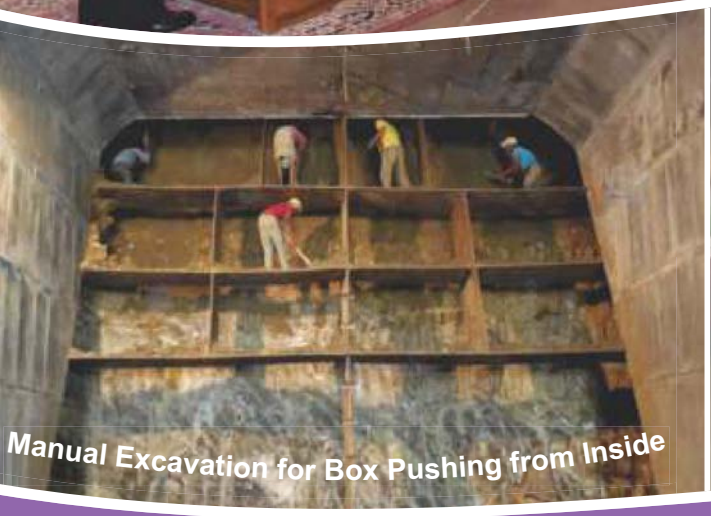
IRICEN Journal of Civil Engineering

ज्ञान ज्योति से मार्गदर्शन

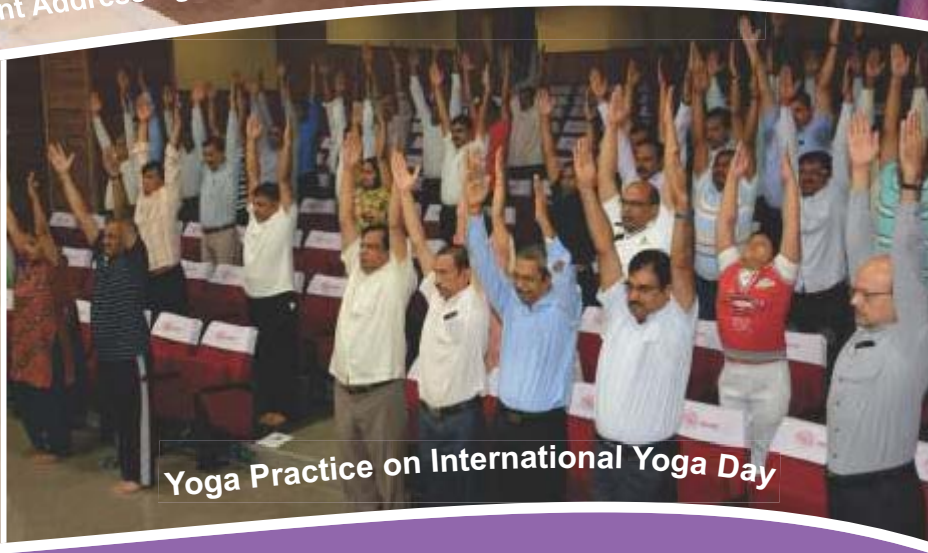
Volume 8, No. 2 www.iricen.indianrailways.gov.in June 2015



Hon'ble President Addressing to Indian Railway's Probationary Officers



Manual Excavation for Box Pushing from Inside



Yoga Practice on International Yoga Day

Indian Railways Institute of Civil Engineering, Pune

Key Recommendations of CE/TP Seminar held on 7th & 8th May, 2015

Item: 1

Provision in the IREPS portal for quoting Entry Tax in the financial bid to be made.
In some of the states Entry Tax is levied therefore, additional column shall be provided in IREPS.

Recommendation:

Additional column shall be provided in IREPS for entry tax.

Item: 2

Standard Tender Document for e-procurement

Recommendation:

The format followed by NWR should be shared for guidance of other railways.

Item: 3

Zonal Railways are inviting tender for fabrication and supply of overriding curved switches of 1:12, 1:8.5 T/Out, derailing switches.

Recommendation:

Following para may be added in the tender conditions:

"In case of non availability of shorter length rail with the flash butt welding plant, 13 meter length rail shall be issued to the supplier. In such cases, the balance cut piece of 1m/4m as the case may be has to be returned by the supplier, along with the finished product to the consignee of the purchaser."

Item: 4

Closure of PO with ±5% (or Rs. 3.0 lacs whichever is less) of purchase value:

Recommendation:

Monitory limit of 3 lacs should be increased to 20 lacs.

Item: 5

Direct issuance of purchase orders.

Recommendation:

The system of issuing of 'Advance Acceptance Letter' should be dispensed with.

Item: 6

Letter for procurement of trial items should be circulated to Railways only after concurrence of finance directorate

Recommendation:

RDSO to be given full powers regarding trial items.

Item: 7

Revision of security deposit amount for safety Items:

Recommendation:

Railway Board is requested to consider SAG committee report at the earliest.

Item: 8

Standardisation PVC formula :

Recommendation:

Board may clarify what rates to be taken as RINL has not declared rate of steel for Feb and March.



from director's desk

Dear Readers,

Keeping in with the tradition, this year also IRSE(P) of 2012 batch called on the Hon'ble President of India. The rare occasion of interaction and guidance from the Hon'ble President of India will be a strong motivating factor during their career and rest of their life.

Observation of **"Railyatri Upbhokta Pakhwada"** during this quarter underlines our invigorated commitment towards rail users continually. Similar commitment towards better physical and mental health for meeting challenges in life is inevitable, where yoga can play a crucial role. A new beginning made in this direction on 21st June as **"International Yoga Day"**.

This edition of the journal includes an interesting paper on remodelling of Godhra (WR) yard on NDLS-BCT Rajdhani route, by an innovative approach to increase speed from 10 km/h to 50 km/h leading to substantial saving in running time.

The papers on quality control of in situ welding of rail joints by mobile Flash Butt Welding plants has enormous significance in ensuring better reliability and strength compared to AT/SKV welding processes. For high speed and heavier axle loads on IR in-situ FB welding would be de-facto standard for its superior performance.

I sincerely hope that the readers would find the papers and other articles contained in this edition timely and useful. I also invite suggestions and contributions for the forthcoming issues of this journal.

(Vishwesh Chaubey)
Director

Pune
22 July 2015

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Suggestion for improvement of **IRICEN JOURNAL OF CIVIL ENGINEERING** are welcome from the readers. Suggestions 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.

Government to Rebuild 150 Bridges, Construct over 200 ROBs

The Road Transport and Highways Ministry is planning to rebild 150 bridges as part of an ambitious project called “Sethu Bharatam” or “Bridging India”. The government is also planning to build over 200 rail over bridges. “The name 'Sethu Bharatam'aims to connect India through bridges.

The government had asked states to give a list of bridges which are in dilapidated condition and require refurbishing. States had given a list of 1000 bridges, of which the Centre selected 150.

The government is already planning the ambitious 'Bharatmala' project, a road connecting India's west coast with east coast at a cost of around Rs.14,000 crore.

The Ministries of Railways and Road Transport last year had signed an agreement to facilitate speedy clearance of rail over and under bridges along national highway corridors.

Ref: CT Today, MAY 2015, Pg 11

L & T Obtains Contract from RVNL Worth $10m

Rail Vikas Nigam Limited (RVNL) has granted a contract worth $10m to L&T InfoTech. “L&T InfoTech, a global provider of information technology services and solutions, has been awarded a contract worth US$10million to integrate the business functions of Rail Vikas Nigam (RVNL),” the company release.

RVNL is a wholly-owned public sector company under the Ministry of Railways, with the specific mandate of fast tracking implementation of rail infrastructure projects.

As per the contract, the company will deploy SAP ERP solutions to integrate business operations within RVNL . According to L&T InfoTech Managing Director V.K. Magapu.

There will be implementing world-class SAP ERP for Rail Vikas Nigam. Their unique solutions will help RVNL streamline its operations thereby helping them save valuable time, resources and money.

According to the agreement, L&T InfoTech will also deliver data centre hosting, collaboration and networking including e-tendering, project management, finance HR functions as well as user support and maintenance. It will also integrate RVNL's 24 project implementing units (PIUs) across India, including their corporate office at New Delhi.

Commenting on the agreement, RVNL Director Finance Ashok Ganju said, that they look forward to working with L&T InfoTech for implementation of the state-of-the-art IT solutions for project management of rail infrastructure projects. Using SAP, RVNL will be able to map business process in a highly integrated way, which will help reduce costs and ensure speedy implementation of railway projects.

Ref: CT Today, April 2015, Pg 12

GMR Consortium Bags Rs.5,080 crore Rail Freight Corridor Project from DFCC

A consortium of companies led by GMR infrastructure has bagged Rs.5,080 crore contract from Dedicated Freight Corridor Corporation of India to design and construct a 417-km stretch of the project's eastern arm.

The consortium has been issued the Letter of Award for two packages, Mughalsarai to Karchana (180 km) and Karchana to Bhaupur (237 km), to be implemented on an engineering, procurement and construction (EPC) basis, the company stated.

“The project, funded by the World Bank, involves design and construction of civil, structures and track works for a double-line railway….and shall be completed in 45 months,” it said.

The GMR consortium's was the lowest among six bids in a global competition last November. The eastern corridor is to cover a total length of 1840 km.

GMR group said it was not required to provide any equity for the project, as this is to be implemented on an EPC basis.

Ref: CT Today, April 2015, Pg 18

Nut Locking Device

In North America, L.B. Foster co. Markets the Tracksure™ range of patented nut locking devices. Used in a variety of special track work applications such as large diamond crossings, the devices prevent nut loosening caused by vibration and settlement.

The Tracksure bolt is suitable for OEM applications and, in certain cases, retrofitting to existing track, the company says. The locking device consists of a modified bolt with a reverse thread added to the end, which accommodates both the original nut and the Tracksure locking nut. This locking nut is applied to the reverse thread until it tightens against the original nut. A serrated steel locking cap then pushes down over both the original nut and the Tracksure nut, held in place with spring clip. If the original nut starts to loosen even microscopically, the locking nut tightens on the reverse thread with the locking cover combining both actions, ensuring a fail- safe bolt fixing, the company says.

The Tracksure bolts does not require expensive capital equipment to install and offers significant benefits in



maintenance - intensive and safety - critical applications - it secures the joint more effectively, reducing railroad down-time, and can be serviced quickly and simply where necessary, the company says.

Ref: Progressive Railroading, Feb-2015, Pg 24

Korean President Launches KTX Honam.

President Park Geun hye of Korea along with 1200 invited guests and members of the public attended a ceremony at songieong station in Gwangiu on April 1 to mark the opening of the new 182 km high-speed line from Osong to Gwangiu. New KTX Honam services from Seoul to Mokpo began using the line the following day.

China Carries out Indian High Speed Study.

China Railway siyuan Survey and Design Group (CRSSD) is conducting a preliminary study of a planned 1754km high-speed line in India linking Delhi, Bhopal, Nagpur, Hyderabad and Chennai which it hopes to complete by August.

The study is being done free-of-charge under a memorandum of understanding signed last year in new Delhi in the presence of India's prime minister Mr. Narendra Modi and the Chinese president, Mr. Xi Jinping.

Tibet Railway to Reach Nepalese Border by "2020"

The chairman of Tibet Autonomous Region Mr Losang Jamcan has told Nepalese president Mr. Ram Baran Yadav that the Chinese government plans to extend the Tibet Railway to the Nepalese border within five years.

According to a statement issued by Nepal's Ministry of Foreign Affairs, Jamcan informed Yadav at a meeting in the Tibetan capital Lhasa on April 1 that the line will be extended 540km from Xigaze, Tibet's second city, to Kerung, 35 km from the Nepalese frontier, by 2020.

Commission Casts Doubt over Spanish HS Test Track.

New doubts over the economic feasibility of a new high-speed railway test centre in southern Spain have surfaced after the European Commission (EC) launched an in-depth investigation to determine if the €359m project violates European Union state aid rules. In September 2013, the Spanish government requested the EU Regional Development Fund (ERDF) to finance up to 269m of the cost of what would be one of the world's largest rail test centres.

Indian Railways to Order 200km/h Trains.

INDIAN Railways (IR) was due to hold a pre-bid conference at the end of last month for a contract to supply a fleet of 15 fixed formation 200km/h trains worth an estimated Rs. 25bn ($US 500m).

Bombardier, Siemens, alstom, and Talgo were expected to participate in the conference, alongside suppliers from China, Japan, and The Czech Republic.

India fastest service is currently the New Delhi Habibganj Shatabdi Express, which completes the 707km Delhi-Bhopal journey in 8.5 hours, reaching upto 150km/h on the Delhi-Agra section.

Catenary-Free LRVs Debut in Dallas

Dallas Area Rapid Transit became the first transit operator in the United States to use catenary-free LRVs in regular public service on April, 13 when the city inaugurated the 2.6km Downtown-Oak Cliff tram line.

Brookville Corporation, United States, has supplied two 20.2m long 70% low floor Liberty LRVs, which are equipped with an onboard lithium-ion energy storage system to enable catenary-free operation over the 101 year old Houston Street viaduct. The batteries are charged through the overhead catenary and the charge state is monitored by an integrated battery management.

Ref. : International Railway Journal, May-2015, Vol.55 Issue 5. Pg 6

Three Point TGV Strategy Seeks Return to Growth.

FRENCH National Railways (SNCF) has unveiled details of a plan to return its high speed business to growth and make "TGV the preferred means of transport for the French".

TGV has suffered a worsening financial situation since the economic crisis began with operating margins falling from 29|% in 2008 to 10.4% in 2014. At the same time, infrastructure costs have soared from €2.1bn in 2014, and are set to reach €3bn by 2020, while competition from other modes including low fares airlines and online car pooling has intensified.

Ref. : International Railway Journal, April 2015, Pg 4

Railways to E-Auction 100 Stations for Redevelopment

Indian Railways is planning to take the e-auction route for the first time for redevelopment of stations. Through PPP, 100 railway stations will be redeveloped. Official, sources said that private players will be able to submit their bids online, after which a technical committee will study and approve the bids. Also, private players tasked with converting the railway stations into world –class transit facilities will be given specified area within the station premises and around it to be exploited commercially. The joint ventures will be formed at the divisional level for the project. Prime Minister had invited French companies to explore commercial opportunities in Indian Railways. India hopes foreign players including companies from Japan will be interested in the investing in the station redevelopment project. Several major stations including tourist destinations to be converted in to a world class transit facility by private companies. Indian Railways is now working on the list of stations which will be offered to private companies for redevelopment.

Ref:The Masterbuilder May 2015

High-Speed Railway Project is on Fast-Track

The feasibility study for first high-speed train of India, between Mumbai and Ahmedabad is likely to be conducted by July 2015. The service would be for 500 kms. The project will start by 2017 and will cost around $ 14 billion. With 12 stations on the route, this train will reach a maximum speed of 320kmph, minimizing the travelling time from eight hours to two –and-a- half hours. The high speed Railway Corporation (HSRC) has been established as a special vehicle for implementing the project under the Railway Vikas Nigam. As per reports, the Japanies consortium, led by the East Japan Railway Company may lead for doing the project by incorporating the Shinkansen technology. They have also committed financial, technical and operational support in the project. In the feasibility study of the project, Japan External Trade Organization (JETRO) is also a participant. A major challenge will be in unbundling the technology- andequipment needs in an effort to keep the 'Make in India' programme effectively.

Ref: Masterbuilder April 2015

DMRC Focus on 'Make in India': 90 Percent of its Trains Manufactured in India

Delhi Metro Corporation has succeede in making 90% of the Delhi Metro trains being manufactured in India. Mandatory indigenization in contract conditions, in consonance with “Make in India”, forced the manufacturing companies to set up the production facilities within the country. The train, made in India will be exported to Australia for Queensland and Sydney Metro. According to DMRC spokesperson the cost of these coaches is much cheaper than the cost of Metro coaches world over.

Three Metro coach manufacturing units which set up their base in India are Bombardier Transportation in Savli, Gujrat, Bharat Earth Movers limited in Bengluru, and Alstom, near Chennai in Tamil Nadu.

Ref: Masterbuilder, April 2015

Making Use of Flyash Bricks Mandatory

To reduce pollution, the government is planning to make it mandatory for builders to use flyash bricks. As per new directive, all brick units within the 100 km radius of thermal power plans are required to use flyash bricks as building material. Every agency engaged in construction within 100 km radius is also required to use flyash bricks.

The ministry has identified 20 construction hotspots in the country such as Delhi-NCR, Bengaluru and Chennai where utilization of flyash could be made mandatory by putting it as condition in local municipal laws. The move is likely to create a huge market for flyash bricks. There is still sufficient demand for flyash products including flyash bricks as the country has yet to construct 70% of its building stocks which will result in an enormous demand for flyash bricks and other flyash-based products, say a senior executive of a reputed construction company.

Ref: New Building Materials & Construction world, June 2015 Pg 34

Maglev Testing Tops 600km/h

A new speed record for a magnetically –levitated vehical was set on April 21, when Central JapaN Railway powered one of its Series L0 superconducting maglev units up to amaximum of 603 km/h on the test guide way in Yamanashi prefecture.

According to JR Central, a speed of more than 600 km/h record established by the MLX01 prototype in December 2003 before the test guide way was lengthened from 18.4 km to 42.8km.

This is seen as an essential precursor to construction of the planned Chuo maglev between Tokyo- Nagoya section , is expected to be completed by 2027 at a cost of ¥5.4tr; the second phase to Osaka would follow around 2045.

With 85% of the Tokyo- Nagoya line to be built in tunnel, Chuo maglev services are expected to run at a maximum of 505 km/h in revenue operation, offering an end to end journey time of 40 min.

Ref: Railway Gazette International, May 2015, pg 76

Delhi Metro Corporation Sees Impressive TBM Numbers

A total of 19 TBMs are simultaneously engaged in constructing tunnels across Delhi. It is one of the largest tunnelling projects ever undertaken.

As part of its third phase of expansion, Delhi Metro is constructing more than 53 km of underground Metro lines comprising of 74 different tunnelling drives of about 37 km. Some 35 TBMs are to be used for this mammoth assignment during the entire third phase and about 21 km of tunnels (or 41kmof tunnels including up and down tunnels) and 33 tunnelling drives have already been completed so far. The entire tunnelling work of Phase 3 is expected to be finished by the end of 2015.

The use of 19 TBMs simultaneously within the confines of one city is among the highest used anywhere in the world. In Phase 2, Delhi Metro had used a total of 14 TBMs during entire span of work.

For the current phase, so many TBMs are being used because the proportion of underground construction has increased significantly compared to the last two phases. While Delhi Metro currently has an operational underground section of approximately 47 km, the third phase alone will alone have more than 37 km underground.

Work on Phase III will require some 25 TBMs in total. In Delhi, the decision to go underground is purely a financial one with overhead lines preferred where possible.

Ref: Tunnels, April 2015, Pg 10

Key Recommendations of CE (Planning) Seminar held on 28th & 29th May 2015

1) Various provisions of GCC- July 14 were discussed in the seminar. Committee recommended for early release of revised GCC.
2) A workshop may be organised in Railway board to address certain issues related with the IRPSM and PAMS.

...and extremely close cost effective projects





Hon'ble President Addressing
Indian Railway's Probationary Officers



Group Photo of IRSE
Probationers of 2012 Batch
with Hon'ble President of India



International Yoga Day Celebrated
in IRICEN on 21st June 2015.



Meditation on
International Yoga Day

Field Tests of Elevated Viaducts in Mexico City.

This paper presents the main results obtained from field tests carried out in four sites of three recently built elevated viaducts in Mexico City. The main objectives of the tests were to determine and assess the structural response of elements located at representative sections of the viaducts. Focus was given to the identification of main static and dynamic properties, the measurement of the lateral displacement of the column-footing assemblage under monotonically increasing loads, and the study of the soil-structure interaction of the assembly. The field tests ranged from ambient vibration measurements to applying horizontal and vertical loads to the structure by means of pulling cranes and both parked and moving vehicles. The tests were aimed not only at providing experimental evidence to support the general assumptions used by the design firm, and to make the proper adjustments if deemed necessary, but to contribute to the body of knowledge with respect to elevated viaducts built by means of precast posttensioned members.

By: David Murià-Vila; Abraham Roberto Sánchez-Ramírez; Carlos Humberto Huerta-Carpizo; Gerardo Aguilar; José Camargo Pérez; and Raul Eduardo Carrillo Cruz.

Ref: American Society of Civil Engineering, January 2015, Pg-D4014001-1.

High-Speed Operators Need High-Speed Reactions

Two of Europe's leading high speed rail operators, French National Railways (SNCF) and German Rail (DB), have announced restructuring plans in a bid to revitalize the lackluster performance of their high speed services and revive growth.

The economic crisis of 2008-09 dealt a savage blow to both operators halting growth. This was followed by increased competition from low cost airlines, car sharing in France, and more recently, and particularly in Germany, long distance buses. In France, the financial performance of the TGV network has been seriously harmed by a sharp increase in track access charges which almost doubled from €1.3bn in 2008 to €2.1bn last year, while in Germany, DB was hit by a severe storm last summer which damaged infrastructure followed by a series of strikes by train drivers later in the year.

Last year SNCF's TGV network suffered a 1.1% drop in sales while Ebita fell by 13% from €782m in 2013 to €680m. DB's long distance passenger business performed even worse, with Ebitda down 15.9% at €546m and Ebit down by a worrying 34.4% at €212m.

Ref. : IRJ: International Railway Journal, april-2015, Vol.55 Issue 4. : Pg.4, 6

Field Testing of All-Steel Buckling-Restrained Braces Applied to a Damaged Reinforced Concrete Building

This paper reports the results of full-scale inelastic cyclic static tests of all-steel dismountable buckling restrained braces (BRBs) applied to an existing damaged reinforced concrete (RC) building. The two concepts set as the design targets for the prototype BRBs were to minimize interference with the functions and aesthetics of the existing building and to use an all-steel dismountable solution to allow for inspection of the yielding core after earthquakes. Two masonry infill panels (typical in RC buildings) were used to hide the braces and satisfy the first objective. Specially designed steel built-up shapes with bolted connections were used to satisfy the second objective. The design criteria and procedure adopted for the retrofitting design are first described, and a description of the BRB specimens and the experimental results follows.

By: Gaetano Della Corte; 'Mario DAniello; and Raffaele Landolfo

Ref: American Society of Civil Engineering, January 2015, Pg- D4014004-1

Instrumentation of a Horizontally Curved Steel I-Girder Bridge During Construction

Horizontally curved, steel I-girder bridges can present unique challenges for engineers and contractors because the curved geometry can result in a complicated torsional response. The most complicated stages for predicting behavior of the girders usually occur during erection and construction when the loads and support conditions are the most unpredictable. Although laboratory experiments can provide valuable insight into the behavior, the high cost of the specimens often precludes meaningful experiments, whereas field monitoring of bridges during construction provides invaluable opportunities to understand the behavior and gather data for validating computational models. A horizontally curved, steel I-girder bridge was instrumented to monitor the bridge during erection and

concrete deck placement. Stresses were monitored as girders were lifted into position, followed by measurements of vertical deflections, rotations, and stresses during the concrete deck placement. The stresses during the erection process were relatively low owing to the proper use of lifting and placing methods; however, high stresses can be induced after girders are placed when the cross frames are ratcheted into position. As expected, higher stresses, compared with the steel erection process, were recorded during the concrete deck placement. Nonetheless, the monitored bridge did not have stability problems because the bridge utilized a relatively stocky flange width-to-depth ratio. For bridges more susceptible to stability challenges, such as tightly curved bridges, highly skewed bridges, narrow bridges, bridges with odd span arrangement, or some combination of these attributes, it is recommended that the designer consider the implication of slender girders and explicitly design for the possibility of construction-related stability challenges. In addition, resulting from the limited availability of field measurements of horizontally curved girders throughout the construction process, the data represent a valuable resource researchers can use to validate computational models for conducting parametric investigations. This paper outlines the methods used during the field monitoring and summarizes the results from the field measurements.

By: Jeremiah D. Fasl; Jason C. Stith; Todd A. Helwig; Andrew Schuh; Jamie Farris; Michael D. Engelhardt; Eric B. Williamson; and Karl H. Frank

Ref: American Society of Civil Engineering, January 2015,Pg- D4014006-1

Field Verification of Simplified Analysis Procedures for Segmental Concrete Bridges

Load tests on segmental bridges are uncommon in the literature given their relatively short history and comparatively smaller presence in the national bridge inventory. This paper presents results from two segmental concrete bridge field tests and compares them with common simplified longitudinal and transverse analysis procedures. These single-cell structures, built with balanced cantilever construction, represent two significantly different segmental concrete bridges. Designers frequently use a beamline model for longitudinal analysis. When compared with the load test results, this simple method produces conservative predictions of longitudinal behavior within 20%, which is also reflected in the literature. Conversely, little information exists in the literature on transverse bending analysis. When analyzing the localized transverse bending from concentrated wheel loads, designers commonly use an equivalent frame model. Most frequently, designers use influence surfaces to estimate the scaled loads to apply to these two-dimensional frame models. This simplified approach is shown to be conservative overall but cannot always predict bending sense and frequently overpredicts demand in excess of 100%.

By: Marc Maguire; Cristopher D. Moen; Carin Roberts-Wollmann; and Tommy Cousins

Ref: American Society of Civil Engineering, January 2015,Pg- D4014007-1

Bridge with CFRP Utilizing a Full-Scale Failure Test and Finite-Element Analysis

A finite element (FE) model was calibrated using the data obtained from a full-scale test to failure of a 50 year old reinforced concrete (RC) railway bridge. The model was then used to assess the effectiveness of various strengthening schemes to increase the load-carrying capacity of the bridge. The bridge was a two-span continuous single-track trough bridge with a total length of 30 m, situated in Örnsköldsvik in northern Sweden. It was tested in situ as the bridge had been closed following the construction of a new section of the railway line. The test was planned to evaluate and calibrate models to predict the load-carrying capacity of the bridge and assess the strengthening schemes originally developed by the European research project called Sustainable bridges. The objective of the test was to investigate shear failure, rather than bending failure for which good calibrated models are already available. To that end, the bridge was strengthened in flexure before the test using near-surface mounted square section carbon fiber reinforced polymer (CFRP) bars. The ultimate failure mechanism turned into an interesting combination of bending, shear, torsion, and bond failures at an applied load of 11.7 MN (2,630 kips). A computer model was developed using specialized software to represent the response of the bridge during the test. It was calibrated using data from the test and was then used to calculate the actual capacity of the bridge in terms of train loading using the current Swedish load model which specifies a 330 kN (74 kips) axle weight. These calculations show that the unstrengthened bridge could sustain a load 4.7 times greater than the current load requirements (which is over six times the original design loading), whilst the strengthened bridge could sustain a load 6.5 times greater than currently required. Comparisons are also made with calculations using codes from Canada, Europe, and the United States.

By: Arto M. Puurula; Ola Enochsson; Gabriel Sas; Thomas Blanksvärd; Ulf Ohlsson; Lars Bernspång; Björn Täljsten; Anders Carolin; Björn Paulsson; and Lennart Elfgren

Ref: American Society of Civil Engineering, January 2015,Pg- D4014008-1

Field Testing of a Decommissioned Skewed Steel I–Girder Bridge: Analysis of System Effects

This paper describes the field testing of a decommissioned, skewed, steel I–girder bridge and the resulting behavior that was observed. To more thoroughly evaluate the behavior observed in the field testing, where a load 17 times the design load was applied, a finite element model of this bridge was created, which illustrates the behavior of this structure at an even greater load and in greater detail than could be achieved in the field. The field and finite element analysis (FEA) results for this bridge were compared with expectations based on current bridge specifications. These results show that there is significant reserve capacity in this common bridge configuration, relative to both current bridge design and rating specifications and the maximum load that could physically be applied to the structure. This is attributed to transverse redistribution of force enabling the strength of this bridge to far exceed the strength of the limiting girder, which is termed the system effect in this work. Conceptual formats that could be adopted to better capture this effect in future bridge specifications are also discussed.

By: Jennifer McConnell; Michael Chajes; and Kervin Michaud

Ref: American Society of Civil Engineering, January 2015, Pg- D4014010-1

Investigation and Retrofit of Distortion-Induced Fatigue Cracks in a Double-Deck Cantilever-Suspended Steel Truss Bridge

This paper discusses a comprehensive investigation and retrofit for extensive fatigue cracks in the end connections of floor beams on a double-deck, cantilever-suspended steel truss bridge. The investigation involved three-dimensional (3D) finite-element analyses using global and local models, field measurement of strains and displacements due to live load and temperature, laboratory testing of steel samples for material properties and high-stress low-cycle fatigue characteristics, as well as development of an effective retrofit based on the analytical, experimental, and field testing results. It was concluded that the cracks were a result of distortion induced fatigue in the floor beam web due to interactive deformations of the global structural system under live load and temperature variations. The retrofit entailed removing the fatigue susceptible weld terminations and reinforcing local areas of the floor beam web for out-of-plane distortion. Construction of the fatigue retrofit was completed in July 2011. The repaired structure has performed satisfactorily since then.

By: Y. Edward Zhou; Jason B. Beecher; Mark R. Guzda; and David R. Cunningham II

Ref: American Society of Civil Engineering, January 2015,Pg- D4014010-1

Field Experiments for Monitoring the Dynamic Soil–Structure–Foundation Response of a Bridge-Pier Model Structure at a Test Site

Summary results from a series of field experiments at a test site in Greece are presented, involving an in situ instrumented bridge-pier model built on realistic foundation conditions, to study the dynamic behavior of structure-foundation-soil system. It was attempted to link the variation of its dynamic characteristics to certain changes in its structural system, including the development of structural damage. This measured response was next utilized to validate numerical tools capable of predicting influences arising from such structural changes as well as from soil–foundation interaction. This bridge-pier model was supported on soft soil deposits allowing the study of structure–foundation–soil interaction effects during low-to-medium intensity artificial excitations. The in situ experiments provided measurements that were used to verify fundamental analytical solutions for soil–structure interaction. They were also used to validate numerical simulations that were developed to predict the response of the studied structure and thus, back-evaluate modeling assumptions. The obtained accuracy of the numerical predictions must be partly attributed to sound knowledge of the mechanical properties of the pier model and of the soil, not necessarily the case in all practical applications. It is evident that more complex finite-element models can improve the quality of the prediction only in cases where their parameters can be defined equally well. A special study further focused on the radiation of the waves generated by the vibration of the bridge-pier model through the soil medium. It is deemed that this comprehensive experimental investigation of soil–structure interaction provides measurements of the system response and enhances our understanding of the physical phenomenon as a whole.

By: G. C. Manos; K. D. Pitilakis; A. G. Sextos; V. Kourtides; V. Soulis; and J. Thauampteh

Ref: American Society of Civil Engineering, January 2015, Pg- D4014012-1

Experimental Studies on the Performance of Rail Joints with Modified Wheel/Railhead Contact

Rail joints are provided with a gap to account for thermal movement and to maintain electrical insulation for the control of signals and/or broken rail detection circuits. The gap in the rail joint is regarded as a source of significant problem for the rail industry since it leads to a very short rail service life compared with other track components due to the various, and difficult to predict, failure modes- thus increasing the risk for train operations Many attempts to improve the life of rails joints have to led to a large number of patents around the world; notable attempts include strengthening through larger sized joint bars, an increased number of bolts and the use of high yield materials. Unfortunately, no design to date has shown the ability to prolong the life of the rail joints to values close to those for continuously welded rail (CWR). This papers report the results of a fundamental study that has revealed that the wheel contact at the free edge of the railhead is a major problem since it generates a singularity in the contact pressure and rail head stresses. A design was therefore developed using an optimization framework that prevents wheel contact at the railhead edge. Finite element modeling of the design has shown that the contact pressure and railhead stress singularities are eliminated, thus increasing the potential to work as effectively as a CWR that does not have a geometric gap. An experimental validation of the finite element results is presented through an innovative non-contact measurement of strains. Some practical issues related to grinding rails to the optimal design are also discussed.

By:Nannan Zong and Manicka Dhanasekar

Ref. Journal of Rail and Rapid Transit, The Journal of Railway Engineering, Pg.857

Optimal Design of Wheel Profiles for Highspeed Trains.

The high maintenance cost of high-speed wheels due to wear and rolling contact fatigue is a major problem in the commercial operation of high speed trains in China. In order to understand the wear behavior of high speed wheels and its influence on the motion stability of high speed trains, the worn profiles and the work hardening of the wheels of the CRH3 high speed trains that operate on the Wuhan-Guangzhou line were monitored in different periods during service; in particular, the influence of hollow wear of the wheel on the lateral acceleration of the bearing box was investigated in detail. A new wheel profile design method was suggested to reduce the hollow wear by seeking an optimization match of the wheel profiles, the vehicles suspension systems, and the wear behavior of wheel in service. The feasibility of the method was verified by numerical simulation using the operation conditions of CRH-3 high speed trains on the Wuhan-Guangzhou line. A new wheel profile was designed using this method. The wheel/rail contact performance and the vehicles dynamic behavior resulting from the designed new wheel were investigated in detail and compared with those of the original wheel. The results show that compared with the original wheel profile, the designed new wheel profile can improve the wheel/rail contact state, reduce the contact stress level, and lower the friction power of wheel and rail. The extent of hollow wear on the new wheel is significantly decreased and the vehicle has improved dynamic behavior when wheel-sets with the designed new profile are used. Thus, the period before re-profiling is required can be effectively extended.

By: Dabin Cui", Hengyu Wang2, Li Li and Xuesong Jin

Ref. Journal of Rail and Rapid Transit, The Journal of Railway Engineering, Pg. 248

Utilizing The Track Panel Displacement Method For Estimating Vertical Load Effects On The Lateral Resistance Of Continuously Welded Railway Track

The safe operation of continuously welded rail depends on its ability to laterally resist forces generated by vehicles. In recent decades, considerable improvement has been made in increasing the lateral resistance and stability of track. This has been achieved by using elastic rail fastenings, increasing the height and width of the ballast shoulder, and modifying the shape of the sleeper. This paper deals with the effect of the vertical load on the lateral resistance and stability of a railway track using frictional sleepers (with a ribbed underside) in comparison with conventional sleepers (with a flat underside). The test results prove that the vertical load has a significant effect on the increase in the track's lateral resistance in both types of sleepers; however, it is more effective in the tracks with frictional sleepers.

By: Jabbar Ali Zakeri and Meraj Barati

Ref. Journal of Rail and Rapid Transit, The Journal of Railway Engineering, Pg.262

Dynamic Monitoring of Railway Track Displacement using an Optical System

With the increases in traffic, axle loads and travelling speed, the dynamic monitoring of railway tracks and structures of becoming more and more important to ensure a high level of safety and comfort. This situation

is particularly critical at transition zones where rapid changes of track stiffness occur. This paper presents a contactless system to measure track displacements and its application in an embankment/underpass transition zone, located on the Northern line of the Portuguese railway network where the Alfa Pendular tilting train travels at a maximum speed of 220kmph/h. The system is based on a diode laser module and a position sensitive detector (PSD). The PSD receives the laser beam emission and the detection of the centre of gravity of the beam spotlight on the PSD area enables the calculation of the displacement. Before field application static and dynamic laboratory validation tests were performed in order to evaluate the system performance for different laser to PSD distances, and an accuracy of 0.01 mm was achieved using data acquisition rates of upto 15 kHz. The optical measuring system proved to be an efficient and flexible way to measure absolute and relative rail displacements in the field, enabling the detection of track deformability differences along the transition zone, even for the passage of trains at high speed (220km/h).

By: Nuno Pinto, Cristina Alves Ribeiro, Joaquim Gabriel and Rui Calcada

Ref. Journal of Railand Rapid Transit, The Journal of Railway Engineering, Pg.280

The Use of Sub-Modelling Technique to Calculate Vibration in Buildings from Underground Railways.

In this paper, a method is presented for the calculation of the vibration created in buildings by the operation of underground railways. The method is based on the submodelling approach which is used to couple a model of a building on a piled foundation to another model that calculates the vibration generated in the soil in underground railway tunnels. The method couples a building on a piled foundation to the soil at discrete points by satisfying equilibrium and compatibility requirements at those points. The method results in efficient numerical calculations. A two-dimensional frame made of beam elements is used to model the building and its piled foundation. This elements are formulated using a dynamic stiffness matrix which accounts for Euler-Bernouli bending and axial behavior. Vibrations created by a train moving in an underground tunnel are calculated using the well known pipe-in-pipe (PiP) model. The model calculates the power spectral density (PSD) of the displacement in the soil. The excitation mechanism is the roughtness of the rail and the PSD is calculated for a train moving on a floating slab track in an underground railway tunnel for a stationary process. The current version of PiP accounts for a tunnel embedded in a half space. The building frame is coupled in this paper at 900 to the tunnel's centerline. The main result of this paper illustrates the significant contribution of the building's dynamics to the displacement wave filed received by the building. The example presented in this paper shows a decrease of more than 20 dB in the displacement PSDs at frequencies larger than 10Hz when accounting for the change in this wave field.

Ref. Journal of Railand Rapid Transit, The Journal of Railway Engineering, Pg. 303

By: Richard Bathurst

Traction, Curving and Surface Damage of Rails, Part 2: Rail Damage.

The tangential forces on a rail resulting from a combination of traction and curving are considered. These forces are a significant component of both wear and shakedown. These two simple mechanisms can be used to understand most types of damage that occur on both rails and wheels.

Damage of all types tends to be greater in curves mainly because tangential forces required to guide a train through a curve are greater than those required in straight track. Different types of damage tend to occur on high and low rails because of both the different forces acting on them and the different contact conditions.

By: Stuart L Grassie

Ref. Journal of Railand Rapid Transit, The Journal of Railway Engineering, Pg. 330

Bio-Toilet Tank on IR

With the total commitment of IR to provide hygienic environment to passengers and to keeping station premises/tracks clean, IR have developed environment- friendly Bio toilets for use in coaches. The technology has been developed jointly by IR and Defence Research & Development Organisation (DRDO).



Bio-Toilet Tank

Out of the Box & Fast Pace Remodeling of Godhra Yard:

"Astounding Approach to Eliminate Bad Layouts and to Ease Sharp Curves
&
Layout Designing for Creation of Dedicated Run Through Lines with Relaxation of PSR from 10 Kmph to 50 Kmph"

By

*Shri Pradeep Ahirkar**
*Shri P.S. Meena***
*Shri Anurag Kumar****
*Shri Anant Kumar*****

Abstract :

Godhra junction of Vadodara division of Western Railway is one of the major stations on NDLS-BCT Rajdhani route. A permanent speed restriction of 10/15 kmph for run through UP and DN trains in about 3km from 468/16-470/30 in Godhra yard was a serious bottleneck which was eating the line capacity as well as consuming a lot of time for passing run through trains .The main reason for the PSR was complicated layout of the yard having no dedicated UP and DN lines. The turnouts on main lines were taking off from inside of the curve of 5-6 degrees creating sharp resultant degree on turnout side. Heavy wear and tear in turnouts and in rails due to slow speed traffic had posed a big challenge in front of P WAY engineers .Since last 30 years, the railway engineers tried many solutions through various plans and different feasibilities but due to heavy traffic repercussions involved and longer project durations, the remodelling work of Godhra yard could not see the light .

In 2012, with detailed study and with 'OUT OF THE BOX' thought process, an innovative approach was thought of to remodel the yard 'from part to whole' in place of reverse which was being tried since long. Each Layout was studied and detailed recording of control points from precision Total Station Survey was done. Finally, with beautiful solution considering all major requirements of operations, a phase wise work model was developed. Scheme of work involved essential realignment of track to change flexure of points taking off from inside of curves using graphical method in AutoCAD which resulted the easing out of sharp curves. These works had been planned so meticulously that it facilitated fewer disturbances in current traffic conditions. AutoCAD was used in real time for executing new alignment by transferring offsets of new alignment on ground . With précised Layout Designing, OHE masts and their alignments were fixed on the ground before laying of track which saved time. This helped in smooth laying of track and planning of traffic repercussion very smartly. This work has resulted 10mins ETA saving for Indian railways .the remodelling work of UP and DN main lines was completed in 11 days each which is one of the record shortest possible execution periods for the work of such complexity and magnitude. Precisely planned and intensive mechanization of the work with maximum usage of track machines has drastically reduced the execution period.

This Paper is intended exclusively to discuss the astounding Layout Design Concepts right from the scratch, cost effective solutions for remodelling of Major Yards, the practical strategy for execution using all types of Track machines to accomplish such a long pending complex work in current scenario of peak traffic volume on Rajdhani Route of IR.

1.0 Introduction :

All Major station yards on IR have been in operation since 150 years. Major Yards have their own limitation of space which has been limited to the extent that no expansion can be done in future. One such junction station is Godhra Junction Yard (GDA), which is the last station of the Vadodara Division towards Delhi. GDA Yard is located about 76Kms from Vadodara station on Main line of BCT-NDLS Rajdhani Route at km 469. GDA has been quite notorious for sudden hooting for Accident Relief Trains and rushing of Officers due to derailments very frequently.

* Sr. Divisional Engineer/ COORD/Vadodara., W. Rly ** Sr. Divisional Electrical Engineer/TRD/Vadodara; W.Rly
*** Divisional Engineer/ East/Vadodara, W. Rly ****Assistant Divisional Engineer/ Godhra, W.Rly

GDA Yard was operated by two end Cabins i.e. A Cabin towards Vadodara End and B Cabin on Ratlam side. GDA yard was having total 14 lines consisting 4 nos. (Line no. 1-4) passenger running lines , 8 nos. (Line no. 5-13) goods running lines, 2 Godi siding lines for goods shed, 2 shunting necks on line no. 4 and line no. 7 as stabling neck. Line no. 1-4 were interlocked and Line no. 5-8 were partially interlocked and line no. 9-13 and rest were Non-interlocked.

Major Bottlenecks:

1. All Points taking off from inside of sharp curves resulting sharp Turnout radius.
2. Entire Yard in S-type geometry with space constraints.
3. Series of Bad Layouts used to result in spate of derailments.
4. Steep Gradients at both ends of the yard
5. No dedicated through main line.
6. PSR of 10/15 kmph for through trains, Normal train passing time about 15min.
7. Crawling speed used to cause high rate of wear and tear on switches on sharp curves and high rate of corrosion of rails due to slow moving trains.
8. Non-standard Early steel Girder on bridge no. 102 in 30 degree skew.
9. Line 4 track was on wooden sleepers anchored on old CC apron restricts the speed.

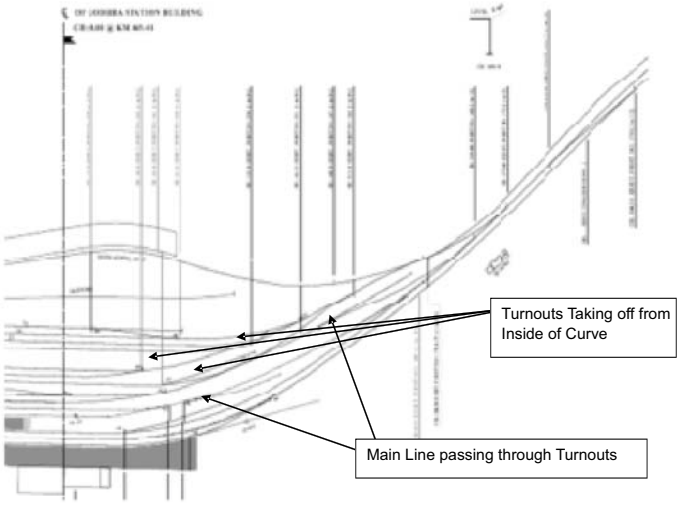
All points on goods lines were of 1 in 8.5 and all were taking off from curve in symmetrical split. Even main line turnouts, in spite of being 1 in 12, were taking off from inside of curve resulting sharp turnout radius on main line and even more in rest of the yard lines. Goods yard was having two ladders, one forming a groups of line no 5,6,8 and other forming a group of line no. 9,12 and 13 before actual remodelling started. Line no. 10 and 14 was removed before 2012.

Yard is having S-Type alignment in a stretch of about 3kms. Both ends of Yard have steep up-gradient which used to generate frequent cases of stalling and banking Engines were to be used to move train beyond Godhra from dead stop towards Delhi. Since inception, serious bottlenecks such as 10/15kmph speed for run through UP and Down trains in a stretch of about 3 kms Km 468/16 to Km 470/30; sharp degree on curves on passenger and Goods lines on serpentine layout; very high abnormal rate of wear on Turnouts and rails were major painstaking constraints in Godhra (GDA) Yard.

One more major problem was of non availability of dedicated through line in Up and Down direction. Up direction train have to negotiate Turnout side on B cabin end to enter in line no.2 and if enters line no. 1 then it has to negotiate turnout side at A Cabin to go back on main line. Similarly DN trains have to negotiate Turnout at A Cabin to enter in to line no.3 and if enters Line no.4 then it has to negotiate Turnout at B Cabin. Thus dead slow speed as Permanent Speed Restriction (PSR) of 10/15 Kmph on BCT-NDLS Rajdhani Route used to kill the considerable time and line capacity.

2.0 History :

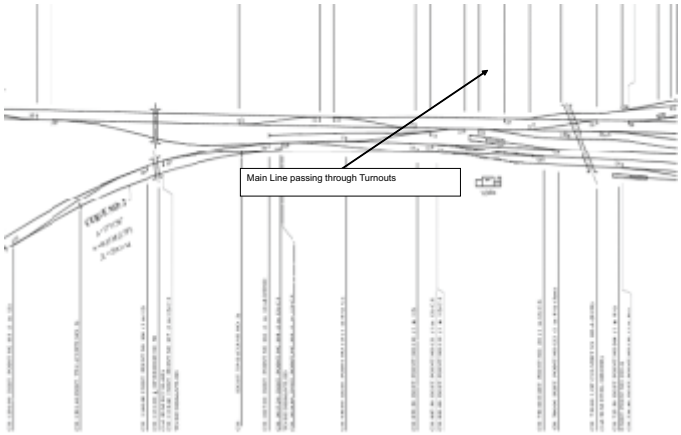
The Yard was having compound curves of variable degree from 1-7 for main line train movement. Basic geometrical problem was that all turnouts were taking off in similar flexure from sharp curves created due to limited space. This has resulted degree on Turnouts to go beyond permissible limit. Such conditions made maintenance of track extremely difficult and unsafe conditions would have usually force any inferior maintained rolling stock wagon or loco to derail. Problem was so grave that the average annual



B Cabin Area (Above)

numbers of derailments were to the tune of a dozen.

PSR of 10/15 kmph was a point of detention on main line. Rajdhani trains used to take 12-15 minutes to pass GDA Yard in both directions. Daily loss of precious capacitating time of trains and loss of revenue due to serious limitation was incomparable.



A-Cabin Area (BELOW)

3.0 Efforts Made Till 2012-13 :

Year	Plan No.	Sanctioned Status	Cost (Rs.)	Scope	Remarks
96-97	DRM 10132/32-F	PB No. 27/96-97	4.15 Cr.	Line 3&4 as UP & DN Line Entire modification of Yard.	S&C Could not be executed till 2001.
01-02	CAO© 18695/F-GDA	PB No. 38/03-04	5.16 Cr.	Line no. 3 &4 as UP and DN Lines. Elimination of 3 lines.	S&C mobilised all resources. Material brought to site. 45 Days NI Not Feasible till 2004 05.
08-09	DRM-16160/32-SK	Not Approved	-	Re - grouping of lines and DN Line on 45 Kmph.	Proposal dropped.
09-10	DRM 16415/32-F	PWP 09-10	17.89 Cr.	Major modification.	Not Sanctioned
10-11	DRM-16882/32-F	PWP 10-11	48.37 Cr.	Entire Yard Remodelling with 75kmph on main line	Not Sanctioned
2011-12	DRM-18002/32-SK	-	-	Alteration in Goods Yard lines for easing out curves	Some points shifted.

Dedicated efforts were made by Engineers since last 30 years when usual spate of derailments had become a common affair after increase in traffic volume manifold on un-designed Layouts. Various plans with different feasibility were prepared and many works sanctioned in the past ranging from 4 Cr. to 48 Cr. but could hardly see light of the day due to major traffic repercussions involved and longer project durations which could not be afforded and were not found operable on this route.

In 2004, work was awarded to Construction organisation for remodelling. After approval of plan and mobilisation of resources at site, preliminary work started but work could not begin and was finally called off in 2008 due to major traffic repercussions.

In 2011-12, it was thought by Engineers to correct some known black spots of derailments. The work was done in pieces with removal of two points declaring unsafe and easing off geometry.

In 2012-13, after series of four derailments including one passenger train, a major overhauling exercise for a month was taken pooling all trackmen from nearby divisions. 17 Turnouts were made on PRC. This has given slight relief but not resulted in correction. However, it gave some time to rethink and redesign the yard.

4.0 Breakthrough in 2012-13:

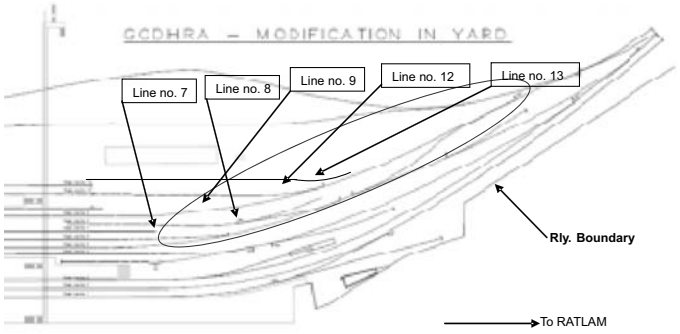
In 2012-13, with detailed study and with 'OUT OF THE BOX' thought process, an innovative approach was thought to remodel the yard from part to whole in place of reverse which was being tried since long.

1. Entire work was bifurcated in two parts Goods yard and other portion affected by Main Line movement.
2. Complete existing layout was taken from ground to AutoCAD with the help of control points in field using precision Total Station Survey.
3. Each Layout was studied and with detailed record of control points and available limitation of space.
4. , all coordinates of OHE Masts/Portals, Signal masts, structures like FOBs, Platforms, Cabins etc. were taken on AutoCAD to identify the requirements of modification in these structures with respect to proposed alignment. Graphical method used for designing.

II. Design Strategy :

Following objectives/ targets were taken in to consideration while designing the yard:

1. All Turnouts shall be brought in straight portion of track and provision of only 1 in 12 Turnouts.
2. If straight is not feasible, Turnout shall be taken out of curve in contrary flexure to utilize the reduction in net radius of lead curve.
3. All curves shall be brought from Non-uniform to Uniform degree in available space.
4. Maximum Easement of sharp curves with in limited space with surrendering of few lines.
5. CSR of all lines shall be restricted to 715m on goods lines and 686m on passenger lines
6. Designing to minimize requirement of Turnouts with functioning of maximum availability of existing lines.
7. Creation of dedicated through line for speed potential of 50 kmph and relaxation of existing PSR of 10/15kmph.



Other major bottlenecks were also planned to be removed along with yard design, which have to be made part of this remodelling for safety of trains. There were as under:

1. Bridge no. 102 was located in yard having 6.1m span girder in 30 degree skew on Line no. 1 to Line no.8. Girders were of 'Early Steel' i.e. of 1904 and in dilapidated condition. Hence, without Re-girdering of Br. 102 (30 degree skew) with specially designed girders and making feasible speed potential of 50kmph it could not be thought of.
2. Line no. 4 was a Platform line and was having dilapidated wooden sleeper track anchored on old CC Apron. Speed restriction was 10 kmph due to Non-Standard tack. Provision of Ballasted track was must for making it standard and safe track.

6.0 Layout Design :

Basic concepts of layout design and curve laying were used. Following steps were involved:

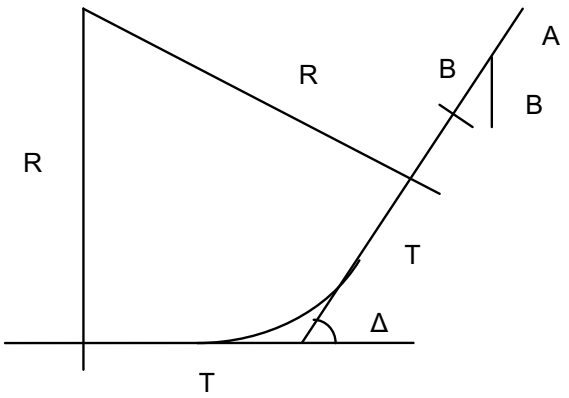
A. Re-designing of ladder in Goods yard (Line no. 7,8,9,12):

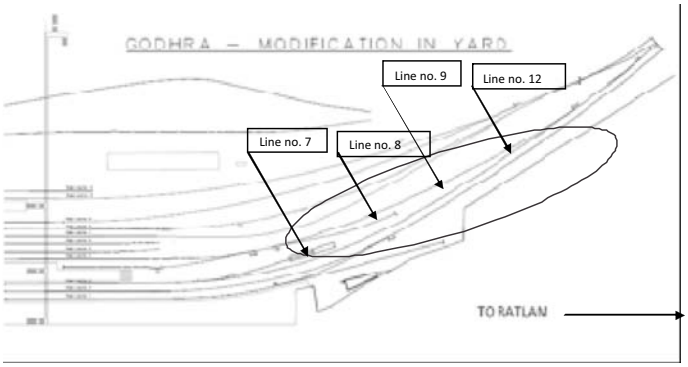
a. Major constraint such as Entire ladder which was laid on 4-5 degree curve and Turnout taking off from inside of curve.

b. Solution was found in taking out ladder from curve to straight portion at one end.

c. Following graphical concept was used with AutoCAD:

2. Calculation of Deflection angle (Δ) from the ground for each Layout.
3. Making one middle line (Line no.9) as reference for setting of a uniform curve.
4. Design of curve with leaving space for connection other lines and making ladder and selecting minimum available tangent length (T).
5. Calculating Radius, R=T/tan(Δ/2) and plotting curve in AutoCAD.
6. After leaving OL of First T/O, fix another T/O (RH) forward by step 6 above to connect line no. 12.
7. Fixed another T/O (LH) for line no. 8 and similarly fixed one more T/O (LH) i.e. outside for line no.7





This will make maximum availability of space for Turn in curves for line. Space requirement of ladder/group is reduced and all lines are connected to one end of curves on all lines. Thus made feasible ladder to come out of curve and become Symmetrical Tree type ladder in placed on one sided Conventional ladder.

B. Designing of Main Line Curves and Turnouts for (Line no. 1,2,3,4):

a. At B Cabin, Major constraint was that Turnouts were taking off from inside of curve. Line no. 2 taking off from Line no.1 with curve of 6.5˚ and Line no. 4 was taking off from inside of Line no. 3 with curve of 4˚. So Effective Turnout degree was sharp.

b. Speed potential is a constraint on such sharp layouts and creation of through line was not possible.

c. Solution was found by converting these Turnouts taking off from inside to outside of curve by relocating.

d. Following design concept were used for main line designing at B cabin area.

1. For Line no.2 which was taking off from line no.1. Therefore, flexure of Point connecting these should be changed from RHS to LHS and point should be lying on straight portion.
2. Line no.2 was taken as reference line and based on deflection angle a uniform curve of 5.5 degree was designed. T=Rx tan(Δ/2).
3. After getting end of T, one straight was fixed for fixing T/O and after it balance portion was provided with another curve ahead.
4. Now Turnout was fixed using centre line method between Line no. 2 & 1 in contrary flexure.
5. This was made feasible by relocating T/O between 1 & 2 about 100m ahead.
6. Similarly, for line no. 3 &4, Line no. 4 was taken as reference line.
7. 3.5 degree curve was set with available deflection. Since, straight was not available further. T/O was fixed taking out side from this curve for connecting line no.3. Thus Line no. 4 was made as DN Through Line and Line no. 3 as DN Loop line.
8. Further both UP and DN curves were required realigning for uniform curvature based on deflection and Tangent length available. At A cabin area, following modifications were required:
9. There was one Turnout no. 119/120 linking line no. 2 and 3 as well as 120/121 was linking Line no.3 &4. Common point no. 120 was removed and Line no. 2 was made dedicated UP Line.
10. Similarly, one cross over 107/108 was laid in 4 degree curved parallel lines which had sharp lead curve degree. This point was removed as one more crossover 109/110 was available on which signalled movement was allowed with S&T modification.
11. Realignment of curves were required to make uniform curves of 3.5 degree for UP and DN lines based on deflection and Tangent length available.

7.0 Line Wise Remodelling Involved:

The entire exercise of designing was completed and line wise work segregated and planning of remodelling was freeze. Concern departments have also made up their strategy to work on the ground based on final Layout. Line wise work involved is listed as under:

Line no13	Pt. 250 of 1in 8.5 taking off from inside of 4 degree curve. Flouting overall curvature.	Line terminated at RTM end. Pt. removed.
Line no12	Pt. 249 of 1in 8.5 taking off from inside of 4 degree curve. Flouting overall curvature.	Provision of Designed curve of 1.25 deg and length 220m,old 1:8.5 point no 249 which was laid on curve higher than 8 deg was replaced by new point of 1:12 for line no 9 and 12 in straight.

Line no9	Un-designed curve Degree of curvature more than 8 deg.	Provision of Designed curve of 1.75 deg and length 220m. A straight portion connecting line no 9,12,8 and 7 keeping line no 9 straight, all converging at point no 170
Line no 8	Undesigned curve S-shape at places. Check rails provided at sharp curvatures. Off taking line no 5&6 having point no 241 at higher degree, having frequent wear. Crossover no 163/164 laid on more than 13 deg reverse curve	Line no 7 and 8 meeting at line no 9 with 1:12 point no 249. After new point, a curve of 5 deg was given for line no 8. No connection with line no 5 &6 and mainline too. Yard movement completely grouped through line no 7,8,9 and 12.
Line no 7	Dead end terminated near FOB at Ratlam End.	New line connected to line no 8 with a curve of uniform degree of 5.75 and closure of line no 5 &6.
Line no.5 &6	Pt. 241, 162,163,164 connecting line no. 8 were taking off from inside of sharp curves.	All points removed. Line no. 5 &6 terminated at RTM End to make way for Line no. 4 &7.
Line no 1&2	Line no. 2 was Off taking from inside of 5-6 degree curve in loop line no 1 at point no 156 having 12deg in curvature.	Line no. 2 made Up main line of GDA yard with a speed of 50 kmph, line no 1 will off take off from outside of line no 2 by shifting the existing point no 156 by 33 m ahead towards Ratlam end. Slewing and realignment of line no 2 in Ratlam end side as well as BRC end side for uniform curve up to 5.5 degree.
Line no 3&4	Line no.4 was taking off from inside of line no. 3 on 4 degree curve with Existing pt. 160.	Line no 4 made as Dn main line of GDA with a speed of 50 kmph by changing the flexure of point 160 and relocating 39 m behind

In addition to above works following critical works were also planned along with remodelling.

8.0 Planning of Works:

Location	Existing constraints	Modified features
Bridge no. 102 on line no. 1&2, 3,4 three spans of 6.1m in 30 deg. Skew.	Existing girders were non standard double leaf type semi through with corroded condition and of Early steel age. Wooden sleepers were laid due to special girders.	Designing of Twin Beam Standard Girders for 50kmph speed with provision of Steel channel sleepers. Provision of extension piece arrangement for provision of channel sleepers in full length.
Platform Line no. 4	Exiting track consisted of wooden sleepers on old CC Apron in dilapidated condition w ith 10 kmph speed.	Provision of proper ballasted track for provision of high speed.

After 6 months of designing and approval of plan most fulfilling all the requirements of operations as well two works were sanctioned in LB and two already sanctioned works for bridge and CTR were utilised.

Year	Plan No.	Sanctioned	Cost (Rs.)	Scope	Remarks
2012-13 and 13-14	PCE 21681-DRM/ BRC-PW dt. 30.07.12	1. LB 12 - 13, PH-16	0.95 Cr	Dedicated Main line with 50 kmph.	Goods Yard Work completed. UP Line created with 50 Kmph.
		2. LB 12 - 13, PH-31	0.99 Cr.	Correction of Bad Layouts but goods yard remodelling	
	Ancillary essential work	3. LB 13 - 14, PH-31	0.26 Cr	CTR of Line 4, Proposed DN	Completed with Yard Remodeling.
		4. LB 11 - 12 PH - 32	0.68 Cr	Re-girdering of Br. 102 UP/DN	

9.0 Sequencing & Scheme of Works:

Entire yard remodelling was planned in Phase Work Model as under.

1. Scheme of work was designed further for each stage.
2. Each stage was designed to suit the traffic diversion available.
3. Duration of each stage was designed based on OHE mast and Portal relocation.
4. Phase -1 shall include remodelling of Goods lines i.e. line n. 13,12,9,8,6,5.
5. Phase-2 shall include remodelling of Passenger line no. 1,2,3,&4.
6. Phase-1 was again divided in three stages i.e. Line no. 13,12,&9 then Line 8 and then line no. 7,6,5.and Phase -2 was divided in to two stages i.e. line no. 1&2 and then Line no. 3 &4.
7. Bridge work shall be independent activity and shall be taken up between Phase 1 and phase-2.
8. Ballasted track of Line n..4 was taken with phase-2 work.

10.0 Scope & Major Works Involved in Remodelling of GDA Yard:

Following major works are involved in the yard modification work :

Track Works :

1. Termination of three Linesi.e. 5,6 & 13 at Ratlam End to make way for realignment of yard.
2. Shifting of Turnouts 3 from inside of curve to straight portion at RTM End for correction of bad layouts in Yard Lines.
3. Elimination of 21 Turnouts from Existing Lines to create dedicated Main Lines i.e. UP & DN.
4. Shifting and relocation of 2 Turnouts with change in flexure from Right hand to Left Hand on Main Line at RTM end.
5. Elimination of 2 crossover on main line for making way for conversion of Line no.4 and Line no. 2 as DN and UP Line as dedicated through main line.
6. Dismantling of damaged CC Apron and CTR of 0.65Km for Line no.4 i.e. Proposed DN Main Line with ballasted track for speed up to 50 Kmph.
7. Slewing of 2.5km Track by T 28 and UNIMAT on UP and DN Main line for relaying of Curves to create uniform curves and easing out of curves for DN line as well as for UP lines.
8. Slewing of Turnouts with T 28 and UNIMAT laid in curve to ease out the curvature on UP & DN Main Line.

Bridge Work:

Regirdering on Br. No. 102 in 30 degree skew for replacement of early steel girders on 3 spans with specially designed double leaf girders for speed potential of 50kmph.

S&T Work:

1. Shifting of Signals for Line no. 3 ,4, 7,8,9 & 12
2. Shifting of Shunt Signals for Line no. 1
3. Shifting of Signaling Junction boxes from proposed alignment to new locations
4. Laying of Cables due to Shifting of Turnouts and Track Circuit alteration.
5. Track Circuit Alteration work on Main Line
6. Indoor alteration in A Cabin and B Cabin and panel modification work.
7. NI working and Testing of Track circuits and Points from Panel.

TRD Works :

1. Relocation of OHE Mast and Portals as per new alignment of lines at RTM and BRC Ends
2. Creation of Isolations at RTM End to facilitate the power block working while T-28 work
3. Shifting of OHE from Old mast to New Mast due facilitate laying of new alignment of track
4. Erection of Portals in lieu of OHE Mast to accommodate alignment of track at RTM End.
5. Shifting of OHE Overlap for UP Line
6. Modification and Conversion of OHE overlap from Line no. 3 to Line 4 i.e. proposed DN Main Line.
7. Erection of OHE Installations, Guys and Foundation works for new Masts.

11.0 Block Programme of Works:

As per above sequence of block program, the work has been formulated keeping in view the alternate available movements of all trains including utilisation of available platform to maximum and change of platforms to get minimum. The program was prepared as under:

1. Work wise Activities of Engineering, Over Head Electrical and Signalling were finalised.
2. After freezing the activities, scheduling of Engineering activities was done.

3. Microsoft Project Software was used for scheduling of activities.
4. After scheduling of Engg. Activities, OHE and S&T activities were assigned for pre, post and during work requirement of Blocks.
5. Overlapping and sequential blocks were identified and total duration was fixed.
6. Realignment of track and realignment of OHE in new alignment were a major activity and were vital for resuming train operation after block. Hence, realignment work was planned after end of one stage for main line work.

Summary of Block Plan as Under:

S. No.	Phase	Remodelling Activity	Lines Close	Line Avl	No. Of Days	From - To	Remarks
Pre -Monsoon (26 May 14 – 21 Jun14)							
1	I-1	Line no. 12	12,13	1-9	9	26 May-5 Jun	On Target
2	I-1	Line 8,9 &12	9&12	1-7	15	6 Jun-21 Jun	On Target
Post-Monsoon (22Nov'14- 15 Dec'14 & 8 Mar'15-30 Mar'15)							
2	I-2	Line no. 7	5,6,7	1-4, 8,9, &12	22	22 Nov-15 Dec	On Target
3	II-A	Prep. Work of Line 1 &2	-	All	8	22 Feb-3 Mar	On Target
4	II-B	Line no. 1 & 2	1	All except L1	11	8 Mar - 17 Mar	On Target
5	III-A	Line no. 3 &4	4	All except L4	12		On Target
6	III-B	Replacement of CC Apron with CTR of Line 4 in 400m	4	1,2, 3 & 7,8, 9,12	11	19Mar – 29Mar	Parallel Activity on Target
7	II-C	Re-girdering of Br. 102 A on Line no. 4	-	ALL	3	19 Oct; 20 Oct; 15 Dec	Parallel Block Activity

12.0 Actual Execution Done:

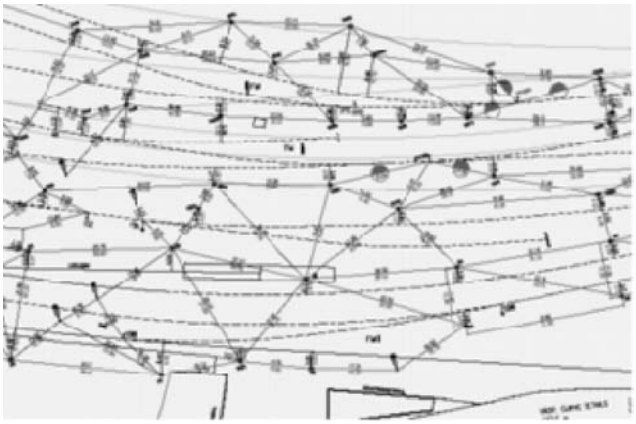
Following sequence of work was formulated to precise remodelling and alteration in Turnouts, lines and their alignment:

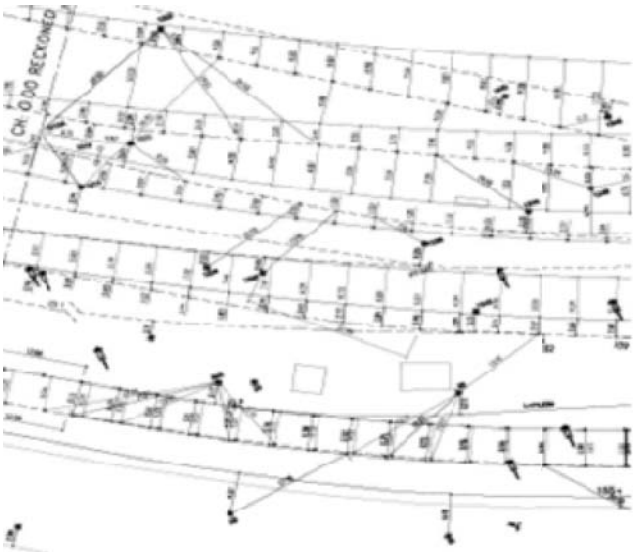
A. Setting Out Layout on Ground

1. Verification of coordinates of existing Turnouts, Lines, OHE Masts and Portals, Signals and Structures using triangulation methods to ascertain the matching of ground features with AutoCAD. Existing OHE masts were taken **reference for triangulation.**

   Autocad presentation of reference points marking
2. Fixing reference/base line which will remain present during the particular stage of execution of work.
3. Working out Offset for proposed line with respect to reference line on AutoCAD.

Reference points marking with OHE masts





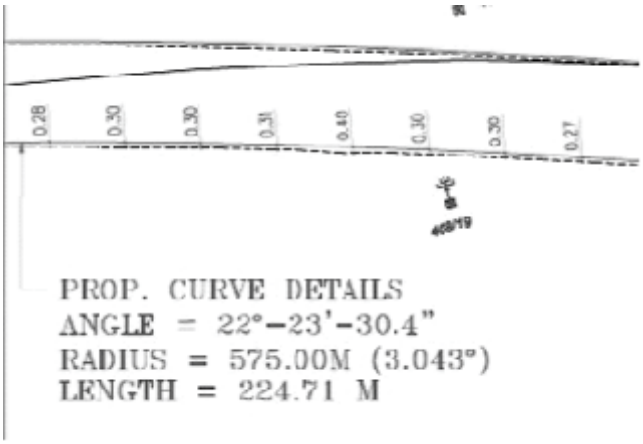
4. Marking of Offset for proposed lines with respect to reference line on ground.
5. Setting out proposed lines and locations of SRJs, Heel of Crossing and Tangent Point of curves.
6. Joint verification of proposed alignment with ENGG., TRD and S&T branch.

Major Activities of Execution

I. Preparatory Work

Engg Works:

1. Stacking of Material to be used and site clearance.
2. Assembly of New Turnouts and testing.
3. Preparation of Rails with drilling and cutting to lengths.
4. Excavation and bed preparation for new alignment.
5. Dismantling of old OHE foundations fouling in proposed alignment.
6. Slew marking on track with reference.



Proposed Curve slew worked out on AutoCAD and used for Machines to give on ground

TRD Works :

1. Fixing of OHE alignment and marking OHE foundations.
2. Casting of new OHE Foundation for proposed alignment of track.
3. Erection of OHE Masts/ Portals, Cantilever/Drop Arm and fixtures and shifting Existing alignment of New OHE mast wherever possible reach available.



4. Cutting of Old OHE masts/Portals for clear way for new alignment.

S. & T. Works

1. Laying of Cables as per new alignment and new location of Turnouts in track circuit area.
2. Shifting of Cables fouling in proposed alignment.
3. Securing of Cables to making way for excavation.

II. Execution and Resources Used in Blocks for Remodelling:

Engg. Works:

1. Dismantling of track and Turnouts including Sleepers where existing track structure cannot be reused. Mechanized Site clearance using small capacity cranes.



2. Relocation of Turnouts and provision of Plain track using T 28 by sandwitching plain sleepers in PRC Turnouts manually for doubling speed for track work.



T 28 removing old Turnout

3. Dismantling of OHE foundations and removal of obstruction in proposed alignment using Heavy duty Rock Breaker, JCB Breaker and Excavator Machines.



OHE Mast Dismantling

4. Excavation and Ballast bed preparation for new alignment using JCB machines.
5. Linking of track and Turnouts in proposed alignment and slewing of track portions using Hydra/ small crane and JCB machines for completion of track. Mechanized hauling of rails for linking.
6. Realignment of existing tracks for making proposed curves using T-28 machines for shift more than 150mm followed by UNIMAT Machines.



Slewing of Curves by T 28 Portals



Cutting and Slewing of Curves portions on New Turnout Location



T28 Machine Changing Flexure and Shifting of Turnout

Bridge Work:

For Regirdering on existing bridge in 30 deg. Skew angle there was no Standard Design was available.Existing bridge was Semi Through Type Double leaf Girders. Following scheme was used to replace girders with speed up to 50 kmph.

Design And Fabrication

1. Designed of Standard 25T Loading Girder for accommodating 30˚ skew angle and low height to maintain clearance for road users.
2. Fabrication of special Double Leaf Girders by Railway Workshop at Sabarmati.
3. Design of Special channel sleeper tailor made for girder.

Launching

Bridge falls in Turnout zone of Signalling and OHE. Suitable scheme was selecting based on constraint as under:

A. Selection of Method:

1. **Launching by Rly./ Road crane:** It was not feasible due to long duration of block work due to multiple OHE of Turnouts involved.
2. **Gantry/ Portal Method:** It was not found feasible due to limitation of track centre between lines.
3. **CC Crib under Girders:** It was not found feasible due to existing waterway is under heavy use of road traffic from East to West in Godhra City and cannot be closed longer.
4. **Side Slew and Trolley method: It was found most suitable but there was a great risk in side slewing in 30 degree skew abutment.** But since no other option found fit in site condition. This method was adopted.

B. Pre-Block Work:

1. New Girders were brought in adjacent to existing girder on same abutment for line no.1 utilising space. This was done using Trolley over Track and side slewed on CC Cribs.

C. Block Working:

1. Track was dismantled and Old Girders were cut in to pieces and dropped down which were taken out and loaded in to trucks.



2. New Girders was lowered on two rail staging on abutment at same place and parallel to abutment. Rail staging extended up to final location of new girder.



3. Two Chain pulleys used and rollers were used under girder to pull new girder to final location using side and longitudinal restraint.



D. Critical Launching on Line No. 3:

This Line was sand-witched between line no. 1 & 4. Slight Alteration in scheme was needed to be done. The steps are as under:

1. Girder brought on Trolley on Adjacent span.



2. Girder was lowered on track.



3. Rail staging was laid on CC cribs on Abutment after removal of girder.
4. Girder was taken on Rail staging and then controlled manner side slewed using rollers.



5. Lowering of Girder from CC Cribs to Abutment and fixing of track.

E. Conversion of CC Apron to Ballasted Track on Line No. 4:

A 400m Long and 300mm thick old CC Apron under wooden sleeper track was a safety hazard and need to be replaced with proper ballasted track for proposed DN main line no.4 for 50 kmph speed.

This herculean task was a challenge to be done in 11 days as remodelling was targeted to be completed on 30 Mar'15.

Work started on 18 Mar'15 and completed in impossible like duration of 11 days. Following strategy was formulated to complete this mammoth task without which 50 kmph could not be possible.

i. Dismantling of CC Base:

a. Adjacent line no. 5 was closed for work.

b. Existing drainage of Platform stalls and Toilet blocks was made through PVC pipe network, to be used for future.

c. 5 Nos. Of Heavy duty Breaker mounted on JCB were used at a time in Hrs shift in day and night.

d. Temporary pathway was made on new commissioned line no. 7-12 for movement of machines.





e. 5 sets of Tractor trailers were used to dispose muck away.

ii. Track Work:

a. Sleepers were placed using light capacity road crane.

b. 39m Rail panels were brought due to SWR track and rails were linked using road crane.

Complete mechanised work completed on Target.

TRD Works



1. Transfer of load from infringing mast to newly erected OHE masts and removal of infringing mast.
2. Slewing of OHE and placement of the same on the new track alignment along with track work.
3. Creation of new insulated overlaps as per modified sectioning arrangement.
4. Splicing and extension of OHE wires over new track.
5. Slewing of OHE work due to Slewing of curves and realignment with respect to track

S&T Works :

1. Disconnection of Points and track for dismantling.
2. Out-door alteration works including Junction Boxes and track circuit alteration works.
3. In-door alteration of circuits and modification.

13.0 Highlights

1. Autocad was used for real time and precise remodelling.
2. Ohe masts were erected as per new alignment before laying of track to make feasible work in ohe territory. Finally, track was found in perfect precise alignment and no modification required in ohe. This has resulted:
   a. Fast track construction of new track
   b. Saving of execution time
   c. Ease of work in ohe territory
   d. Feasibility to work with earth machine due to clearance of infringing mast in new alignment right in the first phase of each stage.
3. T-28 was used to relay the existing curve using offsets from autocad.
4. Most economical & least cost based yard remodelling by using existing track materials to remodel the yard. Costing only about 2.0 cr as aginst hitorical proposals ranging up to 48 cr.
5. Historical long pending work could have been completed with smart strategy and in smooth manner without repercussion on any traffic.

6. No T.W.O. was issued for the work.
7. Ni working was done for only 8 hrs.

14.0 Conclusions :

1. Historically challenged work made feasible and completed with 'Part to Whole' approach in existing constraints.
2. Due to well designed & precise alignments and inclusion of OHE and S&T signals helped better coordination and planning.
3. Due to major mechanisation of activities work *completed in record time of 11 days each for up & dn main line* involving major TRD works of shifting overlaps and shifting of OHE of turnouts ahead and back respectively.
4. Speed on main line raised to 50 kmph which is a major capacity boost.
5. Now steep gradient at approaches is no more a bottleneck now for heavy loads due to higher speed on gradient.
6. Best result was that “now Rajdhani trains takes only 2-3 minutes against 12-14 minutes to pass the entire GDA yard.”
7. The work has eliminated 21 points, 4 crossovers and 2 lines for correction of major bad layouts and builtup safe conditions for running of trains in Godhra yard forever.



After Remodelling Line 1&2



GDA Inside Yard Geometry Before Work



Before Remodelling Line 1&2



GDA Inside Yard Simplified Geometry After Work



After Remodelling

Mobile Flash Butt Welding and Quality Control at Site

By
*Shri Rajiv Kumar Gupta**

1.0 Introduction:

Resistance welding (or more commonly, flash-butt welding) of rail is not the same as conventional stick welding where a filler material is burned into the weld joint. During flash - butt welding, the two rails ends are first heated and then forged together, expelling any liquid and oxides out of the weld joint.

The welding power supplies work on very low voltage and very high current. The transformer open circuit voltage is only 8.8 volts, which is lower than that used in an automobile. The maximum secondary welding current is approximately 30,000 amps. When large amounts of electrical current are passed through steel, heat will be developed at the point of greatest resistance.

At the initiation of the weld cycle the two rail ends are brought together at a high rate until a weld current draw is detected during the flashing process, the rail ends are moved towards each other at a slow rate. The welding current is sufficient to melt and vaporize the small areas of the rail ends that form contact points. This occurs in hundreds of places, forming a protective shield preventing oxidation of the hot, reactive rail faces. After the rail ends have been sufficiently heated by progressive flashing, the rails are forged at a high feed rate. Oxides and liquids steel are expelled from the weld joint resulting in the classic three part Weld burr full forging force is applied to the rails for 10 seconds, this is known as "upset holding time."

After the upset holding time is complete the welding head will shear the burr from the weld joint while the material is still hot. Depending upon the rail section, the shearing operation may require as much as 65 ton forces.

2.0 Flash Butt Weld V/s Alumino Thermic Weld

I) At Weld

- Strength of AT joint is app. only 80% of parent rail.
- More prone to corrosion
- High failure rate.
- Poor Quality of Weld.

II. Flash Butt

- Strength of FB joint is almost equal to parent rail.
- Less prone to corrosion
- Failure rate < 0.5 to 1 %.
- Excellent Quality of Weld. The defects like porosity, inclusion and lack of fusion are eliminated.

3.0 Forging (Upsetting) -

The rail ends are butted together to a stage of fusion under a heavy butting force whose magnitude depends on the make of the welding plant. The welding current automatically gets cut off during the later part of the forging operation. The joint should be left undisturbed in clamped position for ten seconds after the welding cycle.

The recommended butting pressure for different types of rails in indicated below :-

- 72 UTS rails - 5kg/mm² on cross sectional area.
- 90 UTS rails & Head Hardened rails - 6kg/mm² on cross sectional areas.
- 110 UTS rails – 7 kg/mm² on cross sectional area.

4.0 Quality Control

I) Selection of Rails to be Welded

A) Section of Rail :- New as well as released but serviceable rails of same type (section & metallurgy) shall only be welded together. Minimum length of old but serviceable rails for welding shall be 6 meters.

B) Welded panels for laying long welded rails shall, as for as possible, be without fish bolt holes. If it is unavoidable then hole should be at least 40mm away from the rail end.

C) Only ultrasonic tested rails should be taken to flash butt welding plants.

* *Sr.DEN, Lucknow*

D) Permissible vertical/Lateral wear in weld rails to be welded is as follows.

Rail Section	Vertical Wear		Lateral wear	
	Standard Height of New Rail	Minimum Height of Worn Rail	Standard Width of Head of New Rail	Minimum Width of Head of Old Rail
60 Kg	172.00 mm	164 mm	72.00 mm	66 mm
52 Kg	156.00 mm	150 mm	67.00 mm	61 mm
90 R	142.88 mm	139 mm	66.68 mm	61 mm
75 R	128.59 mm	126 mm	61.91 mm	56 mm
60 R	114.30 mm	112 mm	57.15 mm	51 mm

E) Rail End Geometry :-

a) End-bends in the vertical plane not greater than 0.7mm on a 1.5 meter straight edge. Sagging ends not permitted.

b) End-bends in horizontal plane not greater than ±0.7 mm on a 1.5meter straight edge.

c) Deviation of the end from the square not greater than ±0.6mm.

II. Finishing Tolerances for Welds

(A) Welds with New Rails

(i) Vertical misalignment:- {±0.3mm , -0.0mm } at the centre of a 1m straight edge.

(ii) Lateral misalignment :- ±0.3mm at the centre of a 1 m straight edge.

(iii) Head finishing (in width):- Side of rail head should be finished to: ±0.25mm on gauge side at the centre of 10cm straight edge.

(iv) Finishing of top table surface : {+0.2mm, -0.0mm} at the center of 10cm straight edge.

(v) Web zone (under side of head, Web, top of base, both fillet Each side):- {+3.0mm, -0.0mm} of the parent contour

(B) Welds with Old Rails

(i) Vertical misalignment : ±0.5mm at the centre of a 1m straight edge.

(ii) Lateral misalignment :- ±0.5mm at the centre of a 1 m straight edge.

(iii) Head finishing (on side):- ±0.3mm on the gauge side at the centre of 10cm straight edge.

(iv) Head finishing (on top:- table surface) +0.2mm on the gauge side at the centre of a 10cm straight edge.

(v) Web zone (under side of head, Web, top of base, both fillets on each side):- {+3.0mm, -0.0mm} of parent contour

III) Record of Welds :- The chart of the weld recorder shall be analysed every day with respect to voltage, current, upsetting force and pattern travel for each weld. Any parameter not conforming with the standard parameter should be set right. The chart shall also be preserved in addition to the register to facilitate investigations in case of defective joint and joints failing in service.

IV) Marking of Joints:- Every joint shall have distinctive mark indicating the weld number, month and year of welding and the code of the plant as shown below. The marking should be embossed/painted on the gauge and non gauge face sides of the head of the rail and diagonally opposite to each other across the joint at 300mm away from the centre line of weld by punching after finishing of the weld without causing any damage to rail, in letters/digits of 6mm height.

For Mobile Plant:-

XXXX MM YY OO PP EE

The first four digits indicate the weld number starting from 0001 for first weld of every month, the next two digits month of welding followed by next two digits of the year of welding. The letters OO denotes the code for owner of the plant, PP denotes the code for the plant of that particular owner and EE stands for the code of agency executed the welding work.

V) Testing of Weld:- It shall be the responsibility of the Plant in-charge and the quality control supervisors to device adequate stage inspections before final acceptance tests are conducted. Causes for failure either of weld or in heat affected zone at any stage in production shall be investigated and corrective action taken before regular welding is continued. Acceptance test comprises of all the weld being checked by visual inspection, dimensional tolerances and ultrasonic test. Sample welds should be subjected to transverse bending test and detailed metallurgical tests in a laboratory as a quality assurance measure. Results of all the tests shall be maintained in register by the plant in-charge assisted by quality control supervisor.

VI) Tests for Every Joint:-

Visual Inspection :- After finishing grinding, all welds shall be visually inspected for possible cracks, lack of fusion and other surface defects like notching, damage in heat affected zone etc. Welds with visible defects shall be rejected.

Dimensional Check :- All welds shall be inspected using standard 1m and 10cm straight edges and feeler gauges. Welds not meeting standards, if rectifiable by grinding, can be re-ground, failing which they shall be rejected.

Ultrasonic Test :- All welds shall be subjected to ultrasonic testing for detecting presence of internal defects in the weld. This test can be done by installing and on-line USFD equipment or as and interim measure manually with portable USFD machine. Entire cross section of the rail i.e. head, web and shall be tested by trained personnel as per the procedure laid down for Ultrasonic testing of Flash butt welds in 'Manual for Ultrasonic testing of rails & welds' and its correction slips, issued by RDSO, Lucknow to detect internal flaws. Welds having defects shall be rejected. Defective joint shall be distinctly marked and panels with defective joint shall be separately stacked. The defective joint shall be cut and removed before the panel is dispatched from the Flash Butt Welding Plant.

Test on Sample Joint :- Sample test joints shall be made on pieces of rails of similar section and conforming to the same specifications as the rails being welded. The length of each piece shall not be less than 750mm. Following tests shall be carried out on sample test joint. In case a sample joint does not comply with the requirements of the test, two more sample joints will be made and tested. If both the sample joints meet the requirements of the tests, welding may continue. In case of failure of any of the retest joints, RDSO should be consulted for investigation and fixing revised welding parameters.

Hardness Test :- Brinnel hardness test shall be conducted on the test weld sample before conducting transverse load test. The hardness value in HAZ shall not vary from the hardness of the parent rail by more than ±20HB.

Transverse Test :- The finished test weld samples, not less than 1.5 meter long with the weld at the centre shall be subjected to transverse load test in a transverse testing machine in the following manner:-

The test joint shall be supported on cylindrical or semi-cylindrical supports having a diameter of 30 to 50 mm and distance of one meter between them. In case of 60kg 11 0UTS/head hardened rail joints the test span shall be 1.25meter. The mandrel diameter shall be between 30 to 50mm . The mandrel axis should be perpendicular to the horizontal axis of the rail section and it should be in the centre of the span and loaded in such a manner that the foot of the rail is in tension. The load shall be uniformly and gradually increased. The rate of application of the load should not exceed 2.5tons/sec. The test joints shall withstand the minimum load and shall show minimum deflection as given in Table 1 without showing any signs of cracking or failure. The minimum deflection values are corresponding to stipulated minimum breaking loads.

Values of Minimum Breaking Load and Deflection in Transverse Load Test

Sl. No.	Rail Section	Span	Min. breaking load (tones)	Min. deflection at centre (mm)	Frequency of testing	
					Stationary FBW Plant	Mobile FBW Plant
	60 kg (UIC), Grade-1080HH	1.25m	115	30	1 in 500	1 in 100*
	60 kg (UIC), Grade-1080Cr.	1.25m	110	12	1 in 500	1 in 100*
	60 kg (UIC) 90 UTS	1 m	150	20	1 in 1000	1 in 100*
	52 kg 90 UTS	1 m	115	20	1 in 1000	1 in 100*
	60 kg UIC M M (72 UTS)	1 m	135	30	1 in 1000	1 in 100*
	52 kg MM (72 UTS)	1 m	100	30	1 in 1000	1 in 100*
	90 R MM (72 UTS)	1 m	80	30	1 in 1000	1 in 100*
	75 R MM (72 UTS)	1 m	70	30	1 in 1000	1 in 100*
	60 R MM (72 UTS)	1 m	60	25	1 in 1000	1 in 100*

Sample joints for first 1,000 joints welded by mobile flash butt welding plant will be tested at frequency of 1 in 100 joints and subsequently at a frequency of 1 in 500 joints.

5.0 Welding Team for Mobile Flash Butt Welding Plant :-

Welding team may consist of one supervisor and two welders. The educational qualification of supervisor should be min. Diploma in Mechanical/Electrical Engineering or B.Sc. and that of welder should be minimum class X or equivalent, passed. Welders and supervisor already working in Mobile FBW Plant may continue if Chief Track Engineer/Chief Engineer (construction) is satisfied about the quality of welds by these operators. Zonal Railways shall also ensure periodical training of welders and Supervisors of Mobile Flash Butt Welding Plants.

Test for competency certificate of welder of Mobile Flash Butt Welding Plant will be conducted by Zonal Railways as per this Manual and after satisfactory result; the competency certificate well be issued by Zonal Railways.

6.1. Benefits of TWR by Using Mobile Flash Butt Welding Plant:

A) Welding of rail joints by Flash butt welding method has been considered all over the world the safest and most reliable of all the welding methods.

B) By doing TWR with Flash butt welding Method, the no. of THERMIT welds is drastically reduced .

C) Due to welding of Rail joints under machine controlled conditions, the quality of weld is very much superior to other established methods.

D) This method of welding uses the parent metal for the welding purpose and no foreign impurities or other material is added.

E) The strength of such welded joint is almost equal to the parent rail strength .

Various Stages in doing TWR by Flash Butt Welding Method:

The stages may be classified into following stages:

A) Site Inspection/Survey

B) Mobilization of Plant and Machinery

C) Establishing of TWR temporary Depots for making 3/5 rail panels

D) Depot Welding for making 3/5 rail panels

E) In-Situ Welding by Mobile Flash Butt welding Machine

A brief about each of the above is as follows:

A) Site Inspection/Survey & Planning

a) Before taking up TWR works it is very much essential to take in to account the visual inspection of track for recording of locations with special emphasis on identifying defects in rails like scabbing, wheel burns, corrugation, cup weld, low joint, defective weld, excessive side wear on curve etc. A detailed summary of all is taken and marking done with paint of the patches identified.

b) Marking of defective welds /Rails as indentified during routine USFD testing.

c) Assessment & to arrange in advance recoupment for the rail required which will be used for replacing the rejected rail in stages as per site requirements.

d) Identifying locations along the track for establishing temporary FBW welding depots.

e) Liasioning with other departments for ensuring adequate traffic block on a regular basis .



f) Also checking for impediments like level crossing, major and minor bridges, approach of station yards etc. and to plan accordingly.

g) Identifying the patch where change of gauge face is required by inter changing the rail thereby ensuring maximum utilization of rail.

B) Mobilization of Plant and Machinery.

After the survey and inspection is completed, mobilization of Plant and Machinery is to be ensured for successful execution of TWR work. A tentative list of the Plant and Machinery to be deployed is as follows:

a) Flash Butt Welding Machine

b) Specialized Rail Carrier for Lateral and longitudinal movement of the FBW plant.

c) USFD Equipment

d) Various types of hand & rail grinders

e) Generators

f) Measuring Instruments & Inspection Gauges

g) Roller Assembly

h) Rail Disc Cutters

i) Hole Drilling Machine

j) Track Tools

k) Cranes/Hydras

l) Tractor With Trolleys

m) Earth Excavator

C) Establishing of Temporary TWR Depots for Making 3/5 Rail Panels

a) Temporary platforms of approx. size 8 M width and 90 M long (along the track) are made for stabilizing the FBW Machine and doing FBW welds so as to make 3/5 rail panels on cess in advance.



b) The platforms are made by doing earthworks adjacent to track at suitable predecided locations on the TWR

patch so as to ensure maximum utilization of the traffic block and of resources deployed.

c) Once the platform is made the earthwork team moves to make another pre-decided location for making of platform and goes on doing this in a sequential way.

d) The FBW machine is moved to this especially constructed platform by a specialized Mechanical Rail carrier capable of moving longitudinally and horizontally. The machine reaches the platform spot via track and off rail itself on its own through in built mechanism at the platform site and stabilizes itself on the platform for doing FBW welds on the platform thereby resulting into making of 3/5 rail panels at this temporary depot.





e) Once the platform is completed, temporary roller assembly along with other arrangements for feeding of rails to FBW plant and thereafter welded panel to stacking area is assembled at the temporary depot.





f) Released rails of suitable length fit for reuse are brought to this temporary depot for further conversion into 3/5 rail panel.



D) Depot Welding for Making 3/5 Rail Panels

a) The rail ends are checked for any defects and are cut accordingly by abrasive rail cut machine so as to remove defective rail ends and rails

b) After cutting of rails the ends of the rails for

approximately 1 M are thoroughly cleaned & grinded for oil, rust & stencil mark etc, so as to ensure uninterrupted flow of current and to avoid slippage of rail during the weld cycle.



c) After this the rail ends are brought together to the welder head of the FBW machine and alignment done with the help of adjustable aligning screw jacks and is finally checked for all pre welding parameters .

d) The welding head is lowered and clamped and the predesigned weld cycle is commenced. The details of the weld cycle process are detailed separately.





e) After the completion of the weld cycle the inbuilt auto stripper of the machine stripes the excess metal accumulated on the sides of the weld after the forging process.

f) The welded joint is further moved on the roller assembly and grinding of the welded joint to approved parameters is done by rail profile grinder.

g) The above process of welding goes on in a planned way unless 3/5 welded rail panel is made as per site requirement.

h) The 3/5 rail panels are lifted from the roller assembly mechanically after welding and stacked on proper platform.

i) USFD Testing of joints is carried and recorded. Failed USFD joints are marked, cut and sent back for re-welding.



E) In-situ Welding by Mobile Flash Butt Welding Machine

a) Passed welded rail panels are ready to move to site for doing TRR.

b) The welded 3/5 rail panels are moved to the TWR site with the help of multiple Rail Dollies and during block by Dip Lorries.

c) On reaching site the welded 3/5 rails panels are paired and are made ready for doing TRR once traffic block is granted.

d) Once traffic block is granted, Through Rail Renewal with the new 3/5 welded rail panels is started. The Through rail renewal is done by removing elastic rail clips , fittings etc and removing the existing rail and laying the rehabilitated panels and thereafter fixing the rail with fittings . If required TFR (Total Fastening Renewal) can also be planned simultaneously with TRR activity.

e) The FBW machine stationed at the temporary depot is

moved to the running track through its specalised carrier capable of shifting the machine on track laterally.





f) The FBW machine after coming on track moves to the TRR site under the same TRR Block and further welds the 3/5 rail panels for which the TRR is under progress into much longer panels.

g) On the termination of TRR , temporary fish plates are fixed at the end of TRR patch and the FBW machine is closed and sent back to the temporary depot and off track and stationed for Depot working on a safe distance from track .

h) After clearing the site and ensuring for the proper fittings, fastening & track geometry the line is given fit for running traffic.

i) The released rails from TRR are further cut by abrasive rail cutter and serviceable rails are leaded back to the temporary depot for further welding by FBW process as detailed above and unserviceable rails are moved to the nearest scrap rail location.









7.0 Quality Control at Site:-

1. Selection of rails, especially when flash welding is being done old rails to be done very carefully. Old rails should be free from scabs, wheel burns & liner biting.
2. Changing of gauge faces of rails during MBFW can enhance the life of rails in train. It should be done mutatis mutandis with MBFW. Gauge face of rails in train should be marked before dismantling of rails.
3. End square of rail end faces must be ensured. Better weld strength with minimum value and nearly parallel shape of HAZ can be achieved using perfect matching of rail ends.
4. End Cleaning is also a very important activity. End faces of rails to be welded and electrode contact locations shall to be thoroughly cleaned of loose scales, rust, paint etc by brushing and grinding to base metal finish for good electrical contact. Cleaning of rail bottom shall be ensured by placing a minor and watching the cleaned surface.
5. High supervision level must also be ensure at depot working as 70-80% of welds are to be done of depot itself . Every rail should be also checked again before welding for any defect.
6. Welds done at depot must be ultrasonically tested before rail panels carried to site. If any flow is noticed it should be removed a depot.
7. The rail painting by black bituminous paint should be done at depot as bottom of rail can also be got painted early.
8. Around 20-30% of welds has to be done in track, special care should be taken ensure good quality of these welds, minimum 20minutes time after timing is required to pass train through the weld with proper packing and support below the joint.
9. Upper sides, under surfaces and edges of rail foot shall be ground smooth. It is very important to properly grind the under side of rail foot of weld done in train as weld. Special/small grinders may be used for that. The edges of foot should be rounded and bottom of rail foot ground smooth without any minus tolerances to ensure proper sealing on sleepers.
10. Competency certificate of welder for mobile flash butt welding plant will be issued by Zonal Railway for which one has to go through written test and interview.

8. Scope of Work:-

To eliminate old A.T. weld which has passed 50% GMT of Rails threshold GMT value; the work of T.W.R. in Sitapur-Burhwal Section of Lucknow Division of N.E. Railway is taken in hand. The objective is to eliminate maximum No. of A.T. Welds from the track.

A welding contract is awarded to M/S RAILTECH INFRAVENTURE PVT. LTD., ALLAHABAD. The contract has major item as follows

i. Flash butt welding at rail joints on temporary depot .
ii. Flash butt welding on running track.
iii. Earth work for making temporary depot.
iv. Removing of existing rail from track.
v. Hauling & Pairing of rails unloaded in block section.
vi. Laying of rail panels in track.
vii. Distressing.

Rate of weld per joint :-

- On Cess :- ₹ 4557.00
- On Track :- ₹ 4900.00

9.0 Conclusion:-

Higher speed and heavier axle loads, high traffic density less time for servicing & maintenance that is the reality in modern high capacity traffic on the rail which only became possible with the introduction of continuous welded track. The many years of experience with this type of track have shown that the electric flash butt welding process is clearly the best technology to connect two rails. Advance fully automated mobile flash welding machines reduces the possibility of human error like in vertical & lateral alignment.

Mobile Flash Butt welding process is being used successfully in large B.G. conversion projects also. Even in open line high GMT Sections, by arranging just 2 hours traffic block per day, we can achieve a progress of 6-7 Km/month TWR by mobile flash butt welding.

Considering the excellent quality, durability of MFB weld, automatic and computerized control over welding process, Progress of work that can be achieved by MFB welding. Due to its better reliability and higher strength Flash butt joint as compared to AT welds, Mobile Flash Butt welding clearly preferable.

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Success Storey of a Gigantic Rail under Rail Bridge by Box Pushing Method

By
*Shri Ved Pal**

1.0 Synopsis :-

A gigantic Rail Under Rail (RUR) Bridge has been completed by SEC Railway on Nagpur – Raipur busy Group 'A' route by box pushing method. The overall size of the box is 9.75 m x 9.5 m i.e. height of the box is more than a 3 storied building. The barrel length is approx. 60 m. The box is at a skew angle of 29.65 degrees w.r.t. tracks and total weight of boxes pushed is 5400 MT i.e. more than a loaded full length goods train. Entire work was completed in a record period of 56 days against targeted time period of 75 days without any incident or any disruption to any service..

2.0 Introduction :-

A private siding was to be constructed taking off from Kachewani station of Nagpur Division of SEC Railway for M/s Adani Power Maharashtra Ltd (APML) for carrying coal by trains to their Thermal Power Plant. ROR (Rail Over Rail Bridge) was not possible due to gradient problem. ESP was proposed by Division with provision of RUR and the same was approved by SECR HQ track cell without clearance from Bridge cell and without realizing magnitude of work. Bridge Branch was adamant on ROR which was not possible at this stage as party had already acquired land and started work as per approved plan with RUR. There were 2 alternatives, make RUR or continue only with directional surface connectivity to siding which was not sustainable for future increased traffic. To compound the problem, there existed a cross-over on alignment of RUR which made execution of RUR nearly impossible. Cross-over was to be shifted, necessitating regrading of tracks in this electrified busy section. Cut & cover method was not possible as very long duration of traffic block was required due to sheer magnitude of earth work required & due to existence of Rocky formation (metamorphic rock) in bottom 8.9 m depth and existence of cross over. At this stage the author took over as PCE/SECR & came into picture. Operating Deptt was convinced that cross-over is rarely used and can be suspended during execution of RUR. Operating Deptt. agreed to suspend cross-over for 75 days. As the executing agency was fixed by M/s APML, they were asked to change the existing inexperienced agency and fix some experienced and reputed agency who had executed such massive and difficult works (In Railway system changing agency or byepassing L1 is unthinkable and impossible). The author took bold decision to construct RUR duly taking various precautions and work was completed within record time of 56 days. First train passed through RUR on 19-05-2015.

3.0 Importance of Fast Track Implementation:-

This being a very difficult work due to skewness, size of the box, gradient, problems, cross-over existing on the tracks and limitation of time, a series of meetings were done with all the agencies involved and modalities were worked out for completion of work. Following specific steps and special precautions were taken to ensure timely and safe completion :-

3.1 **Strict Supervision**

As Railway does not have adequate number of supervisors and large number of vacancies existing even in the maintenance cadre, M/s APML were asked to engage RITES, IRCON or any other agency to ensure adequate and skilled supervision.

* PCE/SECR

M/s APML fixed RITES/Nagpur for supervision under overall supervision of SECR.

3.2 **Competent Agency Selected for Execution**

The agency fixed by M/s APML was found to be lacking in experience regarding work of such magnitude under such tyring conditions, hence, they were asked to select experienced and reputed agency which had executed similar works. M/s APML agreed and were able to change the agency duly taking care of contractual obligations. The newly selected agency (Ghai Construction Ltd., Pune) had adequate experience including pushing boxes under suburban traffic conditions of Mumbai and twin box near Kakinada Railway Station in South Central Railway.

3.3 **Cables and Such other Services Relocated**

All the services including various types of cables which were likely to obstruct, were meticulously relocated by cable trenching technique. It was ensured that there is no cable cut or any dislocation to any service.

3.4 **Specific Track Attention Gangs Round the Clock**

M/s APML were asked to engage track maintaines and supervisors in 3 shifts round the clock to attend the track under any eventuality.

3.5 **Spare RH girder**

M/s APML were asked to get fabricated and keep at site one 26 m span RH girder for any eventuality or emergency so that same can be put into track for restoration of traffic in case of any cave-in.

3.6 **Spare ballast and sand bags**

3500 Nos. of bags filled with ballast and 18000 sand bags were kept at site for any emergency restoration.

3.7 **Rail Clusters provided for safe passage of trains**

Rail clusters for box pushing is a specific technique developed by SECR and provided to support the track. Even if, earth caves-in, the rail cluster system supports the running rail and traffic can continue to move safely for some time. In this system a transverse cluster of rails (usually 3 Nos. of 60 kg rails) is provided between sleeper spacing which is supported on either side on a set of longitudinal cluster of rails. This longitudinal cluster of rails consists of about 5 Nos. of 60 kg. rails of adequate length to take load during cave-ins. Thus the running rails rest on transverse clusters provided between sleeper spaces and transverse rail clusters rest on longitudinal rail clusters. In case of cave-ins, running rails get firmly supported on transverse clusters which transmit load of longitudinal clusters and longitudinal clusters remain supported on the earth mass that has not caved in. In fact this rail cluster system works as a sort of RH Girder system only. In the instant case, since the box alignment was skewed to alignment of tracks and span was very large, for longitudinal clusters, 10 Nos. of 60 kg. rails of 26 m length were used at each end. A typical rail cluster system is shown in Fig. 1.

3.8 **Controlled Box pushing speed**

In the critical zones under the tracks, rate of earth cutting and subsequent box pushing was reduced to 30 cm at a time. Since the total length of box pushing was approximately 60 m, entire length was divided into critical zones and safe zones as shown in the Fig. 2. Critical zones were under the tracks and safe zones were other than under the tracks. Box pushing in the safe zone was done at normal and accelerated speed to achieve progress within limited time. In the critical zones under the tracks earth cutting and box pushing was restricted to 30 cm at a time so that there is no chance of cave-in. This system of working ensured safety as well as speed of work.

3.9 **Anchoring of track to prevent track alignment moving out during box pushing**

Both up & down tracks were anchored at 3 locations each with chain pulleys to stationary box kept in the same alignment following the box being pushed. (box that was not being pushed under track). This prevented tracks from moving out of alignment during box pushing operation.

3.10 **CCTV Camera System for ensuring safety and for co-ordination of various activities**

This was the most remarkable thing done at this site. CCTV cameras were installed near UP & Down tracks to monitor any sign of track alignment shifting or any track settlement. Another set of cameras was installed underneath in the boxes where excavation, earth cutting and box pushing activities were taking place. All the cameras were having monitors in the control room set at the site and every activity centre was having public address system for giving directives. In the control room tracks were closely

monitored and on seeing any sign of track alignment going out, or any settlement, directives were given on PA system to the supervisors and artisans working below to stop excavation/box pushing. This paid very rich dividends in terms of ensuring safety.

4.0 **Conclusions**

4.1 Relieving spans are redundant for box pushing work for any exigency of cave-in.

They are unsuitable even for air pushing for large box pushing works and skew boxes as due to movement of box while pushing , adjoining soil mass can also move resulting into shifting of R/span supports also and relieving span along with track going out of alignment.

4.2 Box pushing technique has its own utility and suitability in certain cases like -

- Under multiple lines where longer blocks of 8 – 10 hrs duration are not possible to adopt cut and cover method.
- Where rocky strata exists in the alignment of box and rock cutting cannot be done during limited block period. In such case it is not possible to adopt cut and cover method and box pushing has to be resorted to.4.4Rail cluster technique developed by SECR has made box pushing method of construction of RUBs/RURs safer.

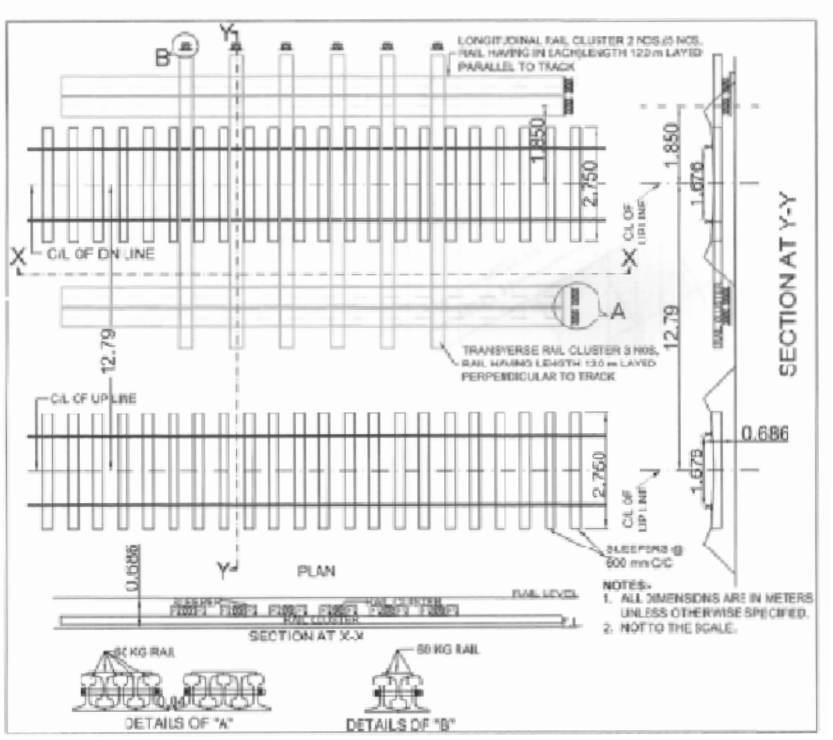


Fig. 1 - Details of Rail Cluster for Box Pushing

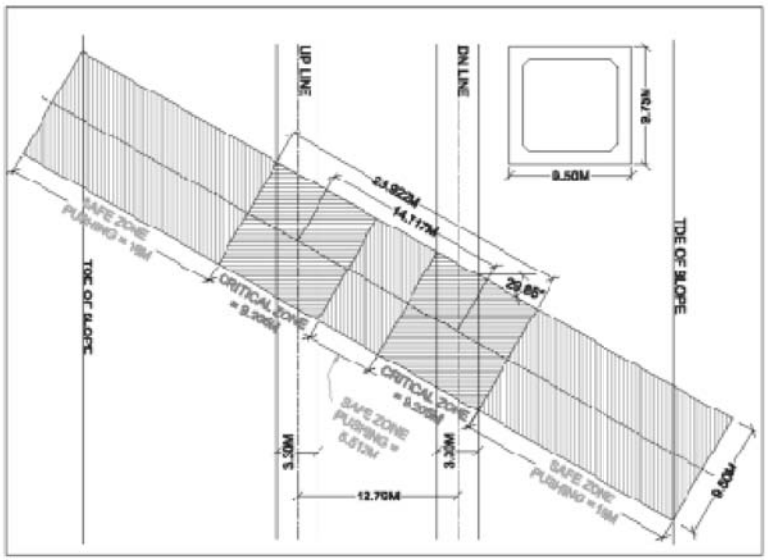
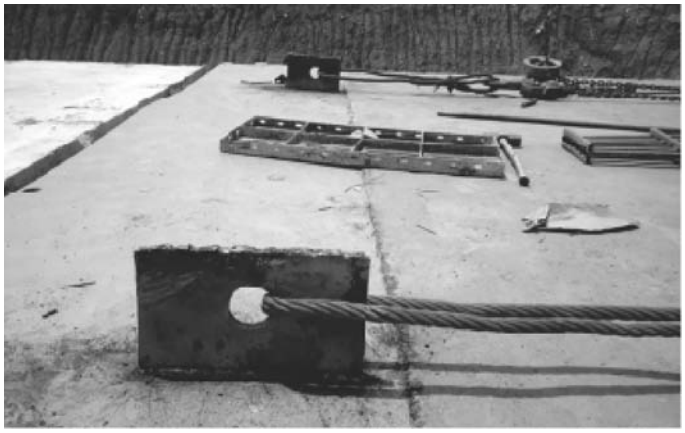
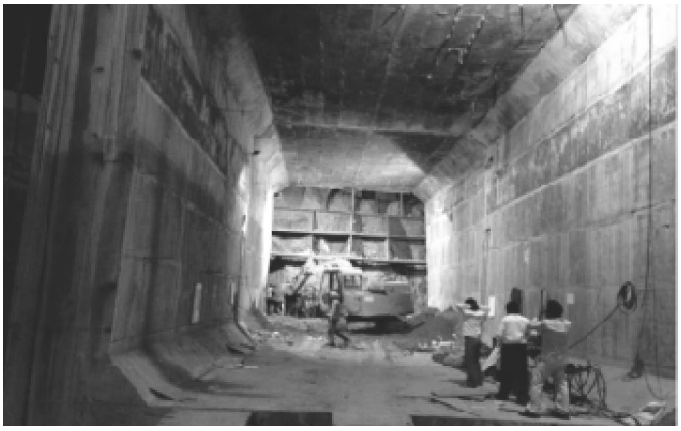


Fig. 2 - Box Pushing at RUR KACHEWANI



Chain Pulley Arrangement - Closer View



Preparation for Box Pushing



Chain Pulley Arrangement at the Time of Pushing



Rail Cluster Arrangement - Closer View



Manual Excavation in the Upper Portion of Cutting Edge



Rail Cluster Arrangement

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Comparison of Chinese and Indian Railways

Particulars	CHINA	INDIA
Country Area (Sq Km)	96,40,821.00	3,87,263.00
Route Kms	80,000.00	63,000.00
Area in Sq Kms/KM of rail line	120.51	52.18

Laying of Blanket for Nerul/Belapur-Seawood-Uran Railway Project

By
*Shri Ashutosh Gupta**
*Shri S.S. Tomar**
*Shri Ashok Kumar**

Synopsis

Nerul/Belapur-Seawood-Uran Railway Project is being constructed in Navi Mumbai on cost sharing basis with CIDCO for extension of suburban railway network up to Uran for running of suburban services. These tracks will be used exclusively for running of EMU rakes for suburban services. This project was sanctioned by Railway board in 1996. In the present paper, effort has been made to document the difficulties faced in dealing with the earth work and subsequent blanketing work as the alignment is passing through the coastal marine clay deposits of substantial depths.

1.0 Geology :

This region falls under tropical belt with Monsoon rainfall conditions. The most of the alignment i.e. from Ch. 0 to Ch. 4000 & from Ch. 13000 to Ch. 22500 (Uran) passing through coastal zone affected by tidal water every day. Most of the coastal zone consists of soft marine clay having depth of 2 m to 16 m. The ground water is at a depth of 0.45m to 2.00m from existing ground level. The whole stretch can be classified in to following zones based on bore hole details

Chainage in Meter	Depth of Clay In Meter	Maximum height of Bank from Ground level in Meters
0.00 to 1050	4.00	10.00
1050 to 1800	6.00	Viaduct/bridge
1800 to 2600	creek	Viaduct/bridge
2600 to 4000	2.00	9.00
4005 to 4150	creek	bridge
4150 to 6100	2.00	10.00
6100 to 13000	Nil	12.00
13500 to 21760	7.00 to 16.00	4.65

The properties of the subsoil indicate that these layers will undergo large settlements under the extra load of embankment.

2.0 Functions of Blanket Layer:

Blanket/ sub-ballast is a layer of coarse grained material between ballast and sub-grade, spread over entire width. On some other railway systems of the world, this layer is also called as sub-ballast. The important roles are:

i) Improve the bearing capacity by modifying the stiffness and achieving a better distribution of transmitted loads on the sub-grade soil, thus preventing ballast penetration into the sub grade.
ii) Reduction of induced stresses on the top of sub-grade to a tolerable level.
iii) To prevent mud pumping and fouling of ballast by upward migration of fine particles from the sub-grade.
iv) To prevent damage of sub-grade by ballast.
v) Shedding surface water from the ballast and drain away from the sub grade.
vi) Protection of sub-grade against erosion and climatic variations.

* Dy C.E.(C), C.R ** XEN (C), C.R *** J.E. (Works), C.R

3.0 Background :-

RDSO has issued various guidelines for laying of blanketing layer on the top of the embankment as under.

Sr. No	Report No.	Title of Report
(1)	GE-G1of 2003	Guidelines For Earthwork In Railway Projects
(2)	GE-IRS 2 of 2005	Specification for Mechanically Produced Blanketing Material for Railway Formation including Guidelines for laying
(3)	GE-0014 of 2009	Guidelines and Specifications for Design of Formation for Heavy Axle Load

4.0 Applicability of These Guidelines

Sr. No	Report No.	Applicable for
(1)	GE-G1 of 2003	All Railway projects
(2)	GE-IRS 2 of 2005	All Railway Projects
(3)	GE-0014 of 2009	These guidelines should be put to use only on new Works and would not apply to ongoing projects.

5.0 Basis for Thickness of Blanket Layer :

Sr. No	Report No.	Basis
(1)	GE-G1OF 2003	Para 4.3.2. - Depth of blanket layer of specified material depends primarily on type of sub grade soil and axle load of the traffic.
(2)	GE-IRS 2 of 2005	Para 3.1 (page 2) - Depth of blanket layer of specified material depends primarily on type of sub grade soil and axle load of the traffic.
(3)	GE-0014 OF 2009	Table 6 (page 33 & 34) - Axle load, subsoil quality, filter criteria, CBR value of soil used in sub grade/ embankment fill, EV2 value of natural ground & soil used for fill & % fine in soil used for earthwork

6.0 Specification of Blanket Material :

Sr. No	Report No.	Basis
(1)	GE-G1of 2003	Para 4.3.4.1 – Page No. 16 a) It should be co arse, granular and well graded. b) Skip graded material is not permitted. c) Non -plastic fines maximum to 12%, whereas plastic fines are limited maximum to 5%. d) The blanket material should have particle size distribution curve more or less within the enveloping curves shown in sketch -B. (annexure-1) e) The material should be well graded with Cu and Cc as under: **<u>Uniformity coefficient</u>**, Cu = D 60/D10 > 4 (preferably > 7) **<u>Coefficient of curvature</u>**, CC = (D 30)2 / D60 x D10 should be within 1 and 3.
(2)	GE-IRS 2 of 2005	a) These specifications are same as given in GE-G1 of July 2003.
(3)	GE-0014 of 2009 (CP- 98)	Para 12 - page no 27 & 28 a) Cu > 7 and Cc between 1 and 3. b) Fines (passing 75 microns) : 3% to 10%. c) Los Angeles Abrasion value < 35%. d) Minimum required Soaked CBR value 25 of the blanket material compacted at 100% of MDD e) Filter Criteria should be satisfied with prepared sub grade/sub grade layer just below blanket layer, as given below : i) Criteria–1: D15 (blanket) < 5 x D85 (sub-grade) ii) Criteria–2: D15(blanket) > 4 to5 D15 (sub - grade) iii) Criteria–3: D50(blanket) < 25 x D50 (sub-grade)

7.0 Type & Properties of Soil available / Used for Embankment in Navi Mumbai :

Sr. No	Property	Value
a.	% fine in soil (Material passing from 75 micron sieve)	10% to 30%
b.	Plasticity Index	More than 7
c.	CBR Value	More than 7
d.	Cu	>7
e.	Cc	1 to 3
f.	D_{15}	200 micron
g.	D_{50}	0.90 mm to 2 mm
h	D_{85}	Up to 4.00 mm
i.	MDD	More than 1.70 up to 1.90
j.	Broad Soil Classification	SM or SC (Silty Sand or Clayey Sand)

It can be seen from the above properties of soil used for embankment in Navi Mumbai, it is classified as silty Sand or Clayey Sand due to presence of fine material more than 12 % and plasticity index is more than 7. Therefore, it requires blanketing layer as per RDSO guidelines.

It is also classified as SQ2. (As per Table-3 of GE-14)

8.0 The Thickness Recommended by RDSO for Such Type of Sub Grade Soil in Various Reports is as Under.

Sr. No	Report No.	Thickness of Blanketing for Silty Sand or Clayey Sand
(1)	GE-G1 OF 2003	1000 mm as Plasticity Index exceeds 7 (as per para 4.3.2.1 c) plus 30cm for 25T axle load
(2)	GE-IRS 2 of 2005	1000 mm as PI exceeds 7. (as per para 3.1.1 on page no 2) plus 30cm for 25T axle load
(3)	GE-0014 OF 2009 In this report formation width for single line is increased to **8.50 m as against 6.85m** in earlier reports.	**750 mm Thick Single Layer Blanketing** for SQ2 & 25 MT Axle load with Minimum Thickness of prepared sub base 50 cm with CBR value more than equal to 6 and (Page no. 37 of report) **OR** **450 mm thick Double Layer Blanketing** for SQ2 & 25 MT Axle load with Minimum Thickness of prepared sub base 1000 mm with CBR value more than or equal to 7 . (Page no. 38 of report) 450 mm is applicable for BSU as depth of embankment is more than 2.00 m with SQ2 type soil in the entire section

9.0 Two Layer System for 25T Axle Load (Prepared Subgrade on Embankment Fill)

Layers	Specification	Axle Load 25T
Layer 1 : Prepared Subgrade (Good/ Imported Soil)	CBR >= 6 - 8 (of compacted soil upto 97%) SQ2/SQ3 & Limit fines 12 – 50% SQ1 to be avoided) Plasticity Index < = 12 Compaction : Minimum EV2 :	100 cm CBR > = 7 generally, but not < 6 in isolated cases 98% MDD 45 MPa
Embankment Fill	CBR > = 4 – 5 (of compacted soil upto 97%) (Organic soils to be avoided) Minimum EV2 : Compaction :	CBR > = 5 generally, but not < 4 in isolated cases (For SQ1 soil, CBR> = 3 generally, but not < 2 in isolated cases) 30 MPa 97% MDD
Ground Soil/Sub-soil Strata	Minimum Undrained Cohesion of soil, Cu = 25 KPa or Minimum EV2 = 20 MPa Ground Improvement is required, if Cu < 25 kPa, or Ev2 < 20 MPa	Min. Ev2 = 20 MPa

10.0 Method Used for Providing Two Layer Blanket in BSU Project:

A. Selection of Blanket Material :

It is very difficult to fulfill all the criteria of Blanketing Material through a single type of soil. So, it becomes necessary to blend two or more types of soils to achieve required properties. Proper survey of the local area may be carried out taking due consideration of soil properties given in table 5 of IS-1498 (annexure- 3), which may help in selecting materials for initial trial.

In the areas where adequate crushers are available

like Navi Mumbai, quarry dust, crushed sand etc may either be mixed with murrum or used separately for trial to conform to Blanket material Specifications.

Following proportion of blending of Soil, Crushed sand 10mm & 20mm aggregates is found suitable for blanket material, as per RDSO Guidelines GE-14 –

Proportion Of Soil (Murrum) = 30%
Proportion of Crushed Sand = 30%.
Proportion of 10 mm aggregates = 30%
Proportion of 20 mm aggregates = 10%

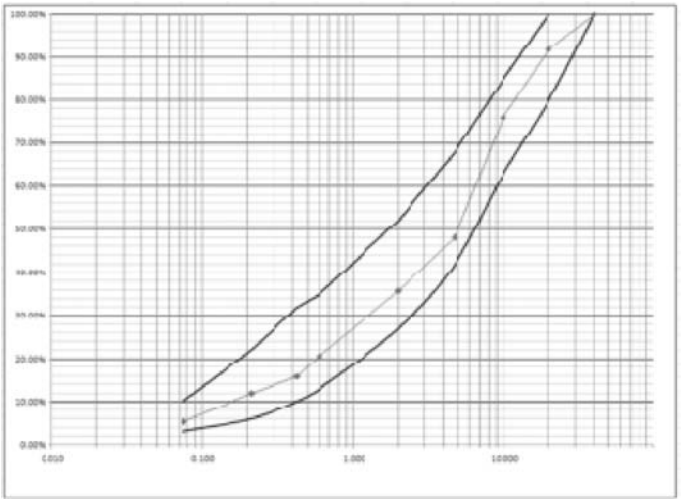
Properties of Blanket material are as follows –

S. No	Required properties as per specification	Values observed after testing	Remarks
1	Cu shall be more than 7	41.18	Cu fulfils requirement
2	Cc shall be between 1 and 3	1.31	Cc fulfils requirement
3	% Particles passing through 75 u sieve < 10%	5.31 %	75 u passing fulfils requirement
4	MDD > 2.10 gm/cc (as per contract agreement)	2.28 gm/cc	MDD fulfils requirement

Additional specifications as per GE 0014

5	Criteria - 1: D_{15} of blanket < 5 X D_{85} of subgrade	D_{15} of Blanket	D_{85} of Subgrade	Result	Fulfils requirement Criteria - 1
		0.35	5.0	0.50< 5 X 5	
6	Criteria – 2: D_{15} of blanket > 4 X 5 times D_{15} of	D_{15} of Blanket	D_{15} of Subgrade	Result	Fulfils requirement Criteria - 2
		0.35	0.08	0.35 > 4 X 0.08	
7	subgrade Criteria – 3: D_{50} of blanket < 25 X D_{50} of subgrade	D_{50} of Blanket	D_{50} of Subgrade	Result	Fulfils requirement Criteria - 3
		5.0	0.9	5.0<25 X 0.9	
8	CBR > 25%		27.41%		Fulfils CBR Criteria
9	LAA < 35%		19.7%		Fulfils LAA Criteria
10	Particle size curve shall be within the enveloping curve as per RDSO Guideline.	The particle size analysis curve is within the enveloping curve, with minor exception. (Graph is attached).			Generally satisfying the Enveloping curve criteria.

1. Gradation Curve Of Blanketing Material : From Ch. 13500 to 18200



2. Gradation Curve Of Blanketing Material :- From Ch. 0.00 to 940 (Seawood Triangle)

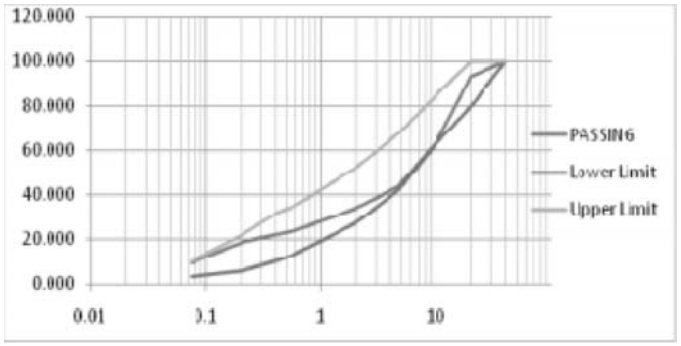
Combined Grading for 100% crushed material for Blanketing (20% 20mm, 40% 10mm and 40% crushed sand less than 4.75mm)

Lab results for second blanket material

(Results fulfill all requirements of GE-0014

The structural system shall be as follows:

Sr. No.	Test Parameters	Results
1.	Silt	9.11%
2.	Clay	0.26%
3.	Cu (Coeff. Of uniformity) Cu= D60/D10	113
4.	Coeff. Of curvature Cc= D30 /(D60xD10)	2.00
5.	Liquid Limit	28%
6	Heavy compaction OMC MDD	8.5% 2.2 gm/cc
7.	Soaked CBR	69.10%
8.	Abrasion value	24.50
9.	Relative Density	87.6%



B. Mechanical Production :

i) Blanket material is produced mechanically by crushing or blending method or by combination of these two.

ii) Crushed blanket material may be produced as sole product or by combination of two or more aggregates of different sizes.

iii) Gradation of these mechanically produced materials should conform to those given in table 5: 'Grading Percentage of Blanket Material' of GE-14.

iv) Proportion of different crushed materials & aggregates may be adjusted to match Recommended Specifications of Blanket material (Para 12 of GE-14).

v) Different ingredients may be poured into separate storage bins.

vi) Opening of storage bins are adjusted through microprocessor based control panel.



i) Specifications of machinery used are –

a.	Makes of Blender	:	Kesar Equipments, Mehsana
b.	Type of Blender	:	Pug mill type
c.	Plant capacity	:	100 ton per hour
d.	Number of persons	:	4 for operating plant
e.	Power Supply	:	operated by 125 KVA Generator
f.	Number of Bins	:	4
g.	Salient features	:	Control panel , bins, pug mills, blender, conveyor
h.	Approximate cost	:	Rs 20Lakhs. Transportation/ Taxes/ Installation extra, which are site specific.

C. Blending Methodology :

Two types of mechanical Blenders are easily available – Drum type & Pug Mill type. However, for continuous production of Blanketing material in large quantity, Pug Mill type blenders are more suitable. In this approved materials are fed through gate opening of storage bins on conveyor, which carries these materials to Pug Mill Blender. Volumetric mixing of materials is done in blender.

Water may be added to blender in required proportion of OMC or slightly above.



Another method may be addition of required water at site also, which also gives proper result.

D. Quality Control:

i) Raw Materials should be selected in such way that gradation of blanketing material produced after blending lies in between enveloping curve of GE-14. Proportion of different ingredients are adjusted to avoid gradation curve lying very near to boundary of enveloping curve, as during execution gradation may slightly differ from those in trial & approval.

ii) 40 mm sieves should used to segregate oversized boulders. In addition to this, labours may also be deployed to segregate oversized boulders.

iii) If proportion of raw materials has been finalized weight wise, it should be ensured to calibrate the gate openings of bins accordingly, which have volumetric control for opening

iv) If water is added in blender itself, pump should be calibrated accordingly.

Automatic Control Panel (to maintain proportion of material)



E. Transportation :

Properly blended blanketing material is loaded into dumpers (around 12 cum) and transported to site.



F. Laying & Spreading :

Blanketing material transported to site is laid with the help of grader. Required amount of Water is to be added and compaction is done near OMC at around 6-9% (which is to be determined from Lab Testing). It is done in two layers by power driven vibro roller of minimum 10-12 tonne capacity to achieve density minimum 98% of MDD and the required relative density of more than 70%.which was ensured during execution.

Actual Site Photo





G. Quality Control Check On Finished Blanket :

i) One set of following tests for every 500 Cum of Blanketing material-

a. Min CBR value of Blanket material compacted at 100% of MDD should be 25.
b. Los Angeles Abrasion value < 35%.
c. Percentage fines (passing 75 microns) 3% to 10%
d. Cu >7 & Cc between 1 &3
e. Size gradation should be within Enveloping Curve.
f. Filter criteria should be satisfied.

ii) Dry density measurement at every 200sqm surface area of each compacted layer should be carried out.

H. Acceptance Criteria : (As per GE-IRS-2)

The blanket material, which contains fines passing 75 micron IS Sieve, upto 5 percent should have the Density Index (Relative Density) a minimum of 70% as obtained in accordance with IS: 2720 (Part 14) – 1983.

For other materials, field dry density should not be less than maximum attainable dry density obtained in field compaction trial. However, in field compaction trial, the maximum attainable dry density should not be less than 98% of MDD values as obtained by Heavy Compaction Test (IS: 2720 (part 8) – 1983) in the laboratory.

11.0 Cost Comparison :

Rate analysis for 100 m length for 12.15m wide formation

- It can be seen from the above that 450 mm thick double layer blanketing as per GE-0014 OF 2009 is substantially economical.

- Rate of earthwork & Blanketing are as per average of rates of existing works undergoing for BSU Project.

12.0 Conclusion :

Report No.	Rate	Unit	GE-G1OF 2003& GE-IRS2 of2005		GE-0014 OF 2009	
Recommended Thickness of Blanketing			1300 mm as PI is more than 7		450 mm thick Double Layer Blanketing	
			Qty	Amount	Qty	Amount
1. Blanketing	625.54	cum	1475	922671.50	587.25	367348.37
2. Earth for less thick blanketing	224.83	cum	0	0	827.75	186103.03
Total				9,22671.50		5,53451.4

i) Blanket criteria of GE-14 are more scientific, rational and economical.

ii) This Criterion takes into account subgrade properties and thereby gives a scope of reduction in Blanket thickness.

iii) Reducing Blanket thickness has resulted in major financial advantage & improved quality in BSU Project.

iv) Adequate contractual provisions be made to implement Blanketing as per GE-14, as it requires specialized machinery, that can be easily customized from those available in market.

v) Implementation of GE-14 criteria is practically possible.

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Fuel Efficiency in Passenger Transport

Mode of Transport	Power	BTU* Per PKM
Railway	Electric Traction	54.6
	Diesel Traction	151.2
	Steam Traction	1,445.8
Road	Diesel Bus	288.5
	Petrol Bus	526.5

Fuel Efficiency in Freight Transport

Mode of Transport	Power	BTU* Per TKM
Railway	Electric Traction	84.5
	Diesel Traction	255.5
	Steam Traction	3,576.3
Road	Diesel Truck	288.5
	Barge	526.5
Pipeline		281.7

*** BTU - British Thermal Unit**

Using Geo-Textile/Geo-Composite Layers in Lieu of Dry Stone Backing Behind Abutments in Bridge Approaches - Value Engineering Scheme:

By
Shri S A K Basha *

1.0 Brief Background:

Indian railways are having number of ballasted and non Ballasted bridges where elastic behaviour of track structure changes suddenly. Instructions have been issued by RDSO to provide RCC slab on approaches of non Ballasted Deck bridges of span 12.2m or more. Para 7.5 of Bridge sub-structure and foundation code, revised in 1985 (including correction slip no.12 dated 22.09.2009) contains details of backfill behind abutment etc of 600mm (min) thick **filling of boulders and cobbles** and behind gravel and well graded sand types of soil as per IS:1498-1970. Along with this backfill, approach slab of minimum 4m length are to be provided for non-ballasted deck bridge having span. 12.2m or more. **RDSO report no. GE:R-50 Transition system on approaches of bridges states that a**ppropriate transition system is required for ballasted deck and other bridges where bridge slab is not below 1300mm from bottom of sleeper, for span 12.2m and above. Further it was suggested to use boulder backing to act as a drainage layer with backfilling of GW,GP,SW type soils.

In the present paper it has been explored about other alternatives of boulder packing behind the abutment for providing drainage or for transition in approaches. Accordingly references have been made to GE-R50 & World Railways. It was found that **non-woven Geo-textile (either hot pressed)/ Geo-composite** material of requisite strength is being used behind abutments directly on the face covering the weep wholes/wrap around the backfill material of GW,GP,SW type soils. This method is being followed partly in NHAI and mostly in other World Railway Systems which will provide the good drainage and prevent the escape of finer material which is a cause for formation of hollows. This will also increase the modulus of the approach as the backfill material is wrapped around with **Geo-textile** and may likely to provide improvement in transition system **without increase in cost as the same can be the replacement to boulder packing**.

2.0 Bridge Approaches:

The bridge approach embankment has two functions: first to support the permanent way system and second to connect the road bed with the bridge deck. The embankment must provide **a good transition** between the road bed and the bridge and in the current RDSO guidelines it was suggested to provide approach slab and other approach components. Thus the backfill materials and their performance become a very important aspect in an approach embankment construction. Apart from the embankment backfill material and construction specifications, the other alternatives, such as using flow able fills (low strength and flowable concrete mixes) as backfill around the abutment**, wrapping layers of backfill material with geo-synthetic or grouting were also employed in world Railways to solve the problem of the excessive settlements induced by the embankmen**t. It was demonstrated that (Burke, 1987) t**he use of geo-synthetics can prevent infiltration of backfill into the natural soil, resistance against lateral movements and improves the quality of the embankment,** resilience and **eliminated** the settlement of the formation and increased the maximum steady state of flow by 12 times

* JGM/C/BBS

Research carried at various bridge locations by Department of Civil Engineering, University of Texas at Arlington, Arlington, Texas 76019 Published: April 2009 the **Mechanisms causing the formation of bump/ approach settlements,**

1. Consolidation settlement of foundation soil;
2. **Poor compaction and consolidation of backfill material**;
3. **Poor drainage and soil erosion**;
4. Types of bridge abutments;
5. Traffic volume;
6. Age of the approach slab;
7. Approach slab design;
8. Skewness of the bridge; and
9. Seasonal temperature variations.

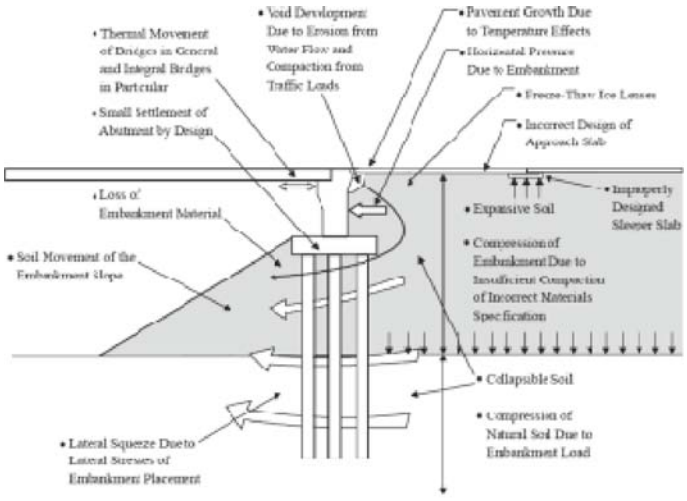


Figure 1 – Schematic of Different Origins Lead to Formation of Bump at the End of the Bridge (Briaud et al., 1997)

Mitigation techniques proposed:

a. Improvement of Embankment Foundation Soil:

b. Mechanical Modification Techniques (Soil replacement)/preloading/Dynamic Compaction

c. Hydraulic Modification techniques (PVD)

d. **Reinforcement Techniques (Column reinforcement/Compaction piles)/ Geosynthetic Reinforcement.**

e. Geo-piers/Deep soil mixing/Concrete Injected Columns

f. Improvement of Approach Embankment/ **Backfill Materials**

3.0 Economic Solution to the Problem of Approach Settlements-Provision of Drainage and Likely Improvement of Transition System in New Bridges:

Of the various reasons analysed ,poor Drainage and escaping of finer materials from the backfill behind abutment is one of problems of concern. Boulder filling is being provided behind abutments expecting proper drainage, dissipation of pore water pressure. However due to inherent voids between interstices of stones finer material is escaping from behind the abutment, causing hollows and settlement of approaches. Further Weep holes in the abutment are also acting as piping system to allow back flow from channel to the approach embankment resulting into settlement of approach at the time of receding of HFL in the bridges. Thus it has been a requirement to find a material which can improve the Drainage at least cost and prevent escape of finer material, avoid causing of hollows/voids in approach embankments.

However, it is important to note that Boulder back filling is not being adopted at present in bridge approaches instead crushed stone aggregate of various gradation are being used as backfill material. *R*esearchers demonstrated that (***Structure/ Embankment Transitions in Railway Infra-structures Behaviour and National and International Practices***- *Luís Miguel Gouveia Coelho Universidade Técnica de Lisboa - Instituto Superior Técnico Av. Rovisco Pais, P-1049-001 Lisboa luismgcoelho@gmail.com),(****Simple design alternatives to improve drainage and reduce erosion at bridge abutment*** *of Iowa State university)* Boulder back filling behind abutments is not a essential feature to improve transition system. Even in RDSO GE R-50 detailing (sketches given at end) of bridge approaches at world railways also confirm the fact. That it is evident from the above reports the use of Geo-textile/Geo-composite drainage system with the backfill reinforcement **eliminated** the settlement of the formation and increased the maximum steady state of flow by 12 times.

Further that as evident from the different technical literature of Nylex, Terram, Maccaferry etc. that Geo-textile/Geo-composite drainage layer is being used worldwide for better performance during service and to reduce the cost.

Associated advantages of Geo-textile/Geo-Composite Drain solutions

a. It will prevent the escape of soil through the drainage pores which may further cause settlement of approaches.

b. It is **Cheaper** than Dry stone packing thus effecting approximately more than 50% saving in cost to the employer.

c. Easy to install and consumes less time.

d. Less possibility of choking.

e. Effectively reduces hydrostatic pressure behind abutments.

f. Provides an airlock between drainage layer and wall.

g. It typically eliminates the need for aggregate back fill.

h. Lightweight and Flexible.

I Saving in cost of drainage fill as it can be filled with clean sand now.

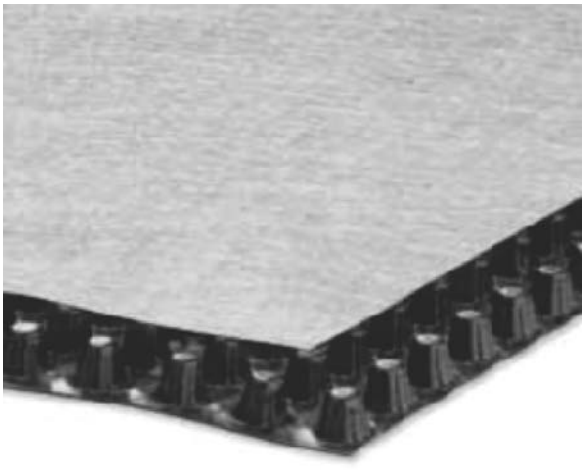
j. It will help in achieving smooth Transition system.

k. Environment friendly.

Therefore for a number of reasons associated ***environmental impact*** with blasting for obtaining boulders, and savings in cost it is wished-for adoption of Geo-textile/Geo Composite Drains which are cheaper and advantageous.

4.0 Technical Features of Drains (Composite) :

There are number of Designs available in the market for the purpose with different names. The main features of one of the common drain include a core sand witched between Two Hot pressed non woven geo-textile layers (118 GSM)with the strength of >20KN/m and in another only hot pressed geo textile layer is being provided. It was also elaborated in various research papers that multi layer Hot pressed non woven geo-Composite / Geo Fabric alone is sufficient for better drainage. Both the systems are in use worldwide based on the design needs. Some of the typical arrangements are shown below.









Key Mechanical & Hydraulic Properties of Drainage Geo-composites

- **CBR** – Geo-fabrics use the 'California Bearing Ratio' to measure the materials' ability to resist puncture and damage during service life.
- **Thickness** – Provides a degree of proportionality with flow rates and protection efficiency.
- Crush Resistance and Compressive Strength – Ensures product performance under long term static load with minimal compressive creep.
- Transmissivity – In plane flow to meet and exceed design requirements.
- Shear Strength – High bond strength minimises the risk of delamination and ensures product integrity and stability on slopes.
- Tensile Strength – High modulus filter to minimise ingress into the drainage core. The composite provides lateral strength but allows for settlement.
- Cone Drop – Ensures resistance to dynamic point load avoiding damage during installation.
- Water flow – Normal to the plane, allowing infiltration into the drainage core itself.

One simple Geo composite drain spec is elaborated below for the sake of brevity. The Specification for a particular drain is based on ASTM standards can be confirmed through NABL laboratories worldwide.

a. Vertical Drain Composite: The vertical drain composite shall be a geo-composite sheet drain material consisting of a drainage core with a subsurface drainage geo-textile attached to or encapsulating the core. Include all necessary fittings and material to splice one sheet, panel, or roll to the next. The drainage core shall be of a material using long chain synthetic polymers composed at least 85 percent by mass of polypropylene, polyester, polyamide, polyvinyl chloride, polyolefin, or polystyrene. The core shall be fabricated in sheets, panels, or rolls of adequate strength to resist installation stresses and long-term loading conditions. The core shall be built up in thickness by means of columns, cones, nubs, cusps, meshes, stiff filaments, or other approved configurations. The geocomposite sheet drain shall have a minimum compressive strength of **40 psi** (275 kPa) when tested in accordance with ASTM D 1621 Procedure A. Splices, fitting, and connections shall be of sufficient strength to maintain the integrity of the system during construction handling and under permanent loading without impeding flow or damage to the core. The geo-composite drain material shall be covered with an opaque, ultraviolet resistant, waterproof covering during storage. The maximum allowable exposure to ultraviolet radiation prior to installation is 10 days. The horizontal and vertical flow of water within the geo-composite sheet drain shall interconnect at all times for the full height of the core. The drainage core with the goetextile laminated to one side of the core shall provide a minimum flow rate of 5 gallons per minute (19 liters per minute) per foot (300 mm) of width when tested in accordance with ASTM D 4716 under the following test conditions:

1. 12 inch (300 mm) long specimen
2. Applied load of 10 psi (69 kPa)
3. Gradient of 1.0
4. 100 hour seating period
5. Closed-cell foam rubber between platens and geo-composites

If the core construction separates the flow channel into two or more sections, only the flow rate on the in-flow face is considered in determining the cores acceptability. Sometimes a steel pipe/PVC pipe is placed at the lowest level to discharge in one of the systems.

b. The geo-textile shall be firmly attached to the core so folding, wrinkling, or other movement cannot occur either during handling or after placement. Attachment shall be through the use of a non water-soluble adhesive, heat sealing, or other method recommended by the manufacturer. Adhesive shall not be used on areas of the geo-textile fabric where flow is intended to occur. Heat sealing shall not weaken the geo-textile below the required strength values.

5.0 Manufacturers/Brands:

1. Nylex drain
2. Delta Drain
3. Terram
4. Enka Drain
5. Tencate Polyfelt
6. Soldrain
7. Geo fabrics

6.0 Method of Installation:

The general method followed for installation in reference to the standards is simple as per manufacturers direction. Most of the Geo Composite drains are simply attached with back face of abutment with adhesive and Geo textile drainage system is comprising of wrapping around the backfill material in single or multiple layers to confine soil particles. Thus the systems are simple and special techniques are not required.

7.0 Economics of the Proposal:

1. That as per provision the basic rate of boulder in Rly projects in odisha is Rs. 850.88/- per Cu.m and as per the LAR cost per Cum is Rs.1097.63/-.

Cost per Square Metre of Boulder Backing= Rs.1097/0.6 = Rs.1828.33/- per Sqm

Cost of Geo Composite Drainage =about Rs.400/- per Sqm

Cost of installation = about Rs.150/- per Sqm

Saving in Cost to Railway is Rs. =about Rs. 1278.33/- per Sqm

(The similar savings can be achieved by using hot pressed non-woven Geo-textile).

8.0 Conclusion:

Railways can also contribute in reduction of environmental impacts by employing Geo-Composite/textile materials extensively in practicably possible ways without compromising on its standards and may become origin to national savings. There are number of projects in coastal areas where availability of stone boulders is meagre and have environmental concerns as frequently stone quarries are being closed for various reasons by the environmental/state authorities. Thus it will be of immense use if the Geo textile/geo composite drains are approved by RDSO .RDSO may be requested to look into for adoption. Alternatively guidance can be obtained from IITs and can be standardised for other projects also.

References:

1. Agt.No. LOA RVNL/BBS/Tender/HDS-PRDP (MJ.Br)14/73/ Dtd. 25.11.2013.
2. RDSO GE R-50 dated Aug'2005- Transition system 1 approaches of bridges
3. Proceedings of the 2005 Mid-Continent Transportation Research Symposium, Ames, Lowa, August 2005. (C) 2005 by lowa State University.
4. Report no. K-Tran:KU-02-6 Use of controlled low-strength material as abutment backfill.
5. Technical literature of Various Manufacturers
6. Design standards of US dept of FWHA-HI-90-001& Report no.FHWA/TX-09/0 6022-1

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Elimination of LCs in 5 last years

Year	By Closure/ Merger/ Subway	By Manning	Total
2009-10	553	377	930
2010-11	800	434	1,234
2011-12	481	777	1,258
2012-13	700	463	1,163
2013-14	777	385	1,162
TOTAL	3,311	2,436	5,747

"State of the Art Repair using Non Shrink Free Flow Cementitious Grout (NFCG)" Case Study: Repair of C.C. Apron on Line No. 1 & 2 at BRCP

By
Shri Anurag Kumar *

ABSTRACT :
"Conventional C.C. (Cement Concrete) Aprons are generally constructed all over Indian Railways on Platform Portion for convenience of cleaning and watering arrangements. Design of conventional C.C. Aprons includes base R.C.C. slab and encasing of PRC Sleepers in Mass CC in surroundings. The base remains isolated from the PRC Sleepers and Mass CC around it also remains isolated. Huge vibrations going in to the mass CC through PRC sleepers make it to lose its bonding from sleepers and sleepers starts moving relatively up and down with respect to CC Apron. Due to this, cavities get formed under PRC Sleepers and grow with time and passage of axles loads in service. Such cavities make sleepers get sunk in CC Apron which results in track parameters go beyond maintenance limits with other uncontrolled deceases like grooving in sleeper seat, Breakage of ERCs, Gauge variations, twists, sags and Rail fractures in worst cases. But till now no confirmatory repair technique was available for repair and rehabilitation of CC Aprons.
In an initiative, 'State of the Art' repair through "Non-Shrink Free-Flow Cementitious Grout" (NFCG) has been adopted from the recent advancements in the industries catering such works. Generally, NGCG is known to be used in Heavy Machine Foundations under continuous dynamic loadings like in Nuclear Power Reactors, Refineries etc. Trial of such special grouting material has been done at Vadodara station on Line no. 1 and 2 in 2012-13. Based on successful trial, through repair has been done. After repair, the CC apron has gained its near to original strength and functioning properly."

1.0 Introduction:-

Since inception of conventional CC Aprons in PF portions there has been a problem of PRC Sleepers leaving bonding to Base slab and side concrete material. This results in jumping of track and vertical movement of sleepers on passage of cycles of axle loads of trains.

If the problem is not attended timely, till now no confirmatory repair available, the problem aggravates to the extent that it may lead to formation of cavities under the sleepers and sinking of sleepers, grooving of sleepers at rail seat, Breakage of ERCs, Gauge widening, cross level variations.

BRC Division has conducted study and Trials of Non-shrink Free Flow Grout Material with early strength gain with short duration blocks and long duration blocks. After, detailed study on the problem and results, it has been found that with minimum 12 hrs setting time, Non-Shrink Free Flow Grout material is very effective in filling up cavities under and around sleepers and rehabilitates the CC Apron near to its original conditions.

Brief details of this State of the art technique has been detailed as under with case study at Vadodara Station (BRCP) on Line no. 1 & 2 (UP & DN Main Lines).

2.0 Track Structure and History:-

C.C. Apron at BRCP (Vadodara Station) Line no.1 & 2 was constructed in year Oct'1991 in 90 days Full Block and Sep' 1999 in 38 days Full Block respectively. Track structure is Conventional C.C. apron with PRC Sleepers laid over R.C.C. base 200mm thick slab and surrounded by Plain Cement Concrete. Track was opened for speed of 15 kmph.

Breakage in CC Apron started in the year 2004-05 and since then repair works are being carried out from time to time.

* DEN/EAST/BRC, Western Railway

2 Details of Previous Repairs and Trials:

Following repairs were carried out chronologically:

Year of Repair	Method of Repair	Method of Execution	Block Duration	Remarks
2008	Lifting and pouring Quick Setting Cement Mortar under sleeper and Laying Concrete Crib in between Sleepers on Line1.	Breaking of Crib portion of Concrete Apron. Replacement of 197 broken sleepers and levelling of track with placing of Quick Setting cement Mortar under sleepers.	8 hrs daily block for 28 days . 4 hrs setting time on Line.1. 1000 sleepers attended.	Due to inadequate setting time and early opening of traffic, Condition deteriorated in 2009 with 4-6 Rail Fractures per year.
2012	Trial Repair done for 300 Sleepers on Line no.1 and Line no.2	Lifting of track and grouting with Free Flow Non Shrink Cement Grout	Line no.1: 8Hrs Block with 6hrs setting time for 6 days. 300 Sleeper were repaired. Line 2: 36 Hrs Block with 6 hrs setting time. 300 sleepers repaired.	Line no. 1: Work done on scattered 300 sleepers. Could not withstand due to quick opening of traffic. Line no. 2: 300 sleepers done on scattered locations. 70% Withstands in continuous stretch. Trial Successful.



Before Repair 2012



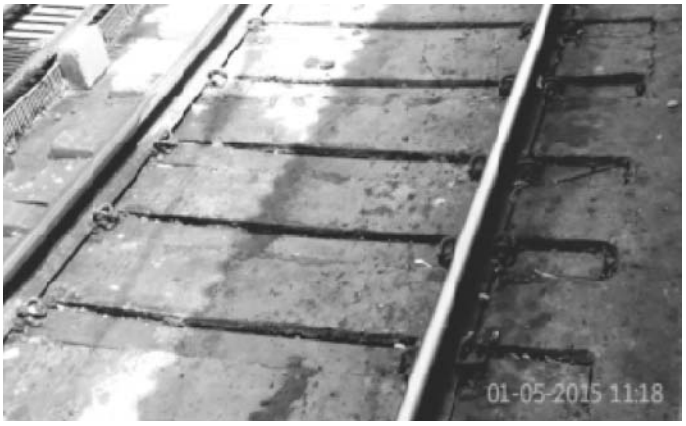
After Trial Repair 2012

3.0 Prevailing Apron Condition of Line No. 1 & 2 (in the year 2015):

Cavities have got created under the sleepers due to non-monolithic structure of conventional CC Apron. The Sleepers have sunk in to the CC Apron and Rails are not able to remain on sleepers due to breakage of fittings and non-withstanding of fitting. Gauge has not been able to maintain and cross level is also going beyond maintenance limits. This has resulted heavy twist on track.

The track readings were much beyond the prescribed limits. It is found that sleepers have been sunk in to the apron. Track is jumping while passage of train. Fitting are not able to hold the rail at its locations. Track parameters have been reaching beyond maintenance limits. Presently, Line no. 1 & 2 are under 15 kmph speed restriction but still jumping of rails could have led to unusual and suspension of traffic.





Line no. 1 & 2 : Sleepers sunk in Apron leading to Rail Hanging on Apron.

4.0 Through Repair Done:

a. Methodology Of Repair: After successful trial in 2012 for 300 sleepers on line no.2 in continuous block of 36 hrs, urgent repair using **"Non Shrink Free Flow Cement Grout"** has been carried out with lifting and levelling of tracks. The present material of grouting is having property of about 0.5-1.5% expansion after grouting which will pack the cavities under sleepers. The strength gaining time of 12 hrs has been found adequate before allowing traffic. Free Flow Pouring is done from a height of 0.5m -0.8m to enable free flow of grout from verge end of sleepers (PF side) to reach inside cavities thereby replacing air, water etc out from cavity from another end of sleepers (Non PF side). Pouring is done in at least three steps with gap to 2 minutes till grout material is going in cavities. Blades of MS plates and iron rods can be utilised in visible gaps to help the grout to go in cavities.

b. Grout Material : The Grout Material is used suitable to repair heavy machine foundations which are under heavy dynamic loading. Mainly CONBEXTRA GP2 of FOSROC Ltd., FLOWGROUT 60(M) of FAIRMATE Ltd., SikaGrout VHS of SIKA Ltd. are various options available in the market.

Specifications and tests:

1. **Dry Ready Mix Qty per sealed Bag**: 25 Kg with Grout yield about 12.5 Ltr. (Non Metallic Chloride free)
2. **Water required**: 3.5-4.0 Ltr per Bag, W/P ratio 0.14-0.16.
3. **Grout thickness**: Up to 50MM with no addition is required, for max thickness up to 150mm addition of 8-9 Kgs stone aggregates shall be required per bag with water less than 3 Ltr. No Pressure desirable to grout.
4. **Mixing Time**: Minimum mixing time shall be 1-2 Min but should not be more than 3 min.
5. **Initial Setting time** : 20-30 Minutes to pour the grout under free flow.
6. **Final Setting time**: 4-5 Hrs.
7. **Flow** : 17-20 cm on Flow Table(BS:4551 Part-12)
8. **Density**: 2000-2100 Kg/cum
9. **Desirable Strength**: Aproxx. 25-30 Mpa- 12 Hrs, 30-35 Mpa- 1 Day, 40-45 Hrs -3 Day, 50-56 Mpa-7 Days, 65-70 Mpa in 28 Days.
10. **Expansion**: 0.8 % - 1.5% in cavities

c. Scope of work: Total, 900 Sleepers on Line no. 2 has been done in 60 Hrs continuous block and 1020 nos. of Sleepers has been planned for grouting.

d. Method of execution:

I. **Cleaning of Track:** After passage of train just before the block, entire track shall be cleaned by water jets using commercial resources.

II. **Opening of cavities:** Side cavities around sleepers shall be scrapped out using drilling machines, scrappers manually then air jet Cleaning was used to clear the space around sleepers and entrapped water under cavities.



Water Jet Cleaning



Scraping of edges



Air Jet Cleaning

III. **Breaking of Edges of CC Apron Around Sleepers to Enable Lifting:**



Breaking Edges using Off Track



Tampers Modified with Cutting Bit

Due to Trapezoidal shape of sleepers, lifting of sunk track becomes difficult at some locations. This requires Breaking of Edges of CC Apron around sleepers using Hand Breaker of 1000W. To do this, 8-10 Off Track Tampers were deployed by changing of Drilling bit available in the market. One sleeper takes around 30Mins -45 Mins to break the edge restriction to enable the lifting and levelling of track. No of sets can be increased base on requirement.

IV. **Lifting and Levelling of Track:** Track shall be lifted using jacks and shall be supported on wooden wedges under rails over CC Apron and levelled.



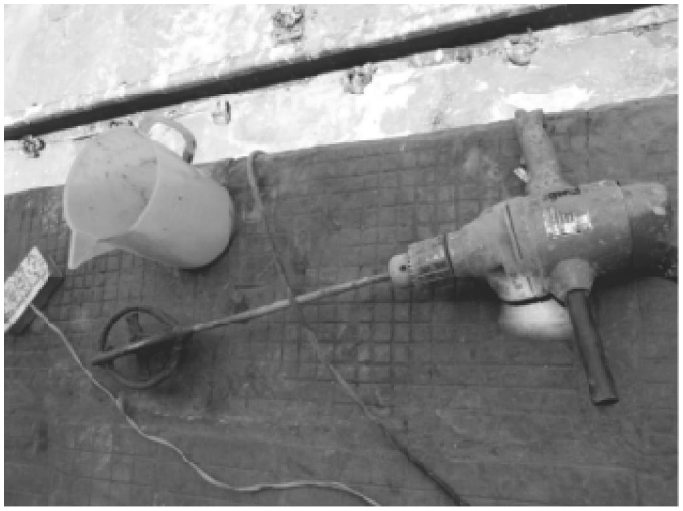
Lifting and levelling of track

V. **Drilling and Making Way for Grouting:** Drilling of Holes and making groves for grouting of free flow cement grout shall be done.



Drilling of Holes

VI. **Mixing, Grouting:** Each Bag of 25 Kg ready mix dry powder shall be mixed to designed water to powder ratio. And shall be mixed using rotary in a bucket. After mix, grout material shall be poured in to the cavities by free flow with precision from one end of sleeper to fill up under sleepers till grout started came out from another end. The pouring shall be repeated 3-4 times per sleepers till level of pour got settles. Finally top surface shall be cleared.

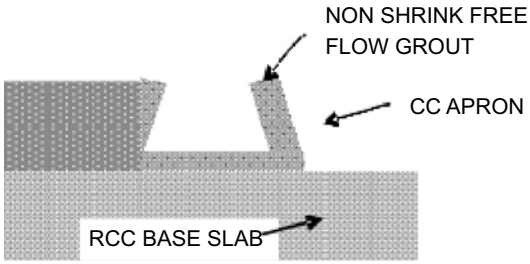


Rotory Mixer



Free Flow Grouting

Initial preparatory time for cleaning of track and lifting and levelling of track shall take about 6-8 Hrs. Average poring time per sleeper is about 20-30 min based on Last trail.



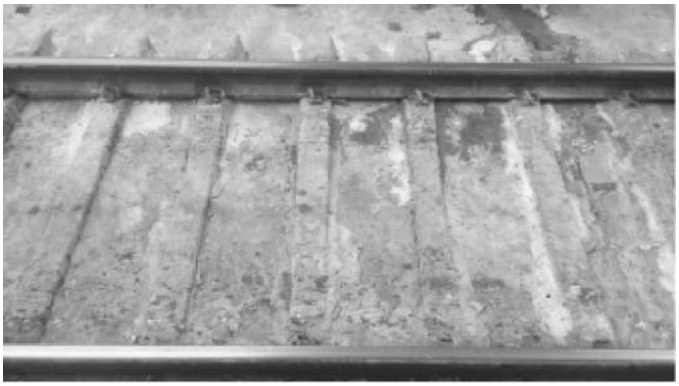
VII. Resources Planned: Based on space constraint, Four-six teams of agency for poring grout have been planned to work on 12 hrs shift for grouting. 60 Trackmen shall be deployed in 8 hrs shift for lifting and levelling of track to correct track parameters like unevenness, Twist etc.

VIII. Block Planning: Excluding 12 Hrs setting time and 6-8 Hrs preparatory time, with average 3-4 sleepers per hour per team i.e. about 16-20 sleepers per hour with all resources, 48-50 Hrs shall be required for Grouting and pouring.

Total about 68-70 continuous Block Hrs shall be required for one line. Hence, 3 days work in one spell shall be suitable. The work has been satisfactorily completed and shall be effective as planned.



IX. Work Planning: Based on no. Of sleepers to be repaired, estimate need to be prepared requirement of with average 2 bags (25 Kg dry Powder) per sleeper under mild repair and 4 bags (25 Kg Dry Powder) per sleeper under heavy repair.



5. Cost Effectiveness: Cost Effectiveness of the repair can be measured with respect to Cost of replacement of CC Apron. Approx. 1.75 Cr (Excluding P. Way) for 700m (about 1000 Sleepers) full length of CC Apron shall be required while repair cost is about 14.0 Lacs which is about 8% of the cost of assets. If life of CC Apron is extends by 4-5 Yrs with such repair, it will delay the 1.75 Cr. investment for the same period. It

means, at 6% general inflation, cost of replacement shall be about Rs. 2.34Cr after 5 years.

Therefore, saving of Rs. 48 Lacs [2.34-1.75-0.14=0.48] shall be there in each spell of 5 years. Accounting on rational basis there shall be direct saving to the tune of approx. Rs. 10 Lacs per year.

After Repair In Service of Line no.2 at BRCP

6.0 Conclusion :

Use of Non-Shrink Free-Flow Grout has been found to be very effective under continuous dynamic loads suiting to requirements in Indian Railways. It has been observed that even if CC Apron had gone to the worst stage and dilapidated condition, it can be repaired to give very high ultimate strength equivalent to PRC sleepers which provides very good bonding to CC around it. High strength of this Non Shrink grout enable effective load transfer and solves the problems faced by Engineers in IR and also serves the very purpose of provision of conventional CC Aprons for effective cleaning and watering which is essential part of train running in IR.

◆◆◆

Details of Latest Correction Slips

Sl. No	Codes/Manuals	Last Correction Slip No.
1	Indian Railways Permanent Way Manual(second Reprint-2004)	**137 of 18-06-2015**
2	Indian Railways Bridge Manual-1998	**31 of 09-02-2015**
3	Indian Railways Works Manual-2000	**10 of 17-2-2005**
4	Manual of Instructions on long Welded rails-2006(II reprint-2005)	**16 of 12-6-2014**
5	Manual for Flash Butt welding of Rails(reprint-2012)	**2 of 05-06-2014**
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)	**2 of 18-12-2014**
8	Manual for Glued insulated rail joints-1998	**5 of 28-08-2012**
9	Indian Railways Track Machine Manual (2000)	**17 of 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 of 19-06-2014**
13	Indian Railways code for the engg dept (third Reprint-1999)	**48 of 01-05-2014**
14	Guidelines for Earthwork in Railway projects-2003	**1 of 22-7-2004**

ITTI Calender of Courses 2015 (Rev.09)

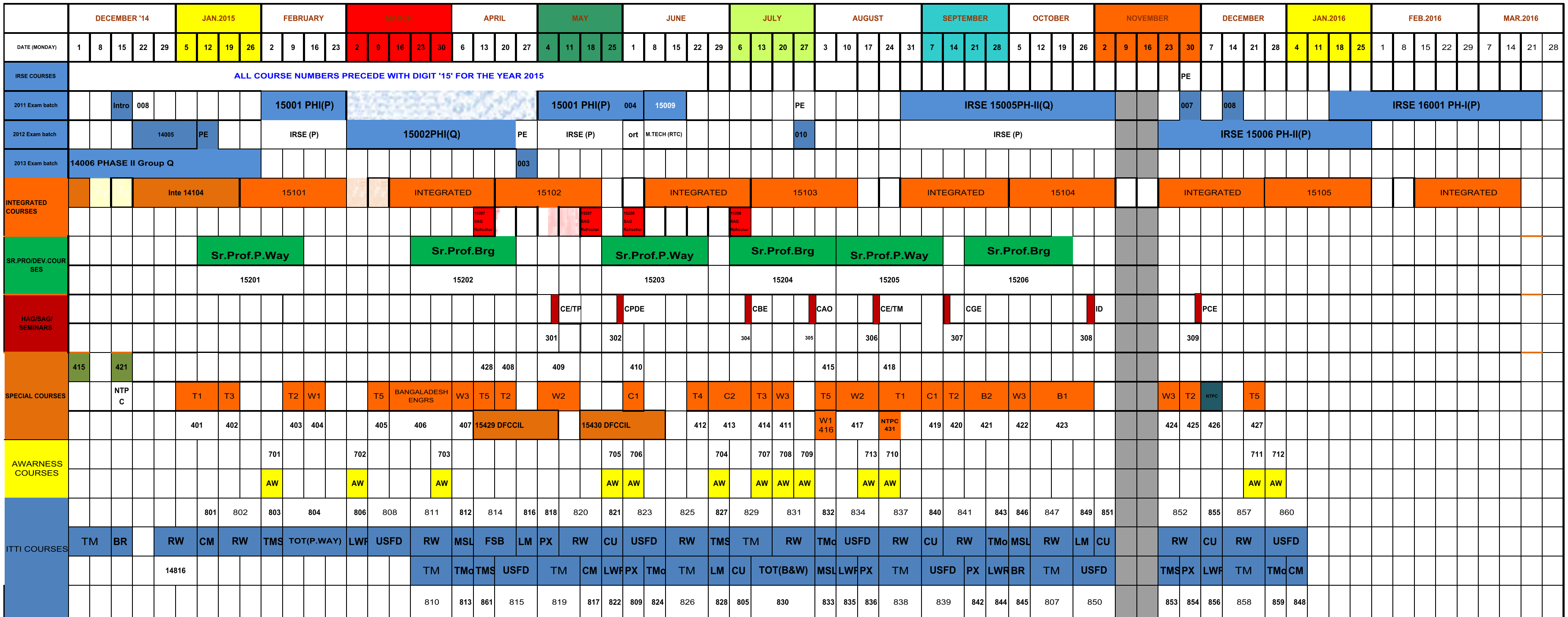
Course No.	From	To	Name of the course	Duration Week(s)	Eligible Group
15805	06-07-2015	10-07-2015	Curves	1	SSE's/P.Way
15807	12-10-2015	23-10-2015	Mechanized Track Maintenance and Renewals	2	SSE's/P.Way
15828	29-06-2015	03-07-2015	Land Management for SSE/Works	1	SSE's/P.Way
15829	06-07-2015	17-07-2015	Mechanized Track Maintenance and Renewals	2	SSE's/P.Way
15830	13-07-2015	31-07-2015	Training of Trainers (Works & Bridges)	3	SSE's/W&B
15831	20-07-2015	31-07-2015	Rail Wheel Interaction & derailments	2	SSE's & Instructor of ZRTI/ZRTS/P.Way
15832	03-08-2015	07-08-2015	Track Monitoring	1	SSE's/P.Way
15833	03-08-2015	07-08-2015	Management of Store & Land for SSE(P.Way)	1	SSE's/P.Way
15834	10-08-2015	21-08-2015	USFD,Welding & Rail Grinding	2	SSE's/P.Way
15835	10-08-2015	14-08-2015	LWR	1	SSE's/P.Way
15836	17-08-2015	21-08-2015	Points & Xings	1	SSE's/P.Way
15837	24-08-2015	04-09-2015	Rail Wheel Interaction & derailments	2	SSE's & Instructor of ZRTI/ZRTS/P.Way
15838	24-08-2015	04-09-2015	Mechanized Track Maintenance and Renewals	2	SSE's/P.Way
15839	07-09-2015	18-09-2015	USFD,Welding & Rail Grinding	2	SSE's/P.Way
15840	07-09-2015	11-09-2015	Curves	1	SSE's/P.Way
15841	14-09-2015	25-09-2015	Rail Wheel Interaction & derailments	2	SSE's & Instructor of ZRTI/ZRTS
15842	21-09-2015	25-09-2015	Points & Xings	1	SSE's/P.Way
15843	28-09-2015	01-10-2015	Track Monitoring	1	SSE's/P.Way
15844	28-09-2015	01-10-2015	LWR	1	SSE's/P.Way
15845	05-10-2015	09-10-2015	Inspection and Maintenance of Bridge	1	SSE's/Br
15846	05-10-2015	09-10-2015	Management of Store & Land for SSE(P.Way)	1	SSE's/P.Way
15847	12-10-2015	23-10-2015	Rail Wheel Interaction & derailments	2	SSE's & Instructor of ZRTI/ZRTS/P.Way
15848	04-01-2016	08-01-2016	Contract Management	1	SSE's
15849	26-10-2015	30-10-2015	Land Management for SSE/Works	1	SSE's/Works
15850	26-10-2015	06-11-2015	USFD,Welding & Rail Grinding	2	SSE's/P.Way
15851	02-11-2015	06-11-2015	Curves	1	SSE's/P.Way
15852	23-11-2015	04-12-2015	Rail Wheel Interaction & derailments	2	SSE's & Instructor of ZRTI/ZRTS/P.Way
15853	23-11-2015	27-11-2015	TMS	1	SSE's
15854	30-11-2015	04-12-2015	Points & Xings	1	SSE's/P.Way
15855	07-12-2015	11-12-2015	Curves	1	SSE's/P.Way
15856	07-12-2015	11-12-2015	LWR	1	SSE's/P.Way
15857	14-12-2015	23-12-2015	Rail Wheel Interaction & derailments	2	SSE's & Instructor of ZRTI/ZRTS/P.Way
15858	14-12-2015	23-12-2015	Mechanized Track Maintenance and Renewals	2	SSE's/P.Way
15859	28-12-2015	01-01-2016	Track Monitoring	1	SSE's/P.Way
15860	28-12-2015	08-01-2016	USFD,Welding & Rail Grinding	2	SSE's/P.Way

IRICEN Calendar of Courses 2015 (Rev. 09)

Course No.	From	To	Name of the Course	Duration	Eligible Group
Probationary Courses					
15005	31-08-2015	05-11-2015	IRSE Ph.II (Gr.Q)	10 weeks	IRSE (P) 2013 Exam.
15006	23-11-2015	28-01-2016	IRSE Ph.II (Gr.P)	10 weeks	IRSE (P) 2013Exam.
15007	30-11-2015	04-12-2015	IRSE Posting Exam & Orientation	1 week	IRSE (P) 2012 Exam.
15008	14-12-2015	18-12-2015	IRSE Introduction	1 week	IRSE (P) 2014 Exam
15010	27-07-2015	31-07-2015	IRSE Posting Exa	1 week	IRSE (P) 2012 Exam
Integrated Courses					
15102	20-04-2015	09-07-2015	Integrated	12 weeks	Gr.B officers
15103	13-07-2015	01-10-2015	Integrated	12 weeks	Gr.B officers
15104	05-10-2015	23-12-2015	Integrated	12 weeks	Gr.B officers
15105	28-12-2015	17-03-2016	Integrated	12 weeks	Gr.B officers
Sr. Professional Courses					
15204	06-07-2015	07-08-2015	Sr.Prof (Br &General)	5 weeks	JAG/SS having 6 yrs service in Group A
15205	10-08-2015	11-09-2015	Sr.Prof (P.Way)	5 weeks	JAG/SS having 6 yrs service in Group A
15206	21-09-2015	23-10-2015	Sr.Prof (Br &General	5 weeks	JAG/SS having 6 yrs service in Group A
15208	01-06-2015	10-07-2015	SAG Refresher	6 weeks	SAG all departments
PCE/HAG/SAG/Seminars/Workshops/Meetings					
15304	09-07-2015	10-07-2015	CBEs' Seminar	2 days	CBEs
15305	30-07-2015	31-07-2015	CAOs' Seminar	2 days	CAOs
15306	20-08-2015	21-08-2015	CE/TMs' Seminar	2 days	CE/TMs
15307	14-09-2015	15-09-2015	Training Manager/CGE Seminar	2 days	CGEs/Pr.CETCs
15308	31-10-2015	01-11-2015	IRICEN Day Seminar for IRSE '89' Exam	2 days	SAG (IRSE '89')
15309	03-12-2015	04-12-2015	PCEs' Seminar	2 days	PCEs
Special Courses (Track/Bridges/Works)					
15411	15-06-2015	19-06-2015	Arbitration for Arbitator (W-3)	1week	JS/SS/JAG
15413	29-06-2015	10-07-2015	Course for Construction Engineers (C-2)	2 weeks	JS/SS of Const. Org.
15414	13-07-2015	17-07-2015	Laying of Pts & Xing, Plg. of yards & design of track using MX rail(T-3)	1 week	JS/SS/JAG
15415	03-08-2015	07-08-2015	TMS (T-5)	1 week	JS/SS Of OL
15416	03-08-2015	07-08-2015	Land Management (W-1)	1 week	SS/JAG
15417	10-08-2015	21-08-2015	Contracts & Arbitration and project Management(W-2)	2 weeks	SS/JAG
15418	24-08-2015	04-09-2015	USFD testing, welding, rail grinding, Track monitoring & Track Machine (T-1)	2 weeks	JS/SS/JAG
15419	07-09-2015	11-09-2015	Modern Surveying(C-1)	1 week	JS/SS/JAG of Const. Org
15420	14-09-2015	19-09-2015	Rail Wheel Interaction & derailments (T-2)	6 days	JS/SS/JAG Of OL
15421	21-09-2015	01-10-2015	Steel structure &PSC (B-2)	2 weeks	JS/SS/JAG
15422	05-10-2015	09-10-2015	Arbitration for Arbitator (W-3)	1 week	JS/SS/JAG
15423	12-10-2015	30-10-2015	Courses for Br. Design Asstt.inclu. Earthquake complaint structure(B-1)	3 weeks	ABE;sDesign Asstts.
15424	23-11-2015	27-11-2015	Arbitration for Arbitator (W-3)	1 week	JS/SS/JAG
15425	30-11-2015	05-12-2015	Rail Wheel Interaction & derailments (T-2	6 days	JS/SS/JAG Of OL
15426	07-12-2015	11-12-2015	Special Course on Track & Bridge Maintenance for NTPC Engineers	1 week	NTPC Engineers
15427	21-12-2015	24-12-2015	TMS(T-5)	1 week	JS/SS of OL
15431	24-08-2015	28-08-2015	Project Management Conceptualization, Design & Construction of Rly. Siding	1 week	Executive's of NTPC
Awareness Courses					
15707	13-07-2015	17-07-2015	Awareness for IRTS (P) 2013	1 week	IRTS (P) 2013
15708	20-07-2015	24-07-2015	Awareness for IRSEE 2013 (P)	1 week	IRSEE (P) 2013
15709	27-07-2015	31-07-2015	Awareness for IRTS (P) 2013	1 week	IRTS (P) 2013
15710	24-08-2015	28-08-2015	Awareness for IRSEE 2013 (P)	1 week	IRSEE (P) 2013
15711	21-12-2015	23-12-2015	Awareness for IRSEE 2013	1 week	IRSSE (P) 2013
15712	28-12-2015	01-01-2016	Awareness for IRPS 2013 (P)	1 week	IRPS (P) 2013
15713	17-08-2015	21-08-2015	Awareness for IRSME (P) 2012	1 week	IRSME (P) 2012

INDIAN RAILWAYS INSTITUTE OF CIVIL ENGINEERING, PUNE-411001

CALENDAR OF COURSES 2015 CHART (Rev. 09)



MAIN COURSES	COURSE No.	WEEKS / DAYS	SEATS PLANNED	SEATS FOR CALL LETTER
IRSE COURSES	001	8	25	35
	002	8	25	35
	003	1	50	70
	004	1	50	70
	005	10	25	35
	006	10		
	007	1	6	
	008	1	50	70
INTEGRATED	101	12	25	
	102	12		
	103	12		45
	104	12		
	105	12		
SR.PROFESSIONAL COURSES	201	5	20	30
	202	5		
	203	5		
	204	5		
	205	5		
	206	5		
PCE/HAG/SAG/SEMINARS/WORKSHOP/MEETINGS	301	2	16/23	16/23
	302	2		
	303	2		
	304	2		
	305	2		
	306	2		
	307	2		
	308	2		
	309	2		
AWARENESS FOR PROBATIONERS	701	1	20	30
	702	1		
	703	1		
	704	1		
	705	1		
	706	1		
	707	1		
	708	1		
	709	1		
	710	1		
	712	1		
SPECIAL COURSES	401	2	20	30
	402	1		
	403	6d		
	404	1		
	405	1		
	406	3		
	407	1		
	408	6 d		
	409	2		
	410	1		
	411	1		
	412	1		
	413	2		
	414	1		
	415	1		
	416	1		
	417	2		
	418	2		
	419	1		
	420	6 d		
	421	2		
	422	1		
	423	3		
	424	1		
	425	6 d		
	426	1		
	427	1		

SPL COURSES for IRICEN

SPL COURSES	Course Name	No.	No.	No.	No.	TOTAL	WKs
T-1	USFD, Welding,RG,Track Moni & M/C	401	418			2	2
T-2	Rail Wheel Intraction & Derailment	403	408	420	425	4	6d
T-3	Points & crossing and Yards	402	414			2	1
T-4	Railway Formation & Geo Tech Inv	412				1	1
T-5	TMS	405	415	427	428	3	1
B-1	Bridge Design Assitant	423				1	3
B-2	PSC & Steel Structure	421				1	2
W-1	Land Mgt	404	416			2	1
W-2	Contract & Arb and Project Mgt	409	417			2	2
W-3	Arbitration for Arbitator	407	411	422	424	4	1
C-1	Morden Surveying	410	419			2	1
C-2	Construction Engineers	413				1	2
BAN ENGRS	Special course for Bangalades Engineers	406				1	3
NTPC	Special course for NTPC Engineers	426				1	1

AWARNESS COURSES

Awarness Courses	No.	No.	No.	No.	WKs
Accouts					1
Electrical engg.					1
mechanical Eng					1
Signal Engg.	701	702			1
storres					1
personel					1
traffic					1

SPL COURSES for ITTI

	C.No	ITTI COURSES	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	Total	Wks
1	TOT(P.WAY)	Trainers (P.Way)	804										1	3
2	TOT(B&W)	Trainer	830										1	3
3	RW	Rail Wheel Interaction & derailments	802	811	820	825	831	837	841	847	852	857	10	2
4	TMS	TMS	803	827	853	861							3	1
5	PX	Points & Xings	809	818	836	842	854						5	1
6	USFD	USFD, Welding & Rail Grinding	808	815	823	834	839	850	860				7	2
7	CU	Curves	805	821	840	851	855						5	1
8	LM	Land Management	816	828	849								3	1
9	MLS	Mangement of Store & Land	812	833	846								3	1
10	Tmo	Track Monitoring	813	824	832	843	859						5	1
11	BR	Inspection & Maintenance of Bridge	845										1	1
12	LWR	LWR	806	822	835	844	856						5	1
13	TM	Mechanized Track Maintenance & Renewals	807	810	819	826	829	838	858				7	2
14	CM	Contract Managemen	801	817	848								3	1
15	FSB	Fabrication of Steel Bridges & PSC constructi	814										1	2

Design at Kalyani Corporation, Pune - 30. Tel. 24486080