IRICEN JOURNAL OF CIVIL ENGINEERING

ज्ञान ज्योति से मार्गदर्शन

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Indian Railways Institute of Civil Engineering, Pune - 411001

IMPORTANT RECOMMENDATIONS OF PCE SEMINAR HELD ON 20th & 21st MARCH 2014 AT IRICEN/PUNE.

1. Correction slip be issued early for increasing the Track center to 7.8 m as recommended in TSC.
2. Railways shall send proposal to Railway Board for converting regular nature work charged post to revenue post.
3. Matching surrender shall not be insisted upon for creation of post for new assets.
4. No goods train shall be pushed in corridor blocks and blocks agreed as per joint programme signed by COM & PCE without personal consent of PCE.
5. A special allowance of Rs 2000/- be granted to Gate Man.

IMPORTANT RECOMMENDATIONS OF CHIEF ENGINEER / PLANNING SEMINAR HELD ON 10th & 11th APRIL 2014 AT IRICEN / PUNE.

1. A committee of CE/Plg/SR, CE/Works /SCR & SPW/IRICEN is formed to look into various issues related with the policy of Zonal contracts in Railways.
2. For issues related with GCC, a committee of CPDE/NWR & CPDE/NFR & SPW/IRICEN is constituted.

From director's Desk:

Dear Readers,

IRICEN is alma mater for all IRSE officers and I am now privileged to be a member of IRICEN faculty since March 2014. It is my pleasure to interact with the vast fraternity of Railway engineers through this Journal.

I am happy to inform that IRSE probationers (2011 batch) had the honour to call on the Hon'ble President of India on 22.04.14 at Rashtrapati Bhawan, New Delhi. It is an honour and memorable session for engineering officers at the beginning of their career in prestigious railway services to interact with the Hon'ble President of India. ThiThis interaction will motivate them throughout their career.

Indian Railways is considered backbone of Indian Economic Development. With the renewed emphasis on infrastructure development, Railways shall play a vital role, with greater emphasis on fast track development of rail infrastructure.

As you all known that as Engineering plays a significant and important role in infrastructure building, we have to energize ourselves to successfully undertake the challenges ahead. Our endeavour should be to simplify processes with an objective to minimize the time taken in various stages/activities of decision making and execution of works.

Safety in all aspects of Railway working be it operations or construction, is of paramount importance and therefore can never be over emphasized. The papers relating to safety in building construction and dismantling of ROB bring often the trivialized and glossed over issues to the fore. One of the papers included in this edition relating to land acquisition for infrastructure projects highlights the importance of the issue, along with various social and environmental aspects.

I am sure that the readers of this Journal would find value in the various papers/articles included in this Journal. I request all the readers to send their suggestions and send their articles/paper etc for inclusion in future issues for future editions of this Journal.

(Vishwesh Chaubey)
Director

Index

Suggestion for improvement of **IRICEN JOURNAL OF CIVIL ENGINEERING** are welcome from the members. Suggestion may be sent to mail@iricen.gov.in

Guidelines to contributors

Articles on the Railway Civil Engineering are welcome from the authors. The authors who are willing to contribute articles in the IRICEN Journal of Civil Engineering are requested to please go through the following guidelines :

1. The paper may be a review of conventional technology, possibilities of improvement in the technology or any other item which may be of interest to the readers. The paper should be reasonably detailed so that it could help the reader to understand the topic. The paper may contain analysis, design, construction, maintenance of railway civil engineering assets. The paper should be concise.
2. The journal is likely to be printed in a paper of size 215 mm X 280 mm. While sending the articles the author should write in 2 columns. Sketches, tables and figures should be accommodated in a 2 column set up only.
3. Author should send the original printout of photograph along with the digital copy of the photograph.
4. Soft copy as well as hard copy of article must be invariably sent to the editors of concerned subject.
5. Only selected articles will be included in the IRICEN Journal of Civil Engineering.

Work on Udhampur-Katra Rail Line in Concluding Stages

Work on the 25-km –long railway track between Udhampur and Katra sections after a series of delay is finally in the concluding stage. The Katra line was expected to be operational by the and of August last year as work was going on full throttle. The date was further extended to October last year. Laying work on 18 km long track between Kajikund and Banihal in Jammu and Kashmir is already complete. While DMUs were already plying from Banihal to Baramula, and also 42 kms long track between Fazlika and Abohar had been Laid.

Ref:- The Masterbuilder, Mar. 2014, Vol-16, Pg -30.

Delhi Metro to Assist Lahore Metro Rail

Pakistan's Punjab province desires to explore the possibilities of cooperation with DMRC in setting up a metro rail system in Lahore. Shortly after his arrival, the Punjab province chief minister met DMRC to learn from their experience in running metro rail in Delhi. His government is expected to invite bids from the global construction firms for construction of metro network in Lahore.

Ref: NBM&CW, Jan. 2014, Pg-30.

India Offers Cheapest Metro Projects

According to the Urban Development Secretary,Sudhir Krishna, in view of the easily available manpower at reasonable cost, India offers the cheapest metro projects in the world. He made this claim during his address at an event organised by the CII and added that the next highest is something that is 20% more but generally it is 40% more than Indian metro projects. While India is not manufacturing all the components, the key lies in the country's large population which allows us to deploy more people in a project. Due to sufficient availability of the manpower, the government can break the project into different components and then bid to get the best possible competitors who are experts in fields, whether it is the signalling system or the rolling stock or in regard to construction of the civil structure. Urbanisation has gathered pace in India and the current trend was that small-and mid-sized cities were growing at a faster pace. Keeping this in mind, the government has fast tracked the work on three Regional Rapid Transit Systems (RRTS) corridors connecting Panipat,Meerut and Alwar with the national capital.

Ref: NBM&CW, Jan. 2014, Pg-30.

FDI in Railways

Introduction of FDI policy in Railways could be delayed. Scope and coverage of the policy and the preferred route for bringing in the foreign investment needed fine tuning. Accordingly to the Department of Industrial Policy & Promotion (DIPP), the railways is yet to provide some clarifications on routes through which it wants the investment to come in and areas which the railways would like to open up for investors. DIPP,which formulates foreign investment policies has stated that investors in the FDI policy could be allowed to hold 100% stake in the SPVs meant for construction of ports, connectivity projects and railway lines connecting mines. Railways stance is that it wants to go beyond FDI in connectivity projects, to areas where it has PPP as the Railways is targeting to attract Rs 6000 crore through the PPP route this year.

Ref: NBM&CW, Jan. 2014, Pg-32.

Marathon Runs Europe's L ongest Freight Train

French national railways (SNCF) in cooperation with French Rail Network (RFF) and intermodal operator Kombiverkehr operated a 1500m-long freight train on January 18 between Sibelin yard near Lyon and Nimes as part of Europe's marathon project to operate longer freight train.

This is the first test operation of a 1500m-long freigt train in Europe and was achieved by reforming three of

Kombiverkehr's regular Germany-Spain intermodal trains into two 750m-long consists,which were coupled together at Sibelin yard to form a 4100-tonne 70-wagon train. This was hauled across France by two Alstom class 37000 electric locomotives operating in distributed power mode.

SNCF says the trial run was preceded by two years of preparation and testing.

Marathon is a €4.4m collaborative project co-founded by the European Commission through its 7th Framework Programme for Research and Development.

The three-year project was launched in April 2011 and aims to demonstrate the effectiveness of operating longer,faster,and heavier freight trains on selected routes in Europe.

Other partners in the Marathon project include Swedish infrastructure manager Trafikverket; suppliers Alstom,Vossloh and Faiveley transport; and industry bodies including the International Union of Railways (UIC) and the European Rail Industry Association(unife).

Ref: International Railway Journal, Feb. 2014,Vol-54, Pg-4.

Pak Railways Seeks Technical Assistance

In order to make its railway operations economically viable, pakistan has sought help and technical guidance from indian Railways. A Pakistani Railways delegation will soon visit India to learn from the knowledge and the experience of the Indian Rail system, which has been turned into a profitable entity while Pakistan was yet to achieve this goal, said Pak Railways minister during his visit to India. Pak needs to take help and guidance from the Indian Railways to make it economically viable and bring it on the right track. Pakistan is also searching for a foreign partner to invest in improving railway infrastructure. Opening of the some dormant as well as new rail lines for promotion of trade and commerce is also on our agenda, he added.

Ref: NBM & CW, Jan. 2014, Pg-32.

Mumbai Elevated Corriodor

Amid fears that the rs 20,000 crore Mumbai elevated corridor project could be put on the back burner following objections from the state government, finally the decks have been cleared for the project, stated a statement from PMO adding that a fresh traffic study for the same is required. RITES is to conduct this study. After the fresh traffic study, yhe state government should agree to sign the state support aggrement so that contract for the project could be awarded by May 2014. Eight to nine leading infrastructure companies are vying to grab this project.

Ref: NBM & CW, Jan.2014, Pg-32.

Hyderabad Metro Rail Project: Phase I Trial Runs to Begin by July

L & T Hydrabad Metro Rail Ltd expects to commence trial run for the first phase of the elevated metro project in Hyderabad by July.

The rail coaches from the Hundai Rotem consortium are expected to arrive in Hyderabad by May and the trial runs for the first phase of the 8km stretch of the 72 km metro project will be taken up by July. While the trials will go on for a few months, the first phase will be ready for commercial operations by March 2015, said N.V.S.Reddy,Managing Director, Hyderabad Metro Rail Ltd.

Speaking to reporters, Reddy said the concessionaire L&T and Hyderabad Metro Have Invested about Rs 4,000 crore so far. This includes Rs 3,100 crore by L&T and rs 900 crore by Hyderabad metro.

Referring to the land acquisition for the project, he said, of the 269 acres assured, 267 acres have been handed over till now. The remaining two acres yet to be handed over as it is under litigation, he said.

"So far more than 1,800 trees have been translocated,wiyh 98 percent survival rate. We have also taken up massive tree plantation drive involving colleges and students. All these ensure that there is good greenery for the project," he said.

Reffering to the possibility of issuing smart cards to passengers, which will potentially double up as multipurpose cards, Reddy said several banks have evinced interest in partnering this initiative. At least two banks will be chosen at the appropriate time, he indicated.

Ref: Civil Engineering & Construction Review, Feb-2014, Pg-18

India, ADB Sign US$ 130 Million Loan Agreement to Improve Rail Infrastructure

The Government of India and Asian Development Bank (ADB) signed US$130 million loan agreement to help India improve rail services along some of its busiest and most critical freight and passenger transport routes. The second tranche loan is part of the US$500 million Railway Sector investment program approved by ADB in 2011, and will finance track components for 840 kilometers of additional tracks along existing railway lines.

The signatories to the loan were Mr. Nilaya Mitash, Joint secretary(Multi lateral Institutions), Department of Economic affairs, ministry of Finance on behalf of the Government of India, and Ms. M. Teresa Kho, Country Director(INRM), on behalf of ADB. The project agreement was signed by Mr. Satish Agnihotri, CMD, RVNL.

Ref: The Masterbuilder, Mar-2014, pg-30

India Looks to Foreign Investors to Fund Rail Projects.

During the announcement of an interim budget of Rs 643bn (US$ 10.26bn) for Indian Railways for 2014-15, India's railway minister Mr. Mallikarjun Kharge outlined plans to allow Foreign Direct Investment(FDI) to fund infrastructure projects,

Kharge told the Lok Sabha, India's lower house of parliament, that Indian Railways' proposal to obtain foreign investment to fund high speed and semi high speed(160-200km/h) rail projects is likely to be approved shortly by the cabinet.

Kharge reiterated that concrete progress on the Mumbai-Ahmedabad high-speed project is likely after the completion of a Jica-sponsored survey. Semi-high-speed services are planned on the Delhi-Agra and Delhi-Chandigarh lines. "Our plans are to make one of these routes operational by the year end," IR's Chairman Mr Arunendra Kumar said later.

The railway minister emphasised the need to continue reforms initiated by the ruling coalition. He said the Rail Tariff Authority (RTA) would shortly become operational. He also announced plans to run 17 premier trains using a yield management pricing model akin to that used by airlines and introduce 72 new train services.

IR's financial performance is a continuing cause for concern. Its operating ratio climbed from 87.8% to 90.8% for the current financial year. IR has suffered a substancial reduction in passenger revenue, while fuel costs have spiralled.

As a result of shortfall in earnings, the ministry's planned outlay for the current financial year has been cut by almost Rs40bn from Rs633bn to Rs593bn.

A new government will assume office in India in May following national elections, when a full railway budget will be presented.

Ref: International Railway Journal, Mar 2014,Vol-54,pg-4

JR East's First Battery EMU Enters Service this Month

He first battery emu for JR East, which was delivered in January, will enter service in march enabling through operation on the partly-electrified line between Utsunomiya and Karasuyama.

The series EV-E301 train will run as an emu on the 11.7km section from Utsunomiya to Hoshakuji which is electrified at 1.5kVdc enabling the batteries to be charged. The train will then switch to battery operation for the remaining 20.4km non-electrified section to Karasuyama. A short overhead catenary feeder section has been installed at Karasuyama station for battery charging.

The 100km/h train consists of two cars, each powered by two 95KW traction motors and fitted with a 600V 95kWh lithium ion battery. The train, which has a lightweight stainless-steel car body, was built by Japan Transport Engineering Company, formerly Tokyu Car Corporation, and now an affiliate of JR East, with Hitachi supplying traction equipment and GS Yuasa Batteries.

Ref: International Railway Journal, Mar 2014, Vol-54, pg-7

Train Running Test Using a Superconducting Feeding Wire

On 24 July, 2013, Railway Technical Research Institute (RTRI) published the running test of a train by a superconducting cable for news media.

A feeding wire, which sends electricity to vehicles from a substation, has an electrical resistance at present. If a superconducting material free from this resistance can be used for the transmission of electric power, it is expected to have merits that the power obtained in regenerative brake can be sent to the train at a distance without any loss of power. In addition, it would also reduce the number of substations by preventing voltage drop.

In 2010, a prototype superconducting cable of 5m length 8 kA-class was manufactured and the evaluation of performance was carried out. Compactness was achieved by supplying a circulating refrigerant (super cooled liquid nitrogen) necessary to keep the superconducting state in one cable.

In FY 2012, the prototype superconducting cable of 31m length 5 kA-class was manufactured. Driving tests using this cable have started on the test line at the premises of the Institute in June 2013. the running test of a train using superconducting cable is the first in the world.

RTRI have planned the test using further long length superconducting cable of 310m, by around the autumn of 2013, and aim to complete the system suitable for introduction on a commercial line.

Ref. : Japanese Railway Engineering, January 2014, No.182, Pg-9

Vertical Vibration Control of Vehicles – Air Spring Car's First System

Railway Technical Research Institute (RTRI) and Hitachi Automotive System Ltd. have newly developed an up and down control system for an air spring vehicle. This is a proven system for the coil spring, but there is no precedent for air spring in the world.

This system was introduced into the cruise train. "SEVEN STARS IN KYUSHU" of JR Kyushu, which started operation in October,2013 and is quite useful in vibration suppression. In the system, vertical motion damper with variable damping function is installed on two places on each truck in parallel with the secondary spring (air spring) supporting a vehicle body. Expansion of the damper is controlled in accordance with the magnitude of the shaking detected by the acceleration sensors provided, thus vibrations are reduced.

In "SEVEN STARTS", the same system was equipped in all seven passenger cars. Thus, compared with the air spring vehicles existing, the peak value which indicates the strength of vibration "vibration acceleration power spectral density(PSD)", was reduced significantly by about one tenth.

Ref. : Japanese Railway Engineering, January 2014, No.182, Pg-9

Linear Motor Car Line Construction Greatly Forward

On 18 September 2013, JR Central published environmental impact assessment prepared statement for the linear central Shinkansen planning between Tokyo Shinagawa and Nagoya, aimed to open in FY 2027. In addition to showing the route of 286km length of which about 86% is tunnels and the detailed location of stations and car maintenance depots, research results of environmental assessment, which were carried out so far, were opened. By the details revealed, the plan will be a major step forward towards the start of construction in 2014.

According to the document, Tokyo terminal station is installed in about 40m underground of the Tokaido Shinkansen Shinagawa station. Nagoya city terminal station is provided at about 30m underground of the Shinkansen Nagoya station. Both stations have 2 platforms and 4 tracks, with a maximum width of about 60m and 1km length.

The 246 km of the line is mountain tunnels or city tunnels (both widths about 13m). Of these, in the point of view of ensuring smooth land acquisition, the sections from Tokyo terminal station to the Sagami river and from border between Giftu and Aichi prefecture to Nagoya terminal station around are mainly deeper underground route more than 40m. On the ground sections such as crossing sections of major rivers and Kofu basin, girder type or a new type viaduct with less tightness slender bridge girder is used depending on terrain (both widths 14m).

Ref. : Japanese Railway Engineering, January 2014, No.182, Pg-16

NPBCL Kicks off Work on Nepal Highway Tunnel

Nepal Construction works on Kathmandu-Kulekhani-Hetauda Tunnel (KKHT) Highway began on 11 Nov 2013.Issuing a statement to the media, developer Nepal Purbandhar Bikas Company Limited (NPBCL) said construction works would begin from Bhimphedi in Makwanpur district."We have the responsibility of starting the project within the time mentioned in the aggrement with the Nepal government. We are happy that we are starting construction works within the timeframe announced earlier," said Kush Kumar Joshi, President of NPBCL.Joshi added that NPBCL wouldn't be holding any formal program to begin construction works as most of the people are busy due to upcoming Constituent assembly (CA) election. The company claimed that the 58 km tunnel highway will shorten travel distance between Kathmandu and hetauda to just an hour from around six hours. The project is estimated to cost around NPR 35bn (USD 350m) and expected to complete by Dec 2016.

Ref: Tunnels and Tunneling, Jan. 2014, Pg-10

Govt to Hand Over 14 More Domestic Airports to Private Parties:

Minister of state for civil aviation K.C.Venugopal announced in Rajya Sabha recently that it intends to give away 14 more airports to private parties for operation and development during the 12th plan period in addition to its current proceeding of privatising six airports including those at Kolkata and chennai.

The other Airport Authority of India (AAI) developed airports which the government is planning to bring under the PPP mode are at Bhubaneshwar, Coimbatore, trichy, Varanasi, Indore, Amritsar, Udaipur, Gaya, Raipur, Bhopal, Agartala, Imphal, Mangalore and Vadodara.

Ref: The Masterbuilder, Mar-2014, Pg-38

IMPORTANT RECOMMENDATIONS OF CHIEF ENGINEER / TRACK PROCUREMENT'S SEMINAR HELD ON 8th & 9th MAY, 2014 AT IRICEN / PUNE.

1. It was recommended that PCEs and CAOs should also be included in the mailing list of Stores Directorate.
2. RDSO is regularly upgrading the drawings, specifications and latest amendments related to track procurement, if particular drawing is not available a reference can be made to RDSO.
3. For track procurement existing provision of performance guarantee (PG) should continue. For pooled PG, Board may please issue guidelines.
4. Policy for trial items and comprehensive policy for dealing unsolicited offers may be issued by Railway Board.
5. RDSO should work out better method for production of sleepers with tight tolerance (T-2 496 CH-4)
6. Adopting limited tender for track items where Board approval is must was recommended. Board may issue instructions.
7. Tenderers not agreeing with the railway terms and conditions, should not be able to quote rates.
8. Weight should be made as a part of P.way materials description.
9. Variation upto 30% recommended without finance concurrence.
10. List of vendor needs to be modified such that a particular vendor is approved for all the components, which are used as a set in order to streamline the procurement.
11. TC limit of SAG officers for track procurement be enhanced from existing 2 to 15 crores to 5-20 crores.
12. For trial items where no LPR is available for arriving on Reasonability of rates, CE/TP be authorized to sanction rate analysis upto 20 lakhs based on WPI available for input material as per market survey certified by Dy.CE/TP.
13. Limit of purchase order for supply of P.way material without constitution of TC by Dy.CE/TP on the basis of rate reasonability certified by XEN/TP be enhanced from existing 5 lakh to 20 lakhs.
14. Force majeure clause should be introduced in IRS conditions.
15. Power to grant extention without LD with PVC & without denial clause upto 25% of total completion period for the supplied quantity be delegated as per SOP.

JLG Launches World's Tallest Telescopic Boom

JLG Industries launched its 1850SJ Ultra boom, world's tallest telescopic boom with nearly three million cubic

feet of reachable space. With a working height over 185 feet ,this is the second boom introduced within the past year to reach 180 feet or above. The 1850SJ includes a telescopic jib that extends and retracts to provide additional reach,up-and-over capability and the ability to telescope into and around structures in a variety of applications, including steel erection; energy-related construction such as petrochemical ,power generation and wind plants; stadium,convention center and theatre construction; and entertainment and studio related applications.

In addition, an exclusive updated platform LCD display provides even more information to optimize service and operator productivity.

Ref: The Masterbuilder,March-2015,Vol.16, Pg-20

ON TRACK - ENSCO Inc.

ENSCO's first autonomous track inspection product was the vehicle/Track Interaction (V/TI) monitor, which has been available for about 10 years and is being used by Class Is, Amtrak, and several other freight and passenger railroads around the world. It's designed to monitor track conditions. It looks for conditions such as poor surface geometry, poor support conditions and impacts at the wheel-rail interface.

Recently, the company introduced the Autonomous Track Geometry measurement system (ATGMS), an unmanned real-time system designed to measure and report track geometry exceptions, including gauge, cross level , alignment and surface. The big advantage of autonomous track geometry is that it no longer needs a dedicated inspection vehicle with staff to operate it. If it's installed in a revenue train, it can test continuously and get in considerably more testing on an annual basis.

In September, ENSCO introduced an upgrade to its RailScan Lite Hi-Rail System, a non-contact sensor that mounts on a hi-rail vehicle and connects to a laptop computer to help inspectors look for deviations during track inspections. The model that's been on the market measures two key geometry parameters: gauge and cross level. The product upgrade performs full track geometry measurements.

Ref.: Progressive Railroading,
Issue : December 2013, Pg-44.

ON TRACK - Plasser American Corp.

Plasser offers a full spectrum of track inspection technology. Video monitoring is one of the latest trends to emerge.

Recently, Plasser worked with a large urban transit agency on a track inspection research project funded by the Federal Transit Administration (FTA). The agency's track inspection car already was equipped with Plasser's track component video system that provided a right of way, rail and gauge-side view of the track area. The research project took that view a step further by providing a field side view of the running rails and the power rails (or third rail) to complete the spectrum of measurement and visual inspection of track components.

The enhanced video monitoring function adds to Plasser's track recording and measuring systems to assist inspectors in analyzing track geometry and other data related to the rail profile, such as wear of the running edge, rail inclination and rail surface faults. Instead of having to walk the track and be in danger of being hit by a train, the task of track walking can be performed in the office. This provides a combined review of track measurements and track video data.

Ref.: Progressive Railroading,
Issue : December, 2013, Pg-52.

Tata Steel- Europe's Second Largest Steelmaker

Tata Steel, Europe's second largest steelmaker announced the launch of a new state of the art facility which will produce train track capable of lasting upto three times longer than standard rail.

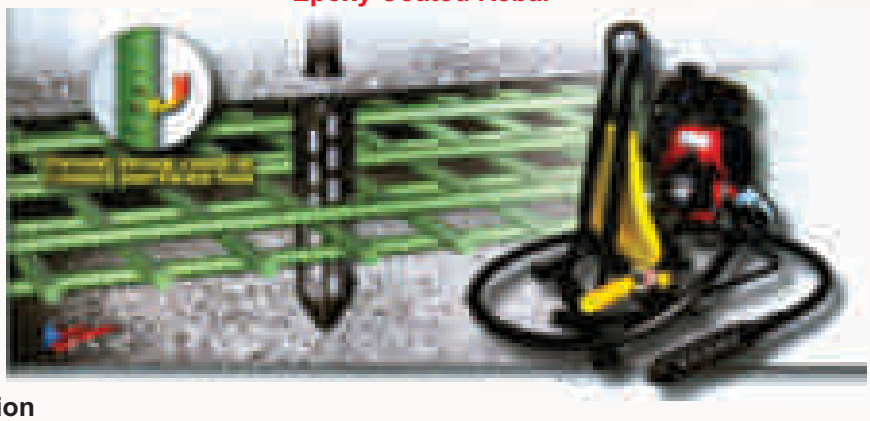
The commissioning of the new heat treatment plant at Tata Steel's Hayange plant, in the Lorraine region of France, means the company will be able to supply long lengths of super hardened rail that they say is heat treated and stress free. These rails of upto 108 meters in length will allow rail operators to enhance performance and reduce costs associated with more frequent worn rail replacement.

Heat treated rail can last upto three times longer than standard rail when used in high wear conditions such as heavy traffic, high axle loads or tight curves designed to cope with heavier axle loads, as well as the traffic on metro systems, where heat treated rails need to have exceptional technical performance in demanding traffic conditions.

Tata Steels' heat treated rail is produced using a unique patented process that ensures it has exceptional wear resistance. The rail moves through an induction furnace which uses an electromagnetic field to heat the steel to 9500C. The rail is then rapidly cooled using compressed air.

Ref. Permanent Way Institution Journal Issue : January,2014 Vol.132-part-1, Pg-33.

High Efficiency "Rubber Head" the Most Efficient tool for Consolidating Concrete Without Damaging Epoxy Coated Rebar

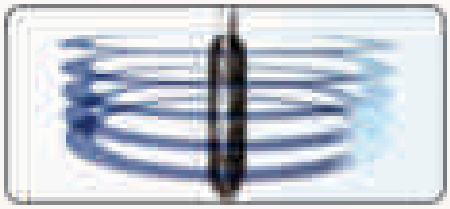


Perfect Consolidation

Oztec's patented "RubberHead" with its large number of openings allows the wet concrete to cool the inner shell and acts like "suction cups", keeping the concrete in constant contact with the entire length of the vibrator head, sending strong shock waves into the mass. The Oztec RubberHead is available in a range of shapes and sizes for any application.

- Will outperform any other type of vibrator... round, square, hi-cycle, etc... Any Type!
- Will protect epoxy coated rebar and expensive forms.
- Is outstanding in low slump (to "0" slump) concrete.
- Essential in large pours of very stiff concrete.
- Makes concrete denser with less voids to patch.
- Vibrates @ 12,000vpm, never drops below 10,500 vpm when lowered deep into low slump concrete.
- Is an absolute must for Architectural concrete where cosmetic surfaces are essential.
- Can be used with Oztec electric or gas powered units.

RubberHead



Standard vibrator head

Oztec's uniform, high efficiency action delivers vibration along the entire length of the vibrator head. This assures better consolidated concrete and is job proven to be more efficient than any other vibrator head on the market.

When a smooth vibrator head (round, square or any other shape) is lowered into a relatively stiff concrete batch, the front or nose of the vibrator drills a hole. It pushes away concrete faster than it can return. Result, shock waves produced mostly from the vibrator's front end.

For details, refer www.oztec.com

Ref: Concrete International, vol-36, Feb-2014, Pg-15

Concrete Reinforcement Products

Quality Engineered Products

Proven Performance

Trusted Experts

Worldwide Code Compliance

1. **Terminator**
   Alternative to hooked rebar anchorage
2. **Quick Wedge**
   Ideal for quick retrofit
3. **Cadweld**
   Premiere mechanical splicing system
4. **Interlock**
   Ideal for precast structures
5. **Taper Threaded Couplers**
   Slimmest coupler on the market
6. **Speed Sleeve**
   For compression situations
7. **Form Saver**
   Ideal for segmental pour
8. **Lock**
   Ideal for in-situ splices

Ref: Concrete International, vol-36, Feb-2014, Pg-24.

Hilti HIT-HY 200 Adhesive Anchor System

Hilti introduced its HIT-HY Adhesive Anchor System. It can be installed with the traditional blow-brush-blow method using compressed air and a wire brush to clean the drill hole. HIT-HY 200 requires two blows of compressed air, two brushes, and two more blows of compressed air when using the traditional method. The blow-brush-blow cleaning technique maximizes the application range of the HIT-HY 200. The system is available in two versions with the same load performance: HIT-HY 200-R for regular working times and HIT-HY 200-A for accelerated working times to allow users to select the right adhesive for the application and for the job site. HIT-HY 200 Adhesive Anchor System installed with the hollow drill-bit method, HIT-Z, or standard hole cleaning is approved by ICC-ES in ESR-3187 for use in all seismic zones and uncracked and cracked concrete.

-Hilti, www.us.hilti.com

Ref: Concrete International, vol-36, Feb-2014, Pg-65.

वृक्ष अपने सिर पर तीव्र धूप को सहन करता है और अपनी छाया से आश्रितों के संताप को दूर करता है। बड़प्पन की परिभाषा यही है।

..... विनोबा भावे

शिक्षक मोमबत्ती के समान है जो स्वयं जलकर दूसरों को प्रकाश देती है।

..... सूफिनी

Provisions Regarding Deflection/Camber in Various National and International Codes for Rail and Road Bridges

By
Ajay Goyal *

A. Deformation control in bridges:

Large deformation of bridges under loads can lead to psychological problems or can lead to large secondary stresses or can also have safety implications. For bridges of small spans (upto 45m) and meant for low speeds, vertical deflection alone are governing criteria as per most national and international codes. There are many other deformations which are to be controlled for large span bridges and for higher speeds. Control of deformations on Rail bridges is much more important as compared to road bridges. Different types of deformations and comfort criteria which are considered in design of bridges are listed below.

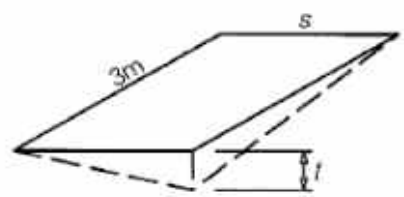
a. Vertical deflection of the deck.

b. Rotation of the ends of each deck about a transverse axis or the relative total rotation between adjacent deck ends to limit additional rail stresses, limit uplift forces on rail fastening systems and limit angular discontinuity at expansion devices and switch blades

c. Unrestrained uplift at the bearings to avoid premature bearing failure

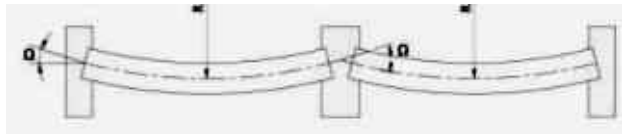
d. Vertical deflection of the end of the deck beyond bearings to avoid destabilizing the track, limit uplift forces on rail fastening systems and limit additional rail stresses.

e. Twist of the deck measured along the centre line of each track on the approaches to a bridge and across a bridge to minimize the risk of train derailment



f. Longitudinal displacement of the end of the upper surface of the deck due to longitudinal displacement and rotation of the deck end to limit additional rail stresses and minimize disturbance to track ballast and adjacent track formation

g. Horizontal transverse deflection to ensure acceptable horizontal track radii



h. Horizontal rotation of a deck about a vertical axis at ends of a deck to ensure acceptable horizontal track geometry and passenger comfort

i. Vertical accelerations of the deck to avoid ballast instability and unacceptable reduction in wheel rail contact forces

j. Limits on the first natural frequency of lateral vibration

* *CE/C/N/CR* SAG Course No. 14201

of the span to avoid the occurrence of resonance between the lateral motion of vehicles on their suspension and the bridge

k. Checks on bridge deformations should be performed for passenger comfort, i.e. vertical deflection of the deck to limit coach body acceleration

For small spans and low speeds as in IR, only vertical deflection criteria is most fundamental and is only applied and therefore has been discussed in detail.

VERTICAL DEFLECTION

Deflection control of bridges is a service design consideration and has been incorporated in various codes since 1800s. The requirement to limit deflection of a railroad bridge is self-evident when one considers the rocking forces that could lead to catastrophe on a bridge that may be too flexible. Large deflections could also lead to secondary stresses that might cause fatigue cracking.Psychologists had found that humans think that vertical deflection they sense is about ten times the actual deflection. Human discomfort is due to acceleration, not deflection alone; therefore limitations have been prescribed on accelerations for passenger comfort.

Limit of maximum span-to-depth ratio recommended in some old codes were also indirectly based on deflection criteria. With the advent of higher strength steels and increases in design stresses, it was possible to keep depth of girders small and limiting values of live load deflection did not permit lesser depths and led to costly designs. As early as the 1950s, ASCE began an investigation of the basis for these limits and found numerous shortcomings, including no clear basis for their use, and no evidence of structural damage that could be attributed to excessive deflections. The live load deflection limit on steel bridges with both pedestrian and vehicular loads was set at Span/1000 as a result of isolated concerns related to human response. The criteria remained optional.

Guidelines for limiting the natural frequency of bridges to provide tolerable motion, the deflection limits are tied to the first fundamental frequency of the superstructure. Wright and Walker found a tenuous theoretical relationship between deflection and natural frequency. In checking all the deflection limits, the 'Span' is typically taken as the full span length of the girder.

The live load used to compute live load deflection has traditionally been the same asthe design live load. This made sense for design based on service loads only.However, for strength-based design, a different and lighter load for service limit statechecks is logical since the criteria are based on a different philosophy. Serviceability relates to thestructure response to likely loads; these likely loads are reasonably less than theload used to check structural strength.

B) The provisions of deformations in various codes, especially vertical deflection are given below;

a. IRS Steel Bridge Code: Para 4.17 :Deflection- For permanent installation other than foot-over-bridges the ratio of deflection to length of the girder shall not exceed 1/600. In the case of foot over-bridges, the ratio of deflection to length of the girder shall not exceed 1/325.

Note:-With the specific sanction of the Board, the limit of 1/600 may be exceeded for girders in permanent installations.

Para 4.16: **Camber-** Beams and plate girder spans up to and including 35 m (115 ft) need not be cambered. In un-prestressed open web spans, the camber of the main girders and the corresponding variations in length of members shall be such that when the girders are loaded with full dead load plus 75 per cent of the live load without impact producing maximum bending moment, they shall take up the true geometrical shape assumed in their design. Where girders are pre-stressed the stress camber change should be based on full dead load and live load including impact.

This code is primarily intended to apply to the superstructure of simply supported steel bridges of spans up to 100 m (325 ft) between centres of bearings. Where appropriate, the provisions of the code may be adopted for larger spans or other types of steel bridges, but care should be taken, in these circumstances to make whatever amendments are necessary for fixity at the supports, continuity and other indeterminate or special conditions.

To sum up, steel bridge code prescribes max deflection of L/600 for rail bridges, it further allows this limit to be exceeded with specific approval of Board. This limit of L/600 is to be applied for Full dead load + live load + Impact. Camber to be provided is as per para 4.16.

b. **IRS Concrete Bridge Code:** No specific provisions have been prescribed in the code for vertical deflection but a load test has been provided in para 18.2.3 to 18.2.5, which is based on deflection.

18.2.3 Test Loads – The test loads to be applied for the limit states of deflection and local damage are the appropriate design loads, i.e. the characteristic dead and imposed loads. When the ultimate limit state is being considered, the test load should be equal to the sum of the characteristic dead load plus 1.25 times the characteristic

imposed load and should be maintained for a period of 24h. If any of the final dead load is not in position on the structure, compensating loads should be added as necessary. During the tests, struts and bracing strong enough to support the whole load should be placed in position leaving a gap under the members to be tested and adequate precautions should be taken to safeguard persons in the vicinity of the structure.

18.2.4 Measurements of deflection and crack width should be taken immediately after the application of load and in the case of the 24h sustained load test at the end of the 24h-loaded period after removal of the load and after the 24h recovery period. Sufficient measurements should be taken to enable side effects to be taken into account. Temperature and weather conditions should be recorded during the test.

18.2.5 In assessing the serviceability of a structure or part of a structure following a loading test, the possible effects of variation in temperature and humidity during the period of the test should be considered.The following recommendations should be met.

18.2.5.1 For reinforced concrete structures, the maximum width of any crack measured immediately on application of the test load for local damage should not be more than two thirds of the value for the limit state requirement. For prestressed concrete structures, no visible cracks should occur under the test load for local damage.

18.2.5.2. For members spanning between two supports, the deflection measured immediately after application of the test load for deflections should not be more than 1/500 of the effective span. Limits should be agreed before testing cantilever portions of structures.

18.2.5.3 If the maximum deflection (in millimeters) shown during the 24h under load is less than 40 L2/h where L is the effective span (in metres) and h is the overall depth of construction in (millimeters), it is not necessary for the recovery to be measured and 18.2.5.4 and 18.2.5.5 do not apply.

18.2.5.4 If within 24h of the removal of the test load for the ultimate limit state as calculated in 18.2.3 a reinforced concrete structure does not show a recovery of at least 75% of the maximum deflection shown during the 24h under load. The loading should be repeated the structure should be considered to have failed to pass the test if the recovery after the second loading is not at least 75% of the maximum deflection shown during the second loading;

18.2.5.5 If within 24 h of the removal of the test load for the ultimate limit state as calculated in 18.2.3 a prestressed concrete structures does not a recovery of at least 85% of the maximum deflection shown during the 24h under load. The loading should be repeated. The structure should be considered to have failed to pass the test if the recovery after the second loading is not at least 85% of the maximum deflection shown during the second loading.

c) There is no IRS code dealing with composite structures, normally provisions of steel

bridge code are applied without any specific provision in any code.

d) IRC 112: Code of practice for concrete road bridges:

This code supersedes IRC 21.

For other than cable supported bridges, following shall apply. Para 12.4 states;

The deflections/deformations of a member or structure shall not be such that it adversely affects its proper functioning or appearance. In some cases, expected deflections may need to be adjusted in structural geometry by pre-cambering, so as to attain the requisite profile at the time of placing expansion joints and wearing course.

Appropriate limiting values of deflection taking into account the nature of structure, bridge deck furniture and functional needs of the bridge, should be established. In the absence of other criteria, the following deflection limits under live load may be considered.

- Vehicular	:	Span/800
- Vehicular and pedestrian or pedestrian alone	:	Span/1000
- Vehicular on cantilever	:	Span/300
- Vehi. & Ped. or Ped. alone on cantilever	:	Span/375

e) IRC 22: Code of practice for road bridges, composite construction:

Para 606.4 states;

The deflection shall be limited to relevant provisions of IRC:21 and IRC:24

f) IRC 24: Code of practice for road bridges, steel bridges:

Para 507.5 state

Rolled steel beams, plate girders or lattice girders, either simple or continuous spans, shall be designed so that the

total deflection due to dead load, live load and impact shall not exceed 1/600 of the span. Additionally deflection due to live load + Impact shall not exceed L/800

In cantilever arm, not more than L/300 due to dead load, live load and impact. Not more than L/400 due to live load and impact

Camber- Beams and plate girder spans up to and including 35 m need not be cambered. In open web spans, the camber of the main girders and the corresponding variations in length of members shall be such that when the girders are loaded with full dead load plus 75 per cent of the live load without impact producing maximum bending moment, they shall take up the true geometrical shape assumed in their design. The camber diagram shall be prepared.

g) IRC 21: Code of practice for road bridges, concrete construction:

This code has been superseded by IRC 112.

No provision for deflection. Appendix 1 gives crack control parameters.

h) UIC776-3R: Deformation of Bridges:

Deformation limits are given for vertical deflection, angle of rotation at ends, track twist and horizontal deflection of Railway bridges. The values given are for three speed ranges; up to 120kmph, up to 200 kmph and above 200 kmph.

Values for speed range 1, values of vertical deflection and camber are as under.

- For spans more than 12m, an upward camber equal to L/1000 under self weight can be given to improve appearance.
- Due to LL and for speed range 1 and passenger comfort as acceptable; for 2 adjacent decks vertical deflection should be < L/350; for 3 to 5 adjacent spans and spans up to 25 m it should be < L/450 and for more than 30 m spans it should be < L/800.

So UIC code also limits deflection based on imposed loads only and for speeds up to 120 kmph, values are as high as L/350 for small spans and less than three adjacent spans to L/800 for larger and more than 3 adjacent spans. These provisions are quite liberal as compared to IRS provisions.

i) UIC 776-2R: Bridges for high and very high speeds:

For high speeds tracks, low tolerances are essential for cross and longitudinal level, track twist and alignment. Following limits are prescribed. These limits are w.r.t live load.

- Vertical deflection : L/800
- Angle of rotation at ends : 1/200
- Horizontal deflection : L/4000
- Skew of bridge : Max twist 1mm/m

Camber: It is desirable to provide camber of not more than half the calculated live load deflection and this value should be limited to L/1500

j) UIC 774-3R: LWR on bridges:

Code prescribes deformation limits when bridges are provided with LWR

- Maximum absolute displacement of deck due to tractive/breaking forces
  - +/- 5 mm if no SEJ or SEJ at one end
  - +/- 30 mm with SEJ on both ends
- Maximum relative displacement between track and deck due to tractive/breaking forces
  - 4 mm
- Maximum displacement between the top of deck end and the embankment or between two deck ends due to deck bending
  - 8 mm
- Maximum lift of deck on SEJ end
- To be specified by Railway, Primarily depends upon speed

k) AASHTO code G12.1.2003: Guidelines for design and constructability

This code is applicable to steel road bridges, does not give any provision for vertical deflection but gives detailed coverage on differential deflection on curved spans.

l) AREMA: Chapter 8 on concrete bridges for Railways:

Flexural members of bridge structures shall be designed to have adequate stiffness to limit deflections or anydeformations that may adversely affect strength and serviceability of the structure at service load. Membershaving simple or continuous spans shall be designed so that the deflection due to service live load plus impact doesnot exceed l/640 of the span.

Deflections that occur immediately on application of load shall be computed by usual methods or formulas for elastic deflections, and moment of inertia of gross concrete

section may be used for uncracked sections. Additional long-time deflection shall be computed taking into account stresses in concrete and steel under sustained load and including effects of creep and shrinkage of concrete and relaxation of pre-stressing steel.

m) AREMA: Chapter 15 on steel bridges for Railways:

For steel bridges, the deflection of the structure shall be computed for the live loading plus impact loading conditionproducing the maximum bending moment at mid-span for simple spans. The structure shall be so designed that the computed deflection shall not exceed 1/640 of the span length centre to centre of bearings for simple spans.

Lateral deflection of spans shall be limited to 3/8 inch (10 mm) for tangent track as measured on a 62 foot (19meter) chord. On curved track, lateral deflection shall be limited to 1/4 inch (6 mm) as measured on a 31 foot(9.5 meter) chord. Allowable lateral deflection for spans shall be calculated based on these limits taken insquared proportion to the span length under consideration.

CAMBER: The camber of trusses shall be equal to the deflection produced by the dead load plus a live load of 3,000 lb per footof track. The camber of plate girders more than 90 feet in length shall be equal to the deflection produced by thedead load only. Plate girders 90 feet or less in length and rolled beams need not be cambered.

Composite spans shall be designed so that the deflection, computed using the composite section, for the live load plus impact load condition does not exceed 1/640 of the span length center to center of bearings.

Camber: The beams of composite construction shall be cambered when the dead load deflection exceeds 1 inch.

n) AS : 5100.1 Bridge design, Scope and general principles:

CAMBER on Railway bridge superstructures with open deck or directly fixed track, and span lengthsgreater than 20 m shall be cambered. The camber shall be determined such that the railwaytrack shall be at its theoretical level under the effects of the permanently applied loads; forexample, dead load, superimposed dead load, long-term pre-stressing, shrinkage and creepeffects where applicable, and half of the design railway traffic loads, excluding dynamicload allowance.

o) AS : 5100.2 Bridge design, Design loads:

For Road bridge: Para 6.11 Deflection: The deflection limits of a road bridge under traffic for serviceability limit state shall beappropriate to the structure and its intended use, the nature of the loading and the elementssupported by it.Notwithstanding this requirement, the deflection for serviceability limit state under live load plus dynamic load allowance shall be not greater than 1/600 of the span or 1/300 of thecantilever projection, as applicable.The live load to be used for calculating deflection shall be LL including dynamic load allowance, placed longitudinally in each design laneto produce the maximum deflection, taking into account the accompanying lane factors.

(a) Deflections do not infringe on clearance diagrams;
(b) Hog deflection does not exceed 1/300 of the span; and
(c) No sag deflection occurs under permanent loads.

When deflections are calculated for serviceability loads, including dynamic allowance, 2/3 of the dynamic load allowance shall be used.

For Rail Bridge: 8.9 Deflection: The deflection limits of a railway bridge under traffic for serviceability limit state shall be appropriate to the structure and its intended use, the nature of the loading and the elements supported by it. Notwithstanding this requirement, the deflection of railway bridges for serviceability limitstate under live load plus dynamic load allowance shall be not greater than 1/640 of the span and 1/320 of the cantilever projection.

NOTE: In order not to detract from their appearance, bridges should be designed so that their hogdoes not exceed 1/300 of the span and they do not sag under permanent loads. Railway bridges shall not deflect so that they infringe clearance diagrams.

p) BS 5400-1, General statements:

Para 3.4: The deflection of the structure or any part of it should not be such as to affect its appearance adversely, violate minimum specified clearances, or cause drainage difficulties. The structure may need to be cambered to counter these effects. Minimum specified clearances should be maintained under the action of load combination 1 for the serviceability limit state. The appearance and drainage characteristics of the structure should be considered under the action of permanent loads only.

q) BS 5400-2, Design Loads: For the purpose of calculating deflection and camber, the nominal loads shall be adopted.

r) BS 5400-3, Code of practice for design of steel bridges:

Para 5.7 Camber: The structure may need to be camberedto achieve a satisfactoryappearance of the bridge. In this connection a sagging deflection of a nominally straight soffit of 1/800 of the span should not be exceeded. The cambered shape of the structure under the action of the actual dead andsuperimposed dead loads should be as specified or approved by the Engineer.

s) BS 5400-4, Code of practice for design of concrete bridges

No specific provision for deflection, 5400-1 and 2 shall apply

t) BS 5400-5, Code of practice for design of composite bridges

Para 5.5 Deflections: Recommendations for deflectionsand general guidance on their calculation are givenin Part 1. In calculatingdeflections consideration should be given to thesequence of construction and, where appropriate,proper account should be taken of the deflections ofthe steel section due to loads applied to it prior tothe development of composite action and of partialcomposite action where deck slabs are cast in stage.

u) EN 1990: Basis of Structural design for Railway Bridges

Excessive bridge deformations can endanger traffic by creating unacceptable changes in vertical and horizontal track geometry, excessive rail stresses and vibrations in bridge structures. Excessive vibrations can lead to ballast instability and unacceptable reduction in wheel rail contact forces. Excessive deformations can also affect the loads imposed on the track/ bridge system, and create conditions which cause passenger discomfort. Deformation and vibration limits are either explicit or implicit in the bridge stiffness criteria given in the code.

Checks on bridge deformations shall be performed for traffic safety purposes for the following items.

Vertical accelerations of the deck to avoid ballast instability and unacceptable reduction in wheel rail contact forces

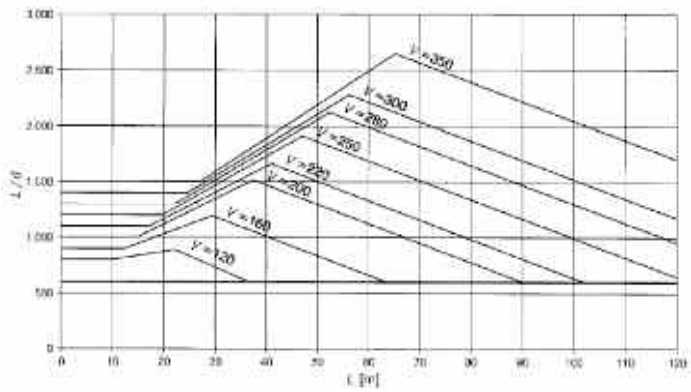
- Vertical deflection of the deck throughout each spanto ensure acceptable vertical track radii and generally robust structures.
- Unrestrained uplift at the bearings to avoid premature bearing failure
- Vertical deflection of the end of the deck beyond bearings to avoid destabilising the track, limit uplift forces on rail fastening systems and limit additional rail stresses
- Twist of the deck measured along the centre line of each track on the approaches to a bridge and across a bridge to minimise the risk of train derailment
- Rotation of the ends of each deck about a transverse axis or the relative total rotation between adjacent deck ends to limit additional rail stresses, limit uplift forces on rail fastening systems and limit angular discontinuity at expansion devices and switch blades.
- Longitudinal displacement of the end of the upper surface of the deck due to longitudinal displacement and rotation of the deck end to limit additional rail stresses and minimise disturbance to track ballast and adjacent track formation.
- Horizontal transverse deflection to ensure acceptable horizontal track radii.
- Horizontal rotation of a deck about a vertical axis at ends of a deck to ensure acceptable horizontal track geometry and passenger comfort.
- Limits on the first natural frequency of lateral vibration of the span to avoid the occurrence of resonance between the lateral motion of vehicles on their suspension and the bridge.

(i) The maximum deck twist t of a track gauge of 1,435 m measured over a length of 3m should not exceed the values

Speed range V (km/h)	Maximum twist t (mm/3m)
$V \leq 120$	≤ 4.5
$120 < V \leq 200$	≤ 3.0
$V > 200$	≤ 1.5

(ii) Vertical deformation of the deck loaded with the classified characteristic vertical loading, the maximum total vertical deflection measured along any track due to rail traffic actions should not exceed L/600.

For comfort criteria, maximum permissible vertical deflection δ for railway bridges with 3 or more successive simply supported spans corresponding to a permissible vertical acceleration of 1 m/s² in a coach for speed V is given as per following diagram.



Rotation of bridge are also to be checked but values have not been given and have been left for individual railway to specify.

v) LRDF 130081, 130081A-130081D:Load and Resistance Factor Design (LRFD) for Highway Bridge Superstructures, Design Manual

Vertical camber is provided to counteract the effect of theself-weight deflection and to impose the vertical curvature of the roadway alignment.

Live Load deflection under normal live load conditions when no other guidance exists, the AASHTO LDRF deflection guidelines for steel orconcrete superstructures are as follows:

- Vehicular live load, general..... Span Length / 800
- Vehicular and pedestrian..... Span Length / 1000 live loads
- Vehicular live load on ..... Span Length / 300 cantilever
- Vehicular and pedestrian ..... Span Length / 375 live loads on cantilever

If factored live loads do not produce deflections greater than these criteria in service
limit states, the design is acceptable.

Dead Load deflection: AASHTO Specifications,including the AASHTO LRFD specification, are essentially silent regarding dead load deflections. Although there are no provisions for limiting of dead load deflection, the Engineer iswise to consider vertical deflection of the steel and its potential effects during thevarious stages of construction of the bridge.

This code gives a good commentary regarding deflection provisions and also history of provisions regarding deflections.

Dead Load deflection: AASHTO Specifications,including the AASHTO LRFD specification, are essentially silent regarding dead load deflections.Prior to composite design, the steel bridgegirder was designed to support both dead and live load. With the advent ofcomposite design, much of the dead load is applied on the non-composite structurewhile the live load is applied to the composite one. This has led to the reduction ofthe recommended depth of the steel section from 1/25th of the span to 1/30th of thespan. This combined with higher strength steels and a smaller factor applied todead load for design has, in many cases, results in very slender steel sections. There are no provisions for limiting of dead load deflection, it is left to Engineer.

Live Load deflection limitation is a service limit state; such criteria are specified inAASHTO LRFD and limit the computed elastic live-load vertical deflections. Although the criteria are optional, most states require their application. The obvious reason for these provisions is to provide a level of stiffness. However, the reason(s) for a required stiffness is less clear.

Until the 1960s, bridges were designed to a working level; i.e., they were designed for a desired service level. Live load deflection has been a service design consideration from early times in the design of steel highway bridges in the U.S. Limits on live load deflection can be traced back to the railway specifications of the late 1800s, which gave limitations similar to those now given in the AASHTO LRFD Specifications. The requirement to limit deflection of a railroad bridge seemsrather self-evident when one considers the rocking forces that could lead to catastrophe on a bridge that was too flexible. Large deflections could also lead tosecondary stresses that might cause fatigue cracking that was not well understood in the early days of iron and steel bridges. As mentioned above, the first specified liveload deflection limit for steel highway bridges in the U.S. was in the Third EditionAASHO Specification, 1941. The suggested limit of Span/800 under vehicular load, which remains in the specification today, isthought to have been recommended by the Bureau of Public Roads after studying several steel-beam bridges that were reportedly subjected to objectionable vibrations. This limit, in addition to the maximum span-to-depth ratio of 25 that was recommended at that time, was the first attempt to control service load deformations. This was only reasonable since the entire philosophy of working stress design was based on serviceability and not strength. The

advent of higher strength steels and concomitant increases in design stressesled to concern about the effect of live load deflection on economics. As early as the1950s, ASCE began an investigation of the basis for these limits and foundnumerous shortcomings, including no clear basis for their use, and no evidence of structural damage that could be attributed to excessive deflections. Competition with pre-stressed concrete bridges in the 1960s led to further investigations as to the need for this serviceability limit. Field investigations at that time, again, showed no direct correlation. Not only did the limitation remain, but In the early 1960s an additional limit was introduced; the live load deflection limit on steel bridges with both pedestrian and vehicular loads was set at Span/1000 as a result of isolated concerns related to human response. The criteria remained optional. One legend has it that this limitarose when a mother and wife of a political figure who was pushing her baby in acarriage across a bridge attributing her baby awakening to vibration of the bridge. This complaint prompted the state's governor to chastise the State Bridge Engineer. The issue of human comfort becomes a serviceability issue when people who might use a bridge find its motion objectionable. This is a departure from the other structural criteria provided in the Specification. The complex issue of the human response of occupants of moving vehicles and of pedestrians to motion has been extensively studied. However, there still are nodefinitive guidelines on the tolerable limits of dynamic motion or static deflection to ensure creature comfort. Guidelines for limiting the natural frequency of bridges to provide tolerable motion are contained in the Ontario Highway Bridge Design Code, in which the deflection limits are tied to the first fundamental frequency of thesuperstructure. These limits are provided in the form of graphs and are separated in conjunction with the anticipated pedestrian use. These provisions require that thedesigner compute the natural frequency of the composite bridge. Wright and Walkerfound a tenuous theoretical relationship between deflection and natural frequency. They observed that user comfort was an important factor. They reported that

Psychologists had found that humans think that vertical deflection they sense is about ten times the actual deflection. Wright and Walker postulated that human discomfort is due to acceleration, not deflection alone. They proposed a parameter, defined as the dynamic component of acceleration in the fundamental mode o fvibration, be limited to 100 in2/sec. The authors suggest that such acceleration is within the tolerable range experienced in building elevators contemporary with the writing of the paper (1960s). They further suggested that only bridges designed forpedestrian traffic or stationary vehicles be limited in motion by such a serviceabilitycriterion. The issue of bridge vibrations and their relation to human response, alongwith the development of a reasonable means of controlling bridge vibrations toensure adequate creature comfort, remains a complex and subjective issue in need of further study.

Other suggested live load deflection limits contained in AASHTO LRFD include a limit of Span/300 for vehicular loads on cantilever arms, and alimit of Span/375 for combined vehicular and pedestrian loads on cantilever arms. In checking all the deflection limits, the 'Span' is typically taken as the full spanlength of the girder. As mentioned previously, the limit on span-to-depth ratio for continuous spans was often determined by defining the span as the length betweenpoints of permanent load contraflexure. This led to shallower bridges with anincreased flexibility when the limiting live load deflection was defined based on theactual span. Some states conservatively limited deflection by using the distancebetween points of permanent load contraflexure in computing the permissibledeflection. Field tests have confirmed that decks of continuous composite girders innegative moment regions actually behave compositely. Tradition has assumedthose regions to be non-composite. Use of the entire deck obviously reduces thecomputed deflections and brings them closer to actual with regard to the behavior of

the deck.

The live load used to compute live load deflection has traditionally been the same asthe design live load. This made sense for design based on service loads only.However, for strength-based design, a different and lighter load for service limit statechecks is logical since the criteria are based on a different philosophy. In strengthdesign, the capacity of the structure is challenged. Serviceability relates to thestructure response to likely loads; these likely loads are reasonably less than the load used to check structural strength. However, even in service load design, liveload application has often been different from application for design of the elements. For example, the 1941 AASHO Bridge Specifications permitted the Engineer to compute the moment in a stringer for deflection purposes by assuming that all of the lanes are loaded with the design load and that the resulting load is uniformly distributed equally to all stringers where adequate depth diaphragms or cross-framesexist. Some have since interpreted this provision to allow a reduction in load basedon the multiple presence factor provision. The

practice of loading all lanes appearsto be at odds, at least in some cases, with the provision in the 1935 Edition, which states: “In calculating stresses in structures which supportcantilevered sidewalks, the sidewalk shall be considered as fully loaded on only oneside of the structure if this condition produces maximum stress.” This provisionreveals an understanding that loading on the far side of a multi-stringer bridgeunloads the near side; this understanding has been borne out in refined analyses. Ifone visualizes the entire cross-section rotating as a rigid body under each of theabove load cases, as assumed in the development of the live-load distribution factorEquation 2.1 for exterior girders given in DM Volume 1, Chapter 2, it is apparent thatthe opposite side of the bridge rises when one side is loaded. Hence, from the time it was introduced, the assumption of uniform loading of girders for computation ofdeflection was known to be a very blunt instrument to simply require less stiffness.With the adoption of Load Factor Design (LFD), many states increased live load toHS25 for strength. Some used the HS25 design live load to compute live loaddeflection; however, others departed from using the same live load for strength andservice as discussed above and used the HS20 live load for checking deflection.

The use of a 25-percent larger live load eliminated some of the economy possiblewith the lower factor applied to dead load in LFD. Since the same factors were notused for deflection, it was logical to keep the same traditional live load.The combination of moving from 33- to 70-ksi yield-stress steel, along with theintroduction of composite design, LFD and then LRFD, and the increase of the span-to-depth ratio for steel girders from 25 to 30 had a net effect of roughly increasingthe permitted live load deflection by about threefold. Field experience of bridgesbuilt has provided scant evidence that the increased flexibility of steel bridges hadled to any reduced functionality. Projection of this trend into the future would implythat the limit on live load deflection should be infinity. However, the First TacomaNarrows Bridge and common sense intervene. It seems that some logical limitexists, but such a limit has proved elusive. It has also been shown that computationof live load deflection as specified in AASHO and AASHTO is not likely to predict theactual deflection. And so, as the live load deflection limit has become anincreasingly critical factor in the design of steel bridges utilizing the higher-strengthhigh performance steels (HPS), an additional investigation has recently beenlaunched into the potential need for improved live load deflection criteria for steelbridges.When applying the current live load deflection criteria, AASHTO LRFD requires that the deflection be taken as the larger of the deflection resultingfrom: 1) the design truck alone (including the 33 percent dynamic load allowance), or2) the design lane load in conjunction with 25 percent of the design truck (includingthe 33 percent dynamic load allowance). As specified in AASHTO LRFD, a load factor of 1.0 is applied according to the Service I load combination. This special loading is intended to produce deflections similar to thosedue to HS20. It was decided by the specification writers that it was unnecessary tocheck live load deflections for the heavier HL-93 design live load used for strengthchecks. The HL-93 design truck has the same weight as an HS20 truck. The HL-93design lane load also has the same weight as that specified for HS20. The use of 25percent of the design truck (0.25 * 72 kips = 18 kips) is similar to the HS20 singleconcentrated load of 18 kips used in combination with the HS20 lane load fordetermining bending moments and deflections in longer spans. Of course, theresulting deflections are less than those computed for HS25; hence, the AASHTOLRFD live load for deflection is more lenient in this case.

The provisions of AASHTO LRFDfor straight-girder bridges allow allinteger 12-foot wide design lanes to be loaded with all girders assumed to deflectequally. This clause should only be applied when the longitudinal stiffness of theindividual girders at all cross-sections is the same. Cases where the clause shouldnot be applied include cases with skewed supports, different girder depths, or girderswith different flange sizes. The assumption of equal live load deflection is notapplicable to horizontally curved bridges. The AASHTO LRFD specifications aresilent with regard to the application of this assumption to bridges with skewedsupports. The live load deflection of individual girders is to be computed for curvedgirdersbased on analysis of the superstructure asa structural system with live loads applied according the loading provisions of theSpecifications.There are other bridges where the equal deflection assumption is not rational.Loading of all lanes simultaneously of relatively wide bridges may not give a rationaldeflection. This is clearly the case if one visualizes the bridge cross-section rotatingas a rigid body under load, much as assumed in the special analysis for determiningthe wheel-load distribution factor for exterior girders.

Concrete barriers and sidewalks, and even railings, often contribute to the stiffnessof composite superstructures at service load levels. Therefore, AASHTO permits the entire width of the roadway and the structurallycontinuous portions of railings, sidewalks and barriers (i.e. continuous cast-in-placebarriers) to be included in determining the composite stiffness for deflectioncalculations. Because the inclusion of the concrete items other than the deck

cancause complications in the calculation of the composite stiffness (and in modelling with regard to their inclusion in refined analyses), it is suggested that these items beignored. If the parapets are on the exterior of the deck, they tend to stiffen theexterior girders drawing load to those girders. Hence, computation of the deflectionsof the critical exterior based on refined analysis methods show that the computeddeflections are not materially reduced by the consideration of the parapets.

AASHTO LRFD deals with checks related to the control ofpermanent deformations in steel I-girder bridges under repeated severe trafficloadings. Control of permanent deformations is important to ensure good ridingquality.To control permanent deformations according to AASHTO LRFD,checks are to be made on the flange stresses and for potential web bend bucklingunder the Service II load combination. The standard design Service IIloading is defined as 1.0DC + 1.0DW + 1.3(LL+IM), where DC represents thecomponent dead loads, DW represents the wearing surface and utility loads and(LL+IM) represents the design live load plus the dynamic load allowance placed inmultiple lanes. As will be discussed later on in the chapter, checks are also to bemade to prevent slip in slip-critical bolted connections under the Service II loading.The Service II load combination is intended to be equivalent to the Overload given inthe AASHTO Standard Specifications. In the AASHTO Standard Specifications, the overload is intended to represent live loads that can be allowed on the structure on infrequent occasions without causing permanent damage. The standard design overload (i.e. for loadings of H20 or above) is defined as D + 5/3(L+I), where Drepresents the dead load and (L+I) represents the design live load plus impactplaced in multiple lanes. Although the live load is to be placed in multiple lanes fordesign purposes, it can be shown that the live load factor of 5/3 essentially makesthe loading equivalent to two times the design live load placed in a single lane.In both the AASHTO LRFD Specifications and the Standard Specifications, whenthese checks are to be applied to a design permit load, consideration should begiven to reducing the load factor on the live load from 1.3 and 5/3, respectively, to1.0 since the load is known.As discussed previously, under certain conditions, AASHTO LRFDpermits flexural stresses caused by Service II loads applied to the composite sectionto be computed assuming the concrete deck is effective for both positive andnegative flexure for the permanent deflection design checks. As specified inAASHTO LRFD, those conditions are that shear connectors must beprovided along the entire length of the girder and that the minimum one percentlongitudinal deck reinforcement must be placed wherever the tensile stress in theconcrete deck due to either load combination Service II or due to the factoredconstruction loads exceeds the factored modulus of rupture of the concrete. Underthese conditions, the crack size is felt to be controlled to a degree such that theconcrete deck may be considered effective in tension for computing the flexural stresses acting on the composite section at the service limit state. When the aboveconditions are satisfied, the Engineer is strongly encouraged to consider theconcrete deck to be fully effective in calculating all Service II flexural stresses, as thisassumption better reflects the actual conditions in the bridge.

C) Recent Railway designs in IR:

Two important bridges are under construction in Indian Railways, one Chenab bridge in USBRL project and another at Bogibheel in NFR.

The criteria adopted in Chenab bridge is based on UIC 776-3R.

Structural Deformation Limit: All the structural deformation limits prescribed in UIC 776-3R shall be complied with wind pressure of 150 kg/sqm, considering the least favorable case with one or two tracks loaded and other forces as given in Table — 2 of Annexure B' and the load combinations given in para 2.0& 3.0 of Annexure 'C' for service conditions.

Vertical Deflection Limit: The ratio of span to maximum vertical deflection shall not be less than 400 given in Table 4 of UIC 776-3R for the case of one or two adjacent decks case for speed range 1 for high quality passenger line.

Lateral displacement Limit: The horizontal deformation of bridge deck should not cause a horizontal change of angle at a free end exceeding 0.0035 radian, nor a change of curvature radius of less than 3500 m for several adjacent decks as given in Table 2 of UIC 776- 3R for speed range 1.

The criteria adopted in Bogibheel bridge is based on UIC and EURO codes.

The reason for adopting international codes is that IRS codes don’t give adequate provisions for long spans. Deflection criteria ideally must be based on performance requirements and also be independent of material & method of construction.All international codes have deflection criteria based on live loads only.Besides vertical deflections, other deformation criteria also must be included. The limiting value of L/600 for vertical deflection based on DL+LL+IL as in IRS steel bridge code cannot be met with by any rational design; in fact design with this criteria may be impossible.

IRS Codes	Steel Bridge Code	L/600 for DL +LL +IL	Applicable to Steel Rail Bridges on IR
	Concrete Bridge Code	No Limits but a acceptance test	Applicable to Concrete Rail bridges on IR
	No code for Composite Br.	Generally both Steel and concrete code limits are adopted	Applicable to Composite Rail bridges on IR
IRC Codes	IRC 112	L/800 for LL+IL	Applicable to Concrete Road Bridges in India
	IRC 24	L/600 for DL+LL+IL and additionally L/800 for LL+IL	Applicable to Steel Road Bridges in India
	IRC 21	No provision other than crack control	Code is superseded by IRC 112
	IRC 22	As per IRC 21 and IRC 24	Applicable to Composite Road Bridges in India
UIC Codes	UIC 776-2R	L/800 for LL+IL; Angle of rotation 1/200	Applicable to High speed rail bridges
	UIC 776-3R	L/350 to L/800 for LL+IL for speeds less than 120 kmph various span combinations	Applicable to Rail bridges
AREMA	Part 15	L/640 for LL+IL	Applicable to Steel and Composite Rail bridges
	Part 8	L/640 for LL+IL	Applicable to Concrete Rail bridges
AS	AS 5100.2	Road Bridge: L/600 for LL+IL (IL can be taken as 2/3) Rail Bridge: L/640 for LL+IL (IL can be taken as 2/3)	Applicable to Road and Rail Bridges
BS	BS 5400-1	Should be limited so that does not affect appearance	Applicable to all bridges
	BS 5400-3	Sagging Deflection of L/800 should not be exceeded. Deflection due to DL + SIDL can be accounted in camber	Applicable to Steel Rail and Road Bridges
	BS 5400-4	No limits given, to be checked for crack control	Applicable to Concrete Rail and Road Bridges
	BS 5400-5	Provision of general code, part 3 and part 4 to be followed.	Applicable to Composite Rail and Road Bridges
EURO	EN 1990	L/600 for LL+IL for freight load. For passenger separate graph is given based on speed.	Applicable to Rail bridges
LDRF	130081: 130081A: 130081D	L/800 for LL+IL	Applicable to Road Bridges

As can be inferred from above table that all foreign codes have deflection criteria based on live load only. Normally deflection due to dead loads are either ignored for small spans or are compensated by providing suitable camber for longer spans.

For concrete bridges, normally dead weight is proportionately quite high in comparison to live load, DL deflections are covered in camber and Live load deflections which are expected to be small is not directly covered in design; deflection is indirectly controlled by controlling crack width in concrete. IRS concrete bride code is based on BS5400, therefore it does not have any deflection criteria; deflection is taken care of by upward camber given to bridge while pre-stressing and by controlling crack width. However in Indian Railways there is unreasonable practice of following criteria of Steel Bridge Code.

Road over bridges in IR are designed as per IRC codes. IRC codes have adopted criteria based on LDRF which limits deflection based on Live load (L/800) but has additionally inserted criteria as per IRS steel bridge code, which is limiting deflection to L/600 for DL+LL+IL. This criteria of L/600 for DL+LL+IL is applicable to steel and composite bridge. Additional criteria of L/600 for DL+LL+IL is unnecessary in IRC codes.

E) Recommendations:

Rail Bridges: In IRS codes criteria for deflection for steel, concrete and composite deck bridges should be based on LL+IL only as per international practice. A value of L/800 can be adopted (satisfies AREMA, AS code and UIC).

- Deflection due DL should be covered in camber. Additional upward camber up to L/1000 should be provided. For open web girders camber criteria given in IRS steel bridge code is adequate.
- Where camber is not provided in small deck spans, total deflection including for DL should be limited to L/600.

The above provision should be applicable for speeds up to 120-130 kmph and spans up to 30m. For higher speeds or longer spans, detailed deformation criteria as per UIC 776-3R should be adopted.

ROAD BRIDGES: IRC codes have adopted values given in LRFD based on LL+IL correctly but have added additional requirement as per IRS steel bridge code which is based on DL+LL+IL. In IRC codes, limit of L/600 based on DL+LL+IL for steel and composite bridges taken from IRS code is unnecessary. For concrete bridges provisions are adequate.

- Where camber is provided, deflection due DL should be covered in camber. Additional upward camber up to L/1000 should be provided.
- Where camber is not provided in small deck spans, total deflection including

for DL should be limited to L/600.

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Details of Latest Correction Slips

Sr.No	Codes/Manuals	Last Correction Slip
1	Indian Railways Permanent Way Manual(second Reprint-2004)	135 dt 07.05.2014
2	Indian Railways Bridge Manual-1998	29 dt 15.04.2014
3	Indian Railways Works Manual-2000	10 dt 17.02.2005
4	Manual of Instructions on long Welded rails-2006(II reprint-2005)	15 dt 04.06.2012
5	Manual for Flash Butt welding of Rails(reprint-2012)	01 dt 14.08.2012
6	Manual for Fusion welding of rails by the Alumino Thermit Process (Revised 2012)	nil
7	Manual for Ultrasonic testing of rails & welds (revised 2012)	nil
8	Manual for Glued insulated rail joints-1998	05 dt 28/08/2012
9	Indian Railways Track Machine Manual (2000)	17 dt 21.02.2014
10	Manual of Inspection schedules for officials of engg. Dept-2000	nil
11	Railways (opening for public Carriage of Passengers)Rules-2000	nil
12	Indian Railways Schedule of Dimensions 1676 gauge revised 2004	15 dt 19.06.2014
13	Indian Railways code for the engg dept (third Reprint-1999)	48 dt 01.05.2014
14	Guidelines for Earthwork in Railway projects-2003	01 dt 22.07.2004
15	General Condition of Contract (July 2013)	03 dt 07.11.2013

Safety in Building Construction

By
B. K. Tirkey*

Introduction:

Construction sector has taken a shape of industry and has registered enormous growth in recent years worldwide. Construction industry is essential for infrastructure development and makes significant contribution to the national economy. Construction works are still labour oriented and provides employment to the large number of people. However, these construction workers are exposed to wide varieties of serious hazards, despite advancement of technology in construction sector. Therefore, safety at work site is of paramount importance. Safety of personnel engaged in building construction, building construction material, machinery, plants & equipments and surrounding properties can be achieved by proper planning, design and implementation of safety codes.

AIMS AND OBJECTIVES:

1. TO STUDY IS CODES, PROVISIONS OF CONTRACT DOCUMENTS AND GENERAL CONDITIONS OF CONTRACT FOR RAILWAY TOWARDS SAFETY PROVISIONS FOR CONSTRUCTION.
2. TO IDENTIFY POSSIBLE SAFETY HAZARDS/ACCIDENTS.
3. TO SUGGEST PRECAUTIONARY/PREVENTINE MEASURES.

BUREAU OF INDIAN STANDARD & SPECIAL PUBLICATIONS AVAILABLE FOR CONSTRUCTION SAFETY:

IS:3696	Safety code for scaffolds and ladders
(Part-I)-1987	Scaffolds
(Part-II)-1991	Ladders
IS:3764-1992	Excavation work-Code of safety.
IS:4082-1996	Stacking and storage of construction materials and components at site-Recommendation.
IS:4130-1991	Demolition of building-Code of Safety.
IS:4912-1978	Safety requirements for floor and wall openings, railing and toe boards.
IS:5121-1969	Safety code for piling and other deep foundations.
IS:5916-1970	Safety code for construction involving use of hot bituminous materials.
IS:7205-1974	Safety code for erection of structural steel work.
IS:7969-1975	Safety code for handling and storage of building materials

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IS:8989-1978	Safety code for erection of concrete framed structures
IS:13415-1992	Safety code for protective barrier in and around buildings
IS:13416	Recommendations for preventive measures against hazards at work places.
(Part- I)-1992	Falling material hazards prevention.
(Part-II)-1992	Fall prevention.
(Part-III)-1994	Disposal of debris.
(Part-IV)-1994	Timber structures.
(Part-V)-1994	Fire protection.
IS:13430-1992	Code of practice for safety during additional construction and alteration to existing buildings.
SP:62-1992	Handbook on building construction practices (excluding electrical works).
SP:70-2001	Handbook on construction safety practices

Provisions available in General Conditions of Contract and Standard Specification 2001 (SER):

- **Working during night:** Contractor shall not carry out any work between sun-set and sun-rise without the previous permission of the Engineer.
- **Damage to Railway property or private life and property:** The Contractor shall be responsible for all risks to the works and for trespass and shall make good at his own expense all loss or damage whether to the works themselves or to any other property of the Railway or the lives, persons or property of others from whatsoever cause in connection with the works. until they are taken over by the Railway. and this although all reasonable and proper precautions may have been taken by the Contractor, and in case the Railway shall be called upon to make good any costs, loss or damages, or to pay any compensation, including that payable under the provisions of the Workmen's Compensation Act or any statutory amendments thereof to any person or persons sustaining damages as aforesaid by reason of any act, or any negligence or omissions on the part of the Contractor.
- **Provision of efficient and competent staff:** The Contractor shall place and keep on the works at all times efficient and competent staff to give the necessary directions to his workmen and to see that they execute their work in sound and proper manner and shall employ only such supervisors, workmen and labourers in or about the execution of any of these works as are careful and skilled in the various trades and callings.
- **Precaution during progress of works:** During the execution of works, unless otherwise specified the Contractor shall at his own cost provide the materials for and execute all shoring, timbering and strutting works as is necessary for the suitability and safety of all structures, excavations and works and shall ensure that no damage, injury or loss is caused or likely to be caused to any person or property.
- **Roads and Water Courses:** Existing roads or water courses shall not be blocked, cut through, altered, diverted or obstructed in any way by the Contractor except with the permission of the Engineer.
- **Provision of access to premises:** During progress of work in any street or thorough-fare, the Contractor shall make adequate provision for the passage of traffic, for securing self access to all premises approached from such street or thoroughfare and for any drainage, water supply or means of lighting which may be interrupted by reason of the execution of the works and shall erect and maintain at his own cost barriers, lights and other safeguards as prescribed by the Engineer, for the regulation of the traffic, and provide watchmen necessary to prevent accidents.
- **Safety of Public:** The Contractor shall be responsible to take all precautions to ensure the safety of the public whether on public or Railway property and shall post such look-out men as may in the opinion of the Engineer be required to comply with regulations pertaining to the work.
- **Use of Explosives:** Explosives shall not be used on the works or on the site by the Contractor without the permission of the Engineer and then only in the manner and to the extent to which such permission is given. Where explosives are required for the works, they shall be stored in a special magazine to be provided by and at the cost of the Contractor in

accordance with the Explosive Rules. The Contractor shall obtain the necessary license for the storage and the use of explosives.

- **Suspension of works:** The Contractor shall on the order of the Engineer suspend the progress of the works or any part thereof for such time or times and in such manner as the Engineer may consider necessary and shall during such suspension properly protect and secure the work so far as is necessary in the opinion of the Engineer. If such suspension is:
  - Provided for in the contract, or
  - Necessary for the proper execution of the works or by the reason of weather conditions or by some default on the part of the Contractor, and or
  - Necessary for the safety of the works or any part thereof.
- **Reporting of Accidents to Labour:** The Contractor shall be responsible for the safety of all employees directly or through petty contractors or sub-contractor employed by him on the works and shall report serious accidents to any of them however and wherever occurring on the works to the Engineer or the Engineer's Representative and shall make every arrangements to render all possible assistance.

Provisions available in the Contract Document (ECoR/Construction Organization):

- Suitable scaffolds should be provided for workmen for all works that cannot be safely done from the ground or from solid construction except for such short periods work as can be done safely from ladders. When a ladder is used an extra labour shall be engaged for holding the ladder and if the ladder is used for carrying materials as well, suitable foot holds and handholds shall be given an inclination not steeper than 1 to 4 (1 Horizontal to 4 Vertical).
- Scaffolding or staging more than 3.5 metres above the ground or floor, swung or suspended from an overhead support or erected with stationery support shall have a guard rail properly attached, bolted, bracketed and otherwise secured at least 1 metre high above the floor or platform of such scaffolding or staging and extending along the entire length thereof with only such opening as may be necessary for the delivery of materials. Such scaffolding or staging shall be fastened as to prevent it from swaying from the building or structure.
- Working platform gangways and stairways should be so constructed that they should not sway unduly or unequally and where the height of the platform or the gangway or the stairway is more than 3.5 metres above ground level or floor level they should be closely boarded, should have adequate width and should be suitably fastened as described in the Para above.
- Safe means of access shall be provided to all working platform and other working places. Every ladder shall be securely fixed. No portable single ladder shall be over 10 metres in length while the width between side rails in swung ladder shall in no case be less than 300 mm. for ladder up to and including 3.5 metres in length.
- For longer ladders this width should be increased by at least 20 mm. each additional metre of length. Uniform steps spacing shall not exceed 300 mm. Adequate precautions shall be taken to prevent danger from electrical equipment. No materials on any of the sites of work shall be so stacked or placed so as to cause danger or inconvenience to any persons or the public. The Contractor shall provide all necessary fencing and lights to protect the public from accident.
- Demolition: Before any demolition work is commenced and also during the process of work.
  - All roads and open area adjacent to the work site shall either be closed or suitably protected.
  - No electric cable or apparatus which is liable to be a source of danger over a cable or apparatus used by the operator shall remain electrically charged.
  - All practical steps shall be taken to prevent danger to persons employed from risk of fire or explosives or flooding. No floor, roof or other part of the building shall be so over loaded with debris or materials as to render it unsafe.
- All necessary personal safety equipment as considered adequate by the Engineer-in-charge should be kept available for the use of the persons employed in the site and maintained in a condition suitable for immediate use and the contractor should take adequate steps to ensure proper use of equipment by these concerned.
  - Workers employed on mixing asphaltic materials cement and mortar shall be provided with protective goggles.
  - Those engaged in white washing and mixing or stacking of cement bags or any materials which are injurious to the eye shall be provided with protective goggles.
  - Those engaged in welding works shall be provided with welder's protective eyesight lids.
  - Stone breakers shall be provided with protective goggles and protective clothing and seated at sufficiently safe intervals.

- When the work is done near any place where there is risk of drowning, all necessary equipment should be provided and kept ready for use and all necessary steps taken for prompt rescue of any persons in danger and adequate provision should be made for prompt first aid treatment of all injuries likely to be sustained during the course of the work.
- Use of hoisting machines and tackles including their attachment anchorage and supports shall confirm to the following standards of condition:

- These shall be of good mechanical construction, sound materials and adequate strength and free from patent defects and shall be kept in good repair and in good working order.
- Every rope used in hoisting or lowering materials or as a means of suspension shall be of durable quality and adequate strength and free from patent defects.
- Every crane driver or hoisting appliances operator shall be properly qualified.
- In case of every hoisting machine and every cable ring, hook, shackle, swivel and pulley block used in hoisting or as means of suspension safe working load shall be ascertained by adequate means. Every hoisting machine and all gear shall be plainly marked with the safe working load. In case of hoisting machine having a variable safe working load of the conditions under which it is applicable shall be clearly indicated. No part of any machinery or any gear shall be loaded beyond the safe working load except for the purpose of testing.
- In case of departmental machine, the safe working load shall be notified by the Technological Engineer-in-Charge. As regards Contractor's machines, the contractors shall notify the safe working load of machine to the Engineer-in-charge whenever he brings any machinery to site of work, get it verified by the Engineer concerned.

- Motors, gearing, transmission, electric wiring and other dangerous parts of hoisting appliances should be provided with efficient safe guards. Hoisting appliances should be provided with such means as will reduce to the minimum the risk of accidental decent of the load; adequate precautions should be taken to reduce the minimum the risk of any part of a suspended load becoming accidentally displaced. When workers are employed on Electrical installations, which are already energized, insulating mats wearing apparel, such as gloves, sleeves and both as may be necessary should be provided. The workers should not wear any rings, watches and carry keys or other materials, which are good conductors of electricity.
- All scaffolds, ladders and other safety devices shall be maintained in safe condition and no scaffold, ladder or equipment shall be altered or removed while it is in use. Adequate warning facilities should be provided at or near places of work.
- Safety provisions should be brought to the notice of all concerned by display on a notice board, at a prominent place at the work spot. The persons responsible for compliance of the safety code shall be named.
- To ensure effective endorsement of the rules and regulations relating to safety precautions, the arrangements made by the contractor shall be open to inspection by the Labour Officer, Engineer-in-charge of the Department or their representative.
- Whenever a Lorry or any other Form of Road transport is required to ply along or in the vicinity of a running line or any other Railway track where Railway Engines or Trains are liable to move, road Vehicles have to operate in the area (for loading, leading or unloading of earth, ballast or any other materials, or plants or equipments) without any obstruction or dislocation to the running Trains. The Contractor shall also furnish the particulars of Vehicles & the names & Photographs of Driver & cleaner retained for each Vehicle to enable the Engineer to issue necessary permits allowing the holder to operate the Vehicles, with such restrictions regarding duration and /or location as are considered necessary.
- The Road Vehicles will ply only between sunrise and sunset.
- The Vehicle shall ply 6 mtr. Clear of track. Any movement/work less than 6 mtr. and up to minimum 3.5 mtrs. from track centre, shall be done only in presence of Rly. Representative authorized by the Engineer-In-Charge. No Road Vehicle will be allowed to ply less than 3.5 mtrs. from track centre.
- In exceptionally vulnerable locations, physical barrier in the form of barricades at height of 1.5 mtr. or trenches on ground shall be provided.
- Under ground/over head obstructions such as pipeline, electrical cables/wires, signal cables/wires, drains may come in the way of execution. Contractor has to take all necessary precaution to safe guard the above till it is diverted/shifted to suitable location.

Site Safety Program

- Determine and incorporate a suitable course of action in the day to day activities, for the effective implementation of any safety program.

- To eliminate the factors affecting the safety program, the problems should be discussed to find solutions, in a fortnightly meeting.
- Analyze all upcoming activities, identify the possible hazards and finalize the precautions to be taken.
- Monitor the performance of the safety program and suggest improvements if required.
- Identify any unsafe working conditions/locations by inspecting the site twice a week.
- Investigate all accidents and reinforce the safety program with additional precautions.
- The site engineer should inspect the work spot daily to check any unsafe acts of the workmen and to eliminate any unsafe work conditions.
- The site engineer should inspect the work spot daily to check any unsafe acts of the workmen and to eliminate any unsafe work conditions.
- Keep first aid/fire fighting equipment/safety appliances on the site and ensure that they are maintained in a good condition.
- Work out the cost of all the accidents that occurred during the month/year.
- Site supervisors should give 'safety instructions' to the workers everyday and highlight the possible hazards in the day's work in addition to the precautions to be taken by the workers.
- Site supervisors should eliminate any unsafe conditions in their area of operation.
- They should keep the work area, especially the upper floors, clean and free of any loose material.
- Site offices should have a list of the following emergency telephone numbers:

* Fire 101
* Ambulance 101
* Police 100
* Nearest Doctor xxx

- Everyone should participate in ensuring the implementation of the safety precautions.

Personal Protective Kit

- Safety helmets – used where work is in progress at different levels.
- Safety belts – used by those working at a height, on the exterior of the building.
- Hand gloves – used for material handling, gas cutter, welding machine etc.
- Safety goggles – used for gas welding, grinding, pavement breaking etc.
- Gumboots – used during asphalting, cutting of hard rock, concreting works etc.

First Aid Kit

- Dressing cotton
- General medicines
- Triangular bandage
- 25mm roller bandage
- 75mm roller bandage
- Potassium paramagnet
- Iodine bottle
- Packet of cotton wool
- Scissors
- Dettol
- Safety pins
- Knife
- Blade

EXCAVATION IN			
SR NO	**STAGE PF WORK**	**POSSIBLE ACCIDENTS**	**PRECAUTIONS/PREVENTION**
1	Black cotton soil for column footings deep trenches.	Sliding of earth from sides of column pits or trenches	Proper slop / strutting to sides of the pits and trenches.
		Possible damage to adjoining structures	Notice to be given to owner of adjoining property. Adequate provision to protect the safety of adjoining property to be ensured.
		Damage to underground structures like water pipe, mains, sewer line, HT/LT cables and other services	1. Position depth and size of underground services should be obtained from the concerned authorities. 2. May be ascertained by manual excavation of trenches.

		Location of machinery and tools, excavated materials and other surcharge material may inadvertently collapsed / knocked into the trench.	To be kept at safe distance from the edge of the cutting.
		Materials required for excavation like ropes/planks for gangways and walkways, ladder etc.	1. Should be inspected by engineer-in charge regularly. 2. Barriers or other protection to stop people should be erected if there is likely hood of the public including cattle frequently in the area. 3. Vibration due to adjacent machinery, vehicles, rail-roads, blasting, piling and other sources require additional precautions to be taken.
2	Water logged area.	Falling of working labor/other equipments due to slippery area.	De-water the area, provide sump well for pumping out water.
3	Rock where blasting is involved.	Blasted material may lead to accident	Dampen the explosive to reduce the impact of the blast. Use a whistle to warn and demarcate with red flags near the boundary of the affected area, to avoid entry.
4	Snake & Scorpion on site	May encounter snake & scorpion at site during excavation	Careful handling / Use of hand gloves and gum boots.

	PILING		
SR NO	**STAGE PF WORK**	**POSSIBLE ACCIDENTS**	**PRECAUTIONS/PREVENTION**
1	Piling		1. Adequate lighting at the work site for work during night. 2. Crane driver or hoisting appliance operator should be competent. 3. Piling rigs should not be erected in dangerous proximity of electric conductors. If two pile drivers are erected at one place these shall be separated by a distance at least equal to the longest leg in either rig. 4. The frame of pile rigs should be in structurarily safe and should be firmly supported on heavy timber seals, concrete beds or other secure foundation. 5. Exposed gears, fly-wheels etc. should be fully enclosed. 6. Pile driving equipment shall be inspected by a competent engineer at regular interval.

CONCRETING			
SR NO	**STAGE PF WORK**	**POSSIBLE ACCIDENTS**	**PRECAUTIONS/PREVENTION**
1	Concreting in foundations for deep trenches or column pits	Sliding of earth sides of column pits or trenches	Proper shuttering to sides of the pits and trenches.

	PLACING		
SR NO	**STAGE PF WORK**	**POSSIBLE ACCIDENTS**	**PRECAUTIONS/PREVENTION**
1	Placing of Heavy column reinforcement	Column reinforcement cage may collapse	Proper strength of labor will ensure the safe placement of reinforcement in position
2	Placing of steel forms for columns, beams etc.	Form side may slip from worker and may collapse on/below causing injury	Careful handling of heavy steel forms. Also inform / alert the workers working below
3	Clamps of columns or beams and pins of the clamps	May slip from position and fall below	Whistle warning immediately

SLAB FORM WORK			
SR NO	**STAGE PF WORK**	**POSSIBLE ACCIDENTS**	**PRECAUTIONS/PREVENTION**
1	Cracked planks used for the beam bottoms & inclined props fixed to support the slab	Splitting up of beam bottom plank while fixing prop. Inclined props may slip, leading to collapse of the shuttering	Avoid use of cracked planks, put prop. Truly vertical with proper packing.
2	Use of steel props.	Crack at pin holes may get sheared off	Check before props are put in to use
3	Use of steel spans	Loose steel span pin may fold the steel span and down.	Centre steel span pin to be tightened properly
4	Nails in wooden loose planks, lapha etc.	Nails in such planks may injure the workers	Remove nails from such planks stack such planks and lapha's separately
			1. Formwork provided shall be properly designed and executed to ensure that it does not collapse during construction. 2. During actual construction of roof, frequent inspection of the formwork shall be carried out to ensure that no damage has occurred to it. 3. All centering shall be finally, inspected to ensure that: a) footings or sills under every post of the centering are sound. b) All lower adjustment screws or wedges

5	Form Work		are sung against the legs of the panels. c) All upper adjustment screws or heads of jacks are in full contact with the formwork. d) Panels are plumb in both directions. e) All cross braces are in place and locking devices are in closed and secure position. f) In case of CHHAJAS and balconies, the props shall be adequate to transfer the load to the supporting point. 4. While using reinforcement in roofs, it shall be ensured that enough working platforms are provided in the reinforcement area to ensure safe working. Provide edge protection to prevent people & material falling. 5. Floor opening and floor holes to be guarded either by railing or by cover. 6. Provide properly hung safety nets

CONCRETING OF SLAB			
SR NO	**STAGE PF WORK**	**POSSIBLE ACCIDENTS**	**PRECAUTIONS/PREVENTION**
1	Lift scaffolding, loose Kathya knot	If not vertical, may slip and collapse	Proper bracing to scaffolding to remain vertical
2	Lift bucket/trolley	Pin of trolley/bucket if not fit properly may fall down	Careful fixing of the pin in proper position
3	Wrong signal to lift operator	Mis-operation of lift may lead to accident	Proper arrangements for giving correct signals for lift operation. Avoid late night work.
4	Throwing of unused reinforcement bars from upper floors	May injure the working laborers below	Proper intimation to bottom worker should be given well in advance
5	Reinforcement for slab	Footware may get stuck into reinforcement cage & worker may fall	1. Walkways to be used for walking on un-concreted slab. 2. Prevention of accidental falling of workmen during the construction of roof shall be ensured providing catch roof etc.
6	Deshuttering of columns, beams, slabs, terrace chajjas	Form work material may fall. Carpenter may fall if deshuttering is done from edge of building.	Temporary bamboo barricade /compound where material is likely to fall down, with one man standing near the deshuttering work

SR NO	STAGE PF WORK	POSSIBLE ACCIDENTS	PRECAUTIONS/PREVENTION
1	High tension/L.T electric line passing near by the work.	While placing reinforcement it may affect working persons	Due care should be taken to handle as per situation involved. Use of hand gloves / gumboots necessary.
2	Cables in excavation	1. While placing concrete it may affect working persons. 2. Live cable may get punctured.	Careful working near cable area. All necessary precaution to locate cables by studying available drawings, manual trenching.
3	Temporary electrical lines on site near window, near damp walls supported on long distances	Wire may get cut during usage and may develop short circuits/earth leakages etc.	All temporary wires are to be supported properly. Check insulation of wires fixed near the steel windows. Proper care should be taken on such situations.
4	Welding work, drilling, polishing work with temporary cables having number of joints in long length without proper cover.	Curing of work near welding area may involve electric current/earth leakage thereby resulting in shock to the working people.	Welding work should be away from the damp area. Temporary cable to be supported at height and not on floor. Cable Joints to be properly insulated before supplying electric current. Well maintained machine to be used. Use of hand gloves/gum boots for insulation purpose.

MASONRY/PLASTER WORK			
SR NO	STAGE PF WORK	POSSIBLE ACCIDENTS	PRECAUTIONS/PREVENTION
1	Throwing of waste material, broken blocks/bricks bats	Unknowingly materials thrown may lead to injury to persons working below	Such materials may be stacked at place known to every working men and while in operation to warn every individual nearby that area.
2 3	While placing bricks /blocks may slip Scaffolding	Loose knots may lead to falling of the scaffolding Bamboos/props may break at the end and scaffolding may fall completely	Scaffolding should be sturdy and properly braced 1. Scaffolding may be of timber, metal, or bamboos sections and the materials in scaffolding shall be inspected for soundness, strength etc. 2. Scaffolding should not be overloaded. 3. Where workmen have to work below scaffolding or ladders overhead protection against the scaffolding materials shall be provided. 4. In case of pre-cast columns, steel beam etc. proper precautions should be taken to correctly handle, use and position them

			with temporary arrangement of guys till grouting of the base. 5. Manila or Sisal rope shall not be used in rainy season for hoisting of heavy materials. 6. No scaffolding, ladder, working platform, gangway runs, shall exist within 3m from any un-insulated electric wire. 7. Gangways and ground below the scaffolding shall be kept free from readily combustible materials. 8. No part of scaffolding or walls is struck by truck or heavy moving equipment and no material shall be dump against them to prevent any damage. Near a public thoroughfare sufficient warning lights and boards should be provided. 9. Adequate precautions should be taken to ensure that the fragments of fragile material do not cause any injury to workmen or general public in that area by way of providing covering. 10. Immediate Whistle warning.

LIFT PIT / DUCT			
SR NO	**STAGE OF WORK**	**POSSIBLE ACCIDENTS**	**PRECAUTIONS/PREVENTION**
1	Lift Pit / Duct	Children / working labor, may fall unknowingly.	1.0m high guard walls to be constructed around lift pit/duct for all the floors.
2	Lift pit with door frame fixed	While peeping into the lift pit/duct one may lose balance and fall.	Proper temporary grill to the door frame opening for all the floors.
3	Lift pit at ground floor used as temporary water tank	Children may fall into the lift pit	1.0 m high guard walls around lift pit should be made on temporary basis
4	Walking on parapet wall	May fall down due to imbalance condition	Over confidence may lead to such accidents. Do not allow to do so even if required in work

PLUMBING WORK			
SR NO	**STAGE OF WORK**	**POSSIBLE ACCIDENTS**	**PRECAUTIONS/PREVENTION**
1	Holes/chiseling on concrete/hard surface	Chisel may slip off and fall down	Careful handling
2	Plumbing nails in concrete/hard surface	Hammer may fall down on breaking of its handle/may slip from its position on hammering and fall down	1. Use of proper tools. 2. Working with due care. Immediately warning to others in the nearby area.

PAINTING WORK			
SR NO	**STAGE OF WORK**	**POSSIBLE ACCIDENTS**	**PRECAUTIONS/PREVENTION**
1	Working on ladder	Ladder may slip and painter may fall.	Use of safety belt anchored to hooks. Co-worker to hold the ladder firmly or ladder should be anchored properly.
2	Working on Zulla for external paint, crack filling or other work.	Ladder may slip/rope on ladder may get loose and painter on zulla may fall	Weight on the ladder should be 2 to 3 times more than the weight on Zulla. Co-worker to hold zullla rope carefully.

TRUCKS WORKING ON SITE			
SR NO	**STAGE OF WORK**	**POSSIBLE ACCIDENTS**	**PRECAUTIONS/PREVENTION**
1		While in reverse motion, playing/ sleeping children may come under the truck.	1. Co-worker to guide the truck properly. Labour children to be kept away from working area. 2. Immediate whistle warning 3. Excavation pits are to be filled back after its use. All manhole chambers to have proper heavy duty covers.
		Breaks may fail while truck is in speed. Wheels may slip into excavation pits/manholes/chambers	1. When trucks are being used on the site, traffic problems shall be taken care of. A reasonably smooth traffic surface shall be provided. If practicable, a loop road shall be provided to permit continuous operation of vehicles and to eliminate their backing.

HANDLING OF PLANTS			
SR NO	**STAGE OF WORK**	**POSSIBLE ACCIDENTS**	**PRECAUTIONS/PREVENTION**
1	Mixtures		1. All gears, chains and rollers of mixers shall be properly guarded. If the mixer has a charging skip the operator shall ensure that the workmen are out of danger before the skip is lowered. Railings shall be provided on the ground to prevent anyone walking under the skip while it is being lowers. 2. All cables, clamps, hooks, wire ropes, gears and clutches, etc. of the mixer, shall be checked and cleaned, oiled and greased, and serviced once a week. A trial run of the mixer shall be made and defects shall be removed before operating a mixer. 3. When workmen are cleaning the inside of the drums, and operating power of the

			mixer shall be locked in the off position and all fuses shall be removed and a suitable notice hung at the place.

CRANES			
SR NO	**STAGE OF WORK**	**POSSIBLE ACCIDENTS**	**PRECAUTIONS/PREVENTION**
1	CRANE		1. Crane rails where used shall be installed on firm ground and shall be properly secured. In case of tower cranes, it shall be ensured that the level difference between the two rails remains within the limits prescribed by the manufacturer to safeguard against toppling of the crane. 2. Electrical wiring which can possibly touch the crane or any member being lifted shall be removed, or made dead by removing the controlling fuses and in their absence controlling switches. 3. Cranes shall not be used at a speed which causes the boom to swing. * A crane shall be thoroughly examined at least once in a period of 6 months by a competent person who shall record a certificate of the check. 4. The operator of the crane shall follow the safe reach of the crane as shown by the manufacturer. 5. Concrete buckets handled by crane or overhead cableway shall be suspended from deep throated hooks, preferably equipped with swivel and safety latch. In the concrete buckets, both bottom drop type and side drop type, closing a locking of the exit door of the bucket shall always be checked by the man-in-charge of loading concrete in the bucket to avoid accidental opening of the exit door and consequent falling of concrete.

CONCRETE PUMPS(AIR COMPRESSOR OPERATED)			
SR NO	**STAGE OF WORK**	**POSSIBLE ACCIDENTS**	**PRECAUTIONS/PREVENTION**
1	CONCRETE PUMPS (AIR COMPRESSOR OPERATED)		Safety requirements in accordance with good practice shall be followed.

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Land Acquisition, Social and Environmental Issues in Infrastructure Projects

By
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SYNOPSIS

The key challenges in the development of infrastructure are land acquisition and various social and environmental issues associated with the acquisition of land. This paper analyses the various provisions of Railway Amendment Act 2008 and innovative steps taken which has resulted in successful acquisition of more than 9500 Hectare of land for Dedicated Freight Corridor Corporation of India Limited (DFCCIL). Besides, an effort has been made to look at the progressive provisions on R&R under various national and international policies which has also now become mandatory in new Land Acquisition Act (The Right to Fair Compensation and Transparency in Land Acquisition and Rehabilitation and Resettlement Act 2013)

1.0 Introduction

The draft of the government's 'National Policy for Rehabilitation' states that around 75% of the displaced people since 1951 are still awaiting rehabilitation.[1] This statement assumes significance in view of the fact that there is ever increasing focus on growth of infrastructure in the country. The Twelfth Five Year Plan (2012-17) document lays special emphasis on development of Infrastructure sector stating that the availability of quality infrastructure is important not only for sustaining high growth but also ensuring that the growth is inclusive. The total investment in the infrastructure sector during the Twelfth Five Year Plan, estimated at Rs 56.3 lakh crore (approx US $1 trillion)[2], was nearly double of that made during eleventh Five Year Plan. The plan also envisages an integrated approach for the transport sector as a whole.

But India seems to have lost the way when compared to the developments in infrastructure in other emerging economies such as China, Korea etc. Time overruns in the implementation of projects is one of the main reasons for underachievement in many infrastructure projects. The status report [2] of major central sector projects costing Rs 150 crores and above for the month of September 2012 shows 258 projects out of 566 delayed with respect to their latest scheduled date of completion. Sector wise, in railways 40 out of 127 and in the road sector 86 out of the total of 146 projects have been delayed. Delay in land acquisition, improper R&R provisions and statutory environmental permissions are some of main reasons for delay in implementation.

This paper is an attempt to share the experience of land acquisition for the Dedicated Freight Corridor project of the Indian Railways, the innovative ideas incorporated in the Act and Land acquisition process and reflecting on the path breaking ideas in other land acquisition laws.

2. Land Acquisition – DFC experience

2.1. Construction of high speed, heavy axle load Dedicated freight corridors is one of the most ambitious project on the Indian Railways, estimated to have a project completion cost of more than Rs 90,000 crores in 2016-17. It envisages construction of more than 3000 km of

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electrified railway system capable of carrying of train load of more than 15000 tonnes with speed of 100 kmph as compared to the present train load capacity of 4000 tons at 75 kmph. It involves acquisition of more than 10500 hectare of land across 9 states from Punjab to West Bengal in the East and Haryana to Maharashtra in the West. The project has been declared as a Special Railway Project with land acquisition being done under Railway Amendment Act (RAA) 2008. DFC has successfully acquired more than 9500 hectare of Land which is 90% land in a little over 3 years.

2.2. The compensation of land is calculated as follows:

- The minimum land value, if any, specified in the Indian Stamp act, 1899 for the registration of sale deeds in the area, where the land is situated; or
- The average of the sale price for similar type of land situated in the village or vicinity, ascertained from not less than fifty percent of the sale deeds registered during the preceding three years, where higher price has been paid, whichever is higher.
- 60% solatium on the compensation. as per 20F(9) of RAA-2008.

2.3. The average land rate across States was compared. The table below highlights wide variations in the average land rates across States on the land being acquired by DFC:

SL NO	State	Total Land Acquired (Ha)	Average Rate per Hectare (Rs crore)
1	Haryana	583	1.19
2	Uttar Pradesh	3091	0.39
3	Punjab	251	3.25
4	Bihar	245	0.84
5	Gujarat	2246	0.63
6	Rajasthan	1909	0.20
7	Maharashtra	297	0.48

As can be seen from the table above, the rates per Hectare vary from Rs 3.25 crores in Punjab & 1.19 crores in Haryana to Rs 20 lakhs in Rajasthan & Rs 40 lakhs in Uttar Pradesh, a difference of over 16 times. This dichotomy further widens when the rates of different districts in particular States are taken into consideration. As can be seen from the Table below (only districts where more than 50 Ha is being acquired have been projected), even within the same state, there is a difference of more than 10-15 times in the average rate per Hectare (Gautam Budh Nagar and Auraiya/Kanpur Rural). Across States, the difference gets much bigger. Whereas Ludhiana district in Punjab fetches Rs 4.04 crore per Hectare, Kheda district in Gujarat fetches a measly Rs 4 lakh per Hectare.

Name of the State	Name of the District	Area (Ha.)	Average Rate per Ha (Rs Crore)
Punjab	Ludhiana	68.69	4.04
	Fatehgarh Sahib	103.36	3.15
	Patiala	79.10	2.69
Haryana	Ambala City	65.44	0.41
	Rewari	241	1.01
	Mahenderagarh	92.72	0.95
	Gurgaon	63.18	1.24
	Palval	107.39	2.36
Uttar Pradesh	Saharanpur	86.67	0.42
	Bulandshar	183	0.47
	Aligarh	233.4	0.68
	Mahamaya Nagar	169.50	0.41
	Agra	77.8	0.56
	Ferozabad	229.12	0.50
	Etawah	293.2	0.18
	Auraiya	108.50	0.12
	Kanpur Rural	159.8	0.12
	Kanpur Nagar	241.6	0.44
	Kaushambhi	121.64	0.20
	Allahabad	390	0.32
	Mirzapur	375.00	0.23
	Chandauli	65.96	0.46
	GB Nagar	64.58	1.45
Rajasthan	Alwar	6.12	0.57
	Sikar	328.4	0.13
	Jaipur	461.07	0.09
	Ajmer	366.37	0.29
	Pali	524.27	0.07
	Sirohi	136.5	0.33
	Alwar	80.63	1.42
GUJRAT	Banaskantha	150.24	1.29
	Mahesana	164.79	0.35
	Gandhinagar	116.53	0.27
	Ahmedabad	261.38	0.21
	Kheda	153.24	0.04

	Anand	263.08	0.31
	Vadodara	417.72	0.79
	Bharuch	326.97	0.38
	Surat	238.3	1.92
	Navsari	46.34	0.80
	Valsad	66.55	0.43

2.4. To cater to these variations in the Land rates, a number of progressive provisions were incorporated by DFCCIL in its approach to acquire the land.

a) In view of the wide variations of rates and during various Public consultation meetings/Focus Group discussions while sensitising the PAPs, a need was felt for additional provisions to tackle the wide variety of issues, Entitlement Matrix was redrafted to include the following:

• Applicability of State laws for acquisition wherever applicable:

The following clause was inserted in the Entitlement Matrix. In case where a State Government through any act or Gazette Notification or as approved by any authority of State Government (duly authorized for the purpose) as per their approved procedure has fixed a rate for compensation of land, the same may be adopted.

(i) Thousands of the PAPs showed resentment in compensation package of Competent Authority of Aligarh and Agra District. With the help of above clause, land rates as applicable to Yamuna Expressway (YEIDA) were provided to PAPs. The rate of Yamuna Expressway was Rs 670/- per square meter as compared to the circle rate of Rs 340-350/- per square meter. Better compensation could thus be provided to the PAPs and PAPs willingly handed over land to DFC without any further litigation.

(ii) Similarly, there was a wide gap in circle rate and market rate in Thane District of Mumbai. An independent Rate Estimation Committee was formed to fix the rate to narrow down the gap. With the help of the same, more than 220 Hectare of land @ Rs 1.07 crore per hectare could be successfully acquired in Thane.

• Appointment of Independent Evaluator

DFCCIL has enacted a provision to hire an Independent Evaluator registered with Government, to assist to assess the replacement cost of land as follows and provide inputs to the competent authority:

(i) Appraise recent sales and transfer of title deeds and registration certificates for similar type of land in the village or urban area and vicinity

(ii) Appraise circle rate in urban and rural areas of the district

(iii) Appraise agricultural productivity rate for land – 20 years yield.

2.5. But is compensation for the land the only issue? There is a popular saying among the Havasupai Apache Indians in the United States, a people displaced repeatedly by development projects: "Land is like diamonds but money is like ice" [3] The pain of displacement is understood only by the one who is affected. Land is not only the main source of livelihood, but also serves as a social symbol and collateral for bad times.

During visit to a rehabilitation colony of an infrastructure project, it was found that the occupational shift from agriculture to service sector sometimes takes more than a generation to adjust. A widow with 4 children losing her complete land holding in Simoi village near Varanasi got only Rs 2.5 lakhs as compensation which when distributed amongst all children left her with only Rs 50000/- and no source of livelihood. There are a number of studies to indicate that displacement results in women's disempowerment. The condition of tribals post displacement is even worse. The principle of "greater good for the larger numbers" can in no way justify the plight of many more such people and communities.

These effects can be mitigated by a systematic Resettlement and Rehabilitation (R&R) package. It is a fact that land acquisition cost is normally less than 7-8% of the project cost in case of infrastructure projects. However the financial cost of time and cost overrun due to delay in land acquisition is many times higher. It is therefore financially prudent too to invest in Social and Environmental issues also. The following paragraph discusses the role and process of Social and Environmental Impact Assessment and steps taken by DFCCIL for development of proper Resettlement Action Plan and Environmental Mitigation Plan.

3. Need and Process of Social Impact Assessment

Social Impact assessment is carried out to identify impact of construction (especially land acquisition) of the corridor on the people; opinion of people about the project and suggested mitigation measures, the social management framework outlines Resettlement & Rehabilitation Policy framework, institutional arrangement as per provision of

NPRR 2007 and implementation arrangement in accordance with construction schedule. RAP was 'the document' to follow for management of resettlement issues during implementation. The following methodology was adopted in conducting SIA:

3.1. Methodology for Social Assessment

Social impact assessment is a critical step taken to incorporate social analyses and participatory processes into project design and implementation for optimizing development outcomes. Specific tasks for social assessment and methodologies adopted have been summarized below:

Specific Tasks	Methodologies
Re conforming zone of Impact through review of data	DFCCIL prepared land acquisition plan for the proposed stretch though its feasibility consultant. The zone of impact was reconfirmed by (i) Review of land width data of Railways, (ii) Estimate land acquisition village wise, (iii) Identification of critical segments, (iv) Review of efforts made by DFCCIL towards minimizing resettlement, (v) Review of technical measures adopted for proposed alignments especially in bypasses and congested stretches.
Identifying zones of major economic and social impact	Identification of zones of major economic and social impact was done by classifying degree of impact segment wise. For this purpose (i) kilometer/ village wise land acquisition was estimated, (ii) critical segments were identified based on type of land(agricultural, built-up, market, eco-sensitive land) proposed for acquisition, (iii) Number and Type of structures being acquired at particular location(km/village), (iv) Categorization of stretches in terms of degree of impacts (a) low, (b) medium and © high
Understanding socio-economic profile of the people	Based on identification of impacts (as mentioned above), a census and baseline socio-economic survey was carried. While census survey enumerated all the project affected families recording lands and assets possessed and likely to lose because of proposed DFCC tracks, the baseline survey emphasized detailed assessment of impacts on vulnerable families . For this purpose following steps were taken. (i) Preparation of list of project Affected Families: As mentioned earlier also, DFCCIL prepared land acquisition plan as per RAA 2008. The land plan included affected survey number (zone of direct impact) and owner of the land and properties. However, preliminary reconnaissance survey indicated that there are other family (who lacks title of the properties) has not been part of listing of PAFs by DFCCIL. These PAFs were also enumerated based on detailed measurement survey as per provision of NRRP 2007. (ii) Training to enumerators: Enumerators were selected from sociological research background from Kanpur Etawah and Aligarh University. Enumerators underwent two weeks of intensive training by the resource person of the consultant. The Social Expert of Consultants and Revenue officials (working for the project) imparted training to this social survey team. Explanation of terms, meaning etc in the questionnaires, methods of getting information from potential PAPs, mechanism of social behavior, and strategy of communication with respondents etc. were part of training program. During training sessions, enumerators were exposed to role play of PAPs, enumerators, public to make them conversant with the approach required for

	collection of information through questionnaires, understanding and appreciating local situations etc. The survey team was mobilized in the field after testing of questionnaire in the project area. (iii) Survey of Potential Affected Structures and land: In order to assess impact, structures coming within the proposed land width were marked, measured and recorded on a strip map. This also included the typology of construction (such as pucca, semi-pucca, and katcha) based on construction materials used and the usage of structure like residential, commercial and others. Extent of loss was determined by measuring the distance of the structure from the proposed centerline of DFCCIL alignment in the following manner. (a) Measure the distance of each affected structure from the existing up track centre (b) Measure the entire structure including length, breadth and height of the structure. At the same time measure the area affected (i.e., portion of the structure coming within proposed DFCCIL Line) to calculate the degree of loss Examine the construction typology of each structure with respect to walls, roof and floor. Note down number of rooms, verandah (if any), sanitation facility, kitchen, etc. (c) This helped in categorization of loss of plots or buildings:

Any landless person not having homestead land, agricultural and residing in the zone of impact(proposed DFCCIL corridor) for not less than three years was included in the list of affected families.(Chapter III. 3.1(b),(iii) NPRR 2007)

Since time assigned to complete the social impact assessment is less, therefore it is proposed to assimilate information of census survey into baseline survey. Further the survey was limited to those families who are eligible for assistance under the provision of NPRR 2007. These families are small and marginal farmers, BPL, SC,ST.

	Less than 10% of the total area Between 10 to 25% of the total area Between 25 to 50% of the total area More than 50% of the total area This helped in identifying project displaced families. (It is pertinent to inform that all project displaced families are project affected families but all project affected families need not be project displaced families.) Similarly for loss of land(impacts) was categorized into: a. Impact on affected plots was done by measuring severity of impact (10%, 20%.50% or 75%) b. Based on severity of impact the plots were classified as economically viable or not. c. In bypasses people would lose accessibility if residual land (after acquisition) is on the other side of proposed DFC corridor. A study was conducted about impact on plots. The plot impact analysis helped in formulating policy about minimum left out land area need to be acquired so that land owner will not have adverse impact. Census and Baseline Socio-Economic Survey: To conduct the census survey an exhaustive interview schedule was prepared and tested in the field (Annexure 1).

	The format was approved from the DFCCIL and World Bank. Census and baseline survey was conducted for the establishment of impacts on the people. The information collected from census survey are Type of land or structure or both, usage of land and structure, household profile with family structure, literacy level, occupation and marital status of each member of the family. The survey also provided information on income of the family; debt status and social information to determine whether project affected persons as per categorization of NPRR 2007. Loss of other assets such as boundary wall, public property, and common resources being lost will also be recorded. Enumerators were directed to make an objective assessment of the loss of property and type of loss based on their field observation. Data Analysis: The interview schedules filled up every day was scrutinized and verified on the spot (project corridor) and the data-sheets will coded. A coding manual was prepared for consistency in data entry. The MS-Excel software package was used for the data feeding and its analysis. Wherever applicable, SPSS package will also be used to generate tables. As a measure of final confirmation about the correctness of the data, random manual calculations and checking will also be done Outcome: Socio-economic profile of the PAFs, type of losses.
Identifying differential impacts on different categories of the people	As mentioned above, the impacts were categorized based on severity of impacts. The PAFs were categorized into displaced and affected. Further these impacts will have differential bearing on different categories of the people. Impacts on categories of people (vulnerable) were evaluated. Based on evaluation, mitigation measures were suggested.
Socio-political analysis of local power relations and institution available for participation, grievance redress and conflict resolution	Social assessment collected information on existing institutions working in the project area for land acquisition, implementation of developmental schemes of Government (DRDA and other line Department), and working style of existing Panchayati Raj Institutions. The assessment process also engaged in social networking, coordination with local NGOs, CBOs, Health workers, ORWs. The assessment team also reviewed existing grievance redress mechanism functioning in the project area. The social team also understood existing institutions of DFCCIL for the implementation of RAA 2008 and NPRR 2007. Efforts were made to understand political background of each affected villages and their representatives (Pradhan.MLA.MP). Based on above study, a conflict resolution mechanism was developed.
Participation of people to minimize displacement	**Stakeholders Consultation** **Methodologies for Stakeholders Consultation** Consultation is key to understand people's perception and seek their opinion. Consultation is also an important tool to improve quality of planning. Following steps were followed during consultation **(I) Identification of key stakeholders and level of Consultation:** Important stakeholders of the project were PAPs (primary), DFCC officials, line department of Districts offices such as LA, Forest, PWD, horticulture department. The consultation were held at individual (during BSES), groups (at village and Tahsil level), FGDs and District level. **(ii) Information dissemination:** Information dissemination was done through

	pamphlet distribution (in Hindi), informal meeting with the people, village level meeting etc. **(iii) Consultation with Key Stakeholders:** One of the strategies of proposed consultation was to involve key stakeholders in the project planning. These stakeholders for the project were Officials of Revenue, Forest, Rural Development, Social Welfare Department, PRIs representatives, PWD officials. These stakeholders were involved in developing strategies in the preparation of LA award, plantation strategies during implementation, dovetailing Government schemes, valuation of properties and assets. **(iv) Strategies for Structured and Focused Consultation:** To provide better and qualitative planning options; consultations with specific objectives, agenda was conducted in structured manner. For this purpose, much advance date and venue of consultation was fixed in coordination with the PRIs representatives at village level and Tahsildar, Forest officials (range official), women groups. Such planned consultation brought out issues of proposed DFCCIL improvement in the agenda for discussion and some of the suggestion given by the community helped in project planning. This also helped in generating sense of ownership through community participation. **(v) Opening of Field Offices:** Field offices was opened at a number of locations which acted as information centre for the project. Besides that. All LA offices, CPM offices, project engineers office were also centre of information. Exchange of information about the project was ensured at these field offices. **(vi) Strategies for Future course of Communication** Several additional rounds of consultations with PAPs were done through active participation of social survey team. These consultations involved agreements on compensation and assistance options and entitlement package. The next round of consultation was held when compensation and R&R assistance were finalized. The R&R entitlements were displayed in billboards along the project corridor in local language. Participation of PAPs in implementation was also ensured through their involvements in various local meeting with line department.
Assessment of construction	Though this is very special case to understand social issues of DFCC project during
Phase impacts	construction phase. However efforts were made to categorize these impacts. These impacts was categorized as (a) community conflict to access their cultural properties (b) Loss of access roads to the agricultural field: Presently a service road (BT, earthen) parallel to the IR track, which is used by local people as access to the agricultural field. Some of these service roads are important arteries of the project affect villages. (c) Dust and other pollutant (d) Cutting of trees and aforestation strategies: Many of the implementation issues get resolved by involving local community in the project. For example afforestation by community. These effects of construction may largely be gathered from consultation in the villages, with DFCC official involved in construction earlier.
Suggesting broad strategies for mitigation of adverse	Based on findings of surveys and consultation, social impacts of the project was established. Based on operational policies of the World Bank, RAA 2008, NPRR

	2007,
impacts	the social assessment suggested mitigation measures These mitigation measures also focussed on institutions likely to involve in implementation of managing social issues.

3.2. Methodologies for the Preparation of Social Management Framework (SMF)

The SMF was prepared which was largely based on finding of impacts assessment, consultation results, on RAA 2008, NPRR 2007, and Operational Policies of the World Bank.

The SMF focussed on developing implementation schedule, R&R entitlement under the project, proposed institutions of R&R under the project, methodologies for disclosure of R&R schemes, grievance redress and measures to address impacts on tribal people. These activities can be broadly summarized in:

(I) Implementation Schedule: The implementation schedule was developed in concurrence with construction schedule. Basic objective of the implementation schedule was to develop time frame for each activities related to LA and R&R. One of the prerequisite of construction under the project is to complete all LA and R&R activities before construction started.

(ii) Formulation of R&R entitlement Framework: An entitlement framework for the PAFs was prepared. The entitlement framework was based on compensation package of RAA 2008,R&R scheme of NPRR 2007 and Operational Policies of the World Bank.

(iii) Institutional Arrangement: To address social issues related to EDFC, a separate Social and Environment Management Unit (SEMU) was set up in DFCCIL headed by a General Manager and assisted by AGM and executives. The institutional capacity was assessed largely through consultation with important stakeholders, existing staffing pattern of CPM offices, need for additional services within the purview of NPRR 2007 to implement in time bound manner. Based on assessment, the SMF developed institutional mechanism, role and responsibility of R&R and other officers of DFCC. Besides DFCC officer, the assessment also identified some other groups like PRIs, CBOs, existing line Department as partner of the project.

Further, the consultant developed fund flow mechanism under the project, monitoring mechanism under the provision of NPRR 2007.

(iv) Methodologies for Disclosure: The consultant identified important places, public offices for the disclosure of SMF. The objective of disclosure in project area was to have mechanism to receive feedback on SMFs from stakeholders. These feedbacks were an input for the finalization of RAP in due course. The SMF was also put on website of DFCC and World Bank.

(v) Issues Related to Schedule Tribe in SMFs

The Social Management Framework(SMFs) not only focussed on the preparation of RAP but other social management plan like tribal development plan(if required),HIV/Action Plan and other safeguard management plan. For this purpose (i) the census survey established impacts on STs (ii) consultations result also identified impact on tribe as community. Based on findings the SMF recommended whether Tribal Development Plan (IPDP) is required or not.

(vi) Resettlement Action Plan

Based on above mentioned social impact analysis, consultation, R&R policy intervention and Social Management Framework a Resettlement Action Plan was prepared. This Resettlement Action Plan was prepared by adopting a social assessment process at different stages. Output of Social impact Assessment Report and agreement reached after feedback of disclosure on SMF was input for the preparation of Resettlement Action Plan. This was the document which was followed during implementation. (Draft RAP for Bhaupur- Khurja section of EDFC is available on official website of DFCCIL)

4.0 Key Issues Discussed in the PCMs

At a series of PCM for draft RAP, participants raised many comments and questions regarding the project, alignments, impacts, compensations, resettlement assistance, employment, etc. Many of them were related to compensations, assistance and employment provisions. These issues were discussed and responded to by the CPM officers, Competent Authorities and experts at the PCMs. Among them, main comments and questions are described below

a) General

- Participants wanted to know the concrete compensation rates at the PCMs. Some of PAPs showed disappointment with the content of the presentation and responses by the officers as they had expected to learn

the exact amount they would receive, especially for their land.

b) Land Rate

- At almost all PCMs, the participants raised the issue of land rate. They said that there is a wide gap between true market rate and circle rate; and therefore, compensation rate should be based on the true market value.
- Reflecting the constant increase of land rate in recent years, some participants showed dissatisfaction with the rate being determined based on the cut-off date, and others, particularly, demanded to apply the new circle rate, which had been adopted on April 1, 2011.
- Participants demanded that the market survey should be conducted by DFCCIL and the result should be shared with PAPs.
- In Gujarat and Uttar Pradesh states, previous examples of land acquisition by the State Government, including by Greater Noida Industrial Development Authority (GNIDA) and Gujarat Industrial Development Corporation (GIDC), were referred to by some of the participants. They said that similar rate for land should be applied to nearby land.

c) Compensation for Shifting Facilities

- Participants inquired whether the extra expenses that would be involved in shifting the facility, including building the electric poles, wires, etc., would be compensated by the DFCCIL.
- Participants asked what would happen if an irrigation channel is cut off by the alignment. In this case, the remaining land (larger potion) will be un-irrigated and become worthless. What will DFCCIL compensate for in such a case.

d) Relocation and Compensation for Non-title Holders

- Squatters raised their concerns, saying that a three months' notice is too short and insufficient to relocate themselves for they have no place to move to.

PAPs (encroachers) demanded to be provided some land to reconstruct their houses. Historically, the legal papers such as 7/12 land revenue record1 had not been provided to the SC, who lived in the land for several decades. Their houses are shown on the village map issued by the District Revenue office, which means their claim was legal

e) Compensation for the Wage Laborers

- Participants in Vadodara PCM jurisdiction mentioned that the (Joint Measurement) survey agency did not identify the number of agricultural laborers employed in the fields correctly and as a result, they were not able to receive compensation. (It is suspected that some people are filing false claims, increasing the number of laborers after the compensation process was completed.)

f) Community Structures

- Some participants were worried whether their community properties would be affected: especially, whether the cremation grounds will be divided in two parts.

g) Compensation for Outside ROW

- Participants pointed out that compensation should be paid for land within 30 meters of ROW since the Indian Railway does not allow developing structures in that area and PAPs cannot use these areas.

h) Other Compensation-related Issues

- In some areas, the 20A Notification was cancelled and reissued more than once. The people lost their source of income because they were not able to cultivate/utilize the land since the notification was published for the first time a few years back. Participants demanded that lost income should also be compensated.
- Some demanded compensation for anticipated damage to crops, structures, and land caused by the activities during construction.

i) Employment

- Development of the notice from the MOR, “one-job-per-affected family”, was one of the most serious concerns raised by the participants. At every PCM, participants requested officers to provide detailed information about the plan. PAP’s opinion for this matter included: permanent employment should be given to the PAPs; training costs should be also provided; a family, not a household, should get a job, as a household is often a conglomeration of several separate families, etc.

j) PAP Should Receive Fair Share of the Project

- Some participants misunderstood that this project is a public-private partnership and the Indian Railways

makes profit out of PAPs' sacrifice. With this misperception, PAPs think that each PAP will be given partnership of the project, and a share of profit or pension should be provided. PAPs at several PCMs suggested that they should get some discount on fares for passenger trains.

k) Middlemen

- Several PAPs had been contacted by touts and/or middlemen who promised them better compensation. Participants demanded that authorities should stop these people who might take advantage of ignorant PAPs on their entitlement and rights.

l) Language of Compensation Document

- A lawyer who represents some of PAPs said the letters given by the Competent Authority to PAPs that explain award were written in English, which most of the PAPs did not understand properly. They should be delivered in vernacular language.

m) Farmers Cannot Get New Land for Agriculture

- It was pointed out that farmers who lose 100% of their land will lose their right to buy agricultural land if they are not able to do so within six months.

n) Negative Impact

- Participants expressed their concern about negative impacts that may be caused by the Project. Farmers were worried that the construction of high tracks may result in flooding of their agricultural fields. PAPs who own structures were afraid that the freight trains may cause impact to old structures due to vibrations.

o) Demand for Changing Plans

- Some participants insisted that options for changing alignment and the width of ROW should be considered further by DFCCIL. Others insisted that existing roads and passages to farm lands should not be affected by the Project, and more ROBs or RUBs should be added.

p) Clarification of the Definition

- The definition of the marginal framers given in the Entitlement Matrix was challenged by a participant. He insists that it is not correct . This need to be reviewed.

q) Ignorance

- PAPs in some area did not know about some of the benefits, such as additional benefits to vulnerable persons, and therefore they were worried whether they received proper compensation. In addition, most of the PAPs were not aware of their entitlement regarding the payment of Rs. 15 per square meter for the land acquired over and above 1500 sq. m.

r) Incorrectness in 20A and Other Legal Documents

- There are many comments by PAPs in several PCMs indicating the incorrectness in the documents providing the foundation for compensation. These claims included discrepancies in 20A and mistakes in the 7/12 records, etc.

s) New Bill

- Many raised voices saying that land should be acquired only after the new land acquisition Bill, which has been submitted to the Parliament, is passed. They believe that they would miss some benefits that are mentioned on the new bill if the land is acquired before the bill is passed.

t) Applicability of Tax on Compensation

- PAPs inquired whether each PAP would be subjected to 20% capital gain tax (income tax) on the compensation. If so, they insisted, this loss should be additionally compensated by the proponent. They demanded a clarification on this point.

u) De-Notification for Non-Acquired Land

- PAPs called for the de-notification of non-acquired land. When 20A notification was issued by DFCCIL, all activities in the entire area of a particular plot number were suspended. But now that the exact area to be acquired is identified, the remaining land should be de-notified so that PAPs can make use of this part of their land.

v) No Objection Certificate (NOC)

- PAPs demanded NOCs should be issued before acquisition starts. Once the land is acquired, they said, it would be very difficult to obtain NOC from the railway offices.

5.0 Steps by DFCCIL:

It is with this purpose of mitigating the effects of displacement to some extent and provide R&R to various affected categories of the PAPs that the following measures have been incorporated in the Entitlement Matrix, which has been specifically designed to cater to the needs of the PAPs and bring about transparency in deciding and distribution of distribution of compensation.

a) Applicability of NRRP 2007 provisions: some of the benefits being disbursed under these provisions are as follows:

i. Ex-gratia amount of Rs.20,000/ to all affected families.
ii. 750 days of minimum wages to small, marginal and landless farmers.
iii. Refund of stamp duty and registration charges.
iv. Cash compensation for structure at replacement cost.
v. Compensation for trees and crops.
vi. Right to salvage material.
vii. Transition allowance of Rs.4000/-
viii. Shifting allowance of Rs.10,000/-
ix. Rs.15,000/- for cattle shed.
x. 300 days of minimum wages to BPL and vulnerable groups.
xi. Benefits to tenants, lease-holders, kiosk owner, Squatters, Encroachers and vulnerable persons etc

b) Multi level grievance redressal mechanisms: DFCCIL has set up a multi level grievance redressal mechanism to enable PAPs to have proper disposal of their grievances.

i) For grievance related to Land compensation, arbitrators have been appointed in each district. More than 3000 applications have been received for enhancement of land compensation rates.
ii) For R&R related grievances, 3 level Grievance Redressal committee (GRC) at field level, Headquarter level and Ombudsman are in place. At field level, representative of the state administration/zilla pramukh, DFC and members of Civil society have been included in the committee to address the local issues of the PAPs.

(RAP's for various section of EDFC and WDFC can be seen at official website of DFCCIL)

6.0 Lessons Learned from PCM (Procedural)

(1) Invitation Process

At almost all the PCMs, PAPs showed their dissatisfaction about the method of the invitation process, demanding that they receive a letter directly. This method might have been ideal; however, there is no complete record of names and addresses of all PAPs at the moment to pursue such an approach. Therefore, placing notices in several permanent locations in the village, including schools, dairy collection places, bus stands, public water places, etc., served as a good alternative to sending individual letters to PAPs after all. Another possible method could have been distributing pamphlets as well as keeping them to spread the message among large sections of PAPs. On the other hand, the advertisement

in the local newspapers, suggested by some of the PAPs, seemed to work for collecting a large number of participants, like PCMs in the CPM Jurisdiction. However, it was not clear if all the participants could be actual PAPs/titleholders and non-titleholders affected by land acquisition and if it could still secure the opportunity to for actual PAPs to speak out such sensitive compensation issues in front of the larger number of participants including non-PAPs.

(2) Participation

The participation rate accounted between 20 - 30% of all households in PCM . It was analyzed that the following facts contributed to this relative low participation rate:

- In some villages , many of the PAPs have already been paid or awarded compensation Therefore, the majority of them might not have been interested in attending the meetings.
- PCMs took place during weekdays. Many PAPs did not want to lose their daily earnings or did not want to pay transportation fees by themselves for attending PCMs. - Previously, two ESIA-related PCMs had been held in several months, targeting almost the same populations, which gave opportunities for PAPs to raise comments and concerns regarding not only environmental impacts but also resettlement and rehabilitation related issues.
- The low participation rate itself should not be of too much concern; rather, the reasons why many PAPs chose not to attend should be addressed by DFCCIL.

(3) Location of PCMs

At some PCMs, PAPs were not able to reach the venue because they could not find it. The venue of the PCMs should be very familiar for the participants. Also it should be close to the railway station or major bus stands for easy access as much as possible unless the affected villages are far away from the railway stations or major bus stands. Alternatively, common vehicles could have been provided to pick and drop PAPs from their respective villages if the number of affected village or participants are small

enough.

(4) Presentation/Handouts

Contents of the presentation should have been localized, like including the state laws and policies, specific information including planned width of ROW, ROB and RUB, etc. In addition, some case examples1 could have been included so that PAPs could relate themselves and understand their entitlement well.

(5) CPM Officers

The outcome of the PCMs often depended on the capacity and attitude of the attending CPM officers. The CPM officer showed his knowledge about entitlement, laws and regulations as well as situations in the field, PAPs were often satisfied with his explanations, even though they do not agree with the contents. CPM officers should always carry related documents with them to answer the questions spontaneously raised by PAPs. Also, CPM offices should give more attention to the prepared materials, including contents of presentations and handouts, and make contributions to the contents at the preparatory stage of the PCMs.

(6) Attendance of CA

CA's presence is very important for the meaningful PCM as some of the critical questions can only be addressed by CA office, including land issues and compensation payments. Therefore, the CPM office should make efforts to secure the presence of CA officers.

(7) Special Attention to Women and SC/ST

Regional cultural contexts may have affected women's participation rates. It is said that women's participation in social activities are more accepted in Gujarat State than the Northern States, and actually there were higher participation rates in CPM in Gujrat

It was effective to collect diversified comments to let minority PAPs (non-titleholders, women, vulnerable groups, etc) who are sitting at the back to raise their concerns/queries, and not only allow people who are sitting in the front rows to voice their individual interests.

(8) Preparatory Workshop

Preparatory workshops, involving CPM officers, presenters, coordinators, and the JST contributed to the success of the PCM this time. They gave presenters and coordinators a clearer image of what they are required to do. They also brought more ownership, awareness and interest among CPM officers. In addition, the workshop contributed to build team sprit among related parties.

7.0 Recommendations for Further Actions

Some of the concerns and suggestions raised by the participants at the PCM for RRP are very important and require further attention by the CPM offices and DFCCIL for the smooth implementation of the land acquisition. In addition, further actions should be considered, including incorporating them into the Entitlement Matrix and/or reflecting them into relevant policies such as RAA 2008 or NRRP 2007, when relevant. Issues raised during the PCM include the following.

a. The result of the market survey conducted by the CPM offices or the Committees appointed by state governments should be shared with PAPs, and if there is a large gap between the survey and circle rate, some adjustment should be considered.
b. Land rates adopted by other land acquisition processes, especially the rate given in the State Government-led projects which happened recently in nearby areas, should be referred to by DFCCIL.
c. The concrete detail regarding job provision for people affected by land acquisition for the railway projects should be clarified and communicated to the PAPs. This subject is one of the issues of greatest concern among the PAPs in all jurisdictions.
d. Errors in the legal documents that become the foundation for the compensation and assistance, including land records and 20A notification, should be corrected and/or updated. CPM offices and DFCCIL should give some direction and advice to PAPs regarding how to address this issue in order for them to receive appropriate compensation.
e. The policy toward applicability of the new land acquisition Bill, which has been submitted to the Parliament, should be clearly defined and communicated to the PAPs.
f. Copies of NRRP 2007 and RAA 2008 should be provided to the representatives of PAPs, most likely kept at the Panchayat offices for their access.
g. The issue of taxation on the compensation should be clarified and information should be conveyed to PAPs.
h. The de-notification of non-acquired remaining land should be done as soon as possible so that they can make use of this part of their land.
i. MOR's "non-structure-is-allowed-in-thirty-meters-from-ROW" policy should be scrutinized and the mechanism to issue the NOCs should be considered and established in the near future.

8.0 Environmental Issues:

As per the current regulations of Government of India, railway projects do not require conducting Environmental

Impact Assessment (EIA) studies and obtaining Environmental Clearance (EC) from the Ministry of Environment and Forests (MOEF). However, considering the magnitude of activities envisaged as part of DFC, the DFCCIL has conducted an EA and prepared an Environmental Management Plan (EMP) to mitigate potential negative impacts for the first phase of the project and develop an Environmental Management Framework (EMF) to be followed for the subsequent phases of DFC.

8.1 Objectives of the EA and EMF study:

- Identify potential environmental impacts to be considered in the design of DFC and recommend specific measures to avoid / mitigate the impacts.
- Formulate an implementable Environmental Management Plan (EMP) integrating the measures to avoid the identified impacts and an appropriate monitoring and supervision mechanism to ensure EMP implementation.
- Review the proposed alignment and other components of entire DFC and identify possible environmental issues to be addressed during the planning, design, construction and operation of the project.
- Develop an Environmental Management Frame work that provides guidance to DFCCIL, design / supervision consultants and the contractors in integrating environmental issues at all stages of DFC development and operation
- Recommend suitable institutional mechanisms to monitor and supervise effective implementation of EMF and respective EMPs.
- The last but not the least to know the impact of any Gove rent Act, Notifications, Rules and Policies on the Project and to understand the process of their clearance and expected time so to avoid last minutes surprises.

8.2 Key Environmental Laws And Regulations

Following table presents the environmental regulations and legislations relevant to project.

Table: Environmental Regulations and Legislations

Sl.	Law / Regulation /	Relevance	Applicable	Reason for	Implementing /
1	The Environmental (Protection) Act. 1986, and Rules	Umbrella Act. Protection and improvement of the environment. Establishes the standards for emission of noise in the atmosphere.	Yes	All environmental notifications, rules and schedules are issued under the act	MoEF, State Department of Environment, CPCB and State PCB
2	The EIA Notification, 2006	Railway projects are exempted from this notification	No	Railway projects are exempted	N/A
3	The Water (Prevention and Control of Pollution) Act, 1974	Central and State Pollution Control Board to establish/enforce water quality and effluent standards, monitor water quality, prosecute offenders, and issue licenses for construction/operation of certain facilities.	Yes	Consent required for not polluting ground and surface water during construction	State Pollution Control Board
4	The Air (Prevention and Control of Pollution) Act. 1981	Empowers SPCB to set and monitor air quality standards and to prosecute offenders, excluding vehicular air and noise emission.	Yes	Consent required for establishing and operation of plants and crushers	State Pollution Control Board

5	Noise Pollution (Regulation And Control) Act, 2000	Standards for noise emission for various land uses	Yes	construction machineries and vehicles to conform to the standards for construction	State Pollution Control Board
6	Indian Forest Act 1927 , Forest (Conservation) Act, 1980 and Forest Right Act 2006	Conservation and definition of forest areas. Diversion of forest land follows the process as laid by the act	Yes	Involvement of forest land diversion for the project	State Forest Department, MoEF
7	Wild Life Protection Act, 1972	Protection of wild life in sanctuaries and National Park	No	No sanctuaries / national park in the project area	N/A
8	Ancient Monuments and Archaeological sites and Remains (Amendment and Validation) Act, 2010	To protect and conserve cultural and historical remains found.	Yes	Depends upon location in Protected Prohibited and Regulated Zone	Archaeological Survey of India, Dept. of Archaeology
9	State Specific Legislation like Taj Trapezium Zone etc	To Protect	yes	Depend on magnitude of impact	State
10	Coastal Regulation Zone Notification 2011(CRZ) and Eco sensitive Zone Notifacation	To protect and conserve	Yes	Depend on magnitude of impact	State
11	The Motor Vehicle Act. 1988	Empowers State Transport Authority to enforce standards for vehicular pollution. From August 1997 the "Pollution Under Control Certificate is issued to reduce vehicular emissions.	Yes	All vehicles used for construction will need to comply with the provisions of this act.	State Motor Vehicles Department
12	The Explosives Act (& Rules) 1884 (1983)	Sets out the regulations as to regards the use of explosives and precautionary measures while blasting & quarrying.	Yes	If new quarrying operation is started by the concessionaire / contractor	Chief Controller of Explosives
13	Public Liability And Insurance Act,1991 .	Protection to the general public from accidents due to hazardous materials	Yes	Hazardous materials shall be used for construction	

14	Hazardous Wastes (Management, Handling and Transboundary) Rules, 2008	Protection to the general public against improper handling and disposal of hazardous wastes	Yes	Hazardous wastes shall be generated due to activities like of maintenance and repair work on vehicles & construction equipment	UP Pollution Control Board
15	Chemical Accidents (Emergency Planning, Preparedness and Response) Rules, 1996	Protection against chemical accident while handling any hazardous chemicals resulting	Yes	Handling of hazardous (flammable, toxic and explosive) chemicals during construction	District & Local Crisis Group headed by the DM and SDM
16	The Petroleum Rules,2002	Storage of diesel, petroleum products for operation of construction equipment etc.	Yes	Storage of Petroleum products is restricted as per The PESO	CCoE or DM
17	National Green Tribunal (Prevention and Protection) Rules, 2011	For settling dispute if any in connection with forest, wenvironmental issues	Yes	Project requires forest land diversion and observation of environmental laws during construction	MoEF
18	Railway(Amendment) Act,2008	Compensation for land	Yes	Some land was acquired for the project	

For projects with potential to have significant adverse environmental impacts (Category A) an environmental impact assessment (EIA) is required. Category B projects are judged to have some adverse environmental impacts, but of lesser degree or significance than those for category A projects and require an Environmental Assessment (EA) to determine whether or not significant environmental impacts warranting an EIA are likely. If an EIA is not needed, the EA is regarded as the final environmental assessment report as is the case for this project. The project railway line passes through very small patches of degraded forests area. No presence of endangered fauna and flora along the project railway line is envisaged. It may also be mentioned that there is only marginal acquisition for forest land due to the proposed project. The Government of India has issued Environmental Impact Assessment Notification in 1994 as a part of Environmental (Protection) Act, 1986 and amendments in September 2006. Railway projects do not fall under any category requiring an environmental clearance from MoEF. Only No Objection Certificate (NOC) is required from SPCB under the Air and Water Acts.

Since this is a large scale project and likely to have some reversible impacts on environment during construction phases & some impact, not of much significance, during operation, this DFC project is being considered as 'A' category project as per the Operation policy of funding agencies. This was done to help not only in tweaking the construction stage to be more eco-compliant but setting systems to have better and more environment friendly construction in forthcoming railway projects. DFCCIL is committed to establish most efficient and eco-friendly system.

8.3 Base Line Environment

Data was collected from secondary sources for the macro-environmental setting like climate, physiography (Geology and slope), biological and socio-economic environment within Project Influence Area, CPM Office/ Project District. First hand information has been collected to record the micro-environmental features within Corridor of Impact, Collection of first hand (Primary) information includes preparation of base maps, extrapolating environmental

features on proposed alignment, environmental monitoring covering ambient air, water, soil, noise and vibration, tree enumeration, location and measurement of socio cultural features abutting project alignment. The environmental profile and strip plan have been prepared.

8.4 Environmental Sensitivity Of The Project- A Case Study Of Apl-1(Khurja- Bhaupur) - Summary Of The Environmental Features Along The Proposed Alignment

8.4.1 The entire environmental profile covering five km on both side of the proposed alignment was studied, and strip plans prepared to cover the RoW of the proposed alignment in parallel as well as detour sections. Based on this analysis, the following conclusions can be drawn:-

1. There is no wild life sanctuary located along the parallel as well as in detour section of the proposed corridor.
2. There is no CRZ and Ecosensitive Zone
3. There is no wetland identified along the proposed corridor.
4. One ASI monument Budhiya-ka-Taal in Agra district is involved in Kaurara-Chamrola section. DFC alignment passes at about 140m distance from ASI monument.
5. Reserve / Protected forest are located along the proposed alignment from Bhaupur to Khurja 343km section. However, these areas are forest land and have scattered plantations of babool. The total forest land that needs to be acquired is 11.55 ha.
6. There are five congested sections with residential / commercial structures located along the existing railway alignment. For each of these locations, five detours are proposed. These locations are Achalda, Bharthana, Etawah, Hathras and Aligarh in Bhaupur-Khurja section (343km).
7. There are no perennial river / water bodies crossing the proposed alignment of 343 km.
8. There are a number of religious structures, schools, and colleges located along the proposed alignment.
9. The proposed Bhaupur-Khurja (without Tundla tour) alignment may result in the cutting of approximately 9800 trees in a stretch of 343 km . The major species present along the alignment are babool, neem, shisam, papal, mango, bargad, kanji, labhera, ashok, sirsa, guler, jamun, ber, eucalyptus, mahua and bel.
10. Approximately 4142 are required to be felled in TTZ

8.4.2 Potential Impact

Environmental impact assessment involved prediction of potential impacts by the development of the project on the surrounding area. Based on the baseline environmental status described and the proposed project activities, potential impacts have been assessed and predicted, and appropriate mitigation measures are suggested to avoid / reduce / compensate for the potential adverse impacts of the project and enhance its positive impacts. The impacts due to the development of the proposed Dedicated Freight Corridor have been assessed for the planning phase, construction phase and implementation phase.

8.4.3 Measures For The Mitigation Of Environmental Impacts

Prevention or avoidance of impact is better than mitigation of impact. Hence avoidance and reduction of adverse impacts approaches were adopted during the design stage through continued interaction between the design and environmental teams. This is reflected in the designs of the horizontal & vertical alignment, cross sections adopted, construction methods and construction materials. In-depth site investigations have been carried out so that sensitive environmental resources are effectively avoided, leading to the environmentally best-fit alignment option. The appropriate mitigation measures have been suggested during various phases of the project including specific measures for noise and vibration.

8.4.4 Environmental Management Plan

Environmental Management Plan is an implementation plan to mitigate and offset the potential adverse environmental impacts of the project and enhance its positive impacts. Based on the environmental baseline conditions, planned project activities and impacts assessed earlier, the plan enumerates the set of measures to be adopted in order to minimize adverse impacts. Social impact mitigation plan and land acquisition plan are included in this section. The process of implementing mitigation and compensatory measures, execution of these measures, agencies responsible for the implementation of these measures and indicative costs are discussed.

8.4.5 Environment Management Framework

The environment management has been prepared covering the objectives to avoid and to minimize adverse environmental impacts/risks due to project, to ensure that adverse environmental impacts/risks are well-mitigated/minimized to achieve applicable environmental

standards, to comply with applicable GOI state laws and regulations, and environmental safeguards requirements of development partners, to provide guidance to its own staff in conducting subsequent monitoring & reporting, and in undertaking corrective actions, to develop and exercise mechanisms for effective supervision by DFCCIL during implementation and guidelines for the DFCCIL in terms of for environmental regulations and its implementation for future projects.

(Environmental Management Plan of DFC project is available on official website of DFCCIL and case studies is placed at Annexure-I)

8.5 Steps by DFCCIL

Even though Railway projects are not required to conduct Environmental Impact Assessment (EIA) studies and obtain Environmental Clearance (EC) from the Ministry of Environment and Forests (MOEF), DFCCIL, considering the magnitude of activities envisaged went ahead with detailed EA and prepared an Environmental Management Plan (EMP) for all the phases. DFCCIL has been committed to ensure the preservation of flora and fauna and a number of steps have been taken for the same:

- Mandatory plantation of trees along the corridor: The contractor has been asked to plant 20 trees per Km as part of the contract.
- Development of Safety, Health and Environment Manual for DFCC which is also the part of contract and the contractor has also been asked to develop his own SHE Manual.
- Deployment of SHE Engineer during construction made mandatory.
- Around 4100 tress were to be cut in the Taj Trapezium Area. DFCCIL is committed to plantation of more than 15000 trees in response, which is much more than the minimum mandated by the Green bench of Supreme Court.
- Applying and Obtaining all the environmental and Forest Clearances, required for pre construction stage ,well in time and before award of Execution Contract.
- Detailed instructions for management of burrow areas, labour camps, water bodies, soil erosion, noise, air & water pollution etc have been provided in the contract during construction phase.
- A Social and Environmental management and review consultant with experts appointed to monitor and review R&R as well as Environmental issues in different phases.

9.0 The Road Ahead

As can be seen from the paragraphs above, DFCCIL has taken a number of proactive steps in the field of Land acquisition provisions, social, R&R and environment impacts and that is at the root cause of the resounding success in the acquisition of more than 95% land. But the process is never complete!!! Is this enough? What more can be done? The options are endless.

This paper would be incomplete if various innovative and progressive provisions [4] being followed worldwide for land acquisition are not discussed even though in brief. These would be an eye opener to the cause and misery of the land loser which cannot be “compensated in full” but can be reduced to some extent in whatever best way an organisation can.

9.1 Progressive provisions on R&R.

A) National Best Practices:

a) The provision of annuity to the PAFs: Providing the PAFs with an income on sustainable basis and not dispense with a onetime cash settlement. The policies of Uttar Pradesh, Haryana and Jharkhand (while including only the land losers) are more progressive in fixing the annuities per acre, thus paying due consideration for the degree of economic losses to the individual land losers.

State Govt./PSU	Progressive Provisions
Uttar Pradesh	Annuity @ Rs.23,000 per acre for 33 years (annual increase of Rs.800)
Jharkhand	Annuities to affected families in lieu of employment @ Rs.1,000/- per month per acre of land (annual increase of Rs.500 every month). Ceiling of Rs.10,000 per month per family.
Haryana	Annuity @ Rs.21,000 per acre per annum for a period of 33 years (annual increase of Rs.750). Annuity of Rs.42,000 per acre per annum for 33 years (annual increase of Rs.1,500) for SEZs/Technology parks/other private developers.

b) Higher compensation to those multiple displaced in development projects (Orissa): Additional compensation amounting to 50 per cent of the normal compensation to each displaced family (over and above the normal compensation) if they are being displaced more than once.

c) Distribution of developed land (Uttar Pradesh): 16% distributed to original land owners.

d) Sharing of projects benefits in the form of distribution of a certain proportion of free power to the people affected by hydro power projects, comprehensive R&R package including equity sharing and compensation in fixed deposits (Jindal Steel, Salboni)

R&R package	State govt/PSU	Provision
Qualification of Common Property Resources (CPR) losses	THDC	100 days of Minimum Agricultural Wage (MAW) to each affected family for 5 years (towards loss of fuel and fodder).
Sharing of project benefits	Arunachal Pradesh	100 units of free electricity per month to each PAF for 10 years. One per cent of free power for local area development.
Investing cash compensation	Haryana	Engagement of professional agencies to provide advice for prudent investment of the compensation amount.
Comprehensive R & R package	Jindal Steel (Salboni)	Employment for one in the family and 6 lakh package (1.5 lakh as cash, 1.5 as fixed deposit and 3 lakhs as equity).

e) Pooling of land. As in case of the Magarpatta city project where farmers pooled their land with a private limited company. The farmers continued to own the land and owned shares in the company.

f) Compensation for "No litigation": Additional compensation of 20 per cent of the basic rate of land as Incentive for "no Litigation". Similar policy has been adopted in Bihar too.

B) International best practices:

Sustained spending for welfare of PAFs through a development fund (China), distribution of taxes to the affected local bodies for the development of the PAFs (Norway), sharing of royalty (Brazil, Papua New Guinea), sharing of project revenues (Colombia) and sharing of equity (Canada, Australia) with the affected communities.

Best Practices	Country	Provisions
Beyond one-time compensation	China	• Annual Allowance: $75 per capital for a period of 20 years. • Financial measures for rectifying past under-payments in the five prior decades. • Post Resettlement Development Fund created with regular contributions from the power companies (.001 yuan per kilowatt hour)
Taxation	Norway	• All electricity companies need to pay 28% tax on their profits with the shares divided equally among the central and country budgets. • 4.75% goes directly to the local municipality • Tax on the use of natural resources (based on the average power generated over previous seven years) distributed to the municipal.
Sharing of Project Benefits	Norway	• Electrical Companies to provide 10% of the electricity produced to the local municipality.

Sharing of Project Revenue	Colombia	• 3.8% to regions watershed agencies for investments in water saving and local irrigation. • 1.5% to municipalities bordering the reservoir. • 1.5% to upstream municipalities Public hydropower plants:
Sharing of Royalties Equity Sharing	Brazil	• 45% of royalties given to overall budgets of affected states. • 45% of royalties directly affected municipalities within those states.
Equity Sharing	Canada/Australia	• Equity stake entitles the communities to a share of project benefits for the long term proportionately with their land share in the construction of the project.

It is time to realise that the PAPs have to be made equal partners in the project benefits for a win-win situation for all.

Reference:

[1]"NAC's seven-point test for land acquisition bill". The Hindu (Chennai, India). 10 June 2011.

[2] Economic Survey of India, 2013

.[3] Mariella 1990, cited in Guggenheim 1990: 32

[4] Dr Reshmy Nair, Land acquisition, Rehabilitation and Resettlement: the impending legislation and beyond.

■ ■ ■

Performance of 45-year-old corroded prestressed concrete bridge beam

The design of prestressed concrete bridge beams usually assumes that the full capacity of the tendons can be achieved under ultimate load, based on the assumption of sufficient deformation capacity of the prestressing wires. Whether this is achieved also in older bridges is of increasing interest in remaining-life assessments since, especially in aggressive marine environments, corrosion of steel is known to cause loss of wire ductility. Results are reported herein of load tests to destruction for three full-sized and deteriorated prestressed concrete bridge beams recovered from a 45-year-old bridge exposed to an aggressive marine environment. The two beams with the greatest superficial deterioration showed progressive and premature failure of the prestressing wires. The beam with little superficial deterioration also showed progressive failure and failed to reach the ultimate load capacity based on current design theory and actual material properties. Possible reasons for the observed behaviour and the practical implications are as follows:

- The present investigation showed that there may be significant loss of load capacity in prestressed concrete beams with corrosion damage exposed to long-term marine environments
- The load to commencement of progressive collapse, the maximum capacity and the deformation capacity at ultimate capacity were all reduced, approximately linearly, as the degree of corrosion loss in the tendons increased
- Examination of the test results for the beams reported herein shows that the possibility of progressive collapse should be considered for older prestressed concrete beams, particularly when exposed to aggressive marine environments.
- The test results showed that the predicted ultimate capacity of prestressed concrete beams based on current design theory, actual material properties, and free of cracking and corrosion damage may overestimate the actual capacity of the beams.

By : Torill M. Pape, Robert E. Melchers

Ref : Institution of Civil Engineering, Nov. 13, Pg-547-557.

Dismantling of ROB using Controlled Blasting Method

By
K. RenukanandaSetty*
Vijay Shankar Singh**
Daya Ram***

Introduction

- A New ROB of span 1x18m+10m RCC T-Beam and slab at KM-510/980 has been constructed in lieu of existing ROB No. 179 of span 1x8m (Squire) or 1x11M(Skew) at km. 510/950 during the Patch Doubling of DWR-KBI line of Hospet-Londa section of SW Railway.
- The exiting ROB is in RH curve of 4.5 degree and suitable for single line, Hence, decision was taken to dismantle existing ROB after constructing New ROB and after diverting the traffic. 400 cum Blasting involved for slab and one Abutment including Wing Walls of Doubling line side.
- It is executed as per Agreement through NS Item at the rate Rs.800/ per cum.
- Requisite Speed Restriction and traffic blocks was arranged by the Railway.
- The track was made fit after every blasting & clearing debris during block period .
- All safety precautions has been taken (as per IRPWM)

Methodology

- The slab of size of 7.20m along barrel length and width of 11.12m and thickness of 70 cms (Approx 55 cu.m)same was pre- splitting into 6 strips of 1.20 M in width along with skew span direction and dismantling was done in controlled manner. The pre-splitting is nothing but splitting of slab in to number of symmetrical strips.
- Holes of 34 mm dia. were drilled by Pneumatic Rotary Drilling Equipment with Air Compressor mounted on a Tractor at equal spacing of 300mm c/c vertically along both directions up to depth of 50 cm against slab thickness of 70cm. First day, the Dismantling was done from one end of 1.20x11.12 m strip-size by blasting.
- Next day another end of the same strip-size was dismantled by blasting.
- Further alternative strip was blasted, till operation was completed.
- Abutment & Wing Walls towards doubling line were dismantled thereafter in stages of 1 m height only.
- 20 cm thickness of RCC Slab below the charge was left to support the blast impact.
- Also the Abutment & Wing Walls (MCC) towards doubling side was dismantled by blasting by after drilling 1M deep holes.
- One hour block was taken daily and completed the entire work for a period of 12 days.

Delay Detonators

- The vibrations are controlled by use of delay detonators.
- Short delay caps are provided with a built-in timing element.
- The quantum of vibration depends upon the charge per delay i.e. the quantity of explosives detonated at a time.
- To reduce charge per delay, short delay detonators were used.
- The connections between every hole is done such that only one hole is blasted at a time.
- Minimum delay of 25 milli second is required in each hole.
- The use of short delay ensures less vibration and better fragmentation.Before blasting, existing track was protected by placing unserviceable Lorry/Bus tyres up to barrel length +3m extra on either end.

*AXEN/C/Hubli, SWR
**AXEN/C/Samastipur,ECR
***AXEN/C/Jallundhar City ,NR

Integrated Course No. 14101

- Over and inside the tyres, sand bags were placed.
- After blasting, hanging reinforcement with the slab, were cut before opening the Rail Traffic.
- For this purpose, Hitachi was used as ladder and gas cutter is used for cutting the reinforcement.

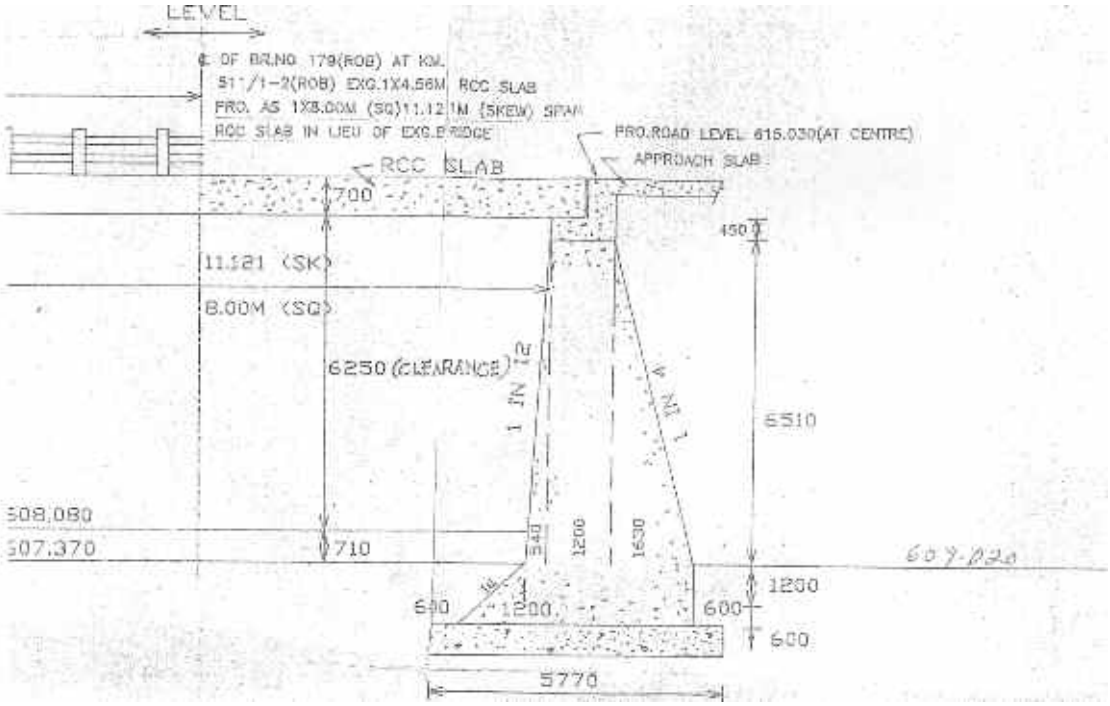
Explosive Details

- Explosive is a substance that undergoes decomposition or combustion with great rapidity, evolving much heat and producing a large volume of gas.
- The reaction products fill a much greater volume than that occupied by the original material and exert on enormous pressure which can be used for blasting.
- ANFO (Ammonium Nitrate Fuel Oil) is very popular explosive which has been used for blasting of this ROB.
- The main component of ANFO is the chemical compound ammonium nitrate (NH4 NO3) is a white crystalline solid at room temperature and standard pressure and it is used as an oxidizing agent in explosive.
- Fuel oil is commonly heating oil or diesel fuel or any Carbon source such as Kerosene, Coal dust etc.

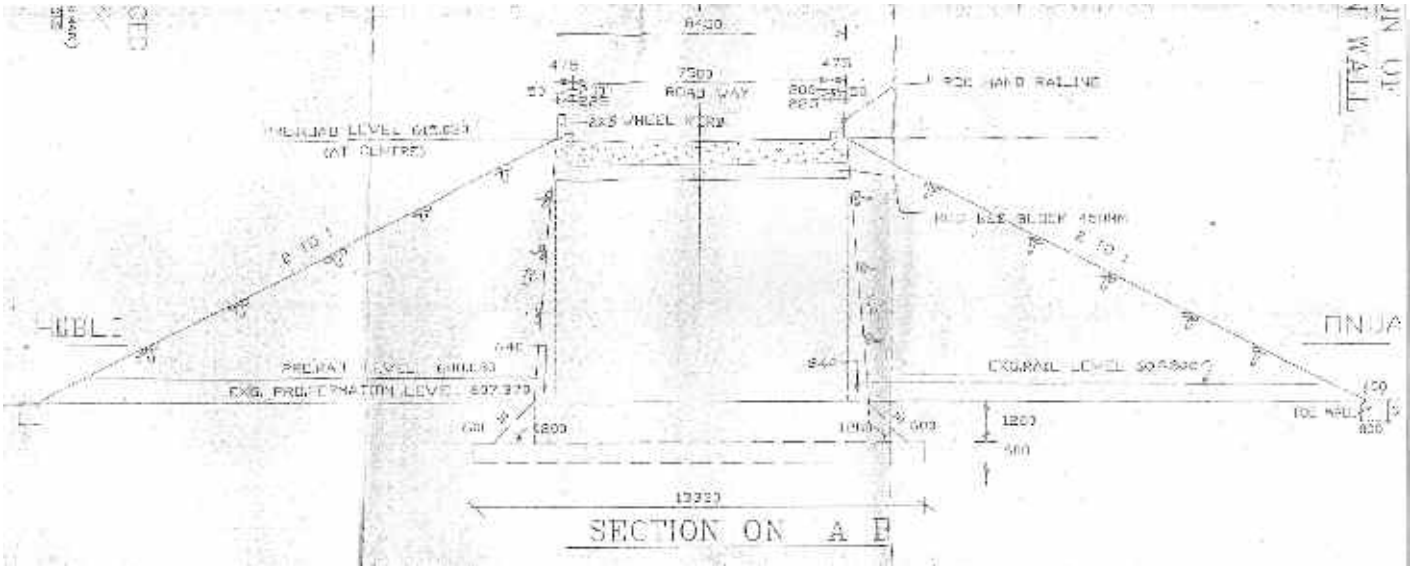
Equipments And Machineries

1) Pneumatic rotary drilling equipment with air compressor mounted on tractor. Drill bit size 34mm
2) Condenser blasting machine with hand operated inductor.
3) Gas Cutting equipments = 2 Nos.
4) Hitachi excavator machine – 2 No. for excavation and removal of debris.
5) Tractor/larry - for disposal of debris.
6) Minimum 40 labors for clearing the debris.
7) To attend track, if required necessary 6 track men kept ready and same are used for cautioning Road users and houses of neighbor area.
8) The blasting time DY.CE in charge also present.

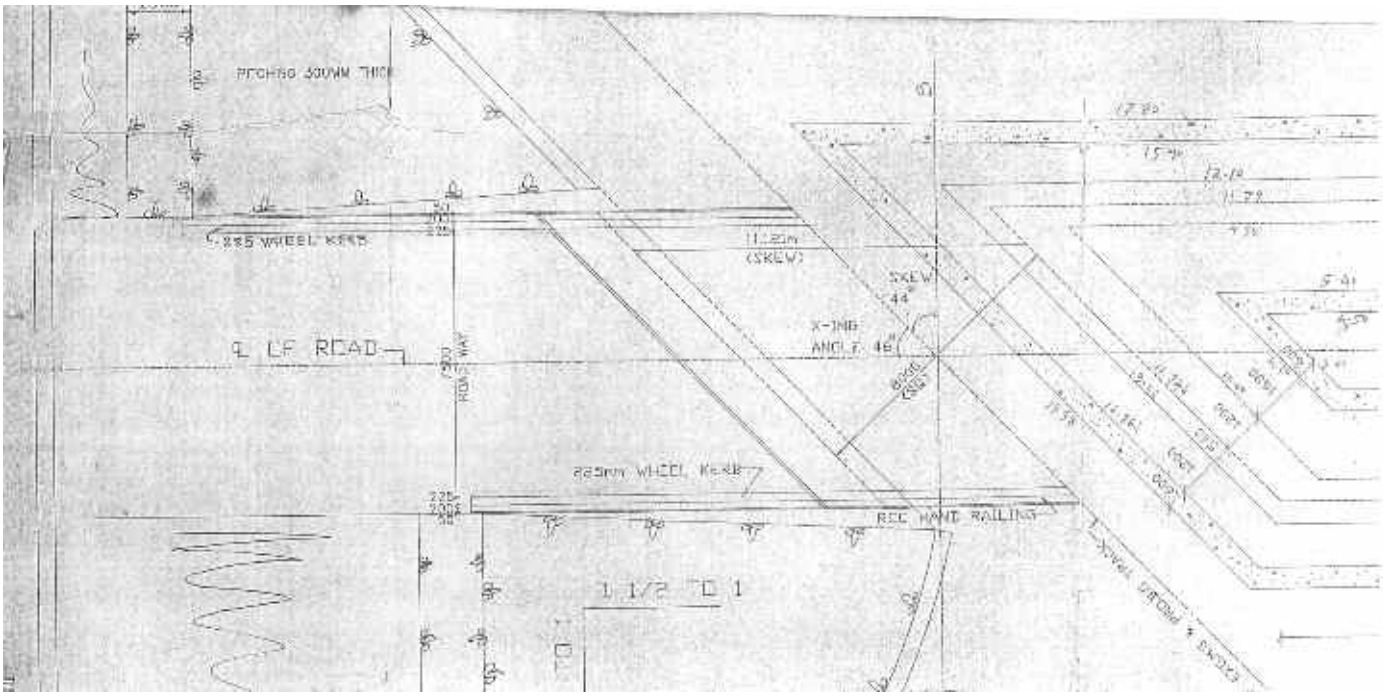
Foundation & Substructure CC M-20



2) Bed Block- CC M-25
3) RCC slab M-25 with 32mm dia tar at 150mm c/c bothways



4) Wearing Coat- CC M-30
5) Abutment and square Return wall with C.C M25.



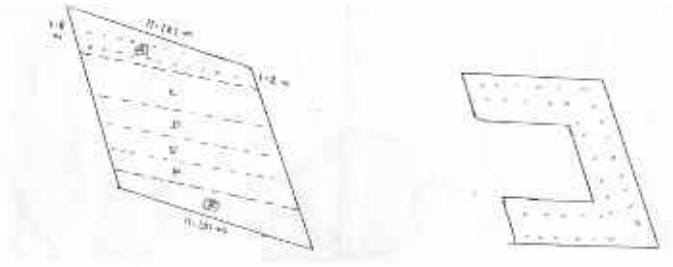
6)Approach slab of 9m Long with RCC M30.

PLANNING OF WORK

- With the help of blasting method described, pre-arranged plan has been prepared to carry out the blasting operation. For this purpose, it is necessary to calculate both the amount of charge required and the anticipated fragmentation.
- Before blasting, the burden, the distance between holes and charges must be determined with regard to the average fragmentation required and the capacity of blasting machine available and the duration of traffic line block available in the section. Further to reduce ground vibrations and to protect adjacent track, working site and surroundings from the throw of stones and fragments from the round, it is necessary

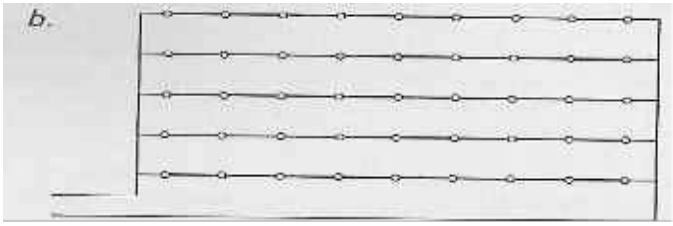
to reduce the burden and the distance between holes.

- Hence it has been planned to dismantle RCC slab quantity of 12 to 15 cum per one hr line block duration. For CC abutment and substructure 30-40 cum per one hour line block.
- Required traffic block has been proposed for approval and sanction at divisional level.
- Area of RCC slab has been divided into different segments along span direction each constituting the quantity of about 12 to 15m3



- Drilling pattern has prepared for multiple- row blasting through a parallel series circuit as shown below.

34 mm dia holes @ 300 mm c/c



PRECAUTIONARY MEASURES

1) Track with 52Kg rail of 60kg sleeper of long welded rails section ,same is protected before Blasting by covering with Larry/Bus tyres and sand bags which should be removed after removing big mass concrete debries the blasting is over and before removal of block.
2) Experienced watchmen are sent to public / private road to stop traffic or warn persons. These watchmen are warned from work spot regarding the commencement and cessation of blasting operation.

EXECUTION UNDER LINE BLOCK

As soon as traffic line block of one hr. duration is allowed

- Contractor's labours 40 workmen are deputed to cover the track with rubber tyres and sand bags – in 10 minutes.
- Evacuation of labours at site, induction of blasting machine and explosion- 5 minute.
- Removal of fragments and debris by machine along with labours, cutting and removal of exposed steel reinforcement by gas cutting equipments- 45 minutes.

Blasting of one segment of RCC Slab

Clearing of Fragments &Debrish by Macheniry and Labour

Cutting & Removal of exposed hanging Reinforcement by Oxy-acetylene Gas

Track-fit Certificate and Line-Block cleared

First Train Allowed toPass the Site

In successive line blocks entire quantity of RCC Slab dismantled

CONCLUSION

- As the site may be in the vicinity of human population and near Railway track, safety of Public and Track is apprehended due to air blast and sound. Hence blasting in controlled way is preferred.
- It is concluded that this methodology of dismantling by controlled blasting is useful for effective execution in view of safety.

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ITTI Calendar Of Courses 2014 (Rev. 3 dt. 19/06/2014)

Course No.	From	To	Name of course	Duration	Eligible Group
14808	30.06.14	04.07.14	Track Management System	1 Wk	SSE(Pway)
14809	21.07.14	01.08.14	Rail Wheel Interaction & Derailment.	2 Wks	SSE(Pway)
14810	04.08.14	21.08.14	Training for Trainers of ZTS/DTS (P.Way Module)	3 Wks	Instructor(Pway)
14811	24.11.14	28.11.14	Management of store & land	1 Wk	SSE
14812	03.11.14	07.11.14	Track Management System	1 Wk	SSE
14813	10.11.14	28.11.14	Training for Trainers of ZTS/DTS (Bridge & Work)	3 Wks	Instructor (Bridge & Works)
14814	01.12.14	12.12.14	Mechanized Track Maintenance & renewals	2 Wks	SSE(Pway)
14815	15.12.14	19.12.14	Bridge Inspection &Maintenance	1 Wk	SSE
14816	22.12.14	02.01.15	Rail Wheel Interaction and Derailment Investigation	2 Wks	SSE(Pway) & Instructor of ZRTI/ZRTS
14818	22.09.14	03.10.14	Rail Wheel Interaction & Derailment	2Wks	SSE(Pway)
14819	25.08.14	05.09.14	Rail Wheel Interaction & Derailment	2Wks	SSE(Pway)
14820	10.11.14	21.11.14	Rail Wheel Interaction & Derailment	2Wks	SSE(Pway)

Advanvce Equipment Build Better Indian Highway

Implementation of national highway development project(NHDP) changed the entire scenario of road construction equipment market in India The construction of road and highways basically consists of 3 phases, rough grading (or earthmoving), fine grading (which includes sub-grade preparation), and surfacing, which can include gravel, concrete, asphalt, or any combination of the three. Paving using concrete or asphalt has evolved significantly over the years, and today's machines can produce large quantities of paved surfaces in record time.

Many multinational and leading overseas companies have entered Indian market and some of them are now having there manufacturing base in India

Asphalt Batch Mix Plant

A batch type plant weighs the raw aggregates into a heater drum, where the batch is then heated up to temperature. The hot aggregate is discharged into a mixing drum where (dry) filler and binder are added. The blend is mixed and discharged either directly into the delivery vehicles or into a small weighing and collecting hopper. To increase output, the heater can be heating the next batch while the previous is being mixed. Capacity is usually of the order of tens of tonnes per hour. Batch heater plant is used where short production runs are common.

An overview of the processes required in plant operations is as follows:

Cold (unheated) aggregates stored in the cold bins (1) are proportioned by cold-feed gates (2) on to a belt conveyor or bucket elevator (3), which delivers the aggregates to the dryer (4), the aggregate is dried and heated. Dust collectors (5) remove undesirable amounts of dust from the dryer exhaust. Remaining exhaust gases are eliminated through the plant exhaust stack (6). The dried and heated aggregates are delivered by hot elevator (7) to the screening unit (8), which separates the material into different sized fractions and deposits the aggregates into separate hot bins (9) for temporary storage. When needed, the heated aggregates are measured in controlled amounts in to the weigh box (10). The aggregates are then dumped into the mixing chamber or pugmill (11), along with the proper amount of mineral filler, if needed, from the mineral filler storage (12). Heated binder from the hot binder storage tank (13) is pumped into the binder weigh bucket (14) which weighs the binder prior to delivery into the mixing chamber or pugmill where the binder is combined thoroughly with the aggregates. From the mixing chamber, the asphalt mixture is deposited into a waiting truck or delivered by conveyor into a surge bin.

Double Drum Tandem Vibratory Rollers And Compactors

Vibratory rollers have become a necessity in order to meet the demands of current roads specification and material. Double drum tandem vibratory rollers, which is used for breakdown, and secondary and finish rolling is a versatile piece of equipment that is used on most paving jobs today the rollers do a good job of breaking down the mix and providing an initial density of 98-97%

Vibratory roller compact the pavement through a combination of dynamic and static loading. Drum vibration ads a dynamic load to the static roller weight to create a greater compactive effort. Drum vibration also reduce friction and aggregate interlock during compaction. Vibratory rollers are very powerful versatile and require considerably less number of passes than static roller. The vibration reduces the internal friction of the mineral mix so that the interaction between dead weight and dynamic load increase the density.

Ref. Construction Technology,
March 2014, Pg-33.

Cutting For Stone

The behavior of rock in response of tunnel construction is determined by both the properties of the intact rock and the properties of the rock mass as a whole. Laboratory testing is done to determine the different properties of the intact rock. However these test results can be misleading because the samples of highly weathered rock or disturbed rock may not be available. Therefore it is crucial to understand and quantify discontinuity properties such as aperture, undulation, roughness, weathering etc. Unfortunately for the Engineer, rock masses are rarely homogenous, continuous or isotropic. Therefore a classification system is required to take account of the inherent variability.

The Development Of Rock Classification Systems

Schemes attempting to formalize relationships in tunnel design were first developed as early as 1879. The first descriptive characterization of ground conditions appeared in 1942 and was developed following experiences in steel arch tunneling through the Alps. In 1946, Karl Tarzaghi became the first to publish a simple rock classification system applied to an engineering environment.

The three classification system most widely used today are:

(1) Rock Mass Rating (RMR)

(2) Q- System and

(3) Geological Strength Index (GSI)

Rock Mass Rating

Bieniawski developed his RMR system, also known as Geomechanics Classification, in 1972 and its latest revision was published in 1989. The system requires an assessment of six parameters; the intact rock material's strength, rock quality designation (RQD), discontinuity spacing, discontinuity condition, groundwater condition and discontinuity orientation relative to the excavation.

The six parameters are each given a rating, which is added together to give the final classification value. The output of RMR classification is a value between 0 (very poor rock) and 100 (very good rock). RMR can also provide an indication of the most suitable tunnel shape and insight into the support capabilities of the shortcrete. However RMR does not consider in situ stress, which can be very important in deep excavations where squeezing ground or rock bursting may be a problem. On the whole, RMR may be more useful in weaker rock, where methods of support such as spiling, dowels, steel arches or canopy tubes are used.

Q-system

The Rock Tunneling Quality Index, or Q- System of rock mass classification, was developed by Barton, Lein and Lunde in 1974 and is also based on assessment of six parameters – although slightly different to those used for RMR. The six parameters are; RQD, joint set number(Jn), joint roughness number(Jr), joint alteration number(Ja), joint water reduction number(Jw), and stress reduction factor(SRF). The first four parameters are similar to that of RMR system. RQD and Jn give an indication of block size, while Jr and Ja shows the frictional characteristics and shear strength of the joint walls. Jw is measure of water pressure and groundwater inflow, while SRF is an empirical way of considering the influence of shear zones and rock stress problems.

Gelogical Strength Index

GSI can be estimated directly by combining the surface condition of the discontinuities with the structure of the rock mass. It can also be based on RMR ratings.

Conclusion

These systems of rock classifications are not the only option available. An additional system such as rock structure rating may be relevant for specific projects. A large tunneling project will likely benefit from the use of multiple systems. The rock classification systems were never intended as an ultimate solution to design problems and should be used in conjunction with – and not as a replacement for – analytical studies, field observations, measurements and engineering judgement.

By: Jon Young

Ref: TUNNELS AND TUNNELING, Frozen Earth, International Edition: Jan. 2014, Pg-56

Selection of Appropriate Bearing Type & Arrangement for Bridges

This paper highlights some of the major design considerations in this regard such as the importance of careful planning of general arrangement of bearings and the selection of bearing type etc.

In view of the author elastomeric bearing should always be the first choice due to their low cast and excellent behavior when subjected to vertical loads. However their behavior under lateral loads like earthquake requires external restrainers such as "reaction blocks" to ensure safety of the bridge. For large vertical loads, POT-PTFE or spherical bearings need to be used. The arrangement of all elements over the pier cap requires careful consideration. Bearing replacement during the time of the structure and edge distances are some of these considerations. A generously dimensioned pier cap is highly recommended. Use of integral Bridge concept reduces the number of bearings and expansion joints and should be adopted where possible.

By: Mahesh Tandon

Ref: The Bridge & Structural Engineering, Dec. 13, Pg-4.

Bearings & their Configuration within Bridge Systems

Since the introduction of bridge bearings, prominently by railways somewhere in 18th century, the bridge bearings have come long way being in perpetual evolution from Plane Bearings to Rotation Bearings to Deformation Bearings. Till the use of elastomer and Teflon in particular as a part of the bearing, the translation and rotation was achieved by pure steel components in Rocker and Roller bearings which increased construction depths of bridges. The induction of elastomer being confined in a pot allowed rotation by deformation and the less than 5% coefficient of friction of Teflon allowed smooth translation and the same can be termed as paradigm shift in Bridge Bearing

Technology. The bridge bearings help the engineers to minimize the restraints in boundary conditions and the engineers can configure them with in the bridge systems to channelize the forces to follow the functions. However Bridge Bearings require regular maintenance and becoming expensive as such whether there will be another paradigm shift in technology or elimination of bearings altogether will be restored to an coming days is to be seen

By: V. N. Heggade

Ref: The Bridge & Structural Engineering, Dec. 13, Vol. 43, Pg-23.

Case Studies on Bearings, Expansion Joints and STUs in Long Span Bridge

Forces from bridge superstructure are transferred to the substructure through bearings. Disposition of bearings & expansion joints in a statically indeterminate structure controls the manner in which forces are transferred to multiple substructures as well as development of secondary forces in the superstructure. The reaction internal forces as well the support reactions in an indeterminate structure depend upon the imposed boundary conditions. An indeterminate structure can be solved for different combinations of boundary conditions. Out of all those sets, one or two sets yield desirable design results in terms of minimum secondary forces as well as manageable support reactions. Bearings and expansion joints translate to the boundary conditions for structural analysis. Therefore, it is necessary to give careful consideration to bearing layout in continuous bridges. It is important for the designer to select the appropriate arrangement of bearings, expansion joints and shock transmission unit (STU) for effective passage of vertical as well as seismic & thermal effect to substructure. This paper presents case studies of arrangement of bearings & expansion joints in two medium span bridges.

By: N Bandyopadhyay

Ref: The Bridge & Structural Engineering, Dec. 13, Vol. 43, Pg-49.

Application of Spherical Bearings with UHMWPE Sliding Material for Bridges

Over the past years in Indian Bridges, various types of bearings systems viz. Steel Sliding Bearings, Rocker Roler, Elestomeric, Spherical & Pot-PTFE Bearings have been used. In recent past time, the Elestomeric Bearings for small to moderate to large span structures are being adopted quiet commonly. However, with the advancement in Construction Technologies and also the fact the Designers being innovative are working on the edge of engineering. As a result, longer spans & thinner superstructures combined with day-by-day increasing traffic load pose more & more severe performance requirements for the Bridge Bearings to deliver.

The required Bearing system thus need to posses both the Strength & Flexibility Characteristics combines in one package to cop up with the dynamic loading, rotation & movement requirements of the present day structures & tomorrow.

For such demanding cases, when comparing the different Bearings options available, Spherical Bearings have been found to be advantageous that not only overcome the limitations of Pot & other conventional Bearing forms, yet able to provide higher rotations while accommodating the higher magnitude of loads & forces.

Although the performance of Pot/Pot-cum-PTFE Bearings in Indian Bridges has found to be satisfactory till now, but the fact remains that their exposure to the Indian Bridges is not as old as in other developed countries. On the other hand, the bridge designers have often felt the requirement of a Bearing System sturdy enough to sustaining adverse combination of heavy horizontal forces with moderate vertical loads that common in earthquake condition & yet at the same time flexible to accommodate large rotation & sliding displacements occurring with high velocity, frequency & magnitude.

While the adoption of Spherical-PTFE Bearings in place of Pot-PTFE eliminates the concerns that arises due to the functional behavior of Elastomeric Pad and that associated with service life limitations of the sealing elements as discussed above. A step ahead, replacement of PTFE sliding material with the Sliding material, MSM (UHMWPE) further eliminates the concerns of limited sliding path, displacement velocities & load carrying ability that exists with PTFE and thus results a Bearing system that would perform almost for the entire life of the structure without requiring any major repair or replacement exercise.

By:Jitendra Rathore, Peter Gunther, Wolfgang W. Fobo

Ref: The Bridge & Structural Engineering, Dec. 13, Vol. 43, Pg-56.

Mix Design Method for High Performance Concrete

As the name suggested, it is hoped that high performance concrete performs better that conventional concrete. High performance concrete is that concrete which performs better during fresh state as well as in

hardened state and provides strength according to the structural requirements. Many additives as well as admixtures such as fly-ash, silica fumes and plasticizer/super-plasticizer are added into it in order to achieve these requirements. However, the basic mix design methods available do not consider the inclusion of these admixtures.

This detailed study was undertaken to investigate the effect of addition of silica fumes into concrete and suggest a best possible mix design method. For this purpose, different mix design methods were studied in two stages to include possible variation in ingredients and it was found that Indian Standard Method provided with best result i.e. high strength at minimum cement content. Based on the above result and the discussions, the following conclusions are being drawn

1. the amount of water required for hydration increases with the increase in silica fumes content as indicated by the increase in normal consistency.
2. Initial final setting times decreases with the increase in silica fume content.
3. Specific gravity of the cementitious material decreases with the increase in silica fumes content.
4. Soundness of cementitious material decreased slightly with the increase in silica fume content
5. The mix design by Indian Standard Method provided best result with the minimum cement content.

By: Dhirendra Singhal, Veerendra Kumar, Balkrishan

Ref: The Bridge & Structural Engineering, Dec. 13, Vol. 43, Pg-88

Effect of Clamping Force of Rivets on the Fatigue Life of a Riveted Connection

Stringer-to-cross-girder connections in riveted bridges have been found to be susceptible to fatigue. Due to multiple cycles of loading on the stringers, these connections are one of the most fatigue critical connections in steel bridges. It is a well-documented fact through experiments carried out on riveted connections that the clamping force in a rivet plays an important role in its fatigue behavior. Stress range concept is a very simple and useful method to predict the residual life of steel bridges. Residual life assessment of steel bridges is done using conventional method of S-N curves.

The global model of the truss bridge was analyzed in SAP-2000 and the load history due to different vehicle combinations was obtained. A stringer-to-cross-girder connection was modeled using finite element method in ABAQUS by incorporating the detailed local geometry of the connection. Load history obtained from SAP-2000 was applied as an external load and analysis was performed for different clamping force in the rivets. The top most rivet of the stringer was found to be the most critical rivet. It was observed that the fatigue life of the rivet decreases with decrease in the clamping force, it also leads to loss in fatigue life of the connection. The fatigue life of the connection was evaluated using the S-N curve and palmgren-Miner linear damage hypothesis. This behavior of the connection can be attributed to the fact that, under high clamping force, the friction between the plate's increases and the load is actually transferred through friction between the plates. Due to partial loss in clamping force, the plates get loosened and there is partial loss of friction contact. In this case, the load is transferred primarily through shear than friction, due to which more damage in the rivet is caused. There is a drastic reduction in the fatigue life when the clamping stress reduces to 100 MPa from 150MPa. It further reduces when the clamping stress is 50 MPa. This shows the importance of clamping force in riveted connections. Since roadway bridges are subjected to less stress cycles their fatigue life is generally more as compared to railway bridges. Hence railway bridges are more critical for fatigue failure.

By: Mohammed Adil Shaikh, N.M. Bhandari, Pradeep Bhargav

Ref: The Bridge & Structural Engineering, Dec. 13, Vol. 43, Pg-103

Development of a Precast Concrete Barrier Wall System for Bridge Deck

In this works, the Author has conducted the experimental and theoretical studies to investigate the structural behaviour of a precast barrier wall connected with the deck slab using pre-tensioned threaded rods. Five actual-scale barrier wall models of the "developed precast barrier wall" system were designed and constructed as per AASTHO and tested up-to-collapse under different load conditions fig.3to examine its structural performance and static load carrying capacity.

RCC barrier wall system of 5 in number 3m long segment were fabricated in the precast concrete plant with the help of ready mixed concrete having the cube strength M28 to M35 and shipped to the bridge site (Fig. 1). The proposed barrier wall system successfully meted the criteria for Canadian Highway Bridge Design code (CHBDC), performance level 3 (PL-3). The proposed PL-3 precast barrier wall system was similar to the cast-in-place barrier specified in the Ontario Ministry of Transportation Structural Manual. However, the geometry of barrier wall also similar.

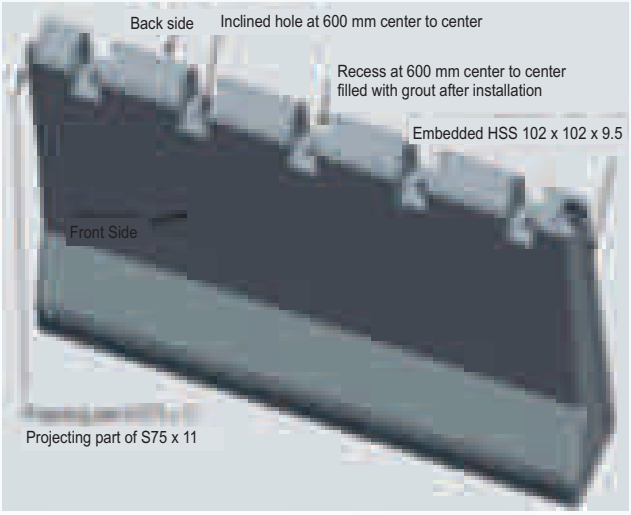


Fig.: 1 proposed precast Concrete barrier wall

CONSTRUCTION DETAIL:

A galvanised steel corrugated sleeve is to be embedded in the precast concrete slab at an angle equal to the slope of the top inclined portion of the inner face of the barrier. Similar galvanised steel corrugated sleeve is to be embedded in concrete deck slab, aligned with those present in the barrier. 600-mm spacing between sleeves is proposed (fig. 2).

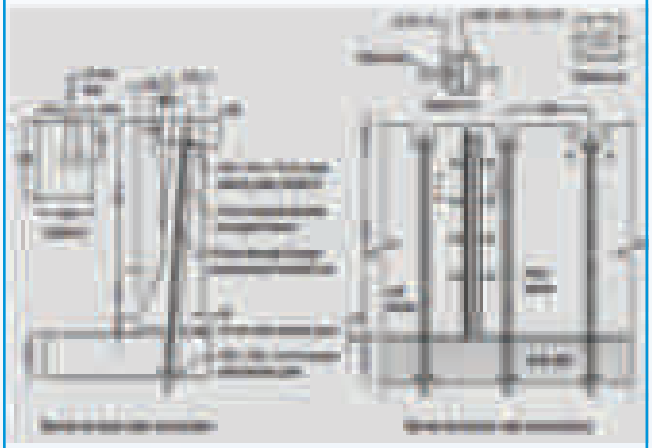


Fig.: 2 structural details of proposed precast Concrete barrier wall connection

After hardening of the deck slab, an overlay of 25 mm concrete grout material is then introduced over the concrete deck slab edge with a width equal to barrier width. Then, barrier segments can be laid over the deck slab edges, with centrelines of sleeves aligned ' so that 25-mm diameter threaded bar made of high strength steel can be inserted through. The threaded rod can then be bolted from the topside of the barrier followed by the bottom side of the deck. A torque force can be applied using mechanical torque to the top to be provided initial force in the threaded rod. The intension of the pre-tensioned force is to produce contact pressure at the contact surface between the bottom of barrier wall and top of concrete deck slab grout and to prevent water leakage over traffic under bridge. To increase shear resistance, the top surface of the concrete deck slab was scratched parallel to the direction of traffic. For a similar surface on the bottom of the precast concrete barrier wall, timber strip can be nailed inside the form. After tensioning the threaded rods to the desired level, M35 concrete grout was inserted from a hole in the top steel plate on the side of the nut to fill the gap between the threaded rod and sleeve. Finally, concrete cresses at the top of the precast barrier wall were grouted. A hollow structure shape (HSS) 102 x 102 x 9.5 mm tube was embedded at one end of the barrier wall segment, with four shear studs welded to it to provide anchorage resistance with concrete. On the adjacent precast concrete barrier wall an S75X11 (S3X7.5) steel member was embedded halfway in to the concrete with a similar arrangement of shear stud to that of the HSS. To activate the joint resistance, one barrier wall segment laid over the deck slab vertical to so the projected portion of the S- shaped member slides through a vertical slot in the HSS skin embedded in the other barrier wall edge. The HSS then filled with concrete grout to fix it in place, enhancing the rigidity and continuity of the barrier to barrier vertical joint to resist vehicle impact.

Ref: PCI Journal winter 2014, Volume 59, Pg-83.

Refining RRIF to include commuter rail

The Railroad Rehabilitation and Improvement Financing (RRIF) program is a program established in the United States by the passage of the Transportation Equity Act for the 21st Century (TEA-21).

- Under the RRIF program, funds can be made available for the development or improvement of railroad infrastructure.
- The FRA can provide direct loans or loan guarantees of amounts up to $35 billion to state or local

governments, railroads, government sponsored companies, or railroad joint ventures.

- It's working for freight rail.
- Direct loans can fund up to 100% of a railroad project with repayment periods of up to 35 years and interest rates equal to the cost of borrowing to the government.

In present scenario when demand of public transportation is growing, commuter rail demand (which connects city centers with suburbs) lags other modes.

So as an opportunity it is rightly seen to transform RRIF into a source of low cost debt capital for commuter rail.

RRIF should create separate loan approval processes for passenger rail projects vs. short line railroads. Others possible improvements could be development of credit criteria for greater predictability, use of credit ratings etc. No matter how it is refined but RRIF can become a powerful tool and can make a real difference in commuter rail because this will lead into greater frequency and interconnectivity which in turn will increase ridership, meeting an untapped demand of currently underserved riders.

Ref: Railway Age, Jan. 2014, Pg-20.

Enhancement of the Tokaido Shinkansen Earthquake Disaster Prevention System

In order to detect an earthquake promptly and stop trains immediately. "the Tokaido Shinkansen Earthquake Disaster Prevention System" has been installed in the Tokaido Shinkansen. This article outlines enhancement of four functions of this system: (1) function of issuing an alarm when an epicentral earthquake occurs. (2) function of issuing an alarm when a multiple shock earthquake occurs. (3) detecting function of an S-wave at a remote seismometer, (4) enhancement of reliability to minimize long-term communication line failures or power supply failures. These new functions have been running since May, 2013.

The seismic wave incidence into seismometers on ground surface is almost vertically upward. A P-wave is a longitudinal wave and shakes in the same direction as the direction of travel. Thus, a P-wave is observed as a wave that shakes the seismometer up and down. The strength of the ground motion by a P-wave can be explained by measuring the strength of the vertical ground motion. On the other hand, an S-wave is a transverse wave. It is observed as a wave that shakes the seismometer horizontally. Degree of structure's damages has a correlation with the strength of horizontal ground motion. Further, the strength of the horizontal ground motion would have a correlation with the strength of a P-wave.

When an earthquake occurs somewhere away from the Tokaido Shinkansen, a remote seismometer detects it immediately and issues an alarm. The remote seismometers estimate the magnitude and epicenter from data of the P-wave of first two seconds. The result of the estimation are transmitted to substations. The section to warn, which would be shaken strongly, is decided from the estimated magnitude and epicenter location. Further, power supply to the warning section is stopped and trains in the area are stopped immediately. The area of the warning section, that is decided through the above process, becomes longer with increasing estimated magnitude.

The fault rupture time of magnitude 7 or larger earthquake is several scores of seconds. In such cases, the remote seismometer may not properly estimate the magnitude from the data of first two seconds. The seismometers, therefore, continue to estimate the magnitude after over 2 seconds of the arrival of a P-wave and warning sections are expanded, if necessary.

It is thought that the fault length of "the 2011 off the Pacific coast of Tohoku Earthquake (the 3.11 earthquake)" was approximately 500km and the fault rupture time was 180 seconds or longer. A new method has been developed for such earhquakes with multiple shock. The same has been discussed in the paper.

By -Shuichi Taya

Ref. : Japanese Railway Engineering, Jan. 2014, No.182, Pg-10

Properties Of Concrete Containing Construction And Demolition Wastes And Fly Ash

The demand of aggregates and cement used in concrete is increasing worldwide every year & there are worrying signs of shortage of natural aggregate sources. At the same time there are vast amounts of Construction and Demolition (C&D) wastes generated due to increased construction activities and demolition of existing structures and create landfill problems worldwide.

Also, the use of Fly ash as a partial replacement of cement imparts environmental benefits, reduces landfill demands, reduces concrete costs, and improves concrete properties.

The concrete obtained from C&D wastes may contain masonry wastes, reinforcements etc. apart from concrete hence the strength of Concrete obtained from such sources may vary widely. The general trend is that addition of RCA decreased the strength of concrete, the

chief culprit being the old cement mortar adhered to RCA which is porous and may contain micro-cracks .

This paper presents the research results on certain mechanical properties of concrete containing coarse aggregate from C&D wastes and locally available fly ash. This paper presents the results at various replacement levels of RCA (Recycled Coarse Aggregate) on the compressive, indirect tensile, flexural strength, and water absorption of concrete. The effect of 40% replacement of cement with class F fly ash on the above properties of concrete containing RCA is also evaluated in this study.

The study consists of 2 parts:

(part A)-- The effect of RCA on the compressive, indirect tensile strength, flexural strength, and water absorption of concrete,

(part B)-- The effect of Fly ash as partial replacement (40% by weight) of cement on the properties of concrete containing RCA .

Materials—Portland cement used in all mixes; Class F fly ash; 5kg recycled C&D waste (which consists of 65% concrete and rest is masonry, tiles, bitumen etc.) . The Natural Coarse aggregate (NCA) used in this study were a mixture of 10mm and 20 mm size.

All testing were done in accordance with relevant Australian standards.

Experimental Program

The compressive strength, indirect tensile strength, flexural strength, and water absorption were measured at four different ages (7,28,56 and 91 days) in each series Slump test was done immediately after mixing the concrete to measure the workability of each mix. At least 3 specimens were cast and tested in each series. All specimens were water cured until the day before the test date.

compressive strength specimen- 100Ø x 200mm cylinders.

Indirect tensile strength test specimen- 150 Ø x 300 mm cylinders.

Flexural strength specimen- 100x100x400 mm prism.

Water absorption test specimens- 100 Ø x 200mm cylinder cut into 3 50-mm thick slices.

Effect of Fly ash and RCA on workability of concrete

The workability of concrete decreased with increase of RCA content (as a replacement of NCA) . On the other hand, the addition of fly ash (as a substitute of cement) increased the workability of concrete (due to the circular particles of fly ash and fly ash being less dense than cement).

Effect of RCA on mechanical properties of Concrete

1. Replacement of 25 % of NCA by RCA increased the compressive strength of concrete at all ages (7, 28, 56, 91 days).
2. The slight gain in strength is attributed to remaining unhydrated cement within the mortar on RCA. Another possibility could be greater % of fines in the RCA which decreases the W/C ratio due to higher water absorption. Also greater the fines, greater will be the packing hence resulting in a better compressive strength of concrete.

Effect of RCA on water absorption of concrete

Water absorption of concrete containing RCA increases with the increase in RCA contents at all stages (due to adhered mortar on RCA).

Effect of fly ash on concrete containing RCA

The compressive strength of concrete with 40% fly ash (replacement of 40% cement with fly ash) showed

PART	STUDY OBJECTIVES	SERIES	NCA (%)	RCA (%)	Fly ash (%)	Mix designation
A	Effect of RCA on the properties of concrete	1	100	0	-	0% RCA+0% fly ash
		2	75	25	-	25% RCA+0% fly ash
		3	50	50	-	50% RCA+0% fly ash
		4	25	75	-	75% RCA+0% fly ash
		5	0	100	-	100% RCA+0% fly ash
B	Effect of Fly ash on the properties of concrete containing RCA	6	100	0	40	0% RCA+40% fly ash
		7	75	25	40	25% RCA+40% fly ash
		8	50	50	40	50% RCA+40% fly ash
		9	25	75	40	75% RCA+40% fly ash
		10	0	100	40	100% RCA+40% fly ash

increased strength at 56 and 91 days. But at the early ages (7 & 28 days) increase in comp. strength is not observed (as pozzolanic reaction of fly ash takes time).

Concrete mixes with RCA Replacement of 75% and 100% are found to be unpractical due to poor workability, however the same can be improved using fly ash or other SCMs (supplementary cementing materials) & superplasticizers .

By:S.F.U. Ahmed

Ref: ASCE Journal of Materials in Civil Engg, Vol-25, No. 12, Dec 2013

Understanding the Trackbed Asset and its Impact on Maintenance and Renawal Strategies

Maintenance and renewal intervention of permanent way track assets, including rail, sleepers and trackbed, are triggered typically by exceedance of track quality limits, rough ride reports or 'surface' track condition surveys (automated or manual). However, research has suggested a significant proportion of track quality problems are sourced in the underlying trackbed (i.e. ballast, sub-ballast, drainage, and subgrade). By using trackbed condition on a supplementary basis to other asset condition data, the engineering need of the railway can be better met, deterioration of track support layers can be predicted and maintenance and renewal decision making improved. Possible benefits include mitigation of track failure earlier in the asset's lifecycle using cheaper interventions, reducing the requirement for more capital-intensive remedial schemes and whole-life costs. Alternatively, the impact of not addressing trackbed failure mechanisms can be understood and the appropriate maintenance plans and budgets put in place.

To optimize future trackbed maintenance and renewal in terms of technique and intervention timing, a detailed understanding of its interdependence with trackbed, drainage condition and historic track quality deterioration is required. An in-depth knowledge is also required of trackbed failure mechanisms and their effects on track quality and component deterioration.

This paper presents lessons learnt from the UK and the possible cost benefits (based upon Discounted Cash Flow analysis) of performing various levels of Trackbed investigation and Design (TBID) on a site and network level to infrastructure owners. The authors have concluded that early stage TBID are key to optimising renewals in terms of technical solution (i.e. where to target formation treatment) and method of delivery (i.e. re-ballasting). This can result in significant savings in the life – costs. However, cost – benefit of this investigation stage may not be realised early in the asset's life (zero to five years). As such, it should be ensured that this is a policy embedded within the decision making process for maintenance and renewal strategy. Without this policy commitment, on the local level, the investigation stage may get ommited, being an additional upfront cost.

Ref. Permanent Way Institution Journal Issue : January,2014 Vol.132-part-1 Pg- 40

INDIAN METRO PROJECTS

City	Open	Under Construction	Planned	Total
Ahmedabad			58.27	58.27
Bangalore	7	35.3	75	117.3
Bhopal			30	30
Chandigarh			35.57	35.57
Chennai		54		54
Delhi	189.8	140	115	444.8
Hyderabad		71.16		71.16
Indore			30	30
Jaipur		9.25	25.9	35.15
Kochi		25.6		25.6
Kolkata	26.2	14.7	73.8	114.7
Lucknow			34	34
Ludhiana			29.4	29.4
Mumbai		53.9	103	156.9
Navi Mumbai		11.1	10.35	21.45
Nagpur			40	40
Pune			31.3	31.3
Raipur			45.1	45.1
Total (km)	**213**	**415**	**736.69**	**1374.7**
Indian Monorail Projects				
Kozhikode			14.2	14.2
Thiuruvanantthapuram			25.2	25.2

IRSE Probationers (2011 batch) calls on Hon'ble President of India Shri Pranab Mukherjee at Rastrapati Bhavan, New Delhi on 22nd April 2014

IRSE Probationers giving honor to Hon'ble President of India

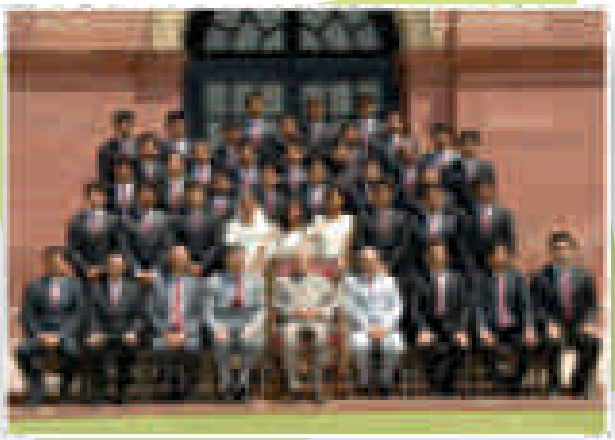
Shri Arunendra Kumar, Chairman Railway Board, Delivering Welcome Address

Address by Hon'ble President of India Shri Pranab Mukherjee

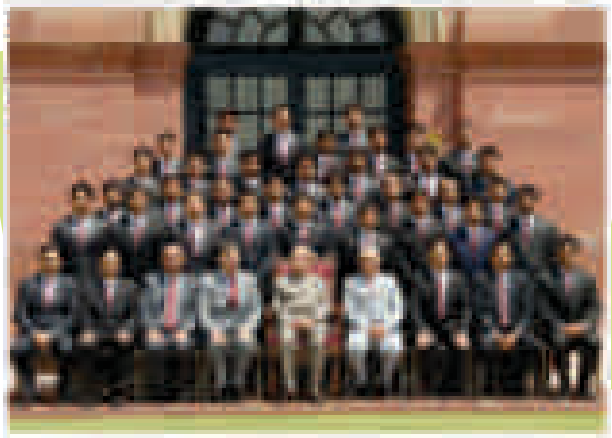
IRSE Probationer Sharing Training Experience

Another IRSE Probationer Speaking on the Occasion.

Shri Vishwesh Chaubey
Director IRICEN
Delivering Vote of Thanks



IRSE Probationers with
Hon'ble President of India
(Group Photo - I)



IRSE Probationers with
Hon'ble President of India
(Group Photo - II)

IRICEN CALENDAR OF COURSES 2014 (Rev. 5 dt. 19.06.2014)

Course No.	From	To	Name of course	Duration	Eligible Group
Probationary Courses					
14005	08.09.14	04.12.14	IRSE Ph.II (Gr.P)	11 wks	IRSE (P) 2012 Exam.
14006	24.11.14	05.02.15	IRSE Ph.II (Gr.Q)	11 wks	IRSE (P) 2012 Exam.
14007	08.12.14	12.12.14	IRSE Posting Exam	1 wk	IRSE (P) 2011 Exam.
14008	08.12.14	12.12.14	IRSE Introductory	1 wk	IRSE (P) 2013 Exam.
Integrated Courses					
14102	28.04.14	17.07.14	Integrated	12 wks	Gr.B officers
14103	21.07.14	09.10.14	Integrated	12 wks	Gr.B officers
14104	03.11.14	22.01.15	Integrated	12 wks	Gr.B officers
Sr. Professional /SAG Refresher Courses					
14202	26.05.14	04.07.14	SAG Refresher	6 wks	SAG all dept
14203	18.08.14	26.09.14	SAG Refresher	6 wks	SAG all dept
14204	10.11.14	19.12.14	SAG Refresher	6 wks	SAG all dept
14205	25.08.14	26.09.14	Sr. Prof. Dev. Course	5 wks	JAG Gr.'A' officers
14206	15.12.14	16.01.15	Sr. Prof. Dev. Course	5 wks	JAG Gr.'A' officers
PCE/HAG/SAG/Seminars/Workshops/Meetings					
14304	24.07.14	25.07.14	CAOs' Seminar	2 days	CAOs
14305	07.08.14	08.08.14	CBEs' Seminar	2 days	CBEs
14306	21.08.14	22.08.14	CE/TMs' Seminar	2 days	CE/TMs
14307	09.10.14	10.10.14	Training Manager Seminar	2 days	CGEs/Pr.CETCs
14308	31.10.14	1.11.14	IRICEN Day Seminar for IRSE '88'	2 days	SAG (IRSE '88')
14309	20.11.14	21.11.14	PCEs' Seminar	2 days	PCEs
Special Courses (Track/Bridges/Works)					
14406	30.06.14	04.07.14	TMS (T-5)	1 wk	JS/SS of OL
14407	07.07.14	18.07.14	Course for Construction Engineers (C-2)	2 wks	SS/JAG of Const. Org.
14408	21.07.14	01.08.14	Land Management & Green Building (W-1)	2 wks	SS/JAG
14409	04.08.14	14.08.14	Steel structure &PSC (B-2)	2 wks	JS/SS/JAG
14410	11.08.14	14.08.14	Rly. Formation and Geo. Tech. Inves (T-4)	1 wk	JS/SS/JAG
14411	18.08.14	23.08.14	Rail Wheel Interaction & derailments (T-2)	6 days	JS/SS/JAG Of OL
14412	25.08.14	05.09.14	Contracts & Arbitration and project Management(W-2)	2 wks	SS/JAG
14413	10.11.14	14.11.14	Modern Surveying(C-1)	1 wk	JS/SS/JAG of Const. Org
14414	03.11.14	07.11.14	TMS (T-5)	1 wk	JS/SS Of OL
14415	29.12.14	16.01.15	Courses for Br. Design Asstt.inclu. Earthquake complaint structure(B-1)	3 wks	ABE;sDesign Asstts.
AWARENESS COURSES					
14710	07.07.14	11.07.14	Awareness for IRSS	1 wk	IRSS (P) 2012
14711	04.08.14	08.08.14	Awareness for Prob	1 wk	IRTS(P) 2012

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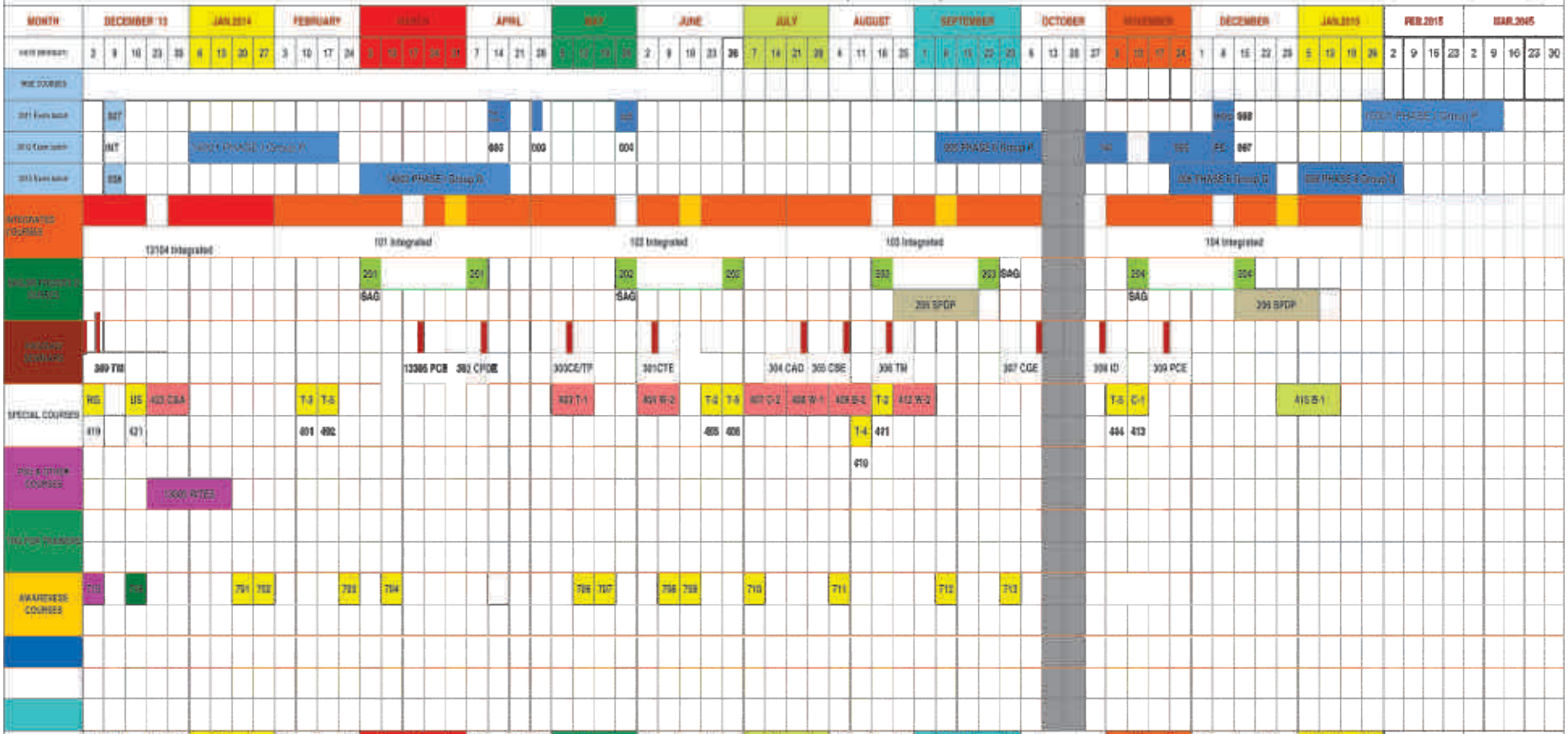
CALENDAR OF COURSES 2014 CHART (REV-5 DI 19.6.14)



SPL-COURSES	Course Name	No.	No.	No.	Wks
T-1	RIFS, Walking/Fit/Tool/Book/ISC	480			2
T-2	Rail Welding/Fracture & Deailment	485	484		3d
T-3	Points & crossing and Yards	484			1
T-4	Bridge/Foundation & Geo Technics	476			1
T-5	TMS	482	485	494	4
B-1	Bridge Design Analysis	415			3
B-2	PSC & Steel Structure	409			2
B-4	Load Mgt & Green Bldg	488			2
B/A2	Contract & Advanced Project Mgt	484	492		4
C-1	Site Surveying	413			1
C-2	Construction Engineers	481			2

Awareness Course	No.	No.	No.	Wks
Accounts				1
Mechanical Engg	282	285	707	1
Mechanical Engg				1
Signal Engg	284	288		1
Signals	283	289		1
personnel				1
Traffic	281	286	711	1

Ethical training for probationers and integrated course

NOTES - MODIFICATIONS

1	1460	Split two weeks break from 13.10.14 to 24.10.14 (Rev.01)
2	1460	Break in 7 th week (Rev. No. 01)
3	1460	Break in 5 th week (Rev. No. 01)
4	1460	Break in 6 th week (Rev. No. 01)
5	1460	Break in 6 th week (Rev. No. 01)
6	1448	Postponed 10.11.14 to 14.11.14 (Rev. No. 01)
7	1478	Postponed & rescheduled as 14/13 (Rev. No. 01)
8	1479	Rescheduled as 14/13 (Rev. No. 01)
9	1480	Prepared 15.04.14 to 25.04.14 (Rev. No. 02)
10	1430	Postponed 09.06.14 to 09.06.14 (Rev. No. 02)
11	1430	Prepared 10.04.14 to 11.04.14 (Rev. No. 02)

NOTES - MODIFICATIONS

12	14705	postponed (Rev. No. 02)
13	14719	Awareness for RRSS-(P) (Rev. No. 02)
14	14301	Postponed (Rev. No. 03)
15	14303	Prepared (Rev. No. 03)
16	14903	Split the duration (Rev. No. 04)
17	14304	Postponed (Rev. No. 05)
18	14905	Postponed (Rev. No. 05)