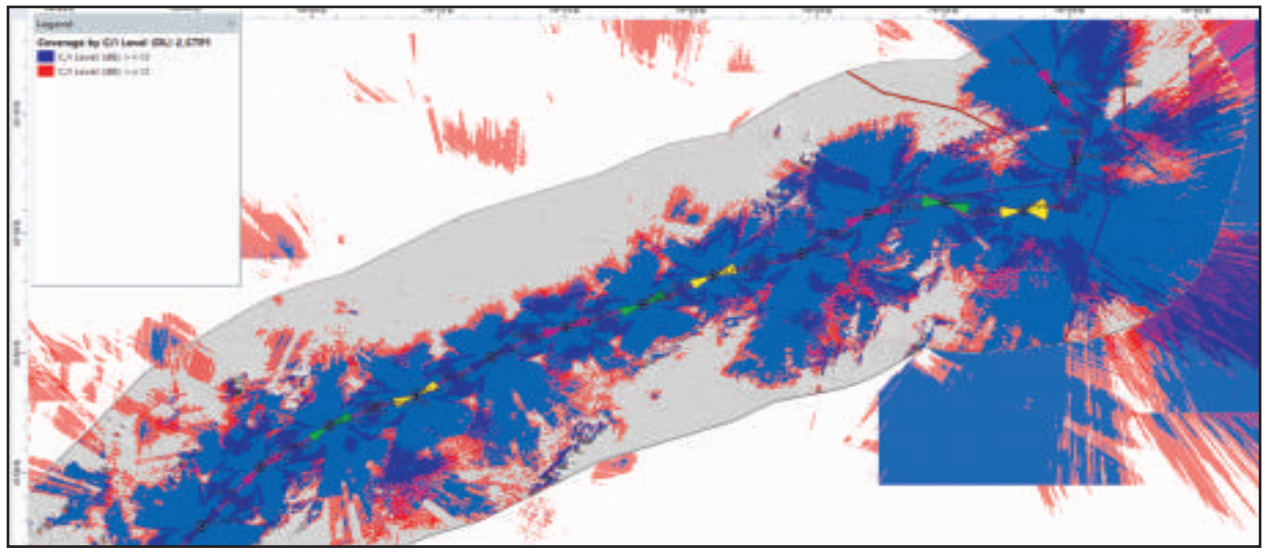


Figure 14: C/I Plot Sample

For ETCS implementation in the future, it is recommended that the frequency spacing within a call be 600 KHz and that between neighbouring cells in maintained at 400 KHz. Consequently, more spectrum will be required

5.0 Conclusion and Recommendations The design objectives for the DFCC network have been met with a core network comprising of an R4 MSC core, IN, GPRS nodes, OAM and BSC equipment slated for deployment at the OCC in Ahmedabad and a total of 172 sites (including the coverage of the OCC site). A substantial number of ALH (auto location huts) locations have been reused in the design, which will result in substantial CAPEX and OPEX savings. Tower heights have been maintained for the most part to be below 40 metres (with maximum tower height limited to 35 metres). The calibrated models developed for the STP5 network design will help in designing future networks of the DFCC GSM-R networks in India. Since the WDFC network is ETCS Level 2 ready, the network can be easily used for piloting the same, provided, more spectrum is made available, in the same band.

Technical Paper on Execution of Earthwork in DFCC CTP 14 Project

Devinder Kumar
GM/Civil/Noida

SYNOPSIS:
The paper includes the process adopted for earthwork in CTP 14 Project draws upon the experience and developments in other parts of the India in order to pass on the right and adequate knowledge to the field engineers concerned with construction aspects. It is particularly encouraging to see the right emphasis on quality control by incorporation of the details of field tests and various formats and proforma through which quality can be monitored at different levels.

This paper also elucidates the use of NDG and the terminologies related to the same. Also, the working as well as procedure for operating the equipment along with appropriate safety measures and regulatory framework have been described in detail. The sources which have been referred to have been mentioned in the end.

1. Background of the Project :

Dedicated Freight Corridor Corporation of India (DFCCIL) is a Special Purpose Vehicle set up under the administrative control of Ministry of Railways to undertake planning & Development, mobilization of financial resources and construction, maintenance and Operation of the Dedicated Freight Corridors. DFCCIL was incorporated in October 2006 Under Indian Companies Act 1956.

Under the Eleventh Five Year Plan of India (2007–12), Ministry of Railways is constructing a new Dedicated Freight Corridor (DFC) in two long routes namely, the Eastern and Western freight corridors. The two routes covers a total length of 3,360 kilometers (2,090 mi), with the Eastern Dedicated Freight Corridor stretching from Ludhiana in Punjab to Dankuni in West Bengal and the Western Dedicated Freight Corridor from Jawaharlal Nehru Port in Mumbai (Maharashtra) to Dadri in Uttar Pradesh.

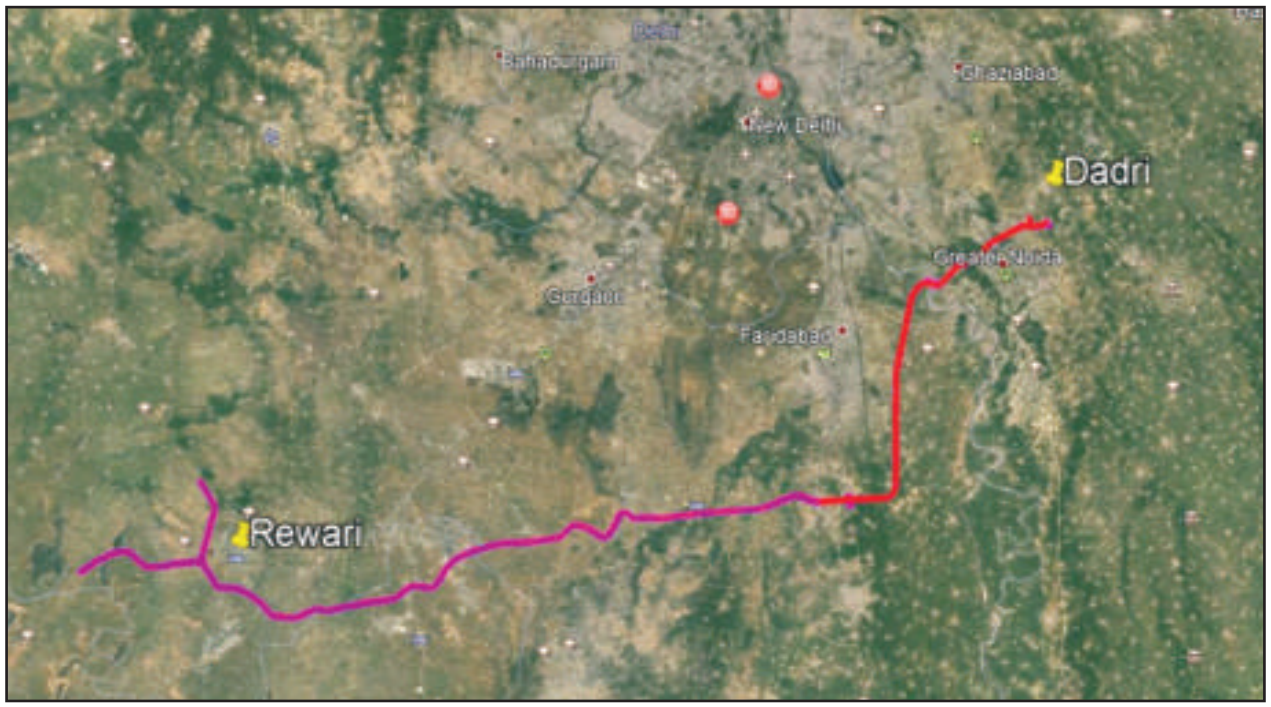
Upgrading of transportation technology, increase in productivity and reduction in unit transportation cost are the focus areas for the project.

The Western Dedicated Freight Corridor covers a distance of 1504 km of double line electric (2 X 25 KV) track from JNPT to Dadri via Vadodara-Ahmedabad-Palanpur-Phulera-Rewari. Alignment has been generally kept parallel to existing lines except provision of detour at Diva, Surat, Ankleshwar, Bharuch, Vadodara, Anand, Ahmedabad, Palanpur, Phulera and Rewari. The Western Corridor passes through 5 states as

follows:-Uttar Pradesh, Haryana, Rajasthan, Gujarat, and Maharashtra

However, CTP 14 projects generally known entirely on a new alignment from Rewari to Dadri. The Western DFC is proposed to join Eastern Corridor at Dadri. Junction Stations between the existing railway systems. Which is passing through the different states as Haryana, Uttar Pradesh, and Rajasthan which involves the total alignment length of 128KM from Rewari (Haryana) to Dadri (Uttar Pradesh) .

Integrated Contract Packages of Design and Construction of Civil, Building and Track works for Double Line Railway involving Formation in Embankments/ Cuttings, Bridges, Structures, Buildings, Ballast on Formation and Track works, Design, Supply And Installation of 2x25 kV Traction Power Supply System, Traction Sub-Stations, Auxiliary Stations, Switching Station, Auto Transformer Station And SCADA System and Design and Construction of Signal and Telecom Works For Double Line Railway involving Train Detection System, Electronic Interlocking in Stations, Block Proving With Axle Counters, Intermediate Blocking Signals (IBS), Train Monitoring & Diagnostic System (TMS), Dispatch Telephone System, Fiber Optic Communication System, GSM(R) System, Digital Electronic Exchange System and Master Clock System including Testing and Commissioning on Design-Build Lump Sum Price Basis For Rewari – Dadri Section of Western Dedicated Freight Corridor Package CTP-14.



Location Plan Showing the alignement of ctp 14 project

2 Scope of the Project (Up to Formation Level) :

Sr. No	Item Description	Unit	Quantity
1	Total Fill (Embankment + SG)	Lac Cum	276.78
2	Embankment	Lac Cum	251.9
3	Subgrade	Lac Cum	24.88
4	Cut	Lac Cum	40.56
5	Blanketing	Lac Cum	12.97

WDFCC CTP-14 is green filed project having green filed alignment passing through National Capital Region. The entire alignment has detour and is passing through low laying area and hilly area of Aravalli. Due to this, the height of the embankment fill is very high i.e. having maximum height of embankment is 25.00 m. The Alignment details with respect to height is mentioned in table no. For the reason that, quantity of earthwork is very high.

3 Planning and Procedure for Execution of Earthwork:

A) Survey:- Following are the steps involved for survey work

a) **Fixing of control points** – During the commencement of the any works we need to fix the control points as TBM, and TBM traversing with the help of Global Position System (GPS) Machine) for proper Execution.

b) **Alignment Verification** – During the Alignment verification all the information is gathered as given below-

i) ROW validation

ii) Existing Road Level Checking

iii) Utilities (PHED – Drinking water, Sever, Electric Lines Etc.)

iv) Hindrances (Pond, Valley, River, Mountain Etc.)

c) **Centre Line Verification –**

i) After Finalizing the Alignment, Centerline of the proposed track is given on the Natural Ground for execution work.

ii) Original Ground Level Recording – After Giving the center lines of the proposed track original and conducting the C&G original Ground level are recorded.

d) Level and Centre Line Checking- Centre lines and Level is checked after every 4th layers to get rid of mis - alignment and proper thickness of soil dumping and compaction.

B) Borrow area selection: Following process are adopted for the selection of Borrow area.

a) **Identification of Borrow area**: Execution works of earth works starts with the selection of the borrow area by connecting with the local peoples /Contractors around the alignment and liaison with them for Smooth progress and easily availabilities of the Soil in Crops seasons as per CA norms.

b) **Document collection of borrow area**: After Finalizing the land, all documents are collected from owner of the land as given below –

1. Jamabandhi / Khatuni
2. Location and Transportation map
3. Land Agreement
4. ID Proof of Land Owner
5. Royalty and Mining Approval

After Collection of documents, these are submitted to Engineer's for review and No Objection for Borrow area sampling.

C) Sampling of soil: After submitting the all documents of Borrow area to engineer, a request for witnessing borrow area sampling is raised as per CA and sampling is done accordance with the reference standards i.e. – RDSO - GE -14. Sample are collected as per frequency given below and sealed as per Engineers discretion.

Table No 1 : Frequency of Sampling

S.NO	Type of Material	Frequency	Reference \Standard
1	Embankment	5000 Cu. M/ Sample	Vol III of CA and RDSO GE-14
2	Subgrade	2000 Cu. M / Sample	Vol III of CA and RDSO GE-14
3	Blanket	500 Cu.M /Sample	Vol III of CA and RDSO GE-14

D) Quality Assurances test Conducted at Laboratory: After the sampling of Borrow Area, Samples are sent to in house laboratory and samples are opened in the presence of the Engineers representative. Following tests are conducted on each sample to check the suitability of sample.

Table No 2 : Name of Test Conducted in In House Laboratory and Number of Tests required for the CTP 14 Projects

(A)	SOIL TESTS	Reference IS Code	Testing Frequency		No of Test To be Perform as per Scope of the Project	
					For Embankment Fill	For S/G Fill
1	Grain size Analysis	As per Part-4	For Embankment Fill @1 test for 5000cum Soil Qty.	For S/G Fill @ 1 test for 2000 cum Soil Qty.	4940	2900
2	Atterberg Limit (LL/PL)	As per IS 2720, Part-5			4940	2900
3	Free swell index (FSI)	As per IS 2720, Part-40			4940	2900
4	Proctor density test (MDD & OMC)	As per I S 2720, Part-8			4940	2900
5	CBR Test	As per IS 2720, Part-16			4940	2900
6	Direct Shear test	As per IS 2720, Part-13	1 test per source/ As required		500	100
7	Bulk density test of Soil/Sand	As per IS 2386, Part-3	As per site requirement		500	
8	Sand pouring cylinder calibration	As per IS 2720, Part-28	As per site requirement		500	
Remark:	**Direct Shear Test conducted for each Embankment & S/G Filling above 3.0m height (1 test for each source/As required)**					

E) Infrastructure of Material Testing Laboratory:

There are Four Nos of Material Testing laboratories are established throughout project alignment (Rewari-Dadri) at different locations which are fully equipped with latest techniques lab equipment and trained technicians. A table given below elaborated the location, Capacity of Lab in terms of No. of test & in terms of quantity. All the Laboratories have facility for various Soil test which includes Grain Size Analysis, Atterberg's Limit, Free Swell Index, Maximum Dry Density, California bearing Ratio & Direct shear Test. Apart from this, Laboratories are equipped with testing facility of Cement, Concrete & Concrete ingredients, Blanket, Ballast, curing tank with temperature control.

Apart from Inhouse testing facility, Contractor also has alliance with 12 Nos of external Laboratories to accommodate the Quality Assurance for testing of soil.

Table No 3: In house Testing Laboratory set up

Location	Capacity of lab in terms of No of test/day for soil	Capacity of lab in terms of Quantity in Cu.m for soil
Daruhera at DFCC Ch 28+020.RHS	5	25000
Sohna at DFCC Ch.73+300 RHS	6	30000
Prithla at DFCC Ch 93+460 LHS.	8	40000
Dadri at DFCC Ch. 139+300 RHS	5	25000

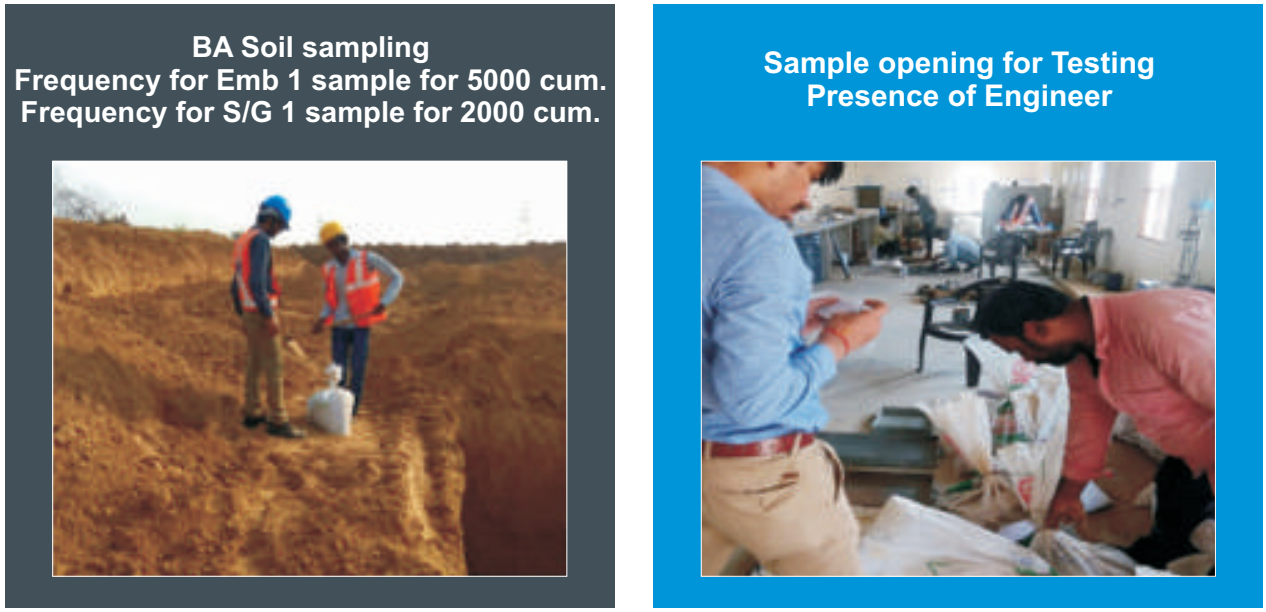


Fig 1. Sampling of Soil from Borrow Area

Fig 2 & 3 In house Testing Facility for Testing of Soil Samples

F) Construction Operation:

a) **Clearing and Grubbing of Natural Ground:** Cleaning of the natural ground is carried out for removing the Roots bushes branches, organic and all types of substance except Soil from ground. Prior to start of activity of C & G, Natural ground levels are jointly recorded. After the completion of C & G, final levels are taken at Original ground level to ensure depth of C & G and further calculation of embankment height as per Plan and profile

b) **Second Step Plat Load Test on OGL:** Before starting the any dumping activity second plate load Test (EV2) are conducted for verification of the soil bearing capacity for earthwork.

i) **Second Step Plat Load Test :** It is required to be conducted in-situ for measurement of strain modulus EV2 of sub-soil,compacted emabankment fill ,prepared subgrade ,blanket etc. at the frequency of 1 test per km of the section as per clause 13.1(C) of guidelines and specifications for design of formation for Heavy Axle load – Report No. RDSO/2007GE: 0014.This practice in German railways and recommended by UIC Code : 719 to measure the quality of earthwork and blanketing after compaction.

Second Step Plat load test is works on Following three concepts.

- **Plate Loading Test :** Test in which load is applied in increments to a soil sample using a circular loading plate and a loading device, released in decrements ,and the entire process is repeated .The average normal stress below the plate is plotted against the settlements ,for each load increment so as to obtain a load settlement curve.
- **Strain Modules:** The strain modulus EV, is a parameter expressing the deformation characteristic of a soil and is calculated taking values from the load settlement curve.
- **Modules of Subgrade Reaction:** The modulus of subgrade reaction, KS is a parameter expressing the elastic reaction of soil under a surface load. It is determined on the basis of load settlement curve obtained from the first loading cycle.

Table No 4 : Specification requirement and frequency of Ev2 Test
As per Chapter 5 of Volume 3A of ER specification

Description	Minimum Requirement as per CA	Frequency of Test as per CA
Subsoil	20 KN/Sq.m.	1 Test per KM
Embankment Top Layer	30 KN/Sq.m	1 Test per KM
Subgrade Top Layer	60 KN/Sq.m	1 Test per KM
Blanket Top Layer	120 KN/Sq.m	1 Test per KM

Fig 4 : Second Step Plat Load Test (Ev2) Conducted on Sub Soil

c) Compaction of Earth dumped- After getting the Approval from the Engineer, dumping is started from borrow area. Compaction Procedure includes dumping, spreading of soil by means of motor grader, sprinkling of water up to Optimum moisture content as derived in laboratory and compacted by mechanical means as Roller. Good Supervision is required during the compaction for proper count of the No. of passes required for compaction as per Trial patch data.

Fig 5: Dumping of Soil From Borrow Area

Fig 6: Spreading of Soil

Fig 7: Watering of Soil

Fig 8: Rolling for Compaction of Soil

d) Field Density Testing of Compacted Layer: After the rolling operation is completed, the compacted layer shall be checked to measure the amount of compaction achieved during construction. There are various methods are stated in the "GE -1 Guideline for the Earthwork in Railway Projects" namely,

- Sand Replacement Method
- Core Cutter Method
- Nuclear Density Gauge (May be Used as consultation with RDSO)
- Compacted Meter fitted on Roller (May be Used as consultation with RDSO)

Sand replacement method is commonly used to check the in-situ density of soil. However SRM method of testing is very time consuming, CTP 14 project is using Nuclear Moisture Density Gauge (NMDG) after getting approval from RDSO.

- **Sand Replacement Method (SRM):** The basic principal of sand replacement method is to measure the in-situ volume of hole form which the material was excavated from the weight of sand with known density filling in the hole. The in-situ density of material is given by the weight of the excavated material divided by the in-situ volume.
- **Nuclear Moisture Density Gauge (NMDG):** Nuclear moisture/density gauges are testing devices that use low level radiation to measure the wet density, dry density, and moisture content of soil and granular construction materials.

This work procedure has been adopted to determine the percentage of compaction and Moisture content of compacted layer as per ASTM D2922 AND ASTM D 6938-10.

This test is required to conduct in site for measuring degree of compaction and moisture content of compacted layers of embankment, prepared subgrade, Blanket layer etc. This test has been included as a future developments for quality assurance test on compacted surface.

The purpose behind using Nuclear Density Gauge can be attributed to the fact that it is a faster method than sand replacement method and can be used at sites where there is a huge quantity of earthwork involved.

This paper elucidates the use of NDG and the terminologies related to the same. Also, the working as well as procedure for operating the equipment along with appropriate safety measures and regulatory framework have been described in detail. The sources which have been referred to have been mentioned in the end.

The NMDG works on following concept.

The radioactive sources in NDG's are always emitting radiation. When the NDG is not making readings, the source must always be retracted to the "Safe" position, with the source secured inside the tungsten shielding block.

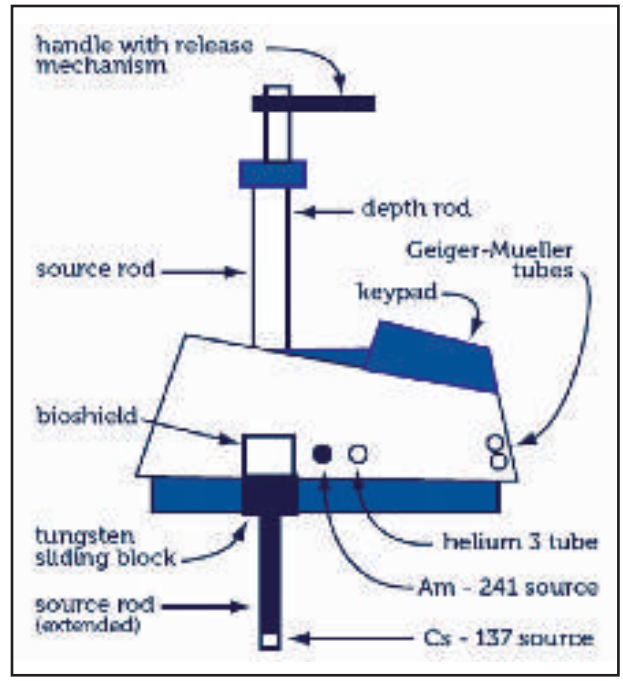


Figure 9 : A diagrammatic representation of the major parts of an NDG

Wet density is measured using a Cesium 137 (Cs-137) gamma radiation source, a pea-sized pellet fixed in the bottom of the source rod, and two Geiger-Muller tube gamma detectors at the rear of the gauge. The Cesium gamma source is lowered to the desired test depth by releasing the handle. When the test is started, the detectors in the gauge record the count rate of the radiation transmitted directly through the soil layer, displaying wet density readings on the keypad. A more dense material absorbs more gamma radiation, resulting in a lower gamma count reading, which converts to a higher wet density value. The volume of material assessed include the material between the source and the detectors, but the actual volume is not precisely known (refer to Figure 10).

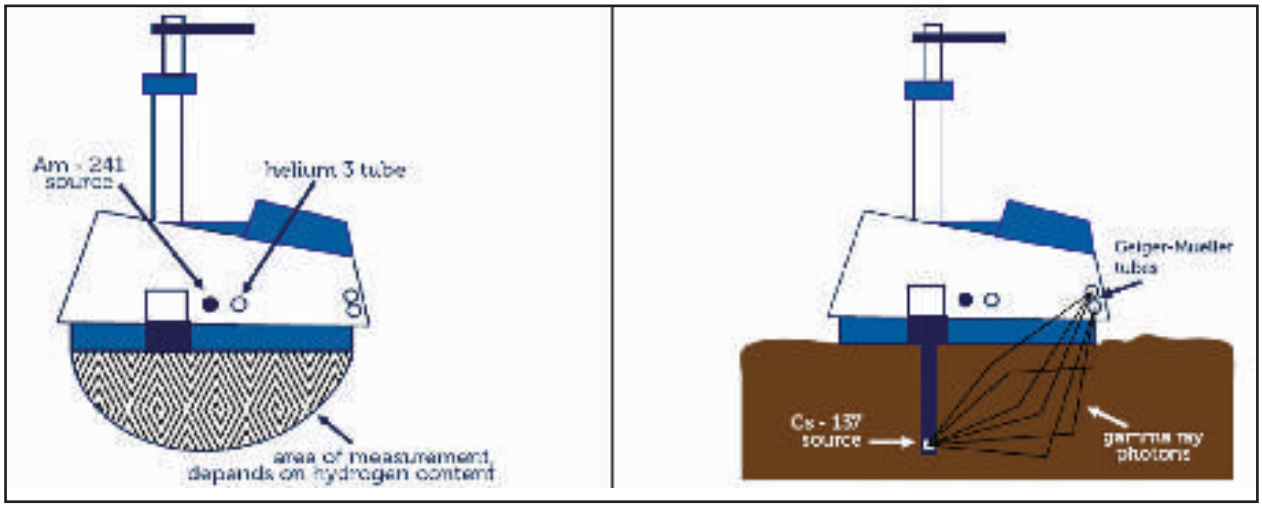


Figure 10 : The NDG operating in indirect transmission (left) and (right) direct transmission mode

In direct transmission mode the NDG determines an average density from the source rod to the gauge, if the NDG is not seated properly and an air gap exists (which has a zero density) the average wet density is reduced proportionally. If the gauge cannot be seated on a flat surface, fines from the measurement layer or dry sand passing 600 µm must be used to provide a complete seal between the NDG base and the surface being tested.

Moisture content is measured using an Americium-241 /Beryllium (Am-241/Be) neutron radiation source that releases high-energy neutrons. These 'fast' neutrons are slowed by interaction with the hydrogen atoms. A 'cloud' of slow neutrons forms around the gauge, passing through a Helium 3 tube detector. This detects only the count rate of the 'slow' neutrons. The neutron source is fixed inside the gauge base, with the detector beside. A wetter material will slow a greater number of neutrons, and also reduce the zone of influence into the material (refer to Figure 4). Not all hydrogen atoms are in water molecules, the mineralogy of the material being testing may contain hydrogen. The moisture content determined by the NDG can be used as a guide but is not accurate and should never be used in further calculations or reporting.

Radioactive sources decay over time, producing lower raw count levels. The field counts must be standardized by comparison with the 'Standard Count', taken using a standard setup. All calculations and processing of results uses the count ratio, the field count divided by the standard count. This applies to both density and moisture systems.

The radiation systems of the NDG provide indirect measures of wet density and moisture content. The systems (the count ratio response) are calibrated against blocks of known wet density and moisture content, prior to use of the NDG in the field. The maximum calibration interval is two years.

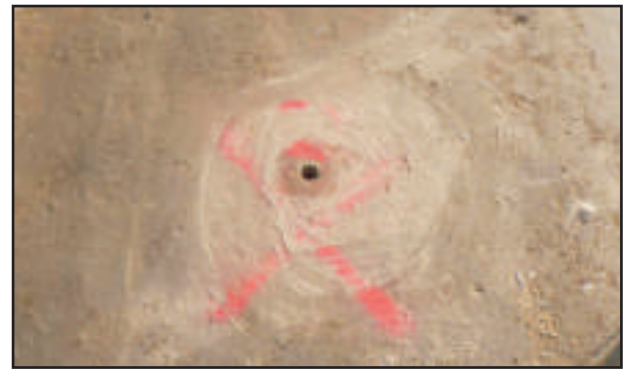
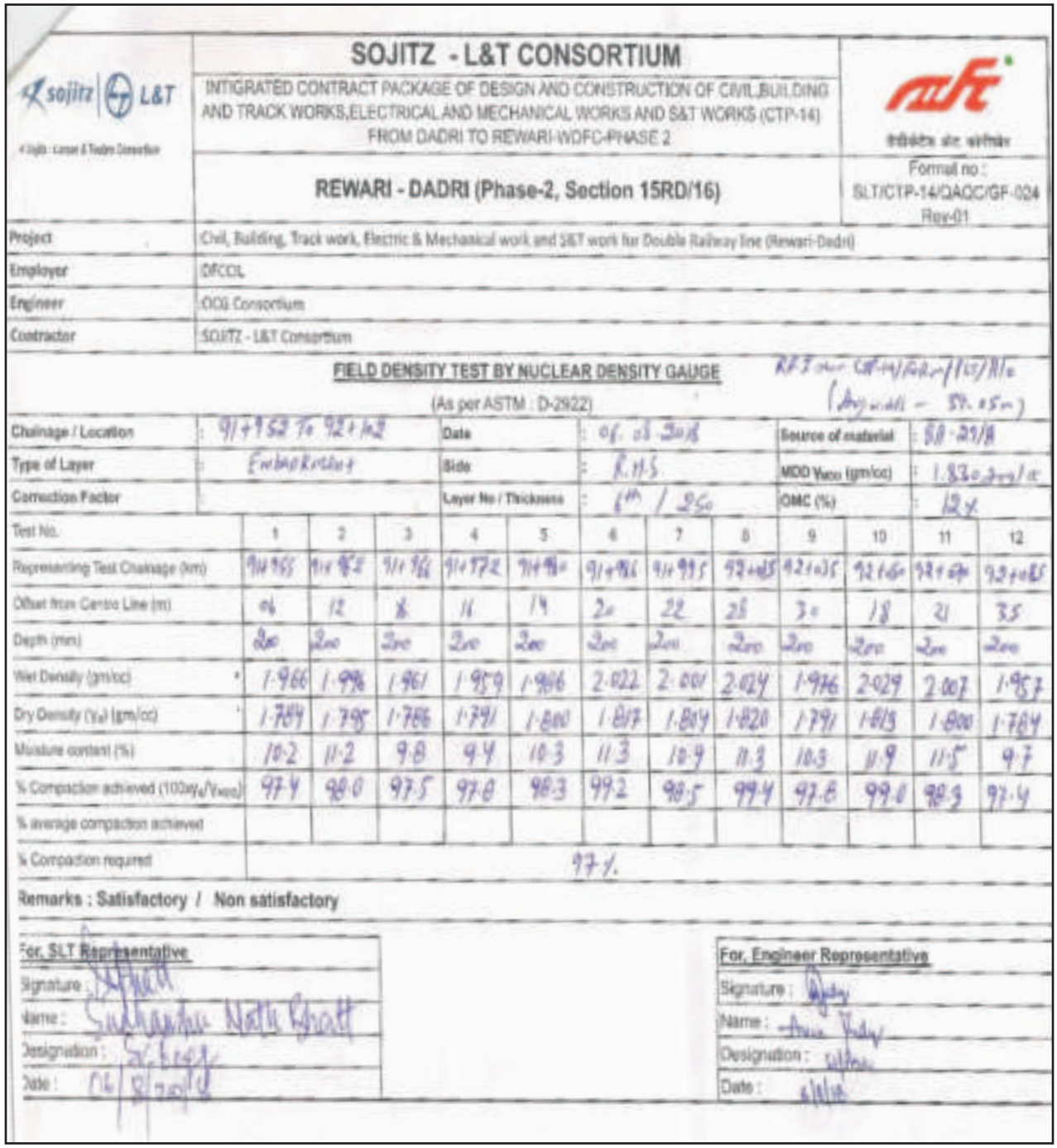


Figure 11: The site for the NDG must be flat and the hole prepared such that it is circular

Figure 12 : Checking of compaction of soil by using Nuclear Density Gauge



SOJITZ - L&T CONSORTIUM

INTIGRATED CONTRACT PACKAGE OF DESIGN AND CONSTRUCTION OF CIVIL,BUILDING AND TRACK WORKS,ELECTRICAL AND MECHANICAL WORKS AND S&T WORKS (CTP-14) FROM DADRI TO REWARI-WDFC-PHASE 2

REWARI - DADRI (Phase-2, Section 15RD/16)

Format no : SLT/CTP-14/QAQC/GF-024 Rev-01

Project	Civil, Building, Track work, Electric & Mechanical work and S&T work for Double Railway line (Rewari-Dadri)
Employer	DFCCIL
Engineer	OCG Consortium
Contractor	SOJITZ - L&T Consortium

FIELD DENSITY TEST BY NUCLEAR DENSITY GAUGE

(As per ASTM : D-2922)

Chainage / Location	: 91+952 To 92+142			Date	: 06.03.2018			Source of material	: SB-29/A			
Type of Layer	: Embankment			Side	: R.H.S			MDD γ_{max} (gm/cc)	: 1.820 gm/cc			
Correction Factor	:			Layer No / Thickness	: 6th / 250			OMC (%)	: 12%			
Test No.	1	2	3	4	5	6	7	8	9	10	11	12
Representing Test Chainage (km)	91+965	91+982	91+996	91+972	91+986	91+986	91+995	92+035	92+035	92+160	92+070	92+085
Offset from Centre Line (m)	06	12	18	11	19	20	22	28	30	18	21	35
Depth (mm)	200	200	200	200	200	200	200	200	200	200	200	200
Wet Density (gm/cc)	1.966	1.996	1.961	1.959	1.996	2.022	2.001	2.024	1.976	2.029	2.007	1.957
Dry Density (γ_d) (gm/cc)	1.784	1.795	1.786	1.791	1.800	1.817	1.804	1.820	1.791	1.813	1.800	1.784
Moisture content (%)	10.2	11.2	9.8	9.4	10.3	11.3	10.9	11.3	10.3	11.9	11.5	9.7
% Compaction achieved ($100\gamma_d/\gamma_{max}$)	97.4	98.0	97.5	97.8	98.3	99.2	98.5	99.4	97.8	99.0	98.3	97.4
% average compaction achieved												
% Compaction required	97%.											

Remarks : Satisfactory / Non satisfactory

For, SLT Representative	For, Engineer Representative
Signature :	Signature :
Name : Sudhanshu Nath Ghosh	Name : Arun Yadav
Designation : Sr. Engg	Designation : Engineer
Date : 06/3/2018	Date : 6/3/18

Figure 13: Test report of Field Dry Density by Nuclear Density Gauge.

G) Blanket :

a) Material Properties: The Blanket material should be coarse granular, hard and well graded and satisfying following.

- Cu > 7 and Cc between 1 and 3
- Fines (Passing 75 micron) – 3% to 10 %
- Los Angeles Abrasion Value < 35 %
- Minimum required soaked CBR value 25 of the blanket material compacted at 100 % of MDD

• Size gradation percentage shall be within the range as specified below,

Sr. No	IS Sieve Size	Percent Passing (By weight)
1	40 mm	100
2	20 mm	80 – 100
3	10 mm	63 – 85
4	4.75 mm	42 – 68
5	2 mm	27 - 62
6	600 micron	13 – 35
7	425 micron	10 -31
8	212 micron	6 – 22
9	75 micron	3 -10

Particle size gradation curve shall be within the enveloping curve of blanket material as shown in figure 9 of "Guideline and Specification for Design of formation for Heavy Axle Load" Report No RDSO/2007/GE: 0014 published by RDSO.

• Filter criteria should be satisfied with subgrade layer as given below.

- Criteria – 1: D15 (Blanket) < D85 (Subgrade)
- Criteria – 2: D15 (Blanket) > 4 to 5 X D15 (Subgrade)
- Criteria – 3: D50 (Blanket) < 25 X D50 (Subgrade)

b) **Frequency of Material Testing: One set of test for every 500 Cum.**

c) Selection of Blanket Material: Proper survey of area close to Embankment site, at different locations needs to be carried out to identify suitable sources for blanket material required. Aim of such source identification survey is to be use naturally available material, which is cheap and conform to the specification laid down.

If naturally available material do not meet the desired specification, blanket material can be produced by mechanical process from crushing or blending method or combination of these two methods.

d) **Mechanical produced Blanket Material:** Course and Fine aggregate produce in the crusher plan are blended in the mechanical pugmill. The proportion of the coarse and fine aggregate is established in the laboratory. The pugmill shall be calibrated as per proportion established in laboratory before starting production from pugmill.

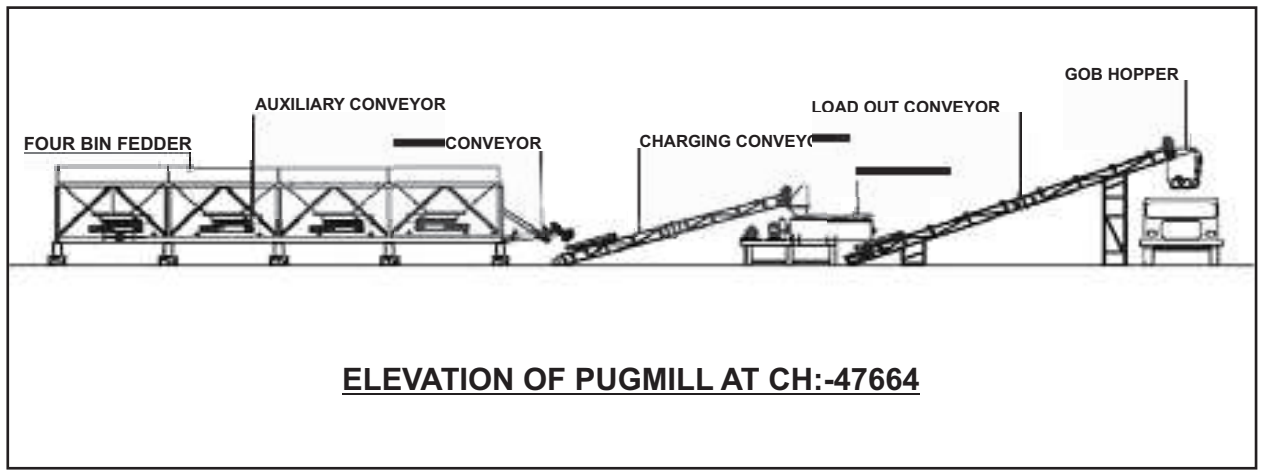


Figure 14: Elevation of Pugmill

Figure 15: Pugmill located at Ch. 47 + 647 Km

H) Challenge Facing:

a) Total scope of earthwork is 2.75 Crore cum. Getting this much amount of suitable soil for the embankment fill is a real challenge for the project as the alignment is passing through National Capital Region (Mewat, Dharuhera, Faridabad, Noida) and industrial area of RIICO and Faridabad.

b) Moreover, farmers are taking crop for all four seasons, local people are not ready to give their land for the excavation of soil.

c) Due to opening of upcoming large infrastructure projects in nearby vicinity of the alignment of CTP 14 particularly in Rewari, Sohna and Prithla area, land-owners are not ready to lease the land to extract the soil considering expected higher rate of the soil in future , which creating problems in progress.

d) From DFC CH No. 131+000 to end the chainage of this project, as our alignment is passing near to NOIDA DEVELOPMENT AUTHORITY, we are finding difficulties to excavate the soil within 15 km of radius as most of the land comes in the Noida Authority. So, we are going beyond that, which increases the leads from alignment causes less productivity.

I) Lesson of Learning:

We have huge amount of earthwork quantity in our project. For the approval of compacted layers, we initially opted the methods of sand replacement method as mentioned in our GE-01 as per RDSO guidelines which is time taking and tedious job. So, we opted another method i.e. Nuclear Moisture Density gauge which took very less time to check our compacted soil beds. But for this, we waited almost 6 months for getting the approval from RDSO. That causes lagginess in our project.

The purpose behind using Nuclear Density Gauge can be attributed to the fact that it is a faster & accurate method than sand replacement method and can be used at sites where there is a huge quantity of earthwork involved.

So, it should also be included in our RDSO guideline, so that Future DFCC Projects don't need any kind of approval from RDSO and testing with NMDG can start from the initiation of the project.

NETWORK STATEMENTS IN EUROPEAN RAIL TRANSPORT SECTOR – A GATEWAY TO TRACK ACCESS CHARGES

Mrs. Ramaaah Deviie G.V.
GM/F/CF

SYNOPSIS:
Apart from being the first of its kind in India to construct fully dedicated track corridors for freight transport, DFCCIL also has the unique task as Infrastructure Manager (IM) to assess the charges to its tracks accessed by Railway Undertakings (RU). While Indian Railways will be the only RU in the present scenario of single operator regime, non-discriminatory access to all the Railway Undertakings will be the norm in a multi-operator regime of the future. Multi-operator regime already exists in European Union (EU) where RUs for both passenger and freight transport services enter into individual agreements/contracts with the IMs based on the guidelines issued by RailNet Europe (RNE).

TGV Train of SNCF (France)

RAILNET EUROPE NETWORK STATEMENT COMMON STRUCTURE IN EU

To establish a common 'Europe-wide organisation' for facilitating international traffic on the European rail infrastructure across its Member states, European Union (EU) has set up RailNet Europe (RNE) in 2004. RNE's mission is to help its members meet the challenges of rapidly-changing railway sector in Europe and to promote international rail traffic by providing solutions that benefit all RNE Members as well as their customers and business partners. EU member states were able to separate the provision of transport services and the management of the infrastructure by the Single European Railway Directive 2012. RNE also provides support as regards compliance with the European Legislations with harmonised international business processes, templates, handbooks and guidelines.

❖ **What is a Network Statement?**

Railway Directives of EU describe the obligation for each Rail Infrastructure Manager to publish a Network Statement which refers to various documents that carry their own appeal procedures- the Network Code, Engineering Access Statement and Timetable Planning Rules. It is the key to market access for the Applicants providing all the information that they need to know in order to place requests for infrastructure capacity, especially the commercial, technical and legal access conditions. It aims to provide Applicants who wish to operate services on a given rail network with a single source of up-to-date, relevant information on a fair and non-discriminatory basis.

❖ **Article 27 of Directive 2012/34/EU mandates the following to all the stakeholders of Rail Transport sector of Member states:**

1. The Infrastructure Manager (IM) shall, after consultation with the interested parties, develop and publish a Network Statement which shall be obtainable against payment of a fee which shall not exceed the cost of publication of that statement. The Network statement shall be published in at least two official languages of the EU. The content of the network statement shall be made available free of charge in electronic format on the web portal of the Infrastructure Manager and accessible through a common web portal.
2. The Network Statement shall set out the nature of the infrastructure which is available to Railway Undertakings (RU), and contains information setting out the conditions for access to the relevant Railway Infrastructure as well as to Service facilities or supply of such Services connected to the network of the Infrastructure Manager, indicating a website where such information is made available free of charge in electronic format.
3. The Network Statement shall be kept up to date and amended as necessary.
4. The Network Statement shall be published no less than four months in advance of the deadline for requests for infrastructure capacity.

- RNE encourages its Members to adopt a Common Document Structure for their respective 'Network Statements' so as to provide standards of user-friendliness and customer orientation, and to assist those who need to consult more than one Statement for their intended operations across EU. Understanding Network Statements is essential for successful communication between IMs and Freight Corridors.

❖ **RNE Network Statement Template for each Member country:**

1 GENERAL INFORMATION

General information about the Network Statement and Contacts

1.1 Introduction
1.2 Objective
1.3 Legal Framework
1.4 Legal Status
1.5 Structure of Network Statement
1.6 Validity

2 ACCESS CONDITIONS

Legal requirements and access proceedings to the railway network

2.1 Introduction
2.2 General Access requirements
2.3 General Business/Commercial conditions
2.4 Operational Rules
2.5 Exceptional Transports
2.6 Dangerous Goods

3 INFRASTRUCTURE

Main technical and functional characteristics of the railway network

3.1 Introduction
3.2 Extent of Network

3.3 Network Description
3.4 Traffic Restrictions
3.5 Availability of Infrastructure
3.6 Service facilities

4 CAPACITY ALLOCATION

Procedure for the allocation of the train paths

4.1 Introduction
4.2 Description of Process
4.3 Schedule for Path Requests and Allocation Process
4.4 Allocation Process
4.5 Allocation of Capacity for Maintenance, Renewal and Enhancements
4.6 Non-Usage / Cancellation Rules
4.7 Exceptional Transports and Dangerous Goods
4.8 Special Measures To Be Taken in the Event of Disturbance

5 SERVICES

Services provided by IM and other Service Facilities managers

5.1 Introduction
5.2 Minimum Access Package
5.3 Access to services facilities and supply of services
5.4 Additional services
5.5 Ancillary services

6 CHARGES

Charging of the provided services as well as incentive schemes

6.1 Charging principles
6.2 Charging System
6.3 Tariffs
6.4 Financial penalties and incentives
6.5 Performance scheme
6.6 Changes to charges
6.7 Billing Arrangements

➢ INDEX

➢ GLOSSARY

❖ **Few of the EU Members' Railway Infrastructure Companies:**

Austria- ÖBB-Infrastruktur AG

Belgium – InfraBel

Croatia- HŽ Infrastruktura d.o.o.

Denmark- Banedanmark Rail Net

France- SNCF Réseau

Germany- DB Netz AG

Greece- OSE

Italy- Rete Ferroviaria Italiana

Switzerland- Trasse Schweiz AG

United Kingdom- Network Rail

❖ **To understand the commonality and adaptability to country specific market segments, certain features (especially those related to Track Access) can be seen from the Network Statements of Germany's DB Netz AG, UK's Network Rail and France's SNCF Réseau along with the Network Statement Template given by RNE:-**

➢ **Network Rail Infrastructure Limited (Network Rail) of UK** owns, operates, maintains and develops the main rail network in United Kingdom. This includes the railway tracks, signalling and electrification systems, bridges, tunnels, level crossings and viaducts.

❖ **Operating Routes:**

The day-to-day running of UK's railway infrastructure is carried out by the eight operating routes and a 'virtual' route that is responsible for freight and passenger operators who operate over multiple routes. Each route operates as a separate business unit, headed by a route Managing Director and management team, which is responsible for operations, maintenance, customer services and

local asset management. Each route also has its own accounting records to enable greater benchmarking of financial performance and efficiency between routes and to share best practice.

➢ Two key elements of the national framework are:
- A Technical Authority to set standards across the network as a whole
- A System Operator to plan and allocate capacity across the network as a whole

➢ The routes are also supported by:
- Route Services Directorate
- Infrastructure Projects
- Digital Railway

❖ **Regulatory Authority:**

Network Rail (NR) of UK is accountable to Office of Rail and Road (ORR), the regulatory body, for compliance with the obligations under their Network Licence and Station Licence. These authorise NR to operate the main rail network and major stations (as listed in the Station Licence schedule). Similar Regulatory body in France is Authorite de Regulation des Activites Ferrovaires Et Routiers (ARAFER) for SNCF Réseau and in Germany, it is Federal Network Agency (FNA) for DB Netz AG.

ORR is the railway industry's economic and safety regulator and is independent of government, but accountable to Parliament. Any Railway Undertaking (RU) wanting to operate trains on the network must, among other things, have a 'Track Access Contract' with NR which has been approved by ORR. RUs may also be required to enter into Station and Depot access agreements.

➢ Disclaimer by NR: While primarily concerned with information relating to the main rail network, the objective of the Network Statement also extends to the provision of further information regarding railway facilities that link to NR's network. The extent of this information is subject to the level of detail supplied to NR by the relevant facility owners and operators when requested. In the cases where NR is not responsible for the management of certain service facilities, the related information contained in this Network Statement is not binding.

❖ **Legal/Statutory Requirements:**

The Network Statement of Germany's DB Netz AG is based in particular on the following legislation/ regulations (National and European):
- Railway Regulation Act (ERegG),
- General Railway Law (AEG),
- Implementing Regulations (EU)
- Railway Construction and Operation Regulations (EBO),
- Railway Signalling Regulations (ESO),
- Railway Safety Ordinance (ESiV),
- Trans-European Railway Interoperability Law (TEIV) and
- Technical Specifications for Interoperability (TSI).

➢ Liability insurance

Before starting services, the Applicant or involved RU shall demonstrate to DB Netz AG that it has taken out third-party insurance covering all claims that can arise for whatever legal reason.

❖ **Information Technology Tools:**

RailNetEurope (RNE) provides Infrastructure Managers and Operators with various computer tools in order to ease international train path planning and control:

➢ Technical Specifications for Interoperability (TSIs) define the technical specifications required to underpin those essential requirements and harmonise the technical and operational characteristics of the rail network:
- Control, Command and Signalling (CCS) TSI relates to the train control and train protection systems.
- Infrastructure (INF) TSI defines the characteristics relating to gauge clearance, including the clearance between trains and platforms in stations, and of the distances provided between adjacent tracks and technical requirements for track components.
- Safety in Railway Tunnels (SRT) TSIs relate to the safety characteristics of tunnels.
- Rolling Stock Noise (NOI) TSI
- Rolling Stock Freight Wagons (WAG) TSI
- Rolling Stock Locomotives and Passenger Carriages (LOC & PAS) TSI
- Operations and Traffic Management (OPE) TSI
- Telematics Applications for Freight (TAF) TSI to

keep track of consignments and to determine when deliveries to customers will be made. This is achieved through messages passed between IMs and RUs that convey the status of trains at all stages from path request through to actual train running.

➢ Train Information System (TIS) is an easy-to-use, web-based application which visualises the trains from origin to destination and supports the train management by delivering data concerning the trains along RNE Corridors and RFCs.

❖ **Categorising the Services:**

In accordance with the extant regulations and template of RNE, SNCF Réseau of France offers services to Applicants, which are broken down into the following categories:

- Minimum services on main tracks
- Basic services provided on service facilities
- Other services grouping together the additional services and ancillary services both on main tracks and service facilities, as well as miscellaneous services

➢ A set of 'minimum services on the main tracks' offered to an Applicant is called Minimum Access Package which comprises of:

(a) Handling of requests for infrastructure capacity; and

(b) The right to utilise such capacity as is granted and, in particular,

(c) Such railway infrastructure including track, points and junctions as are necessary to utilise that capacity;

(d) Electrical supply equipment for traction current, where available and as is necessary to utilise that capacity

(e) Train control, including signalling, train regulation, dispatching and the communication and provision of information on train movements; and

(f) All other information as is necessary to implement or to operate the service for which capacity has been granted.

In relation to rail facilities that are not part of the main rail network, the provision of the Minimum Access Package is the responsibility of the relevant Service provider whose contact details are available on website for any RU to use in order to obtain key information such as hours of operation, capacities and capabilities.

❖ **Charging principles for Minimum Access Package (MAP):**

The amount of the train-path charge reflects the relevant mandatory services. The relevant train-path charge for the minimum access package is calculated using the train-path kilometres in the relevant market segment multiplied by the relevant charge for the minimum access package in this market segment.

Freight train in Great Britain

Principle Market segments in the rail freight sector for Germany's DB Netz AG, UK's Network Rail and France's SNCF Réseau are:

- Franchised passenger services
- Open access passenger services
- Freight services

The charge for the minimum access package per market segment comprises the direct costs of train operation per market segment, and a surcharge to cover the full costs (full-cost surcharge) according to the relative viability of the relevant market segment as well as possible additional elements. The calculation of the charge is based in principle on the contractually agreed train-path kilometres. The charge for the minimum access package accommodates the total fixed costs incurred as a direct result of train operation.

❖ **Principles of calculating costs that incurred as a direct result of train operation:**

To calculate the costs incurred as a direct result of train operation, there is an investigation into whether a change in the volume of traffic results in a change in the service to be rendered by DB Netz AG and thus in the costs. Thereafter, an analysis is carried out as to the extent to which changing the service to be rendered by DB Netz AG causes a change in the costs. It is possible to determine a correlation between traffic volumes and costs incurred by DB Netz AG for the following cost pools:

- Timetable cost pool
- Operation cost pool
- Track Maintenance cost pool
- Track Depreciation cost pool

ORR of UK periodically reviews the charging arrangements every five years. It is responsible for developing the charging framework and Network Rail is responsible for calculating all existing track access charges within this framework. Ultimately, the level of track access charges is determined by ORR. Access charges are set by ORR such that Income from such charges together with surpluses from other commercial activities and any public funds shall at least balance with infrastructure expenditure; and the basic cost of providing the main rail network, after taking account of other revenue sources, is met by fixed charges and variable charges to the RUs.

➢ Network Rail levies a range of track access charges on franchised passenger, open access passenger and freight RUs. These charges may include:

- Variable Usage Charge
- Electrification Asset Usage Charge
- Traction Electricity Charge
- Coal Spillage Charge
- Freight Only Line Charge
- Freight Specific Charge
- Access Charge Supplements
- Capacity Charge
- Fixed Track Access Charge
- Additional Charges

The purpose of the Variable Usage Charge is to recover operating, maintenance and renewal costs that vary with traffic. It reflects the short run marginal cost and does not reflect the cost of providing or changing the capability or capacity of the network. The Variable Usage Charge is paid by RUs. It is largely based on a bottom-up analysis of our incremental costs.

First, the total variable costs associated with all traffic on the network are established. Then these costs are distributed between individual vehicles based on their relative propensity to cause damage to the network. This propensity is established from an analysis of the causes of wear and tear to the network, and the relative characteristics of different rolling stock types. The cost of track maintenance and renewal varies with factors such as axle load, speed, unsprung mass and yaw-stiffness. The higher a vehicle's axle load, speed, unsprung mass and yaw-stiffness - the higher the consequent infrastructure maintenance and renewal costs. As such, the Variable Usage Charge reflects these characteristics. Freight variable usage charges are specified on a pound per thousand gross tonne mile basis.

Variable usage charges vary depending on the commodity type being transported as the operating speed and operating weight of a freight vehicle can vary materially depending on the commodity type being transported. The variable usage charge is indexed, annually, to the Retail Prices Index.

➢ Network Rail furnishes an 'estimate of the charge' for a new vehicle type, to any RU when it provides the information such as:

- Tare weight
- Number of axles
- Unsprung mass
- Yaw-stiffness
- Maximum or operating speed of the vehicle
- Ride Force Count
- Operating weight

❖ **Other charge components:**

1. New service discount:

In order to promote the development of new railway services, DB Netz AG grants all Applicants time limited discount in the form of a percentage decrease to the standard usage charge. It is granted for a period of 12 months from the commencement of operations.

2. The train-path charge includes a component that accounts for noise-related effects of train operation:

The noise-related effects are considered such that loud freight trains must pay a surcharge on the train-path price. A train is deemed to be loud where more than 10 percent of it consists of loud wagons. A wagon is deemed to be loud if it does not satisfy the limits listed in the TSI related to noise.

❖ **Additional services and their charges:**

- Stabling on railway lines not covered by an allocated train path for more than 60 mns (Euro 3.80 for each 60 minutes or part thereof)
- Navigability assessment for oversized vehicles (basic price amounts to Euro 215.00 plus the cost-based charge amounts to Euro 80.00 for each 60 minutes or part thereof)
- Proof of bridge compatibility (Basic price plus expenditure related charges depending on the level of examination)
- Additional equipment on railway lines (per hour charges including water and power charges)
- Charge for disclosure of framework agreements (Euro 80.00 per hour or part thereof)

❖ **Ancillary services (mostly on fixed rate charges):**

- GSM-R based communication for RUs
- Navigability study.
- Operating schedule study
- Dispatcher workstations in control centres
- Timetable studies
- Running time calculations
- Printed timetable books and speed restriction lists
- Key Management Centre (KMC)
- Network Traffic-Regulation Control System for the Customer
- Live Maps
- Data acquisition licence
- Statistical Analysis
- Train path diagrams

❖ **Track access to Service facilities:**

In addition to the track access charges, the Access and Management Regulations provide for entitlements to track access to facilities and the supply of services. Network Rail may recover the costs associated with the following charges:

- Station Long Term Charge - to recover the maintenance, renewal and repair (MRR) expenditure associated with all the Stations, levied on a constant annual basis.
- Depot Charges - in respect of the light maintenance depots that Network Rail leases to depot operators (who are either RUs or specialist train maintenance companies).
- Qualifying Expenditure - recovers the operating costs of common amenities at managed stations such as station cleaning, refuse collection and disposal, insurance, utilities, and the provision of competent and suitably trained staff.
- Facility Charges - recover the costs of any station enhancement funded by Network Rail at an operator's or user's request. Incremental ongoing costs resulting from the enhancement (for example, for the operation, maintenance or renewal of the asset during the recovery period) may also be included in the Facility Charge.
- Property Rent- paid by Station operators under the terms of their station lease. The rent provides Network Rail, as the property owner, a share of the income received by the Station operator from commercial activities at the station- such as retailing and advertising.

❖ **Performance enhancement system:**

Article 34 of the Decree No. 2003-194 transposing Article 35 of the Directive 2012/34/EU, lays out the performance enhancement system as an incentive

mechanism applying in a bilateral manner between infrastructure manager (IM) and the railway undertakings (RU). It aims at encouraging the both to improve traffic punctuality in order to optimise the operation of the network and improve the quality of service offered to its users.

➢ **SNCF Réseau's** Reciprocal Incentives (IR) system is to hold the stakeholders responsible and thus optimise the capacities offered by the network by creating systematic and fixed reciprocal incentives involving penalising the infrastructure manager (IM) or train path applicant in the event of cancellations or modifications made by the latter.

On the one hand, it targets the effective and stable issue of allocated train paths, by encouraging the infrastructure manager of the national rail network to not cancel or modify them, and on the other hand it targets the early return and stabilisation of the capacities reserved by train path applicants both for freight and passenger transport.

The performance indicators of the railway undertaking and of the infrastructure manager in relation to each railway undertaking, expressed as a ratio of "minutes lost/100 km", are calculated as follows:

1. Proportion of minutes lost for which the RU is responsible, over the number of train-kilometres travelled by the RU;
2. Proportion of minutes lost for which the IM is responsible, over the number of train-kilometres travelled by the RU.

➢ **DB Netz AG's Incentives and Penalty payments:**

1. Compensation for additional train path costs for work-related rail freight transport diversions in the working timetable.
2. Automatic reduction- DB Netz AG reduces the payable usage charge in the case of the following faults which, due to a disruption, have resulted in additional delay minutes:
   Faults with the infrastructure, Faults with the command and control system, Faults in providing traction current, Staff-related faults
3. Charging arrangement for diversions due to construction work after conclusion of the Individual Usage Agreement (ENV).
4. Amendments and cancellation- After conclusion of the contract, an amendment/ cancellation by the Applicant may only be made before the scheduled departure with appropriate charges.

➢ **Network Rail's** performance scheme provides compensation to RUs for unplanned delays and cancellations which it is not directly responsible for. It is a liquidated sums regime which provides compensation based on the marginal effect on future revenues of changes in performance caused by Network Rail or other RUs. Track access Contract sets out a framework by which compensation is paid by either party if train or network performance fails to meet set benchmarks. Bonuses are received if either party delivers better performance than the benchmark. The performance scheme therefore has incentive properties for both parties (Network Rail and RUs) to improve their performance.

❖ **Security:**

A right of use of the Network Statement is granted only after suitable and valuable security has been provided. Security may be provided by customary means of security, in particular an irrevocable, indefinite, absolute guarantee of a credit institution with a balance sheet total of at least 1 billion Euros and with its registered office in the European Union.

The amount of security is determined on the basis of the amount of expected charges for the train paths allocated in the then current month and requested for the next following month.

The Applicant can avoid the provision of security by making an Advance payment which equals the amount of services to be obtained from DB Netz AG.\

❖ **Billing arrangements:**

Each RU which operates on the main rail network will for commercial issues communicate with an assigned member of the relevant Network Rail route team. The relevant Network Rail route team is responsible for the cost recovery of monies owed to Network Rail by the relevant RU, much of which is outlined in the specific track access contract. Remedies for non-payment include interest charges, suspension of the contract and termination. All invoices are sent to RUs via Network Rail Finance Shared Services and are typically on a periodic (four week) basis.

❖ **References:**

Following websites may be referred to for further information on Corridors Information Documents, KPIs etc:

1. http://www.rne.eu/organisation/network-statements/
2. https://www.networkrail.co.uk/industry-commercial-partners/information-operating-companies/network-statement/
3. https://www.sncf-reseau.fr/en/rail-network-access/toolbox/national-rail-network-statement
4. https://fahrweg.dbnetze.com/fahrwegen/ customers/network_statement/network_statement/network_statement/
5. All photos - courtesy, Google Images

ICE Train of DB (Germany)

TECHNICAL PAPER FOR THE MODULAR CONSTRUCTION OF WELL STEINING AT YAMUNA RIVER (BRIDGE NO. 180) & AT HINDON RIVER (BRIDGE NO. 188)

SYNOPSIS:

Over the past years, construction time & risk management in project's execution is always associated with uncertainties because certain risk factors such as poor labor productivity, shortage of equipment, delay, cost overrun, time overrun are attributed to project delivery. It was also discovered that the external factors (technology, political and economic factor) are important in evaluating these constructs for further exploration of the construction companies to enhance risk management practice in all stages of the project activities. These risk factors have been generating many experimental interests among the construction stakeholders. These experiments aim at time reduction, better quality, ease of execution and handling, standardized safety, etc. This Project was designed with deep well foundations. The well sinking being one of the major critical activities took a huge amount of project completion period. Hence it was the need of the hour to experimenting and bringing the time cycle for the casting of well steining to as minimum as possible. The below methodology adopted for well steining casting ensured high standard safety and reduced time.

Mr. Y. P. Sharma,
Dy. Chief Project Manager
DFCCIL / Noida Unit

Project

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

Task

1. The casting of 170 Nos. (Yamuna) + 68 Nos. (Hindon) = 238 Nos. of Well Stiening

Brief Technical Details

1. Inner Diameter = 13.2m (for 4 Abutments) & 10.4m (for 13 Piers)
2. Outer Diameter = 13.8m (for 4 Abutments) & 10.8m (for 13 Piers)
3. Heights of Lift = 2.5 m, 2.4 m, 1.9 m, 1.8 m, 1.4 m, 1.2m, 0.8m, 0.3 m lifts
4. Concrete Quantity = 137 cumec
5. Reinforcement Quantity = 195 MT
6. Shuttering Quantity = 195 sqm
7. No. of Lifts = 170 nos. (Yamuna) + 68 nos. (Hindon) = 238 nos.

Challenges Encountered

1. Stringent Time Deadline for Project completion
2. Installation of air and water jetty arrangements for catalyzing well-sinking activity
3. Maintaining weight balance during concrete pouring

Advantages

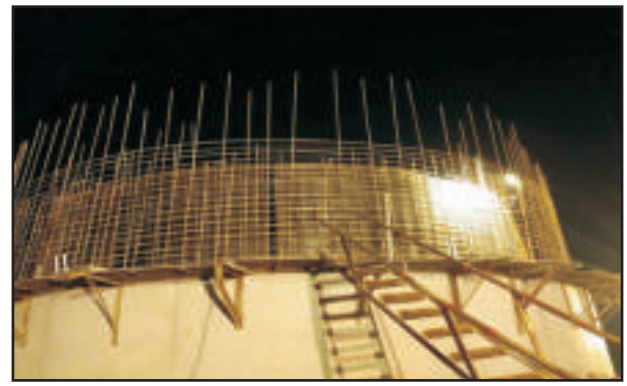
1. Use of 2 cranes for sinking activity facilitated well sinking leading to reduced time cycle for continuous cycles of well steining casting and sinking
2. In Jack down Method, it takes time to remove the beam assembly for steining shutter fixing whereas in this method directly the shuttering works of well steining were started.

Methodology

1. **Working Platform & Inner Shutter Fixing:**
   The working platform shall be installed inside and outside area and position all vibrators and needles at required locations. The Inner shutter was fixed prior to reinforcement fixing, followed by outer shutter fixing. A clear cover of 75mm was maintained from the outer most reinforcement. After fixing of shutters, the proper supporting arrangement as mentioned in the approved drawings was done. The inner & outer shutter were tied with steel prop in the horizontal direction. The inner & outer shutter joints were properly sealed with foam & putty. Checking of the shutter for verticality was approved by Engineer prior to the start of concrete.

Fixing of inner shutter and rebar

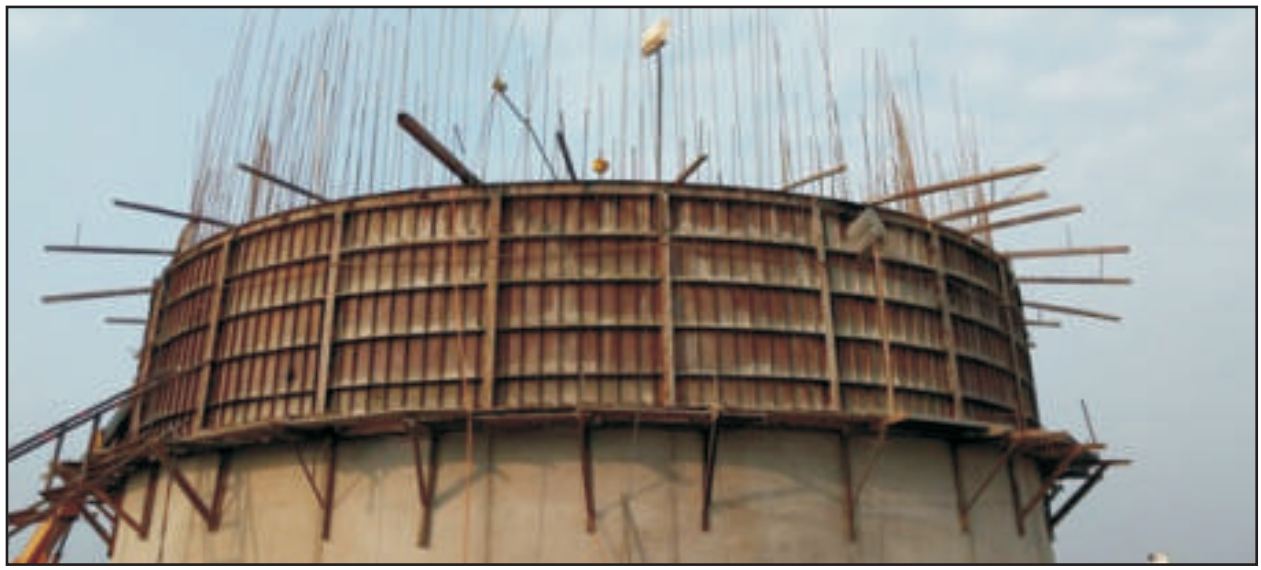
2. **Reinforcement Fixing:**
   The bar bending schedule (BBS) was prepared as per the latest approved drawing, submitted and approved by the Client. Cutting and bending of reinforcement steel bars mainly comprising verticals, circulars and connecting links at the yard was done. The cut & bent rebar were shifted to the site for fixing. The rebar was fixed at the site as per the spacing mentioned in the drawing. The bars were being tied by 1.6mm binding wire. Water jetting and air jetting arrangement were provided to inner & outer faces for the sinking of well till the top of steining



Fixing of rebar and access ladder

3. **Outer Shutter Fixing:**
The formwork was of M.S. sheets shaped and stiffened suitably. Well Steining of 2.50 m height was cast except the tapered portion where steining thickness reduces. The outer shutter was fixed at the outer face after fixing the reinforcement. 75mm clear cover was maintained from the outer most reinforcement. After fixing of shutters, the proper supporting arrangement was done. The inner & outer shutter were tied with horizontal jack. The inner & outer shutter joints were properly sealed with foam & putty.

Fixing of the outer shutter



Complete fixing of the outer shutter

4. **Concreting:**
M-35 grade concrete was prepared in the batching plant and shifted to the site by transit mixers. Concrete was poured in layers of 300mm thick in clockwise & anticlockwise to avoid tilting of the well by using concrete boom placer. The slump of concrete, temperature were checked at batching plant and site as required.

Concreting of well steining lift

Concreting of well steining lift

Upper view after concrete pour completion

5. **De-shuttering:**
Remove the shutter after 24 hours of concreting. The maximum used horizontal steel props were loose and removed. The outer & inner shutter each individual M.S. plate was removed. The forms were conveniently removed without disturbing the concrete. Curing was done continuously and gauge marking shall be done on four sides of the well.

De-shuttering of the outer shutter

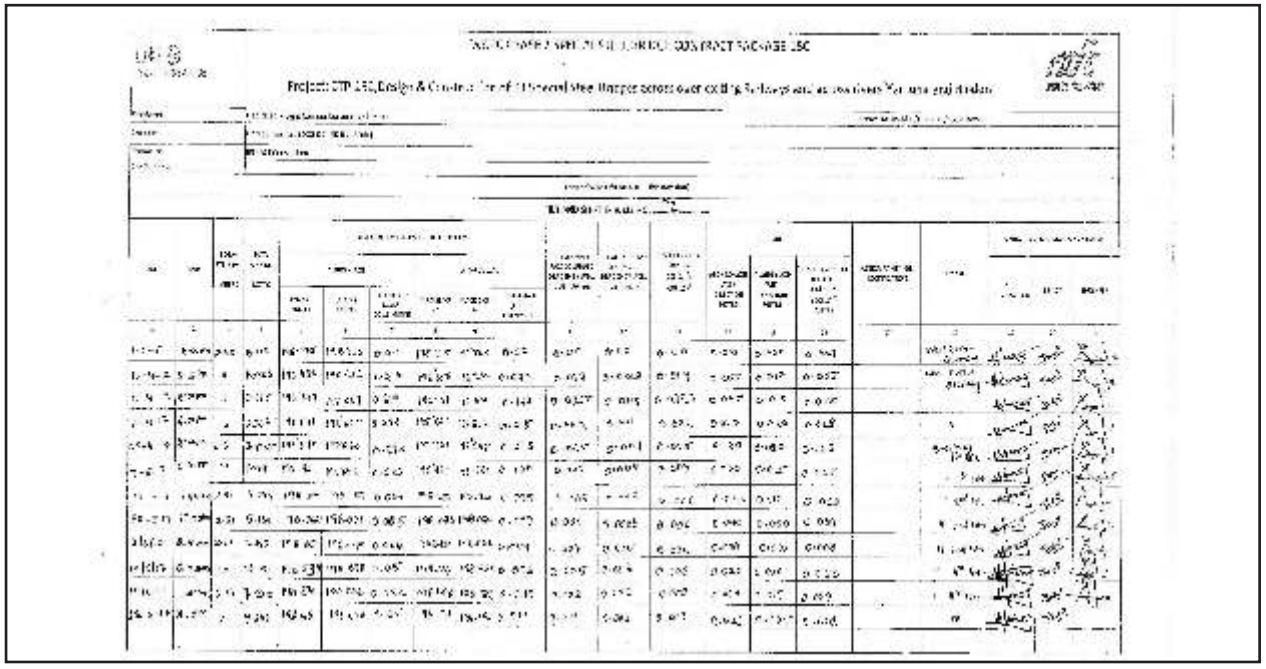
Curing of well steining lift in progress

Measures adopted for Control of Tilt & Shift during Sinking

Following precautions were considered to prevent shifting and tilting of well foundations:

- The diameter of well curb was kept more than the external diameter of steining.
- The well steining was symmetrically placed over the curb.
- The outer surface of the well curb and steining were kept smooth.
- All the sides were uniformly dredged.
- The cutting edge was fabricated uniformly thick and sharp.
- Proper markings and survey checks were done to regularly monitor the tilt and shift of the well foundation

Markings on well foundation



Sample Report of regular monitoring of tilt and shift of well foundation

Further, to rectify any shift or tilt the following provisions were adopted

Eccentric Loading

- The well tilt if any was rectified by placing eccentric loading on the higher side. Higher side is nothing but the opposite side of tilt or lower side.
- This eccentric load will increase downward pressure on higher side and correct the tilt.
- The amount of load and eccentricity was based on the depth of sinking.
- Greater is the depth of sinking of well, larger will be the eccentricity and load.

Eccentric loading to control tilt of well foundation

Excavation on Higher Side

- When well is tilted to one side, excavation was increased on the other side which is opposite to tilted side.
- This technique was used only in the initial stages of well sinking.

Water Jetting

- Provision for water jetting correction was kept in the design and execution of the well foundation.
- Water jetting on external surface of well on the higher side is another remedial measure for rectifying tilt.
- When water jet is forced towards surface of well, the friction between soil and well surface gets reduced and the higher side of well becomes lowered to make well vertical.

FAST TRACK CONSTRUCTION OF OPEN LINED DRAIN WITH GEOCELL ALONG WITH DFC FORMATION IN MADAR -IQBALGARH SECTION OF WDFC

1. SYNOPSIS:-

Proper drainage arrangement along formation is necessity to ensure stable formation. Stone lined drain was being constructed for drainage arrangement in between the DEC formation and existing IR Track in Ajmer unit. The construction of stone lined drain was very slow due to availability of quarry/material, frequent change in mines and mineral policies and transportation. The stone lined drain is also not environment free, having frequent quality issue, require heavy repair and also not long lasting. To overcome these issues, now Geocell lined drain are being constructed in which helped in speedlly construction, long lasting, maintenance and environment free and cost saving. In large infrastructure project, construction of open line drain using Geo cell may be interest of All.

SUNIL SINGH
CGM/DFCCIL/AJMER

2. Introduction :-

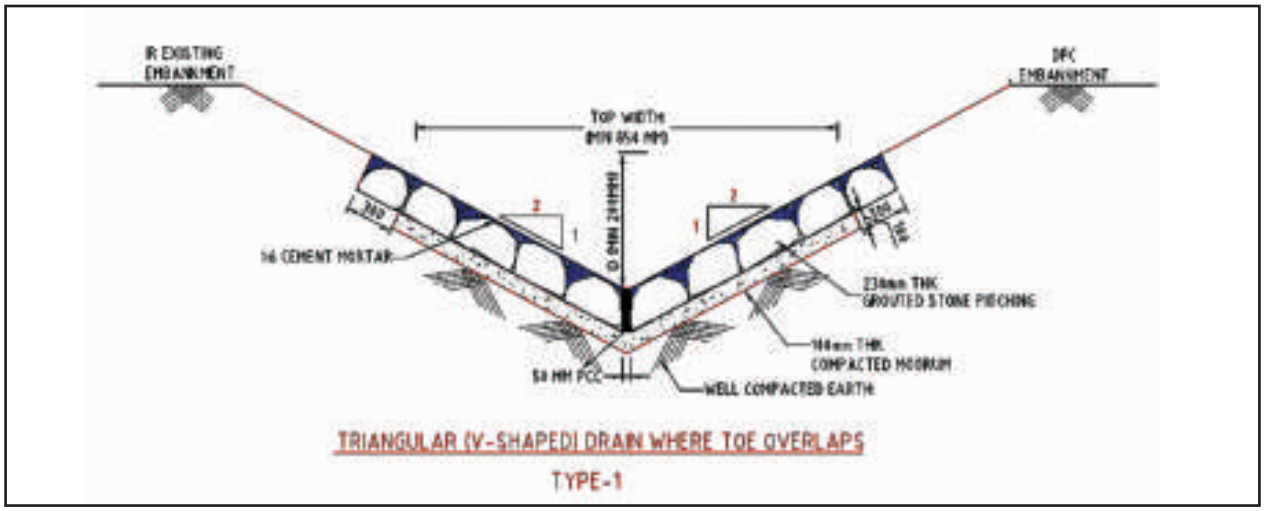
Ajmer Unit is executing DFC work from Madar to Iqbalgarh section (342 Km) of the WDFC project. Madar to Iqbalgarh have complicated section having hilly terrain, high embankment etc. Maximum alignment is almost parallel to the existing IR track and construction of open lined drains are to be provided for developing drainage arrangement in between DFC & IR formation. These drains are designed with such a material, shape and section which provide adequate flow capacity, require less maintenance and uniform longitudinal gradient adequate to ensure a self-cleansing velocity etc. About 280 Km drains are to be constructed between DFC & IR track in between Madar to Iqbalgarh. WDFC project from Rewari to Palanpur is targeted to commissioned by March-2020.

As per Employer's requirements, Stone Pitching Drain are to be constructed having stone pitching of 230 mm with cement grouting on 100 mm thick compacted moorum having trapezoidal shape.

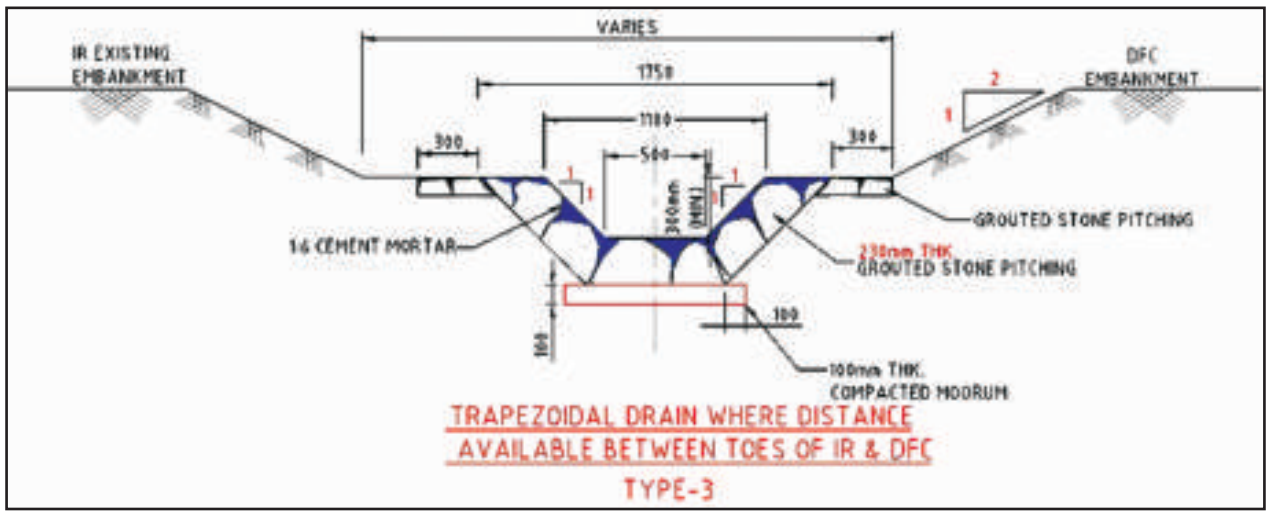
3. Stone pitching drains and problem being faced:-

Following type of the stone pitching drains are being used:-

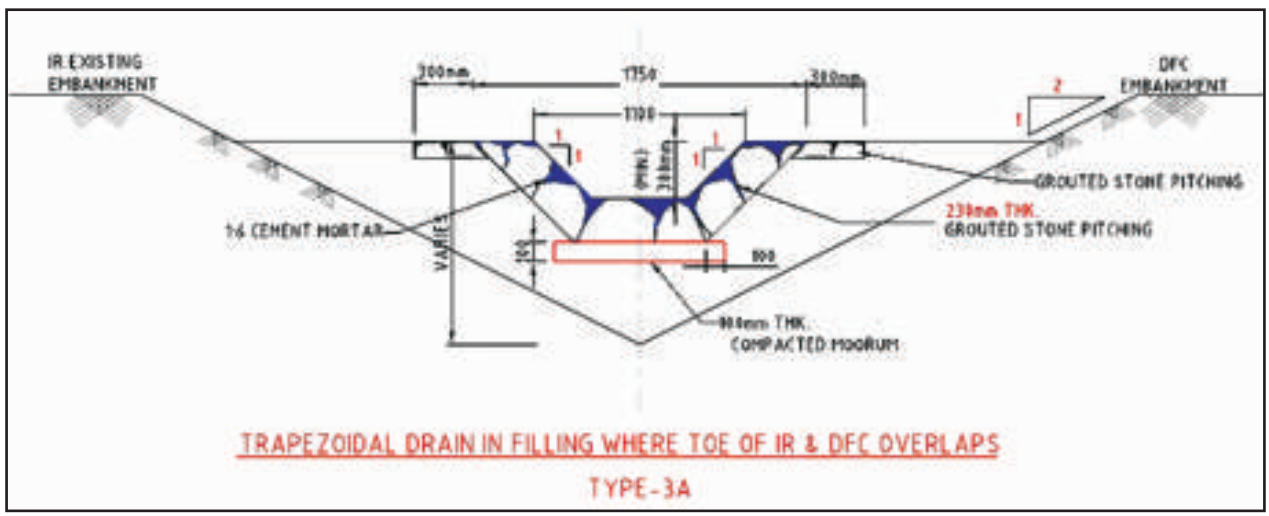
(I) Triangular (V-shaped) Drain where Toes of IR & DFC overlaps.



(i) Trapezoidal Drain where Distance available between Toes of IR &DFC.



(i) Trapezoidal Drain in filling where Toes of IR & DFC overlaps.



Following difficulties are being faced during construction of stone pitching drains:-

1. Non-availability of stone/quarry due to frequent banning on mining.
2. It is difficult to execute good quality of stone pitching drain work as per drawing.
3. Construction as per approved drawings is difficult to maintain and requires heavy repair.
4. Uniform longitudinal gradient in stone pitching is not easy to maintain.
5. Difficult to ensure self-cleansing velocity in stone pitching drain due to roughness.
6. Difficult in maintenance in future.
7. Progress of construction of drain with stone masonry is very slow which causes delay and affects the commissioning of project.
8. Construction of stone pitching drain is not environment friendly.
9. Stone pitching drains are not aesthetic as surface finishing is not good.
10. Stone pitching drains are costly in construction and transportation of quarry/stone is difficult.
11. Removal of waste/excess material after completion of work is difficult.

4. New technique and material for construction of open lined drain:-

Considering problems in stone pitching drain, it was planned to use the modern technique and material so that the problem being faced during construction of drain using stone can be avoided.

5. Construction of Geocell open line drain:-

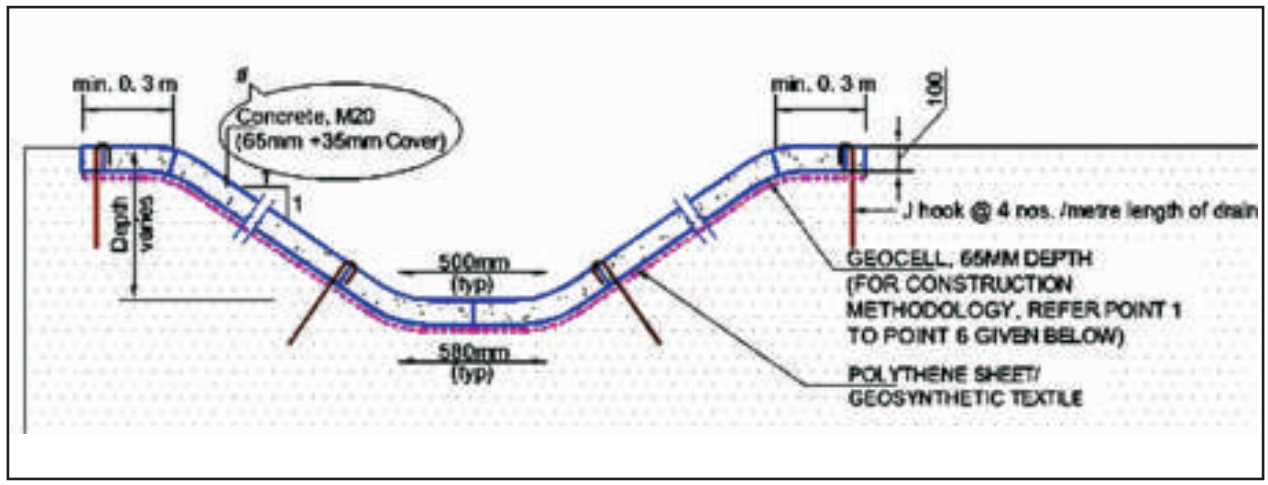
Sojiitz and L&T Consortium, is executing civil and track work of CTP-1 & CTP-2 package for WDFC which is from Rewari to Iqbalgarh. To overcome these issues, contractor proposed to construct open lined drain using Geocell as one of the main constitute. Trial were done with open line drain designed Geocell supplied by HM Geoweb system.

HM Geoweb Cellular confinement system provide a wide variety of flexible stabilization for open channels/drains and hydraulic structures. The structural performance and durability of four conventional protection materials such as concrete, gravel, riprap and vegetation can be significantly improved by confining the materials within the cells of HM Geoweb systems.

The design of lined drain requires the maximum anticipated flow conditions and the associated hydraulic stresses for which the protection will be depend. Subgrade drainage requirements and the potential for long term or seasonal deformations of the drain channel as a whole are also to consider. In designing other factors as also include the surface roughness on which hydraulic efficiency of the drain/channel system and the ease with future maintenance and sediment cleaning operations also taken in account. The Geocell drains also have compatibility with local environmental, ecological and aesthetic requirements.

6. Geocell Drains:-

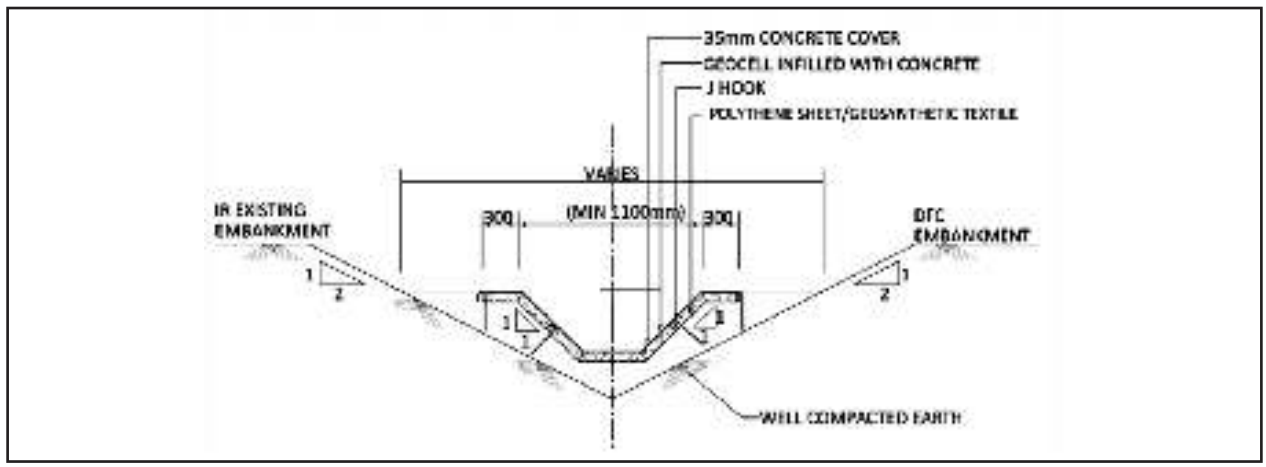
Thus, Geo Cell drains are being constructed with following drawing:-



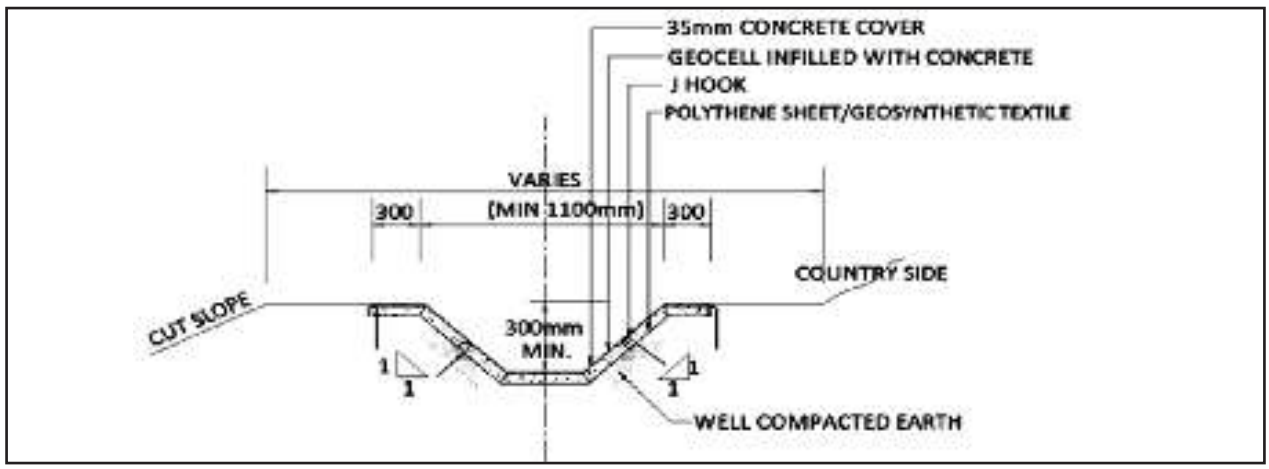
Typical Cross-Setion of Lined Drain with Geocell-0.3m to 1.0m Depth

In the Geocell line drain, Geo Cell are laid on polythene sheet/Geo synthetic textile and using J-pins to nail the Geocell to group and infilling Geo Cell with M20 concrete and above that 35 mm thick cover of concrete. These Geocell drain are designed for 30cm to 100 cm depth.

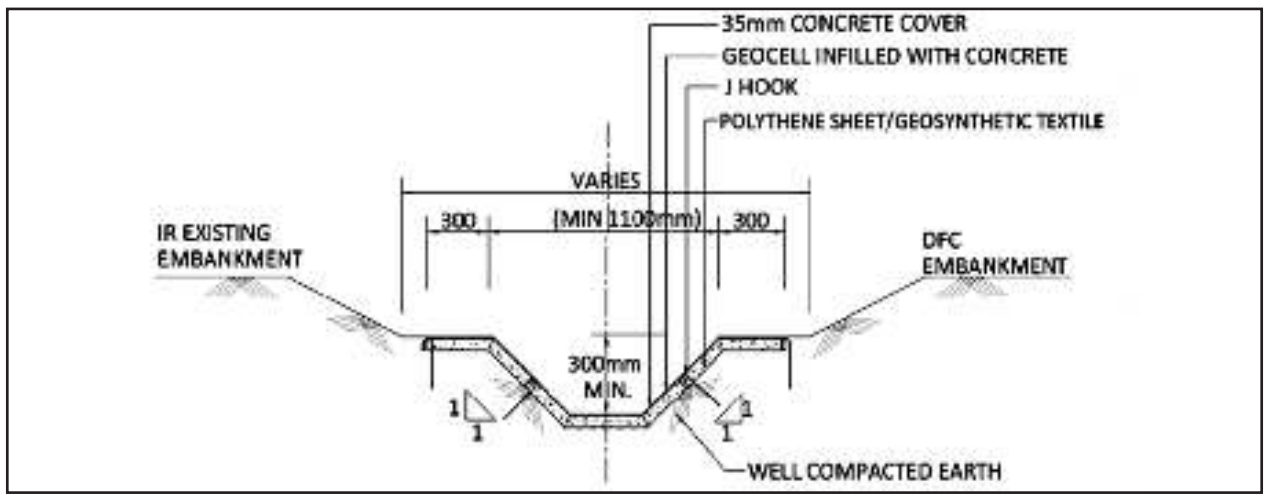
(i) Triangular (V-shaped) Drain where Toes of IR & DFC overlaps.



(ii) Trapezoidal Drain where Distance available between Toes of IR & DFC.



(iii) Trapezoidal Drain in filling where Toes of IR & DFC overlaps.



Following are the design consideration to provide Geocell drain:-

(i) Surface roughness.

(ii) Erosion Resistance and Durability.

(iii) System Stability

(iv) System Flexibility

(v) System Permeability

(vi) Ease of Maintenance

7. Construction Methodology:-

1. **Site Preparation:** The excavated drain shall be compacted by suitable means (by plate compactor and / or manually) and dressed to meet the required dimensions as per drawings.
2. **Separation Layer:** Polythene Sheet (min 125 micron thick) or geosynthetic textile shall be laid on the dressed slope.
3. **Geocell Placement:** After installation of polythene sheet or geotextiles, the s ection/units of geocell supplied in collapsible forms shall be placed at the top along the drain. The geocell unit shall be expanded down the slope to cover the drain.
4. **Anchoring/Fixing of Geocell:** After positioning, the geocell shall be fixed at the top using J-pins. After fixing the J-pins on one side of the drain, the Geocell shall be stretched to the required cell dimensions down the slope and simultaneously shall be fixed by using J-pins. The no. of J-pins used for fixing the geocell system shall be
   a. 4nos./meter length if depth of drain is 0.3m to 0.7m.
   b. 8 nos./meter length if depth of drain is >0.7m.

   Adjacent geocell units shall be joined/fastened using polymer ties before start of concrete infilling.
5. **Filling with Concrete:** After geocell is placed and fixed in position, the concrete infilling shall commence from the top of the drain and progress towards the bottom. It shall be ensured that the height of the concrete infill drop into geocell shall not exceed 0.5m. the concrete shall overtop the geocell (10mm minimum) to trowel smooth without the rim of geocell being visible.
6. **Finishing operations:** After concrete infilling to the required geocell depth, the concrete finishing operations followed by curing shall commence along the drain.
7. V-Shape groove of 20 mm depth shall be provided at every 2 m interval. Expansion joint throughout the entire drain shall be provided at every 20 m interval.

8. Specification and Properties of Geocell:-

Geocell works as a reinforcement to infill material i.e. concrete and improve the strength and deformation properties over the unreinforced concrete. Geocell have three dimensional cell made of a strong and stiff polymer which provide tensile strength and increases the strength of the infill and the drain. Geocell drain provide higher engineering performance with sustained long life which is achieved with much lower construction and maintenance cost.

Geocell is cellular confinement system having honeycomb geocell structure by 3D interaction of concrete, cell walls. Geocell cellular confinement system maintains the concrete compaction, thereby increase the strength of the infill. Geocell works as reinforcement mechanism which provide lateral and vertical cellular confinement.

Specification of Geocell used in drain.

Property	Test method	Unit	Minimum Require Value
Polymer Density	ASTM D1505	gm/cc	0.90
Environmental Stress Crack Resistance	ASTM D1693	Hrs	3000
Carbon Black Content		% by weight	1.5 to 2
Cell Wall Thickness	ASTM D5199	mm	1.20
Seam Peel-Strength Test		N per 25 mm of cell depth	350

Cell Properties

Depth of Geocell	mm	75
Nominal Opening Size /Expanded Cell Area	Cm2	1050 to 1100
Perforation in Cell Wall	%	11 to 16
Welded Distance	mm	660

9. Benefits of Geocell Drains:-

1. Geocell drains are environment friendly. Geocell are three dimensional structure filled with concrete and don't require any intensive quarry, which also avoid transportation of stone/quarry material and also lower carbon footprint.
2. Easy in construction with good quality.
3. Drain surface of concrete is smooth and maintain self cleansing velocity.
4. Geo Cell drain is maintenance free in comparison to stone drain. The cost of Project construction is also minimised due to saving in maintenance and repair cost for long time.
5. Geocell drain are low in cost in comparison to stone drain and have high strength.
6. Geocell are perforated cellular and lined drain designed with Geocell are crack free and long lasting.
7. Geocell are designed to offer strength, flexibility and durability and cell fill with local available infill material that are best suited. Geocell are made of polymer strip and have high resistance against temperature and thermal cycling and have more durability.

10. Photograph of site:-

Laying of Geocell

Finished Open drain constructed with Geocell

Concreting of Geocell drain

Stone Pitching Drain

11. Conclusion :-open lined Geocell drains have many advantages in comparison to Stone Pitching Drains in large infrastructure railway projects.

News and views from All over

1. Predictive Maintenance Trial: Track and Bridge components at London Bridge are to be fitted with Condition monitoring sensors during 2019 as part of a trial to assess the potential for advanced maintenance techniques to be deployed across the UK Network. The trial is being led by Engineering technology start up

"Enable My Team" working in partnership with the University of the West England and Costain. Maintenance staff will use augmented reality tools via a smart phone or a head mounted display to located failing components or structural faults and read on screen instructions in real time to help undertake repairs.

A network of sensors at the London Bridge test site will gather data on tracks and station facilities such as ventilation systems barriers or lighting. Condition data will then be analysed using software called i-RAMP or IoT enabled platform for rail asset monitoring and predictive Maintenance. The Objective is to predict when a fault is likely to occur and highlight any stress points or component failures on a 3D virtual model of the station and track. Parameters to be monitored by the sensors will include vibration, strain or pressure on a structure, humidity and temperature. The London Bridge trial is due to conclude in April 2020, after which more extensive tests are planned with five more stations being considered for fitment. A wider roll out of the scheme is planned for 2011. (RGI Feb 19 pp 57)

2. China Network Expansion: On Jan 5 2019, China launched the new time table adding 275 pairs of high speed trains across the network. This takes the national total to 2850 trains each way per day plus an extra 220 which run at weekends. It is predicted that a total of 2.99 billion journeys will be undertaken in 2019. In two weeks from December 25, Chinese Railways put into service almost a dozen high speed lines and Intercity railways along with a number of mixed traffic and freight railways adding more than 3,000 Route kms taking the China's national network to 130,000 route kms. (RGI Feb 19 pp50)

3. Automated Inspection on Network Rail: Network Rail uses a fleet of 13 Inspection trains across UK making the Network rail's asset information service as the major business critical resource underpinning maintenance and renewal strategies. The trains are based at Derby. The initiative began as a response to the Hatfield accident in 2000, in which a Intercity derailed at speed by a broken rail. The incident revealed Railtrack's lack of knowledge about its infrastructure asset condition and triggered extensive research into the development and spread of rolling contact fatigue. Within a couple of years Network rail had launched the New Measurement train a 200kmph diesel HST set specifically converted to monitor track geometry on its principal routes. It also stepped up Ultra sonic rail inspection by a factor of four. This has resulted in reduction in Broken rails from 952 in 1999-2000 to 125 in 2011-12. Now it has plateaued to 100 per year. Plain line Pattern recognition (PLPR) was implemented from June 2013 to replace manual track inspection. Enabling more effective more frequent inspection to sub millimetre accuracy at line speed, a technology that took more than two years to develop. Seven cameras are mounted beneath the IMT's Inspection car, looking down at the track from different angles and illuminated by high powered

white lights. with a resolution of 0.7 mm, the cameras can pick out track components including individual ballast stones at up to 200 kmph. The pattern recognition software identifies the rails, sleepers, fastenings and joints as well as other track components and stray debris. Advanced algorithms analyse the images to assess the track condition against standards and tolerances, looking for critical faults and using red dots to highlight 'çandidate' defects for manual interpretation.

A second inspection vehicle in the NMT carries the track geometry measurement systems with 47 bogie and body mounted sensors feeding data into a track analysis programme that displays 13 major channels, looking at ride comfort, dipped rails and track twist amongst other factors. While it is possible for the train to detect a serious 'block the line' faults, which would be reported to the Signalling centre in real time. A fraunhofer laser measurement system is used to monitor the stagger and height of the overhead contact wire on electrified routes in an unloaded condition. Accurate to +/- 0.5 mm, this can also measure wire wear by using spectral analysis to calculate the distance between the oxidation patches at each side of the flattened contact area.

All the recorded data must be correlated by time and location and this is done by using a real time positioning system developed in collaboration with several suppliers. Using tachometry and up to 15 GPS satellites simultaneously the location tool can provide an almost military level degree of accuracy. These vehicles also carry Ground penetrating radar to assess the depth of track formation to a depth of around 2 mtrs and KLD rail profile measurement systems that identify rail wear and shape. The NR likes to use the data to bring in change from 'find and fit' to 'predict and prevent'.

NR is looking for other options like LIDAR which is fitted to vehicles but not to the main inspecting trains. NR is also looking for using drone to undertake inspections without track access. Use is also being made of the company's helicopter which has high powered cameras that can look at the condition of overhead line and line side fencing, turnouts are fitted with inbuilt condition monitoring system. (RGI Feb '19 pp:32). DFCCIL can emulate the concepts elucidated in the original article.

4. Reprofiling rails without facets: The concept of tangential grinding has emerged in the past few years as a new tool in the track measurements armoury, aimed primarily at minimising the development of rolling contact fatigue(RCF). The article says wide spread use of hardened rails has significantly reduced the wear rates and rail replacement is triggered largely by RCF. Further Turnouts where the transit of wheels from stock to the switch rails, the closure rails and finally over the crossing noses invariably produces higher dynamic forces and lateral movements, magnifying the process of defect formation. Conventional grinding processes can leave distinctive ridges on the rail surface known as 'facets'. These may linger on or wear down quickly depends on the traffic frequency and the quality of grinding. The facets act as points of excessive contract stress between wheel and rail. (RGI Feb '19 pp28).

5. Block to repair L-Canaresie subway line: despite two years of preparation, New York Metropolitan Transportation Authority announced that it had dropped its plans for a 15 month blockade to repair the line. Instead it accepted the recommendations put forward by academics and engineers to limit the anticipated disruption. (RGI Feb '19 pp26).

6. Raising awareness about Climatic advantages of Freight Transport: A demonstration Freight train has been making its way round Europe, raising awareness of he role that rail freight can play in combating climate change. Rail Freight Forward (RFF) advocates that freight transport accounts to 6% of the European GDP and demand is expected to projected to grow around 30% over next two decades which is equivalent of the total German Transport sector today. Given that the Freight represents almost third of the total transport emissions equivalent to 275 million tonnes of CO2 per years, RFF advises that without radical change the climate impact can be expected to increase substantially in future, (RGI Feb '19 pp24).

7. Competitive Freight Wagon Concept: The CFW concept is based on block trains comprised of multi material lightweight wagons offering a significantly lower tare weight and higher pay load than current designs, with improved aerodynamics to lower noise and energy consumption. Electro pneumatic disc brakes would allow higher running speeds, facilitating mixed traffic operation using available

daytime train paths between passenger services. Centre couplers will provide better longitudinal train dynamics it is opined. Onboard power supplies would support refrigerated goods and telematic services for continuous monitoring of the wagons, their loads and train integrity. (RGI Feb 19 pp20)

8. Battery Shunter: Colmar Technik supplied a battery shunter in Italy. The 31 tonne vehicle can haul upto 3200 T, has Zero emissions at the point of use. The shunter has two 40KW traction motors and is powered by three battery packs with capacity of 200AH providing 8 hours of operation. (RGI Feb '19 pp19)

9. Eliminating weeds by Concrete Canvas: Concrete Canvas geosynthetic cementitious composite material has been installed in Rotterdam to prevent growth of weeds which could obstruct the Optical character recognition systems used to identify containers on passing freight trains. (RGI Feb'19 pp19).

10. 3D Printed components: Three companies have collaborated to use additive manufacturing to produce four train interior components meeting the standards required for use in UK rolling stock. The components made are arm rest, a grab handle and a seat back table. The aim is to produce replacements for obsolete parts, enabling vehicles to remain in service for longer. Operators will be able to produce low-run parts as required, without needing the mass production of large quantities. (RGI Feb '19 pp19).

11. Memorandums signed: India signed two memorandums of understanding with Russia covering educational development in Transport. It also covers technical cooperation in specialist railway disciplines. (RGI Dec '18 pp51).

12. Rail Drone specialist wings Innovation challenge: Mandrid based railway surveying start up won a regional innovation challenge for its work supporting resignalling schemes in spain and internationally (RGI Dec'18 pp51).

13. JR East on path of Change: JR East in their vision document MOVE UP 2027, have noted that the Business conditions are set to become far more challenging over the next 30 years, largely due to the changing Japanese demographic changes. There is a strong possibility that demand will decrease. As well as ageing population, changes in working patterns resulting from spread of telecommuting and spread of satellite offices, the ubiquity of Internet and emergence of autonomous driving technology. Hence JR East concluded that in the face of such challenges it is difficult to envisage that growth will continue on the basis of an unchanged business model.

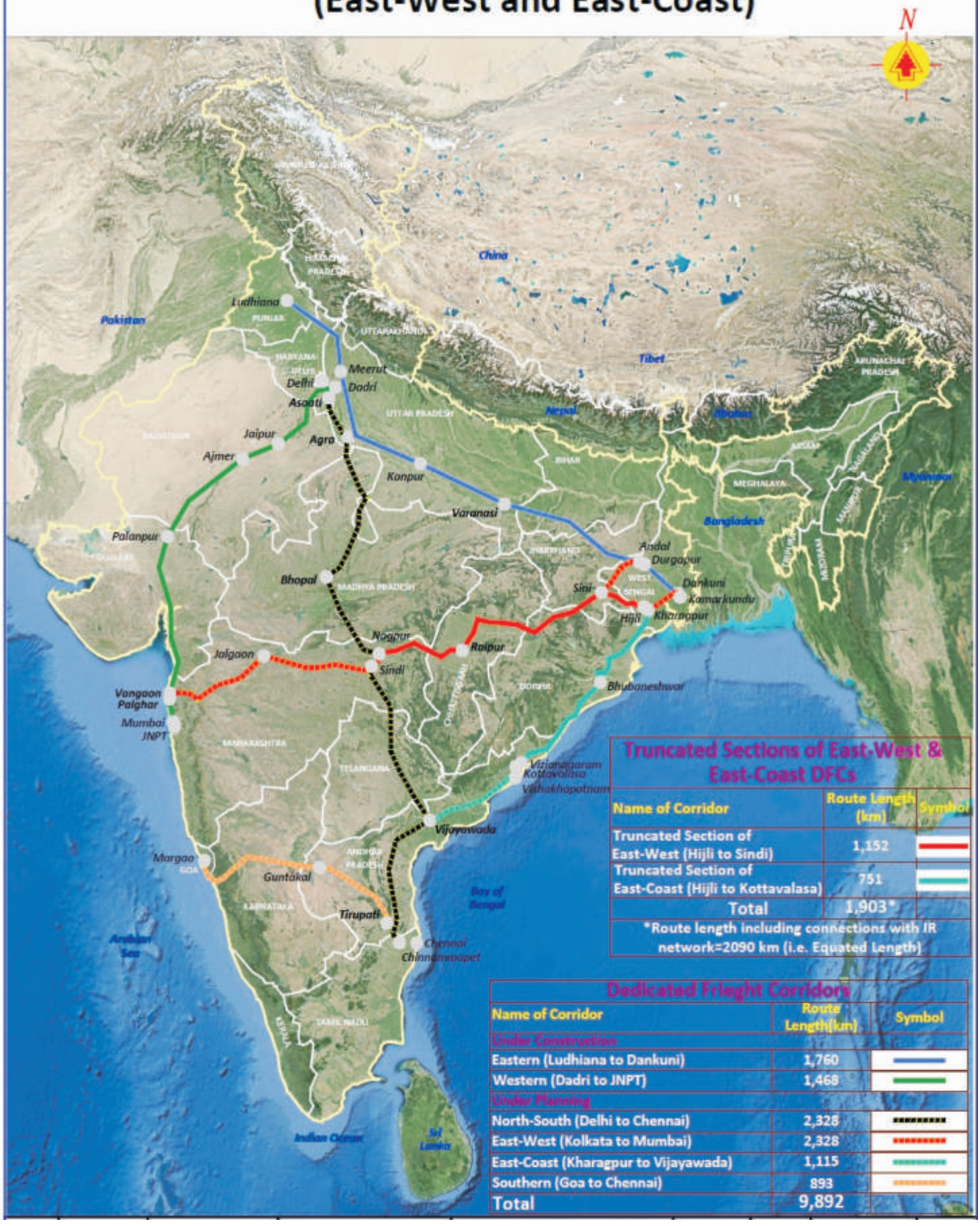
JR East in their vision document adopted in July 2018 believe that they should fundamentally shift focus from railways to people. JRE wants to move beyond providing services focussed on our railway infrastructure to providing society with added value that enriches people's lives. JRE will like to retain the trust of the people for which Safety shall be their first priority and the group will strive for 'extreme safety levels' that will make this trust even more unshakable. Their stations already serve as exchange hubs for people, offering a multi layered network of transport, life style and IT services, including the Suica smrt ticketing and e-payment system. The group must take maximum advantage of these established strengths but the important point is not to consider things exclusively from the perspective of railway operations but to think carefully about the enrichment means for customers and local communities as well as employees and their families.

JR East Vision document builds on three main themes: making cities more comfortable, making regional areas more affluent and developing businesses for the world. (RGI Dec 2018 pp34).

14. High speed freight service launched: FS group freight subsidiary launched its first high speed service designed to meet the needs of express couriers, logistic operators, producers and distributors. The Fast freight runs overnight at an average speed of 180kmph with end to end journey of 3 hrs 30 min.

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

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 कारपोरेशन ऑफ इंडिया लि.

Dedicated Freight Corridor Corporation of India Limited

(भारत सरकार का उपक्रम)

(A Govt. of India Enterprises)

5th Floor, Pragati Maidan Metro Station Building Complex,
New Delhi -110001 Ph-011-23454700, Fax-23454701

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